On behalf of:
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
of the Federal Republic of Germany

TÀI NGUYÊN MÔI TRƯỜNG

Published by:
ponre Viet Nam

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Strategic Mainstreaming of Ecosystem-based Adaptation in Vietnam: Vulnerability Assessment for Ecosystem-based Adaptation

Report 2

QUANG BINH PROVINCIAL LEVEL VULNERABILITY ASSESSMENT FOR ECOYSTEM-BASED ADAPTATION

icem A study by ICEM

IMPRINT

Published by
Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE)
479 Hoang Quoc Viet Street, Hanoi, Vietnam
E info@isponre.gov.vn
I http://isponre.gov.vn

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GIZ in Vietnam
Strategic Mainstreaming of Ecosystem-based Adaptation in Viet Nam (EbA)
49, Hai Ba Trung, Hanoi, Vietnam
E office.eba@giz.de
I www.giz.de/viet-nam

International Centre for Environmental Management (ICEM)
| Hanoi | Sydney | Kathmandu | Hong Kong | Vientiane | Phnom Penh
E info@icem.com.au
I icem.com.au

Responsible editors
Nguyen The Chinh (ISPONRE); Carew-Reid, Jeremy (ICEM); and Wahl, Michael (GIZ)

Lead authors
Mackenzie, Catherine and Mather, Robert (ICEM)

With contribution of
Benedikter, Simon; Dao Trong Hung; Ho Dac Thai Hoang; Litzenberg, Ivo; Mai Ky Vinh; Mai Van Trinh; Ngo Dang Tri; Ngo Nu Quynh Trang; Nguyen Hoang Duc; Nguyen Huu Hao; Nguyen Thi Ngoc Anh; Nguyen Si Ha; Pham Quynh Huong; Schaefer, Christine; Tran Thi Kim Lien; Tran Thi Thu Ha; and Wahl, Michael

Report format
Le Thi Thanh Thuy

On behalf of
The Vietnamese Ministry of Natural Resources and Environment (MONRE)
The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

Vietnam, December 2016

ACKNOWLEDGEMENTS

The project team would like to sincerely thank the following people for their valuable contribution of time, knowledge, information, data and advice in conducting the assessment and preparing this report:

Mr. Pham Van Luong - Vice Director of Quang Binh DONRE

Mr. Phan Dinh Hung - Vice Head of Sea and Island sub-department, Quang Binh DONRE

Mrs. Ho Thi Nhi Min - Head of Technical Division, Sea and Island sub-department, Quang Binh DONRE

Mr. Dinh Huy Tri - Vice Director of PNKB NP Management Board

Mr. Phan Xuan Hao - Head of Environment sub department, Quang Binh DONRE

Mr. Tran Dinh Du - Vice director of Quang Binh DARD

Mr. Tran Dinh Hiep - Head of technical division Quang Binh DARD

Mr. Pham Thanh Trung - Head and Planning and Finance division, Quang Binh DARD

Mr. Nguyen Hoai Nam - Vice director of Quang Binh DPI

Mrs. Ngo Nu Quynh Trang - Head of Economic and Foreign Relations division, Quang Binh DPI

Mr. Le Quoc Cuong - Vice director of Quang Binh Transportation Facilities Department

Mr. Le Tra Khoai - Vice director of Quang Binh Industry and Trade Department

Mr. Trinh Dinh Duong - Vice director of Quang Binh DOLISA

Mr. Hoang Van Tan - Vice head of Quang Binh EMC

Mr. Hoang Van Long - Head of Urban development and technical infrastructure division, Quang Binh Binh construction department

Mrs. Nguyen Thi Ngoc Anh - GIZ Quang Binh

ABREVIATIONS

ADB	Asian Development Bank
AFF	Agriculture, Forestry and Fisheries
CCA	Climate Change Adaptation
CCRAP	Climate Change Responding Action Plan
CSA	Climate Smart Agriculture
DARD	Department of Agriculture and Rural Development
DONRE	Department of Natural Resources and Environment
DOST	Department of Science and Technology management
DRR	Disaster Risk Reduction
EbA	Ecosystem-based Adaptation
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GIZ	Gesellschaft für Internationale Zusammenarbeit
GSO	General Statistics Office
HCM	Ho Chi Minh
ICEM	International Centre for Environmental Management
ISPONRE	Institute of Strategy and Policy on Natural Resources and Environment
JICA	Japan International Cooperation Agency
MARD	Ministry of Agriculture and Rural Development
MoLISA	Ministry of Labour, Invalids and Social Affairs
MPI	Ministry of Planning and Investment
NTP	National Target Programme
PGR	Population Growth Rates
PNKB NP	Phong Nha Ke Bang National Park
SEDP	Social and Economic Development Plan
SES	Socio-Ecological System
SFE	State Forest Enterprise
SUF Forest	Special Use Forest
TOR	Terms of Reference
UNDP	United Nations Development Program
VA	Vulnerability Assessment
VND	Vietnam Dong
WWF	World Wildlife Fund

TABLE OF CONTENTS

LIST OF TABLES

LIST OF MAPS

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES OF THE VULNERABILITY ASSESSMENT

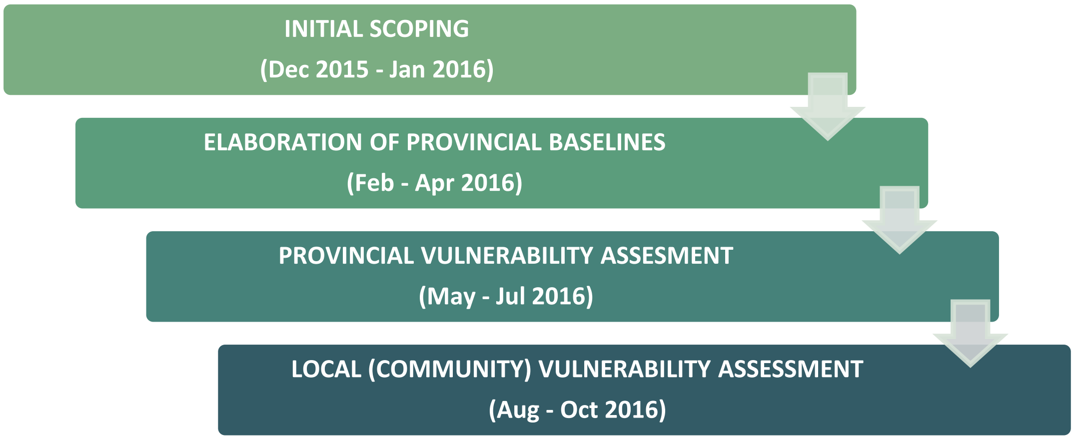
This report presents part of the results of a Vulnerability Assessment (VA) of Quang Binh Province conducted in order to identify Ecosystem-based Adaptation (EbA) interventions. This work was carried out by a team including two international consultants employed by ICEM (through a GIZ contract to ICEM); and 6 national consultants employed directly by GIZ. This report focuses on the implementation of the VA and the identification of EbA options at the provincial level. A companion report focuses on VA and EbA at the local (community) level at two selected sites in Quang Binh province. Similar provincial and local VAs were also conducted in Ha Tinh province by the same team. The two VAs of Quang Binh (together with the two VAs of Ha Tinh) together form one set of activities in the overall GIZ project "Mainstreaming EbA in Climate Change Adaptation in Vietnam"
The main objectives of the vulnerability assessment were to analyse all components of vulnerability (exposure, sensitivity, and adaptive capacity); to provide data and recommendations for decision-making on introducing the EbA concept into provincial policies and planning processes; and to provide recommendations for first practical EbA measures in selected ecosystems on the ground.

The first report produced by the project team described the overall approach to be taken in implementing these tasks. That report introduced the concepts and methods of Vulnerability Assessment for Ecosystem-based Adaptation (EbA) to climate change. It highlighted the idea on which EbA is predicated: the understanding that ecology, society and economy cannot be separated. Natural ecosystems are the foundation of human existence on this planet, and of all our economic activities. However, these ecological foundations have been profoundly modified and in many places weakened from their original state, by people pursuing their livelihoods (economic activities) in unsustainable ways. Now climate change is adding to the stresses that people have already induced in natural systems, with potentially grave consequences. (The reader is referred to that first report for more information).

The specific tasks associated with the VA objectives, as originally detailed in the TOR included the following:

- Perform a multi-scalar, interdisciplinary and holistic vulnerability assessment to climate change for the provinces of Ha Tinh and Quang Binh referring equally to biophysical and socio-economic risks. Assess the physical exposure, the sensitivity and the adaptive capacity of eco-systems, economic sectors and societal groups dependent on the corresponding ecosystem services (social-ecological systems).
- Provide practical knowledge products (reports, maps, facts sheets) on eco-systems, climate change effects, socio-economic hazards and risks and adaptation options to inform stakeholder workshops, planning activities and capacity building measures.
- Under consideration of the results of preceding provincial planning process review and the result of the vulnerability assessment, recommendations shall be provided for locally appropriate and feasible EbA options. This shall include recommendations how to strategically integrate these EbA options into provincial land-use planning, socio-economic development planning and other relevant sector-specific planning.
- Provide recommendations for the EbA project's future interventions within its lifetime 2014 - 2018 to achieve its set objectives

The implementation of the work to address the tasks and objectives of the vulnerability assessment was conducted in a number of phases:



Each of these is discussed in more detail below. The results of each part of the work are presented in the different chapters of this report, as explained below.

1.2 INITIAL SCOPING PHASE

The purpose of scoping is to define the physical extent, subject(s) and/or sector(s) under consideration; to identify the key stakeholders to be consulted and the participants in the assessment process - i.e. the what, where and who, of the process. The scope defines what issues are considered, what must be ignored - and what decisions are targeted to be influenced by the eventual recommendations of the VA report. Ideally, recommendations emerging from any VA will be implemented, although many factors will determine whether or not this is in fact ultimately the case. Anyway, the VA should be implemented as a process for identifying (and hopefully enacting) required change, rather than simply as a fact finding or scientific investigation mission. The identification of who the VA is for, what decisions it aims to influence, whose and what vulnerabilities are to be assessed, and who should be involved in the assessment process, done early in the VA process help ensure its clarity and effectiveness. Keeping a record of what physical areas, key issues or stakeholder groups cannot be included, is also important in evaluating potential biases in conclusions or challenges in implementing adaptation actions at the end of the process.

The steps involved in scoping included:

- Preliminary meeting with ISPONRE and national consultant team members in Hanoi (December 09)
- Training of national consultant team members in the VA approach at ICEM office in Hanoi (December 10-11)
- Field visits to Quang Binh and Ha Tinh (December 12 – 23)
- Review of information, consolidation of field notes, and preparation of next steps (December 24-28)
- Inception Workshop with ISPONRE and GIZ (29 December)

Guidance from Client and Partners for framing and scoping of the assessment

The scoping started with the detailed ToR for the VA that was provided to the consultants by GIZ. Further clarification of expectations of the scope and outputs were also provided in discussions with GIZ project staff and ISPONRE officials. Based on the discussions at the first meeting at ISPONRE offices on Wednesday 9th December, and further discussions during 10-11th December at the ICEM meeting room, as well as a debriefing meeting with DONRE Quang Binh on 18th December, after the first field visit, the following key considerations for the scope, direction and priorities of the Vulnerability Assessment study was determined:

- The VA should promote a clear and simple understanding of EbA amongst all involved stakeholders. EbA uses the benefits of ecosystems and the services they provide to help address problems caused by, or exacerbated by, climate change. To identify something as an EbA measure therefore requires that we can show that (a) it is based on use of an ecosystem service, and (b) it is addressing a problem caused by, or made worse by, climate change.
- This EbA project has been directed by the German government to focus more on inland ecosystems and not so much on coastal ecosystems, as there are already e.g. many GIZ projects working on mangroves in the Mekong Delta in Vietnam. However, the VA team feels that to conduct an effective Province-wide Vulnerability Assessment at the provincial level, it is important to consider the full range of important socio-ecological systems that contribute significantly to local livelihoods and the provincial economy.

The VA will recommend a broad portfolio of potential EbA interventions in both inland and coastal areas - the EbA project may then choose to focus only on inland systems for the selection of pilot activities to support, but it will be important that both provinces also seek additional funding to implement other recommendations.

- The vulnerability assessment does not have to be "rocket-science" and does not have to be exhaustive. It does not have to focus on policy-analysis for EbA, as GIZ is already conducting other studies on that aspect. The VA does have to come up with something that can be usefully applied and used to support investment decisions.
- The VA should propose (and prioritise) reasonable EbA related, and <u>other adaptation measures</u>. These recommendations should be supported by explanations of why these measures are necessary and important, giving some indication of their initial feasibility, what benefits they will provide, and an indication of appropriate phasing/timing for their implementation.
- The adaptation measures proposed should include some which address shocks, and some which address stresses, caused by, or exacerbated by climate change. They should relate to not only disasters caused be extreme climate events, but also to the cumulative stresses on systems derived from accumulation of continuing directional change (in temperature, rainfall patterns, sea level rise, etc) that will modify or in some cases transform these systems.
- Based on the understanding that vulnerability is derived from the interplay between exposure, sensitivity and adaptive capacity - then EbA interventions may fall into one of three broad classes - (i) interventions to strengthen adaptive capacity; (ii) interventions to reduce or manage sensitivity; and (iii) interventions to limit or manage current and future exposure.
- The VA should be careful not to label things as EbA if they do not clearly meet the definition. This will create (or add to existing) confusion about EbA approaches. Nevertheless, the project should be practical and pragmatic - it doesn't always have to be about something that is 100% pure EbA and nothing else.
- Some recommendations will relate to "Climate Smart Agriculture" (CSA) focusing on aspects of crop production, livestock-raising, plantation forestry, and aquaculture. These may include a mixture of EbA and non-EbA elements, but are best considered as an overall package of interventions for the sector.
- Some recommendations will relate to "Climate-proofing" infrastructure investments. Bioengineering interventions may be considered as part of this – and in some cases as "stepping stones" necessary as part of the process to help bring back nature so that additional future ecosystem service benefits can be obtained.
- The main objective of the overall project is EbA mainstreaming and GIZ is mainly a capacity-building organisation. Support for implementation of real EbA activities on the ground in this project will therefore be limited - essentially some small pilot activities to demonstrate approaches, that can then be used as the basis for mainstreaming, and to attract bigger funds for scaling-up - the EbA project team, and GIZ more generally will assist in helping the provinces to access further funding for larger-scale implementation of EbA activities in the future. In this context, the project team has to strike a delicate balance between engaging intensively enough with people on the ground to obtain necessary and relevant information, while at the same time not raising unrealistic expectations amongst the local people.

Beyond the above, the scoping part of the VA was intended to allow the VA team to get a clearer understanding of the geographical, biophysical, socio-economic, political and overall development context of Quang Binh and Ha Tinh Provinces through review of available literature, and meetings with a wide range of local authorities in each province, as well as some very preliminary site visits. The team conducted scoping visits in Quang Binh from 14 to 19 December 2015.

Five days were spent in the province, three days meeting with key government agencies[1] and two days making field visits to important ecosystems. In Quang Binh, visits were made to Phong Nha -Ke Bang National Park, revetments and boat shelter on the Roon River and nearby coastal casuarina plantations. The full list of people met is provided in Annex I. Annex II provides an illustrative list of the types of semi-structured questions that were asked in all of these meetings.

[1] DONRE, DARD, DPI, DOLISA, SCEMA, DOC, DOIT, DOT.

In particular, in the scoping part of the VA process, the team focused on ***Identifying the major ecosystems in the area of the vulnerability assessment (including their associated ecosystem services important to society, and the way they are managed)***

Overview information was gathered about the main forest, river and coastal ecosystems, and the different types of management regimes being applied. This provides a basis for deciding on which aspects to include in the more detailed baseline assessment and impacts assessment steps of the VA. The next steps of the Macro level assessment will further consider large-scale ecosystem assets, while the subsequent Micro level assessment may consider ecosystem assets as a much finer scale.

Identifying the major societal assets - both tangible and intangible - important to the area of the vulnerability assessment

Overview information was gathered on the population of each province including information on ethnicity, poverty, and migration. Information was collected on the provincial economy and the main sectors contributing to it (including industry, trade, construction, tourism, agriculture, forestry, aquaculture, and fisheries) as well as on the overall development trajectory, and major plans. This provides the basis for deciding on which aspects to include in the more detailed baseline assessment and impacts assessment steps of the VA.

The provincial level assessment considers economic assets in terms of major sectors (and sub-sectors) contributing to the economy while the local-level assessment looks more at household and community-level livelihoods.

Identifying the major socio-ecological systems

Based on the scoping of ecosystems and of societal assets, a preliminary identification of socio-ecological systems can be made. In the more detailed baseline assessment these socio-ecological systems are mapped across the entire province. The definition of these socio-ecological system categories is quite broad at the provincial level and could be further refined for the specific locations in the local-level assessments.

The initial information collected in the scoping phase is not presented on its own in this report, rather it was combined with the additional information collected in the baseline phase, and is therefore presented in the sections of the report that relate to the baseline situation (Chapters 2-6).

1.3 ELABORATION OF PROVINCIAL BASELINE PHASE

The baseline phase continued building on the information collected in the scoping phase, adding more detailed information for each sector and issue. The baseline assessment includes the development of a social profile; an ecological profile; an economic profile; and a climate profile for the province (Chapters 2, 3, 4, and 5 of this report). Based on these, a complete list of SESs is identified and an SES profile is also developed (Chapter 6 of this report)

Chapter 2 - Social Profile

The impacts of climate change are felt by people – on their health, their housing, the other people, infrastructure and services they rely on, the natural resources they depend on, and on the other ways they earn their livelihoods. The social brief for Quang Binh (Chapter 2) therefore focuses the analysis on people, asking which groups are most vulnerable and why. Chapter 2 essentially examines the social context for EbA in Quang Binh - highlighting the information at the provincial level that provincial departments should keep in mind in analysing and planning for CCA or EbA. It also examines the key social parameters used in this study to develop and describe the SES.

Chapter 3 - Ecological Profile

Chapter 3, Ecological Profile, focuses on the ecosystems of Quang Binh, detailing which types of ecosystem are present, how much there is of of them and what condition are they in. It also identifies those which may be critical for supporting livelihoods and the economy in the face of climate change, and identifies to some extent how the ecosystems themselves are vulnerable to climate change. Although change is inherent in all global systems, eco-systems have limits to the extent of the changes they can tolerate, without losing their essential structure and functions, on which we all depend. EbA identifies ecosystem degradation as a key underlying cause of vulnerability. This chapter examines the ecological dimensions of EbA in Quang Binh, including the contextual information at the Provincial level that any provincial department should keep in mind in analysing and planning for CCA or EbA.

Chapter 4 - Economic Profile

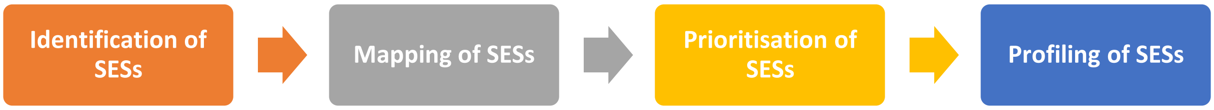
Chapter 4 - the Economic Profile of Quang Binh identifies the main sectors of the provincial economy considering a variety of aspects including contribution to GDP, employment generated, and future development direction, etc...as well as dependence on natural resources, linked to climate change. Like the social and ecological profiles, the economic profile is also based on existing data made available to the study by the different departments of the provincial government, and should be updated when more recent or more complete data become available.

Chapter 5 - SES profile

To understand the issues and threats posed by climate change and devise practical and sustainable solutions, ecological, social and economic factors need to be considered together, as parts of an integrated whole. Thus, as set out in that first report on overall approach, for this EbA vulnerability assessment, the most important unit of analysis is the "socio-ecological system" (SES). SES are defined as:

"complex bio-geo-physical units together with social and institutional actors and their (economic) activities".

The SES Profile of Quang Binh takes the information from the preceding profiles, in order to develop and present a classification of the main SES for Quang Binh. This Chapter presents the methods and outcomes of the work on Socio-Ecological System (SES) carried out involving four main steps:



Chapter 6 - Climate profile

This chapter provides information on the current climate of Quang Binh, and the history of climate-related hazards and disasters that the province has already faced for many years. It identifies the districts and communes of the province most affected by each type of disaster, and provides details of the type and amount of damages caused. Finally, it recommends priority geographic and thematic areas for Ecosystem based intervention in Disaster Risk Reduction (Eb-DRR) and climate-change adaptation (EbA) based on the analysis provided.

1.4 PROVINCIAL VULNERABILITY ASSESSMENT PHASE

Chapter 7 - Climate Change Impacts

While Chapter 5 provided an overview of the climate of Quang Binh and the history of climate-related disasters in the province, Chapter 7 now looks at likely future climate changes and their potential impact on Quang Binh at the province-wide level. It starts off by firstly explaining the rationale for focusing on a certain set of parameters as measures of climate change, when looking at it from a vulnerability assessment and ecosystem-based adaptation perspective, and then presents possible scenarios for Quang Binh. The bulk of the chapter discusses the likely impacts and implications of those changes, with a main focus on the natural resource related sector of agriculture, forestry, fisheries and aquaculture, as well as on the natural ecosystems that are the source of important ecosystem services. More superficial treatment is generally given to climate change impacts on urban and rural settlements and infrastructure.

Chapter 8 - Adaptive Capacity

Climate change adaptation is essentially a human-managed process, embedded in an ecological context and an economic structure. It is about people understanding climate change and what it means for their lives, and making the appropriate, often innovative changes needed to secure a sustainable future for their families and communities. It is about governments supporting these processes and tackling the underlying causes of vulnerability. Climate change and our adaptation to it are thus quintessentially social issues: people are at once the major cause of climate change, and its victims; and they will in turn be the main agents of adaptation and mitigation.

1.5 FINALISING CONCLUSIONS AND RECOMMENDATIONS

Chapter 9: Overall Vulnerability and EbA recommendations

The final chapter presents overall vulnerability at the provincial level, including worked examples of vulnerabilities of some specific SESs. It then goes on to present recommendations for targeted EbA interventions - some broadly applicable across the province or across different sectors; and some more specific to each SES.

ANNEX 1.I: PEOPLE MET IN QUANG BINH PROVINCE

December, 2015

Date and Location of Meeting	Name	Agency/ Affiliation
December 14, 2015 Phong Nha - Ke Bang National Park	Dinh Huy Tri	Deputy Director of PN-KB NP
	Le Thuc Dinh	Director of Rescue Centre
	Tran Xuan Mui	Department of Science & International cooperation
	Tran Huu Hao	DARD Quang Binh
December 15, 2015 (Morning) Quang Binh PPC meeting at DONRE office	Pham Van Luong	PGD DONRE Quang Binh
	Tran Mui	DOT Quang Binh
	Truong Thi Thanh Hoa	DOLISA Quang Binh
	Le Tra Khoai	Deputy Director of DOIC Quang Binh
	Hoang Van Tan	Deputy Director EMC Quang Binh
	Dinh Huy Tri	Deputy Director VQG PN-KB
	Mr. Long	DOC Quang Binh
	Mr. Hoa	DOC Quang Binh
	Mr. Tuan	Water - DONRE - Quang Binh
	Phan Dinh Hung	Sea and islands sub department - DONRE Quang Binh
	Phan Xuan Hao	Environment - DONRE - Quang Binh
	Ngo Thi Quynh Trang	DPI Quang Binh
	La Thanh Huyen	DPI Quang Binh
December 15, 2015 (Afternoon) Quang Binh DPI	Nguyen Hoai Nam	Deputy Director of DPI Quang Binh
	Ngo Thi Quynh Trang	Head of External Economic Department
	La Thanh Huyen	Deputy Head of Economy Department
	Tran Anh Son	Planning Department
December 15, 2015 (Afternoon) Quang Binh DONRE	Pham Van Luong	Deputy Director of DONRE Quang Binh
	Phan Xuan Hao	Environment Department, DONRE
	Dang Thu Thuy	Biodiversity, DONRE
	Truong Thi Mai Thuyen	Environment Department, DONRE
	Ho Thi Nhi Min	Sea and Islands sub Department, DONRE
December 16, 2015 (Morning) Quang Binh DARD	Tran Dinh Du	Deputy Director of DARD Quang Binh
	Tran Dinh Hiep	Technical Department of DARD Quang Binh
December 16, 2015 (Afternoon) Quang Binh DOT	Le Quoc Cuong	Deputy Director of DOT Quang Binh
	Tran Mui	DOT Quang Binh
	Pham Huu Chung	DOT Quang Binh
	Pham Duy Hung	DOT Quang Binh
December 16, 2015 (Afternoon) Quang Binh DOC	Nguyen Tuan Long	DOC Quang Binh
December 17, 2015 Quang Binh DOIC	Le Tra Khoai	Deputy Director of DOIC Quang Binh
	Nguyen Dinh Chien	Environment Safety Technology Department
	Tran Duc Phu	Technical Department
	Nguyen Ngoc Hai	Commercial Management Department
	Vu Tuan Trung	Industrial Management Department
December 17, 2015 (10:00AM) Quang Binh DOLISA	Tran Dinh Duong	Deputy Head of DOLISA Quang Binh
	Truong Thi Thanh Hoa	DOLISA Quang Binh
	Nguyen Hoai Phuong	DOLISA Quang Binh
December 17, 2015 (Afternoon) Quang Binh EMC	Hoang Van Tan	Vice head of Quang Binh Mountainous and Ethnicity Committee
	Tran Huu Linh	Head of Policy Department
	Nguyen Minh Phuong	Head of Propaganda Department
December 18, 2015 (5:30 PM)	Pham Thanh Trung	Quang Binh DARD

ANNEX 1.II: SEMI-STRUCTURED QUESTIONAIRE FOR SCOPING

This document provides a set of guiding questions that were referred to during initial discussions with provincial departments to help start discussions on a number of relevant issues during the scoping phase. The questions cover areas related to ecological, social and infrastructural assets of the province; the main economic sectors of importance to the province; climate hazards and climate change; awareness and understanding of climate change and adaptation (particularly EbA approaches) as well as provincial planning and implementation of plans. The list of questions is not intended to be exhaustive, nor prescriptive, simply to help provide entry point questions to start the conversation.

1. INTRODUCE THE PROJECT, THE TEAM AND WHAT WE ARE DOING

Following process introduced in presentation:

2. ASK ABOUT ECOLOGICAL ASSETS

- What are the main natural or ecological assets of the province – forests? Rivers and wetlands? Coastal ecosystems, etc?
- How important are these ecosystems to economy?
- What are the main benefits and values that they provide?
- What kinds of ecosystem services do they provide that support local livelihoods and the provincial economy?
- What are some of the main threats to these natural ecosystems, or the main challenges in their management?
- What are the trends in status of natural habitats?

3. ASK ABOUT KEY ASSETS BY ECONOMIC SECTORS

3.1. Agriculture, Forestry and Fisheries

- What are the main production systems and which social group is doing each type and where - let's MAP? Socio-agro-ecosystems
- What are the trends in these sectors?
- Challenges
- Investments

3.2. Other Sectors

- What are the other main economic sectors of the province?

For each named sector:

- Describe main features of the sector.
- What are the main challenges or issues?
- What are the main development investments planned by province?

4. ASK ABOUT POVERTY

- Describe poverty in your province.
- Which districts or communes have higher rates of poverty than others? Why?
- What are the trends

5. ASK ABOUT CLIMATE

- What are some of the previous extreme weather/climate events that you can remember, what damage did they cause and what was done to address that?
- What are the trends?
- What aspects of future climate-related risks are you most concerned about? (Rainfall, temperature, floods, drought, storms, sea-level rise, etc?
- What impacts do you think will these changes have - on forests, on rivers and wetlands, on mangroves and other coastal areas, on farming livelihoods, on fishing livelihoods, on urban areas, on tourism, on other sectors?

6. ASK ABOUT EXISTING PLANS

- What Climate related Plans and Strategies have already been developed in your province to address some of these challenges? (Provincial Socio-economic Development Plans, Climate Change Adaptation Plans, Disaster Risk Reduction Plans, Biodiversity Strategy and Action Plans, etc?
- How were these plans developed?
- Which plans are being implemented?
- What is being done, where (participating communes) and by whom (responsible implementing agency)?
- And how are they being funded?
- Have these activities been implemented effectively?
- Do you consider them successful?
- How would you change/improve them?
- Considering all the plans that have already been developed, what are the main gaps remaining that you can see?

7. ASK ABOUT AWARENESS

GOVERMENT

- What do you all think about Ecosystem-based Adaptation, Ecosystem-based DRR, or Nature-based solutions?
- Are there any good examples from your own province or from other areas?
- What training/information have provincial policy-makers and decision-makers like yourselves had on EbA approaches?
- What further information/training do you need?
- What needs to be done to increase the use of EbA approaches? (who needs to be convinced they are good approaches? What barriers need to be addressed, etc.?)

COMMUNITIES/PUBLIC

- Level of climate change awareness amongst communities/general public?
- Dissemination/availability of climate/weather information to general public?

8. CLOSING

- What else would you like to see happen?
- What else would you like to tell us?

ANNEX 1.III: GUIDANCE FOR REPORTING

1. GENERAL REQUIREMENTS FOR REPORTING

Minimum requirements related to the content of the reports of results are as follows:

- Cover Page
- Executive summary (background, objectives, scope, methodology, results, conclusions and recommendations) 4-5 pages
- Table of Contents (list of abbreviations, list of figures, maps, charts, etc.)
- Introduction (background, objectives, scope, methodology, structure) up to 5 pages
- Content organized by chapters up to 40 pages (15.000 words) including results (detailed assessment and interpretation of results) / this includes an adequate number of charts, graphs and maps to support the analysis and presentation of findings/results
- Conclusions and recommendations up to 5 pages
- Bibliography
- List and summary of interviews
- Directory of collected secondary data
- Directory of interviewees
- Documentation of (participatory) methods (e.g. photographs of PAR activities/outputs, standardized questionnaire, etc.)
- Directory of all consultants involved (national and international) including name, professional background, organizational affiliation and contact detail of each consultant
- Appendix

2. GUIDANCE FOR THE PROVINCIAL/TOP-DOWN ASSESSMENT REPORT

The report will identify and spatially determine the whole spectrum of existing ecosystems in the pilot provinces. This shall include an assessment of the current state of integrity, healthiness and adaptive capacity of these ecosystems. In parallel to this, a regional climate projection drawing on scenario-driven assessments based on predicted climate variations, weather extremes and their impacts on the local population, production systems and the ecosystems and their services (social-ecological systems) shall be conducted. The fact that the adaptive capacity of ecosystems, ultimately, is also subject to climate change impacts need to be duly considered in the whole assessment, particularly when it comes to the assessment of adaptive capacity of ecosystems under consideration. The macro-scale study shall cover the period from 1985 to 2050 and encompass an analysis of the predicted development trends of temperature, precipitation, floods, droughts, salinity, sea level rising, forest fires, pests, landsides, sedimentation, erosion and other relevant parameters. Moreover, non-climate change related factors driving environmental change need to be determined. This particularly refers to factors such as infrastructure development, land-used change, urbanization, demographic change, all of which are to be assessed regarding their potential impacts, both negative and positive, on ecosystems and ecosystem services. Moreover, the top-down approach looks at the vulnerability of predominant economic sectors, the political economy and livelihood strategies of different social groups. Exposure, sensitivity and adaptive capacity of the most predominant social- ecological systems shall be visualized on the basis of impact-chain maps/scenarios that illustrate potential risks and hazards arising from the nexus of climate and non- climate change environmental alterations. Impact-chain maps, spatial vulnerability maps will be used to visualize results and facilitate exchange in the context of stakeholder consultation workshops and other project activities. Based on the results of the macro-scale/top-down assessment, recommendations shall be deduced for integrating EbA into land-use, socio-economic development and other relevant planning processes at provincial scale such as water resources, forestry, agriculture, aquaculture, irrigation and biodiversity. Furthermore, they will be used as input for a scenario workshop that aims at bringing together relevant stakeholders to reflect on climate change impact-chains, discuss adaptation needs and jointly explore feasible (ecosystem-based) adaption options to be integrated in local development planning. Referring to the results of the review of EbA relevant review processes, the report shall include specific recommendations of EbA integration into the 2016 - 2020 provincial land-use and socio- economic development plans of Ha Tinh and Quang Binh, inputs for the 2021 - 2030 land-use master plans, and recommendations other EbA relevant planning processes (water resources, agriculture, biodiversity, forest, etc.).

CHAPTER 2 SOCIAL PROFILE OF QUANG BINH

2.1 INTRODUCTION

The concepts and methods of Vulnerability Assessment for Ecosystem-based Adaptation (EbA) to climate change were introduced and discussed in Chapter 1. It highlighted the idea on which EbA is predicated: the understanding that ecology, society and economy cannot be separated. Natural ecosystems are the foundation of human existence on this planet, and of all our economic activities. However, these ecological foundations have been profoundly modified and in many places weakened from their original state, by people pursuing their livelihoods (economic activities) in unsustainable ways. Although change is inherent in all global systems, eco-systems have limits to the extent of the changes they can tolerate, without losing their essential structure and functions, on which we all depend. Now climate change is adding to the stresses that people have already induced in natural systems, with potentially grave consequences. EbA identifies ecosystem degradation as a key underlying cause of vulnerability. Urgent action is needed to restore these natural systems to health, to help us sustain our socio-economic systems, indeed our very survival, to the coming challenges. We also need to harness the services of healthy ecosystems to help us adapt to the changes ahead.

To understand the issues and threats posed by climate change and devise practical and sustainable solutions, ecological, social and economic factors need to be considered together, as parts of an integrated whole. Thus, as set out in Chapter 1, for this EbA vulnerability assessment, the unit of analysis is the "socio-ecological system" (SES), defined as:

"complex bio-geo-physical units together with social and institutional actors and their (economic) activities"

The impacts of climate change are felt by people - on their health, their housing, the other people, infrastructure and services they rely on, the natural resources they depend on, the other ways they earn their livelihoods. The severity of impacts and peoples' ability to cope are also felt because of the state of such things. Climate change adaptation too, is entirely a human process, embedded in an ecological context and an economic structure. It is about people understanding climate change and what it means for their lives, and making the appropriate, often innovative changes (to their vision of the future and their activities) needed to secure a sustainable future for their families and communities. It is about governments supporting these processes and tackling the underlying causes of vulnerability. Climate change and our adaptation to it are thus quintessentially social issues: people are at once the major cause of climate change, its victims, and they will be the main agents of adaptation and mitigation.

This social brief (Chapter 2) for Quang Binh focuses the analysis on people, asking which groups are most vulnerable and why. In this way, vulnerability can be understood as:

"the state of individuals, groups or communities in terms of their ability to cope with and adapt to any external stress placed on their livelihoods and well-being. It is determined by i) the availability of resources and; crucially, ii) by the entitlement of individuals and groups to call on these resources." (Adger and Kelly 1999)

The underlying causes of vulnerability are important and distinct from the existing dimensions of vulnerability: poor housing, undifferentiated livelihoods based on climate sensitive natural resources, poor health, education, etc. It is important to understand these and processes that drive change. As Adger and Kelly (1999) indicate, the basic causes are access to livelihood resources in the widest sense, and this access is geographically, ecologically and politically determined. Table 2.1 below provides examples of local and higher level processes that affect vulnerability. Clearly all approaches to climate change adaptation, be they conventional or ecosystem-based, need to consider and address these underlying issues to ensure effective, just and sustainable outcomes.

Table 2.1: Examples of process that affect vulnerability

Local-scale processes	Processes at higher scales
Increasing labour migration	Population growth
Declining labour availability	Increasing/decreasing provision of services by the state
Loss of customary rights and change to "modern tenure systems	Increasing penetration of global markets/ reorientation of most production away from local circulation and reciprocity
Increasing need for cash to operate economically	Changing legislation and tenure systems
Increasing cost of inputs	Declining biodiversity and forests/expansion of agriculture
Privatization of land and resources / Loss of access to communal resources	Declining indigenous knowledge
Monetization of resources and services, with increasing costs of health and education.	Urbanisation
Increasing skill requirements for non-agricultural employment	Deagrarianisation

Source: Adger et al 2004

This Chapter examines the social context for EbA in Quang Binh - highlighting the information at the macro or Provincial level that provincial departments should keep in mind in analysing and planning for CCA or EbA. It also examines the key social parameters used in this study to develop and describe the SES. Chapter 3 then presents the ecological factors; and Chapter 4 the economic factors and then later in the report these three elements are brought together and used to present a classification of the main SES for Quang Binh. Like the ecological and economic profiles, this social profile is based on existing data made available to the study by the different departments of the provincial government, and should be updated when more recent or more complete data become available.

2.2 KEY SOCIAL FACTORS FOR THE MACRO-SCALE ASSESSMENT IN HA TINH

2.2.1. Overview

This section presents information to answer key practical questions on social issues for climate change vulnerability assessment and adaptation planning at the provincial level. It does not attempt to provide a full social profile of Quang Binh. The provincial-level study is intended to use secondary data only. While many interesting and relevant questions could be posed at provincial level, there is only a limited number of social factors for which sufficiently comprehensive data already exists. Other factors will be examined in the local level assessment of actual vulnerability and adaptive capacity, supported by primary data collection where necessary, as shown in Table 2.2. What this provincial profile does attempt to be is "spatial explicit" - that is, to map the selected parameters - to contribute to the mapping of socio-ecological systems, and to help inform the selection of sites for the local level analysis.

Table 2.2: Social analysis at the macro- and micro-levels of assessment

Macro-level assessment	Micro-level (community) assessment
Based on secondary information available at provincial level	Based on secondary available locally, primary data collection and local stakeholder participation
Focus on broad context and understanding; prioritization	Focus on planning and action
Population, population density, population growth rate, migration,	Population, population growth rate, migration, age-class distribution.
Vulnerable groups: The poor Ethnic minorities Vulnerable livelihoods	Vulnerable groups: Poor, women, elderly, infirm Main livelihood groups, employment Relative well-being within community Underlying causes of poverty and vulnerability: health, education, access to resources, services, governance, decision making;
Adaptive Capacity: provincial government History of responding to extreme events	Adaptive Capacity: commune government, households, individuals. History of responding to extreme events Education, health, skills development; Decision making; innovation

A few simple questions guide the analysis presented below:

- Now, and in the future, how many people in Quang Binh will be affected by climate change?
  - Where do they live?
  - What are the trends in population? What factors contribute to this?
- Which social groups will be most vulnerable to climate change? Where do they live?
- Which livelihoods are most vulnerable? Where are they found?
- Conclusion: (based on contributions from ecological and social analysis) What should be focus on for the micro-level assessment.

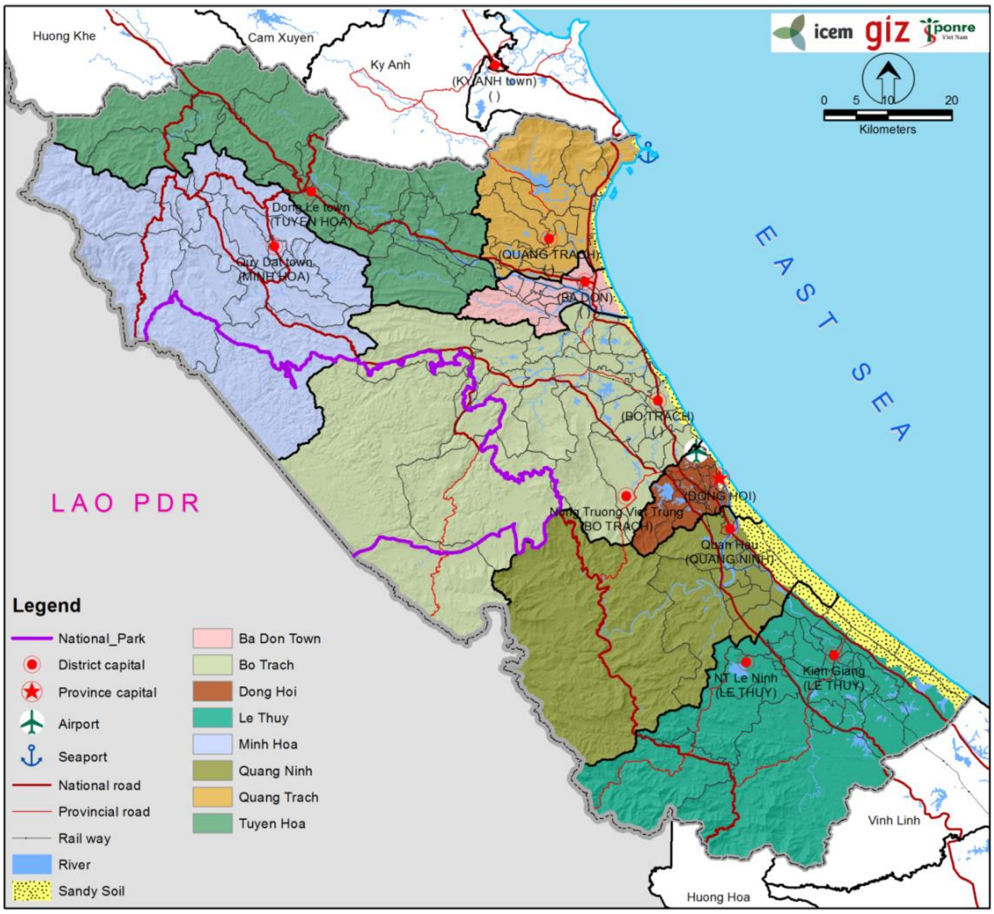
These issues are explored in the following sections. To facilitate understanding the data presented, we begin with an overview of Quang Binh's administrative and governance arrangements.

2.2.2. Administration and Governance

Quang Binh has eight district-level administrative units, including two urban units - the city of Dong Hoi, Ba Don town, the four coastal districts of Quang Trach, Bo Trach, Quang Ninh and Le Thuy, and the two mountainous districts of Tuyen Hoa and Minh Hoa. These, and their administrative centres, are shown on Map 2.1. Within these, there are 159 commune-level administrative units, of which 10 are wards, eight are towns and 141 are communes. Ba Don was elevated to township status only in 2013 and in some statistics is still included in Quang Trach District (Quang Binh PC 2012; Quang Binh Statistics Office 2014).

Responsibilities for disaster response and climate change adaptation are divided between province, district and communes, with communes responsible for the front-line response. Table 2.3 shows the distribution of the 159 communes across the 8 districts. There are between 15 and 30 communes under each district, and between around 3,000 and 7,000 people in each commune. The montane commune authorities are responsible for fewer people, but as shown in the next section, these are more spread out.

Map 2.1: Districts of Quang Binh province and their administrative centres



2.2.3. Population

For efficient use of adaptation funds, actions should benefit as many people as possible, against the most important threats and addressing the most common drivers of vulnerability. However, this must be balanced against the bias this often establishes against more remote and dispersed populations.

As populations grow, pressures on natural resources tend to increase, potentially exacerbating the impacts of climate change. It is important to understand where growth is taking place and why.

2.2.3.1. CURRENT SITUATION

The last census in 2009 recorded a total population for Quang Binh of 845,000 people and by 2013 this was estimated to have grown to 863,350 people, in approximately 227,644 households. Quang Binh is thus the 46th most populous province in Vietnam, accounting for about 1 % of the total population (2010). As will be discussed in more detail in the Economic Profile, Quang Binh is one of the poorest provinces in Vietnam, contributing little to the national GDP. These facts have implications for the attention and budget received from central government.

Table 2.3: Population-related statistics for the districts of Quang Binh, 2013

Name of city/ district	Area		No. com-munes	Population			
	Ha	%		Total	%	p/km2	p/comm
Total	806,613	100	159	863,350	100	107	5430
Urban Areas							
Dong Hoi city	15,657	1.9	16	114,897	13.3	737	7181
Ba Don town	16,319	2.0	16	104,172	12.1	639	6511
Rural Districts							
Minh Hoa	141,271	17.5	16	48,528	5.6	34	3033
Tuyen Hoa	115,098	14.3	20	78,341	9.1	68	3917
Quang Trach	45,070	5.6	18	104,945	12.2	233	5830
Bo Trach	212,418	26.3	30	181,618	21.0	86	6054
Quang Ninh	119,169	14.8	15	89,062	10.3	75	5937
Le Thuy	141,611	17.6	28	141,787	16.4	100	5064

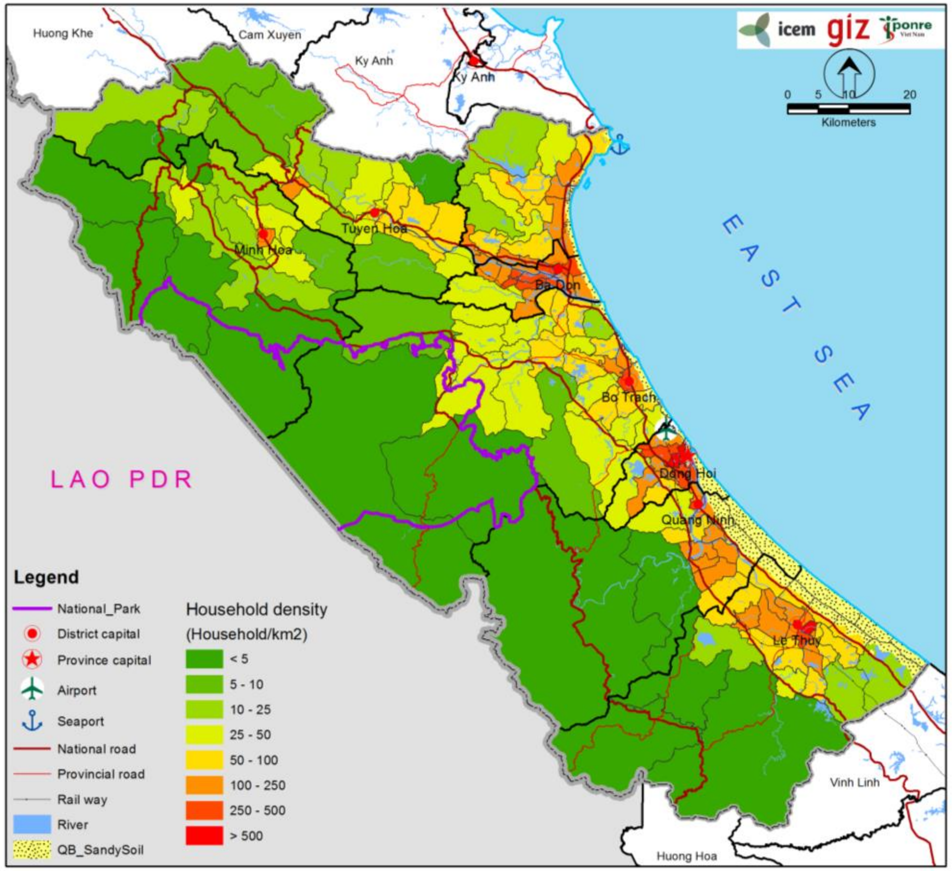
Source: Quang Binh Statistical Yearbook 2014

It is well-known that the majority of the population in Quang Binh is concentrated in the coastal plain. Agricultural land in Quang Binh is very limited, representing only 7% of the provincial land area, and the entire lowlands represent only 15% of the total - but support about 80% of the population. There are many small, densely populated rural communes and two urban districts, the latter accounting for 25% of the total population. The lowlands have been the locus of the most important traditional and intensive livelihoods: paddy-rice growing, fishing, salt-making and trade and commerce, and in the modern era agri-business, heavy industry, manufacturing and services. The coastal plain is on the frontline of the most destructive climatic events, typhoons, tidal surges and will be most exposed to sea-level rise.

The mountains comprise around 85% of the land area, but are inhabited by only 20% of the people. There are relatively few large, sparsely populated communes, reflecting the more extensive nature of traditional ethnic minority livelihoods of subsistence swidden cultivation and forest product gathering. From the 1940s, the potential of the more remote inland valleys for paddy rice has been developed by migrating Kinh people and more recently, hillsides developed for commercial tree crops, such as acacia and certain fruit trees and other market oriented economic activities been established.

Map 2.2 presents population density data at the commune level. The only higher density populations outside the lowlands are along the Gianh River valley and in district towns of the inland districts of Minh Hoa and Tuyen Hoa. The average population density for the province is 107 p/km^2, but this varies from only 34 p/km^2 in the inland district of Minh Hoa, to 735 p/km^2 in the provincial capital. Map 2.3 shows the pattern of rural and urban settlements, illustrating how in rural areas, settlement follows roads, rivers and administrative centres, particularly in the low density mountainous areas.

Map 2.2: Density of households by commune, Quang Binh 2013



Map 2.3: Distribution of rural and urban settlements

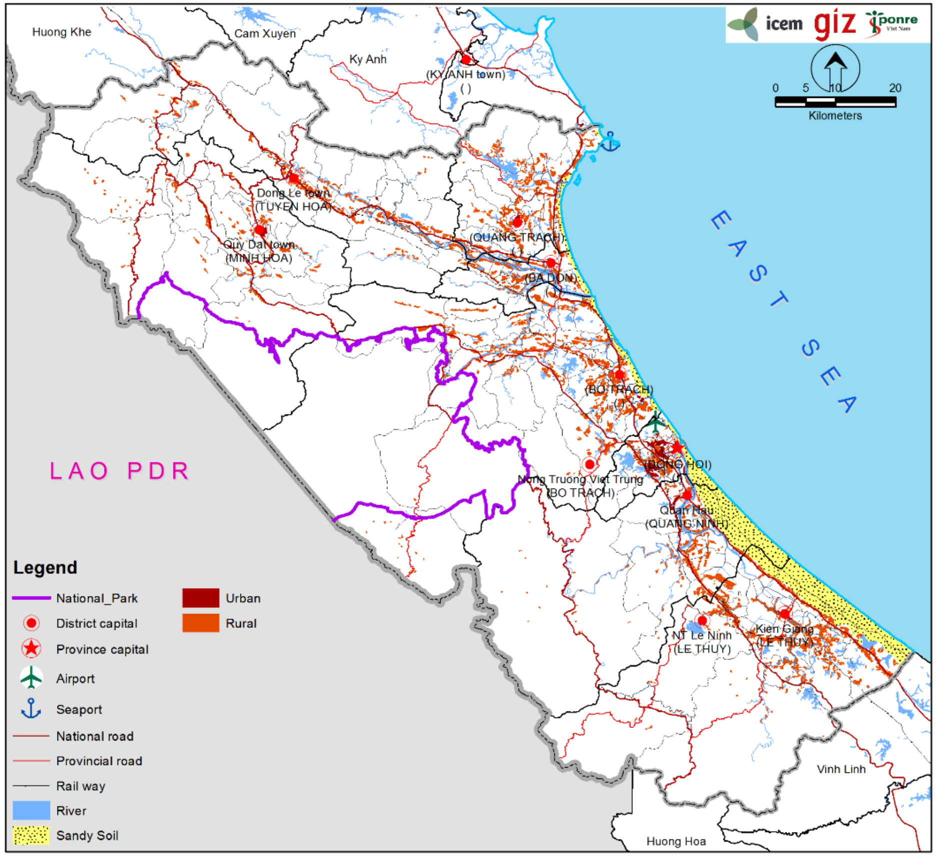


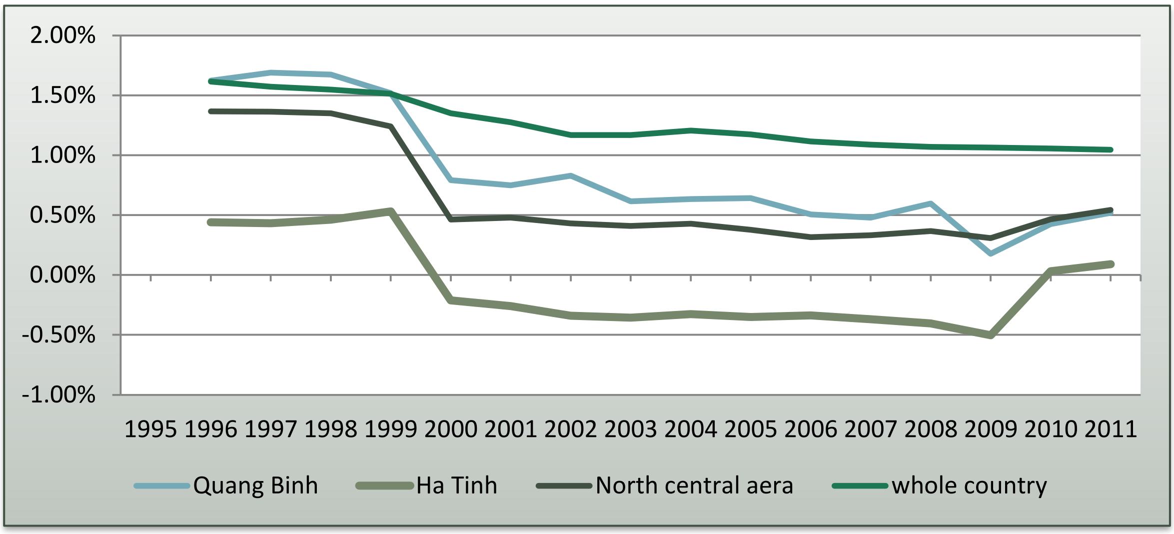
Table 2.3 presents population-related data for the districts of Quang Binh and the province as a whole, showing the same pattern. With over 20% of the provincial population, Bo Trach is the most populous district, combining large paddy growing areas and the tourism centre of Phong Nha-Ke Bang, followed by Quang Ninh, again, with a large paddy growing area. The inland border district of Minh Hoa is least populated, with only 5% of the provincial total.

2.2.3.2. POPULATION TRENDS

To better understand climate change predictions used in this study (see Chapter 4), population growth rates (PGR) need to be examined. The PGR in Quang Binh is currently low, at 0.6% pa. Even so, if maintained, this means that the provincial population will increase to 944,401 in 2030, 1064,427 in 2050 and 1,435,538 in 2100.

Population trends are, however, difficult to predict. According to GSO data for Quang Bing for the years 1995-2010, the present PGR represents a considerable slow-down from a high of 1.6% pa in 1996 and an average PGR for the period of 0.85% pa. Vietnam's overall PGR has decreased from 2.3 % pa in 1985 to 0.9% in 2010[2] , with the most precipitous drop occurring between 1990 and 2000, when rate declined from 2.2% pa to 1.2% pa. The provincial pattern thus parallels the population trends in the country as a whole (Figure 2.1). Both rates are equivalent to those of countries with high human development index scores.

Figure 2.1: Quang Binh population growth trend compared to other regions in Vietnam



Population growth rates vary amongst the different districts (Figure 2.2). Currently, Minh Hoa has the highest rate at about 1% pa, although it also has the lowest total population (Table 2.4), so the numbers added are less significant ~ 5,000 pa. The relatively high rate is most likely related to development of the Cha Lo border crossing special economic zone. The urban centre of Dong Hoi has the next highest growth rate. Tuyen Hoa, the other inland district, has the lowest rate at 0.3% pa.

Migration is an important factor in the population trends in the poorer provinces of Vietnam, and in some cases, represents an adaptation of individuals or households to climate change. Migration of household members is something of a double-edged sword: it can diversify a household's livelihood, providing a source of cash income, often more reliably than a natural resources-based activity at home. However, it also takes labour, often the youngest and strongest, from households and communities, reducing their immediate ability to cope and adapt and leading to the phenomenon of the "empty village". Quang Binh has experienced high levels of out-migration of labour in the past, and this has contributed to the low PGR observed. Available migration data is provided in Table 2.4, however the meaning of "migration rates by local" remains obscure.

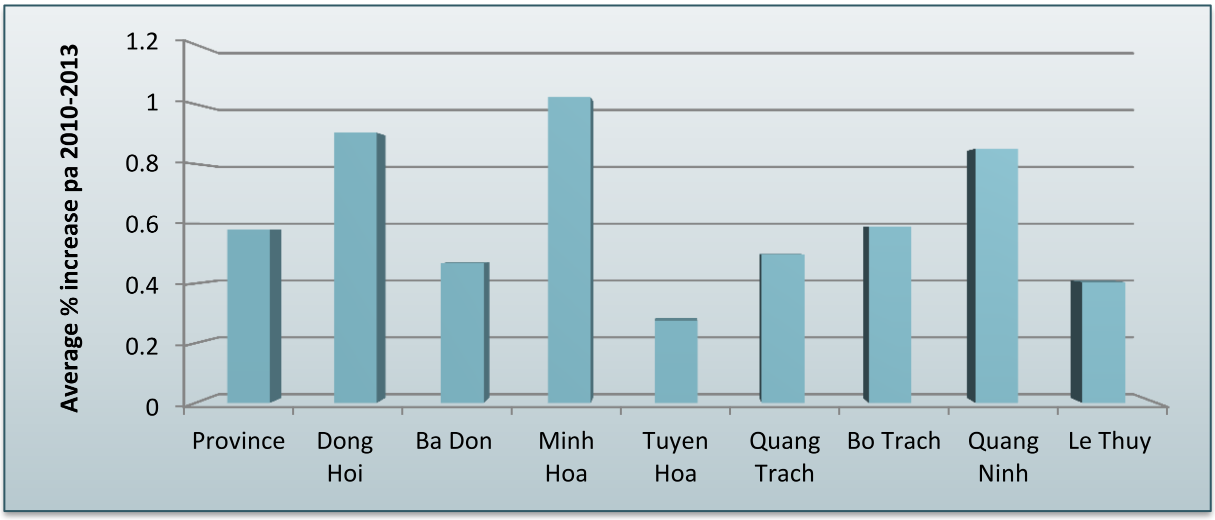
[2] http://hdr.undp.org/en/content/average-annual-population-growth-rate

Table 2.4: Migration in Quang Binh, 2007-2014

Unit	Net-migration Rate (%)	Migration Rates by local (%)	Out-Migration Rate by Province (%)
2005	-0.80	2.60	3.40
2007	-2.40	3.30	5.70
2008	-5.40	1.50	6.90
2009	-9.60	1.90	11.50
2010	-11.00	2.40	13.40
2011	-6.3	4.00	10.30
2012	0.00	7.60	7.60
2013	-8.00	6.50	14.50
2014	-5.70	5.80	11.40

Source: Vietnam GSO website

Figure 2.1: Population growth rates by district, Quang Binh 2010-2013



Source: Provincial Statistics Office

To better understand climate change predictions used in this study (see Chapter 4), the current growth rate means that the provincial population would increase to 944,401 in 2030, 1064,427 in 2050 and 1,435,538 in 2100.

2.2.4. Vulnerable groups

Chapter 1 introduced the concept of vulnerability to a climate change impact as a function of exposure to that hazard and sensitivity that the object in question (crop, natural habitat, socio-ecological system, community) has to it, in the context of a particular vulnerable situation.

Different groups of people vary in terms of their exposure and sensitivity to climate change. To achieve effective and just CCA, it is important to understand who they are, where they live and the nature of their vulnerability, including their dependence on ecosystem services. At the provincial level, useful social indicators and drivers of vulnerability, for which some data are available include: poverty, ethnicity, livelihoods and employment.

2.2.4.1. THE POOR

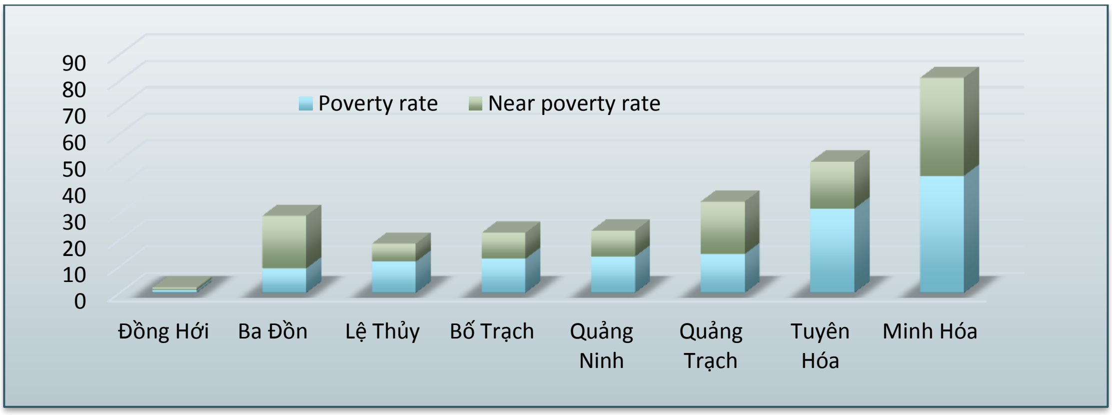
Poverty is one of the key determinants of the vulnerability of households and communities to climate change, and of their capacity to adapt[3]. Poverty is multi-dimensional[4] - different aspects of poverty contribute to

[3] In Vietnam, 'poverty' is calculated by two ministries utilizing different levels or thresholds: by the General Statistics Office (GSO) under the Ministry of Planning and Investment (MPI) against the food poverty line and general poverty line; and by the Ministry of Labour, Invalids and Social Affairs (MoLISA) against the official poverty line. Both are based on income or income equivalents. Although the GSO uses an internationally accepted methodology, the one used by MoLISA is considered as the official poverty line. (UNDP 2012a, p:3).

determining peoples' vulnerability to different stress factors brought by climate change. The livelihoods framework (DFID 2001) provides a useful basis for analysing poverty in the context of EbA, identifying five asset areas for consideration: natural, physical, human, financial and social. Thus poverty is configured by: lack of access to natural resources and ecosystem services; poor housing, remote location lacking essential infrastructure, lack of essential tools; lack of household labour, skills, health; lack of access to credit and lack of financial and food reserves to fall back on after a shock; lack of supportive social networks and political engagement. As some of these dimensions of poverty are alleviated, pressure on natural ecosystems often increases, causing degradation which in turn can increase peoples' vulnerability to climate change, and the possibility of falling back into poverty.

As mentioned above, Quang Binh is one of the poorer provinces in Vietnam, with 17 % of the population counted as poor in 2016[5] compared to an average of 12 % nationally. A further 14.4% are "near poor". The resultant total of 31.4% is quite high - compared to the national total of 18%. Further, it is persistently high - while some households may escape absolute "poverty", few escape "near poverty" and the near poor are at risk of falling back into poverty. Figure 2.3 compares the percentage of poor and near poor households by district, showing the significance of near poor in some of the better off districts (Ba Don and Quang Trach).

Figure 2.2: Percentage of poor and near poor households, by district (2015)



Source: Graph produced by consultant team from information provided by DOLISA.

In terms of the total number of poor households, this is highest in the more populous districts, despite their significantly lower poverty rate.

Reasons given for the province's relatively high poverty include its distance from the country's main economic centres - Ha Noi, Da Nang and HCMC - and, more relevant to this study, its difficult climate. Climate and other natural disasters doubtless contribute to poverty - especially turning "near poor" back to "poor" - but no mention is made of this in provincial statistics and studies.

Map 2.4b shows commune level poverty rates in 2015, and indicates that poverty is now primarily a phenomenon of remote rural areas. It is also most prevalent amongst farmers, particularly ethnic minorities and amongst fishing families (see below). However, according to government informants, existing data masks significant pockets of poverty, notably amongst the fishing communities that are part of the relatively most prosperous coastal communes. Data to support this contention is lacking.

The main reasons for household poverty in Quang Binh are reported as:

- lack of the means of production including access to good cultivable land
- limited access to credit
- high dependency ratio (many children/old/sick but few labourers)
- lack of education and skills
- lack of employment opportunities (DOLISA, 2015)

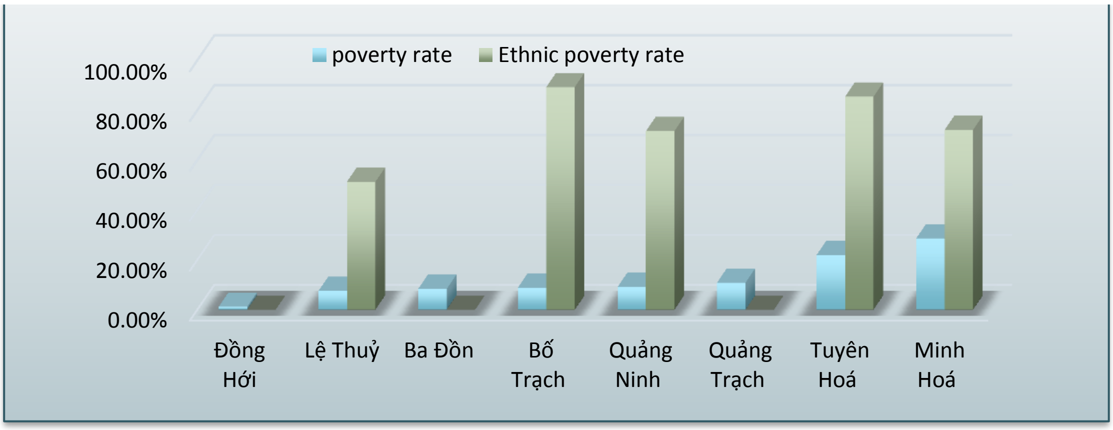
[4] From 2016-2020, Vietnam will adopt a national measure of multidimensional poverty, based on the Alkire-Foster method, which will show the disadvantages poor people face across five different areas: i) living conditions; ii) income levels; iii) access to education and health care; iv) access to information; and v) access to insurance and social assistance. (http://www.mppn.org/mppn_news/vietnam-moves-to-multidimensional-approach-to-poverty-reduction).

[5] The figure of 17% is based on the new poverty level established in 2016 using a multi-dimensional approach. According to the previous poverty rate in use from 2010-2015, the current rate would be 10.2%.

Unemployment is a significant problem. As elsewhere in the country, graduate unemployment is said to be a particular problem. The national unemployment rate is at 2.4 % percent, yet workers with college degrees are facing the highest unemployment rate of 7.2 % (MOLISA 2015); but data for Quang Binh are lacking.

However, poverty clearly has strong links to geography and ethnicity. As we have already seen, overall poverty rates are highest in the inland montane districts of Tuyen Hoa and Minh Hoa and this is in part associated with lack of access to government services. Across the province 70% all ethnic minority households are poor, compared to 10% of Kinh households (DOLISA 2015). Figure 2.4 compares general poverty rates with the poverty rates for ethnic minority households for Quang Binh's districts. In all districts, poverty amongst ethnic minorities is at least twice as high as the general poverty rate, and in Bo Trach, it is 10 times higher.

Figure 2.3: Overall poverty rates and ethnic minority poverty rates compared (households, 2015)



Source: Graph produced by consultant team from information provided by DOLISA.

Elsewhere in Vietnam, poverty rates are also typically higher amongst female-headed households, but data on this for Quang Binh is lacking.

Poverty alleviation

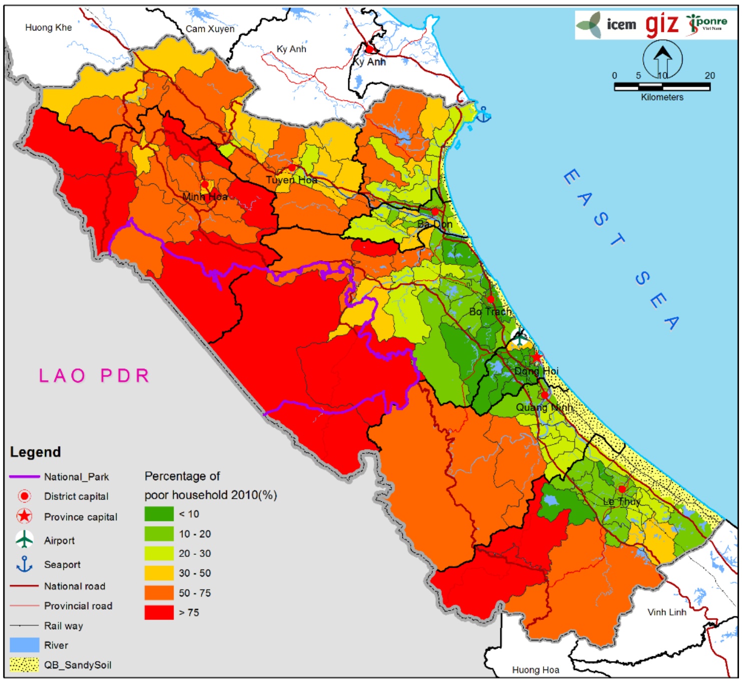
Poverty alleviation in Vietnam has been driven mainly by economic growth and restructuring of the agricultural sector towards commodity production, but there have also been several more targeted poverty alleviation programmes, notably (National Target Programme) (NTP) - Socio-economic Development of the Most Vulnerable Communes in Ethnic Minority and Mountainous Areas in Vietnam aka Programme 135 Phases I-III (1998-2015) and Resolution 30a on Rapid and Sustainable Poverty Reduction (2009 - 2020). In Quang Binh, 43 communes in six districts were involved in the last phase of P135, but only Minh Hoa district receives support under Resolution 30a. Over the years, P135 has focused mainly on infrastructure investments, but also included support for access to basic social services such as health, culture, education, housing and clean water, loans to develop income-generating production and vocational training. Support for forest land allocation under P661. In Minh Hoa, Resolution 30a funding has focused again on infrastructure development - such as schools, training centres, health centres, irrigation, bridges and roads. In addition, in border communes the Vietnamese Peoples' Army Border Defence Force carries out a range of development and relief works. Many ethnic minority communities receive food relief on a regular basis, and alcohol abuse is quite widespread; both can undermine peoples' adaptive capacity.

The inter-ministerial NTP - New Rural Development (2010-2020), managed by MARD, does not integrate climate change adaptation or disaster risk management into its commune level plans, although there are some environmental targets.

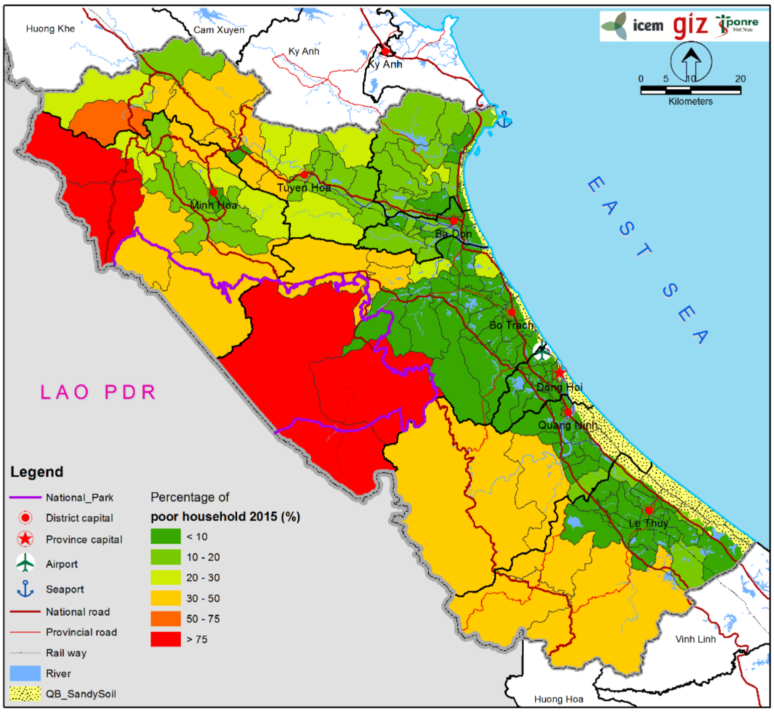
The results of these programmes in Quang Binh, as elsewhere in the country, are that poverty levels have declined rapidly in recent years. In 2014, only 10.2 % of households were below the poverty line, down from 25.2 % in 2010 - a reduction of about 3% pa - (Quang Binh SO 2015) and 46% in 1998 (UNDP 2012a). While considerable progress has been made, chronic poverty becoming more entrenched, and as mentioned above, disparities persist between regions and socio-economic groups (UNDP 2012b). Maps 2.4a and 2.4b illustrate this. The highest levels of poverty remain in the remote ethnic minority dominated communes in the mountains bordering with Laos.

As poverty is a key determinant of vulnerability to climate change and often of capacity to adapt to it, these declining poverty rates should be good news. However, increased household prosperity can translate into an increase in unsustainable use of resources and thus increase vulnerability. Further studies are needed to understand the relationship between poverty alleviation and ecosystem-related climate change vulnerability at the macro-scale.

Map 2.4a: Distribution of poverty (% poor households) in Quang Binh, 2010



Map 2.4b: Distribution of poverty (% poor households) in Quang Binh, 2015



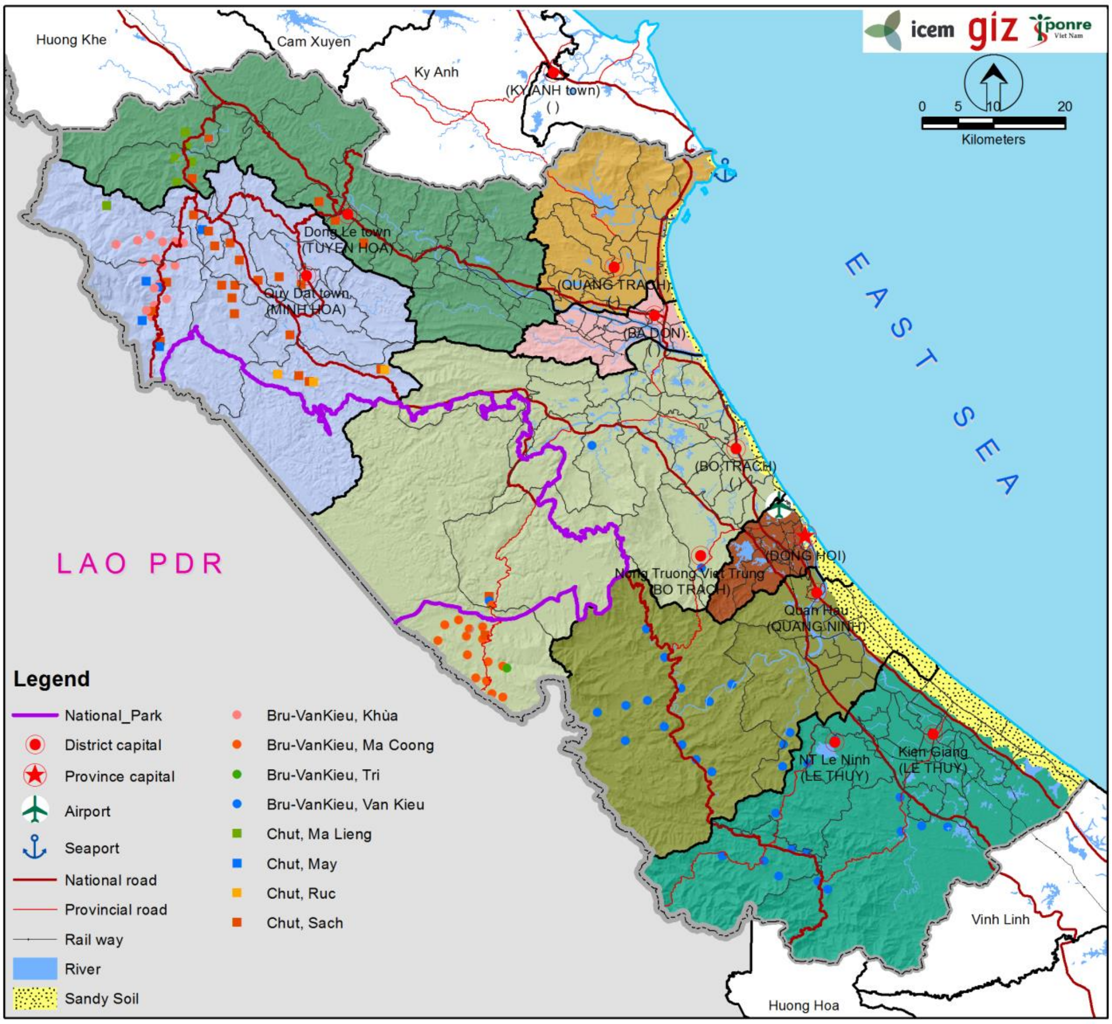
Source: Map produced by consultant team from information provided by DOLISA.

2.2.4.2. ETHNIC MINORITIES[6]

Some observers treat ethnicity as a special case of poverty (and thus vulnerability), exacerbated by language issues and remote locations that limit access to good education and health services. To others, ethnic minorities with their "traditional" livelihoods and knowledge systems are inherently adaptable in their particular context, and efforts to modernise and integrate minorities into the Kinh mainstream, or provide permanent safety nets of food relief, represent a kind of "maladaptation".

Quang Binh has 15 groups of ethnic minority people with a total population of about 22,000, in approximately 5,000 households (2015). This represents 2.5% of the total population of the province, compared to the national figure of 13%, and about 1.8% of Vietnam's total ethnic minority population (of approximately 12 million people). In 2009, 14,800 of the total ethnic minority population lived in the 13 communes in the immediate buffer zone of Phong Nha-Ke Bang, where they represented about 20% of the buffer zone population.

Map 2.5: Distribution of the main ethnic minority groups in Quang Binh



There are two main ethnic groups in Quang Binh, each with a number of sub-groups, and six other smaller groups with less than 100 people in total. More information is provided in Table 2.5. The largest group is the Bru-Van Kieu, who number around 14,000 people or 73% of the province's ethnic minorities. They belong to the large and widespread Austroasiatic language group, which nationally comprises 21 ethnic groups and 2.6 million people. The largest sub-group in Quang Binh is the Van Kieu; they live in nine communes in Quang Ninh and Le Thuy. The Khua live in 7 communes in Minh Hoa district. Other sub-groups include the Macoong and the Tri. The Bru-Van-Kieu are quite assimilated with the majority Kinh population, relatively well-educated and engaged in commercial crop production and trading. They still grow upland rice, but also cultivate in paddy rice and forest crops on allocated forest land. One Van Kieu group of about 450 people still lives in Phong Nha-Ke Bang - the Doong village enclave in the south-eastern corner of the park, a situation made possible by a forest protection contract (QB PC 2012b).

The Chut number only around 6,000 people nationally about 5,500 of whom (26% of total EM) live in Minh Hoa, Tuyen Hoa and Bo Trach; the remaining members live in neighbouring Ha Tinh. Of the five sub-groups, the Sach is most widespread. The Arem used to live in caves in and around Phong Nha-Ke Bang and 89 households now live in a resettlement village (Ban 39) close to the margin of the park. Other groups include the Malieng, Ruc and May. The Chut are linguistically related to the Kinh, but characterised as "traditional", living a more isolated, subsistence way of life, growing hill rice in difficult upland environments and collecting forest products.

Ethnic minority livelihoods are typically highly dependent on natural resources. Hill rice, grown in upland swidden plots is the staple crop, but vulnerable to drought, and food shortages are increasingly common. The socio-ecological system of ethnic minorities is described in more detail in Chapter

Despite many government programmes, discussed above, ethnic minority poverty remains stubbornly high. Government development goals do not always tally with ethnic minorities' own preferences. Many ethnic minority communities receive food relief on a regular basis, and alcohol abuse is quite widespread; both can undermine peoples' adaptive capacity.

The distribution of the main ethnic minority settlements is show on Map 2.5. Nearly all settlements are in mountainous areas of five districts, in 28 of the province's 159 communes. Many of the settlements are located in reach of major transport arteries: the HCM Highway comes in from Ha Tinh, loops around PNKB, then splits into two branches, and the western branch continues through the mountains climbing the Huoi Nam Se River before entering Quang Tri. The Asia Highway # 131, linking Vung Anh port in Ha Tinh with Laos and Thailand, crosses Trong Hoa and Dan Hoa communes in Minh Hoa district and the border crossing at Cho La is being developed as a special economic zone, so the road is broad and traffic quite heavy. One group, is however, quite isolated. This is the community of about 500 households living in an upland watershed between PNKB and the Lao border in Bo Trach District. There is a border crossing here, but because the road must first cross the national park, traffic is very limited - as are facilities and services.

At the commune level, most of the ethnic minority groups mix with other groups, although villages may be exclusive to one group. In 12 of the communes, more than one ethnic minority group resides, and all communes have populations of Kinh people. For the 19 communes (three districts) with data, ethnic minorities on average represent 25 % of the total households. In seven of those communes, minorities represent less than 10% of the population, and in six, they represent over 50% of the population. The highest percentage is found Trong Hoa commune in Minh Hoa district, where of the total of 783 households, 95.5% are Malieng, belonging to the Chut ethnic minority. Only Minh Hoa District has substantial numbers of ethnic minority people, but this is still only 20% of the total district population.

Table 2.5: Population of ethnic minority groups in Quang Binh, by district (2007 and 2015)

District	Chut						Bru-Van Kieu					Muong	Other	TOTAL	TOTAL HH 2015
	Sach	Ruc	Arem	May	Malieng	TOTAL	Van Kieu	Macoong	Khua	Tri	TOTAL				
Urban Areas															
Dong Hoi city															
Ba Don town															
Rural Districts															
Minh Hoa	2579	437	7	1163	540	4726			4244		4244	37	52	9059	2377
Tuyen Hoa	62				487	549			6		6	10	21	586	178
Quang Trach															
Bo Trach	14		149			163	495	1848		72	2415	21	6	2605	688
Quang Ninh							2848				2848				834
Le Thuy							4771				4771		2	4773	1262
Total (2007)	2655	437	156	1163	1027	5438	8114	1848	4250	72	14284	68	81	19871	
Total (2015)						5848					16425			22285	**5339**

Sources: Ethnic Minorities of Quang Binh (2007)

2.2.4.3. LIVEHOODS AND VULNERABILITY

Livelihoods that are dependent on natural resources tend to be more vulnerable to the changing climate. These typically include fishing and agriculture. Further, the less diversified a family's livelihood is, the more vulnerable it is likely to be since if one livelihood suffers impacts of climate change, they lack alternatives to fall back on.

Specific studies on the relationship between livelihoods and poverty and thus vulnerability to climate change in Quang Binh are lacking. However, it is generally accepted that jobs or livelihoods dependent on renewable natural resources (agriculture, forestry, fisheries) are more vulnerable to climate change because the resource base itself is vulnerable - to drought, storms, flooding, pests and diseases, wind and the like. Chapter 5 examines livelihoods in Quang Binh in the context of about 30 socio-ecological systems. The SES then provides the basis for assessing exposure, sensitivity and vulnerabilities across the province.

The data on employment and livelihoods available for Quang Binh is limited. Table 2.6 provides information for 2010, breaking down the provincial workforce into seven main sectors. Obviously this obscures a lot of diversity important for understanding vulnerability to climate change. In 2010, the workforce, defined as persons over 15 years of age[6], totalled 518,191 people, and 454,536 people or 87% of the workforce was employed. Over 65% of the workforce was engaged in agriculture and forestry (56.2%) and fisheries (9.4%), activities that are inherently vulnerable to climate events and change. Figures are not available, but many of these people will be self-employed. The other main sectors are services (20%) industry (mining and processing, 10%), construction (4.1%) and eight per cent of the workforce is employed in the state sector. Many of these will be in waged employment, and their livelihoods less vulnerable to climatic events and changes. Only 22% of the workforce is formally trained and only 3.8% trained to an intermediate or high level, implying that nearly 80% of the workforce is considered "untrained". The workforce is increasing at nearly 5% per year.

Table 2.6: Employment and employment mix in Quang Binh in 2010

Sector	No. labourers	%
Agriculture and Forestry	255,347	56.2
Fisheries	42,150	9.4
Construction	18,574	4.1
Mining – processing	45,786	10.0
Trade, vehicle repair	34,753	7.6
Hospitality	9,206	2.0
Transport, storage, communication	9,699	2.1
Other	39,021	8.6
TOTAL	454,536	100

Source: Quang Binh statistical year book, 2010

2.3 CONCLUSIONS AND RECOMMENDATIONS

In this chapter we have assessed and mapped the key social data relating to climate change and ecosystem-based adaptation to it, at the provincial level Quang Binh: population and vulnerable groups.

The densest populations in Quang Binh are in the coastal lowlands. Here too are the largest numbers of poor people, and here too people are on the front-line for many of the region's most severe climate events. But in the lowlands, people also have the best communications, infrastructure, market access and services, the greatest scope for alternative livelihoods and the best institutional support in time of need. Although the provincial population is increasing slowly, the fastest increase is taking place in the lowlands, where exposure is greatest. The growing population is accompanied by increasing urbanisation, which may exacerbate certain climate related problems - like flooding and heat stress.

The poorest and most marginalised people in Quang Binh are the ethnic minorities living in the mountains. With over 22,000 people, their population is small, but significant. They have the least diversified livelihoods, and most limited access to infrastructure and services to support those livelihoods. As such, they are potentially extremely vulnerable to climatic event, and government programmes, though well-meaning, neglect to engage with the people in planning their own futures, and often create dependencies which can undermine initiative and adaptation capacity.

[6] According to the International Labour Organisation definition, no upper age limit is stated.

The majority of the Quang Binh workforce (65%) is engaged in agriculture, forestry and fisheries - all based on natural resources and all vulnerable, to a greater or lesser extent, to extreme climatic events and to climate change.

This initial analysis suggests that, from the social perspective, priorities for micro-level assessment and adaptation action would be

- upland ethnic minorities
- poor inshore fishing communities along the coast
- people engaged in agriculture forestry and fisheries generally

2.4 REFERENCES

Adger WN et al 2004. New Indicators of Vulnerability and Adaptive Capacity. Tyndall Centre for Climate Change.

Adger WN and PM Kelly 1999. Social vulnerability to climate change and the architecture of entitlements. Mitigation and Adaptation Strategies for Global Change 4: 253-266.

Gebert R and Trang Hieu Tuong 2011. Report of study on gender, poverty and ethinicity in Phong Nha - Ke Bang national park buffer zones communes, Quang Binh province, Việt Nam. GIZ.

McElwee P et al. 2010. The Social Dimensions of Adaptation to Climate Change in Vietnam. World Bank Discussion Paper 17. Washington DC.

Quang Binh PC, 2011. Socio-economic development plan to 2020.

Quang Binh PC 2012. Quang Binh Socio- Economic to 2020 Master Plan and vision to 2050.

Quang Binh PC 2012b. Strategic Management Plan 2013-2025, Phong Nha-Ke Bang National Park, The World Heritage Site

Quang Binh PC, 2014. Quang Binh implementation report of Socio-economic situation 2014 and socio-economic plan for 2015.

Quang Binh SO, 2014. Quang Binh Statistical yearbook 2013.

Quang Binh PC 2015. Report of implementation of National target programs in Quang Binh 2011-2015.

Quang Binh Department of Ethnic Minorities 2008. Handbook on Ethnic Minority groups.

UNDP 2012a. A preliminary analysis of disaster and poverty data in Quang Binh province, Vietnam.

UNDP 2012b. Sustainable poverty reduction and natural disaster risk management in central coastal region: lessons learned and policy implications.

CHAPTER 3 ECOLOGICAL PROFILE OF QUANG BINH

3.1 INTRODUCTION

The Approach and Methods Report introduced the concepts and methods of Vulnerability Assessment for Ecosystem-based Adaptation (EbA) to climate change. It highlighted the idea on which EbA is predicated: the understanding that ecology, society and economy cannot be separated. Natural ecosystems are the foundation of human existence on this planet, and of all our economic activities. However, these ecological foundations have been profoundly modified and in many places weakened from their original state, by people pursuing their livelihoods (economic activities) in unsustainable ways. Although change is inherent in all global systems, eco-systems have limits to the extent of the changes they can tolerate, without losing their essential structure and functions, on which we all depend. Now climate change is adding to the stresses that people have already induced in natural systems, with potentially grave consequences. EbA identifies ecosystem degradation as a key underlying cause of vulnerability. Urgent action is needed to restore these natural systems to health, to help us sustain our socio-economic systems, indeed our very survival, to the coming challenges. We also need to harness the services of healthy ecosystems to help us adapt to the changes ahead.

To understand the issues and threats posed by climate change and devise practical and sustainable solutions, ecological, social and economic factors need to be considered together, as parts of an integrated whole. Thus, as set out in Report 1, for this EbA vulnerability assessment, the unit of analysis is the "socio-ecological system" (SES), defined as:

"complex bio-geo-physical units together with social and institutional actors and their (economic) activities"

The severity of impacts and peoples' ability to cope are also felt because of the state of such things. Climate change adaptation too, is entirely a human process, embedded in an ecological context and an economic structure. It is about people understanding climate change and what it means for their lives, and making the appropriate, often innovative changes (to their vision of the future and their activities) needed to secure a sustainable future for their families and communities. It is about governments supporting these processes and tackling the underlying causes of vulnerability. Climate change and our adaptation to it are thus quintessentially social issues: people are at once the major cause of climate change, its victims, and they will be the main agents of adaptation and mitigation.

The impacts of climate change are felt by people - on their health, their housing, the other people, infrastructure and services they rely on, the natural resources they depend on, the other ways they earn their livelihoods. Chapter 2 of this report - the Social Profile of Quang Binh Province, therefore focused the analysis on people, asking which groups are most vulnerable and why, based on an understanding of human vulnerability as:

"the state of individuals, groups or communities in terms of their ability to cope with and adapt to any external stress placed on their livelihoods and well-being. It is determined by i) the availability of resources: and crucially, ii) by the entitlement of individuals and groups to call on these resources" (Adger and Kelly 1999).

Chapter 4 - the Economic Profile of Quang Binh identifies the main sectors of the provincial economy considering a variety of aspects including contribution to GDP, employment generated, and future development direction, etc. as well as dependence on natural resources, linked to climate change.

This Chapter, the Ecological Profile of Quang Binh Province now focuses on the ecosystems of Quang Binh, detailing which types of ecosystem are present, how much there is of them, and what condition are they in. It also identifies those which may be critical for supporting livelihoods and the economy in the face of climate change, and identifies to some extent how the ecosystems themselves are vulnerable to climate change (although this is addressed in more detail in Chapter 7 on Climate Change Impacts). The present chapter examines the ecological dimensions of EbA in Quang Binh, including the contextual information at the Provincial level that any provincial department should keep in mind in analysing and planning for CCA or EbA.

This chapter also examines the key parameters used in this study to develop and describe different types of Socio-ecological Systems (SES) found in the province. The SES Profile of Quang Binh (Chapter 5) takes this information together with similar information from the Social and Economic Profiles, to develop and present a classification of the main SES for Quang Binh. As with the Social and Economic Profiles, this Ecological Profile is based on a review of existing data made available to the study by the different departments of the provincial government, as well as through more general literature review. As new or more updated data becomes available, this profile should be updated.

3.2 OVERVIEW OF KEY ECOLOGICAL FACTORS FOR PROVINCIAL-SCALE ANALYSIS QUANG BINH

This section presents information to answer key practical questions on ecological issues for climate change vulnerability assessment and adaptation planning at the provincial level. It does not attempt to provide a full ecological profile of Quang Binh. The provincial-level study is intended to use secondary data only - it does not involve conducting any original research. While many interesting and relevant questions could be posed at the provincial level, there are only a limited number of ecological factors for which sufficiently comprehensive data already exists at this level. Other factors may be examined at the micro-level assessment of actual local vulnerability and adaptive capacity, supported by primary data collection where necessary. What this profile does attempt is to be “spatial explicit” - that is, to map the selected parameters - to contribute to the mapping of socio-ecological systems, and to help inform the selection of sites for the micro-level analysis.

Table 3.1: Ecological analysis at the provincial and community-levels of assessment

Provincial-level assessment	Local-level (community) assessment
Based on secondary information available at provincial level	Based on secondary data available locally, primary data collection and local stakeholder participation
Focus on broad context and understanding; prioritization	Focus on planning and action
Type, extent and condition of main ecosystems found in the province	Type, extent and condition of local ecosystems in the micro-assessment site
How ecosystems contribute to the provincial economy/main economic sectors, and support provincial level resilience	How local ecosystems support local livelihoods and resilience
Vulnerability and resilience of ecosystems	Vulnerability and resilience of ecosystems
How ecosystems are managed at the provincial scale	How local ecosystems are manage by communities and other local groups

A few simple questions guide the analysis presented below:

- What are the main types of ecosystems found in Quang Binh?
  - Where are they; how much of them are there; and what condition are they in?
  - What are the trends in their extent and condition?
- How do the ecosystems support resilience?
- How are the ecosystems themselves vulnerable to climate change?

3.3 PHYSICAL DESCRIPTION: TOPOGRAPHY, SOILS AND CLIMATE

3.3.1. Topography

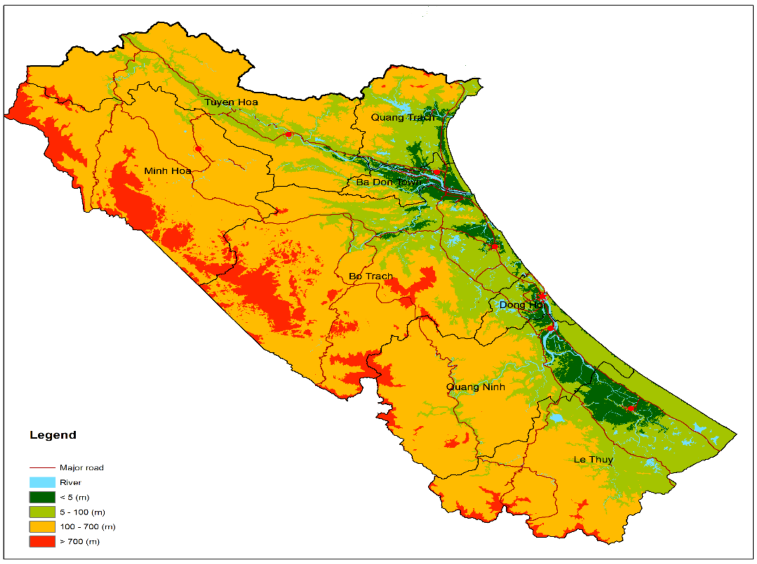
The 1,200km long, and 50-75km wide Truong Son Mountain range is the dominant geological feature of Central and North-Central Vietnam, generally running parallel to the coastline, and straddling the border with neighbouring Laos. Quang Binh occupies an area of 8,065km^2 located to the east of the Truong Son mountain range, to the South of Ha Tinh province, and to the North of Quang Tri, with a 116km long coastline along the East Sea. In general, the terrain is complex and highly dissected. There is a rapid decrease in altitude from west to east. The majority of the territory is mountainous. The rest consists of a hilly transition area between the mountains and the narrow coastal plain, dissected by many rivers, as well as coastal sand dune areas. Quang Binh has been regularly faced with disaster risks from typhoons and floods in the rainy season and drought in the dry season. Many of these hazards may get worse with climate change.

In general, four main zones can be identified in Quang Binh Province:

- Mountainous areas along the Truong Son range in the western side of the province rise up to 2,500m, with an average slope of about 25% - found in Tuyen Hoa, Minh Hoa, Quang Trach, Bo Trach Quang Ninh and Le Thuy districts.
- Hilly areas are found mainly in Bo Trach, Quang Trach, Quang Ninh and Le Thuy districts and Dong Hoi city.
- Lowland plain land stretches along narrow areas that connect the hilly areas in the west and the coastal sandy areas in the east of the province and is dissected by many rivers. Plains land is the main land for paddy rice production and the main residential land of most of the local population, and is located mainly in Quang Trach, Bo Trach, Dong Hoi, Quang Ninh and Le Thuy districts.

- Coastal sandy areas are located along the sea shore, including sand dunes and sandy beaches in Quang Trach, Bo Trach, Dong Hoi, Quang Ninh and Le Thuy districts.

Map 3.1: Elevation map of Quang Binh



3.3.2. Soils

The following soil types are found in Quang Binh (*Quang Binh Provincial Socio-Economic Development Master Plan by 2020*).

Sandy soils (Arenosols), including 3 soil units i.e. Luvic Arenosols, eutric Haplic Arenosols, and acid Haplic Aresonols. Arenosolos occupy up to 6% of the province, including sand dunes that located along seashore from Quang Trach to Le Thuy districts and sandy land in Le Thuy, Quang Ninh and Quang Trach districts. These soils are low quality, poor in nutrients and with rough soil texture. The process of moving sand (cát di động), flying sand (cát bay), and flowing sand (cát chảy) happens in the sand dune areas with an average volume of 3.2 million m^3 of sand moved each year, causing annual losses of 20-30 ha cultivated land.

The original types of vegetation cover on sandy soils included natural coastal forest and sandy plain areas along the seashore. Because of changing of land use patterns (forest cutting, mining titan, introducing agriculture and so on) the sand dune area has become more dynamic and unstable, and movement of both wind and water has led to mis-shapen soil morphology and harm to crops as well as farmers' assets. The dominated land cover on this land today is very stunted shrubs which the local people describe by saying the "plants are not higher than a dog - "Chó chạy lòi đuôi". Because of the very poor land-cover, so the sand is more exposed to the rain and wind, it can be easily eroded and flow to the stream and be conveyed by the wind. These soil type are mostly used for planting of casuarinas and acacia, as well as for some growing of peanuts, sweet potatoes and rice.

Saline soils (Salicfluvisols) are formed by river and sea sediments deposited in salic water environments. This soil group includes 2 units (i.e. Hapli Salic Fluvisol and Molli Salic Fluvisols) and accounts for around 9,000 hectares or less than 1% of the province's geographical area, distributed in most of river mouths like Giang, Dinh and Nhat Le rivers and aalong their estuaries in Le Thuy, Quang Ninh, Bo Trach districts and Dong Hoi. Saline soil areas tend to increasing due to sea level rise or high tidal and wave front activity during typhoons.

Alluvial soils (Fluvisols) cover about 2-4% of the province and are created from alluvial deposition located in flat lands and valleys and distributed across the coastal plain. They are formed by alluvial deposits from the Gianh, Kien Giang, Roon and other rivers. Originally most of the areas with alluvial soils would have supported some forms of lowland forest type. However these are the main soils types used for cultivating food crops and annual industrial crops and the original vegetation cover has long been transformed.

Thionic Fluvisols are formed by alluvial deposits with alkaline-generating materials in salic environment where drainage is difficult, this soil group accounts for 0.58% of the province area and are found in Le Thuy and Quang Ninh.

Swampy soil (Umbric Gleysols) and peat soils are distributed in depression areas in Le Thuy, Quang Ninh, Quang Trach and Bo Trach districts. They only accounts for a small area of 0.32% of the geographical area of the entire province.

Acrisols cover more than 64% of the total area, distributed mainly in the western mountainous areas in minh Hoa, Tuyen Hoa, partly of Western Bo Trach, Quang Ninh and Le Thuy districts

Ferralit soils (Ferrasols) cover 0.43% of the province

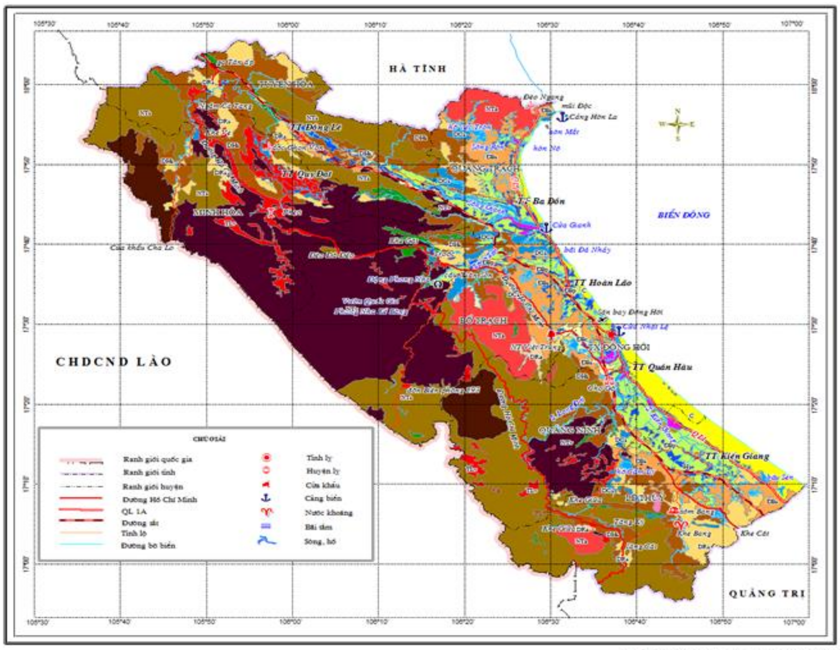
Cambisols accounts for ~ 0.77% of the geographical area of the entire province and is distributed in communes of Quang Kim, Quang Phu, Quang Hoa, Quang Tien, Quang Luu in Quang Trach district; communes of Duy Ninh, Hien Ninh, Tan Ninh, Xuan Ninh in Quang Ninh district, Duc Ninh in Dong Hoi City, communes of Hoa Thuy, Lien Thuy, Kim Thuy in Le Thuy district, and communes of Quy Hoa and Tan Hoa in Minh Hoa district.

Planosols accounts for only 0.1% of the province's geographical area, and are distributed in the communes of Hoa Phuc and Hoa Thanh in Minh Hoa district and Hoa Thuy in Le Thuy District.

Lithosols accounts for about 3% of the province, and are distributed mainly in the hilly areas of the districts of Le Thuy, Bo Trach and Quang Trach.

In general, soils in Quang Binh are poor in plant nutrient, soil layers are thin, area of alluvial soils is small but area of sandy soil, swampy soil and peat soils are high. Nevertheless, there are high potential uses for land resources, especially hilly land can be invested in for development of perenial industrial crops, forest plants and also towards a trend of agro-forestry.

Map 3.2: Soil map of Quang Binh



Chú giải Bản đồ Địa mạo Thổ nhưỡng

KIỂU	PHỤ KIỂU	LOẠI	KÍ HIỆU	TỔ HỢP ĐẤT	MÀU
Núi	Trung bình	Phiến sét	NTBs	Humic Acrisols - Humic Cambisols	NTBs
	Thấp	Macma axit	NTa	Arreni Acrisols - Dystric Cambisols	NTa
		Phiến sét	NTs	Dystric Acrisols - Dystric Cambisols	NTs
		Đá vôi	NTv	Umbric Leptosols - Eutric Leptosols	NTv
Đồi	Cao	Phiến sét	DCs	Ferralic Acrisols - Dystric Cambisols	DCs
	Đồi xen đáy trũng hẹp	Macma axit	DHa	Arreni Acrisols - Dystric Fluvisols	DHa
		Phiến sét	DHs	Dystric Acrisols - Dystric Fluvisols	DHs
		Bazan	DHb	Haplic Ferralsols - Eutric Fluvisols	DHb
	Đồi xen đáy trũng rộng	Macma axit	DRa	Arreni Acrisols - Dystric Pinthosols - Dystric Fluvisols	DRa
		Phiến sét	DRs	Dystric Acrisols - Dystric Pinthosols - Dystric Fluvisols	DRs
Đồng bằng và thung lũng	Thung lũng	Tích tụ trên đá vôi	TLv	Ferralic Acrisols - Haplic Ferralsols	TLv
		Tích tụ trên các đá khác nhau	TLs	Albic Acrisols - Ferralic Cambisols - Eutric Fluvisols	TLs
	Đồng bằng đồi	Các đá khác nhau	ĐBs	Ferralic Acrisols - Dystric Plinthosols - Dystric Leptosols	ĐBs
	Đồng bằng trũng	Phù sa	ĐBp	Eutric Fluvisols - Dystric Fluvisols	ĐBp
		Phù sa bị úng ngập	ĐBg	Gleyic Fluvisols - Dystric Gleysols	ĐBg
	Đồng bằng ven biển	Phù sa bị mặn, phèn	ĐBs-t	Salic Fluvisols - Thinic Fluvisols	ĐBs-t
		Cát	ĐBc	Ferralic Arenosols - Gleyic Arenosols	ĐBc
	Đồng bằng gió biển	Cồn, đụn cát	C	Haplic Arenosols	C

3.3.3. Climate

Quang Binh is located in the tropical monsoon zone, but the local climate is complex and differs between locations, strongly influenced by topography. From a temperature perspective the year can be considered as having 2 main seasons, the warm season from April to September with an average temperature of about 35°C and cool season from October to March with an average temperature about 22 - 25°C. Overall annual average temperature is about 24 - 25°C, increasing from North to South and decreasing from East to West. In the mountainous areas, the daytime and night-time temperature differences can be as much as 9 - 10°C in compared with 7 - 8°C in the plains. In the warm (dry) season, the south-westerly monsoon wind blows strongly through the Truong Son Mountains, the natural border between Vietnam and Lao, leading to extremely hot and dry weather and known colloquially as the “Lao wind”.

Table 3.2: Monthly average temperature in 2012 (^{0}C)

Month	1	2	3	4	5	6	Mean
Temperature	17.8	18.5	21.4	26.3	29.2	30.1	25.1
Month	7	8	9	10	11	12	
Temperature	29.7	29.2	26.8	25.6	24.8	21.5	

Source: Year book Quang Binh province 2013

From the perspective of precipitation, there are two distinct seasons in the Province, i.e., the dry season, which lasts from November to April and the rainy season from May to early November. According records from 1961 - 2009, the average annual rainfall is 2,000 - 2,300mm/year, while the maximum and minimum annual rainfall are 3,092mm (in 1964) and 1,570mm (in 1969), respectively. The average number of rainy days is about 152 days/year. However, they are mostly concentrated during the period from September to November, accounting for 56-65% of the total annual rainfall. This heavy rainfall concentrated in a short period, combined with the steeply sloping terrain and fast-flowing rivers often results in widespread flooding (ISPONRE, 2009).

Table 3.3: Monthly average rainfall in 2012 (mm)

Month	1	2	3	4	5	6	Mean
Rainfall	38.3	11.0	17.5	82.2	154.7	82.6	145.3
Month	7	8	9	10	11	12	
Rainfall	123.2	145.2	547.0	281.9	156.8	103.7	

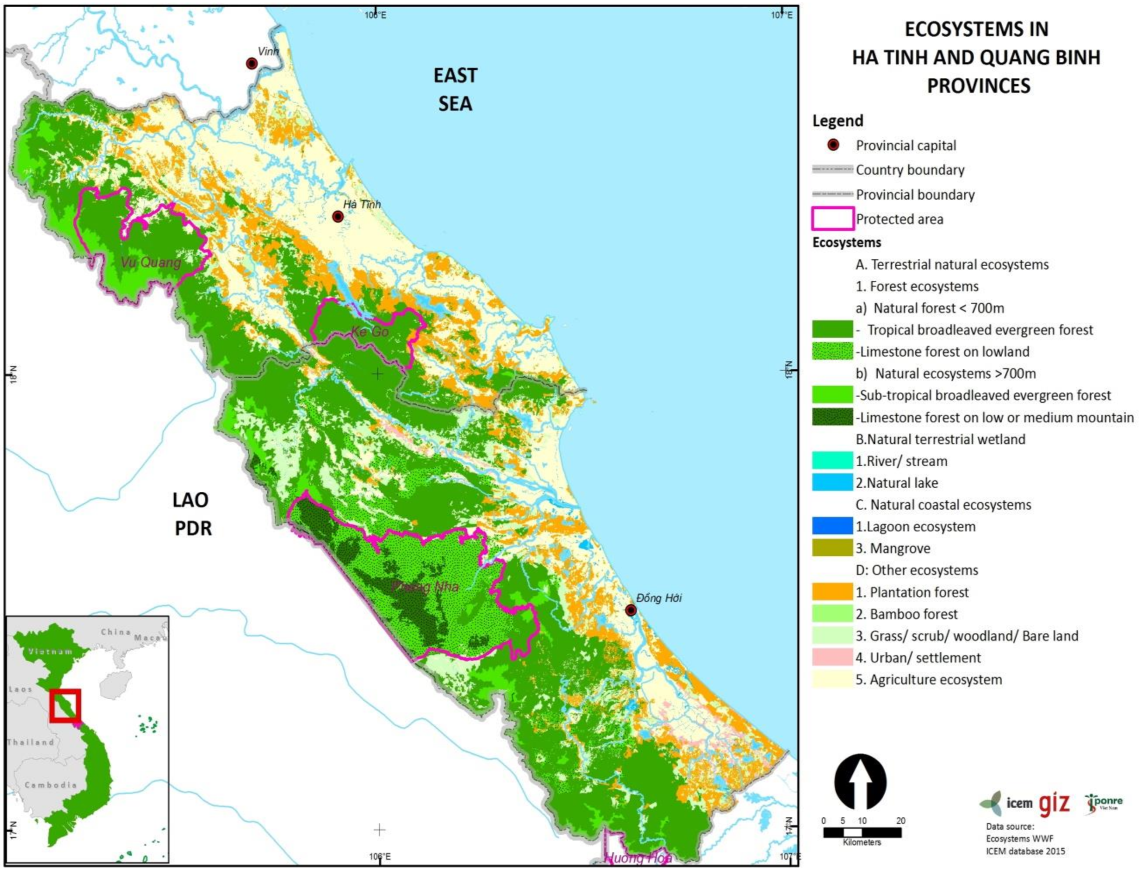
Source: Year book Quang Binh province 2013

3.4 NATURAL ECOSYSTEMS

This section provides information on the type, amount, condition and issues facing each of the main ecosystems in Quang Binh.

On a low resolution mapping of global ecoregions conducted by WWF, all of Quang Binh province falls within two ecoregions, namely the Northern Annamite Rainforest Ecoregion, and the Northern Vietnam Lowland Rainforest Ecoregion (Wikramanayake et. al., 2002). A higher resolution mapping of ecosystems at the national level of Vietnam, recognises a number of natural terrestrial, freshwater wetland and coastal ecosystems which are present in Quang Binh. The mapping of terrestrial ecosystems is generally good, however when considering coastal ecosystems, it does not identify sand dune systems as a specific type of coastal ecosystem, and the resolution of the mapping is too coarse to identify any small areas of sea grass and coral reefs in Quang Binh. Furthermore, for freshwater ecosystems, the mapping does not clearly distinguish between different types beyond the classes of “river/stream” and “natural lake”. Without systematic ground-truthing, it is entirely possible that many water bodies mapped as natural lakes are in fact man made reservoirs (See BCA, WWF, Stockholm University, 2013: Ecosystems classification mapping in Vietnam. Hanoi, Vietnam). While more detailed mapping of especially coastal and freshwater ecosystems would be very beneficial, it is beyond the scope of this project to conduct detailed original province-wide mapping of all ecosystem types.

Map 3.3: Ecosystems of Ha Tinh and Quang Binh



Source: ICEM, based on BCA, WWF, Stockholm University, 2013: Ecosystems classification mapping in Vietnam. Ha Noi, Vietnam

3.4.1. Terrestrial Ecosystems

The main forest and other terrestrial ecosystems of Quang Binh are as follows:

- coniferous forest above 700m altitude
- sub-tropical broadleaf moist evergreen forests above 700m altitude
- tropical moist evergreen broadleaf forest below 700m altitude
- forest on limestone above 700m altitude
- forest on limestone below 700m altitude
- cave ecosystems

There are also grassy and shrubby areas, rattan and bamboo, degraded forest, plantations agro-forestry and agricultural areas, but these are not treated here as original natural ecosystems.

About 10% of the original terrestrial ecosystems of Quang Binh have been converted to agriculture, and a further 11% to other uses (Figure 3.4 and Table 3.4). The province still retains one of the highest tree cover rates anywhere in Vietnam - 79% of the province is designated as forestry land (Table 3.4) and almost 550,000 ha (70% of the province) has some form of tree-dominated land-cover (Table 3.5 and Figure 3.5). Of this, 456,000 ha is natural forest and the rest is plantation (Table 3.6). Information on changes in forest area in Quang Binh from 1998 until 2012, shows that total forest area increased by about 77,000 ha - increasing at an average rate of 5,500 hectares/year during this period, mostly through the increase in plantation areas (Table 3.6)

Map 3.4: Land-use patterns in Quang Binh

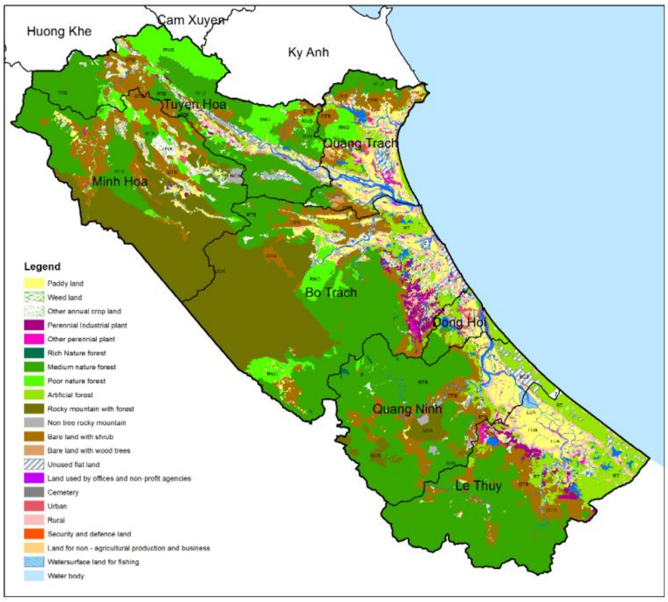


Table 3.4: Overall Land-use patters (2012-2013)

Use type of land	Quang Binh	
	ha	%
Total	806,526	100
Agricultural land	79,618	9.87
Forestry	633,522	78.55
Aquacultural	2,786	0.345
Resident/homestead land	5,285	0.655
Special use/dedicated land	27,068	3.01
Other Non-agriculture land	21,104	2.61
Unused land	37,144	4.60

Source: Quang Binh Statistical yearbook 2012

Table 3.5: Area of three types of forest, 2012

	Quang Binh (2012)
Total area of forest (ha)	549,540
Special Use forest (PNKB) (ha)	125,501
Protection forest (ha)	191,995
Production forest (ha)	257,404
Forest cover (%)	70,1
Distribution: districts: ha	Bo Trach: 162,271 Minh Hoa: 106,949 Le Thuy: 96,828 Quang Ninh: 88,523 Tuyen Hoa: 82,936

Source: MARD- FIPI, 2012

Table 3.6: Change of forest area 1998-2005-2012

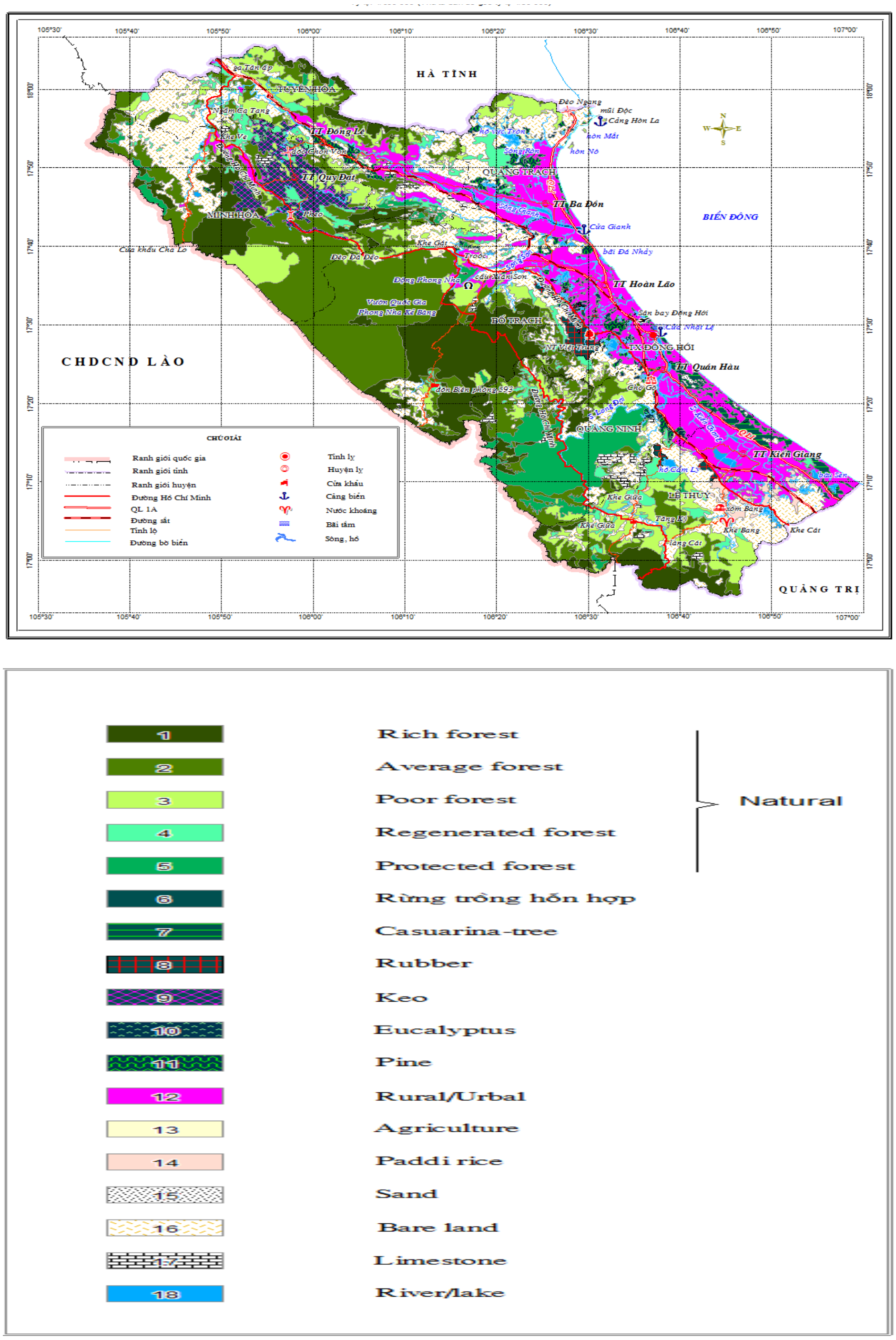
Quang Binh Province	1998	2005	2012
Forest tree area (ha)	473,287	517,363	549,540
Natural forest (ha)	*452,634*	*452,285*	*456,536*
Planted forest (ha)	*20,652*	*65,787*	*93,004*

Source: MARD: Restructure of National Forestry, Hanoi-2014

Forests are amongst the most valuable ecosystems in terms of the services they provide and they are their importance for EbA. Almost one quarter of Quang Binh's forest is natural forest in relatively good condition in the Special use Forest of PNKB NP. As such it represents a significant commitment on behalf of the government and people of Vietnam and especially Quang Binh to maintaining natural ecosystems in a protected state.

Phong Nha-Ke Bang National Park is one of the world's two largest limestone regions. If the Hin Namno, borderring Phong Nha on the west (in Laotian territory) was to be combined with the national park in a continuous trans-boundary reserve, the combined area would be the largest surviving karst forest in south-eastern Asia (317,754 ha). Around 95% of the park is covered with forest, most of which is intact primary forest. It contains the best representative examples of all the major terrestrial ecosystem types found in Quang Binh Province, protecting significant areas of each of them. Almost three-quarters of the park (or over 1,100 km^2) is covered with evergreen moist forest on limestone under 700m elevation, while a further 126 km^2 is evergreen tropical moist forest on limestone rocks at an elevation higher than 700 m; 122 km^2 is evergreen tropical wet forest on soil mounts at the elevation of under 700m. In the park here is also a 50 km^2 forest of Calocedrus macrolep is on limestone mounts. This is the largest forest with this tree in Vietnam. Most of the trees here are 500-600 years old. These trees are listed in group 2A (rare, precious and limited exploitation) of the official letter 3399/VPCP-NN dated 21 June 2002, an amendment to the Decree 48 by the Government of Vietnam.

Map 3.5: Forests of Quang Binh province



The primary tropical forest in Phong Nha-Ke Bang consists of 140 families, 427 genera, and 751 species of vascular plants, of which 36 species are endangered and listed in Vietnam's Red Data Book. The dominant plant families are the Lauraceae, Fagacaeae, Theaceae and Rosaceae, and he most common tree species include *Hopea sp., Sumbaviopsis albicans, Garcinia fragraeoides, Burretionendron hsienmu, Chukrasia tabularis, Photinia aroboreum* and *Dysospyros saletti.* There are some deciduous trees including *Dipterocarpus kerri, Anogeissus acuminate, Pometia pinnata* and *Lagerstroemia calyculata,* with some scattered gymnosperms such as *Podocarpus imbricatus, Podocarpus neriifolius,* and *Nageia fleuryi.*

The forest is also home to 98 families, 256 genera and 381 species of vertebrates. Sixty-six (66) animal species are listed in the Vietnam's Red Data Book and 23 other species in the World Red Book of Endangered Species. As noted in IUCN's 2011 evaluation (IUCN, 2011), PNKB NP is of particular importance for the conservation of primate species. Of the 9 primate species that occur in the park (i.e. 43% of Vietnam's 21 primate species), 7 are globally threatened, and PNKB NP possibly has the largest protected viable populations of 3 of them: Hatinh Langur (EN); Red-shanked Douc Langur (EN); and Southern White-cheeked Gibbon (EN) (Haus et. al., 2009; Le Troy et. al., 2009). Other globally threatened mammal species in PNKB NP include Owston's Civet (VU). (Timmins et al., 1999). Several larger carnivores and other large mammals historically found in the property have had no confirmed observations or documentation of presence for many years (or decades in some cases); this includes tigers, leopards, elephants and bears.

PNKB provides significant ecosystem services especially in terms of provision and regulation of water supply and quality for downstream communities, as well as carbon sequestration, climate regulation, and especially tourism and recreation services. To some extent the importance of these services is recognized simply in the decision to continue to maintain these areas as protected areas - but the amount and value of the services has not been assessed. It is therefore difficult to see if the level of investment of government budget in management of the area is appropriate or not when considering the value of the services the area provides. It is also difficult to develop innovative financing mechanisms such as payment for Ecosystem Services (PES) when the overall importance and value of these services is largely unknown.

Cave Ecosystems

A major feature of the province is the The Phong Nha–Ke Bang karst landscape which dates to the Paleozoic some 400 million years ago, making it the oldest major karst area in Asia. As many as seven different major levels of karst development have occurred as a result of tectonic uplift and changing sea levels, producing an extremely complex karst landscape with high geo-diversity and many geomorphic features of considerable significance (My and Limbert, 1993; Pham Kang, 1985). The Phong Nha Ke Bang karst landscape is how to some of the most spectacular and the largest caves in the world (National Geographic, 2011). Karsts and caves are well known for their invertebrate biodiversity, with high levels of endemism, and many species often limited to a single site. Several species new to science have been discovered in the Phonh Nha Ke Bang area (Moulds et. al., 2010; Golovatch et. al., 2013).

IUCN's 2011 evaluation of PNKB for the World Heritage Committee (IUCN, 2011; Worboys, 2012), pointed to a number of threats and some of these persist. Specific concerns related to poor law enforcement and illegal harvest of timber and non-timber forest products (NTFP) including endangered wildlife. A number of commercially valuable hardwood timber species were being logged including Sua Wood (*Dalbergia cochinchinensis*) go huế wood (*Dalbergia rimosa*), go mun wood (*Diospyros spp.)* and Iron Wood (*Nephelium chryseum*). This has been the cause of conflicts between rangers and loggers. Historically there have been very high levels of poaching and this continues although efforts to halt it are increasing (Viet Nature, 2013; WCS, 2013). The property has suffered from past developments and its integrity could be threatened by further uncontrolled tourism developments, notably the development of increased cave access with artificial lighting systems; access roads and trails; and a proposed new cable car (Rosen, 2014). A significant threat emanates from the development of tourism infrastructure, either proposed or implemented without proper environmental impact assessment. A tourism strategy has been developed for the property and Quang Binh Province has prioritised tourism as a key driver of provincial development (Hubnerand Chau 213; Hubner et. al. 2014). To ensure the ecosystem services of PNKB continue to support the people and the province of Quang Binh and contribute to climate change resilience as effectively as possible, any remaining management issues need to be addressed as urgent priorities.

3.4.2. Fresh water Ecosystems

The main fresh water ecosystems fall into the classes of riverine ecosystems (streams and rivers) and lacustrine ecosystems - lakes, ponds and other surface water bodies.

Riverine Ecosystems

There are five main river systems in Quang Binh, with a combined length of about 260km and combined watershed of 7.778 km^2. These are the Ron River, Gianh River (which includes the Gianh, Con and Nan rivers), Ly Hoa River, Dinh River, and Nhat Le River (which includes the Kien Giang River and Long Dai River), with a combined flow of 539.72 m^3/s and total annual water flow volume of 17 bcm. (See Table 3.7)

Table 3.7: Characteristics of main rivers in Quang Binh province

River	Length (Km)	Basin Area (km^2)	Tier 1 Tributaries	Annual Dishcharge ($106m^3$)
Gianh	121	4,462	13	10,895.0
Kien Giang (Nhat Le)	59	2,652	8	4,772.0
Roon	21	275	3	607.6
Ly Hoa	22	177	3	318.0
Dinh	37	212	0	382.0

Source: *Quang Binh's aggregated plan for natural disaster management by 2020 - Department of Agriculture and Rural Development; and Southern Natural Resources and Environment Company 11*

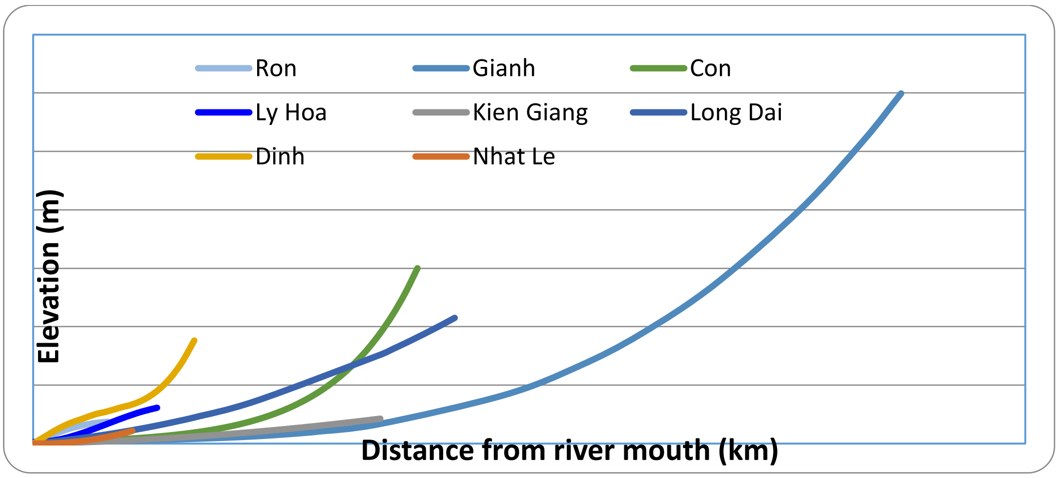
All these rivers are derived from the Truong Son Mountain Range and flow out into the East Sea via the Ron, Gianh, Ly Hoa, Dinh and Nhat Le river mouths. Apart from the main rivers, the Province also has many underground streams flowing through the limestone mountains. Most of the rivers and streams in Quang Binh are short and steep. The river flows are therefore relatively high and fast, especially in the rainy seasons, and this often leads to flooding. Flash flooding occurs along rivers emerging from Phong Nha-Ke Bang and inundation happens further downstream. From 2007-2013, there were a total of 45 floods. Figure 3.6 shows the major river systems of Ha Tinh and Quang Binh, while Figure 3.7 shows the longitudinal profile for some of the major rivers in Ha Tinh.

While no information was found on the ecological condition of the rivers, it is assumed that headwaters areas and upper reaches of rivers, especially where forested watersheds are contained within national parks, nature reserves and other protected forests (and in some cases natural production forest) are likely to still be in relatively good condition.

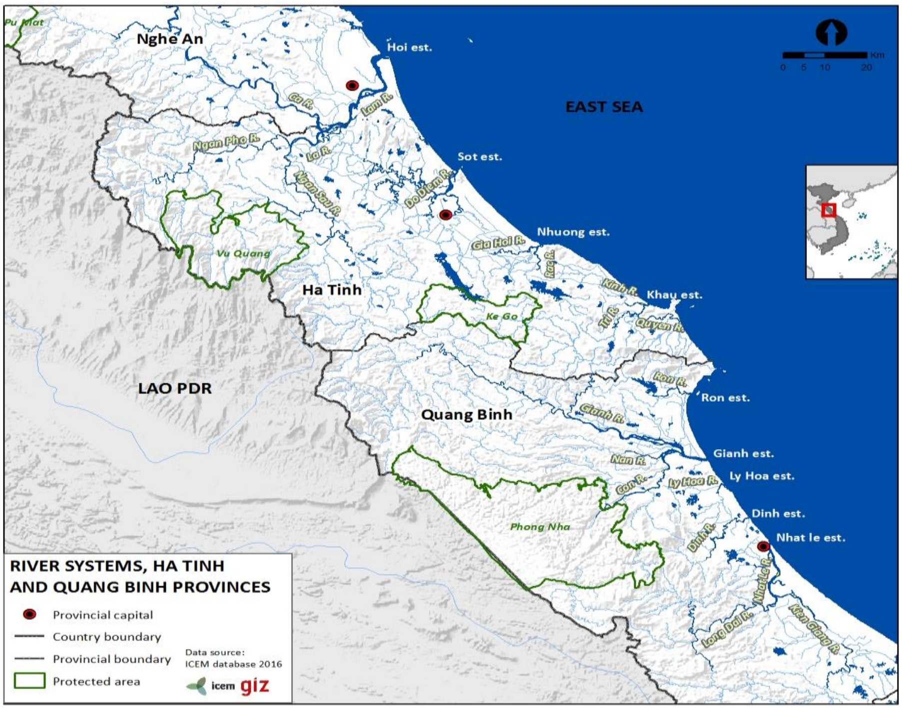
Despite the relative health of the upper reaches of most rivers in the province, their middle and lower reaches have been impacted by various forms of development including hydropower and irrigation reservoirs, saline intrusion barriers, flood prevention dykes, and human settlement. Natural flow patterns have been changed, and natural riparian vegetation has largely been removed. Sixty-seventy percent of catchments have already been exploited for reservoir development, and there are already downstream problems of reduced flows and salinity intrusion upstream for 10s of km.

Some information was found on fish species. A total of 170 species were recorded from the Phong Nha-Ke Bang Region, of which three and 15 species are listed in the Red Data Book of Vietnam (2007) and the IUCN Red List of Threatened Species (2012) respectively. In addition, 16 species are endemic to Vietnam and the Truong Son mountain range. Eight species were described as new species to science from this region: *Aspidoparia viridis, Yaoshanicus albus, Acrossocheilus albus, Acrossocheilus carongensis, Acrossocheilus fissirostris, Acrossocheilus lineatus, Acrossocheilus longianalis and Acrossocheilus sp*.

Figure 3.1: Longitudinal profiles of major rivers in Quang Binh province



Map 3.6: Map of river systems and estuaries in Ha Tinh and Quang Binh Provinces



<u>Lacustrine Ecosystems</u>

Natural surface water bodies in Quang Binh province are found in small areas and distributed along the coastal parts of Bo Trach district (5 lakes) Dong Hoi city (4 lakes) Le Thuy district (4 lakes) with a total water volume of about 11,052 mil. m^3. The largest lake is Bau Tro with a total surface area of 24ha, located in Dong Hoi city, providing the fresh water supply for the city. Bau Sen Lake in Le Thuy district and Tram Tuan Lake of Dong Hoi city are also large size lakes and play important roles in landscape ecology, environment and livelihoods of local people. In addition, there are about 160 artificial water bodies in Quang Binh Province.

Dong Hoi city still retains a number of small wetlands under near natural conditions. These should be retained (protected from in-filling and construction) and studied for potential to link them into a network and for management as havens for wildlife and recreation as well as urban cool-spots.

3.4.3. Estuarine Ecosystems

Estuarine Ecosystems of Quang Binh are the estuaries themselves, together with associated mangroves, mud-flats and some small lagoons. The Province has five major estuarine systems, corresponding to the five river systems. Small lagoons along estuaries, where salinity is about 15%, contribute valuable income to local people from tiger prawns, greasyback shrimp and other species. DARD (2015) also reported the presence of 186 fish species in Quang Binh, of which, a large number of daily-use fish come from the lake and lagoon areas.

Mangrove forests of Quang Binh province were originally distributed in significant areas along the banks of all the main river estuaries. Before 1975, large areas of mangrove with higher species diversity were recorded especially in the estuaries of the Roon River and the Gianh River. (Nguyet and Hoang, 2014; Thanh et. al. 2006). Tran Trung Thanh, Ho Dac Thai Hoang and Pham Hong Thai (2006) listed 23 main species of 17 families of mangrove flora in the Gianh estuary. Nguyen Thi Nguyet and Ho Dac Thai Hoang (2014) also found the same species from the Gianh estuary in the Long Dai estuary and also reported 2-3 layers of mangrove structure in Le Thuy district. Mangrove poles have been used for construction, as well as for charcoal production and over the years their area has steadily declined with conversion to other purposes such as aquaculture and settlments. Today, according to DARD there are almost 11,000 hectares of mangroves in Quang Binh (DARD, 2015), but according tot he Quang Binh CCRAP, these exist as “small and insignificant scattered patches”.

Table 3.8: List of main lakes larger than 1 mil m^3 volume in Quang Binh province

No.	Name of Lake	Location		Volume (mil.m^3)
		Commune	District	
1	Buoi Roi	Quang Hop	Quang Trach	1,100
2	Vuc Trun	Quang Hop	Quang Trach	52,000
3	Sung Thai	Quang Kim	Quang Trach	9,250
4	Mui Rong	Quang Tion	Quang Trach	1,100
5	Bau Sen	Sen Thuy	Le Thuy	1,250
6	Von Tien	Quang Luu	Quang Trach	1,100
7	Trung Thuan	Quang Thach	Quang Trach	4,530
8	Tien Lang	Quang Lien	Quang Trach	16,570
9	Khe Ngang	Phyc Trach	Quang Trach	1,710
10	Vuc Sanh	Ha Trach	Quang Trach	3,120
11	Dong Ran	Bac Trach	Quang Trach	5,250
12	Mu U	Thanh Trach	Quang Trach	2,750
13	Vuc Noi	Van Trach	Bo Trach	11,200
14	Thoc Chuoi	Phu Dinh	Bo Trach	34,060
15	Dap Da Mai	Vu Trung Town	Bo Trach	3,200
16	Tram Tuan	Loc Ninh	Dong Hoi City	3,000
17	Bau Tru	Hai Thanh District	Dong Hoi City	3,600
18	Phy Vinh	Dong Son District	Dong Hoi City	22,000
19	Ray Ho	Nghia Ninh	Dong Hoi City	1,500
20	Dong Son	Nghia Ninh	Dong Hoi City	2,500
21	Dieu Ga	Vinh Ninh	Quang Ninh	1,610
22	Rao Da	Truong Xuon	Quang Ninh	84,000
23	Cam Ly	Ngon Thuy	Le Thuy	42,000
24	Phy Hoa	Phy Thuy	Le Thuy	8,640
25	Chou Xo	Mai Thuy	Le Thuy	1,350
26	An Mo	Kim Thuy	Le Thuy	67,846
27	Vung Mo	Thoi Thuy	Le Thuy	1,600
28	Tien Phong	Thoi Thuy	Le Thuy	1,500
29	Dap Lang	My Thuy	Le Thuy	1,500
30	Minh Tien	Ton Thuy	Le Thuy	1,700
31	Thanh Son	Ton Thuy	Le Thuy	6,000
Total				**398,536**

(modified from source: Report on planning, surveying and management water resources in Quang Binh province from 2025 - 2020)

In general estuary and river mouth areas of all main estuarine systems in Quang Binh are highly developed and normal ecological functioning is disrupted. Normal ecological functioning of the ecosystems is also interrupted by saline intrusion barriers. The intention of these barriers is to maintain freshwater conditions suitable for rice growing, upstream of the barriers. However, this also impacts sediment transport to the coastline and reduces freshwater mixing with the saltwater downstream of the barrier, significantly changing the natural water conditions of the estuary and the ecological functioning of estuarine ecosystems. This also impacts the remaining mangroves downstream of the barriers, where conditions are too salty for some mangrove species to survive. Meanwhile, another government priority - the construction of “hard engineered” typhoon shelters for fishing boats (see Photo 3.1) is further degrading natural coastal ecosystems. Flanking the shelters with mangroves to enhance their resilience, while supporting estuarine biodiversity, could be considered.

Figure 3.2: The new typhoon shelter for fishing boats in the lower Ron River (in background)

Reestablishment of mangroves in front of the shelter could protect the infrastructure and the boats inside the shelter

3.4.4. Coastal ecosystems

The main coastal ecosystems of Quang Binh are

- sandy beaches and sand dune ecosystems (together with coastal forest formations at the landward edge of sand dune systems)
- coral reefs
- sea-grass beds

Deeper water (50m+) offshore marine ecosystems and island ecosystems have not been considered in this study.

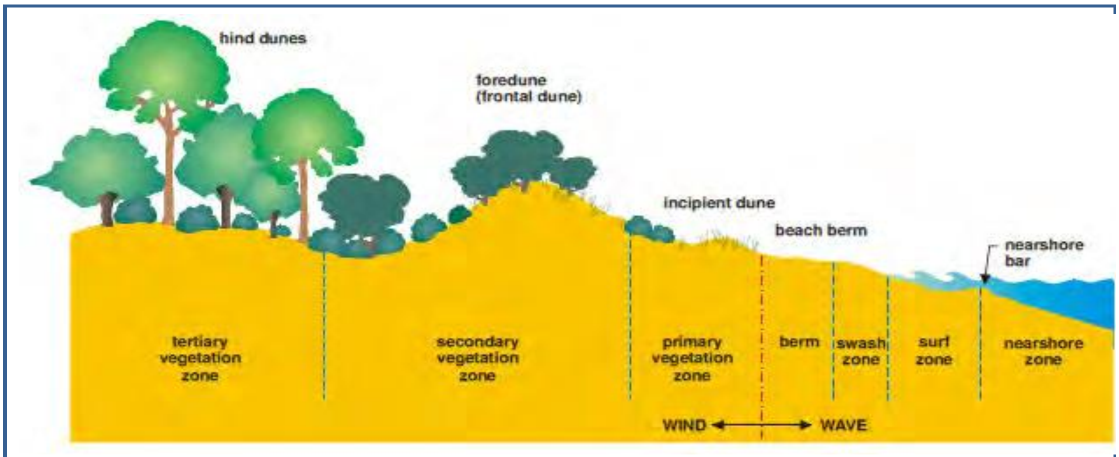
Sandy beaches and sand dune ecosystems

Sandy areas include coastal sandy beaches and sand dune ecosystems that stretch several kilometers inland from the shoreline. Quang Binh has over 35,000 ha of coastal sandy areas, representing the largest area of any of the original coastal ecosystems found in Quang Binh Province. Coastal dunes are accumulations of wind-blown sand located behind the beach. Typically, an undisturbed beach will be backed by a foredune (also known as a frontal dune) and hind dunes. Vegetation cover is a crucial element of dune landscapes. Wind velocity is generally reduced by plant cover, encouraging deposition and trapping of wind borne sand. The presence of a stable dune system provides a natural physical defence mechanism against coastal storm hazards and sea level rise. Sand dune ecosystems also provide a very important function in filtering rain water and storing underground water, providing a critical dry season water supply. Natural vegetation of sand dunes areas can provide grazing for livestock and some edible and medicinal plants used by people.

Sand dune ecosystems are very dynamic areas, but if ecological processes are occurring naturally, then on the landward side of the system mature tree cover eventually stabilizes the movement of sand. Consequently, coastal sandy areas in Quang Binh province were historically covered by forests with more than 250 indigenous tree species. Today however, the fore-dunes are already extensively developed, with large and small aquaculture and the villages of inshore fishermen, while on the landward side of the dune system, the original natural forest habitat has almost all disappeared. With increasing population and expanding residential land, the natural forests were clear cut and replaced with Casuarina equisetifolia for fuel wood needs of local people. Nowadays, in addition to the main planted tree species only a small number of other species can be found growing with the casuarina, such as Axonopus compressus, Pandanus humilis, and Pandanus odoratissimus.

There are only a few scatterred small remnant patches of natural coastal forest remaining in some parts of the province. In Quang Dong commune of Quang Trach district and Hung Thuy commune of Le Thuy district, there areas some 150 ha of natural sandy forest with indigenous tree species. In Quang Dong commune, Melaleuca cajuputi forest is good example of indigenous tree species in coastal protection forest.

Figure 3.3: Typical features of a dynamic beach system



Source: Coastal Dune Management, Land & Water Conservation Department, NSW, 2001

Figure 3.4: Melaleuca cajuputi native coastal protection forest in Vinh Son village, Quang Dong commune

Coral reefs

Vietnam's coastal waters contain a wide range of reef diversity and structures supporting over 350 species of hard corals in an estimated area of 1,122 km^2. Coral reefs in Vietnam's coastal waters are mostly fringing and patch reefs, with sparse cover and are limited in size compared to barrier reefs and atolls. The condition of 60% of Vietnam's reefs has been described as fair, 20% as poor, 17% as good, and only 3% as excellent (Chou et al. 2002). These coral reefs continue to be stressed by a variety of threats, particularly in areas of dense human populations. Including over-fishing, destructive fishing, pollution, coastal development and sedimentation, coral exploitation, and tourism, as well as from bleaching events and outbreaks of crown-of-thorns starfish (Tuan et. al. undated National Report on Coral Reefs of Vietnam fort UNEP South China Seas Project)

In the last decade, the Vietnamese government has become interested in the study of coral reefs, demonstrated by the investigation of reefs in the Cat Ba - Ha Long coastal area, the monitoring of reefs in Nha Trang Bay, Con Dao Archipelago and Phu Quoc Islands (Tuan et al. 2005; Tuan et al. 2008), towards development of a network of marine protected areas. However, no specific information or studies could be found on coral reefs in Quang Binh Province. Not even the Seas and Islands Division of DONRE which has direct responsibility for management of coral reefs had any information at all about location of coral reefs in the province. From the coastal morphology and oceanic conditions, we can expect there to be some fringing reefs running parallel to the shore line. Unconfirmed reports from local fishermen suggest this is in fact the case.

Coral reefs are important in supporting fisheries productivity, and in providing physical protection to the coastline from storms and strong waves. It is important to find out more about the location, size and condition of coral reefs in Quang Binh. This can be done by starting from local knowledge of fishermen about the location of reefs, as well as using the remote sensing methodology recently developed and tsted by Tran et.al. (2012) for mapping the benthic cover of coral reefs n Vietnam's coastal waters from high-spatial resolution, multi-spectral satellite image data.

Sea-grass beds

Sea-grass areas are common at the edges and landward sides of typical fringing reefs. The effects of typical fringing reefs in reducing the effects of wave action on the coastline, creates an environment suitable for sea-grass development. A good example of this mix of coral reefs and sea-grass beds can be observed at the Southeastern Bay of Con Dao Island, in Binh Thuan Province along the Vinh Hao coast, and along the Ninh Hai coast in the Ninh Thuan Province. As with coral reefs, sea-grass beds are extremely important in supporting fisheries productivity. And similarly to the case of coral reefs in Quang binh, no specific information could be found on sea-grass in Quang Binh. Again the Seas and Islands Division of DONRE has no information whatsoever on whether or not there is any sea-grass in Quang Binh, where it is, what condition it is in, etc.

3.5 ECOSYSTEM RESILIENCE AND EBA

Natural ecosystems provide a wide array of goods and services to human societies. Amongst these ecosystems services are the many ways in which nature helps support human resilience in the face of climate change, and extreme events associated with climate change. "Natural infrastructure" such as coastal mangrove forests, and melaleuca forests, can provide a "bio-shield" offering protection from storms and strong winds. Under certain conditions silt trapped by mangroves can raise the level of the land to keep pace with sea-level rise; and large sand dunes constitute a natural sea wall offering very significant physical protection against storm surges and sea level rise. Similarly, forest cover on steep slopes can offer protection against soil erosion and flash flooding which are likely to be increasingly serious issues with the more frequent heavy rainfall events predicted to come with climate change. Significant areas of tree cover can also have a cooling effect on air temperature and soil surface temperature. Natural wetlands can help absorb flood-waters, reducing the onset, severity, depth and duration of downstream flooding, which is also likely to become an even bigger problem under climate change scenarios.

However, to play these roles effectively, natural ecosystems clearly need to be present not only in the required location, but also in an appropriately large area (relative to the size of the problem faced and the level of protection required). At the same time, natural ecosystems themselves are also threatened by climate change, and so to ensure survival and effective functioning of the ecosystems and to allow them to continue to provide the services that support human resilience, the ecosystems must also be maintained in good condition. In general, resilience of ecosystems to climate change can be improved by first reducing other non-climate stresses on the ecosystems. More specifically characteristics that are important for ecosystem resilience that management needs to take into account according to Bezuijen et. al. 2011; Bickford et. al., 2010; Bobenreith et.al. 2012 include:

- size of ecosystem area (larger areas of natural ecosystems will be more resilient)
- connectivity of ecosystems across landscapes (more connected areas have higher resilience - necessary to allow both latitudinal and altitudinal movement of species in response to changing conditions, e.g. a one degree change in temperature means organisms need to move either 55km away from the equator towards the poles, or to 100m higher altitude in dry areas or 200m higher altitude in wet areas, to find the same climate conditions that they are used to)
- species and genetic diversity within the ecosystem (more diverse systems have higher resilience)
- phylo-geographic diversity (the extent to which genetically different populations of a species are dispersed across the landscape, with more diverse and widely scattered populations probably being more resilient to change)
- functional redundancy of species (the higher number of species that can play a similar role in the ecosystem functioning, then the greater the resilience - if some of these species disappear because of climate change the overall ecosystem will still continue to function)

When further considering the resilience of individual key species within each ecosystem, the following are also important:

- Life history traits of species will determine the ability to adapt to change (species with high reproductive rates, fast life history, short life span and ability to disperse widely across habitats to track the preferred climate space, are predicted to be more resilient and recover faster from change)
- 'Ecological' plasticity of species or the ability of individuals and populations to make active changes in the short-term - both physiological changes (e.g. acclimation, modified thermoregulation) or behavioural changes (e.g. seeking out shelter within the existing habitat, dispersing away from the site to more suitable areas, changes in daily or seasonal temporal activity, changes in microhabitat use within the site, changes to biotic interactions) allows species to cope with change

Table 3.9: Summary of key points of Quang Binh ecosystems for resilience and EbA

Ecosystem type	Amount	Status (condition) and main threats	Main climate vulnerability
Evergreen coniferous forest >700m altitude	37,000ha (including 5,000ha of *Calocedrus*)	Medium size area , good condition, protected in PNKB	Already at high altitude, may have restricted opportunity to move when temperature increases; Increased risk of forest fire
Forest on Limestone >700m altitude	3,000ha	Small area, but good condition and protected in PNKB	Already at high altitude, may have restricted opportunity to move to when temperature increases; Increased risk of forest fire with more very hot days and longer/drier dry season Conditions may become too dry for some species in longer hotter dry seasons, so species composition of the forest may change over time
Semi-tropical broadleaf moist evergreen forest >700m altitude	26,000ha	Medium size area, good condition protected in PNKB	Already at high altitude, may have restricted opportunity to move to when temperature increases; Increased risk of forest fire with more very hot days and longer/drier dry season Conditions may become too wet for some species as soils get waterlogged with more abundant and intense rainfall in the rainy season. Species composition may change over time
Forest on Limestone <700m altitude	90,000ha	Large area, mostly in PNKB where it is well protected. In other parts of the province large areas of karst are quarried and any forest destroyed in the process	Increased risk of forest fire; Conditions may become too dry for some species in longer hotter dry seasons, so species composition of the forest may change over time
Tropical broadleaf moist evergreen forest <700m altitude	300,000ha	Very large area but of varying condition. A lot of secondary forest that had previously been logged. Large areas smothered by invasive climbers. Illegal logging a problem in some areas. Most of this ecosystem is designated as production forest, but no harvesting is currently happening in most of it. 25,000ha has FSC Certification and will be allowed to start harvesting some time in 2016 onwards	Conditions may become too dry for some species in longer hotter dry seasons, so species composition of the forest may change over time Conditions may become too wet for some species as soils get waterlogged with more abundant and intense rainfall in the rainy season. Species composition of the forest may change over time
Caves	Total number unknown	A large number of caves are protected in PNKB, even	Increasing and increasingly heavy, rainfalls on thin soils over permeable limestone will

Ecosystem type	Amount	Status (condition) and main threats	Main climate vulnerability
		though some of them are impacted to some extent by tourism development. Many caves in other parts of the province are destroyed by limestone quarrying	change the water floes in underground streams flowing through the karst landscape. This can lead to damaging floods in some of the caves
Rivers and streams	5 main rivers with 260km length, 27 Tier 1 tributaries	Headwaters in forested areas can be expected to be in reasonable condition; In lower reaches riparian vegetation has been removed as crop fields go right to the river edge; Natural movement of rivers across the floodplain has been restricted by dykes and polders; Natural flows of water and sediment have been interrupted by construction of reservoirs and saline intrusion barriers	Rivers will have lower flows in dry season and higher flows in rainy season due to changed rainfall patterns. Saline intrusion up rivers will increase with sea level rise and with lower dry season flows
Open water bodies (ponds, lakes and lagoons)	31, with 400 trillion cubic metres total volume	Natural vegetation around lowland lakes has been mostly replaced by casuarina and acacia Urban/peri-urban wetlands in Dong Hoi ae being reclaimed (filled-in) for development	Heavy rains and storms may cause increased erosion in headwaters areas that will cause faster in-filling of the water bodies with sediment The overall net effect on the size of water bodies of increased rainfall in the rainy season and increased evaporation in the hotter dry season is unclear
Mangroves	11,000ha	Mangroves are found in scattered patches in the estuaries, and are heavily degraded, and of low stature	Small remaining area, with lack of connectivity of different patches and barriers to landward movement makes mangroves very vulnerable to SLR and temperature changes
Melaleuca Forests	150ha	Only very small remnant areas remain. Even these small area are still being cut for firewood by local people	The small size of remaining areas greatly reduces resilience to climate changes
Sandy beaches and sand dune ecosystems	35,000ha	Sandy areas account for a very significant part of the coastal zone - but have mostly been heavily degraded by a combination of human settlement, tourism development, aquaculture, agriculture and titanium mining. Native species tree cover has been replaced with casuarina and some acacia	Stronger and more unpredictable storms will blow more sand and blow it more vigorously. As there is very little natural vegetation to hold the sand, the ecosystem is likely to be further degraded by climate change
Sea-grass beds	Unknown area	Unknown - but based on overall trends in Vietnam, are expected to be fairly degraded	SLR, higher water turbidity from storms
Coral reefs	Unknown area	Unknown - but based on overall trends in Vietnam, are expected to be fairly degraded	SLR, increased sea water temperature, ocean acidity

Reviewing the extent condition and trends of ecosystems in Quang Binh described above, it is clear that in the lowlands and coastal area, most areas of original natural ecosystems have either disappeared entirely or been highly degraded. Mangrove forest, and Melaleuca forest only exist in small remnant patches. Sandy beaches and sand dunes have been impacted by tourism development, fishing village settlement and the development of aquaculture on sandy areas, as well as titanium mining. There is very little natural riparian vegetation and floodplain vegetation in the lower reaches of the main rivers, and the flow regimes of these rivers have been altered through water infrastructure development. Estuaries have been highly developed and estuarine ecosystem functioning significantly altered.

In this situation, most of the remaining lowland and coastal ecosystems are not in a good position to be able to offer significant ecosystem services that help build resilience to climate change - and these ecosystems themselves may not survive the double stresses of their current degradation together with climate change for much longer.

As identified in Chapter 2 of this report - the Social Profile, the majority of Quang Binh's population (including the largest numbers of poor people) are concentrated in the lowland and coastal areas. It is therefore understandable that the ecosystems found in the lower reaches of river basins, in the estuaries river mouths and along the coastlines have been the most transformed from their original state. However, the coastal population of Quang are on the climate change front-line, being most the exposed to many of the region's most severe climate events - tropical storms, tidal surges, saline intrusion, while at the same time they are now left with the least remaining natural environment to support their resilience. In addition, although the provincial population is only increasing slowly, the fastest increase is taking place in the lowlands and coastal areas where exposure is greatest. The growing population is accompanied by increasing urbanisation, which may in turn exacerbate certain climate related problems like flooding and heat stress.

In the hilly and mountainous areas there is still significant forest cover. A large proportion of this is natural forest, of varying condition. A significant portion of this forest is contained within the PNKB National Park and World Heritage Site, as well as its adjacent buffer zone. As identified in the social profile, the poverty rate is high in the mountain districts, especially amongst ethnic minority groups. Poverty increases vulnerability to climate change and reduces the capacity to adapt. Livelihoods that are dependent on natural resources such as forestry tend to be more vulnerable to the changing climate. Furthermore, the less diversified a family's livelihood is, the more vulnerable it is likely to be since if one livelihood aspect suffers impacts of climate change, they lack alternatives to fall back on. In this situation the forest still provides very significant ecosystem services, and can make a huge contribution to building increased resilience to climate change if managed properly.

3.6 CONCLUSIONS AND RECOMMENDATIONS

In this assessment, 'ecosystem-based approach to climate change adaptation' is understood as promoting the conservation and restoration of ecological processes and habitats that build both ecosystem and community resilience to climate changes by maintaining ecosystem services that protect and support livelihoods and infrastructure.

This initial analysis suggests that, from the ecological perspective, priorities for Macro-scale EbA action would be:

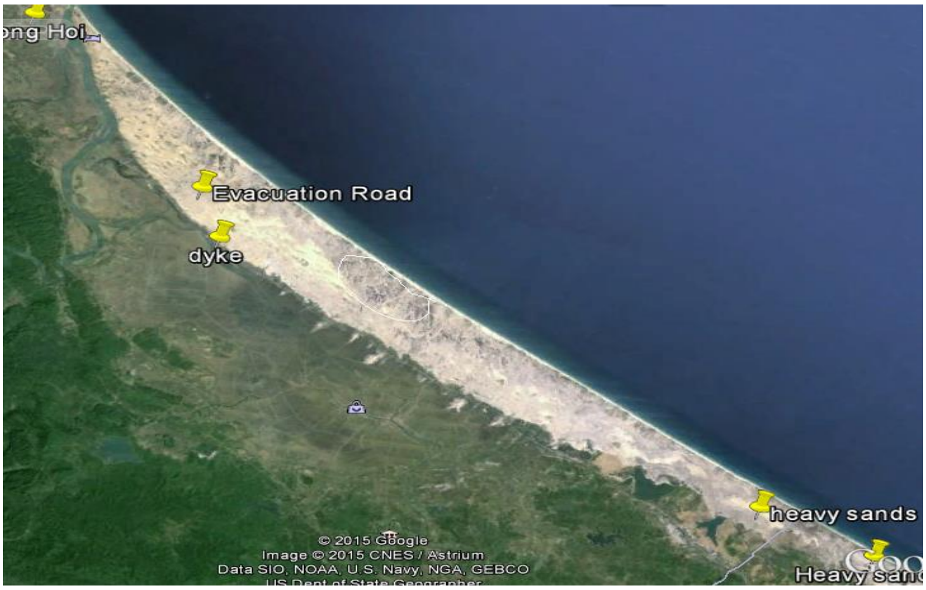
3.6.1. Restoration of Native Species Coastal Forests

The importance of coastal forests in the context of climate change has been recognized at the highest level in Vietnam through the Prime Minister's Decision No. 120/QD-TTg on Protection and Development of Coastal Forests to cope with climate change. However, the coastal protection forest in Quang Binh today is almost exclusively plantations of introduced species - mainly Casuarina equisetifolia, and some acacia. While these trees provide some physical protection, air quality maintenance, climate buffering and fuel biomass services, these are not as effective as services from a natural ecosystem.

Any meaningful EbA intervention in the coastal areas of Quang Binh would therefore have to involve a large-scale ecosystem restoration effort. It would require significant investment but could also provide very significant returns on investment. For example mangroves can increase surface elevation from 1-10mm/year, keeping pace with sea level rise; and because 75% of all tropical fish species spend some part of their life cycle associated with mangroves, then each hectare of mature mangroves roughly translates to one additional ton of fisheries production per year; and for the best return on investment of all, each $1 million invested in mangroves in Vietnam can reduce the budget needed for dyke maintenance by over $6 million (Schmitt et.al., 2013).

Government officials are very concerned about the sand dune landscape all along the coastline stretching southwards from Dong Hoi. Blowing sand and migrating dunes are likely to become more serious problems as storm events intensify. Photo 3.3 shows tongues of sand extending landward into the back-dune lagoon area. This is an important rice growing area, and people living here are threatened from both sides: from the sea by blowing sand, and from the land by floods, that it is feared will overtop existing dykes. Blown sand contaminates the paddy land, and interferes with roads and livelihoods, but it is also clear that this spreading sand has provided higher ground for settlements, and the dunes also provide fresh water for local communities and aquaculture.

Map 3.7: Google Earth image of the sand dune ecosystems south of Dong Hoi, Quang Binh



Tongues of sand appear to be extending into the paddy lands

A really significant EbA approach could focus on the sand dune landscape, which although severely degraded, occupies a large area, still has some natural vegetation cover remaining in places, and continues to offer very significant physical protection from storm surges and sea level rise, as well as providing a major surface and ground water source. At the same time, the dunes south of Dong Hoi have enormous potential for tourism and recreation, to complement developments already taking place on the Bao Ninh peninsula. A series of 10 golf courses is planned for the dunes, and the first 2,000ha resort with 36 holes, hotel, spa, shopping complex and zoo, is expected to be operational in late 2016. Sand dune restoration work with native species could possibly be considered in collaboration with the golf course developments.

The situation needs further review or investigation - to identify the areas most affected by blowing sand, the causes and detailed impacts of it, the past plantings and their strengths and weaknesses in addressing the problems, interactions between the different ecosystem services and scope for ecological restoration using native species.

3.6.2. Management and Restoration of Coral Reefs and Sea-grass beds to support resilience of near-shore fisheries

There is very little information available about coral reefs and sea-grass beds in Quang Binh. These ecosystems can be extremely important as breeding nursery and feeding grounds for many commercially important fishery species at different stages of their life-cycle. Their physical impact on reducing wave energy also provides a valuable form of coastal protection against erosion from strong waves and storm surges. An important first step would be to conduct a baseline survey to assess the location, amount and current status of these two ecosystems in Quang Binh. Based on this information, appropriate action can be identified.

3.6.3. Maintaining/restoring natural flows and rewilding rivers

At least one of the 5 main rivers in Quang Binh could be maintained in a relatively natural state. Release of water from upstream reservoirs could be managed to maintain environmental flows. In the lower reaches, dykes/polders could be removed and space should be provided to allow the river to move naturally. No additional saline intrusion barriers should be built. Crop fields should be set back from the river's edge and riparian vegetation replanted.

3.6.4. Landscape connectivity of natural terrestrial forest

To enhance the resilience of natural forest, corridors should be maintained linking different areas of natural forest together. In this way connectivity can be maintained between SFU Forest in PNKB, and Natural Production Forest in the wider landscape.

3.7 REFERENCES

BCA, WWF, Stockholm University (2013) *Ecosystems classification mapping in Vietnam*. Ha Noi, Vietnam

Bezuijen, M. R., Morgan, C., and Mather, R. J. (2011). *A Rapid Vulnerability Assessment of Coastal Habitats and Selected Species to Climate Risks in Chanthaburi and Trat (Thailand), Koh Kong and Kampot (Cambodia), and Kien Giang, Ben Tre, Soc Trang and Can Gio (Vietnam).* Gland, Switzerland: IUCN > Download (5 MB)

Bickford, D., S. D. Howard, D. J. J. Ng and J. A. Sheridan (2010), *Impacts of climate change on the amphibians and reptiles of South-East Asia.* Biodiversity and Conservation 19: 1043–1062.

Bobenrieth, M.E., Sun, K., Kong, K. and Mather, M. (2012). *Vulnerability and Capacity Assessment of Koh Kong and Kampot provinces, Cambodia*, Gland, Switzerland: IUCN. 36 pp. > Download (1.45 MB)

CEE, 2011, Center of Environmental Engineering, Southern Nature Resources and Environment Company

Chou, L.M., Tuan, V.S., PhilReefs, Yeemin, T., Cabanban, A., Suharsono, & Kessna, I. (2002). Status of Southeast Asia coral reefs. In C. Wilkinson (Ed.), *Status of Coral Reefs of the World: 2002* (pp. 123-152): Australian Institute of Marine Science.

DARD 2015 Protection Forest Planning

Decision by the Vietnamese Prime Minister on establishment of Phong Nha-Kẻ Bàng National Park". 12 December 2001. Archived from the original on 22 January 2008. Retrieved 24 February 2008.

Dudgeon, D. 2007. Going with the flow: global warming and the challenge of sustaining river ecosystems in monsoonal Asia. Water Science & Technology: Water Supply 7: 69-80.

Gebert, R (ed). (2012) Gender-Poverty-Ethnicity: the challenge of social inclusion conservation planning for the PNKB.

Golovatch S, Geoffroy JJ & Vandenspiegel D. (2013). On several new species of the millipede family Glomeridae from Vietnam (Diplopoda: Glomerida). Arthropoda Selecta, 22(3): 201-206. Clark, B. (2013)

Haus T., Vogt M., Forster B., Thanh Vu N., and Ziegler T. (2009) Distribution and Population Densities of Diurnal Primates in the Karst Forests of Phong Nha-Ke Bang National Park, Quang Binh Province, Central Vietnam. International Journal of Primatology 30:301–312.

Hubner, A and Truong Si Hong Chau (editors). (2013) Sustainable Tourism. Johnson, I, and Nguyen Thi Ngoc Anh (eds). (2012)

Hubner, A., Phong, L. T., Chau, T. S. H. (2014) Good governance and tourism development in protected areas: The case of Phong Nha-Ke Bang National Park, central Vietnam. Koedoe, 56(2).

ISPONRE 2009. Ha Tinh Assessment Report on Climate Change.

IUCN Conservation Outlook Assessment, Phong Nha - Ke Bang National Park http://www.worldheritageoutlook.iucn.org. Accessed March 2015.

Le Trong D., Do Tuoc, Dinh Huy Tri, Le Thuc Dinh and Dang Ngoc Kien (2009) Census of Southern white-cheeked crested gibbons in U Bo and adjacent buffer zone forests, Phong Nha-Ke Bang National Park, Bo Trach District, Quang Binh Province, Vietnam. Fauna and Flora International (FFI) - Vietnam Primate Programme.

MARD (2014), Restructure of National Forestry, Hanoi.

MARD-FIPI (2012)

Moulds, T.A., Pham, D.S., Mouritz, R. (2010) Preliminary Survey of Cave Fauna in the Phong Nha-Ke Bang World Heritage Site, Vietnam. Unpublished report to GTZ, May 2010, pp 34

National Geographic (2011) *"World's Biggest Cave Found in Vietnam". National Geographic Daily News. 3 January 2011. Retrieved 7 April 2013*

Nguyen Quang My and Howard Limbert. (1993). *Tropical Karst in Vietnam*. Hanoi University.

Nguyen Thi Nguyet, Ho Dac Thai Hoang, 2014. *Structure of mangrove forest in downstream area of Long Dai river, Quang Ninh district, Quang Binh province. Journal of Agriculture and Rural development*) (Old name:

Science of Agricultural engineering; Agriculture and Food industry; Forestry, Irrigation; Agricultural economics) (Ministry of Agriculture and Rural development), No: 4, P: 262-268.

Pham Khang. (1985). "The development of karst landscapes in Vietnam". *Acta Geologica Polonica*. 35 (3-4). pp 305–319.

Quang Binh GSO, 2014, General Statistical Office of Quang Binh province

Rosen, E. (2014) World's largest cave in Vietnam threatened by cable car, The Guardian, 3 December 2014.

Schmitt, K. Albers T., Pham T.T., and Dinh, S.C. (2013)

Site-specific and integrated adaptation to climate change in the coastal mangrove zone of Soc Trang Province, Vietnam, GIZ

Tran Trung Thanh, Ho Dac Thai Hoang, Pham Hong Thai. 2010. *Actual state and solutions to manage sustainable mangrove forest ecology at Gianh estuary, Quang Binh province*. Ecological Economy journal. Ecological Economy Institute. Hanoi. 36: 36 – 46

Timmins, R. J., Do Tuoc, Trinh Viet Cong and D. K. Hendrichson. (1999). *Preliminary Assessment of the Conservation Importance and Conservation Priorities of the Phong Nha - Ke Bang Proposed National Park, Quảng Bình Province, Vietnam*. Fauna and Flora International - Indochina Programme, Hanoi.

Tran, V.D.; Phinn, S., and Roelfsema, C. (2012) *Coral Reef Mapping in Vietnam's Coastal Waters from High-spatial Resolution Satellite and Field Survey Data* 2012 AARS Corresponding author: dien.tran@uqconnect.edu.au *Asian Journal of Geoinformatics, Vol.12,No.2 (2012)*

Tuan, V.S., Ben, H.X., Long, N.V., & Hoang, P.K. (2005) *Status of coral reefs in Southeast Asia: Vietnam.* In, Japan Wildlife (pp. 95-112).

Tuan, V.S., Yet, N.H., Long, N.V. (undated) *National Report on Coral Reefs in the South China Sea – Vietnam* UNEP

Tuan, V.S., Long, N.V., Ben, H.X., Hoang, P.K., & Tuyen, H.T. (2008). *Monitoring of Coral Reef in Coastal Warters of Vietnam: 1994-2007.* In (p. 105). Nha Trang: Institute of Oceanography.

Viet Nature (2013) Action plan for strengthening forest law enforcement and wildlife management in Phong Nha-Ke Bang National Park Region and Quang Binh Province.

Wikramanayake, E.D. et al. (2002). *Terrestrial Ecoregions of the Indo-Pacific: A conservation Assessment*. Island Press, New York. ISBN 1-55963-923-7

Wildlife Conservation Society (2013) *Forest Law Enforcement and Wildlife management status survey in PNKB Region and Quang Binh Province.*

Worboys, G. (2012) *Phong Nha - Ke Bang National Park, World Heritage Management Planning Requirements Mission Report.* IUCN, Gland.

World Heritage Nomination, IUCN Technical Evaluation; Phong Nha - Ke Bang National Park, pgs. 53-55" (PDF). IUCN. Retrieved 28 February 2008.

CHAPTER 4 ECONOMIC PROFILE OF QUANG BINH FOR VULNERABILITY ASSESSMENT AND EBA

4.1 INTRODUCTION

This Chapter presents the provincial-level economic analysis that contributes to the Vulnerability Assessment for Ecosystem-based Adaptation to Climate Change in Quang Binh. It does not attempt to present a full economic profile of Quang Binh. The study is intended to use only secondary data, and, while many interesting and relevant questions could be posed at provincial level, there are only a limited number of economic factors that are relevant to the discussion and for which sufficiently comprehensive data already exists. Rather, this is essentially a scoping exercise, with the objective of identifying the most important and historically most vulnerable economic activities and assets at provincial level that should form the basis of socio-ecological systems and be prioritised in the vulnerability assessment.

4.2 KEY ECONOMIC FACTORS FOR THE PROVINCIAL EBA ASSESSMENT OF QUANG BINH

4.2.1. Overview of Questions and Data

Given the objective of identifying the most important economic activities and assets at provincial level for consideration in the climate change vulnerability assessment, this study focuses on answering a few simple questions:

- What is the current structure and status of Quang Binh's economy?
  - Which sectors contribute most to GDP; exports, employment; land use etc.
  - What are the key activities within those sectors?
  - Who is involved/most important (state, private, smallholder)
- What plans are there for future development?
- What are the key assets supporting economic activity and where are they located
  - Transport (road, rail, ports), power, water.
- How have the key activities and assets been affected by extreme climatic events in the past?

Together with the findings of the ecological and social profiles for the province, the answers to these questions will help establish the units of analysis for the Vulnerability Assessment - the socio-ecological systems (SES) of Quang Binh, and then help prioritise of a small number of the SES for the local level vulnerability assessment.

At the time of research and writing, the SEDP for 2016-2020 was still being finalised. Although an overview was available (QBPPC 2015), much of the background information was omitted. Thus, some of the data presented here is from the previous SEDP 2011-2015 and somewhat out-of-date, or data is compiled from multiple sources, presenting inconsistencies in years or units of analysis. The account presented should thus be taken as indicative, rather than definitive.

For readers at the provincial level, much of the information provided below will be familiar - but presented in a new, concise and useful way. For readers outside the province - it is intended to provide an overview of the economy, highlighting the factors to consider in EbA planning.

4.2.2. Overview of the Status and Structure of the Provincial Economy

4.2.2.1. GDP

Of Vietnam's 63 provinces, Quang Binh represents 2.4% of the total area (806,613 ha) and only 1% of the population (863,350 people in 2013), but has a GDP per capita equivalent to USD 1,240 (2015), only 60 % of the national average (USD 2073). In 2014, total GDP was 43,433 billion VND, (USD 2 billion) representing 1.1% of national GDP. In 2012, the province contributed 1,840 billion VND (USD 90 million) to its own state budget (of the total US$37.68 billion) or only 0.24%. The remainder of the budget is provided by central government. Thus, Quang Binh is one of the poorest provinces in Vietnam. However, as described below, it is also has one of the fastest growing economies in the country.

4.2.2.2. STRUCTURE OF THE ECONOMY

4.2.2.2.1. Three Sectors

In Vietnam, as elsewhere, structure of the economy is described in terms of the GDP contributions of three main "sectors": i) the primary sector: agriculture, forestry and fisheries (AFF); ii) the secondary sector: industry, including mining and construction; and iii) the tertiary sector: services, including trade and tourism. In Quang

Binh, by 2015, "services" was the most important sector, contributing 50.6% of GDP7, followed by industry at 24.8% and AFF at 24.6%.

4.2.2.2.2. Principal economic activities by sector

Within each of these sectors, a few activities stand out and help to characterise the economy of Quang Binh. Table 4.1 shows some key activities in the three sectors. Often overlooked, the most important sector in the province is retail services and most of these are concentrated in the Dong Hoi and other urban areas. Better known is the fact that construction materials, particularly cement, are the second most important component of the province's economy. Interestingly, the third ranked activity is civil infrastructure construction. More surprising, is that the fourth most important economic activity overall, and single most important within the AFF sector, is pig production.

Table 4.1: Principal economic activities in Quang Binh, by sector, 2014

Sector	Activity	Value (m VND, 2014)	Rank
AFF		(10,258,958)	
Agriculture	Cereal production (rice, maize)	1,784,000	7
Livestock	Pig Production	2,168,366	4
Forestry	Timber production	699,890	10
Fisheries	Capture Fishery	1,896,581	6
Industry		(9,723,327)	
Processing	Construction materials (cement)	2,990,894	2
	Food processing (incl beer)	1,082,792	8
	Timber processing	1,920,652	5
Construction		(4,485,047)	
	Civil infrastructure	2,412,140	3
Services			
	Retail	12,943,000	1
	Tourism (Accomodation, catering)	1,254,000	9
	Export		?

Source: Quang Binh Provincial Year Book, 2015

4.2.2.3. LABOUR AND EMPLOYMENT

Employment provides another perspective on the importance of different sectors to the economy. Table 4.2 presents data on the employment in different sectors from 2010 and 2013. Although "Services" now generate the greatest proportion of provincial GDP, the sector provides only about 11% of the jobs, while the AFF sector continues to provide the most employment, engaging over 65% of the workforce.

Table 4.2: Labourers and employees by activity, Quang Binh in 2010

Sector	No. labourers	%	2013 No. employees	%
Agriculture and Forestry	255,347	56.2	2,989	7.2
Fisheries	42,150	9.4		
Construction	18,574	4.1	11,985	28.7
Industry - Mining, processing	45,786	10.0	11,001	26.4
Retail, vehicle repair	34,753	7.6	8,208	19.7
Hospitality	9,206	2.0	1,981	4.7
Transport, storage, communication	9,699	2.1	1,774	4.3
Other	39,021	8.6	3,773	9.0
TOTAL	454,536	100	41,711	100

Source: Quang Binh Statistical Year Book, 2011

Formal employment is another matter altogether - less than 10% of labour is officially employed in a registered enterprise. Of these, approximately 30% are women. The most important sectors are construction and industry - together employing over half the work force. Retail trade is also important.

[7] It is unclear how the value of the service sector is calculated: in the SEDP, it appear includes export and import revenues – sums that are also included under industry and AFF.

Data on labour trends between 2005 and 2010 are provided in Table 4.3. They show that employment in all sectors is rising - but negligibly in AFF, while employment is services nearly doubled. In terms of employers, those in agriculture actually decreased over the period, while again, in services they increased substantially. This reflects the restructuring that the government is seeking. Labour productivity doubled in AFF and Services, and increased 200% in industry.

Table 4.3: Quang Binh labour statistics by sector: 2005-2010

	Unit	2005	2010	% change
1. Labour by sector	'000 persons	410.5	454.5	10.7
Ag/For/Fish	'000 persons	291,381	298,150	+2.3
Industry and Construction	'000 persons	56,580	65,290	+15.4
Trade and Service	'000 persons	62,496	91,060	+45.7
2. Employers	%	100	100	-
Ag/For/Fish	%	71	65.6	-7.6
Industry and Construction	%	13.8	14.4	4.3
Trade and Service	%	15.2	20.0	31.6
3. Labour productivity*	Million VND	11.06	28.44	157.1
Ag/For/Fish	Million VND	4.63	9.35	101.9
Industry and Construction	Million VND	25.55	78.41	206.9
Trade and Service	Million VND	27.77	54.50	96.3

SEDP 2011, * GDP/hh

4.2.2.4. LAND USE

Land use patterns provide a different set of insights into an area's economy. Table 4.4 presents figures for Quang Binh, and Map 4.1 shows the distribution of the principal land uses.

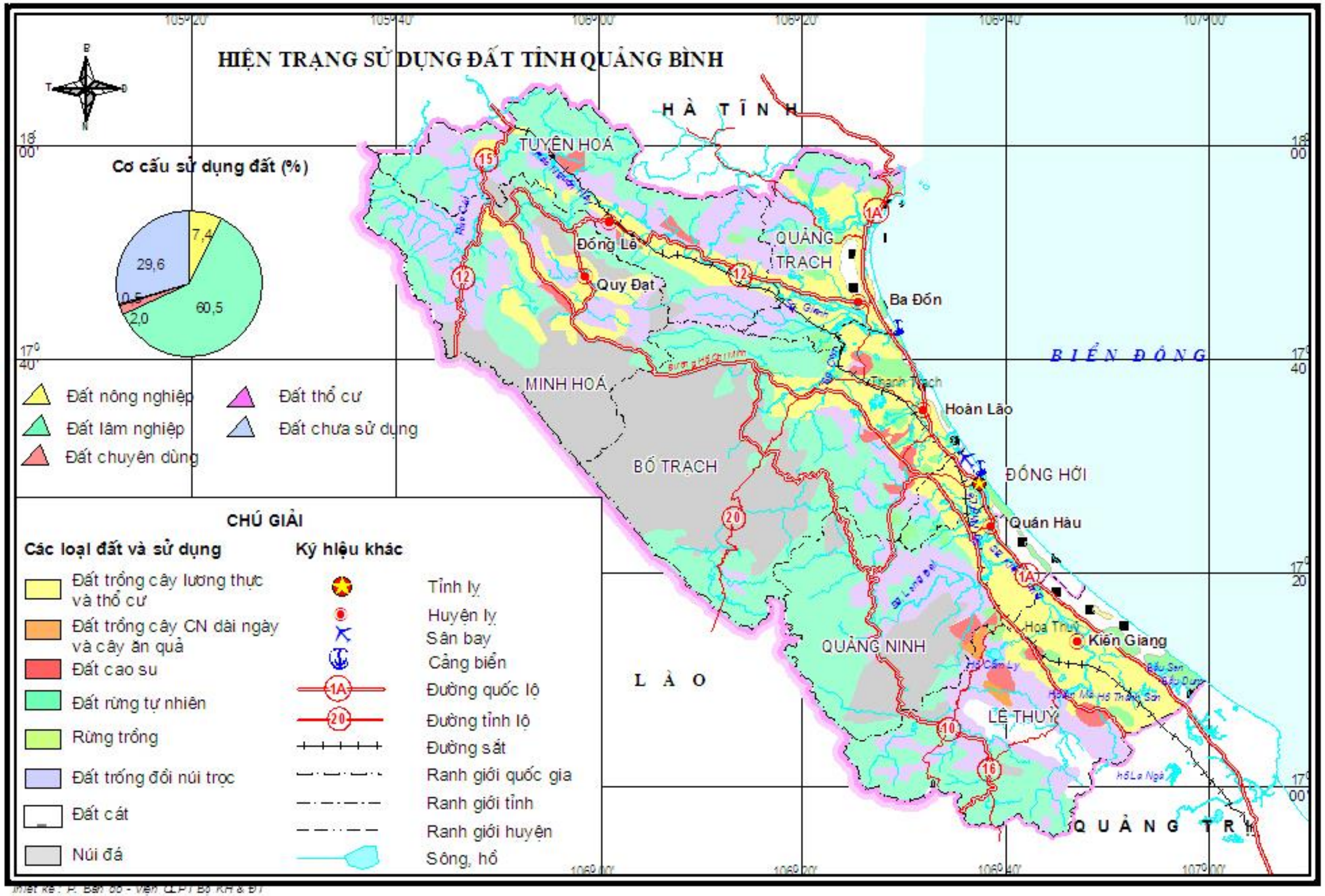
Reflecting the province's mountainous terrain and narrow coastal plain, described in Chapter 3, the principal land use in the province is Forestry, occupying 78.2% of the land, followed by agriculture occupying 10.3% of which paddy rice accounts for 4%.

Table 4.4: Land use in Quang Binh, 2013

No.	Use	Area (ha)	%
	Total	806527	100.00
1	AGRICULTURAL LAND	716802	88.9
1.1	Agricultural production land	82831	10.3
1.1.1	Annual crop land	58062	7.2
1.1.1.1	Paddy land	32455	4.0
1.1.1.2	Pasture land for animal raising	1130	0.1
1.1.1.3	Other annual crop land	24477	3.0
1.1.2	Perennial crop land	24769	3.1
1.2	Forest land	630872	78.2
1.2.1	Production Forest	309253	38.3
1.2.2	Protection Forest	198043	24.6
1.2.3	Special Use Forest	123576	15.3
1.3	Fisheries Area	2793	0.4
1.4	Land for salt production	84	0.0
1.5	Others	222	0.0
2	NON-AGRICULTURAL LAND	55181	6.8
2.1	Settlement land	5495	0.7
2.1.1	Urban	647	0.1
2.1.2	Rural	4848	0.6
2.2	Specially used land	28590	3.5
2.2.1	Land used by offices and non-profits agencies	166	0.0
2.2.2	Security and defence land	4938	0.6
2.2.3	Land for non-agricultural production and business	2373	0.3
2.2.4	Public land	21113	2.6
2.3	Religious land	75	0.0
2.4	Cemeteries	3013	0.4
2.5	Rivers and specialized water surfaces	17969	2.2
2.6	Other	39	0.0
3	UNUSED LAND	34664	4.3
3.1	Unused flat land	10249	1.3
3.2	Unused mountainous land	16624	2.1
3.3	Non-forested rocky mountain	7671	1.0

The forest area is split almost equally between protective (special use or conservation - 15.3% of total land - and protection forests - 24.6 %) and production functions (38.3% of total land). The protected forests still contribute to the economy - the special use forests as Phong Nha-Ke Bang National Park, which draws large numbers of domestic and foreign tourists, and the protection forests, less visibly, in the environmental services they provide to other sectors of the economy and the population in general. The production forests include a small area of managed natural forest and a much bigger area of plantations, both of native pine and exotics like acacia and eucalyptus. The total area under agriculture represents 10.3 % of the total. The three main uses - paddy, other field crops and perennial crops are also quite balanced (4%, 3 % and 3.1% respectively. The fourth use category - pasture for animal-raising is currently very limited in extent - but economic development plans include considerable emphasis on animal production, so this is likely to change (see below). The next most important land uses include pubic land (2.6%) and rivers and lakes or reservoirs (2.2%). Settlements occupy a surprisingly small area - 0.7% of total. Just over 4% of the land is classified as “unused”.

Map 4.1: Principal land uses in Quang Binh, 2010



4.2.2.5. OWNERSHIP

In 2013, the state still controlled 23% of Quang Binh's economic production, compared to 44% by the private sector, and 32.4% by households. Cooperatives and foreign ownership are not significant, statistically (Table 4.5). Foreign direct investment (FDI) is being encouraged in all of Vietnam, particularly in coastal special economic zones. These areas are amongst the most vulnerable to climate change and as the situation worsens, FDI is likely to decline.

Table 4.5: Quang Binh's sectoral GDP by economic agent, 2013 (billion VND)

Ownership	State	Non-State				TOTAL
Sector		Collective	Private	Household	Foreign	
TOTAL	7,748	170	17,653	12,483	5.9	38,061
%	23	.6	44	32.4	0.07	100
Industry	787.3	38.9	6,428	2,462	5.9	9,723
Retail	1,146	15	4,413	7,369		
Accommodation	44	-	312	898		

Source: Quang Binh Statistical Office (2015) Quang Binh Statistical Yearbook, 2014

4.2.2.6. EXPORT AND IMPORT

In 2013, the value of Quang Binh's exports was 138.3 million USD, or 0.1 % of Vietnam's total export revenue[8] (See Table 4.6). This represents a decline from 158.5 million USD in 2011. The main exports are rubber, wood chips and other timber products and pine resin products, titanium and cement. Most of Quang Binh's trade is domestic, within Vietnam. International trade is set to increase. Currently, China is the main trade partner. Much cement goes to Pakistan. Hon La port is the closest port for Laos and parts of Northern Thailand - so trade with these countries is likely to increase.

Table 4.6: Quang Binh, export value, trend and products, 2013

Commodity	2013	%	5 yr trend	Main products
Minerals and heavy industrial	649	0.5	Fluctuating x 5	Titanium, cement
Handicrafts, light industrial	31,825	23.0	Increasing	
Agricultural	77,698	56.2	Decreasing	Rubber
Forestry	24,222	17.5	Increasing	Logs, chips, colophon
Fisheries	3,916	2.8	Fluctuating	Frozen shrimps, squid, fish
TOTAL	138,310	100		

Source: Quang Binh Statistical Office (2015) Quang Binh Statistical Yearbook, 2014

Imports, on the other hand were worth less than half of exports, at USD 65.64 million. The main imported goods are fuel, raw aluminium (bauxite), timber products for processing and consumer goods.

4.2.3. Economic development: Performance and Plans

While Quang Binh is one of the poorest provinces of Vietnam, it is experiencing remarkably rapid growth and provincial government fully intends for this growth to continue. Table 4.7 presents performance data for the economy for the last 5 year planning period (2011-2015) and the growth targets for the present planning period. The economic targets for last planning period have been largely missed, due in part to weakness in the global economy. However, the targets were ambitious to begin with, and the results are still impressive: 6.5% pa GDP growth; 3,100 new jobs per year; 4% pa reduction in poverty rate. Social development achievements are also impressive - and the number of targets has been increased for the coming period.

[8] Vietnam's total exports in 2013 were USD 143, 186, 372, 666. http://data.worldbank.org/indicator/NE.EXP.GNFS.CD?order=wbapi_data_value_2013+wbapi_data_value&sort=asc

Table 4.7: Quang Binh economic performance 2011-2015 and targets for 2020

Indicator	2011-2015		2020
	Target	Achievement	Target
GDP growth pa	12-13%	6.5	8.5-9
GDP per capita	USD 14-1600	USD 1240	USD 30-3200
GDP total			
State Budget Revenue	2,500 b VND	2,745 b VND	8,000 b VND
AFF value growth pa (%)	4.5-5	4.2	4-4.5
Industry value growth pa (%)	21-22	9.1	11-11.5
Services value growth pa (%)	12-12.5	6.7	9-9.5
AFF (% GDP)	16.5	24.6	20
Industry/Construction (% GDP)	43	24.9	28
Services (% GDP)	40.5	50.5	52
Food production (tonnes)	27,5-28,000	29,800	n/a
Annual job creation (jobs)	3-3,200	3,100	3,1-3,200
Poverty reduction rate (%)	3.5-4	4.0	2-3%
National health care standard met (% communes)	80-85	80.5	90.6
Lower secondary school completion (% students)	100	100	100
Trained workers (%)	50-60%	60%	65%
Communes meet NRD standard	20%	21.3%	50%
Urban access clean water (% pop)	95	96	97
Rural access clean water (% pop)	75-80	84.3	90
Forest cover (%)	67.5-68.5	68	69-70
New targets for 2016-2020			
Social investment capital			60,000 b VND
Access national grid electricity			99.8% HH
Hospital beds/thousand			25.5
Health insurance participation			> 80%

Quang Binh's socio-economic development strategy seeks to build on its natural advantages and mobilise resources effectively, while protecting the environment and, importantly, responding to climate change. Economic restructuring takes centre stage. Agriculture, particularly those subsectors oriented towards commodity production, will still be promoted, for food security and political stability, but rural areas will be reconceived as satellites to urban areas and more integrated with them. The New Rural Development programme will continue to upgrade rural communes, closer to urban standards.

Table 4.8: Summary of projects included in the Quang Binh SEDP, 2016-2020

Sector	No. Projects	Budget (b VND)	%	Notes
Industry and Power	75	11376	27.4	Shoes, cement, 18 power plants
Agriculture Forestry Fisheries	17	3200	7.7	Forest, rubber, dykes, DRR, seafood processing; 32 poor coastal communes
Transport	33	9224	22.2	Roads (new, upgrades), bridges
Trade, services	18	5629	13.5	Diverse resort and ecotourism development
Defence Security	3	530	1.3	Border access and patrol roads ; combat training
Public infrastructure	34	6485	15.6	New urban areas,industrial parks, housing, water supply
Information/communication	8	1615	3.9	Peripheral, landline, internet.
Education	7	1040	2.5	Building upgrading schools, unis
Health	9	965	2.3	Build/enlarge/equip hospitals
Culture Sports	11	1496	3.6	Golf course, entertainments (Bao Ninh), marine park (Hai Ninh), monument restoration
TOTAL	215	41,564	100	

Source: SEDP Quang Binh 2011-2020

Greater attention will also be paid to the maritime economy, particularly restructuring capture fisheries better to exploit the deeper water resources. However, most emphasis will be put on industry, tourism and services, particularly services relating to tourism. Regionally, Quang Binh will exploit its location to provide logistic and transport services to its landlocked neighbour Laos, to northern Thailand and even to eastern Myanmar. In all sectors, modern technologies and efficiencies will be pursued and infrastructure developed comprehensively to support it all.

Quang Binh's socio-economic development strategy has a strong spatial component identifying special zones and corridors. Two highlighted areas are the western arm of the Ho Chi Minh Highway and the economic corridor of Highway 12A connecting the Cha Lo border crossing with the ports at Hon La and Vung Anh. Both projects will affect the mountains and the forests.

Table 4.8 presents a summary of the 215 projects proposed in the 2016-2020 SEDP, providing further insights into Quang Binh's development strategy. Industry, power and infrastructure get 55% of the total budget. By contrast, AFF receives only 7.7% of the budget, of which at least 30% appears to be for infrastructure. Trade and services receives 13.5% of the budget, most of which is for tourism related infrastructure. Similarly, education and health focus on building new facilities or improving old ones. The development strategy is thus very strongly infrastructure based - with important implications for climate change vulnerability and adaptation.

Additional details on development plans for individual sectors are provided in the next section.

4.2.4. Sectoral Description and Analysis

This section presents further information and analysis on the different sectors of the economy, as needed to help identify the province's economic assets and development priorities for the climate change vulnerability assessment.

4.2.4.1.3. THE PRIMARY SECTOR: AGRICULTURE FORESTRY AND FISHERIES AND MINING

As set out in the preceding section, over 80% of Quang Binh's population and 65% of its workforce depend on this sector, and it occupies nearly 90% of the land area. For some years, agricultural development has focused on the production of commodities, such as rubber, fruit trees and pepper, but basic food production also continues to increase. In pursuit of efficiency, there is a drive to convert underproductive rice paddy to shrimp, fish and other crops have higher economic value. There is also a new drive to promote more commercial livestock production - particularly pigs and dairy cows. The contribution of forestry to GDP is declining, but there is an increasing awareness of the value of forests' environmental services, such as water supply, erosion control and tourism. Fisheries are gaining in importance and the future of fisheries is seen in commercial shrimp production, especially on sand, and the restructuring the capture fishery from many small-scale inshore boats, to larger off-shore boats exploiting the abundant resources of deeper waters.

Across the AFF sector, the government is promoting greater commercialisation and recognises "farms" - larger scale units - in its annual statistics. These may produce annual and perennial crops, livestock and aquaculture products.

4.2.4.1.1. Agriculture

Annual crops

Rice remains the most important annual crop in Quang Binh, both by area and by value. The other important crops are peanuts, maize, sweet potato and cassava. A major policy in annual cropping is the promotion of "large fields" - larger scale production enterprises. In 2015, there were 17 enterprises on 6,509ha (1,269ha rice, 5,020 ha cassava, 40ha maize, 80ha sweet potato, 65 ha chili).

Rice

The total land area available for paddy cultivation is currently about 30,000 ha, the vast majority of which is located on the coastal plain. As shown in Table 4.9, the southern district of Le Thuy has the largest paddy area, while in the mountainous districts of Minh Hoa and Tuyen Hoa, paddy cultivation is restricted to small areas of flood plain of in narrow river valleys. Three crops are possible, each of around three months: winter-spring (December - March), early summer (April-June) and summer (July/August onward). The area cultivate each seasons depend on water availability - both from rainfall and irrigation. The winter-spring crop is the most extensive - taking 29,000 ha (2014); spring-summer drops to 24,000 ha. Both these areas have increased since 2001, by 12% and 37% respectively, mostly due to the expansion of irrigation. The summer crop however has decreased by nearly 80% and now stands at only 514 ha. Due to drought early in the season, and floods later in the season, the land is being used for other purposes.

Table 4.9: Rice production in Quang Binh, by district, 2013

Crop	Total		Winter spring		Early summer		Summer	
District	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)
Dong Hoi City	1864	4.1	982	5.5	881	3.6	0	0
Ba Don Town	4944	5.2	2749	5.4	2159	5.1	0	0
Minh Hoa	1033	4.1	451	4.8	441	4.5	132	0.49
Tuyen Hoa	2773	5.1	1504	5.5	1269	4.6	0	0
Quang Trach	6277	5.2	3181	5.4	3071	4.9	61	0
Bo Trach	8713	4.6	5306	5.4	3174	3.4	233	0.53
Quang Ninh	8588	4.6	4957	5.8	3541	3.1	90	1.1
Le Thuy	19414	4.5	9904	6.2	9510	2.7	0	0
Total	53606		29034		24046		516	

Drought also leads to saline intrusion, as river debits decline. In the lower Kieng Giang River, farmers are converting paddy fields to aquaculture.

About 36,040 ha are irrigated (FAO 2013). However, decreases in annual rainfall to 60% of normal in 2014 and 80% in 2015 l have meant that reservoirs were only filled to 60% capacity in 2014 and 30-40% in 2015. This is creating problems for paddy rice production.

Paddy lands and crops are also damaged by floods. This was particularly serious in 2007 and 2010, in the districts of Le Thuy and Quang Ninh. Table 4.10 provides some statistics on crop damage from flooding from 1989-2010.

Quang Binh is also affected by hot "foehn-like" winds from Laos, between March and April, and these are particularly strong from April to July. The wind decreases humidity, increases evaporation and causes water stress in plants which reduces yields. In 2005, losses of 58 billion VND were incurred.

There are no separate statistics for upland rice or information on how its production is being affected by climate change.

Table 4.10: Damage caused by storms and floods in Quang Binh, 1989-2010

Damage/Yr	Inundated paddt	Inundated farm produced
1989	28,500	10,299
1990	15,000	2,605
1991	12,300	1,970
1992	8,918	-
1993	3,871	2,253
1994	-	-
1995	4,178	4,648
1996	4,479	997
1997	-	2,141
1998	-	-
1999	-	-
2000	4,555	1,54
2001	6,685	-
2002	322	439
2003	-	559
2004	7,827	-
2005	550	1,346
2006	7,039	1,957
2007	8,701	3,372
2008	501.8	4,426
2009	386	3,819
2010	2,951	6,611

Source: Total main damage of Quang Binh in the period of 1989-2010

Some new rice cultivation techniques are being introduced, in part in response to climate change. In a few potential water deficit areas, sustainable rice intensification (SRI), which saves 40% of normal water demand, 30% fertiliser and 50% pesticides, while increasing yields, is being piloted. In 2013, 350ha were under SRI and the area is increasing every year. Elsewhere in the province, 9,000ha are now (2015) under ratoon cultivation during the spring-summer season provides a reasonable crop in about 60% of time of conventional transplanted rice, avoiding water shortages, while keeping costs down. In Le Thuy, now 7,500ha of 9,000 of late spring is ratoon rice from the winter/spring crop. In some estuarine areas, salinization is causing declining yields - and there is a drive to covert these underproductive areas, amounting to some 2,000ha, or 7% of the total paddy area, to other crops or shrimp production.

Other adaptation and production strategies being tried in Quang Binh include:

- Switching from longer to medium and short duration rice varieties.
- Switching from rice to non-rice crops, such as maize, green beans or fodder grasses that are less sensitive to drought. In 2013, 380ha were switched to other crops; by 2015, this had increased to 1,500ha.
- Shifting the planting date of the winter-spring rice from December to September, and early summer rice to February, to avoid extreme cold in January.
- Adjusting rice variety, cropping calendar and planting patter to ensure flowering in May - the optimal time to ensure high and consistent yield.
- Breeding rice for seed in southern provinces of Quang Nam and Da Nang.
- In areas of saline intrusion (Le Thuy and Quang Ninh), introducing crop rotations, of rice and fish, or rice and shrimp.

Table 4.11: Other principal annual crop areas and yields by district, Quang Binh, 2013

Crop	Maize		Sweet potato		Cassava		Peanuts	
District	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)
Dong Hoi city	57	3.7	89	6.6	48	7.4		
Ba Don town	315	5.0	850	8.3	49	8.4		
Minh Hoa	947	5.2	140	5.6	334	10.0		
Tuyen Hoa	1054	5.0	330	7.3	290	10.2		
Quang Trach	340	4.6	877	7.8	571	8.6		
Bo Trach	1160	5.4	435	7.1	3278	23.8		
Quang Ninh	360	3.5	191	7.4	403	19.0		
Le Thuy	264	2.8	820	6.1	870	12.3		
Total	4497	3.7	3732	7.4	5843	18.5	6500	2.7

Source: DARD 2014 and 2015

<u>Other field crops</u>

Table 4.11 presents the most recent available data on the cultivation areas and yields of the principal field crops for the districts of Quang Binh. The area under any particular annual field crop depends a lot on market conditions and government policy and in many places, farmers can switch amongst them. Certain crops, notably cassava and maize, are primarily grown for export to China. The government targets certain crops in certain areas - so for example, in some communes, over 97% of house-holds plant cassava. Bo Trach has the largest area of field crops, grown in the hilly area inland of the narrow coastal plain.

Maize is the second most important annual food crop in Quang Binh, helping to ensure food security in the upland districts of Bo Trach, Tuyen Hoa and Minh Hoa, where paddy rice growing is limited. Most of the maize is planted in the spring and summer seasons. The area grown has increased steadily since 2001 and is expected continue to expand as climate change adaptation policy suggests using maize to replace rice in marginal areas with limited irrigation.

In 2015 the total area of cassava in the province was 6,500ha. The area has steadily increased from 3,842ha in 2001 to 5,843ha in 2014 and 6,500ha. In the past, cassava was grown for human consumption, then later for animal food, and now is now high demand for animal food, food processing (for tapioca starch, for candies, cakes), and especially as raw material for industrial production of methanol/ethanol. Now cassava for industrial purposes accounts for 5,500ha, and the area is expanding rapidly. Cassava is normally planted in hilly areas but now is also planted in flat areas, event replacing some rice fields and providing higher production and income. This can also be considered as a form of adaptation as cassava requires less irrigation than rice.

Peanuts are highly suitable on Quang Binh's sandy soils. They have been planted for many years and the cultivation area continues to increase. In 2015, 6,500ha were planted and produced a harvest of 17,300tonnes. Planted in spring, it is being promoted as a Climate Smart Crop, to replace paddy, where irrigation is difficult.

Beans and vegetables, including chili, have also become important since urbanisation and tourism.

Perennial crops

Rubber is the most important perennial crop in Quang Binh, the cultivation area growing rapidly from 3,931ha in 2001 to 17,980ha in 2014. It is very suitable in the lower hill areas of the province, although it suffers from extreme climate events - cold spells in winter that affect latex yields and storm damage; Storm 11 of 2013 damaged half the planted area. Nevertheless, the province plans to adapt to these threats and increase the area under rubber to 23,000ha by 2020. However, planting in 2015 was only 25% of that planned, due to low latex prices.

Pepper is increasingly important. The planted area nearly doubled between 2001 and 2005 to 718ha, but planting then slowed, so by 2014 there were nearly 900ha of pepper. It is grown on relatively small plots, primarily in hilly areas. By 2020 it is planned to have 1,500ha, producing 1,725t/year.

The third key perennial category is fruit, and currently there are 3,500ha with production of 20-25,000 t/yr. The province is focused on developing high-value high-demand crops such as the Phu Trach Pomelo, oranges, bananas through improving garden management.

Livestock

Although livestock numbers are not high, the sector currently contributes about 45% of agricultural GDP. Pigs are most important. Disease prevention and control are increasingly concerning with serious outbreaks in neighbouring provinces. DARD is developing vaccination programmes and responses to epidemics.

The SEDP aims to raise the contribution of animal husbandry to 48% of the total value of agricultural production by 2020, by:

- Promoting larger more commercial and more intensive animal production units. In 2015 there were 107 livestock farms[9], mostly raising pigs, but also including some 20 cattle farms using Zebu hybrids, and poultry. All these farms are located in the coastal districts.
- Continued genetic improvement "Sindhilisation" of cattle herds through AI, with the aim of increasing proportion of highly productive Zebu hybrids from 38% to 65% of the provincial herd by 2020; cross breeding of pigs to increase the proportion of meat to fat.
- Promoting highly nutritious pasture grasses for cattle rearing.
- Promoting high value species: deer, bees, goats, ostriches, French ducks.

4.2.4.1.2. Forestry

The forest sector is extremely important to Quang Binh's socio- economy and environment. The resource management part of the sector contributes 850,000m VND to the economy, and involves nearly 70% of the land area, while forest industry add a further 1.9b VND and tourism to the Phong Nha-Ke Bang National Park adds another sum. The sector has been transformed in recent years from one based on exploitation (logging) to one focused on plantation development, protection and conservation. These priorities continue to orientate management and planning.

Quang Binh's Forest Estate

Details of the forest situation in Quang Binh are not easy to understand accurately, as forest statistics are incomplete and inconsistent, and maps are difficult to interpret. Table 4.12 presents data from both DONRE and DARD on forest cover under the three main forest types. According to DONRE's land use figures from 2013, 78.2% of the total land area, or 630,000ha is forest, with 38% production forest, 25% protection forest and 15% special use forest. However, DARD figures show forest cover of 561,621 ha or 69.6% of total land area, with 34% under production, 20% protection and 15% SUF. Table 4.13 records the forest area statistics in 2014 as they relate to management responsibility and reports 588,948ha or around 70% total forest cover; and elsewhere

[9] A "farm" is defined variously by income, area and production capacity, depending on the product and region. In the North Central Coast, a farm exceeds 40 m VND/year (~ USD 2,000), a crop production area > 2 ha; perennial crop area > 3 ha; forests farm > 10 ha; aquaculture area > 2 ha; shrimp area > 1 ha; large animal (cow, buffalo, horse) farm for milk or breeding > 10 head; large animal farm for meat > 50 head; small animal (sheep, goat) for milk or breeding > 20 head; small animal for meat > 100 head; poultry farm > 2000 ha.

DARD states plans to increase forest cover to 65% by 2015 and to 70% by 2020, suggesting that the reality was lower than that. A DARD report from 2015 states forest cover at 68%, and anticipates finalisation of plans for the "three forest types" by 2020[10].

Of particular interest to the EbA study is the proportion of natural to plantation forests, as natural forests provide more environmental services than plantations, but plantations tend to deliver more income. Again, there are inconsistencies in the data from different sources, as evident in the different tables. Table 4.12 provides DARD's breakdown of the forest area into natural and plantation forest, indicating that 86% (481,349 ha) of the forest is natural[10]. Other data reveal that of the 14% that is plantation, one-fifth is newly planted. The planted area is increasing by about 1,000 ha per year, but it is not clear how much of the planted area was previously under-productive natural forest and how much was barren land.

Natural forests are further classified by their quality: rich, average, poor and rehabilitation. Criteria for defining these classes, data on the relative extent and understanding on the drivers of quality change were not available. Poor forest is very vulnerable to being converted to plantation.

Table 4.12: Proportion of 3 forest types in Quang Binh, 2014

Forest Type	DONRE (2013)		DARD (2014)					
	TOTAL		TOTAL		Natural Forest		Plantation	
	ha	%*	ha	%*	ha	%*	ha	%*
Production forest	309,253	38.3	275,498	34.2	209,939	26.0	65,559	8.1
Protection forest	198,043	24.6	162,867	20.2	148,224	18.4	14,643	1.8
Special use forest	123,576	15.3	123,256	15.3	123,186	15.3	70.20	0.0
TOTAL	630,872	78.2	561,621	69.6	481,349	59.7	80,272	10.0
% of forest area				100		86		14

Source: QB DONRE; QB DARD –Change in forest cover 2004-14 of total land area*

Forests are also classified by their management arrangements, with consequences for livelihoods and ecosystem services. Table 4.13 provides a summary of available data. Four major types of forest manager can be identified: Special Use Forest Management Boards (2), State Forest Enterprises (2), Protection Forest Management Boards (8) and private households. Together, they manage 86% of the forest area. In addition, there are three minor types of forest manager: military/security; communes and "other organisations". A substantial area of forest (68,568ha) remains unallocated.

Table 4.13: Forest managers in Quang Binh, 2014

Management Type	Management Authority	Area (ha)	Total Area (ha)	%
I. Special Use Forest Management Board	Phong Nha- Ke Bang NP	126,168	126,304	21.4
	Historical- Cultural forest	136		
II. State Forestry Enterprise	Long Dai LLC	91,834	124,365	21.1
	North Quang Binh LLC	32,531		
III. Protection Forest Management Board (PFMB)	Minh Hoa PFMB	19,713	148,306	25.2
	Tuyen Hoa PFMB	28,905		
	Quang Trach PFMB	12,295		
	Dong Hoi PFMB	2,968		
	Long Dai PFMB	38,027		
	Ba Ren PFMB	11,849		
	Dong Chau PFMB	18,327		
	Coastal Quang Binh PFMB	11,513		
IV. Security, defence Units			3,946	0.7
V. Private Households			110,950	18.8
VI. Not yet allocated			68,658	11.7
VII. Communes			2,390	0.4
VIII. Other Organizations			4,029	0.7
Total Forest Area of Quang Binh			588,948	100

Source: DARD

[10] DARD figures on plantation areas under different managers for 2014 (Table 11) report a total plantation area of 93,000ha. Further, DARD data from 2004 indicate a natural forest area of 334,000ha across the three forest types, so it is difficult to understand how the area under natural forest increased by nearly 30% in the intervening 10 years.

Forests on sand

As of 2015, almost 27,000ha of the coastal sandy areas are designated as protection forest - most of this (about 85%) has some amount of tree cover but there is still about 3,800ha of bare land.

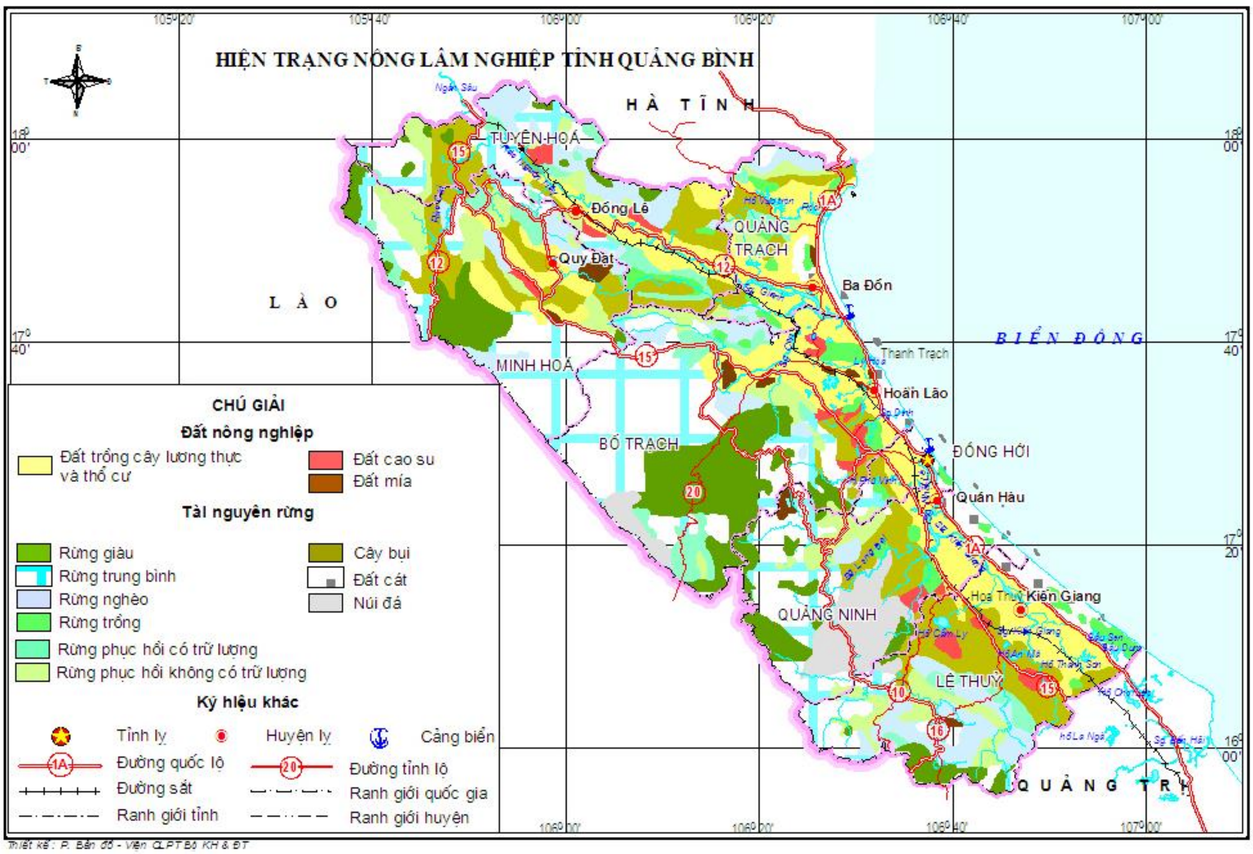
Table 4.14: Areas of protection forest on sand in Quang Binh (ha) (2015)

District	Total sandy areas	Planned forest land	Protection forest	Bare land
Quang Ninh	5,744.0	3,609.3	3,290	319.3
Le Thuy	10,345.3	7,538.1	6,756.1	782
Bo Trach	356	353.4	161.7	191.7
Quang Trach	2,443.6	855.1	799.9	55.2
Dong Hoi	2,197.9	935.3	691.3	244.0

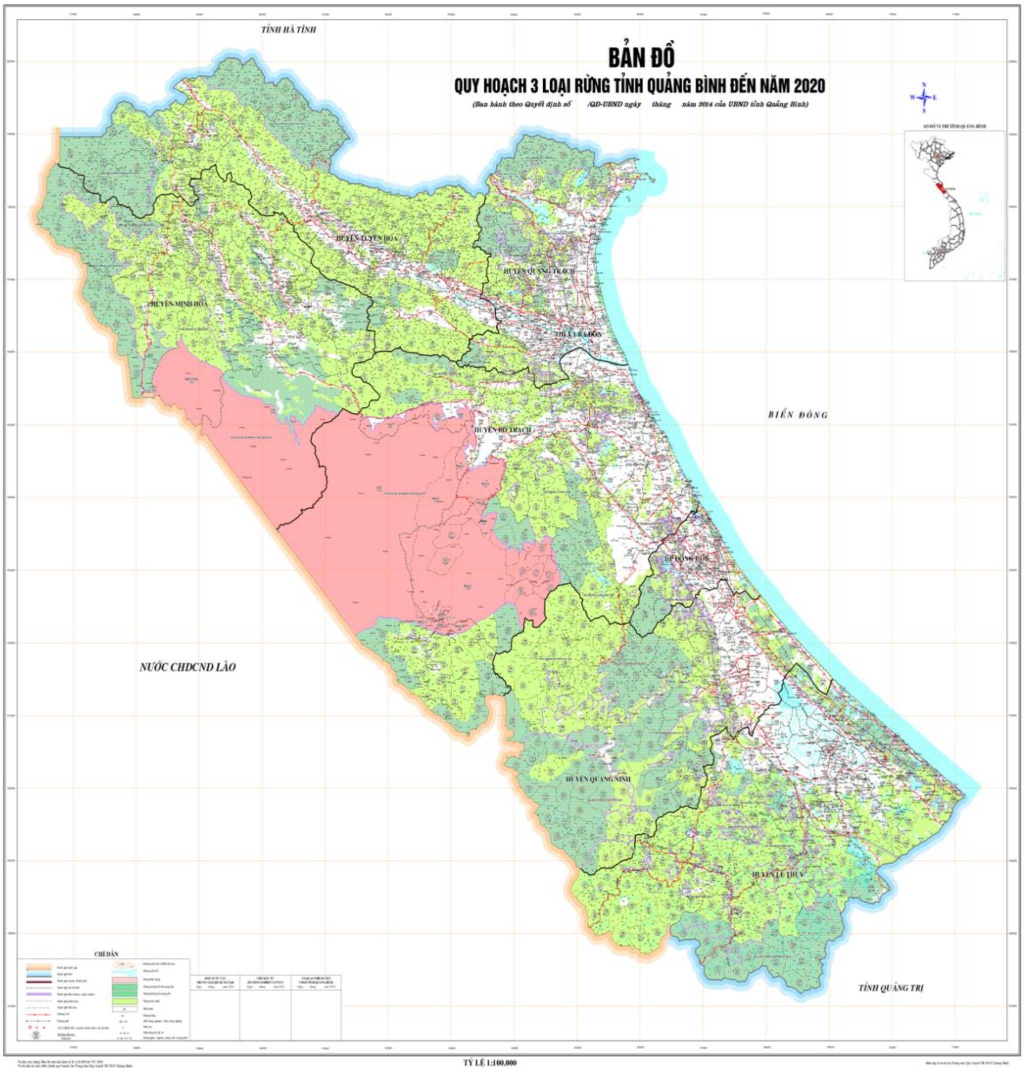
Sources: Forest development Department of Quang Binh province

Protection forests on coastal sands are found in 5 districts. Most of these forests have been established since 1964, as plantations of *Casuarina equisetifolia* to control blowing and moving sand. However, because of poor soil, *Casuarina* often grows poorly and adopts a creeping habit and in recent years foresters have experimented with other species - such as *Acacia auriculiformis, Acacia crassicarpa* and some species of *Eucalyptus*. In areas where it does grow well, it is heavily exploited by local people for firewood.

Map 4.2: Current status of agriculture and forestry industry in Quang Binh 2011



Map 4.3: Forest Management Units in Quang Binh



The single largest forest management unit is the Phong Nha-Ke Bang National park, which consists of 126,168ha of primarily limestone forest. The SFEs are much reduced in size since 2004, largely due to the allocation of their areas to households and forest protection management boards. It is unclear how many households have received forest land, where they are or what they have done with their forests as data does not appear to be collated at the provincial level. There is an issue with the allocation of natural forest to villagers, who usually cut it down and plant crops, rubber or acacia.

The Special Use Forests comprise national parks and nature reserves and protect most of the rich very high biodiversity forests, including remaining areas of primary forest on the Eastern flank of the North Truong Son mountains on the border between Vietnam and Lao PDR. Protection Forest Management Boards are also responsible for large areas of natural forest - most designated as watershed protection forest. These estates also include some plantation forest. Quang Binh's two State Forest Enterprises manage most of the province's production forest including both natural and plantation forests. Households manage 45% of the province's plantations. Land allocation data was not available, but it appears that under-productive natural forest as well as barren forest land is allocated, and much of the former is converted to plantation.

Table 4.15: Plantation forest ownership, Quang Binh, 2014

Owner	Quang Binh	
	Area (ha)	%
Special Use Forest Management Board	10, 580	11.38
Protection Forest Management Board		
State Forest Enterprises	20,861	22.14
Other organizations	1,510	
Commune People Committee	18,400	19.79
Households	41,944	45.12
Total	92,944	100

Source: QB DARD

Forest production

In 2014, the forest sector generated 824 billion VND, 85% of which came from timber harvesting and the remainder from forest planting and services (14%) and NTFP (1%). Around 250,000 m3 of timber is harvested, of which 97% is from plantations. The main species are *acacia* hybrid and *Pinus merkusii*, and there are 5,129ha of rubber on forest land. Overall, 80% of harvested timber is chipped and 20% goes for sawn timber or poles. Harvesting natural forest was prohibited in 2013, but the Long Dai SFE in Truong Son Commune has 31,483ha of FSE-certified natural forest, from which it harvests about 5,500m^3 pa of *Aglaia gigantea* (Gội).; *Dipterocarpus alatus* (Dầu rái), *Erythrophleum fordii* (Lim), *Garuga pinnata* (Chủa), *Heritiera cochinchinensis* (Huỵnh) and *Sindora tonkinensis* (Gu) (FSC 2015). The North Quang Binh SFE has no quota at all for harvesting natural forest. The key NTFPs are resin, from the pine plantations, bamboo and rattan. Production of resin is dropped by 40% between 2012 and 2014. Some illegal logging does go on - contributing to the local economy - but data are not available.

Table 4.16: Forest production in Quang Binh, 2014

Item	Volume (m^3)
Timber (natural forest)	5,500
Timber (plantation)	17,300
Chips and pulp	230,158
Bamboo	343,000 sticks
Pine resin	2,700 tonnes
Rattan	958 tonnes

Forest Industry

In 2015, there were 77 forest industry units in Quang Binh, of which 70 were timber-based, and 7 were NTFP-based. DARD admits that, in general, the province's forest industry employs primitive technology and generates poor quality products. There are several wood chip mills exporting directly to China and Japan, and also some sawmills processing native timbers and acacia mostly for the domestic market[11]. Another mill processes bamboo into plywood. There are two large furniture factories and numerous smaller facilities in rural areas. There are several boat building yards, using, amongst other species, domestic and imported "lim" (*Erythrophleum fordii*), much of which may be illegal.

Forest Development

Forestry development to 2020 is, like in other sectors, focused on increasing productivity through application of modern technologies (species selection, quality seed, tissue culture) and business methods, including larger-scale management units.

[11] Data unavailable

DARD has a policy of enhancing the economic value of forest land through planting schemes. Most planting is acacia and other exotic monocultures, mostly for pulp. However, short-rotation industrial crops leave soils in critical watersheds vulnerable to erosion for three out of every five to seven years of a rotation, which may have significant consequences for sedimentation and in-filling of downstream reservoirs. Over repeated rotations this could also deplete soil fertility, despite the nitrogen fixing capacity of species like acacia. Photo 4.1 shows the production forest under state forest enterprise management around the Phu Vinh reservoir near Dong Hoi City; the large areas of bare land are likely to contribute to siltation. More work needs to be dome to explore the impacts of short-rotation monocultures on the watersheds and consider how EbA approaches could result in better management of this important "green infrastructure".

Map 4.4: Production forests around the Phu Vinh reservoir near Dong Hoi, showing large proportion of bare land

Reforestation has been taking place at a rate of 1-2,000ha per year, and 18-20,000ha are to be planted during the period 2011-2020. Of this, 65% is intended to supply wood processing plants.

Forest protection continue to be a problem, and efforts will be redoubled to control illegal exploitation and clearance and forest fires, including through improved awareness raising, forecasting and communication and preparedness.

Although government policy is to enhance forest protection, combat its illegal use, conserve biodiversity, manage watersheds, many proposed measures seem contrary to these objectives:

- conversion of "poor forest" to rubber and other estate crops;
- large scale "enhancement" of natural forest by plantation establishment;
- increased production of native timber to 10-15,000 m^3 pa;
- continued allocation of natural forest to households.

Natural forests are generally quite resilient to climate change, but young plantation forests, like rubber plantations mentioned above, are vulnerable to wind throw and other storm damage.

4.2.4.1.3. Fisheries

The government sees Quang Binh's future comparative advantage in the marine sector, and wants to concentrate investment to bring fisheries to prominence as a driver of economic development. In 2015, the sector produced 69,000 mt of fish and shellfish - a 134% increase over 2010. In 2014, fisheries contributed 2.9 trillion VND to the provincial economy - less than agriculture and livestock, but more than forestry. Of the 30,000 people employed in the sector, 80% work in the capture fishery, which is about twice as valuable as aquaculture. A considerable number of industries, services and logistics are associated with fisheries, further adding to the economy. Currently 85% of production is consumed in the province and in the region, and 15% exported, primarily fresh fish, shrimp and squid, to China.

The future of fisheries in Quang Binh is seen as commercial shrimp production, especially on sand, and the restructuring of the capture fishery from many small-scale inshore boats, to a smaller fleet of larger off-shore boats exploiting the abundant resources of deeper waters and, importantly, helping to protect national sovereignty towards sea areas and islands.

There is much interest globally about the impact of climate change on fisheries. In a study by Malone and Brenkert (2008) Vietnam was assessed as the most sensitive country in the world in terms of the importance of its fisheries to its economy, and another recent study (Allison et al 2009) ranked Vietnam as 24th in the world in terms of relative national economic vulnerability to climate change impacts on its capture fishery. Coastal mangroves, salt marshes and coral reefs, which are critical to breeding marine life, are all threatened by temperature rise, storms and storm surges. Coral reefs are degraded by ocean acidification that comes with increasing atmospheric CO_2. The ranges and populations of algae, plankton and fish are affected by increasing water temperatures, as well as the changes in accompanying levels of salinity, oxygen and circulation. In the South China Sea and indeed worldwide, as ocean temperatures rise, species from tropical waters are migrating towards the poles at a rate of about 17km per decade (King 2015). Fishing stock scarcity caused by the new migration patterns is exacerbated by over-fishing. In Vietnam, coastal waters are warming fastest and fish are migrating off-shore - putting them out of reach of many poor artisanal fishermen. Climate change also affects the fisheries through increased incidence and severity of storms, storm surges and water spouts. Many small fishing boats are destroyed each year. Two storm shelters have been built in the Roon and Gianh River estuaries, each accommodating 800 larger boats, but most of the small boats are simply pulled high up on the beach. These changes exacerbate existing political conflicts between neighbouring states; disputes over fishing rights in the South China Sea between China, Vietnam and Philippines are increasingly acute.

Capture fishery

The capture fishery in Quang Binh engages around 28,000 people in 18 coastal communes[12]. Over 100 species are exploited, including fish, shellfish, shrimp and squid. Over 57,550 metric tonnes were produced in 2015, an increase of over 130% since 2011. In 2014, the capture fishery earned 1,896,581 million VND, making it the most valuable part of the Primary Sector.

The structure of the capture fishery, shown in Table 4.17, is based on engine size, reflecting the distance from shore of the waters exploited. A diverse array of equipment and technologies is used, including gillnets, seines, trawls.

Table 4.17: Structure of Quang Binh's capture fishery

Engine size (horsepower)	Number of boats	Fishing area
>400 HP	0	Distant waters
200	800	Off-shore
94	1400	Off-shore
20	2000	Near shore
TOTAL	4200	

Currently there are some 2000 small often woven bamboo-hulled boats (20 h.p.), operated from beaches by groups of 6-10 men and fishing on-shore (within 10km of shore). The fishing season is limited by storms in winter. The main catch is sardines and mackrel, some boats specialise in squid. Routine catches are landed and sold on the beach near the largely poor villages where the fishermen live. Although data are not available, it is said that the near-shore fishery is over-exploited, illegal fishing methods (pesticides, electric current, bleach, small mesh-sized nets) are widely used and the proportion of "trash fish" and "undersized fish" is now around 60%. For this reason, the government is encouraging the redeployment of this labour to larger boats for off-shore fishing, into aquaculture, processing, and even out of the sector altogether, into horticulture and animal husbandry. Loans are made available for groups of fishermen to buy larger boats; nearshore boats should reduce by 300 per year.

By 2020 it is planned to have 1,500 boats over 90 CV, and to have reduced the inshore fleet of boats less than 20 hp to less than 1,000 units. Government also wants to encourage the development of factory fishing fleet of over 1,000 vessels of 400 HP or more, fully equipped with modern fish detecting technology, on board facilities to exploit distant waters, and has plans to develop all the port and auxiliary infrastructure (storm shelters, markets, landings, repair yards) required. Cooperatives will be the main mechanism for consolidating exploitation into larger vessels, and to promote aquaculture development by small operators. Wooden boats will be replaced by iron hulled boats, reducing the environmental impact.

In early April 2016, the fishery was hit by a mass die off of fish, caused by pollution emanating from the Formosa Steel Mill in the Vung Ang Special Industrial Area in southern Ha Tinh. The incident has had a serious impact on the fishing community. Fishing was prohibited until late June, when the company finally admitted responsibility[12]. Initially, land based pollution from agriculture and aquaculture, in combination with climatic events and climate change were blamed.

Aquaculture

Quang Binh's aquaculture sector currently occupies nearly 5,000ha and produced 12,000mt in 2015, 85% of which is consumed in province. Production is concentrated in the coastal districts of Bo Trach, Quang Ninh and Le Thuy (see Table 4.18 and Map 4.4), but cage fish rearing is found quite far inland along major rivers. Table 4.19 presents figures for the growth of the sector, showing that it expanded by over 50% between 2005 and 2010, but grew only very modestly (6%) between 2010 and 2014. Today, the biggest production area is for freshwater fish, but the highest value comes from the much smaller area of intensive brackish water shrimp production. However, disease in shrimp rearing is affecting 30-70% of the area - resulting in some producers failing entirely. Disease is likely to be exacerbated by the higher temperatures resulting from changing climate.

Soft-shell turtles (*Tryonyx steinachderi*) are now being raised in freshwater ponds for meat and breeding in a pilot location in Quang Trach (see Map 4.4). They bring high incomes for farmers and another pilot is planned in Le Thuy.

Table 4.18: Aquaculture area in Quang Binh, by district, 2014

District	Dong Hoi	Ba Don	Minh Hoa	Tuyen Hoa	Quang Trach	Bo Trach	Quang Ninh	Le Thuy	TOTAL
Aquaculture Area (ha)	376	480.6	36.5	66.2	244.1	1,026.2	1,122.5	1,616.6	4,968.7

In Quang Binh, there has been no practice of raising fish (or ducks) in rice paddies, along with the rice crop, but consideration is now being given to this.

Extreme weather events, such as storms and storm surges can flood coastal aquaculture ponds, sweep away fish or kill them from the shock of a rapid salinity change. On the other hand, saline intrusion into near-coast paddy lands makes their conversion to aquaculture a viable option. Fresh water cage aquaculture, which takes place inland Eamu Lake, Minh Hoa commune, is also affected by climate change: temperature rises increase evaporation from lakesurface, leading to water shortages. Enhance algal populations compete with fish for oxygen, reducing fish outputs by up to 50%.

Fish Processing Industry

Currently, Quang Binh as two seafood processing facilities, producing frozen and dried seafood and fish sauce and in future a fish meal processing plant is planned near Hon La port. The governmnet target is that by 2020, 35% of total fish production will be processed, of which 20% will be exported.

Map 4.5: Capture fishery and aquaculture in Quang Binh 2011

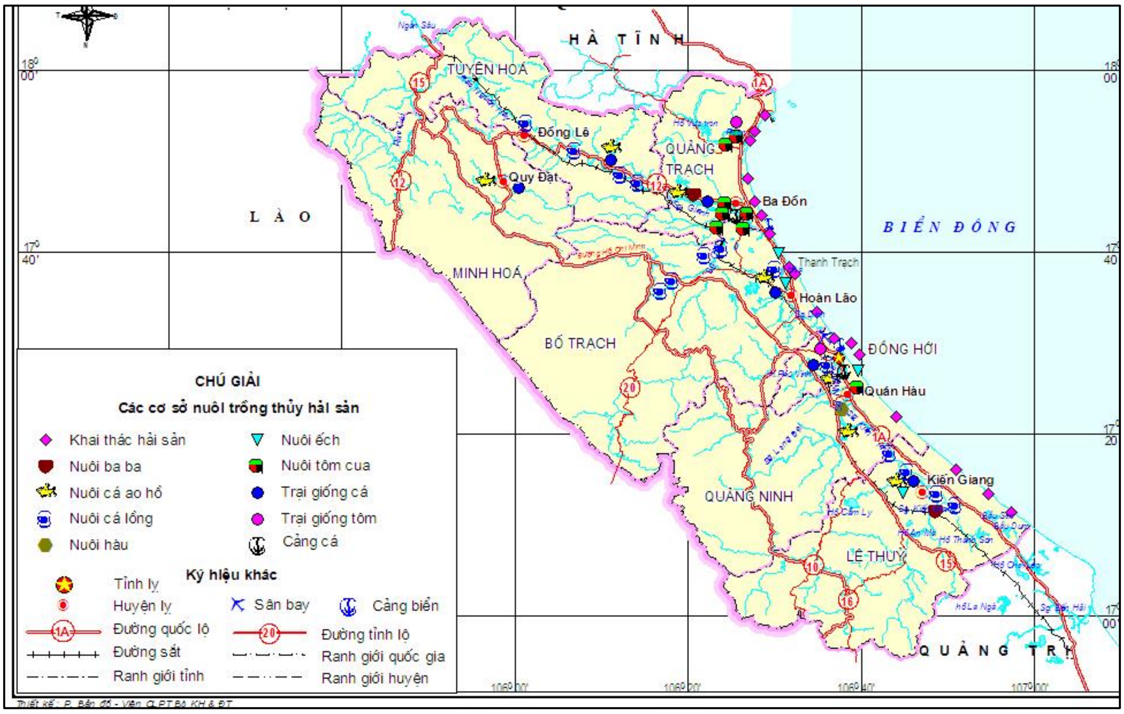


Table 4.19: Aquaculture area (ha) in Quang Binh by product, farming method and water type, 2010-2014

	Year				
	2010	2011	2012	2013	2014
By Product					
Shrimp	1052.5	1064.7	1068.2	1020.3	1001.8
Fish	3464.9	3404.0	3433.9	3477.2	3796.2
Other aquatic species	200.2	163.9	162.5	167.1	170.7
By Farming Method					
Intensive aquaculture	916.1	899.6	1571.2	1247.0	1179.0
Semi intensive aquaculture	1817.5	1784.8	2281.3	2629.9	2555.1
Extensive / improved extensive aquaculture	1984.0	1948.2	812.1	787.7	1234.6
By Type of Water					
Freshwater	3443.6	3409.3	3426.6	3471.8	3788.0
Brackish water	1274.0	1223.3	1238.0	1192.8	1180.7
Salty water	-	-	-	-	-
TOTAL	4717.6	4632.6	4664.6	4664.6	4968.7

Source: DARD 2014 and 2015

The province has 3 shrimp nursery stations, 8 fish nursery stations supplying 5-7 million tiger shrimps larvae, 40-45 mil fish larvae and 4-5 million fish fingerlings annually.

Deeper sea resources are said to be plentiful, but the current fishing fleet is not equipped to exploit it.

4.2.4.1.4. Mining[15]

Quang Binh has significant mineral resources, including titanium gold, silver and lead, which are attracting considerable foreign investment from China and Australia. In addition, there is abundant limestone, quartz, kaolin, slate, marble and granite, on which an important building materials industry is based, most notably cement.

Illegal mining of river sand and gravel on the Gianh River has become an issue, causing the river to change course. Likewise, dune mining for titanium leads to erosion of this essential coastal protection feature.

4.2.4.2. THE SECONDARY SECTOR: INDUSTRY AND CONSTRUCTION

The secondary sector transforms raw or semi-processed materials into finished or semi-finished products for consumption or further transformation.

4.2.4.2.1. Industry

Industry (including construction) contributes 25% of provincial GDP. Most important is the production of cement and other construction materials from limestone, clay deposits and other non-renewable natural resources. Food (cassava, seafood, rice), timber (chips, sawn wood, paper) and rubber processing, based on renewable natural resources are of approximately equal importance. As discussed above, many of these resources are sensitive to climate change. In addition, there are industries based, all or in part, on imported materials - beer, textiles and garments, aluminium, ship building, electronics assembly.

Industrial Development

In the coming years, the government plans for industrial development are to focus on areas where Quang Binh has comparative advantage: the marine economy, including seafood processing, ship building and repair and seafloor mining[12], as well as improving technologies and increasing production in other existing industries.

Throughout Vietnam, and much of E and SE Asia besides, specially constructed industrial areas are highly favoured by governments as means of stimulating economic investment. They take various forms - industrial parks, special economic zones, etc. Quang Binh currently has two industrial park (Dong Hoi and Hon La) and two special economic zones with preferential investment and tax treatments (Hon La - near the seaport, and the Cha Lo Border Gate Economic Zone in Minh Hoa District, where Asia Highway 131 crosses into Laos). By 2020, it plans

[12] Sea floor mining typically takes place at depths in excess of 800m. Since the Gulf of Tonkin, offshore of Quang Binh is less than 100 m in depth, this implies that exploitation will take place in international and potentially disputed waters.

to have a network of 8 industrial parks with an area of 2,060ha and distributed in the districts and cities of the province. These can have unintended environmental economic impacts. Site clearance and development degrades natural ecosystems and can create off-site problems. Further multiple economic zones can and frequently do compete with each other and planning should proceed cautiously and step-wise, in full awareness of off-site implications and climate change vulnerabilities.

4.2.4.2.2. Construction

Construction contributed 4.9 bil. VND in 2014, making it the second most important sector by value. This reflects Quang Binh's current stage in the development process, with much of the SEDP focused on infrastructure. The government acts as the main investor in construction projects and there is a tendency to "over-construct". This will not and should not last, and the province is endeavouring to diversify its economic base.

4.2.4.3. THE TERTIARY SECTOR: SERVICES, INCLUDING TOURISM

The services or "tertiary" sector in Quang Binh includes economic activities such as wholesale and retail trading, banking and financial services, legal and accounting services, telecommunications, transport, health care, media, entertainment, hospitality and the like. These are mostly "face-to-face" transactions that do not deliver a concrete product, but support activities in the primary and secondary sectors. The most important tertiary sector activity in relation to EbA in Quang Binh is tourism.

Tourism

The number of visitors to Quang Binh in 2015 was 2.86 million, of which foreign tourist arrivals were 46,900, an increase of 8.9% over 2014. Overall tourism revenues, including hotel and restaurant takings, increased 19% to more than VND 179 billion (USD 8 million)[13].

The main tourist destination is the Phong Nha-Ke Bang National Park and World Heritage Site, which depends on the environmental services of spectacular above and below-ground natural landscapes and in-tact, bio-diverse ecosystems for its draw. The province also has fine white sand beaches, hot springs and numerous cultural/historical sites, including Vung Chua - the resting place of Vietnam's national hero, General Giap. These sites benefit, though to a lesser extent, from the same environmental services. New resort developments and golf courses are planned, but these are more dependent on modern infrastructure, urban-style services and designed landscapes.

Although national tourists to Quang Binh are by far the most numerous, the international tourists are most focused on eco-tourism and pay the most money. The demands of the two very different tourist markets need to be balanced strategically. An interesting illustration is provided by the Son Doong Cave, the largest cave in the world, located in Phong Nha-Ke Bang National Park. In 2014, 243 tourists visited the cave, paying $3,000/person for 5 night packages. By the end of August 2015, this number had risen to 482, including 47 Vietnamese, and the limit of 500 visitors has already been booked for 2016. It is unclear what impact the planned mass-tourism development of a cable car to the mouth of the cave will have on total revenues from what is currently a niche-market "eco-tourism" asset.

The provincial government recognises the natural advantages that Quang Binh has for tourism, and plans to increase tourism revenues by 18-19% for the period 2011-2020, attracting 1.4-1.5 million tourists by 2020, including 90-100,000 international guests. However, plans for tourism development, as with other sectors, are focused on infrastructure: "Investment in construction of tourism products of high quality, large scale" (SEDP 2011). It has to be realised that from the perspective of international tourists, excessive infrastructure can detract from eco-tourism destinations.

Trade

The total value of Quang Binh's trade in 2014 was 18 trillion VND, mostly arising from retail sales and small supermarkets, notably Coopmart and various services. There are large wholesale "wet markets" in the urban areas Dong Hoi and Ba Dong. Available data show Quang Binh's trade growing at 15% annually. Rural markets are particularly vulnerable to climate change. Storms and floods can cut off communities for several days, resulting shortages of food and other goods in some locations. The government's "four on the spot" programme is intended to prepare for such events, but it is not implemented everywhere.

4.2.5. Key assets supporting the economic sectors

4.2.5.1. TRANSPORT

4.2.5.1.1. Roads

[13] http://tuoitrenews.vn/business/32206/tourism-revenue-in-vietnamese-province-soars-thanks-to-son-doong-cave-officials

The National Road No. 1A and the Ho Chi Minh Highway are the main North-south road arteries of the province. On the East-West Transport Corridor, the National Road No. 12A connects Quang Binh with Laos, Northeast Thailand, Myanmar and the Greater Mekong sub-region through Cha Lo international border gate, and this road is considered the shortest and most convenient route to these neighbouring countries.

Landslides present the greatest threat to the provincial road network - affecting all types for roads from the Nation 1A, to small rural roads - and climate change is likely to worsen the impact, if remedial EbA and other measures are not taken.

4.2.5.1.2. Ports

Currently, Quang Binh Authority has restored and upgraded Gianh Port to accommodate vessels of 1,000 tons and increase the loading capacity to 100,000 tons/year. Hon La seaport was put into operation to accommodate ships of 10,000 tons of cargo, and a new area in the city's suburb is being prepared to relocate Nhat Le seaport. Each year Hon La Port handles 1.8 million tons of imported goods, 1.4 million tons of which are transferred to Laos. Sea level rise could eventually flood these port facilities.

4.2.5.1.3. Railways

The national railway system extends 172km through Quang Binh. There are 19 provincial terminals, of which Dong Hoi station is the most important. Tan Ap Station, near Hon La port complex on the border with Ha Tinh, is the future Trans-Asian transit railway station. Trade relations with Laos, North-east Thailand and Myanmar have been expanded including tourism, commerce, agriculture, forestry, fisheries, minerals, etc. In the Mekong Sub-region, Quang Binh is part of the East-West Economic Corridor and is becoming a significant hub for cross-border trade, cooperation and development. Many sections of the railway in Quang Binh have been degraded by severe weather events, including erosion of the road bed, flooding and subsidence, and landslides. Quang Binh has the opportunity to promote a "green approach" to these problems, such as protection plantings and renaturation with wetlands, across the Mekong Region.

4.2.5.1.4. Air transport

Dong Hoi airport is located in Loc Ninh commune, Dong Hoi City, Quang Binh Province, 6km from Dong Hoi city centre to the south, near the coastline of East Sea and has the runway 300 meters to the east of National Highway 1A.

4.2.5.2. POWER

Quang Binh has both thermal and hydropower plants for electricity generation and is getting involved in alternative sources, such as solar and wind. Demand figures are not available, but demand is said to be high and the provincial strategy is to generate energy locally to satisfy internal demand, and then supply the national grid.

Decisions regarding energy investment are decentralised to the provinces, but the Ministry is still involved in large scale investments. The PPC is interested in exploiting the hydro-power potential of small and medium watersheds, for combined irrigation and power production, A preliminary survey of the river power potential showed a total capacity of 1.43 billion kWh of electricity (SEDP). However, the environmental impact of such schemes could be enormous - flooding important forest resources, reducing environmental flows of rivers and aggravating salinization of coastal areas.

Presently, Quang Binh's only hydro-electric plant is the Ho Dam, on the border with Ha Tinh, which generates an average of 1.25 million kwh/month. The dam is controversial and in October 2016 heavy rains, which caused serious flooding throughout the province, damaged the plant and an emergency discharge was needed which caused significant damage to downstream communities (in Ha Tinh). A few years ago, another hydro plant in Ming Hoa District was under construction, but was cancelled because of flood damage to the site.

The Quang Trach thermal plant will total 2,400 MGW in two stages and is located near the Hon La port and economic zone. Thermal plants need to be located on the coast with access to salt water for cooling, and freshwater for boilers.

Solar energy is seen as a solution for remote and disadvantaged areas, especially areas where it would be expensive or impossible to connect to the national grid. South Korea is currently supporting such a rural solar power project.

The potential for wind power development along the coast is also being explored. Government does not invest directly in wind power, but subsidies may be available to private investors through feed-in-tariffs to the national grid, to overcome the higher production costs (7c/kwh vs 4c/kwh for coal). Some private investors have come forward and conducted the necessary surveys, but investors are still awaiting government decisions on subsidies.

The PPC is also taking measures to promote energy efficiency and conservation, including energy labelling on appliances, progressive and peak hour pricing of electricity, participation in the global “Earth Hour” and other communication activities.

Besides the flood damage mentioned above, damage to energy infrastructure includes electricity poles being blown down and transmission lines broken in storms.

4.2.5.3. WATER RESOURCES

Water is the most important natural resource and environmental service in Quang Binh and perhaps the one most vulnerable to climate change. A holistic study of the water sector in relation to climate change is urgently needed, taking into account all the economic and domestic sectors supported, the interactions between different water users and their environmental impacts. The CCRAP (2010) presents a summary of Quang Binh’s 2009 Plan for water exploration and production to 2020. As the latter document was not available to the present study, some findings presented in the CCRAP are discussed briefly here.

4.2.5.3.1. Water Supply

Overall, Quang Binh has abundant water resources, including natural waterbodies, man-made reservoirs and ground water. However, these resources can be unpredictable and unreliable at certain times of year, and these problems are likely to increase with climate change.

There are two main watersheds (Gianh and Nhat Le) and three smaller ones (Roon, Ly Hoa and Dinh), all emerging from the Truong Son Mountains and crossing the narrow coastal plain to the sea. Average annual discharge rate is estimated at 539 m^3/s across the province and total runoff is approximately 16.97 trillion m^3. The few natural lakes in the province are located near the coast on the landward edge of the dunes, and probably represent old river courses. They extend over 2,500 hectares in all; largest is Bau Sen in Le Thuy district.

The province has 13 large national reservoirs managed by state irrigation companies, and 147 smaller locally manged reservoirs, with a total volume of 528,793 million m^3 (CCRAP, 2011). Besides playing an important role in regulating river flow and providing irrigation, these reservoirs bring other economic benefits to the surrounding communities, notably fish production. Sedimentation of the reservoirs due to erosion in the watersheds is a serious problem, reducing the provinces overall water supply capacity.

Ground water sources in the province are plentiful, but unevenly distributed and of variable quality. The depth of the water table varies depending on terrain and seasonal precipitation. The coastal plain tends to have shallow water table, vulnerable to saline intrusion, while the middle hills are vulnerable to deep groundwater depletion in the dry season.

Water quality in the region is generally quite good, very suitable for agriculture and forestry as well as industrial and domestic use. Saline intrusion is contaminating water in some estuarine areas. Map 4.5 shows the distribution of saline soils (dark pink) in the Gianh River estuary as represented in an undated soil map; it is likely that the extent of the affected area has now increased.

4.2.5.3.2. Water demand

Table 4.20 summarises the projected water demand by sector, by 2020, presented in the CCRAP of 2010. Although the use of different units of analysis for different sectors makes comparisons difficult, it appears that total demand from agriculture, industry and residential uses will reach around 800 million m^3/yr by 2020. In addition, aquaculture is estimated to require 9 million m^3/yr. The new golf course developments on the dunes south of Dong Hoi are also expected to use vast amounts of ground water - although some recycling is planned. Problems in supply and quality are localised and seasonal and likely to become more serious in the future.

Map 4.6: Distribution of saline soils (dark pink) in the Gianh river estuary

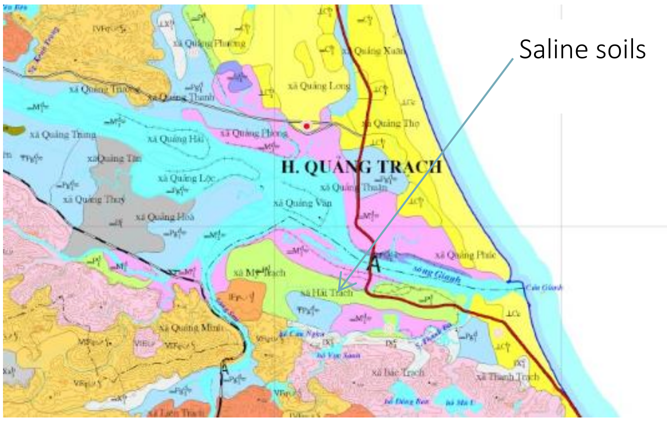


Table 4.20: Projected water demand by 2020 by sector

Sector	Subsector	Demand	Notes
Agriculture		1.3 mn m^3	By 2020
	Rice	6,550 m^3/ha	
	Crops	2,001 m^3/ha	
	Trees	2,132 m^3/ha	
	Livestock	60 litre/head/day	Cattle/buffalo
Industry		716,219 m^3/yr	By 2020
Residential	Urban	104,517 m^3/day	By 2020 (270 l/p/day) ~90% surface water
	Rural	58,640 m^3/day	By 2020 (100 l/p/day) ~ 30% surface
TOTAL		2.18 m m^3/day	By 2020
Aquaculture	On sand	30,000 m^3/ha/yr = 9 million m^3/yr	By 2020 for 300 ha Supplied from groundwater
Golf Courses	On sand	Data not availalble	Supplied from ground water

Source: CCRAP, (2010)

4.2.5.3.3. Impacts of climate change

The increase seasonal rainfall in predicted from global climate change poses serious threats to numerous dams in the province: they are in danger of breaking due to the inability to contain flood water, in part due to sedimentation reducing the reservoir capacity. Lakes particularly at risk are the Mui Rong, Vuc Tron, Tien Lang, (Quang Trach) Cam Ly, An Ma (Le Thuy), Be (Tuyen Hoa), Vuc Noi, Da Mai (Bo Trach) and Phu Vinh (Dong Hoi city). Floods already submerge and contaminate domestic wells, and this problem is likely to increase in the rainy season.

Rising temperatures and increased frequency of drought means that at other times of year, many, often the same, reservoirs drop below "dead water level" and are unable to supply irrigation water when most needed. Most affected are mid-sized reservoirs, such as Cam Ly, An Ma (Le Thuy), Long Dai, Dieu Ga (Quanh Ninh), Phu Vinh (Dong Hoi), Vuc Noi (Bo Trach), Rao Nana, Khe Sot (Quang Trach), Tien Lang, Be and Dong Ran (Tuyen Hoa). At the same time, the reduced water flows in the rivers, due to impoundments and off-take for human use, is aggravating saline intrusion in coastal areas, already caused by sea-level rise and storm surges.

4.2.5.4. EXISTING INFRASTRUCTURE RELEVANT TO CLIMATE CHANGE ADAPTATION

As will be discussed in Chapter 8 on adaptive capacity for climate change, Vietnam generally and Quang Binh particularly have long experience in mitigating and responding to climate-related disasters, including floods, tidal surges, saline intrusion and landslides which gives the government and people a head-start in adapting to climate change.

Quang Binh already has an extensive network of dykes and sea walls to cope with flood related issues, including 189km Level IV dykes, 103km of dykes, 153km of sea dykes, 12km of embankments, 107 wiers and a saline intrusion barrier (CCRAP 2010). However, many of them are old and of simple construction, or need to be raised and erosion is occurring much faster than the province is able to build defences. JICA is already working to study hydrodynamics in two main river basins - Giang and Nhat Le - and has helped support the development of an integrated flood-management master plan, as well as showcasing demonstrations of community-based soft-engineering measures.

4.3 DISCUSSION

This scoping of Quang Binh's economy has considered a range of different quantitative parameters: GDP contribution, land use, employment, contribution to export, as well as more qualitative parameters related to the nature particular activities that explain past vulnerability to climatic events and indicate potential sensitivities to climate change. Table 4.21 presents a preliminary, largely qualitative attempt to consider these factors together and identify the economic activities that should be prioritised for further EbA analysis.

In terms of its contribution to GDP, the proportion of land area used, employment provided and contribution to downstream value-adding activities in the province, the "agriculture, forestry and fisheries" sector (AFF) remains the most important in Quang Binh's economy. Although the PPC wants to "restructure" the provincial economy, shifting investment and activity to industry and services, the process over the last five years (at least) has been slower than hoped, and agriculture is likely to remain important for years to come.

Within AFF, the single most extensive land use is forestry, occupying 88% of the sector's land and 70% of total land in the province. Of this, plantation forestry occupies some 80-90,000ha - around 10% of total land. Although the primary productive value of forestry is not that high, its raw materials feed processing industries worth three times as much, so the overall value of forestry is high. Since plantations are managed primarily on short rotations for chip and pulp wood, their impact on the environment is high. The state is still highly involved in forestry - though roughly 20% of forest land has now been allocated to households.

Crop cultivation is the next most important land use after forestry, taking 10% of total land, divided roughly equally amongst paddy (4%, 30,000 ha), other field crops (3%) and perennials (3%). Rice is also the most important crop in terms of labour and supporting infrastructure, but total contribution to GDP is relatively small. Some of the most important crops - rice, hill rice, acacia, rubber, fruit trees, shrimp - are already experiencing serious sensitivities to climatic events: drought, saline intrusion, wind damage, cold, heavy rain and heat - which are affecting production. Other crops - especially cassava - and natural forest are more resilient. Annual crop cultivation is primarily carried out by small holders, but commercial interests are heavily involved in estate crops, such as rubber and tea, and larger units are being encouraged by government for all products.

Livestock production is just beginning to intensify - with some large cattle units being installed. Pig production is most important and still predominantly part of mixed farming systems on individual small farms. Fisheries do not occupy a significant area (0.4% total) - either the capture fishery or aquaculture - however their GDP value is growing, and may soon outstrip crop production.

While Quang Binh's most important industry, cement manufacturing, is based on non-renewable resources, plans for future industrial development are to enhance seafood processing and light manufacturing of clothing and electronics. Seafood processing, based on renewable natural resources, depends on sound management of the coastal and marine environment and the services the ecosystems provide.

There has been considerable progress with climate change adaptation in Quang Binh, building on previous decades of coping with extreme climate events. The government has successfully promoted range of sensible strategies, including crop diversification or switching and land use change, but hard infrastructure development remains at the heart of adaptation plans.

Currently, there appears to be an over-emphasis and over-dependence in the provincial economy on construction. The state is the major sponsor of these projects. While many of these projects are over-planned and excess to requirements, they generate a lot of demand for labour, materials and services. Climate change adaptation provides a strong justification for further infrastructure development. Ecosystem-based adaptation measures could contribute to a strategy to wean the economy off construction. Development and adaptation are more than just infrastructure.

Water is the single most important asset, natural resource and environmental service supporting the provincial economy. While overall, resources are abundant, there are serious seasonal and local shortfalls that are set to get much worse with climate change. Provincial development plans do not appear to attempt to solve problems in one area, simply create more problems in another. For instance, the construction of more dams to provide power and irrigation will reduce environmental flows in rivers and accelerate salinization in coastal areas.

Table 4.21: Identification of economic sectors for further EbA analysis

Economic activity	GDP	Future emphasis	Land used	Use of Labour	Organisation	Export	Base for VA	Climate damage trends	Environmental Impact	Notes	Rank
PRIMARY SECTOR										Extensive	
Annual crops	xx	x	x	xxx	SH	x	x	xxx	xx	Drought, salinisation	xx
Perennial crops	x	xx	xx	xxx	SH+Co	xx	x	xxx	xx	Rubber windthrow	xx
Livestock	x	xxx	x	xx	SH+Co			x	xxx	Disease, heat stress	
Plantation Forestry	x	xx	xxx	x	SH+State	xxx	xxx	x	xxx	Acacia windthrow	xxx
Protection Forestry		x			SH + State						xxx
Capture fishery	xx	xxx	-	xx	SH + Co	x		xx	x	Storms limit on-shore fishing	xx
Aquaculture	x	xxx	x	x	SH + Co	xx	x	x	xx	Disease, pollution	xxx
Mining	x	xx	x	x	Co	x	xx	x		Localised Env impact	x
SECONDARY SECTOR										Localised	
Cement etc	xxx	xx	x	x	Co	xx	xx	x	xx	Localised	x
Food processing	x	xxx	x	x	Co	x		x			x
Wood processing	xx	xx	x	x	Co	xx		x			xx
Construction	xx	x	xx	xx	Co+State			x	xx		xx
TERTIARY SECTOR										Localised	
Retail/Wholesale Trade	xxx	xxx	x	xx	SH + Co			x			x
Tourism	x	xxx	xxx	xx	SH + Co		x	xx	x	Extensive	xx
KEY ASSETS											
Transport	xxx	xx	xx	x	SH+Co+State		xxx	xx	xx		xx
Power	xxx		x	x	Co + State		xxx	xx	xxx	Transmission pole windthrow	x
Water	xxx		xx	x	Co		xxx	xx	xx		xxx
Urban areas	xxx		x	x	Co+State			x	xx		xxx

4.4 CONCLUSIONS

The economic analysis presented above indicates that while industry and services are set to expand in the near future, EbA should focus on socio-ecological systems relating to the primary sector, based on renewable natural resources, that is Agriculture, Forestry and Fisheries. A *priori*, these activities have both the greatest dependence on ecosystem services and greatest impact on them. Urban areas are also very important to the provincial economy, but the scope of this EbA assignment was to focus on rural areas, so this will not be a priority.

The government remains a major stakeholder in the provincial economy - with 23% of the economy still state-owned. While ultimately EbA needs to be mainstreamed throughout the economy, the government has an important role to play in pioneering and demonstrating the approach in the sectors in which it has a major stake, such as forestry.

Construction is another important sector in the economy with significant impacts on ecosystems and services and one in which the government still plays a major role. There is an urgent need for construction to embrace new approaches to climate change related problems such as flooding, urban heat stress and energy efficiency of new buildings. Approaches like Sustainable Urban Drainage (SUDS) and green construction principles apply ecosystem principles, but are implemented largely through engineering and architectural activities. In the construction sector, the Government is both the regulator and a main investor - and thus the greatest scope for implementing EbA in construction projects is in government hands.

4.5 REFERENCES

Allison E H et al, 2009. Vulnerability of National Economics to the impacts of climate change on fisheries. Fish and Fisheries, Blackwell. Oxford.

Center of Environmental Engineering, Southern Nature Resources and Environment Company. 2011. Quang Binh Climate Change Response Action Plan 2010-2020.

King, MD 2015. Climate Change and Vietnamese Fisheries: Opportunities for Conflict Prevention. Briefer 26. The Center for Climate and Security. WordPress. 9 pp.

https://climateandsecurity.files.wordpress.com/2012/04/climate-change-and-vietnamese-fisheries-opportunities-for-conflict-prevention_briefer-263.pdf

Malone EL and A Brenkert, 2008. Vulnerability, sensitivity and coping adaptive capacity worldwide. In Mattias Ruth, Maria Ibarranaran (eds). The Distributional effects of Climate Change: Social and Economic Implications. Edward Elgar Press.

Quang Binh GSO, 2014, Statistical Year Book, Quang Binh province

QB DARD 2015 Implementing Dispatch No.1060 / TCLN- QLSXLN day of the General 03/8/2015.

Quang Binh DARD, 2016. Report on the results of mining, processing, consumption of aquatic resources in Quang Binh province in the past and orientation of future development.

Quang Binh DONRE 2009. Plan for water resources exploration and Production in Quang Binh by 2020.

CHAPTER 5 SOCIO-ECOLOGICAL SYSTEMS (SES) PROFILE OF QUANG BINH

5.1 INTRODUCTION

This Chapter presents the methods and outcomes of the work on Socio-Ecological System (SES) carried out under the macro-level assessment for Ecosystems-based Adaption in Quang Binh Province. Four main steps were involved, each of which is described below:

- Identification of SESs
- Mapping of SESs
- Prioritisation of SESs
- Profiling of SESs

The next chapter presents the climate-related information for Quang Binh followed by a chapter on climate change impacts.

5.2 IDENTIFYING SOCIO-ECOLOGICAL SYSTEMS (SES)

The purpose of the provincial -scale vulnerability assessment is to help the provincial government anticipate the most important climate change impacts and then suggest how ecosystem-based adaptation measures may help address them. Some climate threats may be considered important because they affect the biggest number of people, or affect the most people who are poor; yet others may be considered important because they affect a strategic "asset" in the provincial economy.

Using socio-ecological systems as the unit of analysis - building on a concrete understanding of the province's social, ecological and economic context, and the government's development priorities, these risks can be analysed "holistically"

The concept of social-ecological systems (also termed human-environment systems or coupled human and natural systems) highlights that people and nature are interconnected, with their inter-relationships constantly co- evolving, thus making them analytically inseparable (Folke 2006; Folke et. al., 2005; Folke et. al. 2011; Hanspach et. al., 2014; Rockström et. al., 2009). The need for climate change vulnerability assessments to focus on socio-ecological systems has been clearly identified (ISPONRE, 2012; WWF, 2012), but no advice has been provided on how to define, recognize and identify individual SESs. The team was therefore required to develop our own innovative approach to SES identification and analysis for the purpose of vulnerability assessment and identification of EbA options.

It has been suggested that the landscape scale is the best scale for studying social-ecological systems (Liu et al. 2007, Carpenter et al. 2012) but in fact most research to date has focused either at the global scale or at very fine scales (e.g., individual villages) while intermediate scales have been neglected (Rounsevell et al. 2012). For the provincial-level vulnerability assessment, our scale of analysis is the whole of Quang Binh province - requiring all SESs present in the province to be identified. For the local-level assessment that follows, the SES are prioritized, in terms of their ecological, social and economic importance, and two are selected for more detailed and participatory study.

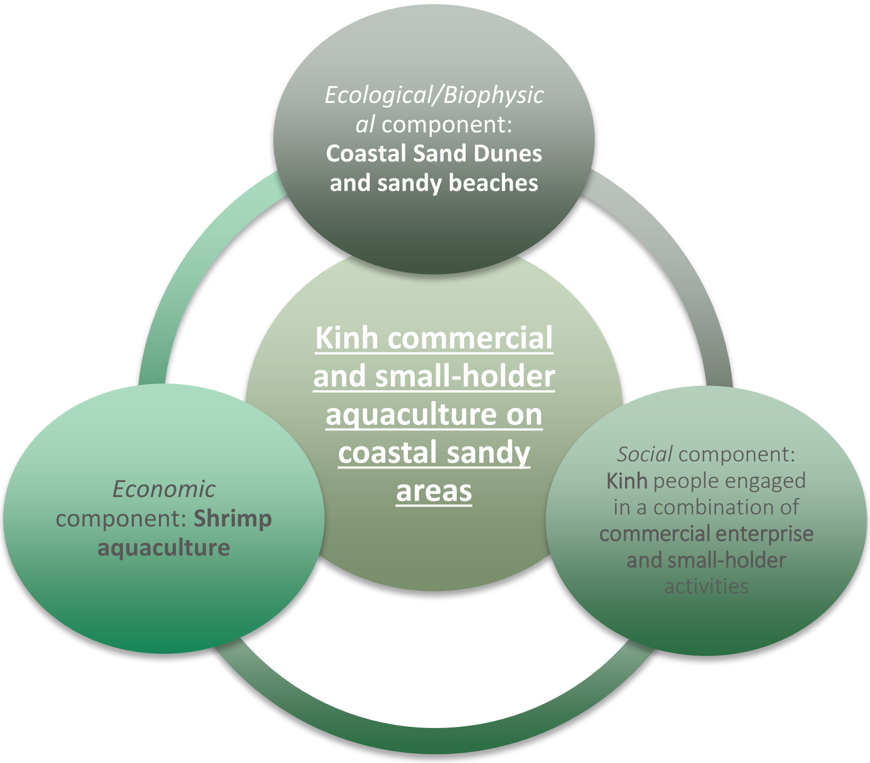
Although social-ecological systems are characterized by dynamic complexity, many are fundamentally shaped by a relatively small number of variables (Walker et al. 2006). Building on the baseline studies presented in Chapters 2-4, three sets of components - ecological, social and economic - and their constituent variables relevant to Quang Binh, were identified. These are shown in Table 5.1.

Table 5.1: Ecological, social and economic component categories for SES identification

Ecological	Social	Economic
Mountains > 700 m	Ethnic minority smallholders	Paddy rice (irrigated or not)
Sub-trop BL moist forest	Kinh smallholders	Upland rice/cassava/maize
Hill Areas < 700 > 10 m	Kinh SME commercial	Field crops
Tropical broadleaf moist forest	Kinh large scale enterprise	Forest product gathering
Lowland Coastal < 10 m	State-owned enterprises	Small-holder acacia
River systems	Foreign owned enterprise	Commercial rubber
Coastal sandy areas		Industrial fruit crops
Mud flat estuary		Fish cultivation
Mangrove Forest		Shrimp cultivation
Lagoon and lake		Capture fishery
Inshore marine areas		
Off-shore marine areas		

One parameter from each component was then combined, as appropriate, to constitute a socio-ecological system. These were confirmed with Google Earth and other mapping overlays. Based on the different combinations of these variables found in different parts of the province, the team identified 41 different SESs occurring in Quang Binh. An example of how one of the SESs was defined is provided below (Figure 5.1), together with a photograph illustrating a representative area of this type of SES (Photo 5.1). The same approach was followed for all of the SESs. The full list of SESs is provided as Table 5.2.

Figure 5.1: Kinh commercial and small-holder aquaculture on coastal sandy areas SES



Map 5.1: Commercial aquaculture in sandy areas

Table 5.2: List of all socio-ecological systems in Quang Binh

SES Code	Full name of SES
PNKB1	Phong Nha Ke Bang National Park (PNKB NP) coniferous forest > 700 m
PNKB2	PNKB NP forest on limestone > 700 m
PNKB3	PNKB NP sub-tropical moist evergreen forest> 700 m
PNKB4	PNKB NP forest on limestone < 700 m
PNKB5	PNKB NP Tropical Moist Evergreen Forest <700m
FPMB3	Forest Protection Management Board (FPMB) sub-tropical moist evergreen broadleaf forest > 700m
FPMB4	FPMB on limestone <700m (low karst)
FPMB5	FPMB on Tropical Moist Evergreen Forest <700m
SFE4	State Forest Enterprise (SFE) production forest management forest on limestone < 700m (low karst)
SFE5	SFE production forest management tropical moist broadleaf evergreen forest < 700m
4b	Commercial limestone quarry and cement production asset in limestone forest < 700 m
5a	Upland Ethnic minority small holder swidden cultivation and forest product collection
5b	Kinh smallholder inland valley or transition paddy cultivation + tree crops (acacia, citrus, rubber, tea) (combine with 6b)
5c	commercial rubber estate
5d	commercial livestock farming enterprises in sub-tropical forest < 700m
5e	Kinh small holder field crops and tree crops on hills
5f	Kinh small-medium tourism development PNKB gateway
6a	Kinh smallholder coastal floodplain irrigated paddy rice cultivation
6b	Urban developments on floodplain
7a	Kinh smallholder freshwater capture fishery
7b	Kinh smallholder/commercial mixed freshwater aquaculture
8a	Kinh cage and pond aquaculture in estuary, mangrove, mudflat areas
8b	Kinh artisanal shell fish collecting
8c	Kinh smallholder salt production
FPMB9 (9a)	Forest protection management board on sand dunes
9b	Kinh small scale vegetable growing on sand
9c	Kinh Commercial pond aquaculture on sandy areas
9d	Kinh Commercial golf resort development on sand
9e	Kinh smallholder freshwater fish ponds
9f	Commercial sand and heavy sand mining
10a	Kinh inshore capture fishermen in delta and marine areas up to 6 nautical miles offshore
10b	Kinh offshore capture fishermen in marine areas > 6 nautical miles offshore
10c	Kinh small and large scale beach tourism services
11a	Irrigation and hydropower reservoirs and related infrastructure in Tropical BL Forest < 700 m
11b	Medium-scale processing assets (wood, cassava) in Tropical BL Forest < 700 m
11c	Fishing and other marine and coastal infrastructure : ports, typhoon shelters
11d	Hon La Port Industrial Zone
11e	Processing enterprises in coastal areas (wood, furniture)

SES Code	Full name of SES
11f	other transport infrastructure : road, railway, bridges, airport
11g	Saline intrusion barriers
11h	Special Economic Zones in TBLF < 700 m

Although the principles for identifying SES are straightforward, in practice, identification and subsequent mapping of SES presents numerous challenges. In order to capture an important variable in one category (ecological, social or economic), it is often necessary to unrealistically split or lump together variables in the other categories. For instance - the marine ecosystem has characteristics totally distinct from the terrestrial ecosystems and climate change will have distinct impacts, requiring distinct interventions. However, the people who use the marine system for their livelihoods typically live on coastal sand dunes and also engage in freshwater pond aquaculture, vegetable growing and other activities, each of which also will respond differently to climate change. Conversely, protected areas such as PNKB, under a single management entity, may incorporate five or six different ecosystems. Rivers - considered ecosystems in themselves - typically have different characteristics as they cross through several ecosystems before reaching the sea.

Further, land units are found in complex matrices across landscapes and house-holds' livelihoods are often complex. Photo 5.1 illustrates these points well - showing the commercial shrimp aquaculture enterprise, beside a small fishing village, where households also engage in some vegetable production in the land surrounding their houses.

Finally - certain key economic "assets" are part of the built environment and do not have strong "ecological" dimensions, or cut across or are found in many different ecosystems. These include infrastructure such as roads, bridges, reservoirs, irrigation canals, power transmission, ports, special economic and industrial areas, and urban areas.

In the identification and classification of SES, we have tried to strike a balance: capturing interesting differences to explore in the climate change vulnerability assessment, while not becoming unworkably complex. Different specialists will likely disagree with our analysis and may see Quang Binh's SESs differently. This is to be welcomed. The classification and analyses we present here represent a first step in what must be an iterative process.

5.3 MAPPING OF SOCIO-ECOLOGICAL SYSTEMS

Spatial variation can arise for a number of reasons. Both biophysical and socioeconomic conditions may vary across a province, and different drivers of change may be more or less pronounced in different locations (Baumann et al. 2011). Spatial mapping can therefore help to elicit spatial variation and can highlight trade-offs and synergies among different system properties such as ecosystem services (Raudsepp-Hearne et al. 2010, Qiu and Turner 2013). Spatially explicit mapping is therefore a key part of studying socio-ecological systems. Mapping all of the SESs across the entire Quang Binh Province was therefore a very critical part of the SES assessment process. The map of SESs of Quang Binh is presented as Figure 5.2.

The SES map was compiled from a variety of sources. The WWF ecosystems and forest type maps for Vietnam and the DONRE land use maps provided basic data, which was complemented by maps of geology and soils, and economic factors provided by different government departments. It was often not possible to obtain digital copies of maps, so some precision has been lost. Google Earth was used intensively to understand Quang Binh's landscapes and confirm SES units and boundaries. A limited amount of ground-truthing was carried out, focusing on particular sites and landscapes where uncertainty existed.

5.4 PRIORITISING SOCIO-ECOLOGICAL SYSTEMS

Due to the limited availability of time and resources, the VA team was not able to investigate all 41 SESs in detail. It was therefore necessary to make a selection of priority SESs. This was done based on 12 criteria selected based on the content of chapters 2-4 - by ranking the SESs, assigning scores to each SESs by considering its importance in relation to social, economic, environmental and climate change issues, including its contribution to provincial GDP, contribution to employment, spatial extent, provision of and dependence on ecosystem services, etc. The process largely used the professional judgement of the consultants. Due to the lack of the up-to-date and reliable quantitative data on many aspects of interest, the scoring of the criteria was largely qualitative. The SES map provided an estimate of the area of land occupied by each SES. The top 10 ranking SESs of Quang Binh are presented in Table 5.3. More details of the ranking of the SESs - showing the scoring for 12 different criteria, are provided in Annex 5.I. The top 10 ranked SESs in Quang Binh account for almost 60% of the land area of the provinces, and all of its near-shore waters.

Map 5.2: Map of socio-ecological systems of Quang Binh province

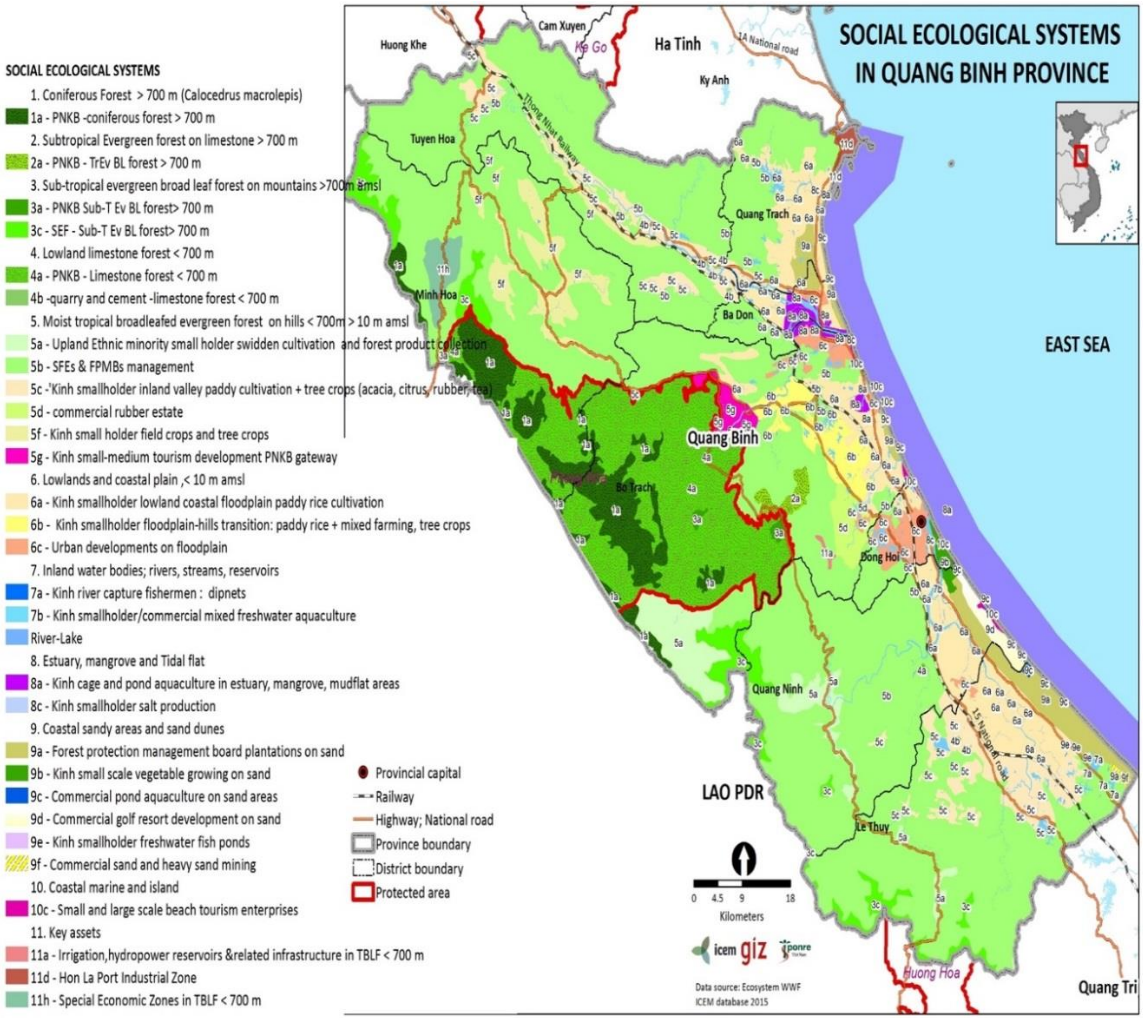


Table 5.3: Top 10 priority SESs in Quang Binh

Rank	SES Code	Name of SES
1	6a	Kinh smallholder coastal floodplain irrigated paddy rice cultivation
2	5b	Kinh smallholder inland valley or transition paddy cultivation + tree crops (acacia, citrus, rubber, tea)
3	PNKB 1-5	Phong Nha-Ke Bang National Park (World Heritage Site)
4	SFE 5	State Forest Enterprise management of production forest in lowland (<700m) moist evergreen broadleaf forest areas
5	9c	Kinh small-holder/commercial shrimp aquaculture on sand dunes
6	FPMB 9	Forest Protection management Board management of coastal protection forest on sand dunes and sandy areas
7	10a	Kinh inshore capture fishermen (estuary to 6 km offshore)
8	5a	Upland Ethnic minority swidden cultivation
9	5c	Hilly forest commercial rubber estates
10	11a	Irrigation and hydropower reservoirs and related infrastructure

5.5 PROFILING THE SOCIO-ECOLOGICAL SYSTEMS

To assist readers in understanding the SES, 5 of the top 10 have been profiled, providing an overview of the ecological, social, economic and climatic characteristics of each, an estimation of their relative importance, a Google Earth sketch map showing their geographic extent in the province and some photographs. Most of the profiles are based around a site that was visited during the scoping mission, and then the further extent of the SES within the provinces and its main variations are discussed. Intended as stand-alone documents, the profiles also provide summaries of the ecosystem services assessment and the climate change vulnerability assessments, which are discussed in detail in Chapter 9. The profiles are provided in Annex 5.II.

From the perspective of Vulnerability Assessment and EbA, a key aspect to consider is the resilience of the ecosystem component of each SES. Resilience is the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity. Holling (1973; 1986; 2001) explained resilience as the amount of disturbance a system can absorb without shifting into an alternate regime. Social-ecological systems exhibit thresholds that, when exceeded, result in changed system feedbacks that lead to changes in function and structure. When this happens the system can be considered as having undergone a regime shift (Scheffer et al. 2001, Carpenter 2003) The more resilient a system, the larger the disturbance it can absorb without shifting into an alternate regime.

Transformability is the capacity to create a fundamentally new system when the existing system is untenable (Walker et al. 2004). Social-ecological systems can sometimes get trapped in very resilient but undesirable regimes in which adaptation is not an option (carpenter et.al. 2001; Carpenter and Brock, 2008). Escape from such regimes may require large external disruptions or internal reformations to bring about change (Holling and Gunderson 2002). The transformation of a social-ecological system can be in response to the recognition of the failure of past policies and actions, triggered by a resource crisis, or driven by shifts in social values (Gunderson et al. 1995).

The resilience of an ecosystem will also determine the extent to which it can continue to provide ecosystem services on which the SES depends. Each SES depends to varying extents, on a combination of ecosystem services that are generated from within the SES itself and also ecosystem services that are generated from other SESs (e.g. water supply from upstream watersheds).

From the perspective of ecosystem services, the Phong Nha Ke Bang (PNKB) National Park SES is the single biggest area of healthy natural ecosystems, and the single biggest provider of ecosystem services. It plays a major role in provision and regulation of water supply on which many downstream activities are dependent. Some Forest Companies under the State Forest Enterprise Management Board production forest SES are also managing large areas of natural forest (as well as plantations) and these are also providing significant ecosystem services to downstream areas. All of the other SESs represent areas in which the original natural ecosystems have been extensively modified or transformed into other systems - some of them may have some small components of natural ecosystems remaining - such as mangrove forests or Melaleuca forests for example, but these are essentially remnant patches. In these cases, it is important to understand what ecosystems services these socio-ecological systems depend on, for their continued productivity, more than what services they provide to other areas. The large sand dune landscapes of Quang Binh have already been significantly transformed from their natural state but nevertheless may still provide important environmental services such as ground-water supply that support the economic activities such as aquaculture and vegetable growing, going on within the same landscape. Forest plantations, while not being natural ecosystems do provide some similar services such as carbon storage and physical protection that would have been provided by the original natural ecosystem they replaced, though often with more limited effectiveness. The limited area of natural ecosystems remaining within many of the SESs reduces their resilience, and adds to their vulnerability. Detailed ecosystem service-related assessments of each of the most important SESs are provided in Annex 5.III.

5.6 CONCLUSION

The provincial-level identification of all SESs in a province is the key innovation in this approach to mainstreaming ecosystem-based adaptation to climate change at the provincial level. The identification of 41 SES for Quang Binh, and the further identification of the top 10 most important SESs presented here, represents a preliminary analysis, based on incomplete data, and limited opportunity for verification on the ground. The methodology is still evolving and the results here should be considered provisional. Nevertheless, the authors believe that the SES-focused approach represents valid entry point for multi-sector cross-cutting vulnerability assessments and EbA planning.

As the overall objective of the GIZ project is mainstreaming, it may have been of more benefit if provincial government staff has been able to work closely together with the consultant team in identifying, mapping, ranking and profiling SESs. This would have enabled them to have some ownership over this innovative approach, and would have allowed them to have a more meaningful discussion with the consultants about this.

It is therefore suggested that the provincial GIZ team in Quang Binh, together with counterparts in provincial government agencies (especially DONRE) should continue the SES exercise, by developing at least five more SES profiles, and by conducting additional on the ground verification. It should be much easier for local government staff to conduct a series of rapid visits to a range of SESs than it was for the consultancy team (especially the international consultants), who required long lead-in times to request permission for field visits, in which exact locations to be visited had to be specified - this greatly restricted flexibility in field work, reducing the total amount of time spent in the field, and the number of areas visited. Without trying out the approach in practice for themselves, it will be difficult for provincial authorities to assess the usefulness of this approach and to consider whether and how to mainstream the approach in future.

5.7 REFERENCES

Carpenter, S., B. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: Resilience of what to what? *Ecosystems* 4(8):765-781. http://dx.doi.org/10.1007/s10021-001-0045-9

Carpenter, S. R., and W. A. Brock. 2008. Adaptive capacity and traps. *Ecology and Society* 13(2): 40. [online] URL: http://www. ecologyandsociety.org/vol13/iss2/art40/.

Carpenter, S. R., C. Folke, A. Norström, O. Olsson, L. Schultz, B. Agarwal, P. Balvanera, B. Campbell, J. C. Castilla, W. Cramer, R. DeFries, P. Eyzaguirre, T. P. Hughes, S. Polasky, Z. Sanusi, R. Scholes, and M. Spierenburg. 2012. Program on ecosystem change and society: an international research strategy for integrated social-ecological systems. *Current Opinion in Environmental Sustainability* 4(1):134-138. http://dx.doi.org/10.1016/j.cosust.2012.01.001

Carpenter, S. R. 2003. *Regime shifts in lake ecosystems: pattern and variation.* Excellence in Ecology Series Number 15. Ecology Institute, Oldendorf/Luhe, Germany.

Carpenter, S. R., and W. A. Brock. 2004. Spatial complexity, resilience and policy diversity: fishing on lake-rich landscapes. *Ecology and Society* 9(1): 8. [online] URL: http://www.ecologyandsociety.org/vol9/iss1/art8/.

Folke, C. 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16(3):253-267. http://dx.doi.org/10.1016/j.gloenvcha.2006.04.002

Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30:441-473. http://dx.doi.org/10.1146/ annurev.energy.30.050504.144511

Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4:1-23.

Holling, C. S. 1986. The resilience of terrestrial ecosystems: local surprise and global change. Pages 292-317 *in* W. C. Clark and R. E. Munn, editors. *Sustainable development of the biosphere.* Cambridge University Press, Cambridge, UK.

Holling, C. S. 2001. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4:390-405.

Scheffer, M., F. Westley, W. Brock, and M. Holmgren. 2002. Dynamic interaction of societies and ecosystems: linking theories from ecology, economy and society. Pages 195-235 *in* L. H. Gunderson and C. S. Holling, editors. *Panarchy: understanding transformation in human and natural systems.* Island Press, Washington, D.C., USA.

Walker, B. H., and R. L. Lawson. 2006. Case studies in resilience: fifteen social-ecological systems across continents and societies. The Resilience Alliance. Available online at: http://www.resalliance.org/1613.php.

Walker, B. H., and J. A. Meyers. 2004. Thresholds in ecological and social-ecological systems: a developing database. *Ecology and Society* 9(2):3 [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art3/.

Walker, B., L. Gunderson, A. Kinzig, C. Folke, S. Carpenter, and L. Schultz. 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society* 11(1): 13. [online] URL: http://www.ecologyandsociety. org/vol11/iss1/art13/.

ANNEX 5.I: RANKING OF PRIORITY SES IN QUANG BINH

No	SES	Ecological		Social			Economic						Climate/ Environment		Rank
		Provider of ES	Depend on ES	Population	Poverty	Other Vulnerable Group	GDP	Future emphasis	% Tri measure	Land used *<5%; ***>20%	Labour used	Base for VA*	Climate damage trends	Neg Env Impact	
PNKB 1-5	Phong Nha-Ke Bang National Park	xxx	xxx	x	x	x	xx	xxx	16.0	xxx	x	xx	x	-	3
SFE5	State forest enterprise forest management lowland forest	xx	xx	x	x	xx	x	x	15.5	xxx	xx	xxx	x	xx	4
5a	Upland Ethnic minority small holder swidden cultivation and forest product collection	x	xx	x	xxx	xxx	x	x	2.7	x	xx	x	x	xx	8
5b	Kinh smallholder inland valley or transition paddy cultivation + tree crops (acacia, citrus, rubber, tea)	xx	xx	xx	x	x	xx	xxx	12.8	xx	xx	x	xx	xx	1
5c	Lowland moist TRF commercial rubber estate	x	xx	x	x	-	x	x	1.0	x	x	x	xx	x	10
6a	Kinh smallholder coastal floodplain irrigated paddy rice cultivation	x	xx	xxx	x	-	xx	xx	8.2	xx	xxx	x	xx	x	2
FPMB9	Forest protection management board on sand dunes	xx	x	x	-	-	x	x	2.3	x	xx	-	x	x	6
9c	Kinh SH and Commercial shrimp aquaculture on sand	-	xx	x	-	-	xx	xx	0.02	x	x	xx	xx	xx	5
10a	Kinh artisanal inshore capture fishermen in delta and marine areas 6 nm offshore	xxx	xx	xx	xxx	-	xx	x	0.0	x	xx	xx	xx	xx	7
10c	Kinh small and large scale beach tourism services	x	xx	x	x	-	xx	xx	0.2	x	x	xx	xx	xx	11
11a	Water supply, irrigation and hydropower reservoirs and related infrastructure in Tropical BL Forest < 700 m	xxx	xxx	xxx	x	-	xx	xx	0.1	x	x	xxx	x	xx	9

ANNEX 5.IIA: SES DESCRIPTIONS - QUANG BINH 5A

Name: Upland (<700m) Ethnic Minority SwEdden Cultivation and forest product gathering

Example: Thuong Trach commune, Bo Trach District, Quang Binh

1. KEY DESCRIPTORS

1.1. *Socia:* Ethnic minority; Van Kieu, Chut (Arem), poor, isolated

1.2. *Ecological:* Upland valley 400-600m amsl; tropical broad leafed evergreen forest 700m amsl; degraded

1.3. *Economic:* Subsistence swidden cultivation; hill rice, cassava, maize; cattle, pigs, chickens; forest products; poor market access.

1.4. *Trends:* Government discouraging swidden cultivation; in some places allocating forest land for plantation or protection.

1.5. *Climate change threat:* Drought, cold, heat, landslides.

2. DESCRIPTION

2.1. Location, topography and ecology

Thuong Trach commune is located in the upper watershed of the Son River at elevations of 400 - 600m, between the Lao border and Phong Nha - Ke Bang National Park. The river arises on the Lao border and cuts through the limestone massive of Phong Nha - Ke Bang before joining the Gianh River near its estuary.

The topography of the valley is characterised by rolling or steep hills > 25% slope, bordered on the north by the karst towers of PNKB and on the other sides by the lower peaks of the Annamite mountain range. Originally, the vegetation would have been tropical broadleaved evergreen forest in the main valley, with sub-tropical BLE forest on the surrounding Ammanite peaks above around 700m and limestone forests in PNKB. The valley vegetation has been transformed into a mosaic of agricultural fallow of different ages. Bamboo strongly colonises in some places and there are also patches of secondary forest. The fallow period has now been reduced to about 5 years and there many signs of soil degradation. It appears that the sub-tropical forest above 700m is more or less in fact, but has doubtless been logged. The forests on limestone in PNKB are still subject to illegal logging, and there is evidence of past cultivation on the slopes above the Son River, in what is now the Ecological Restoration Zone of the NP.

2.2. Social profile

This high valley is inhabited by a population of about 500 ethnic minority households; most belong to the Ma coong group of the Van Kieu minority, but there are also Arem (Chut) families located on the boundary of PNKB. Some villages were moved here from the core of PNKB, when the park was created in 2001. Many villages and the commune HQ remain beside the river, while others have been encouraged by the government to relocate next to the minor road that crosses into Laos. The communities live in relative isolation, because of restrictions on traffic passing through the park, and the lack of a major border post with Laos. According to DOLISA figures, in 2015 this commune had a 92.5% poverty rate.

2.3. Economic profile

Ethnic minority households have primarily subsistence livelihoods, based on swidden cultivation of upland slopes. Plots are cleared and burned in the winter. Rice is planted once a year around March, intercropped with cassava and maize, roughly in proportion 3:1:1. After the final harvest of cassava, plots are abandoned, and left fallow for only five years before being slashed, burnt and cultivated again. In the past, plots were fallowed for 15-20 years, and the shortened cycle is affecting soil fertility. No soil conservation measures are practised. Hill rice is sensitive to drought and the last two crops (2014, 2015) have been lost. Maize and cassava are more drought tolerant, and increasingly replacing hill rice. There is insufficient water for other field crops (peanuts, vegetables). Some animals are kept, particularly pigs, cattle and chickens, and are often sold if cash is required.

In recent years, forest land has been allocated to some communities for protection, providing a small cash income and a limited degree of exploitation for subsistence needs. There is some acacia planting. PNKB has promoted acacia in villages through a scheme where villagers are hired to do the planting on village land. Villagers then sell to PNKB. Some people have started planting on their own land, but the remote location reduces their profitability. There is some collection of forest products: bamboo shoots, wild bananas, wild eggplant and forest yams for food; and rattan, firewood and small timber for sale. Animals are an important source of livelihood. Pigs and chickens are raised for food and cattle for cash. Apart from government jobs in the commune centre, waged employment is only available outside the valley.

All communities receive food aid from the government, in the form of 5-10kg of rice/person/month, delivered 2-3 times per year. Additional aid is provided in times of crop failure. The 135 programme has provided new housing. Electricity will be available next year. Radio is the only source of information. There is no public transport, but many people have motorcycles.

2.4. Ecosystem services

Key ecosystem services communities obtain from the landscape, and their current status are shown in Table 5.4. This analysis is based on secondary sources and field visits, and would be expanded and improved in the context of a micro-level assessment, based on local stakeholder perceptions.

This SES is highly dependent on ecosystem services, particularly the provisioning of water and supporting services of nutrient cycling and soil formation. But many services are in a poor condition due to loss of forest cover.

Table 5.4: Ecosystem services important to people in the upland ethnic minority swidden cultivation SES

No	Main Services	Description	Source of ecosystem service	Rank		Justification for ranking
				Imp	Cond	
Direct Provisioning						
P1	food	Forests and some fallows still provide wild foods (wild bananas, bamboo shoots, forest yams, teas) for human or livestock (esp pig) consumption, but quantities are declining and collection distances increasing. Cattle graze freely. Fish are traditionally caught hand nets, but Kinh are now taking all the fish.	Forest in SES itself and surrounding FPMB	3	2	Some wild human foods are important, but primarily in emergency situations.
P2	water	River water is used for all domestic purposes; small streams have dried and levels of main river have declined in last few years. There is no irrigation.	Forested upper parts of SES and FPMB around the SES	5	3	Vital service, increasingly degraded. Villages resettled from riverside to roadside particularly challenged.
P3	medicines	Forests still provide some, the modern health services are also available at the commune centre	Forest and fallow in the SES itself	3	3	People rely on both local herb and modern medicine
P4	fibres	Rattans are collected to make baskets and for sale, but quantities have decreased and distance increased	Forests of SES and surrounding FPMB	4	3	Rattan, barks etc are still used for is a source of income
P5	building materials	Houses were previously built on wooden stilts with walls and floors of bamboo. Timber is difficult to obtain, but the latter is still widely available. Bamboo still much used in fencing and house extensions.	Forest and fallow in the SES itself	3	3	The government is providing a lot of housing, using materials from outside the SES. Local people actually prefer bamboo walls and floors.
P6	water energy	Micro-hydro may be harnessed by riverside villages	SES itself and upper watersheds in FPMB and Laos	2	3	It would be highly suitable, and potential exists, but it is unclear whether it is currently used.
P7	biomass energy	Forests and fallows supply firewood.	SES itself	4	4	Firewood is still the main source of energy for local people. Bamboo plentiful
P8	transport	Used by riverside villages for short-distance travel.	Watersheds above SES	1	5	Now roads and motorbikes used more
Regulating Services						
R1	carbon fixation/ storage	Shifting cultivation involves frequent burning of vegetation and some forest clearance	SES itself	1	1	People are unlikely to perceive importance of this ES. SES generates more GHG than it fixes.
R2	water quality maintenance	Degraded swidden landscape suffers erosion which has negative impact on water quality	SES itself	2	2	SES has a negative impact on water quality; but water quality still relatively

No	Main Services	Description	Source of ecosystem service	Rank		Justification for ranking
				Imp	Cond	
						high.
R3	air quality maintenance	Smoke from swidden burning and dust from fallow land affects air;	SES itself	1		SES has negative impact on air quality, but otherwise air quality high
R4	climate buffering	Forests can provide favourable microclimates for adjoining fields, but this is diminished by degraded nature of forest, and uninterrupted swidden landscape	SES itself	2	1	Insufficient forest to make a significant impact
R5	pest and disease control	Unclear	SES itself	-	-	unclear
R6	waste recycling/ detoxification	Much waste biodegradable. Few toxic substances used. So service not needed.	SES itself	1	3	Degraded ecosystems will have limited capacity for this
R7	physical protection	Forests provide protection from hot winds in certain locations.	SES itself	1	2	Probably only in fields close to the forest
R8	control of water flows	Limited forest cover, limits water retention in watershed; narrow valley limits flood control. River levels have declined in the last few years	SES itself	1		Could be improved
R9	control of sediment flows	Unclear	SES itself	-		SES has little capacity to moderate sediment flows already in watercourses
Supporting services						
S1	carbon cycling			0		
S2	Photosynthesis/ primary production	Agricultural SES livelihoods dependent on this	SES itself	5	3	Dependent on primary production
S3	nutrient cycling	The fallow cycle is now reduced to 5 years, compromising this ecosystem service	SES itself	1	3	
S4	soil formation	Dependence on agriculture, low level use of fertilisers means	SES itself	5	1	The fallow cycle is now reduced to 5 years, compromising this ecosystem service
S5	water cycling	Integrity of water cycle not important at this scale		-	-	
S6	pollination	Hill rice and maize wind pollinated; cassava not needed; bananas bat pollinated.	SES itself, watershed natural forests in other SESs	2	3	New economic crops may require pollinators, so good to ensure healthy populations
S7	seed dispersal	Not important for crops currently cultivated and wild foods used	SES itself, watershed natural forests in other SESs	1	3	Most crops are planted by farmers, natural seed dispersal is of limited importance for this SES
Cultural-spiritual						

No	Main Services	Description	Source of ecosystem service	Rank		Justification for ranking
				Imp	Cond	
C1	religious-spiritual	Enquiry needed				
C2	recreation, sports, ecotourism	Unlikely				
C3	science, education	Unlikely				
C4	historical/ nation building	Unlikely				
C5	relaxation/ mental health	Enquiry needed				
C6	aesthetics/ artistic inspiration	Enquiry needed				

EbA measures would assist in restoring some of these services:

- Improved fallow management to enhance nutrient cycling and soil formation.
- Improved soil fertility management in cropping system (contour terraces, etc)
- Plantation of long rotation perennial crops to supplement swidden crops
- Restoration and sustainable management of indigenous forest to enhance availability of resources on which people still depend.
- Identification and protection of small watercourses for domestic water supply in settlements away from river.
- Managing the bamboo resource for income generation.

2.5. Climate and Climate Change

Rainfall is from 2,000-3,000mm/yr. The main rains fall from June to September, though there is usually some drizzle from March-May. Heavy rainfall events are unusual. The hot dry Lao wind (NW, SW) occurs frequently between March and September. Very hot days are increasingly frequent, especially in months of May-July. The winds are getting stronger, to the extent that animas die and houses collapse. The weather is cool from October to February, but only February is actually cold. A summary of climate information for Quang Binh is provided in Table 5.5.

Table 5.5: Summary of climate information for meteorological stations in Quang Binh

Climatic Descriptors	Tuyen Hoa	Ba Bon	Dong Hoi
Annual Mean Temp.	23.8^{o}C	24.3^{o+}C	24.6^{o}C
Lowest Temp.	5.9^{o}C (Jan)	7.6^{o}C	7.7^{o}C (Jan)
Highest Temp.	40.1^{o}C	40.1^{o}C	42.2^{o}C
Annual Mean Rainfall	2,266.5mm	1,932.4mm	2,159.4mm
No. of rain days per year	159 days	130 days	135 days
Highest Rainfall per day	403mm	414mm	415mm
No. of dizzle days per year	18 (Jan, Feb, Mar)	9.3 (Nov)	17 (Dec)
Av. Air humidity	84%	84%	83%
Av. Minimum humidy	66%	67%	68%
No. of foggy days	47 (Jul, Aug, Sep)	20 (Sep, Oct)	13.8 (Sep, Oct)
Air evaporation	1,031mm	1,035mm	1,222mm

Source: Ministry of Culture, Sport and Tourism (2014) Phong Nha - Ke Bang National Park. Renomination

In Table 5.6, the impact of predicted changes in the climate (exposure and sensitivity) on this SES is explored.

Table 5.6: Vulnerability of upland ethnic minority swidden cultivation to predicted climate change

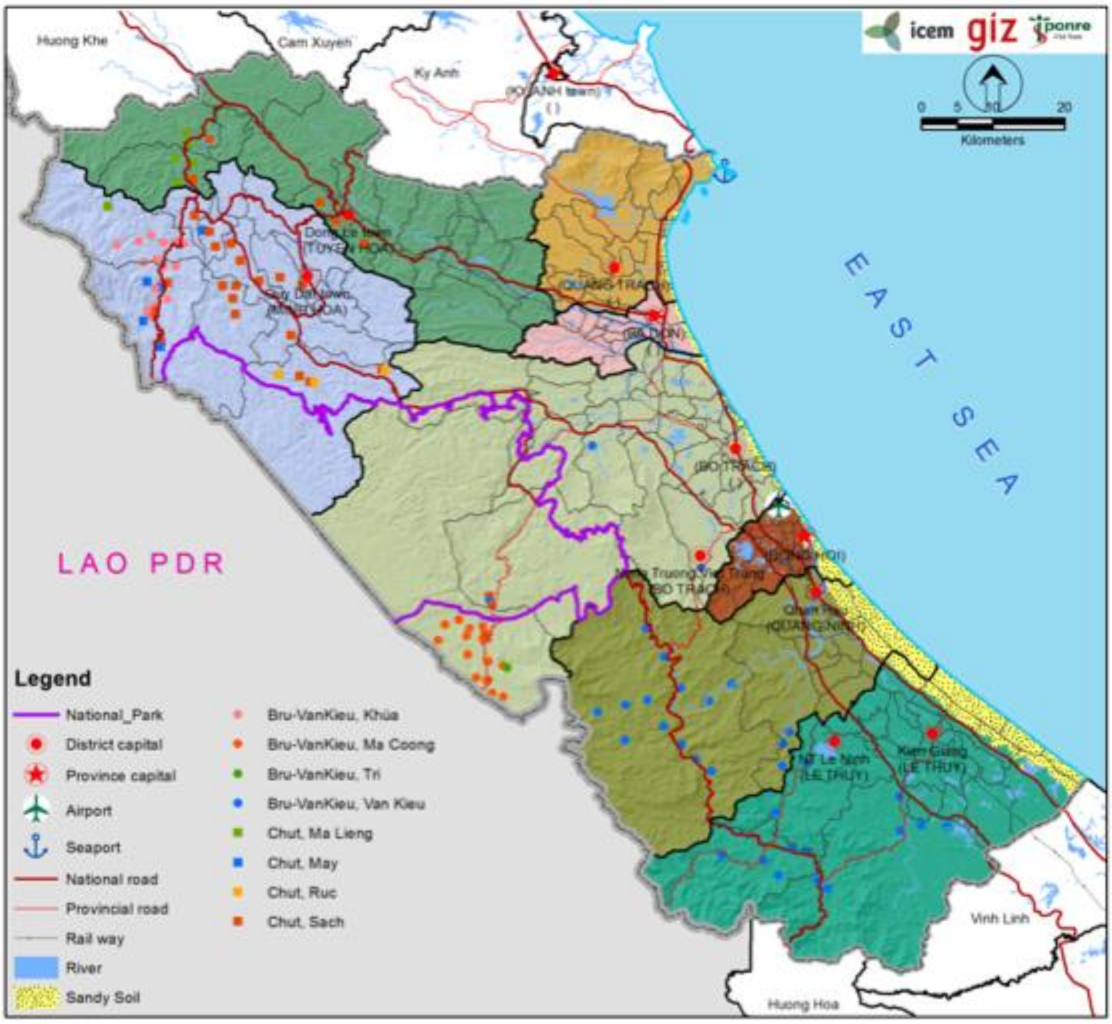
CLIMATE CHANGE RISKS	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	AC	Explanation (AC)	Vulnerability
TEMPERATURE								
Hot season will be hotter and longer Summer average maximum temperature will increase	4	2050: 1.7 - 1.9 C ° 2100: 3.2 - 3.6 C ° Over baseline of 23.8 ° C	5	Upland rice, maize, vegetables, but not cassava, grow slowly and die in prolonged heat, particularly combined with drought and the desiccating Laos wind	5	2	*Remote from extension services and markets. Lack of livelihood alternatives, resources, knowledge, organisation for adaptation. Reliance on food hand-outs reduces initiative*	5
Number of hot days > 35°C per year also increase	5	2050: 34 - 48 days 2100: 41 - 63 days	5	Heat increases pig, chicken, cattle disease; reduces labour efficiency	5			5
Temperature will increase faster and earlier in Spring	4	*No quantitative data*	5	High temperatures early in growing season slows rice growth	5			5
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase	4	2050: + 3-5% 2100: +7-9%	4	Heavy rain can cause flash floods, and landslides and erosion on steep slopes	4	2		4
Dry season will be drier. Rainfall of Spring will decrease	5	2050: - 5% 2100: -8-10%	5	Drought causes rice, maize, vegetables crop failures	5		*Farmers are increasing the proportion of cassava planted (coping strategy)*	5
Number of Dry days will increase	5	2050: 17-20 days 2100: 14-19 days Over baseline of 188 dry days	5	Rain-fed upland agriculture, especially rice and maize is very sensitive to drought, decreasing production and eventually killing crops	5	2		
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	Currently 1 big storm every 2 yrs Heavy rains accompany wind Storm winds weaker when they reach the mountain	4	Many houses and roofs cannot withstand storm winds (vis 2010 storm experience). Flash floods along smaller rivers erosion on exposed slopes	3	3	*Government usually provides support for storm damage to housing*	3
SEA LEVEL RISE not relevant	1		1		1	5		1
	4.0		4.1		4.0	2.7		4.0

2.6. Extent and relative importance of the SES:

Although swidden cultivation was once widely practised by ethnic minorities in the uplands, government campaigns for sedentarisation and permanent cultivation that began in the late 1960s mean that, by now, many minority groups have been resettled and assimilated into the Kinh cultural and economic mainstream, and practise paddy rice cultivation and/or mixed farming and forestry, depending on location and the particular group. According to the strategic management plan for PNKB, about 2,000 of Quang Binh's remaining 5,000 ethnic minority families still practise swidden cultivation.

Main centres of ethnic minority distribution are shown on Figure 5.3.

Map 5.3: Distribution of ethnic minority settlements in Quang Binh



In Minh Hoa district, the Chao La border area development project has brought improved roads, more traffic and commerce and greater integration with the Kinh. Here, many ethnic minority households still practise swidden cultivation of hill rice, cassava and maize, although paddy cultivation has also been introduced. Acacia plantations are also widespread and some forest land has been allocated to households. In Truong Hoa, Sach and Rut villages are not allowed to practise swidden. They no longer cultivate subsistence food crops, but plant acacia and pine on their old swiddens, and maize, cassava and peanuts in the valley. They to gather non-timber forest products and engage in illegal logging from the natural forest.

In Quang Ninh and Le Thuy districts the upland communes are home to many settlements of Van Kieu people, mostly located within a short distance of the Ho Chi Minh Highway. Agricultural land is severely limited and the SFE has not made much forest land available to communities.

The Chut people are considered the most traditional of the region's ethnic minorities. Numbering only about 3,000 people, they are found in a small area including parts of Minh Hoa, Tuyen Hoa, and neighbouring Huong Khe District of Ha Tinh province.

3. CONCLUSION

If the government permitted a study, Thuong Trach would be a very suitable site for a micro-level assessment. As an upland valley bordering PNKB and Laos, its boundaries are clearly delimited. Households suffer high levels of poverty, are heavily dependent on natural resources and ecosystem services for their livelihoods and they are already suffering hill rice crop losses from exceptional heat, drought and landslides. Settlements are far from the district headquarters and associated services, thus information and support to enhance adaptive capacity is limited. The military provides some support, but this can undermine peoples' initiative.

EbA interventions might include soil conservation measures, other drought resistant crops, forest enrichment with native species, management of the bamboo that regenerates naturally, to diversify livelihoods.

Map 5.4: Google earth photo of Thuong Trach commune

Figure 5.2: Steep slopes (> 25%) are cultivated, without any soil conservation /moisture retention measures

Figure 5.3: View northeast across ethnic minority upland fields to karst of PNKB National Park

Here, red/yellow soils derived from schist or sandstone predominate and slopes exceed 25%. Matrix of fields and old fallow. Bamboo is abundant. Acacia is not.

Figure 5.4: Village 59 in Thuong Trach

ANNEX 5.IIB: SES DESCRIPTIONS - QUANG BINH 5B

Name: 5b Kinh smallholder inland valley or transition paddy cultivation + tree crops (acacia, citrus, rubber, tea) + field crops

Example: Thuan Hoa commune, Tuyen Hoa district, Cu Nam commune, Bo Trach district and Le Ninh town, Le Thuy district

1. ABSTRACT/SHORT DESCRIPTION/KEY DESCRIPTORS

1.1. Ecological

This SES occupies a transition area of valley floors and lower slopes leading to hilly areas. Formerly it would have been lowland moist evergreen broadleaf forest but it has almost entirely been converted to an agricultural landscape

1.2. Social

This SES is occupied by Kinh smallholders

1.3. Economic

Key crops are rice, other field crops and tree crops including citrus, rubber and tea

2. FULL DESCRIPTION

2.1. Location, Topography, Ecology

This SES is found at the inland margins of the coastal flood plain and along broader inland valleys, in three river systems in Quang Binh Province. There are two areas of rolling hills just inland of Quang Binh's narrow floodplain, a large area west of Dong Hoi in the Dinh River watershed, and another in the south, inland of the province's main rice growing area in Le Thuy and Quang Ninh, west of the Kien Giang River. In the Giang river system the SES is found in areas including Huong Hoa, Thanh Thạch, Thanh Haa, Kim Hoa, Thuan Hoa, Dong Le (town), Thach Haa, Duc Hoa, Mai Hoa, Tien Hoa, Canh Hoa, Van Hoa and Cao Quang communes. In the Dinh River system it is found in Le Ninh town, Pha Thuy, Mai Thuy, Truong Thuy, Van Thuy and Thai Thuy communes, and in the Con River system it is found in Cu Nam, Van Trach, Tay Trach, Hoa Trach, and a part of Nam Trach communes.

The majority of the SES is in lower altitudes, above 10 m but below 200m, with low and small hills separated by small valleys, creating a very irregular pattern. The valley bottoms vary in width and topography - with different proportions of paddy land, and terraces for field crops. Most of the valleys are flanked by slopes > 25%. Except where the valleys border protected areas, the lower slopes are converted to tree crops. Some intact (but degraded) lowland moist evergreen broadleaf forest remains in places above the limits of this SES. The highest areas are in the upper watersheds of short Gianh River tributaries in Minh Hoa District.

Using Le Ninh as an example, Le Ninh town is located in Le Thuy district, in an area originally managed by Le Ninh state farm since 1966. It consists of a combination of flat land in valley bottoms and sloping land in the transitional area between the valleys and hilly areas, ranging from elevations of less than 10m asl. In the valleys to 25-50m on the slopes. This area has 3 main soil types: fluvisols derived from Sao Vang River; acrisols, and ferrasols. Formerly it would have supported lowland moist evergreen broadleaf forest, but the land has now been converted to agricultural use, and is currently used for growing paddy rice, as well as tree crops (citrus, rubber, acacia, tea) and mixed farming.

2.2. Social profile

Paddy cultivation is largely a Kinh practice, so this SES is dominated by the majority group. However, and undetermined number of households in the more assimilated ethnic minorities so also plant some paddy. Poverty levels in most of the communes of this SES are low (< 10% of households). At higher elevations, like Kim Thuy commune in Le Thuy District, the poverty levels increase to 20 - 50% of households. Typically, the more diverse the planting and other livelihood activities, the better off the household. Le Ninh town has a population of more than 6,000 Kinh people on a total area of 1,135ha.

2.3. Economic profile

Agriculture is the dominant activity in this SES. It incorporates paddy, annual field crops and tree crops, but the proportion of each will vary substantially from household to household, as will the particular crops planted. The main crops are rice as well as acacia, rubber, oranges, mangoes, tea, pepper, cassava, maize, sweet potato and vegetables. Other livelihood activities include livestock rearing. Pigs are the most important livestock species in the province and contribute over 2 billion VND to the economy, but cows and chickens are also common and raised for domestic use and sale.

Paddy fields may be irrigated by small reservoirs in the adjacent hills, ln some cases, one crop of rice is planted, followed by another short-rotation field crop. The most important field crop in this area is peanuts, but maize and cassava are also planted, as well as some vegetables. The main crop rotations in the area are spring rice - early summer rice; spring rice - early summer rice and winter crop; spring peanut - other upland crops (like onion, maize)

What is planted also varies with land elevation changes. The higher elevation and sandy soils are suitable to upland crops such as peanuts, maize, and onion, while medium elevation areas are suitable more intensive cultivation (may have 3 harvests per year - rice - rice - winter crops) and low elevation areas are normally used for rice only.

There has been a lot of changing of rice cultivation patterns over time. Previously, winter spring rice (with duration of 180 days) was the key crop - seedlings were produced in late November, transplanted in January and harvested in June, but now this has shifted to late spring season with short duration rice varieties that are sown in early February, transplanted in late February and harvested in June. Summer rice planting has also changed from using very long duration varieties (with photo-period sensitivity that only ripens with short daylight hours in Autumn-Winter to early summer season.

Fluvial soil along valley floors is most suitable for planting rice and some other annual crops such as maize and peanuts as well as winter crops like potato, sweet potato and vegetables. The hilly areas are planted many upland crops and perennial crops. Normally Acrisol soils are used for planting cassava, maize, acacia and tea, while Ferrasols are used for planting citrus and rubber).

Since the 1990s, forest land has been allocated to households in Quang Binh, and much of this is under acacia, grown on short-rotation for wood chips. More recently, rubber has been promoted, and now some 18,000ha has been planted across the province, making it the most important tree crop in Quang Binh, both by area and value. Though a significant proportion of the planted area is under 5 major companies, approximately half of the total amount is grown by smallholders in this SES. Many rubber plantations were seriously damaged by storms in 2013.

3. ECOSYSTEM SERVICES

This SES is highly dependent on ecosystem services from other SESs, especially upstream watersheds and natural forests which are a source of water supply, and some physical protection, as well as pollination and pest control services of varying importance (depending on distance away from the forest). Tree crop plantations in this SES, while not being natural ecosystems, nevertheless can provide some types of beneficial ecosystem services including provision of some building materials and fuel-wood, as well as nitrogen-fixation in soils by acacia and some protection from erosion (although this is reduced by the short-term harvesting rotation cycle of the plantations.

EbA interventions in this SES, to maintain or improve ecosystem services could include:

- Increasing the diversity of species used in tree plantations (this would also increase diversity of animals and plants that can live in the plantation, and will increase natural pollination and biological pest control services);
- Increasing the duration of the harvest cycle for acacia (this will improve the soil fertility and soil erosion protection services);
- When harvesting tree crops leave some tress standing along the edges of rivers and streams (this will improve the water supply and water quality services).

Investigate possibility of group certification for FSC for smallholders (this will provide an incentive to increase duration of harvest cycle - see above)

Key ecosystem services communities obtain from the landscape, and their current status are shown in Table 5.7. This analysis is based on secondary sources and field visits, and would be expanded and improved in the context of a micro-level assessment, based on local stakeholder perceptions.

Table 5.7: Ecosystem services important to people in Kinh smallholder

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	The small amount of any natural ecosystem remaining in this SES does not directly provide any food for people living in this SES Some fish, crabs, frogs etc. may be collected from the rice fields Fodder/food for animals	SES itself	1	The amount of this wild food may not be so important to the community
P2	Water	Most of the water for people's daily life and production activities in this SES is provided by rivers, streams and springs originating from uphill forests	Watershed natural forests in other SESs	5	Rains can provide some water but rivers, streams and springs are still the main source of water for people and production activities in this SES
P3	Medicines	Unclear/Unimportant		0	There is no clear evidences of using wild medicines in this SES
P4	Fibres	Unclear/Unimportant		0	There is no clear evidences of using wild fibres in this SES
P5	Building materials		Watershed natural forests in other SESs	1	
P6	Water energy	Unclear/Unimportant		0	There is no evidence of water energy being used in this SES
P7	Biomass energy		SES itself	3	Firewood from plantations is an important source of fuel for cooking and heating in this SES
P8	Transport	Unlikely/Unimportant		0	
Regulating Services					
R1	Carbon fixation /storage	Communities do not benefit directly from this service	SES itself	1	This service is not really important to people and production activities in this SES
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter pollutants and improve water quality	Watershed natural forests in other SESs	4	Water quality affects directly people's health and crop productivity
R3	Air quality maintenance	Unclear		0	
R4	Climate buffering	Forests can provide favourable microclimates for rice fields and tree farms	Watershed natural forests in other SESs. Plantations in this SES can also provide this service to some extent	3	Agriculture crops are vulnerable to climate change. Since the climate gets hotter and hotter in recent years, with a large enough area , tree crops in this SES could help to reduce its impact on crops cultivated in/near to plantations, although this is not a natural ecosystem service
R5	Pest and disease control	The forest is a source of insects that can perform biological pest control in nearby fields, and of insectivorous bats that control mosquito and other harmful insect populations	Watershed natural forests in other SESs	2	Watershed natural forests provide this service but they are located quite far from fields, thus the effectiveness of pest control is reduced
R6	Waste recycling / detoxification	Unclear			

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
R7	Physical protection	Forests provide protection against soil erosion, hot wind, landslide to downhill fields and farms	Watershed natural forests in other SESs	4	Plantations provide some services to all agricultural crops, although they are not the same as the original natural ecosystem
R8	Control of water flows	Forest acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows	Watershed natural forests in other SESs	3	This services Indirectly affects crop productivity in the valley but provide some services to transitional area although they are not the same as the original natural ecosystem
R9	Control of sediment flows		Within the SES itself	2	
Supporting services					
S1	Carbon cycling	Unlikely/Unimportant		0	
S2	Photosynthesis, primary production	Unlikely/Unimportant		0	
S3	Nutrient cycling	Acacia is a nitrogen-fixing species		1	
S4	Soil formation	Unlikely/Unimportant		0	
S5	Water cycling	Unlikely/Unimportant		0	
S6	Pollination	While natural forest may be far from the agricultural fields, some wild insect and bat pollinators can still survive in the agricultural landscape	SES itself	3	With the exception of some citrus species and mangoes, most of the crops grown in this SES do not require insect or bat pollination
S7	Seed dispersal	Birds, rats, squirrels, civets, monkeys, gibbons and other species facilitate seed dispersal from the forest but this is of no real value in this SES	SES itself, watershed natural forests	1	Most crops are planted by farmers, natural seed dispersal is of limited importance for this SES
Cultural services					
C1	Religious-spiritual	Unclear		0	Very few King households
C2	Recreation, sports, ecotourism	Forest provide landscape beauty as bases for ecotourism	Neighbouring natural forest SESs	1	Upland landscape beauty attracts tourisms to visit, providing some extra income to ethnic minority depend on distance from remaining natural forests
C3	Science, education	The agro-ecologial system may provide opportunities for scientific research and educational activities	SES itself	1	This service seems not to be very important to communities than it does to scientific communities
C4	Historical / nation building	Unlikely/Unimportant		0	
C5	Relaxation/mental health	Unlikely/Unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/Unimportant		0	

4. CLIMATE AND CLIMATE CHANGE

Average rainfall varies from 1,800-2,300 mm/year depending on different topological conditions. The main rains fall from Jun to Sep, though there is usually some drizzle from Mar to May. Heavy rainfall events are unusual. The hot dry Lao wind (NW, SW) occurs frequently between March and September. Very hot days are increasingly frequent, especially in months of May - Jul. The winds are getting stronger, to the extent that animas die and houses collapse. The weather is cool from Oct to Feb, but only February is actually cold. A summary of climate information is provided in Table 5.8.

Table 5.8: Summary of Climate Information in Tuyen Hoa, Ba Don and Dong Hoi Meterologial Stations in Quang Binh

Climatic description	Unit	Tuyen Hoa station	Ba Do station	Dong Hoi station
Annual mean temperature	^{o}C	23.88	24.46	24.58
Lowest temperature	^{o}C	12.83	14.23	14.09
Highest temperature	^{o}C	38.18	37.54	37.36
Annual mean rainfall	mm	2293.1	1992.5	2173.5
No. of rain days per year	Day	69	61	67
Highest rainfall per day	Mm/day	665	630	657
No. of drizzle days per year	day	-	-	-
Annual evaporation	mm	963.4	1005.7	1,212.4
Av. Air humidity	%	84	83	83
Av. winspeed	m/s	1.5	1.5	1.5
Sunshine hour	h/year	1510.3	1808.1	1,821.2
No. of foggy days	day	16	15	15
Cloundy day	day	7.6	7.6	7.6
Total solar radiation	kcal/m2	109.2	120.8	108.0

Source: Department of Science and Technology management (DOST, 2013)

Map 5.5: Four climate zones of Quang Binh

Notes:

- The North delta: Blue
- The South delta: Green blue zone
- The North mountain: Pink zone
- The South mountain: Yellow zone

Table 5.9: Exposure and sensitivity SES 5c to predicted climate change

	Exposure	Explanation (E)	Sensitivity	Explanation (S)
TEMPERATURE				
Hot season will be hotter and longer; will increase 2 - 2.5 degree C in 2050, 3.6 degree in 2100	4	▪ *Temperature increase cause shorten crop duration, shorten of hydrate carbon synthesis, reduce crop yield* ▪ *More disease and new diseases* ▪ *Impact on flowering, polling, evapotranspiration and hydrate accumulation process*	4	▪ *More evaporation & evapotranspiration, crops require more water, strongly impacts on metabolically processes* ▪ *All terraces rice and Hilly land planting tree crops facing with drought more frequency Risk of more disease and new diseases* ▪ *Impact on flowering, polling, evapotranspiration and hydrate accumulation process; This SES occupies large land use area of QB and impact to livelihood of 1/3 households of the province.* ▪ *Change micro climate and change crop grow rate and crop distribution; many change of landuse, change of crop rotation, change of plant and animal varieties,...may be make more sensitivity.*
Number of Dry days increase, Number of hot days > 35oC also increase	4	▪ *High risk for crop tolerate with short dry time* ▪ *Soil moisture go down below wilting point, plant die* ▪ *Reduce crop yield when drought period coincide with tellering and flowering period*	5	▪ *Drought will be more often damaging crop* ▪ *Small reservoirs will be emptied before rain season, spring season will be lack of irrigation water* ▪ *Need payment more for irrigation*
Temperature will increase faster and earlier in Spring	4	▪ *Tree crops will start earlier* ▪ *Some tree crops will not suitable* ▪ *Some vegetable and temperature crops will not be suitable*	3	▪ *Tree crops have sensitive with early season* ▪ *Rice also sensitive with early season and normally have very low yield in warm spring rice* ▪ *Many crops will not be suitable to new climate conditions*
PRECIPITATION (RAINFALL)				
Higher rainfall in rainy season; Rainfall in Summer will increase 5 - 10% in 2050; No. heavy rains (>50mm) increase	3	▪ *Higher rainfall is good for crop production*	3	▪ *Crop grow better* ▪ *More rainfall during flowering time may rotten pollen of fruit tree* ▪ *More rainfall during rainy season may cause nutrient leaching and erosion on hilly land and terraces rice, lack nutrient at the end of season*

	Exposure	Explanation (E)	Sensitivity	Explanation (S)
Dry season will be drier, Rainfall of Spring will decrease 4 - 9% in 2050	5	▪ *Drier dry season has strong impact to tree crop because tree crop grow very slowly* ▪ *Drier dry season may lead to longer drier period, associated with soil moisture content drop below wilting point, some crop die* ▪ *Need more irrigation, increase cost*	4	▪ *Soil will be degraded, lower productivity* ▪ *Some crops may not suitable and farmer have to change crop and crop calendar* ▪ *May cause some delay growing during very low soil moisture content*
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	▪ *Small storm (weaker level 7) may not impact tree* ▪ *Strong typhoon may break tree (i.e. extreme typhoon in 2013 break a lot of rubber)*	3	▪ *Later storm season may impact on mature periods of fruit trees* ▪ *Later storm season may associated with later rainfall, good for tea and fruit tree* ▪ *Monoculture such as rubber, acacia, pepper, cashew plantation may be make more sensitivity from CC*
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	▪ *These area is deeply in mainland, so not impacted by sea level rise*	1	▪ *Not impact on this land use*

5. EXTENT AND RELATIVE IMPORTANCE OF THE SES

Some aspects illustrating the relative important of this SES are:

- This SES is quite important for producing food (both rice, and non-rice annual crops) contributing to local food security and a stable economy.
- There is a quite large area of gardens and mixed tree crops in this SES contributing to the farmers' income
- This SES helps to prevent soil erosion from upstream hilly areas into the river systems, especially agriculture on river terraces that can stop overland flow and capture sediment from soil erosion processes
- There are a lot of river branches that alluviate annually, creating very fertile soils and yielding very high quality agro-products
- Much of the land in this SES is situated near to rivers, providing easy opportunities for irrigation, which together with the fertile soil, helps maximize crop production
- Many of the rivers also provide opportunities for water transportation - good to transport materials and products to and from markets.

5.1. Locations

Located along three river basins in areas under 200m elevation at floodplain margins and low hills.

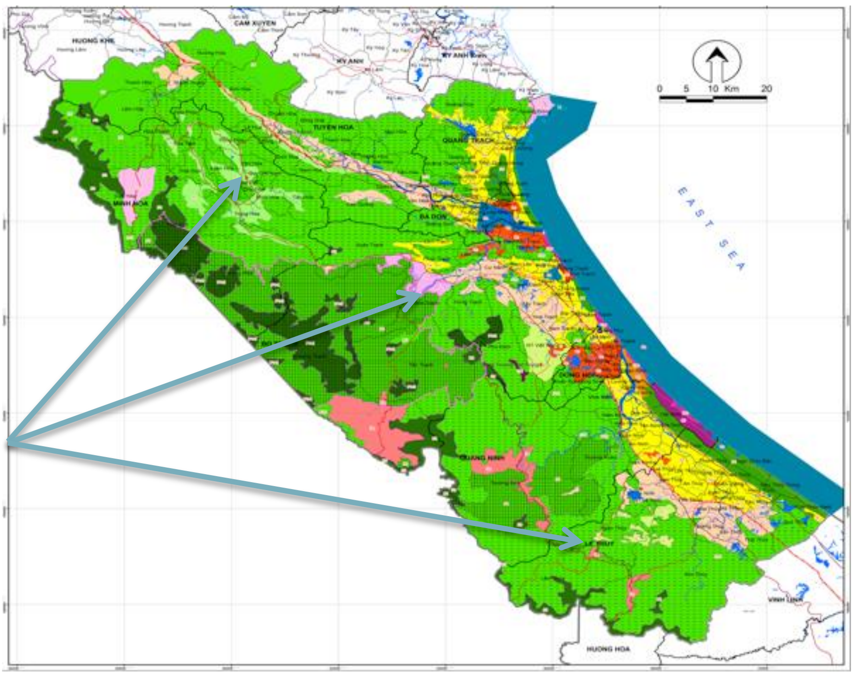
5.2. Approximate extent

About 101,859 ha

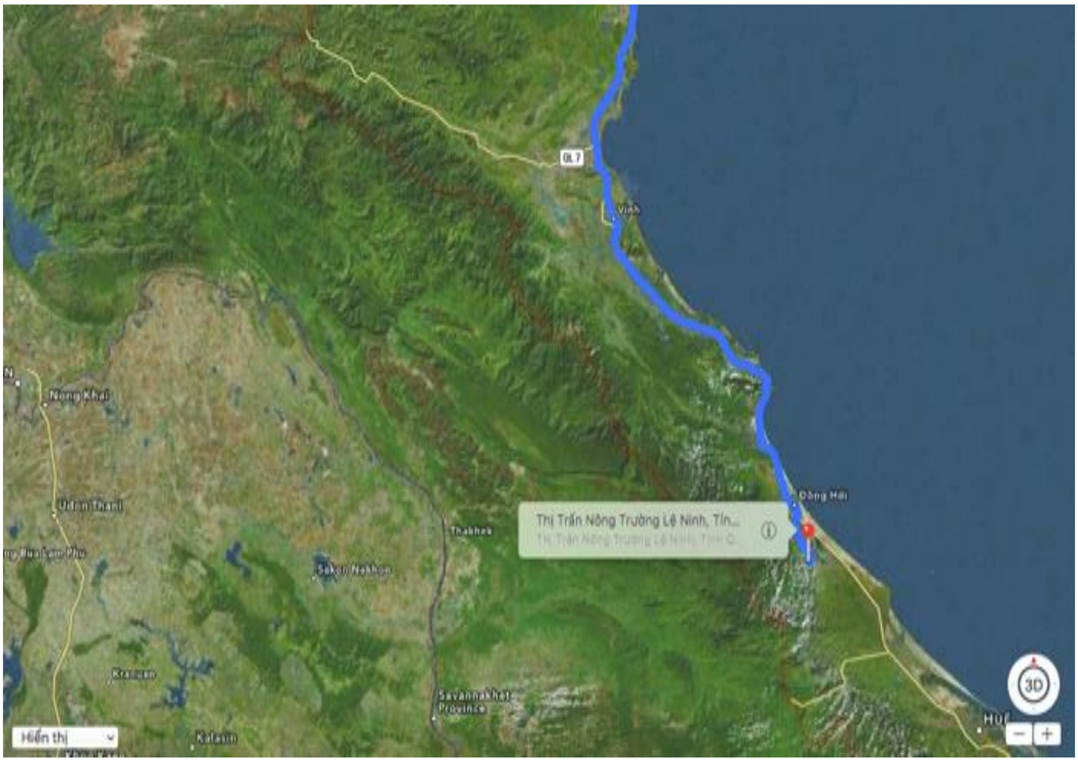
6. CONCLUSION

This SES is quite important for ensuring sure food security of the people living along river systems. It has very high potential of producing non-rice annual crops and industrial crops and fruit trees, which can improve farmer incomes in the future. The SES needs to be invested in, to enhance income and living standards and create more jobs without further degrading the environment because this present mixed-farming form of agro-ecological system may be more sustainable than other more intensive forms of farming and industrial tree crop production occurring in Quang Binh.

Map 5.6: Location of SES 5b and SES 6b



Map 5.7: Le Ninh town on the map of Quang Binh province



Map 5.8: Le Ninh town including rice land and other upland crops, especially rubber

ANNEX 5.IIC: SES DESCRIPTIONS - QUANG BINH 5C

Name: 5c Kinh Commercial Rubber Plantations

Example: Viet Trung company, Le Ninh company, Cu Nam commune, Bo Trach district and Le Ninh town, Le Thuy district

1. ABSTRACT/SHORT DESCRIPTION/KEY DESCRIPTORS

1.1. Ecological

Lowland forest < 700m, inland flat and lower hilly land in transitional areas at flood plain margins, suitable for rubber plantation

1.2. Social

Primarily Kinh commercial rubber estate.

1.3. Economic

Key crops, economic activities (focusing on the one this description is about, then any supplementary activities). Dominated by rubber plantation

1.4. Trends

Rubber plantation are a relatively new industrial crop for Quang Binh

1.5. Climate change threats

Drought - reliant on rainfall and some small-scale irrigation

2. FULL DESCRIPTION

2.1. Location, Topography, Ecology

EXAMPLE: Le Ninh town representative

Le Ninh enterprise is located in Le Thuy district, occupying a range of elevations from less than 10m asl (valley flood plain) to hills of 50m+ The area has 3 main soil types: Fluvisols derived from Sao Vang Rver, Acrisols and Ferrasols.

Rubber is an upland industrial crop growing in hilly areas, especially on the low hills that are transitional between flood plains used for food crops and the mountainous areas. Most of the soils in Quang Binh where rubber grows are Cambisols, Acrisols and Ferrasols, and some farmers also grow rubber on Arenosols.

Of these soil types suitable for rubber, Ferrasols are also good for fruit trees as citrus, while Acrisols are widely distributed over the hilly areas of Quang Binh.

2.2. Social profile

More than 30 villages in 23 communes depend on this SES.

2.3. Economic profile

Key crops, economic activities. Rubber was first introduced into western Quang Binh in 1960. Since 1984, rubber has been planted continuously in Quang Binh, but at a time when food security was of paramount importance, it was not prioritized and was planted mainly in state farms replacing low productivity forest and other industrial crops with low value. After 1997 (the first land allocation time) rubber cultivation expanded rapidly across 6 districts of the province as smallholder farmers recognized it provided a good and consistent income (at least until recent global rubber price declines in 2014-2015).

Together with small-holder rubber, there are now 5 main large farms cultivating rubber - Viet Trung company with total area of 3,000ha; Le Ninh company with area of 1,727ha; Long Dai company with 1,522ha; North Quang Binh Company with 362ha; and multi-battalion number 79 with 760ha. Plantation area grew very quickly from 3,900ha in 1996 to 7,672ha in 2005, 14,086ha in 2010 and 17,980ha in 2014 (Table 5.10).

Table 5.10: Area, Yield and production of rubber over years

Unit	1996	2001	2005	2010	2012	2014
Plantation area (ha)	3,931.4	6,150.3	7,671.9	14,086		17,980
Area of harvesting rubber (ha)	ND	ND	2,887.3	5,573.7	6,677.6	ND
Average yield (ton/ha)	ND	ND	0.9	0.99	0.96	ND
Total dry latex production (ton)	ND	ND	2,585.0	5,529.9	6,423.1	ND

ND: no data

Table 5.11: Rubber plan to 2015

No	District	Plantation area to 2015	Plantation area to 2010	Rubber plantation in period 2011-2015					
				Total	2011	2012	2013	2014	2015
		18,086	14,086	4,000	900	940	790	640	640
1	Dong Hoi city	194	94	100				50	50
2	Le Thuy	4,311	2,311	2,000	500	500	400	300	300
3	Quang Ninh	452	152	300	100	50	50	50	50
4	Bo Trach	10,845	10,245	600	150	150	100	100	100
5	Quang Trach	516	316	200	40	40	40	40	40
6	Tuyen Hoa	800	400	400	100	100	100	50	50
7	Minh Hoa	968	568	400	100	100	100	50	50

Rubber variety

Rubber is considered as a suitable crop for Quang Binh as well as other central coastal provinces. The Rubber Research Institute has recommended the PB235, PB 255, PB260, Rrim600 and Rrim712 varieties are suitable to Quang Binh's soil and climate conditions.

Rubber is planted province-wide in both smallholder and large farms but there are only 8 enterprises doing rubber latex processing, of which two are large scale - Viet Trung and Le Ninh companies (they were State Enterprises in the past and have a capacity of 3500 ton of dry latex per year. The others enterprises and companies are Lan Thanh company, Viet Trung - Bo Trach, Truong Sinh (Dong Hoi), Huy Toan (Dong Hoi), Thanh Long, and Nguyen Van Diem, having capacity of between 100 to 300 tons of dry latex per year.

Rubber yield and quality has been increasing over the years, but more so from the big companies with high yields of 1.3 to 1.5 tons of dry latex/ha (depending on variety, planting intensity and other inputs), while smallholder rubber farmers' yield is somewhat lower as they have limited access to technology, investment and other support. Most labour working on rubber farms is unskilled but the larger companies also employ skilled technicians.

3. ECOSYSTEM SERVICES

This SES is highly dependent on ecosystem services from other SESs, especially upstream watersheds and natural forests which are a source of water supply, and some physical protection, as well as pollination and pest control services of varying importance (depending on distance away from the forest). Tree crop plantations in this SES, while not being natural ecosystems, nevertheless can provide some types of beneficial ecosystem services including provision of some building materials and fuel-wood, as well as nitrogen-fixation in soils by acacia and some protection from erosion (although this is reduced by the short-term harvesting rotation cycle of the plantations.

EbA interventions in this SES, to maintain or improve ecosystem services could include:

Table 5.12: Ecosystem services important to people in Kinh commercial rubber plantations in hilly areas

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	The small amount of any natural ecosystem remaining in this SES does not directly provide any food for people living in this SES	SES itself	1	Only rubber is grown in the SES
P2	Water	Most of water for people's daily life and production activities in this SES is provided by rivers, streams and springs originated from uphill forests	Watershed natural forests in other SESs	5	Rains can provide some water but rivers, streams and springs are still the main source of water for people and production activities in this SES
P3	Medicines	Unclear/Unimportant		0	There are no clear evidences of using wild medicines in this SES
P4	Fibres	Unclear/Unimportant		0	There are no clear evidences of using wild fibers in this SES
P5	Building materials	Rubber stems after harvesting period can provide wood for minor works of local households, and for furniture	SES itself	1	Wood produced by this SES is mostly for both commercial purpose and building
P6	Water energy	Unclear/Unimportant		0	There is no evidence of water energy being used in this SES
P7	Biomass energy	Plantations provides firewood to local people through pruning of branches and collection of dry/dead branches	SES itself	3	Firewood from plantations is an minor source of fuel for cooking and heating in this SES, only during cleaning rubber branches and dry branches
P8	Transport	Unlikely/Unimportant		0	
Regulating Services					
R1	Carbon fixation/storage	Rubber trees can store carbon in their biomass as the second product after harvesting period. this is of limited important to the human and economic activities of this SES	SES itself	1	This service is not really important to people and production activities in this SES
R2	Water quality maintenance	Rubber plantations reduce amount of sediment in water flows, filter pollutants and improve water quality	Watershed natural forests in other SESs	3	Water quality affects directly people's health
R3	Air quality maintenance	Unclear		0	
R4	Climate buffering	Rubber plantation can provide favourable microclimates for other annual crops		3	Agriculture crops are vulnerable to climate change. Since the climate gets hotter and hotter in recent years, with a large enough area , rubber in this SES could help to reduce its impact on crops cultivated near to plantations, although this is not a

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
					natural ecosystem service
R5	Pest and disease control	Plantation is a very minor source of insects that can perform biological pest control in nearby fields, and of insectivorous bats that control mosquito and other harmful insect populations	Watershed natural forests in other SESs	2	Rubber plantations seem not provide this service to other crop fields and tree crops.
R6	Waste recycling/ detoxification	Unclear			
R7	Physical protection	Rubber plantations provide some protection against soil erosion, hot wind, and landslides to downhill fields and farms. The plantations themselves are protected by other forests	Watershed natural forests in other SESs, and the SES itself	4	Rubber plantations provide some services to all agricultural crops, although they are not the same as the original natural ecosystem
R8	Control of water flows	Rubber plantation acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows	Watershed natural forests in other SESs and The SES itself	3	This services Indirectly affects crop productivity downstream but provides some services to transitional area although they are not the same as the original natural ecosystem
R9	Control of sediment flows	Plantation trees with their strong roots could help to reduce soil erosion, thus control sediment flows in streams and springs	Within the SES itself	2	Plantations provide some services although they are not the same as the original natural ecosystem, this service will be reduced by short-rotation harvesting cycles of tree crops and large areas of bare soil
Supporting services					
S1	Carbon cycling	Unlikely/Unimportant		0	
S2	Photosynthesis, primary production	Unlikely/Unimportant		0	
S3	Nutrient cycling	Unlikely/Unimportant		1	
S4	Soil formation	Unlikely/Unimportant		0	
S5	Water cycling	Unlikely/Unimportant		0	
S6	Pollination	Insects, bats and birds from rubber plantation scould facilitate pollination process in crop fieldsnearby	SES itself, watershed natural forests in other SESs	4	Insect and bird pollination is very important for many crops but effectiveness it depends on the distance from the rubber field to the fields. Insect bird and bat diversity of plantations is lower than of natural forests so the value of the service from plantations is lower than from natural forest
S7	Seed dispersal	Unlikely/unimportant	SES itself, watershed natural forests	0	Rubber does not require seed dispersal

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
Cultural services					
C1	Religious-spiritual	Unlikely/unimportant		0	
C2	Recreation, sports, ecotourism	Unlikely/unimportant		0	
C3	Science, education	Rubber plantations may provide opportunities for scientific research	SES itself	1	This service is not important to communities in the SES
C4	Historical /nation building	Unlikely/Unimportant		0	
C5	Relaxation /mental health	Unlikely/Unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/Unimportant		0	

4. CLIMATE AND CLIMATE CHANGE

Average rainfall is from 1,800-2,300 mm/year. The main rains fall from Jun to Sep, though there is usually some drizzle from Mar to May. Heavy rainfall events are unusual. The hot dry Lao wind (NW, SW) occurs frequently between Mar and Sep. Very hot days are increasingly frequent, especially in the months of May-Jul. The winds are getting stronger, to the extent that animas die and houses collapse. The weather is cool from Oct to Feb, but only February is actually cold. A summary of climate information is provided in Table 5.13.

Table 5.13: Summary of climate Information in Tuyen Hoa, Ba Don and Dong Hoi Meterologial stations

Climatic description	Unit	Tuyen Hoa station	Ba Do station	Dong Hoi station
Annual mean temperature	^oC	23.88	24.46	24.58
Lowest temperature	^oC	12.83	14.23	14.09
Highest temperature	^oC	38.18	37.54	37.36
Annual mean rainfall	mm	2,293.1	1,992.5	2,173.5
No. of rain days per year	Day	69	61	67
Highest rainfall per day	Mm/day	665	630	657
No. of drizzle days per year	day	-	-	-
Annual evaporation	mm	963.4	1,005.7	1,212.4
Av. Air humidity	%	84	83	83
Av. winspeed	m/s	1.5	1.5	1.5
Sunshine hour	h/year	1,510.3	1,808.1	1,821.2
No. of foggy days	day	16	15	15
Cloundy day	day	7.6	7.6	7.6
Total solar radiation	kcal/m2	109.2	120.8	108.0

Source: Department of Science and Technology management (DOST, 2013)

Table 5.14: Exposure and sensitivity SES 5c to predicted climate change

CLIMATE CHANGE RISKS (2050)	Exposure	Explanation (E)	Sensitivity	Explanation (S)
TEMPERATURE				
Hot season will be hotter and longer; will increase 2 - 2.5 degree C in 2050, 3.6 degree in 2100	3	▪ *Hilly land areas where rubber is planted are more exposed to more frequent drought*	3	▪ *With more evaporation and evapo-transpiration, rubber will require more water, and this will strongly impact on metabolic processes* ▪ *Latex yield will reduce*
Number of Dry days increase, Number of hot days > 35oC also increase	4	▪ *Soil moisture may go down to below wilting point, plant die* ▪ *Rubber suitable temperature levels are below 30oC, 35oC is outside the "comfort zone"*	4	▪ *More frequent drought will damage productivity* ▪ *For some shallow soils, light soils and high stone content soil, which dry out more quickly, rubber will encounter water shortages* ▪ *Dry conditions may increase pest and diseases*
Temperature will increase faster and earlier in Spring	2	▪ *Rubber will start to grow earlier after cold winter* ▪ *Growth season will be longer*	2	▪ *Longer growing season will produce higher biomass and latex yield*
PRECIPITATION (RAINFALL)				
Higher rainfall in rainy season; Rainfall in Summer will increase 5 - 10% in 2050; No. heavy rains (>50mm) increase	2	▪ *Rubber trees will grow better*	2	▪ *Excessive rainfall may reduce quality of latex* ▪ *More rainfall during rainy season may cause nutrient leaching and erosion and more disease outbreaks*
Dry season will be drier, Rainfall of Spring will decrease 4 - 9% in 2050	4	▪ *Rubber faces drough risk* ▪ *Grow rate reduce*	4	▪ *Soil will be degraded, leading to lower productivity* ▪ *Rubber will suffer from stronger impacts from dry season and have less vigour to initiate growth in the rainy season* ▪ *May cause some delays to grow during very low soil moisture content*
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	5	▪ *Tropical low pressure depressions and storms happen on a regular basis*	5	▪ *Later storm season strongly impacts on rubber harvesting time* ▪ *Later storm season associated with heavy rainfall can result in spread of disease* ▪ *Late storms associated with heavy rainfall reduces latex quality* ▪ *Strong typhoon may break tree (e.g extreme typhoon in 2013)*
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	This SES is far inland so not directly impacted by sea level rise	1	

5. EXTENT AND RELATIVE IMPORTANCE OF THE SES

5.1. Locations: Widespread across all districts of the province

5.2. Approximate extent 18,000 ha

5.3. Approximate population: Number of people dependent on this SES. - unknown

6. CONCLUSION

This SES is an important source of income for both smallholders and commercial companies. It is somewhat vulnerable to storms and droughts, but is not really considered as a high priority for a micro-level assessment.

Map 5.9: Cu Nam commune location

Map 5.10: Rubber in the harvesting period in Cu Nam commune

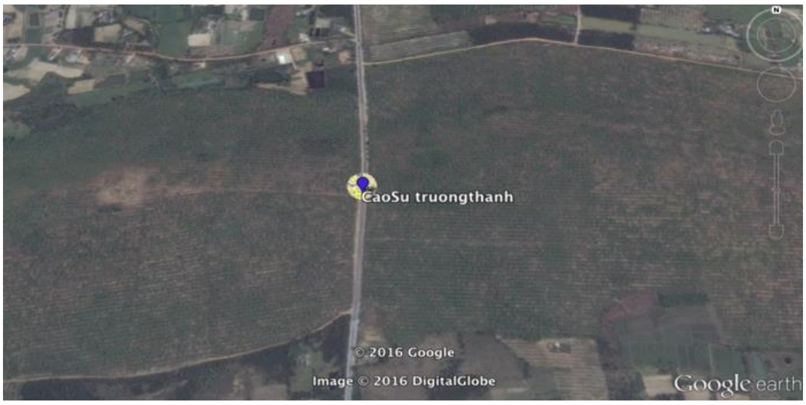


Figure 5.5: A good rubber plantation in Cu Nam commnue, Bo Trạch district

ANNEX 5.IID: SES DESCRIPTIONS - QUANG BINH 10A

Name: 10a - Kinh inshore capture fishery in delta and marine areas to a distance 6 nautical miles

Example: Quang Hung, Quang Trach, Quang Binh

1. KEY DESCRIPTORS

1.1. Social

Kinh people, mostly poor fishermen, but including some with a higher income from processing and trading, or possessing larger boats, or more than one boat.

1.2. Ecological

In Quang Trach, 78.2% of the total land is upland areas, with 16.7% fluvial soil areas in deltas and about 5.1% of the district is sandy areas running along the sea shore, with a total coastline length of about 32.4 km. Two of the main rivers of the province - the Gianh River and Roon River run through Quang Trach. This SES encompasses the coastal waters from the sandy shoreline to approximately 6 nautical miles out to sea, or to where water depth is a maximum of about 50m. This area includes some sea-grass and coral reefs as well as sandy substrate seabed. Economically important pelagic fish species are found in this area.

1.3. Economic

The 612km^2 area of Quang Trach District in Northern Quang Binh has a population of about 199,000 (2015) with a population density of 325 person/km^2. Out of a total workforce of 95,800 people, about 7.2% are working in fisheries. There are 1,709 fishing boats in Quang Trach district (2014), with more than 80% of these being inshore capture fisheries boats, while only 20% are bigger boats that catch the fish in deeper waters further offshore. The main economic activity of the SES is inshore capture fisheries. This may be supplemented with raising fish and shrimp in ponds on sandy areas, and growing of some annual crops such as sweet potato on sandy areas, as well fish processing and trading, and fisheries support services (boat repairs, net-making, etc).

2. ECOSYSTEM SERVICES

Table 5.15: Ecosystem services in Kinh near-shore fisheries SES

No	Main Services	Rank	Description
Direct Provisioning			
P1	Food	5	A part of aquatic species captured by fisherman will be consumed by their households and in their communities, the rest enters the market chain
P2	Water	3	Moving sand dunes cause changes to the the depth of underground water
P3	Medicines		N/A
P4	Fibres		N/A
P5	Building materials		N/A
P6	Water energy		Wave energy is not harnessed for any benefit
P7	Biomass energy		Seaweed and algae are sometimes harvested and used for fuel
P8	Transport	5	Travel by boats, fishing activities could not be done without water-based transportation
Regulating			
R1	Carbon fixation/storage	5	Huge amounts of carbon dioxide are dissolved in the sea
R2	Water quality maintenance	5	Water quality is important in determining fish stocks and productivity available for fisherman to capture. Flood sin rainy and storm season cause change water quality. There is a high risk of pollution in much of the area
R3	Air quality maintenance		N/A
R4	Climate buffering		N/A
R5	Pest and disease control		N/A
R6	Waste recycling / detoxification	4	Domestic, industrial and commercial waste are all discharged into the sea
R7	Physical protection		N/A
R8	Control of water flows		N/A
R9	Control of sediment flows	4	Sediment flows and tidal mudflats are important in the Gianh and Roon river mouths Sediment dynamics in the bottom water of the offshore sea coast are also important
Supporting (basic ecosystem functions)			
S1	Carbon cycling		N/A
S2	Photosynthesis, primary production		N/A
S3	Nutrient cycling		N/A
S4	Soil formation		N/A
S5	Water cycling		N/A
S6	Pollination		N/A
S7	Seed dispersal		N/A
Cultural-spiritual			
C1	Religious-spiritual		
C2	Recreation, sports, ecotourism	1	Many tourists re attracted to coastal fishing areas
C3	Science, education		
C4	Historical / nation building		
C5	Relaxation/mental health		
C6	Aesthetics /artistic inspiration	1	Many artists are inspired by the sea

3. CLIMATE AND CLIMATE CHANGE

The dry season in Quang Trach is from Apr to Aug and the rainy season is from Sep to Mar. Tropical typhoons, coastal erosion, drought and salinity in summer are the 4 main climate problems currently experienced. Climate change may add to these existing hazards while also creating new impacts, particularly through the long-term effects of increased water temperature and acidity of the oceans which will have many different impacts on key fisheries species.

Table 5.16: Exposure and sensitivity of the coastal sandy SES to predicted climate change

Climate Change Variables and Phenomena /	Degree Exposure	Nature of sensitivity (describe)	Degree Sensitivity
TEMPERATURE			
Hot season is hotter and longer	MOD	• Some fish like sardines arriving earlier in the Spring • Many aspects of feeding, reproduction and migration of many species wil be affacted by increased temperature • E.g. Anchovy and squid may be more productive, sardine and mackerel may be less productive	HIGH
by 2-3 deg C in 2050			
Hot days >35C increasing	MOD	• Increasing occurrence of algal bloom and eutrophication • Changes in pH of bottom water impacting bottom water fish • Increasing occurrence of coral bleaching	HIGH
PRECIPITATION			
Wet season is getting wetter	MOD	• heavy rain increases turbidity of the water reducing sunlight penetration and impacting photosynthesis of coral and sea-grass	MOD
5% more rain in summer by 2050			
Dry season is getting drier	MOD	unclear, may be some sensitivity of surface water fish?	LOW
5% less rain in spring by 2050			
More frequent drought	MOD	unclear - may be some sensitivity of surface water fish?	LOW
WIND AND STORMS			
Wind speeds higher	HIGH	Typhoons change water flows and bottom fish composition Increased turbidity limits sunlight penetration affecting corals and sea-grass Storms may damage boats and fishermen's houses	MOD
Storms frequency less predictable	MOD	Unpredictability makes it more dangerous for fishermen, harder to know when they should not go out fishing	LOW
Storm season coming later	MOD	Sensitivity probably does not change, just because the storms are later	LOW
SEA-LEVEL RISE			
Average 3mm/year, for last 20 years	HIGH	As sea level rises, mangroves, coral and sea-grass will all have to move to new locations to maintain their preferred conditions (appropriate depth for preferred sunlight penetration for corals and sea-grass and appropriate mixture of fresh and salt water for mangroves)	MED
1m rise by 2100			

4. EXTENT AND RELATIVE IMPORTANCE OF THE SES

Capture fisheries is a key sector in Vietnam. In 2010, capture fisheries production was 2.5 million tons, accounting for 4% of national GDP. Capture fisheries are however under a lot of pressure. Over the 1990-2008 periods, there was a sevenfold increase in the horsepower capacity of the fishing fleet, compared with only a threefold increase in production. “Trash fish” or “by-catch” now accounts for an estimated 60% of the total marine catch. Most of this is consumed locally or used in the production of fish sauce or fish feed used in aquaculture. Excessive ‘trash fish’ harvests are removing the seed and fingerlings of many valuable species, thus contributing to the depletion of coastal resources. Over 100,000 small fishing boats are operating in near shore areas (up to 6 nautical miles) throughout Vietnam, and most of them have an engine capacity of less than 50 horsepower. In the central part of the coastline there are 33,000 boats, with 75% of them less than 50 horsepower. Most of the fishing gear that are being used violate current regulations related to mesh size leading to the high proportion of trash fish in daily catches. In some cases, explosives or chemicals are used seriously damaging coral reefs and spawning areas.

This near-shore fisheries SES occurs along most of the entire 116km long coastline of Quang Binh Province, employing around 9% of the province’s population, and providing a significant contribution to food security and the provincial economy. A total of 18 coastal communes are involved in fisheries. Figures for 2011 show a total of 4,932 fishing boats of which 3,299 were less than 20 horsepower and a further 395 were under 50 horsepower. In 2015 DARD reported that 57,000 tons of fish were caught in Quang Binh by 4,000 boats (2,600 fishing in near-shore waters). Shelter during typhoons is a critical issue. Especially in the sand dune areas and the river mouths. Presently there are only two shelters that can accommodate only 800 of the 4,000 boats. Sedimentation at river mouths is also an issue in several of the river mouths. In Nhet Lay sometimes the boats cannot come and some of the larger boats have to land the fish in Da Nang instead.

In Quang Binh, as with the entire coastline of Vietnam, a combination of over capacity and destructive fishing practices has taken a heavy toll on biodiversity, the quality of resources, and the viability of livelihoods of many coastal communities. Recent policy has been to reduce the number of near-shore fishing boats in Quang Binh by around 300 vessels each year to protect near-shore resources and ensure sustainable livelihoods in the future. Co-management could also help enforce regulations and improve sustainability of near- shore fisheries. Decree No. 33/2010/ND-CP issued by the government in 2010 explicitly assigns open access coastal areas to local authorities and fishing communities to implement a partnership of co-management models. To translate this into action, local fishing communities, as well as local authorities, would need support to strengthen their capacity to carry out their new responsibilities.

5. CONCLUSION

Most fishing households are relatively poor, and highly dependent upon natural resources. While there is no hard data available it is assumed that fisheries resources in Quang Binh are in decline, as they are elsewhere. These poor near shore fishing households are therefore amongst the most vulnerable segments of Quang Binh’s population, making this a SES that should be a high priority for more detailed micro-level assessment.

Figure 5.6: Fishing boats of Quang Trach district, Quang Binh province

ANNEX 5.IIE: SES DESCRIPTIONS - QUANG BINH

Name: State Forest Company/ Enterprise- Forest Management

Subtropical (>700m) and Tropical (<700 m) forests, State forest enterprise for Protection Forest, Production Forest.

Example: Long Dai Forestry Company

1. KEY DESCRIPTORS

1.1. Social

There are two SFCs in Quang Binh province: Long Dai LLC and North Quang Binh LLC. These SFC manages 124, 365ha of forest, occupies about 21.6% of total forest area of Quang Binh province.

Long Dai SFC manages 96,142ha forest, including 68,548ha of natural forest, 16,844ha of plantation forest, and 10,750ha of bare land (REDD Vietnam, 2014). Forest area manages by Long Dai SFC covers territory of Bo Trach, Dong Hoi, Quang Ninh and Le Thuy districts.

About 2,000 farmer households co-operates with Long Dai Company. Livelihood of ten thousand local people depends on forestry activities, including total Van Kieu ethnic minority of Truong Son commune, Quang Ninh district.

There are 7 State Foerst Enterprises/ SFE (Khe Giua, Truong Son, Ba Ren, Long Dai, Kien Giang, Dong Hoi and Pine Forest Enterprise Bo Trach) and 4 Forest Product Processing Enterprise/ FPPE belong to Long Dai SFC.

Forest management: Main function of Long Dai SFC are: 1) Forest protection, especially to 10.000 ha of protection forest managed by Truong Son and Khe Giua SFEs; 2) Plant forest (forest plantation): pine, acacia, rubber; 3) Exploitation of natural forest timber, 30,000ha of natural forest of Truong Son SFE have got SFC; 4) To harvest, to process planted timber /acacia and pine oleoresin.

1.2. Ecological

This SES involves two types of forest ecosystem:

- *Sub-tropical evergreen broad leaf forest on mountains > 700m amsl*: Forest covers on high Truong Son mountain, almost 700- >2,000m amsl., along Viet-Laos border, west of Bo Trach, Quang Ninh, Le Thuy districts. Almost forest still have high biodiversity, high primary characters, rich of valued timber such as Lim *(Erythrophleum fordii),* Sen *(Madhuca pasquieri),* Gu do *(Sindora tonkinensis),* Vang Tam *(Manglietia fordiana),* Re huong *(Cinnamomum sp.),* Gioi *(Michelia gioi),* De *(Castanopsis spp.)* … There are 60,000 ha of this natural forest type managed by Truong Son and Khe Giua SFEs. About 30,000 (?) ha this forest of Truong Son SFE have got SFC already. The company have planning to improve forest quality of Khe Giua SFE for having SFC in the coming years. (Long Dai company report, 2015).
- *Moist tropical broad leaf evergreen forest on hill <700m- >10m amsl*: Almost are of this type of forest is production forest, including natural forest and planted forest (acacia, rubber, pine). Long Dai company have allocated forest land to about 1,500 private households, to protect natural forest for regeneration, to plant acacia, rubber, to care and to harvest pine oleoresin.

1.3. Economic

- In 2014, Long Dai SFC exported 1,100tons of pine oleoresin, 43,000 tons of material wood of acacia and planted 154ha of rubber.
- 2014: Export turnover of Company is: 1.23 million of USD; paid for National budget: 16 billion VND; worker salary average: 3.5 million VND per month.

Trends:

Climate Change Threats:

- Hot in summer combine with Laos wind cause high risk of forest fire (pine)
- Storm/ typhoon cause high risk/ broken rubber, acacia, …
- High rainfall/flood risk cause landslide, broken the road, …makes difficult for protect forest of rangers

Ecosystem services

2. CONCLUSION

The SFC, hundred percent of state capital, owner of rich/good forest but paid for national budget and state income, worker salary really low (16 billion VND/year equivalent 200m^3 ironwood and 3ha choosing exploitation!

Figure 5.7: Pine forest of Long Dai company (March, 2016)

ANNEX 5.III: ECOSYSTEM SERVICES ASSESSMENTS OF PRIORITY SESS IN QUANG BINH PROVINCE

Ecosystem services provided by the PNKB National Park (World Heritage Site), PNKB 1-5

Summary

This SES is not really dependent on inputs from other SESs, but is itself a major source of environmental services that support other SESs and the economic activities happening in those SESs. The forests and limestone karsts of PNKB are extremely important for water supply and water regulation for downstream users, are an incredibly important area for carbon storage, and provide very significant tourism and scientific research opportunities. They are also important for the provision of a number of other ecosystem services.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Forests still provide foods (wild animals, bamboo shoots, wild bananas, mushrooms, etc.) for human and livestock consumption	The SES itself	3	Although wild food provided is declining in quantity, it is still an important source of food for local people and livestock
P2	Water	Forest help form streams and springs, providing water to forest-dwellers as well as downstream communities and other users. Water supply from PNKB is extremely important for a number of other downstream SESs	The SES itself	5	Together with other forest ecosystems and with it large area, forest on limestone < 700 m provide water, supporting for agricultural production and other economic activities in PNKB buffer zone
P3	Medicines	Some plants in forests could be used as medicines, especially in ethnic minority communities living in or near to the forest	The SES itself	2	Even health care system is now available at village level people living in PNKB buffer zone still use some forest medicinal plants for their minor illness treatment
P4	Fibres	Rattans are collected to make baskets and for sale	The SES itself	3	Despite quantity of rattans is declining, baskets made of rattans are very popular in PNKB buffer zone's households
P5	Building materials	Forest timber can be used for house building	The SES itself	2	Illegal logging for house building and for sale still occurs but less frequent than previously
P6	Water energy	Unlikely		0	
P7	Biomass energy	Forest provides firewood to local people	The SES itself	3	Firewood from forest is still an important source of fuel for cooking and heating in PNKB buffer zone
P8	Transport	Unlikely		0	
Regulating Services					
R1	Carbon fixation/storage	Forest absorb and stores carbon in its biomass	The SES itself	5	With its large area, PNKB forest greatly contribute to absorb and store carbon and to reduce CO_2 in the atmosphere. This is a global environmental service

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
R2	Water quality maintenance	The forests and limestone karsts of PNKB play a major role in maintenance of water quality especially for water supply to downstream SESs	The SES itself	3	Forest ecosystems in PNKB, forest on lime stone <700 m provide service to protect nearby SESs, supporting for agricultural production and other economic activities in nearby regions
R3	Air quality maintenance		The SES itself	3	Together with other forest ecosystem, forest on limestone <700 m contributes to maintain fresh air within and outside the SES
R4	Climate buffering	Forests can provide favourable microclimates for the region	The SES itself	3	With their large area, forest on lime stone <700 m could change the microclimate in nearby SESs, supporting for agricultural production and other economic activities
R5	Pest and disease control	Unclear		0	
R6	Waste recycling / detoxification	Unclear		0	
R7	Physical protection	Forest can provide protection service against physical damage	The SES itself	3	Together with other forest ecosystems in PNKB, forest on lime stone <700 m provides service to protect nearby SESs, supporting for agricultural production and other economic activities
R8	Control of water flows	Forest acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows, providing services to support agricultural production and other economic activities in nearby SESs and other SESs further downstream	The SES itself	3	Forest ecosystems in PNKB play an important role in regulating water flow, however much of PNKB is very porous limestone and water passes through very quickly
R9	Control of sediment flows	Forest trees with their strong roots could help to reduce soil erosion, thus control sediment flows in streams and spring provides service to support agricultural production and other economic activities in nearby SESs and other SESs further downstream	The SES itself	3	forest ecosystems in PNKB, provides service to support agricultural production and other economic activities in nearby SES
Supporting services					
S1	Carbon cycling	PNKB forest plays an important role in carbon cycling	The SES itself	4	
S2	Photosynthesis, primary	PNKB forest is a major source of primary productivity	The SES itself	4	

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
	production				
S3	Nutrient cycling	PNKB forest plays a major role in nutrient cycling	The SES itself	4	
S4	Soil formation	PNKB forest plays a major role in soil formations	The SES itself	4	
S5	Water cycling	PNKB forest plays a major role in the water cycle	The SES itself	4	It is a major source of evapo-transpiration
S6	Pollination	Insect and animal pollinators from PNKB provide an important service to neighbouring farmlands	The SES itself	4	
S7	Seed dispersal	Bird, bat and other animal seed dispersal agents provide a major service supporting regeneration of fallow fields adjacent to the forest	The SES itself	4	
Cultural services					
C1	Religious-spiritual	There are some religious sites within the park	The SES itself	2	
C2	Recreation, sports, ecotourism	PNKB is a major tourism destination	The SES itself	5	PNKB Forest and caves greatly contribute to landscape beauty for PNKB National Park tourism
C3	Science, education	Forests and caves provide opportunities for scientific research and educational activities	The SES itself	5	Significant research has been conducted in PNKB including on eh cave systems and cave dwelling species. Many species new to science have been discovered in PNKB. Natural, intact, rare > 500 years old coniferous forests distributed at an attitude of 700-1000 m are precious sources of scientific and educational opportunities
C4	Historical /nation building	There are some important sites related to the American war	The SES itself	4	
C5	Relaxation /mental health	The park provides clear opportunities for relaxation that benefits mental health	The SES itself	3	
C6	Aesthetics /artistic inspiration	The dramatic karst scenery can be especially inspiring for artists	The SES itself	3	

Ecosystem services important to people in upland ethnic minority smallholder swidden cultivation and forest product collection

SES (5a) of Quang Binh province

Summary:

The forest is critically important especially for providing abundant and clean water supply, and fuel-wood for the ethnic minorities. It is also highly important for their religious and spiritual activities, and provides them with important amounts of some wild foods as well as timber for building materials. Agricultural fields close to the forest benefit significantly from close proximity of insect and animal pollinators, and biological pest control. Seed dispersal by forest species assists rapid regeneration of fallow fields, which is becoming increasingly important as the fallow cycle has now been reduced to 5 years by the government.

No	Main Services	Description	Source of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Forests still provides foods (wild animals, bamboo shoots, wild bananas, mushrooms, etc.) for human and livestock consumption	SES itself	3	Although wild food is declining in quantity, it is still an important source of food for local people and livestock, especially when crop loss happens
P2	Water	Forests help to form streams and springs, providing water for ethnic minority's domestic use	SES itself	5	Rains can provide additional amounts of water but water from streams and springs are still the main resource for ethnic minorities' domestic use
P3	Medicines	Some plants in forests are used as medicine in ethnic minorities	SES itself	3	Even though health care is now available at village level but ethnic minorities still use forest plants as their traditional medicines for minor illnesses
P4	Fibres	Rattans are collected to make baskets and for sale	SES itself	2	Quantity of rattans is declining
P5	Building materials	Households are still allowed to cut up to 5 m^3 of forest trees to build new houses	SES itself		Government encourages and supports ethnic minorities to build modern houses of brick and cement. Using timber for building materials is declining
P6	Water energy	Some communities take advantage of water flow in streams/springs in forests to generate micro-hydro electricity for household use	SES itself	1	Very few households actually use this service
P7	Biomass energy	Forest provides firewood to local people	SES itself	5	Firewood from forest is almost the sole source of fuel for cooking and heating in upland areas
P8	Transport	Unlikely		0	
Regulating Services					
R1	Carbon fixation/storage	Not perceived as a benefit to forest dwellers	SES itself	0	The forest (and regenerating swidden) stores/fixes large amounts of carbon, but this is a global

No	Main Services	Description	Source of Ecosystem service	Rank	Justification for ranking
					ecosystems service but not contributing any direct benefit to forest dwellers – this could be changed by e.g. introduction of a PES or REDD+ type arrangement
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter pollutants and improve water quality	SES itself	4	Most of water used by ethnic minority for their daily life and agriculture production is from streams and springs. Water quality affects directly people's health and their agricultural productivity
R3	Air quality maintenance	Unclear			
R4	Climate buffering	Forests can provide favourable microclimates for rice field near by	SES itself	3	Crops are vulnerable to climate change. Since the climate gets hotter and hotter in recent years, forests could help to reduce its impact on crops cultivated in/near to forests by helping reduce the rice-fields exposure to the effects of climate change
R5	Pest and disease control	The forest is a source of insects that can perform biological pest control in nearby fields, and of insectivorous bats that control mosquito and other harmful insect populations	SES itself	3	This service is quite important to local people and crop fields near by forests
R6	Waste recycling /detoxification	Unclear			
R7	Physical protection	Forests provide protection from hot "Lao: winds and other strong winds in certain locations	SES itself	2	In summer, Laos wind is very strong. Only forests can provide a relief to local people who are living near to them
R8	Control of water flows	Forest acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows	SES itself	3	Absence of forest cover will reduce water in springs and streams, negatively affecting local people daily life and their agricultural production
R9	Control of sediment flows	Forest trees with their strong roots could help to reduce soil erosion, thus control sediment flows in streams and spring	SES itself	2	Indirectly affect to crop productivity
Supporting services					
S1	Carbon cycling	The forest plays a major role in carbon cycling but this service is not of direct benefit to the forest dwellers	SES Itself	0	Not directly important to ethnic minority

No	Main Services	Description	Source of Ecosystem service	Rank	Justification for ranking
S2	Photosynthesis, primary production	The forest is a major source of primary production, but only a small part of this is of direct benefit to local communities	SES Itself	1	Not really important to ethnic minority
S3	Nutrient cycling	Forest and regenerating fallow play important roles in nutrient cycling	SES Itself	3	The fallow cycle is now reduced to 5 years, compromising this ecosystem service
S4	Soil formation	Forest and regenerating fallow play important roles in soil formation	SES itself	3	The fallow cycle is now reduced to 5 years, compromising this ecosystem service
S5	Water cycling	The forest plays a major role in water cycling	SES itself	3	
S6	Pollination	Insects, bats and birds from forests could facilitate pollination process in crop fields of ethnic minorities	SES itself	3	Insect and animal pollination is very important for some crops
S7	Seed dispersal	Birds, bats, squirrels, civets, monkeys, gibbons and other species facilitate seed dispersal from the forest to regenerating fallow land that will enable the fallow to quickly regenerate to a forest condition	SES itself	4	The fallow cycle is now reduced to 5 years, meaning that this ecosystem service is now even more important than it was before
Cultural services					
C1	Religious-spiritual	Forests provide specific places recognised as sacred sites or sites inhabited by certain spirits or having a certain spiritual association, important in the practice of the ethnic minorities religion.	SES itself	4	Forest God Worship ceremony is an important part in lives of ethnic people
C2	Recreation, sports, ecotourism	Forest provide landscape beauty as a basis for ecotourism		2	Upland landscape beauty attracts tourists to visit, providing some extra income to ethnic minorities
C3	Science, education	Forests provide opportunities for scientific research and educational activities		1	This service is not very important to upland ethnic minorities
C4	Historical /nation building	Unlikely		0	
C5	Relaxation /mental health	Unlikely		0	There is an increasing body of research showing how spending some time in natural conditions can reduce stress levels and improve mental health of people living in urban areas - but the ethnic minority lives near to the forest all the time anyway
C6	Aesthetics /artistic inspiration	Unclear		0	

Ecosystem services important to people in Kinh smallholder inland valley paddy cultivation + tree crops (acacia, citrus, rubber, tea) SES (5b) of Quang Binh province

Summary:

This SES is highly dependent on ecosystem services from other SESs, especially upstream watersheds and natural forests which are a source of water supply, and some physical protection, as well as pollination and pest control services of varying importance (depending on distance away from the forest). Tree crop plantations in this SES, while not being natural ecosystems, nevertheless can provide some types of beneficial ecosystem services including provision of some building materials and fuel-wood, as well as nitrogen-fixation in soils by acacia and some protection from erosion (although this is reduced by the short-term harvesting rotation cycle of the plantations.

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	The small amount of any natural ecosystem remaining in this SES does not directly provide any food for people living in this SES	SES itself	1	Rice, other annual crops and fruit trees grown in the SES, are extremely important, but they are not a natural ecosystem service
P2	Water	Most of water for people's daily life and production activities in this SES is provided by rivers from uphill forests	Watershed natural forests in other SESs	5	Rains can provide some but rivers are still the main source of water for people and production activities in this SES
P3	Medicines	Unclear/Unimportant		0	There are no clear evidences of using wild medicines in this SES
P4	Fibres	Unclear/Unimportant		0	There are no clear evidences of using wild fibers in this SES
P5	Building materials	Plantations can provide timber for minor works of local households	SES itself	1	Timber produced by this SES is mostly for commercial purpose, not for building
P6	Water energy	Unclear/Unimportant		0	There are no evidence of water energy being used in this SES
P7	Biomass energy	Plantations provides firewood to local people through thinning activities	SES itself	3	Firewood from plantations is an important source of fuel for cooking and heating in this SES
P8	Transport	Unlikely/Unimportant		0	
Regulating Services					
R1	Carbon fixation/storage	Plantations, crop trees can store carbon in their biomass but this is of limited important to the human and economic activities of this SES	SES itself	0	
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter pollutants and improve water quality	Watershed natural forests in other SESs	4	Water quality affects directly people's health and crop productivity
R3	Air quality	Unclear		0	

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
	maintenance				
R4	Climate buffering	Forests can provide favourable microclimates for rice fields and tree farms	Watershed natural forests in other SESs	3	Agriculture crops are vulnerable to climate change. Since it is getting hotter and hotter in recent years, plantations in this SES could help to reduce its impact on crops cultivated in/near to plantations
R5	Pest and disease control	The forest is a source of insects that can perform biological pest control in nearby fields, and of insectivorous bats that control mosquito and other harmful insect populations	Watershed natural forests in other SESs	2	Rubber and pepper plantations seem not provide this service to rice fields and tree crops. Watershed natural forests do but they are located quite far from fields, thus the effectiveness of pest control is reduced
R6	Waste recycling / detoxification	Unclear			
R7	Physical protection	Forests provide protection against soil erosion, hot wind, landslide to downhill fields and farms	Watershed natural forests in other SESs	4	This service is very important to all agriculture crops
R8	Control of water flows	Forest acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows	Watershed natural forests in other SESs	3	This services Indirectly affects crop productivity
R9	Control of sediment flows	Plantation trees with their strong roots could help to reduce soil erosion, thus control sediment flows in streams and springs	Within the SES itself	2	But harvesting the plantations on short-term rotations reduces the effectiveness of this service as large areas of bare soil are exposed by harvesting
Supporting services					
S1	Carbon cycling	Unlikely/Unimportant		0	
S2	Photosynthesis, primary production	Unlikely/Unimportant		0	
S3	Nutrient cycling	Acacia is a nitrogen-fixing species		1	
S4	Soil formation	Unlikely/Unimportant		0	
S5	Water cycling	Unlikely/Unimportant		0	
S6	Pollination	Insects, bats and birds from forests could facilitate pollination process in crop fields of ethnic minorities	SES itself, watershed natural forests in other SESs	4	Insect and bird pollination is very important for many crops but effectiveness it depends on the distance from the forests to the fields. Insect bird and bat diversity of plantations is lower than of natural forests so the value of the service from plantations is lower than from natural forest

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
S7	Seed dispersal	Birds, bats, squirrels, civets, monkeys, gibbons and other species facilitate seed dispersal from the forest but this is of no real value in this SES	SES itself, watershed natural forests	1	Most crops are planted by farmers, natural seed dispersal is of limited importance for this SES
Cultural services					
C1	Religious-spiritual	Unclear		0	Very few King households
C2	Recreation, sports, ecotourism	Unclear		0	Upland landscape beauty attracts tourisms to visit, providing some extra income to ethnic minority
C3	Science, education	The agro-ecologial system may provide opportunities for scientific research and educational activities	SES itself	1	This service seems not to be very important to communities than it does to scientific communities
C4	Historical / nation building	Unlikely/Unimportant		0	
C5	Relaxation/mental health	Unlikely/Unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/Unimportant		0	

Ecosystem services important to people in Kinh smallholder lowland coastal floodplain irrigated paddy rice cultivation, Quang Binh SES 6a

Summary:

This SES is highly dependent on upstream forest ecosystems for water supply for rice growing. The rice fields themselves may still supply some natural foods in the form of wild fish. Crabs and frogs etc. that can live in the rice fields (although increasing use of chemicals in rice-growing will reduce this wild food supply)

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Some wild fish, crabs, frogs, etc. may be harvested from the rice fields	SES itself	2	Rice is an very important food for people living in this SES, but it is not produced by a natural Ecosystem service
P2	Water	Most of water for people's daily life and production activities in this SES is provided by rivers from uphill forests	Watershed natural forests in other SESs	5	Rains can provide some but rivers are still the main source of water for people and agricultural production activities in this SES
P3	Medicines	Unclear/Unimportant		0	
P4	Fibres	Unclear/Unimportant		0	
P5	Building materials	Unclear/Unimportant		0	
P6	Water energy	Unclear/Unimportant		0	There are no evidence of water energy to be used in this SES
P7	Biomass energy	Unclear/unimportant	SES itself	0	While rice straw can be used for cooking, it is no longer a popular source of fuel for cooking and heating in this SES. It is also not a natural ecosystem service
P8	Transport	Unlikely/Unimportant		0	
Regulating Services					
R1	Carbon fixation/storage	Unimportant		0	
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter pollutants and improve water quality	Watershed natural forests in other SESs	2	Water quality affects directly people's health and crop productivitiy. However, the service is reduced, along with the degradation of watershed natural forests
R3	Air quality maintenance	Unclear		0	
R4	Climate buffering	Forests can provide favourable microclimates for rice fields. (Paddy field emit significant amounts of methane gas that is a major greenhouse gas causing climate change)	Natural forests in other SESs	2	There are not really any significantly large areas of natural forest close to most lowland paddy areas
R5	Pest and disease control	Unclear		0	

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
R6	Waste recycling / detoxification	Unclear		0	
R7	Physical protection	Forests provide protection against soil erosion, hot wind, landslide to downhill fields and farms	Natural forests in other SESs	2	There are not really any significantly large areas of natural forest close to most lowland paddy areas
R8	Control of water flows	Forest acts like sponges: soaking up water in rainy season and realising water in dry season, regulating water flows	Watershed natural forests in other SESs	1	There are not really any significantly large areas of natural forest close to most lowland paddy areas
R9	Control of sediment flows	Forest trees with their strong roots could help to reduce soil erosion, thus control sediment flows in streams and springs	Watershed natural forests in other SESs	1	This services Indirectly affects crop productivity
Supporting services					
S1	Carbon cycling	Unlikely/Unimportant		0	
S2	Photosynthesis, primary production	Unlikely/Unimportant		0	
S3	Nutrient cycling	Unlikely/Unimportant		0	
S4	Soil formation	Unlikely/Unimportant		0	
S5	Water cycling	Unlikely/Unimportant		0	
S6	Pollination	Unlikely/unimportant		0	
S7	Seed dispersal	Unlikely/unimportant		0	Seed dispersal is very important for some crops
Cultural services					
C1	Religious-spiritual	A number of traditions and ceremonial activities are linked to the annual rice planting and harvesting calendar	The SES itself	2	Although this is a service of the rice fields system, not the original natural ecosystem
C2	Recreation, sports, ecotourism	Unlikely/Unimportant		0	
C3	Science, education	Unlikely/Unimportant		0	
C4	Historical /nation building	Unlikely/Unimportant		0	
C5	Relaxation /mental health	Unlikely/Unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/Unimportant		0	

Ecosystem services important to the Kinh cage and pond aquaculture in estuaries and mangroves, QB SES (9a)

Summary

This SES is critically dependent on appropriate levels of flows of good quality water in the estuary to ensure appropriate conditions for successful cage and pond aquaculture, avoiding floods and avoiding sudden large changes in salinity levels that can cause shocks, as well as ensuring that sediment levels are not excessive (which can also be harmful to cage-raised fish). Some of these services are provided from within the SES itself, but it is also highly dependent on input flows from upstream SESs. These flows from upstream may also be changed by water infrastructure including dams. Dykes and saline intrusion barriers. The SES itself also provides some wild food provisioning services, and mangroves within the SES can supply medicinal plants, edible plants some construction materials and some wood for charcoal. However the very limited area of mangroves remaining means that these services are negligible at this point in time.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Some fish, shellfish, crabs and prawns can also be harvested from the water around cages and from inside the prawn ponds. Some edible plant species are found in the mangroves	The SES itself	3	Wild shrimp, fish, crab are important sources of food for people living not only in this SES but also in other locations in the country
P2	Water	Water is one of the most important inputs for fish raised in cages and ponds in estuaries/mudflat areas	The SES itself (but also depends on water supply reaching the estuary from upstream SESs)	5	Cages float in the estuary water, and water is taken directly from the estuary for prawns
P3	Medicines	Some medicinal plants can be collected in the mangroves	SES itself	1	Mangrove area is very limited so availability of this service is low
P4	Fibres	Unlikely/unimportant		0	
P5	Building materials	Mangrove poles can be used for some construction needs by people in the SES	SES itself	1	Mangrove area is very limited so availability of this service is low
P6	Water energy	Unlikely/unimportant		0	
P7	Biomass energy	Mangroves can be used for charcoal production by people in the SES	SES itself	1	Mangrove area is very limited so availability of this service is low
P8	Transport	Unlikely/unimportant		0	
Regulating Services					
R1	Carbon	Mangroves and mudflats store significant	SES itself	1	The area of mangroves is very small, and the local

	fixation/storage	carbon			communities do not directly benefit from the carbon storage
R2	Water quality maintenance	Water quality directly affect the productivity of fish raised in cages and ponds in estuaries/mudflat areas	SES itself and upstream watershed SESs	5	Any change in water quality can result in mass death of cage fish as they are very sensitive to rapid environmental change (shocks)
R3	Air quality maintenance	Unlikely/unimportant		0	
R4	Climate buffering	Unlikely/unimportant		0	
R5	Pest and disease control	Mangroves may play some role in pest and disease control	Mangroves in the SES itself	1	Effectiveness reduces if cage and ponds are far from mangroves forests. Area of mangroves is limited so service is limited.
R6	Waste recycling / detoxification	Mangroves can help in waste recycling	Mangroves in the SES itself	0	Area of mangroves is very small, the service is very limited
R7	Physical protection	Mangroves may reduce the exposure of ponds and cages to storms, strong winds direct sunshine and rain, ec	Mangrove ecosystems	1	Area of mangroves is small, so the service is quite limited
R8	Control of water flows	Adequate water flow from upstream is important to dilute the salinity of estuary water to the brackish level appropriate for the species being raised in cages and ponds. Control of water flow is also important to prevent too much water flow causing floods after heavy rains floods	Dependent on upstream SES, but may be impacted by water infrastructure including dams	4	Changes in water flows result in changes in salinity - sudden shocks caused by rapid changes in salinity can cause mortality of cage species. Floods can damage ponds and cages.
R9	Control of sediment flows	Mangroves trap sediment	SES itself	1	Too much sediment can increase turbidity of the water and can have negative impacts on some cage fish species, blocking their gills, etc.
Supporting services					
S1	Carbon cycling	Unlikely/unimportant		0	
S2	Photosynthesis, primary production	Unlikely/unimportant		0	
S3	Nutrient cycling	Unlikely/unimportant		0	
S4	Soil formation	Mangroves trap sediment and raise the level of the land – this can be from 1-10mm/year, so it is possible to keep pace with sea-level rise	SES itself	1	There are of mangroves is small so this service is limited. Alteration of sediment transport to the estuary by dams and saline intrusion barriers also reduces the value of

		under certain conditions			this service
S5	Water cycling	Unlikely/unimportant		0	
S6	Pollination	Unlikely/unimportant		0	
S7	Seed dispersal	Unlikely/unimportant		0	
Cultural services					
C1	Religious-spiritual	Unlikely/unimportant		0	
C2	Recreation, sports, ecotourism	These activities are often conducted in mangrove areas	The SES itself	1	Not many tourism activities are available in this SES, and the area of mangroves is very limited
C3	Science, education	Unlikely/unimportant		0	
C4	Historical / nation building	Unlikely/unimportant		0	
C5	Relaxation/mental health	Unlikely/unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/unimportant		0	

Ecosystem services important to the forest protection management board plantations on sand, QB SES FPMB 9

<u>Summary</u>

This SES is dependent on ground water supply that may largely be determined by the sand dune ecosystem and tree cover within the SES itself. The coastal protection forest is almost exclusive plantations of introduced species - Casuarina equisetifolia, and some acacia. While these trees provide some physical protection, air quality maintenance, climate buffering and fuel biomass services, these are not services from a natural ecosystem. The original coastal forest were more diverse and would have provide these services more effectively

Possible EbA interventions include:

- Increasing diversity of coastal protection forest planting, by including a large number of different native species in the planting. This may require the establishment of tree nurseries for these species, and the provision of training in nursery and planting techniques for these species

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Unlikely/unimportant			
P2	Water	Coastal protection plantations requires underground water for trees to survive	Sand dune SES	5	Together with seedling quality, water is an very important factor for the success of the planting
P3	Medicines	Unlikely/unimportant		0	
P4	Fibres	Unlikely/unimportant			
P5	Building materials	Plantations provide some timber for local households, which are allocated forestry land to plant and manage protection plantations, to use in their minor works though thinning activities	SES itself	2	Most of timber are used for commercial purpose, not for local building
P6	Water energy	Unlikely/unimportant			
P7	Biomass energy	Plantations supply firewood which may be used by the households which are allocated forestry land to plant and manage protection plantations	The SES itself	3	Local people only use a little amount of dried, fallen branches of forest trees for fire wood for heating (not so much for cooking?)
P8	Transport	Unlikely		0	
Regulating Services					
R1	Carbon fixation/storage	Protection plantations are carbon stores, and they are carbon dioxide sinks but this is not important at all for local communities		0	
R2	Water quality maintenance	Protection plantations help to maintain water quality but this is not important to the SES as a	The SES itself	1	

		whole			
R3	Air quality maintenance	Protection plantations provide protection against blowing sand, preventing sand particles from travelling in the air and landing in agriculture production areas on the landward side of the sandy areas	The SES itself	4	Air quality is important to local people's health and agricultural production activities not only in the SES itself but also in other nearby SESs. Original coastal forest would have provided better service, but now at least the plantation provides some service
R4	Climate buffering	Protection plantations can provide favourable microclimates for the region	The SES itself	3	With their large areas, protection plantations could change the microclimate in this SES and nearby SES Original coastal forest would have provided better service, but now at least the plantation provides some service
R5	Pest and disease control	Unclear		0	
R6	Waste recycling / detoxification	Unclear		0	
R7	Physical protection	Protection plantations can provide protection service against physical damage to the coastal communities from storms and strong winds	The SES itself	4	Plantations not only protect aquaculture production but also human life, property and other economic activities in and outside of the SES from damages caused by natural disasters Original coastal forest would have provided better service, but now at least the plantation provides some service
R8	Control of water flows	Unlikely/unimportant		0	
R9	Control of sediment flows	Unlikely/unimportant		0	
Supporting services					
S1	Carbon cycling	Unclear		0	
S2	Photosynthesis, primary production	Unlikely		0	
S3	Nutrient cycling	Unlikely		0	
S4	Soil formation	Unlikely/unimportant		0	
S5	Water cycling	Unlikely/unimportant		0	
S6	Pollination	Unclear		0	

S7	Seed dispersal	Unclear		0	
Cultural services					
C1	Religious-spiritual	Unclear		0	
C2	Recreation, sports, ecotourism	Coastal protection plantations may attract tourists to visit this SES, providing extra income to the local community by providing tourism services to tourists		1	So far this is limited
C3	Science, education	This SES may provide opportunities for scientific research and educational activities		2	Not many studies/educational activities have been recorded in this SES despite its potential.
C4	Historical / nation building	Unlikely		0	
C5	Relaxation/mental health	Unlikely		0	
C6	Aesthetics /artistic inspiration	Unlikely		0	

Ecosystem services important to people in Kinh small-scale vegetable growing on sand, QB SES (9b)

Summary:

This SES is critically dependent on the underground water supply in the sandy areas that largely depends on the sand dunes for filtration and recharge of this water supply. Sand dunes also provide physical protection to the vegetable growing area. The coastal plantation protection forest is not as effective as the former original natural species diverse coastal forest, but does provide some protection and fuel-wood services.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food			0	Irrelevant to vegetable growing
P2	Water	Underground water is one of the most important inputs for vegetable growing	Sand dunes	5	All vegetable farms are far from other sources of water. All water used for vegetable growing is extracted from underground water beneath sand dunes
P3	Medicines	Unimportant		0	Natural medicines are not used for vegetable growing on sand
P4	Fibres	Unimportant		0	Fibres are not used in vegetable growing on sand
P5	Building materials	Bamboo	Bamboo forest	1	Very few households use bamboo to build their farm
P6	Water energy	Unimportant		0	Water energy is not used in vegetable growing on sand
P7	Biomass energy	Dead branches may be collected from coastal protection forests	The SES itself	1	Biomass energy is not really used in vegetable growing on sand
P8	Transport	Unlikely		0	
Regulating Services					
R1	Carbon fixation/storage			0	Irrelevant to vegetable growing
R2	Water quality maintenance	Sand may provide a good filter for the surface water that percolates down and recharges ground water - especially in some cases when it passes through 30 m of sand dunes	Sand dunes	4	Water quality affect directly on vegetable growth and quality
R3	Air quality maintenance	Coastal protection forest provide protection against blowing sand, preventing sand article from travelling in the air and landing in the vegetable farm	Coastal protection forests	4	Air quality is important to human health and vegetable production
R4	Climate buffering			0	Vegetable growing on sand can grow well in adverse climate condition (i.e., temperature > 50^{0}C

R5	Pest and disease control	The coastal protection forest may be a a source of insects that can perform biological pest control in nearby fields		2	Insect diversity in the plantation forest is low, and so this function is very limited. Natural diverse coastal forest would be more effective
R6	Waste recycling / detoxification	Sand may filter wastewater run out of vegetable farm	Sand dunes	1	Farmers may not use many chemicals for their vegetable growing
R7	Physical protection	Sand dunes and coastal protection forest can provide protection service against physical damage to the vegetable farms from storms and strong winds	Sand dunes and Coastal protection forest	3	Along with the support from coastal protection forests, farmers often use artificial materials to protect their farms
R8	Control of water flows	Unlikely/unimportant		0	
R9	Control of sediment flows	Unlikely/unimportant		0	
Supporting services					
S1	Carbon cycling	Unimportant		0	
S2	Photosynthesis, primary production	Unimportant		0	
S3	Nutrient cycling	Unimportant		0	
S4	Soil formation	Unimportant		0	
S5	Water cycling	Unimportant		0	
S6	Pollination	Unimportant		0	
S7	Seed dispersal	Unlikely			
Cultural services					
C1	Religious-spiritual	Unimportant			
C2	Recreation, sports, ecotourism	Unimportant		0	No tourism activities are in practice in this SES
C3	Science, education	Unimportant		2	Very few studies/educational activities have been done with this SES
C4	Historical / nation building	Unimportant		0	
C5	Relaxation/mental health	Unimportant		0	
C6	Aesthetics /artistic inspiration	Unimportant		0	

Ecosystem services important to the commercial pond aquaculture on sand, QB SES (9c)

Summary

This SES is critically dependent on two things - underground abundant and good quality water supply within the SES, for freshwater input, and commercial feed based on "trash fish" from other coastal and marine SESs. Any remaining natural forest together with planted coastal protection forest, provides some physical protection from storm damage, and polluted waste water is released directly untreated into the surrounding environment.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Shrimp are fed on commercial feed which is normally fish meal made from so-called "trash fish" The supply of this fish to the feed mills is therefore an important service on which commercial aquaculture depends	Offshore (and possibly also near-shore) Kinh commercial fisheries SES	4	Without the shrimp feed, the intensive commercial system annot be developed
P2	Water	Aquaculture production requires a large amount of underground water (approximately 50.000 m3/year for a pond of 10.000 m2)	The SES itself	4	Most of aquaculture farms are built far from residential areas, thus cannot reach to other sources of surface water but underground water provided by the SES ifsefl
P3	Medicines	Unlikely/unimportant		0	No natural medicines are used in aquaculture production
P4	Fibres	Unlikely/unimportant			
P5	Building materials	Unlikely/unimportant		0	Local people no longer use wood/timber from forests for house building
P6	Water energy	Unlikely/unimportant			
P7	Biomass energy	Forests and fallows supply firewood which may be used by the people who own or work at the aquaculture ponds	The SES itself	1	Local people only use a little amount of dried, fallen branches of forest tree for heating
P8	Transport	Unlikely		0	
Regulating Services					
R1	Carbon fixation/storage	Coastal protection forests are carbon stores, and they are carbon dioxide sinks but this is not important at all for commercial shrimp production	The SES itself	1	With low density and poor quality, coastal protection forests only have limited capacity of carbon sequestration
R2	Water quality maintenance	Sand may provide a good filter for the surface water that percolates down and recharges ground water – especially in some cases when it	The SES itself	5	Water quality affect directly on shrimp productivity and local people's health

		passes through 30 m of sand dunes			
R3	Air quality maintenance	Coastal protection forest provide protection against blowing sand, preventing sand article from travelling in the air and landing in the ponds	The SES itself	4	Air quality is important to human health and production activities not only in the SES itself but also in other SESs nearby
R4	Climate buffering	Coastal protection forests can provide favourable microclimates for the region but this is of limited importance to the aquaculture activities	The SES itself	2	Low density and poor quality of coastal protection forest prevent it from changing microclimate of the region
R5	Pest and disease control	Sand may provide good filter for surface water, eliminating most of disease in waste water discharged indiscriminately into environment before the water percolates down and recharges ground water which will be used for aquaculture production in the region	The SES itself	4	In aquaculture production, disease mostly spreads out through untreated wastewater discharged into environment. Thank to this service of the SES, disease is controlled better.
R6	Waste recycling / detoxification	Sand may provide good filter for wastewater discharged indiscriminately into environment by shrimp farmers	The SES itself	3	This service helps to reduce disease spread in aquaculture production
R7	Physical protection	Coastal protection forest can provide protection service against physical damage to the ponds and associated facilities, and protection against excessive turbidity of the water that can be harmful for the prawns	The SES itself	5	Coastal protection forest not only protect aquaculture production but also human life, property and other economic activities in and outside of the SES from damages caused by natural disasters
R8	Control of water flows	Unlikely/unimportant		0	
R9	Control of sediment flows	Unlikely/unimportant		0	
Supporting services					
S1	Carbon cycling	Unclear			
S2	Photosynthesis, primary production	Unlikely			
S3	Nutrient cycling	Unlikely			
S4	Soil formation	Coastal protection forest may help to form new land which could be used for aquaculture		1	There are not much evidences for this kind of service provided by the SES

		practice			
S5	Water cycling				
S6	Pollination	Unlikely			
S7	Seed dispersal	Unlikely			
Cultural services					
C1	Religious-spiritual	Unclear			
C2	Recreation, sports, ecotourism	Sand dunes may attract tourists to visit this SES, providing extra revenue to the local community		2	Not many tourism activities are in practice in this SES, despite of its potentials
C3	Science, education	This SES may provide scientific/educational information to interest communities.		2	Not many studies/educational activities have been recorded in this SES despite of its potentials.
C4	Historical / nation building	Unlikely		0	
C5	Relaxation/mental health	Unlikely		0	
C6	Aesthetics /artistic inspiration	Unlikely		0	

Ecosystem services important to the Kinh inshore capture fisherman in delta and marine areas up to 6km offshore, QB SES (10a)

Summary

The SES depends provides significant catches of fish, shellfish, prawns and crab, depending on good quality se water in the coastal area. The SES also absorbs large amounts of carbon dioxide which is dissolved in the sea, but this is causing increasing problems of acidification, which has serious impacts on marine life. The SES provides some waste recycling and detoxification services, but it can be overwhelmed by sudden influxes of large levels of pollution or highly toxic substances, that can have huge impacts on marine life.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	A part of aquatic species captured by fisherman will be consumed by their households and in their communities, the rest enters the market chain	The SES itself	5	Shrimp, fish, crab and shellfish are important sources of food for people living not only in this SES but also in other parts of the country
P2	Water	Unlikely/unimportant		0	
P3	Medicines	Unlikely/unimportant		0	
P4	Fibres	Unlikely/unimportant		0	
P5	Building materials	Unlikely/unimportant		0	
P6	Water energy	Unlikely/unimportant		0	
P7	Biomass energy	Unlikely/unimportant		0	
P8	Transport	Fishing activities could not be done without water-based transportation	The SES itself	5	
Regulating Services					
R1	Carbon fixation/storage	Huge amounts of carbon dioxide get dissolved in the sea	The SES itself	5	Increasing concentration of carbon in seawater created acidification which has many negative impacts on crabs, prawns and shellfish as well as coral reefs
R2	Water quality maintenance	Water quality is important in determining fish stocks and productivity available for fisherman to capture	The SES itself	5	This service is greatly important to the SES as a whole.
R3	Air quality maintenance	Unlikely/unimportant		0	
R4	Climate buffering	Unlikely/unimportant		0	
R5	Pest and disease control	Unlikely/unimportant		0	

R6	Waste recycling / detoxification	Domestic, industrial and commercial waste are all discharged into the sea		4	Sometimes high levels of pollution can happen too quickly in a limited area and the system cannot cope with it and there are sever impacts such as massive fish die-offs, etc.
R7	Physical protection	Unlikely/unimportant		0	
R8	Control of water flows	Unlikely/unimportant		0	
R9	Control of sediment flows	Unlikely/unimportant		0	
Supporting services					
S1	Carbon cycling	Unlikely/unimportant		0	
S2	Photosynthesis, primary production	Unlikely/unimportant		0	
S3	Nutrient cycling	Unlikely/unimportant		0	
S4	Soil formation	Unlikely/unimportant		0	
S5	Water cycling	Unlikely/unimportant		0	
S6	Pollination	Unlikely/unimportant		0	
S7	Seed dispersal	Unlikely/unimportant		0	
Cultural services					
C1	Religious-spiritual	Unclear		0	
C2	Recreation, sports, ecotourism	Coastal communities may attract tourists to visit the region	The SES itself	1	Not many tourism activities are available in this SES
C3	Science, education	Unlikely/unimportant		0	
C4	Historical / nation building	Unlikely		0	
C5	Relaxation/mental health	Unlikely		0	
C6	Aesthetics /artistic inspiration	The sea is a source of inspiration for many artists		1	

Ecosystem services important to the small and large scale beach tourism enterprises, QB SES (10c)

Summary

This SES is critically dependent on fresh water supplies, and seafood supplies originating from other adjacent SESs. Nearby coastal forest is also important for physical protection from storms and blowing sand, and may provide some micro-climate regulation. However, coastal forest is nowadays almost exclusively casuarina plantations. Original natural diverse species coastal forest would be more effective at providing these services.

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
Provisioning Services					
P1	Food	Seafood is provided for the many visitors to tourist destinations	Offshore and possibly also near-shore Kinh commercial fisheries SES	4	Seafood is always an important part of every beach tourism business
P2	Water	Tourism activities require a huge amount of fresh water (i.e., for cooking, bathing, washing)	Some main destinations close to Dong Hoi city, rely on municipal water supply from the river is used, in other areas ground water under the sand dunes may be used	4	Apart from seawater, underground fresh water is also very important for tourism business
P3	Medicines	Unlikely/unimportant		0	
P4	Fibres	Unlikely/unimportant			
P5	Building materials	Unlikely/unimportant		0	
P6	Water energy	Unlikely/unimportant			
P7	Biomass energy	Unlikely/unimportant		0	
P8	Transport	Water-based transportation is popular in tourism as well	Ocean	3	
Regulating Services					
R1	Carbon fixation/storage	Unlikely/unimportant		0	
R2	Water quality maintenance	Sand may provide a good filter for the surface water that percolates down and recharges ground water – especially in some cases when it passes through 30 m of sand dunes	Sand dunes	3	Quality of fresh water is important but it is not the most important factor in beach tourism business
R3	Air quality maintenance	Coastal protection forest provide protection against blowing sand, preventing sand article from travelling in the air and landing in tourism facilities	Coastal protection forests	3	Air quality is important to tourists and tourism facilities (hotels, restaurants, etc.) Natural coastal forest would be more effective at providing this service than the planted casuarina forest
R4	Climate buffering	Coastal protection forests can provide favourable microclimates for the region and this is important to tourists	Coastal protection forests	3	Low density and poor quality of coastal protection forests in Quang Binh may prevent them from changing microclimate of the region. Original natural forest would be better but it has all bens cut down

R5	Pest and disease control	Unlikely/unimportant		0	
R6	Waste recycling / detoxification	It is unclear how many beach hotels have waste-water treatment facilities or just pump waste water into the sea. Many small restaurants dump garbage directly in the river estuary in Dong Hoi town	3	0	Needs further investigation
R7	Physical protection	Coastal protection forest can provide protection service against physical damage to the tourism facilities (hotels, restaurants)	Coastal protection forests	3	The importance of this services varies, depending on the distance of coastal protection forests and tourism facilities
R8	Control of water flows	Unlikely/unimportant		0	
R9	Control of sediment flows	Unlikely/unimportant		0	
Supporting services					
S1	Carbon cycling	Unlikely/unimportant		0	
S2	Photosynthesis, primary production	Unlikely/unimportant		0	
S3	Nutrient cycling	Unlikely/unimportant		0	
S4	Soil formation	Unlikely/unimportant		0	
S5	Water cycling	Unlikely/unimportant		0	
S6	Pollination	Unlikely/unimportant		0	
S7	Seed dispersal	Unlikely/unimportant		0	
Cultural services					
C1	Religious-spiritual	Unlikely/unimportant			
C2	Recreation, sports, ecotourism	Landscape beauty of the beach is one of the most important factors attracting tourists, thus most important to tourism business	Sand dunes, coastal protection forests, beach	5	
C3	Science, education	Unlikely/unimportant		0	
C4	Historical / nation building	Unlikely/unimportant		0	
C5	Relaxation/mental health	Unlikely/unimportant		0	
C6	Aesthetics /artistic inspiration	Unlikely/unimportant		0	

CHAPTER 6 CLIMATE AND CLIMATE - RELATED DISASTER PROFILE OF QUANG BINH

6.1 INTRODUCTION

This chapter provides information on the current climate of Quang Binh, and the history of climate-related hazards and disasters that the province has already faced for many years. It identifies the districts and communes of the province most affected by each type of disaster, and provides details of the type and amount of damages caused. Finally, it recommends priority geographic and thematic areas for Ecosystem based intervention in Disaster Risk Reduction (Eb-DRR) and climate-change adaptation (EbA) based on the analysis provided.

6.1.1. Climate of Quang Binh

Quang Binh Province is located in the tropical monsoon zone, but the local climate is complex and differs between locations, strongly influenced by topography. From a temperature perspective the year can be considered as having 2 main seasons, the warm season from April to September with an average temperature of about 35°C and cool season from October to March with an average temperature about 22 - 25°C. Overall annual average temperature is about 24 - 25°C, increasing from North to South and decreasing from East to West. In the mountainous areas, the daytime and night-time temperature differences can be as much as 9 - 10°C in compared with 7 - 8°C in the plains (Nguyen et. Al., 2013) In the warm (dry) season, the south-westerly monsoon wind blows strongly through the Truong Son Mountains, the natural border between Vietnam and Lao, leading to extremely hot and dry weather and known colloquially as the "Lao wind". Each year there are about 40-48 hot-dry days with temperatures over 35^{o}C. Conversely the north-easterly monsoon brings a mostly cold and dry air mass and temperatures can drop considerable in January and February. Wind speed during rainy season is usually higher than in dry season.

Table 6.1: Monthly average temperature in 2012 (^{o}C)

Month	1	2	3	4	5	6	Mean
Temperature	17.8	18.5	21.4	26.3	29.2	30.1	25.1
Month	7	8	9	10	11	12	
Temperature	29.7	29.2	26.8	25.6	24.8	21.5	

Source: Year book Quang Binh province 2013

From the perspective of precipitation, there are two distinct seasons in the Province, i.e., the dry season, which lasts from November to April and the rainy season from May to early November. 80-90% of total annual rainfall occurs in the rainy season. According records from 1961 - 2009, the average annual rainfall is 2,000 - 2,300 mm/year, while the maximum and minimum annual rainfall are 3,092 mm (in 1964) and 1,570 mm (in 1969), respectively (SNREC, 2010) The average annual rainfall has slightly decreased over time, by an average of about 8 mm/year (Nguyen et al. 2013). Average number of rainy days is about 152 days/year, mostly concentrated during the period from September to November, accounting for 56-65% of the total annual rainfall. Precipitation is not evenly spread across the province. Highest average precipitation occurs in Huong Hoa (2,715mm), while lowest annual precipitation is in mountainous areas and southwestern valleys in Quang Phuc (1,683mm) and Quang Luu (1,892mm), as well as in Ron (1,898mm) and Trooc (<2,000mm). On average, every year Quang Binh encounters five to six storms and/or tropical depressions. From 1955-1984, there were 43 hurricanes directly landing in the province, mostly in August, September and October. Heavy rainfall concentrated in brought by storms combined with the steeply sloping terrain and fast-flowing rivers often results in widespread flooding, especially when combined with periods of high tides (ISPONRE, 2009).

Table 6.2: Monthly average rainfall in 2012 (mm)

Month	1	2	3	4	5	6	Mean
Rainfall	38.3	11.0	17.5	82.2	154.7	82.6	145.3
Month	7	8	9	10	11	12	
Rainfall	123.2	145.2	547.0	281.9	156.8	103.7	

Table 6.3: Main weather characteristics in three meteorology station in Quang Binh

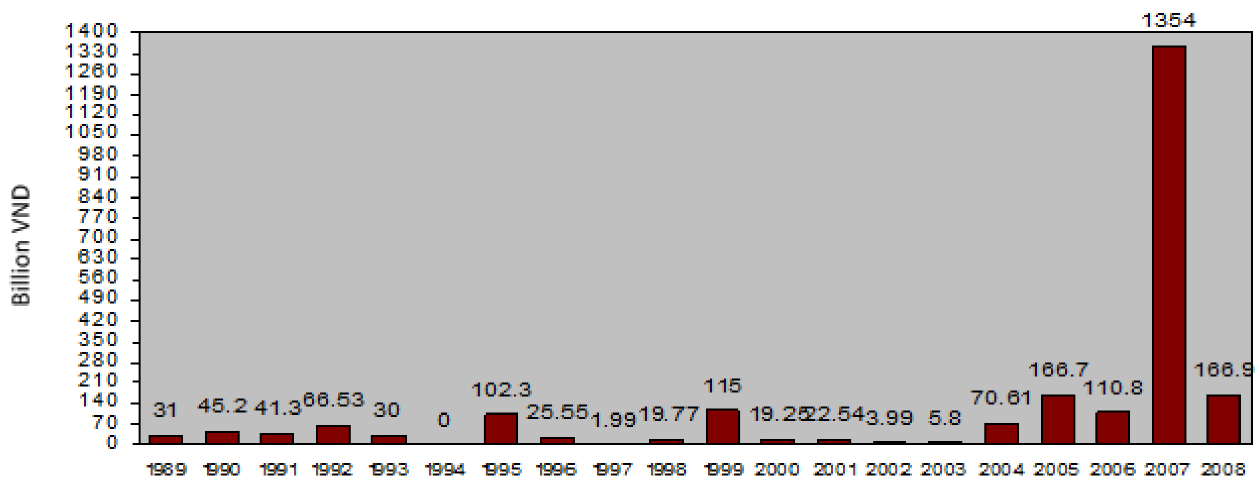
Type of climate	Tuyen Hoa station	Ba Don station	Dong Hoi station
Average annual temperature	23.8 °C	24.3°C	24.6°C
Lowest temperature	5.9°C (Jan)	7.6°C (Dec)	7.7°C (Jan)
Highest temperature	40.1°C	40.1°C	42.2°C
Average annual rainfall	2,266.5mm	1,932.4mm	2,159.4mm
Annual number of rainy days	159 days	130 days	135 days
Highest daily precipitation	403mm	414mm	415mm
Annual number of low rainfall days	18 (Jan, Feb, Mar)	09.3 (Nov)	17 (Dec)
Average air humidity	84%	84%	83%
Average minimum humidity	66%	67%	68%
Foggy days	47 (Jul, Aug, Sep)	20 (Sep, Oct)	13.8 (Sep, Oct)
Water evaporation	1,031mm	1,035mm	1,222mm
Coordinates			
North latitude	17°50'	17°45'	17°-29’
West longitude	106°08'	106°25'	106°37'
Elevation above sea level	25m	8m	7m
Observed years	1961 - 2000	1960 - 1999	1900 - 2000

6.1.2. Climate Hazards and Economic Costs of Disasters in Quang Binh

Quang Binh is one of the twenty most hazard prone provinces in the country (CCFSC) The province is particularly vulnerable to storms, floods, whirlwinds, river and sea bank erosion and salinity intrusion. During the rainy season, storms and tropical low pressure systems often cause heavy rains and tidal floods, resulting in inundation in lowland regions and flash floods in mountainous and hilly areas. Due to the particular topography of the province, all the rivers of Quang Binh are relatively short and steep. When storms bring heavy rains, then combined with the nature of the river system this often results in floods with a very rapid onset with high velocity flows and high erosive power. Floods usually occurring from Aug to Oct are considered a normal feature of life in Quang Binh Province. Other types of natural hazard in the Province are early floods, which occur from Apr to Jun, whirlwinds, thunderstorms and salinity intrusion.

The average number of events reported per year (referred to as “data cards”) in Quang Binh is eleven. In most cases when a disaster happened, particularly as a result of storms and typhoons, it affected all seven districts in the province. Heavy rainfall and floods in some cases affected the whole province, while in other cases had more localized impact. These hazards have a significant impact on the province’s economy, natural resources and the lives and livelihoods of the population (see Figure 6.1, and Table 6.4).

Graph 6.1: Estimated economic loss due to natural disasters in Quang Binh (1989 - 2008)



Source: Quang Binh Department of Irrigation, Flood and Storm Control

Table 6.4: Statistics of damage caused by natural disasters from 1989 to 2008

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Mortality	5	13	2	39	13	0	35	4	15	23
Injury	6	7	2	7	32	0	12	5	1	2
Loss (billion VND)	31.0	45.2	41.3	66.53	30.0	-	102.3	25.55	1.99	19.77
Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Mortality	33	5	10	5	5	3	17	9	25	12
Injury	12	0	1	0	1	3	8	8	148	46
Loss (billion VND)	115.0	19.25	22.54	3.99	5.8	70.61	166,7	110,8	1354,0	166.9

Source: Quang Binh Department of Irrigation, Flood and Storm Control

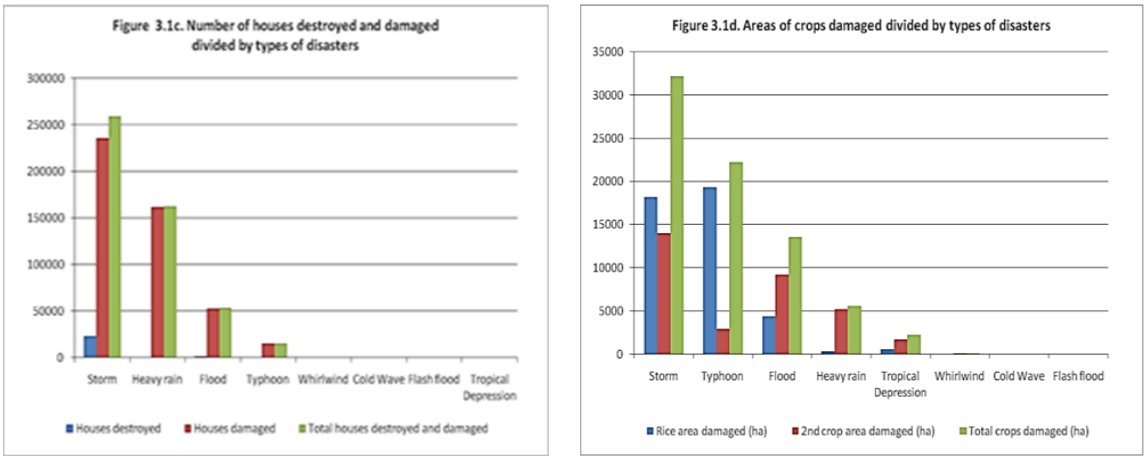
6.1.3. Overview of disasters and their impact in Quang Binh over the period 1997-2010

Storm (65 data cards) is the most reported disaster type accounting for 45% of the reported events. Flood (32 data cards, 22%), typhoon (17 data cards, 12%) and heavy rain (15 data cards, 10%) were the next most frequent disasters. Other less frequent disaster types were whirlwind (5%), tropical depression (4%) and cold wave (1%). Taking into account the inconsistent classification of disaster types in Vietnam, if tropical depression, storm and typhoon are combined under one large 'storm' category, this accounts for 61% of all disasters occurrences; combining heavy rain and flood accounts for 32%.

Over the period 1997-2010, 151 people died in Quang Binh due to disasters, making an average of 12 deaths per year. Storm is the most fatal disaster type with over 65 people killed, accounting for 43% of the total number of deaths in the province. Heavy rain was the second most fatal with 58 deaths (38%) and flood the third with 14 deaths (9%). Other disaster types, such as typhoon, tropical depression and whirlwind, caused fewer deaths and combined, account for around 9% of deaths over this period. Flash floods and cold waves did not cause any reported fatalities.

Storm and heavy rains had the highest impacts on houses destroyed or damaged, followed by floods and typhoons. Whirlwinds had negligible impact and cold wave, flash flood and tropical depression do not have any reported impact on housing. Storms, typhoons and floods caused the most damage to rice paddies and other crops. Heavy rain and tropical depressions also caused damage to agricultural production, while negligible to no damage was caused by whirlwinds, cold waves and flash floods.

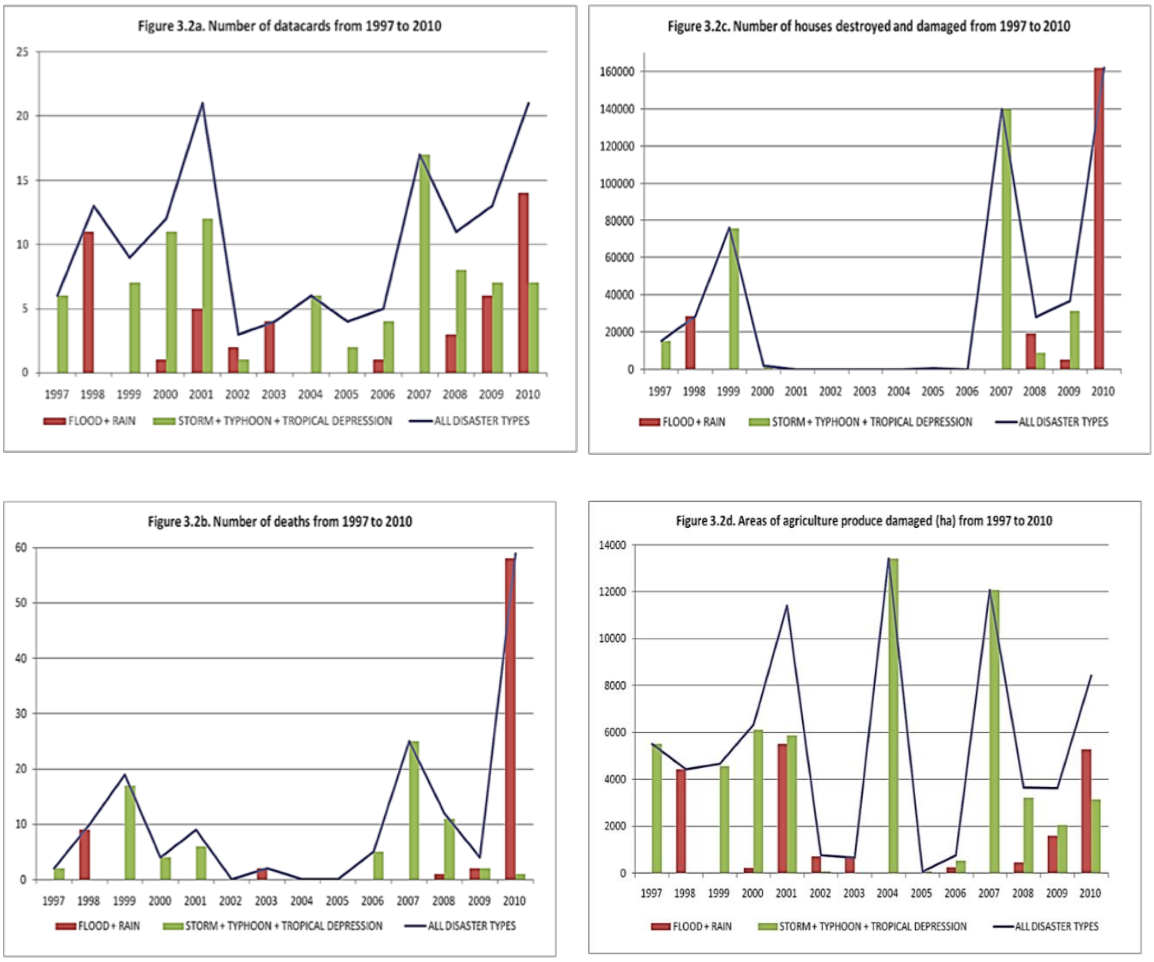
Graph 6.2: Houses and crops destroyed/damaged by disasters



Source UNDP, 2012

Examining the trend line for all disaster types, there appears to be an increasing impact on lives, housing and agricultural production over time, although there is a gap in reporting for damage to housing between 2001 and 2004.

Graph 6.3: Temporal trends in number of events reported, number of deaths, houses destroyed and damaged, and agricultural produce houses destroyed and damaged



Source: UNDP, 2012

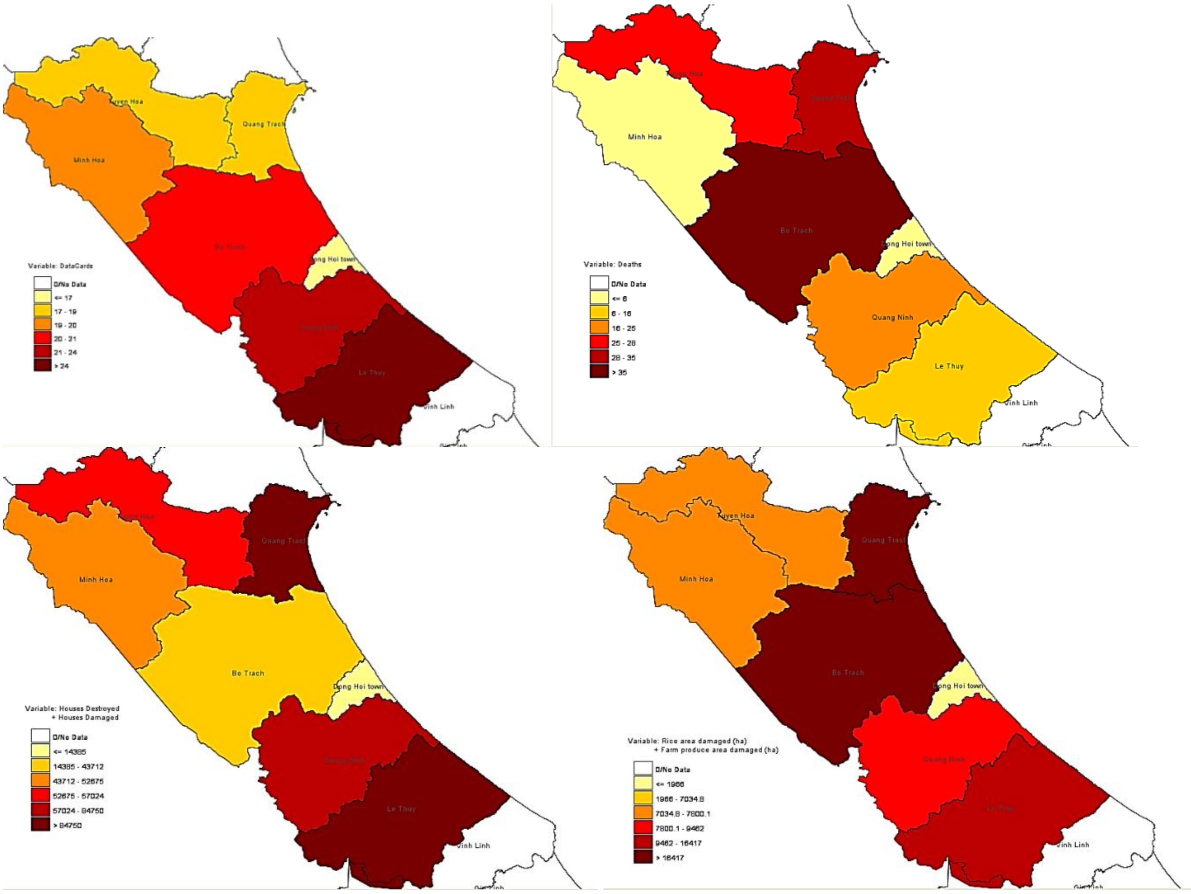
Districts in the central and south of the province have reported more disasters than districts in the north. The most southern district, Le Thuy, has been impacted by most events - 26. Quang Ninh and Bo Trach districts follow closely, with 24 and 21 respectively. Dong Hoi City in the center of the province is the least affected by disasters with only 17 reported events.

Examining fatalities over this same period, Bo Trach is the most affected district with 37 deaths, followed by Quang Trach, Tuyen Hoa and Quang Ninh with 35, 28 and 25 deaths respectively. Dong Hoi and Minh Hoa have the least number of deaths with 6 deaths in each district.

On the other hand, Le Thuy and Quang Trach experienced the most damage and destruction to housing over the period, with over 100,000 houses damaged or destroyed. Quang Ninh district follows with almost 85,000 damaged and destroyed houses. Tuyen Hoa and Minh Hoa also each have more than 50,000 houses destroyed and damaged over the same period. Dong Hoi is the least affected with approximately 14,000 houses affected by disasters.

Bo Trach and Quang Trach districts are where agriculture is the most impacted, closely followed by Le Thuy. All three districts lost more than 16,000ha of rice and other produce over the period. Again, for agricultural impact, Dong Hoi is the least affected as its economy is much less focused on agriculture compared with other districts.

Map 6.1: Spatial distribution of (a) all reported events (b) deaths (c) houses destroyed and damaged and (d) agriculture produce damaged or all disaster types



Source UNDP, 2012

Seven districts in Quang Binh are prone to direct impacts of storms, namely Le Thuy, Quang Ninh, Quang Trach, Bo Trach, Dong Hoi City, Truong Xuan and Truong Son. Residential and seafood processing areas are concentrated along the coastline and in river mouths. These areas are directly affected by many storms, some with wind speeds of over 30m/s. Fishing during the storm seasons is usually dangerous for fishermen as storms and tropical depressions are happening with stronger and harder to predict intensity. The highest recorded damage was in 1995 inflicted by the 11^{th} hurricane with total of 564 vessels sunk or damaged. Heavy rain, hurricane and cyclones also affect the economics of the seaport. In June 2009, there was a level 7-8 cyclone in the vicinity of Hon La port that snapped anchor chains and capsized 10 berthed ships.

Six communes in the lowland areas of Quang Ninh district are seriously affected by flash floods: Tan Ninh, An Ninh, Hien Ninh, Xuan Ninh, Van Ninh, Duy Ninh, and Ham Ninh. These areas are surrounded by dykes therefore water cannot escape when flooding occurs. Flooding usually happens 3-4 times every year, blocking transport in the district. After each flood season, diseases like pinkeye epidemic, dengue, or diarrhea affect public health.

6.1.4. *Details of specific climate-related disaster events*

6.1.4.1. STORMS

In Quang Binh, storms normally occur from July to September causing damage to property, crops, and loss of life. Statistics from 1989 to 2008 showed that 13 major storms hit Quang Binh with an average of 0.7 storms per year. Some years have no storm, but other years may have 2 or 3 consecutive storms. The severe impact caused by storms including whirlwinds typically lasts 2-5 days with heavy rain causing serious flooding problems. The total rainfall volume contributed by storms and low pressure cyclones accounts for approximately 40-50% of the total rainfall during the rainy season.

According to observed data between 1999 and 2008, the province was attacked by 8 storms and 36 tropical low pressure cyclones (an average of about 4 storms/cyclones per year). In recent years, there has been an increase in the number of storms and the degree of dangerous levels. It appears that predictions about directions of storm tracks are often unreliable thereby creating difficulties for flood and storm protection preparations.

In November 1999, a large flood resulting from storm Eve (#9) at the end of October, resulted in 19 deaths and 79,000 houses damaged or destroyed. This event was reported under the 'storm' category.

In 2001, tropical storm Trami (#5) in mid-July and a flood caused by a tropical depression mid- October, resulted in a considerable damage to agricultural produce.

In June 2004, although not resulting in a large number of deaths or major damage to housing, storm Chanthu (#2) did cause serious damage to rice and other crops (13,500 ha).

In 2006, storms #5, and #6 caused 5 heavy floods, killing 9 people, with a total estimated economic damage of VND 111 billion.

In 2007 Storm #2 in Aug (internationally classified as a tropical depression rather than a storm) and Storm #5 (Lekima), caused heavy rain in the Gianh River Basin, leading to a historic flood of 9.47m in Mai Hoa commune. Storms #2 and #5 combined killed 25 people and injured 148 others, damaged 139,000 houses (7,692 seriously) including 270 houses that collapsed or were swept away. The storms also sank 22 ships, destroyed 560 hectares of vegetables and flooded 2,420ha of rice and other crops, as well as 51 hectares of aquaculture. In addition, 305 electricity poles, 129 bridges and culverts, 140 classrooms, 160 clinics and healthcare centers were heavily damaged. Many rubber tree plantations were devastated by powerful winds, inflicting serious damage to the rubber sector of the province. A massive amount of water inundated the lower Gianh River for an extended duration. Amongst other things this also caused the death of mangrove trees in the estuary and damaged the aquaculture sector. Total estimated economic damage was almost VND 1.4 trillion.

In September 2008, storm #7 (Higos) swept across Quang Binh with strong winds of level 9 and 10 and gusts of level 11. The storm killed 12 people and injured 46 people. 8,221 houses were damaged with lost roofs, 52 houses collapsed or wre swept away, 01.8 hectares of rice, 859 hectares of other crops, 826 hectares of industrial and fruit trees, 3,061 hectares of forest, 748 hectares of aquaculture, 28 ships, 260 classrooms, 82 healthcare facilities, 252 welfare centers, 85 community culture houses and 398 electricity poles were destroyed. The total loss was more than 167 billion VND.

In 2009, storm #9 and the floods and tornados it caused killed 4, injured 13, and knocked down 31 houses, with a total estimated economic damage of 135 billion.

In 2013 Typhoon Wutip, a category 2 typhoon hit Dong Hoi on 30 September leaving 5 dead and estimated damages over VND 4,000 billion.

6.1.4.2. FLOODS

A total of 23 flood events (an average of 3.1/year) happened in the period 1979-2010. Historically, major floods happened in 1985, 1992, 1993, 1996 and 2005. In the last 10 years, major floods have happened in 2006, 2007, 2008, 2010, and 2013 with severe impacts including loss of life, damage to property and economic losses of billions of Vietnamese Dong. Floods appear to be happening more unexpectedly, and particularly the 2007 and 2010 floods have significantly damaged summer-autumn crops and seasonal rice. Four significant and prolonged floods during the 2006-2010 period are described as follows:

- In 2006 Quang Binh was attacked by some storms and tropical low pressure cyclones, resulting in 5 floods, of which 3 reached warning levels II and III in the Gianh River, Kien Giang River and Dai Giang River. The massive rainfall had caused deep inundation over the Province. Water levels in the Gianh River were above the warning level II, and water levels in the Kien Giang River in Phan Xa Commune were measured at 13,32m, 0.32m higher than the warning level III. Total economic losses caused by these 5 floods were more than 110 billion VND In total 9 people died, 8 were injured, 13,829 houses were flooded, and 21 boats were destroyed.
- The historical flood in August 2007 was caused by a tropical low pressure cyclone with prolonged and heavy rain. This was the biggest flood recorded in the Province, whose water level exceeded the historical flood level recorded in 1993 (64cm). It was reported that 16 people were killed, 78 people were injured, 68 towns and 95,009 households were flooded (8,278 and 8,870 households were flooded under 2m and 4m, respectively); 3,655 households collapsed, were swept away, or completely destroyed; 6,002ha of rice were lost; and 122,024 poultry animals were killed. Infrastructure and business assets were severely damaged. The total loss exceeded 810 billion VND.
- In 2008, Quang Binh Province experienced three consecutive floods. The first one was from 29-30 Sep, caused by moderate to heavy rainfall, which ranged from 130mm to 375mm. The second storm occurred from 18-20 Oct, caused by heavy rain patterns throughout the Province. The third storm happened during 28-30 October with strong winds and rainfall. All the rivers in the Province were

flooded. Water levels exceeded warning level III. These storms and flooding events destroyed 19,356 houses. The total loss was more than 55.9 billion VND.

- In 2010, a historic flood happened in Oct, killing 59 people and injured 239 others, inundating 106 communes in 6 districts, washing away 419 houses and thousands of hectares of rice and crops, and killing many cattle and poultry. 35,000 houses were flooded, many to a depth of 1-2m. Total estimated economic damage to the province was over 2,734 bn. The floods drove up the water level in the Son River to a record high, causing the Centre for Eco and Social Tourism at Phong Nha Ke Bang to be submerged under 5-7m of water - all the equipment for tourism activities was destroyed and swept away, the two river banks were severely eroded, and the boat landing damaged. The strong current in the Phong Nha cave cracked some stalactites and stalagmites, and part of the cave collapsed. The tourism infrastructure at Thien Duong cave (a newly discovered cave recently opened for tourism) was similarly severely impacted, and investors suffered loses estimated to be hundreds of millions of Vietnamese dong. This disaster was recorded in the database as 'heavy rain' rather than flood.

During the rainy seasons the mountainous areas of the province such as Truong Xuan and Truong Son communes in Quang Ninh District are usually exposed to flash floods causing damage to life, crops and property. Floodig in 1992 wiped out Tan Son village in Truong Son. In the 2007 flood many villages in Truong Son were completely isolated. In addition, flooding usually occurs with serious impacts on communes along the Giang River including Van Hoa, Chau Hoa, Thanh Hoa, High Quang, and Tien Hoa. Along the river banks, severe erosion up to 50 - 70 cm p.a. can occur and families residing along the riverbank are forced to relocate.

Many transport routes have been severely eroded and damaged by floods. Routes that run through mountainous communes have been particularly affected by ferocious flash floods, including route 20 and 12A heading to the Cha Lo international border crossing; route 559 and routes leading to villages in Thuong Ha commune (Minh Hoa district). Serious landslides often happen in Da Deo pass, north of U Bo Pass, Khu Dang Pass, in Tan Ap commune (in Minh Hoa); Tan Trach (in Bo Trach); Truong Son (in Quang Ninh); as well as in Lang Cat and Lang Ho (in Le Thuy). In the rainy season of 2010 alone, the Ho Chi Minh Road experienced serious landslides at 10 different places blocking transport in the mountainous areas, while in lower lying areas the Ho Chi Minh Road and National Road 1A had sections which were inundated to a level of over 1 meter for several kilometers along their length.

There are 172km of railway lines and 19 stations in Quang Binh, including the main one at Dong Hoi. Due to harsh weather conditions, many railroad sections running through Quang Binh are already in a degraded condition. Every year, the system of waterway transportation also suffers damage in the flooding season. Many ferries, boats and vessels have been swept away. When road traffic is cut off in many areas, residents must use small and often unsafe boats to travel around. Nearly every year during the flood season, there are accidents with boats capsizing and human casualties.

Flood events not only cause huge life and property damages, but also serious environmental pollution in inundated areas with serious public health consequences. Faeces, garbage, waste water, effluents from livestock pens, dead bodies of some animals, and industrial wastes may all end up in the flood waters. Trees and crops also die killed from prolonged immersion in water According to reports from the Steering Committee for Storm and Flood Prevention of Quang Binh, 108,472 household wells were submerged during the 2010 flood season, including 32,000 in Quang Trach, 27,500 in Le Thuy, 16,500 in Quang Ninh, 15,977 in Bo Trach, 8,977 in Tuyen Hoa, 3,939 in Dong Hoi city, and 3,579 in Minh Hoa. Wells were polluted with microbial organisms, causing subsequent health problems.

6.1.4.3. SEA LEVEL RISE, COASTAL EROSION AND SALINIZATION

Historically sea level has been rising at an average rate of about 3mm/year over the last two decades. Several parts of the coastline are already severely eroded. For example in parts of Nhan Trach commune in Bo Trach District, the sea encroaches 30-40cm every year causing many houses to crack and collapse. Many hectares of crops and home gardens have been lost and residents have had to migrate further inland.

Rising tides in conjunction with the North East monsoon push salt water further up rivers and into the mainland. Saline water can seep under the bases of dykes and into agricultural fields.

In-field salinization of Quang Binh's coastal plains is already a problem. Increased salinity has damaged agricultural production. Saltwater causes productivity to drop significantly, especially for the Winter-Spring crops.

6.1.4.4. EXTREME COLD

Cold weather typically occurs from late January to the end of February. In 2008, cold weather winds decreased temperature to a very low level over the entire province. This prolonged and extreme cold weather event caused serious damages to livestock, killing 1,742 buffalos, 3,037 cows and 1,334 goats. Temperature reduction in recent winters and springs has led to to severe frosts which have harmed local rice varieties (mainly HT6, HT1, SH2, TBR1, hybrid rice).

6.1.4.5. WHIRLWINDS, TORNADOS AND BLOWING SAND

Whirlwinds often occur during the transition period between dry and wet season (March-April). For instance, on March 18, 2008, a whirlwind occurred in Kim Hoa and Le Hoa communes, in Tuyen Hoa district, with gusts above level 8. The whirlwind was accompanied with hail, which had a diameter of 1.0 to 2.0 cm, and damaged 9 classrooms, 131 houses and 15 hectares of maize. Tornados often blow the roofs off houses in Duy Ninh and Hien Ninh communes, also damaging rice and other crops. Tornados and thunderstorms have been more unpredictable in recent years.

Vo Ninh and Gia Ninh communes in Quang Ninh district are seriously affected by blowing sand. So is Hai Ninh Commune, with over 100ha of coastal sand dunes without windbreak trees, causing serious problems affecting many residents in coastal villages including Tan Hai, Tan Dinh and Xuan Hai. During storm seasons, yards and gardens and even houses are covered with sand. Many families have to evacuate or relocate themselves, but some 100 households are still living with blowing sand and flowing sand. Many roads connecting villages are covered by sand, restricting accessibility.

In Hong Thuy, Thanh Thuy, Cam Thuy, Hung Thuy, Sen Thuy communes of Le Thuy district near National Road 1A, rain with even relatively light intensity can already fill streams with water and cause sand to flow at high speed and cover arable land. It is estimated that each commune loses 2 ha p.a. on average. The three coastal communes of Ngu Thuy Bac, Ngu Thuy Trung and Nguy Thuy Nam are less affected. As a result of the 2010 flood in Le Thuy, many areas suffered sand deposited up to 1.5m high, and people had to abandon their fields which were no longer arable. Many parts of concrete roads along the coastline were cracked and damaged by these unexpected streams. Coastal residents were also caught by surprise by the formation of streams on sand dunes and suffered significant damage when floods occurred.

6.1.4.6. DROUGHT AND HOT DRY WINDS (LAOS WIND)

Some 30-40 communes in Quang Binh are regularly affected by drought and water shortages. In addition, Quang Binh is also impacted by hot dry winds, the so-called “Laos wind”, that occurs from January to August, but mainly from Apr to Jul. The hot wind accelerates the evaporation rate and reduces both humidity and soil moisture, adding to the severity of any drought and water shortages.

In 1998, 2002, 2003 and again in 2005, low rainfall and hot dry winds limited the water supply available for domestic uses and irrigation. The water level in many reservoirs such as Phu Vinh, An Ma, Tien Lang, Cam Ly, Vuc Sanh, Dong Ran, and Be, was very low due to a combination of reduced rainfall inflow and increased evaporation, and was unable to supply irrigation needs. Additionally, saltwater intrusion deepened the problems during the drought period, intensifying the damage to agricultural production.

The 1998 drought was the most severe in 30 years. 312,000 people (38.8% of the provincial population) in 65 out of 148 communes had restricted use of clean water. This drought severely affected 25,600ha of rice during the winter-spring season. It was estimated 9,700ha of rice, 436 hectares of sugarcane, 280ha of rubber trees, and many hectares of coffee plants were destroyed. Many parts of Kien Giang River dried out. Approximately 150 meters of the river bank were severely eroded, and many houses and roads were destroyed, resulting in a total loss of about 193 billion VND.

In 2003, the drought diminished production yield by 18,547 tons of rice, 270 tons of green beans, and 12,960 tons of sugarcane. The total losses exceeded 32 billion VND.

In 2005, water levels in reservoirs declined so severely there was not enough water for production, leading to serious crop failure and damages: 3,745ha of rice and 1,048ha of other crops were lost, while an additional 5,064ha suffered yields reduced by at least 30%. Total damages were VND 58bn.

Water supply facilities are still scarce scene in mountainous areas. Tuyen Hoa and Minh Hoa are the two mountainous districts most seriously affected by droughts. During severe dry seasons, irrigation facilities can sometimes be left with no water. In 2010, by June, none of the reservoirs in Minh Hoa could be used for irrigation. Minh Hoa district had 50 out of 460ha of paddy fields and 100 and of 844ha of maize fields of the winter-spring crop completely destroyed due to drought and insects, mostly in Dong Hoa, Yen Hoa, and Trong Hoa. Drought decreased the productivity of the remaining winter-spring crop by about 15-20%. Tuyen Hoa also suffered from serious water shortage causing tremendous hardship to farmers.

In Quang Trach District 4,800 out of 5,550ha of cultivated land of summer-autumn crops was left without sufficient water, and Quang Ninh completely lost 60ha of maize and a large area of paddy fields due to early drought. Land was cracked dry and abandoned as it was no longer arable. Similar situations happened in many places in Bo Trach, Nam Thien and Le Thuy. In all, housands of hectares of the summer - autumn crops were lost. The Gianh River, the biggest and deepest river in Quang Binh, ran dry, exposing its riverbed.

In Minh Hoa the when the drought was followed by sudden rains Rice leaf folder and Sheath Blight outbreaks appeared in many places such as Quy Dat, Hoa Hop, Quy Hoa, Xuan Hoa, Yen Hoa, which prevented large areas of rice in the flowering stage from generating grains.

6.1.5. Summary and Conclusion

Storms (45%) together with heavy rains and floods (32%) are the most frequent sources of climate-related disaster events in Quang Binh. Storms, heavy rains and floods together account for 90% of all fatalities associated with disasters, most of the damage to housing and agricultural fields, and a high proportion of the economic losses caused by disasters.

The central and southern parts of the province are more heavily affected by disasters than the northern parts. Le Thuy District has the highest number of recorded disaster events overall, and also suffers the most damage to housing. Hong Thuy, Thanh Thuy, Cam Thuy, Hung Thuy, Sen Thuy communes of Le Thuy district also suffer from blowing and flowing sand that degrades agricultural land. Bo Trach has the most deaths caused by disasters and the most damage to agricultural fields overall. Quang Ninh and Quang Trach are the third and fourth most heavily impacted districts. Agricultural production in Le Thuy, Bo Trach, Quang Ninh and Quang Trach has all also been significantly impacted by droughts.

The least affected areas in terms of total damages and loss of life are Dong Hoi city, followed by Minh Hoa and Tuyen Hoa, the two mountainous and least populated districts of the province, (explaining the smaller impact on housing and agricultural production). However, Tuyen Hoa district has the third largest number of deaths in the province, occurring mainly during Storm Lekima in October 2007 and the historical floods of October 2010. Tuyen Hoa and Minh Hoa are also affected by droughts, and Kim Hoa and Le Hoa communes in Tuyen Hoa have been severely impacted by whirlwinds and hail storms.

The time series of comparable data available is not yet sufficient to conduct robust statistical analysis, to suggest whether or not the number of disaster events and their intensity are showing clear trends. What clearly stands out however, is that the recorded total economic damage caused by disasters has increased dramatically over a 25-year period (see Table 6.5, below). Again it is not possible to say definitively how much of this increase in recorded losses is due to actual increases in damage caused by disasters; how much is due to higher monetary values being assigned to each instance of damage; and how much is due to improved data collection and reporting about damages.

Table 6.5: Summary of climate-related disaster information 1989-2013

Time Period	Total # disasters recorded	Loss of Life	Total Economic damage
1989-1993	N/A	72	214 billion VND
1994-1998	N/A	77	150 billion VND
1999-2003	47	58	166 billion VND
2004-2008	40	66	1.9 trillion VND
3009-2013	34 (2009 +2010 data only)	68	6.7 trillion VND (2009, 2010, 2013 data only)

Source: Compiled from information from Quang Binh Department of irrigations, Flood and Storm Control, and UNDP 2012

In conclusion, highest priority should be given to ecosystem-based disaster risk reduction and ecosystem-based climate change adaptation in Bo Trach, Le Thuy, Quang Ninh and Quang Trach; followed by Truong Xuan, Truong Son, Tuyen Hoa, and Minh Hoa. The primary emphasis should be on addressing impacts of storms and floods on human life, housing and agricultural fields. A secondary emphasis should be on addressing impacts of drought, and of blowing and flowing sand in affected lowland communes.

6.2 REFERENCE

Asian Development Bank (2014) *Urban Environment and Climate Change Adaptation Project IE131001410-06-RP-103C*

Barbier EB, Hacker SD, Kennedy C, Koch EW, Stier AC, Sillman BR (2011) The value of estuarine and coastal ecosystem services. *Ecological Monographs*, 81, 169–193.

Central Committee for Flood and Storm Control (CCFSC) under the Ministry of Agriculture and Rural Development (MARD)

Kha, L.D. 2001 Studies on the use of natural hybrids between *Acacia mangium* and *Acacia auriculiformis*, Vietnam. Agricultural Publishing House, Hanoi, Vietnam.

Kha, L.D. 2006 Role of *Acacia* hybrids in the reforestation programme in Vietnam. Research Centre for Forest Tree Improvement, Forest Science Institute of Vietnam, Hanoi, Vietnam.

Lima FP, Wethey DS (2012) Three decades of high-resolution coastal sea surface temperatures reveal more than warming. *Nature Communications*, 3, 704.

Matthews, R. B., Kropff, M. J., Horie, T. & Bachelet, D. (1997) *Agric. Syst.* 54, 399-425.

MONRE (2012) *Climate Change and Sea Level Rise Scenarios for Vietnam*. MONRE, Hanoi.

Nguyen et al. (2013): Meteorological and hydrological regime of Quang Binh. Science and Technics Publishing House.

Nguyen, T.T., Coulier, M., Nhu, O.L., Wilderspin, I (2012) *A preliminary analysis of disaster and poverty data in Quang Binh Province,* Vietnam, UNDP.

Poloczanska ES, Brown CJ, Sydeman WJ, et al. (2013) Global imprint of climate change on marine life. *Nature Climate Change*, 3, 1–7.

Quang Binh Province's action plan in response to climate change and sea level rise for 2011-2015 and orientation towards 2020

Southern Natural Resources and Environment Company (2010*), Action plan in response to climate change in Quang Binh Province in 2011-2015, and vision to 2020.*

Thang, T.N., and Duong, D.T., *Evaluation of the drought and high temperature tolerance of Acacia crassicarpa varieties in the central coastal region, Vietnam*. Undated/unpublished report

UNDP (2009) *Risk knowledge fundamentals: Guidelines and lessons for establishing and institutionalizing disaster loss databases*, United Nations Development Programme, Regional Centre, Bangkok, Thailand.

Vozzo, J.A. 2002 Tropical tree seed manual, USDA Forest Service Agriculture Handbook 721. Washington D.C. p. 899.

CHAPTER 7 EXPECTED CLIMATE CHANGE IMPACTS ON QUANG BINH

7.1 INTRODUCTION

While Chapter 6 provided an overview of the climate of Quang Binh and the history of climate-related disasters in the province, this chapter now looks at likely future climate changes and their potential impact on Quang Binh at the province-wide level. It starts off by firstly explaining the rationale for focusing on a certain set of parameters as measures of climate change, when looking at it from a vulnerability assessment and ecosystem-based adaptation perspective, and then presents possible scenarios for Quang Binh. The bulk of the chapter discusses the likely impacts and implications of those changes, with a main focus on the natural resource related sector of agriculture, forestry, fisheries and aquaculture, as well as on the natural ecosystems that are the source of important ecosystem services. More superficial treatment is generally given to climate change impacts on urban and rural settlements and infrastructure. The original scenario-related work undertaken by the project team is provided as Annex I and Annex II.

The chapter draws heavily from 4 key publications:

- Asian Development Bank (2014) *Urban Environment and Climate Change Adaptation Project IE131001410-06-RP-103C;*
- MONRE (2012) *Climate Change and Sea Level Rise Scenarios for Vietnam*. MONRE, Hanoi;
- Nguyen, T.T., Coulier, M., Nhu, O.L., Wilderspin, I (2012) *A preliminary analysis of disaster and poverty data in Quang Binh Province*, Vietnam, UNDP;
- Southern Natural Resources and Environment Company (2010), *Action plan in response to climate change in Quang Binh Province in 2011-2015, and vision to 2020*.

as well as a number of other important references, and adds the original work and analysis of the vulnerability assessment team to this.

7.1.1. Selection of Climate Change Parameters for Quang Binh

Vietnam is likely to be one of the several countries most adversely affected by climate change. During the last 50 years, Vietnam's annual average surface temperature has increased by approximately 0.5 to 0.7°C, while the sea level along the coastline has risen by approximately 20cm. Climate change has resulted in more severe and/or frequent occurrences of natural disasters, especially cyclonic storms, floods and droughts becoming more extreme (ADB, 2014). Due to climate change, the intensity and geographical scope of the multiple hazards hazards Quang Binh is already facing (described in detail above) will increase (UNDP, 2009).

Overall climate is expected to change and to become more variable, in a number of different ways. In the dry season, there will be less rainfall and longer periods of time without any rain. Maximum and average temperatures will increase and the number of very hot days will also increase. During the hot dry period, night-time temperatures will not cool down as much as they used to. Conversely during the cold season, intense cold spells may also increase.

In the rainy season, rainfall will increase overall but will be concentrated in a shorter period. There will be more days with very heavy rain. Storms will be more unpredictable, and may happen more often and with greater intensity. Sea level rise will continue to increase.

There are a large number of different parameters that can be used to measure different aspects of climate variability and climate change. For example, considering only one factor - temperature, one could consider:

- Changes in annual mean temperature
- Changes in annual mean maximum temperature
- Changes in annual mean minimum temperature
- Changes in annual mean day-time temperature
- Changes in annual maximum and minimum day-time temperature
- Changes in annual mean night-time temperature
- Changes in annual maximum and minimum night-time temperature
- Changes in number of very hot days
- Changes in number of very cold days

A similarly large number of possibilities exist when we look at precipitation. In addition, all of the above parameters could also be measured as changes on a month by month, or a seasonal basis. Give this vast range of possibilities, it is necessary to pick a few parameters that are important and relevant to our objectives - conducting a vulnerability assessment to identify Ecosystem-based Adaptation (EbA) options - and for which we have the capacity to assess changes and interpret the likely consequences of those changes.

When looking at the species of plants and animals that make up natural ecosystems, we can think in terms of "comfort zones" - the range of climate conditions to which each species is best suited, and in which they will thrive. Similarly, with agricultural crops and tree plantations of both native and exotic species, there are climate conditions that are most appropriate to growing each of these species. In this context, measures of average annual changes in temperature and rainfall are not so useful. They tend to even out changes in different directions that happen in different seasons, and don't lead to any real understanding of how living things will be affected.

Changes in extremes and the duration of time over which those extremes persist are more informative, as they may relate to thresholds beyond which agricultural and plantation forestry productivity may be affected, and key species in natural ecosystems may be impacted. For example, in coral reefs, if sea water temperature exceeds a certain threshold, the symbiotic algae in the coral polyps start to produce more toxic by-products. To protect themselves, coral polyps then expel the algae. If the high temperature only lasts for a few days, the algae can return, and the coral can recover. However, if the elevated water temperature persists for a longer period, the algae do not return and such a long-term coral bleaching event can lead to mass mortality of the corals.

Similarly, considering growing of rice and other crops, it is generally understood that higher levels of atmospheric carbon dioxide should stimulate more efficient photosynthesis, leading to increased plant growth. However, theoretical, experimental and real world studies have shown that increased carbon dioxide concentration, combined with increased temperature actually reduces rice yield.

Simulated yield potential in the major rice-growing regions of Asia with present atmospheric CO2 concentration decreased by 7% for every 1°C rise above current mean temperature (Mathews et al 1997). Nevertheless, it is unlikely that rice plants are responding to mean temperature. Further research using actual real world rice yields and temperature records from the International Rice Research Institute (IRRI) in the Philippines over a 23 year period from 1979 to 2002 has showed that the strongest correlation was between increasing night time temperature during the growing season, and reduced rice grain yield. It appears that plants are indeed producing more in the day time as photosynthesis is indeed increased. However, they are also burning up more energy at night time as respiration is also increased with higher temperature. The extra photosynthesis in the day time may produce less than the extra respiration burns up during the night, with the net result of lower yield (Peng et.al 2004). Similar negative effects of increased night temperature on grain yield have also been reported for maize, wheat, and soybeans (Peters et.al. 1971).

Considering the above types of issues, the project selected the following climate change-related parameters to focus on:

Table 7.1: Important climate change parameters

Factor	Type of Change	Rationale/importance
Temperature	Hot season hotter and longer	Reduced soil moisture and increased evaporation, can cause crop wilting and increased risk of agricultural drought. Forest fire risk may be increased. Frequency of some pest and disease outbreaks may increase
	# days > 35°C increasing	Heat stress impacts on humans, crops, and livestock as well as wild species. Forest fire risk may be increased
	Temperature increasing faster and earlier in Spring	May cause changes in phenology of crops and wild plant species, and changes in timing of life-cycle stages of wild insect, animal and bird species
Precipitation	Dry season drier, more dry days	Both hydrological and agricultural drought risk increased, significant issue for crop production.
	More rainfall in rainy season	Waterlogging may reduce productivity of certain crops and trees. Inundation of lowlands may be more common; infrastructure may be damaged. Reservoir capacity may be exceeded with a danger of dam failure
	# days >50mm rain increasing	Increases chance of destructive flash floods, erosion and landslides
Storms	Storms with increasing speed(intensity)/stronger winds	Significant physical damage to crops, infrastructure, property and life, huge economic cost
	Storms more unpredictable and happening at different times	More difficult to plan response, and e.g. to adjust cropping calendar to avoid storm damage
Sea Level Rise	3mm/year in last 20 years, 1m rise predicted by year 2100	Erosion, submergence of coastal land and saline intrusion

The selected parameters combine those that are highly relevant to existing climate-related disasters in Quang BInh - particularly storms and rainfall changes (relating to both floods and droughts), as well as sea-level rise that is likely to become of increasing concern as time goes by.

7.1.2. Climate Change Scenarios

The climate change and sea level rise scenarios developed and published for Vietnam in 2009 were based on the low (B1), medium (B2) and high (A2, A1Fi) scenarios. The average B2 scenario was recommended for all Ministries, sectors and localities to initially assess the impact of climate change and sea level rise and to build action plans to respond to climate change. Scenarios were updated and developed for each province in 2012. (MONRE, 2012). The below description of the scenarios for temperature and rainfall changes as well as sea level rise, are all taken from MONRE, 2012.

Scenarios for temperature change

Low emission scenario (B1): by the end of the 21st century, annual mean temperature in most of areas of Vietnam north of Hua Thien - Hue (Including Quang Binh) would increase by 1.6 to 2.2°C relative to the baseline period (1980 - 1999).

Medium emission scenarios (B2): by the middle of the 21st century, areas from Ha Tinh to Quang Tri, including Quang Binh would increase by 1.6 to 1.8°C. By the end of the century temperatures in areas from Ha Tinh to Quang Tri, including Quang Binh are forecasted to increase by 3.1 to 3.3°C. In addition, the number of days with maximum temperature higher than 35°C would increase by about 15 to 30 days.

High emission scenario (A2): by the end of the century, annual mean temperature in most of the country would increase by between 2.5 to more than 3.7°C.

Scenarios for rainfall change

Rainfall in the dry season is expected to decrease in most regions of Vietnam, particularly in the southern region. Rainfall during the rainy season and the total annual rainfall are forecasted to increase in all zones.

Low emission scenario (B1): By the end of the 21st century, annual rainfall would increase in most of the country by about 6% relatively to the reference period 1980-1999. In the Central Highlands, the increase could be lower, less than 2%.

Medium emission scenarios (B2): By the end of the century, annual rainfall would increase by about 2 to 7% in most of the country. In general, the dry season rainfall would decrease and rainy season rainfall would increase. Maximum daily rainfall would increase in the North Central zones (including in Quang Binh). Extraordinary daily rainfall may occur anywhere with rainfall about 2 times higher than present maximum daily rainfall.

High emission scenario (A2): By the end of the century, annual rainfall would increase by about 2 to 10 % in most of the country.

Scenarios for sea level rise

Low emission scenario (B1): By the end of 21st century, average sea level rise in most of the coastal zones of Vietnam is anticipated to be about 49 to 64cm.

Medium emission scenarios (B2): By the end of the century, in Quang Binh, the rise is forecasted to be 60 to 71cm.

High emission scenario (A2): the sea level will rise by 100cm.

According to reports on the implementation of CCA plan in Quang Binh in the period of 2000 - 2015, the weather situation has been more complicated and extreme weather phenomena have been happening more frequently. Reported climate trends in Quang Binh are presented in Table 7.2. And predicted impacts of these continued climate changes are shown in Table 7.3.

Table 7.2: Trends in climate factors

Climate Trend	Trend
Irregular Rainfall in Rainy season	↗
Annual rainfall	↘
Average annual temperature	↗
Heat waves/ hot-dry days	↑
Meteorological Droughts	↗
Cold spells	↗
Tropical hurricanes/ depressions	↗
Unusual strong wind (cyclone)	↗
Lightning	→

↗ Increasing
↑ Highly increasing
↘ Decreasing
↓ Highly decreasing
→ Unchanged

Table 7.3: Trends in climate-related impacts

Climate Trend	Trend
Upstream floods/ flash flood	↑
River bank erosion and landslides	↑
Downstream widespread inundation	↑
Sedimentation of reservoirs and river mouths	↗
Agricultural Droughts	↗
Water Shortages for domestic and industrial use	↗
Forest fires caused by hot dry weather	↗
Loss of forests and agricultural land by sea level rise	↗
Increasing salinization of coastal plains	↗
Storm damage to infrastructure	↑

↗ Increasing
↑ Highly increasing
↘ Decreasing
↓ Highly decreasing
→ Unchanged

The Vulnerability Assessment team used the official IMHEN/MONRE data used in generating the official 2012 scenarios and produced more detailed maps of the expected changes for Quang Binh (and Ha Tinh) provinces. These changes and their likely implications are discussed in the different sections below. Full details are provided in Annex 7.I.

7.1.3. Likely Climate Change Impacts for Quang Binh

7.1.3.1. IMPACTS OF STORMS

Under climate change projections, the intensity and frequency of storms is expected to change and storms may become more unpredictable. In Quang Binh, storms normally occur from July to September every year. However, in recent years, it seems storms have already started to become more unpredictable and have happened even in March and April, or alternatively in October. Storm intensity has apparently also increased. With increased frequency, intensity and unpredictability, the damages caused by storms are likely to increase with climate change.

7.1.3.1.1. Impacts on Agriculture Forestry and Fisheries

Storms may cause direct physical damage to aquaculture operations in the coastal areas and to crop fields especially in the lowland plains. Strong winds associated with severe storms that penetrate further inland can also cause physical damage to rubber plantations, snapping or uprooting trees, but are still less of a threat to acacia plantations even further inland and at higher elevations.

Increasing storms (and other strong winds) will cause sand blows to occur more frequently and more severely in areas along the coast in two districts - Quang Ninh and Le Thuy, increasingly affecting daily life and agricultural production of local residents. Although there are extensive dune systems in these areas, their natural vegetation cover has been removed. The sparse coverage of casuarina coastal protection plantation forests are incapable of sufficiently protecting the area from wind and blowing sand. Casuarinas nearer to the sea are exposed to strong wind and sea waves and are left with bare roots. Further inland many have a creeping form rather than growing as an upright tree. With climate change, increasingly stronger winds will blow more sand into houses and fields will also be increasingly covered with sand. The effort required to dig up the sand to reclaim arable land area after the storm season will increase over time with climate change.

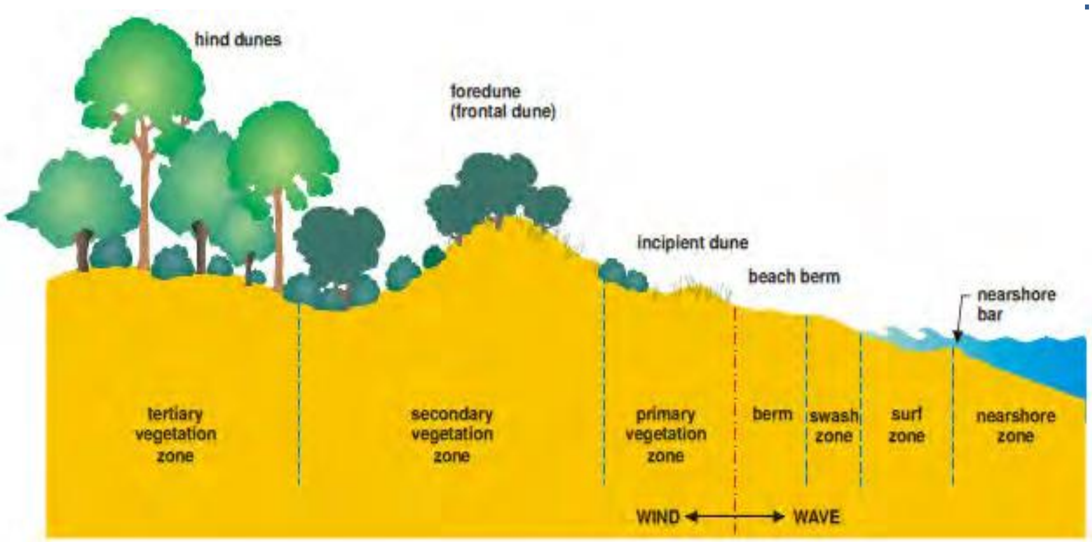
7.1.3.1.2. Impacts on natural ecosystems

Storms create highly turbid conditions which limit light availability for sea-grasses and have caused declines of sea-grass populations in other tropical regions (Shaffelke et al., 2005; Waycott et al., 2007). Sea-grasses are particularly vulnerable to these changes and physical disturbance to sea-grasses resulting from sediment movement (erosion and deposition), turbulent water motion and storm surges (Waycott et al., 2007). Flooding associated with severe storm also reduces salinity and increases turbidity, creating difficult and often fatal conditions for sea-grasses to grow in (Waycott et al., 2007).

Coral reefs are also impacted by turbid conditions reducing sunlight penetration. They can also suffer physical damage from very strong storm surges, but are not as sensitive to this as sea-grass. Mangrove trees can also be physically damaged by strong storms.

More than half of the reported climate impacts on natural ecosystems synthesized by Poloczanska et al. (2013) came from coastal systems. However, sandy beach systems have largely been overlooked in studies of the ecological (and socio-economic) impacts of climate change (Dugan et al., 2010; Barbier et al., 2011, Schoeman et. al., 2014). A typical beach system is depicted in Figure 7.1.

Figure 7.1: A typical beach dune systems



Source: Coastal Dune Management. Land & Water Conservation Department. NSW. 2001

Coastal dunes are accumulations of wind-blown sand located behind the beach. Typically, an undisturbed beach will be backed by a fore-dune (also known as a frontal dune) and hind dunes. Vegetation cover is a crucial element of dune landscapes. Wind velocity is generally reduced by plant cover, encouraging deposition and trapping of wind borne sand. The presence of a stable dune system provides a natural defense mechanism against coastal storm hazards. However, in much of the coastal dune systems of Le Thuy and Quang Ninh Districts, natural vegetation has been extensively removed or degraded. Despite ongoing efforts to stabilize the dunes through planting of casuarina and acacia, the problem of blowing sand that impacts infrastructure and settlements inland of the dunes is likely to continue and may get worse with climate change.

Changes in storm intensity and frequency are likely to have less significant impacts on inland ecosystems, especially those at higher elevation.

7.1.3.1.3. Impacts on Urban and rural settlements and infrastructure

As identified in the previous chapter, the greatest impact of storms is in the coastal and lowland areas of central and southern Quang Binh. As identified in Chapter 2, this is also where most of the population is concentrated, and as identified in Chapter 4, it is also where much of the infrastructure supporting the economy is located. All types of natural coastal ecosystems - including coral reefs, sea-grass beds, mangrove forests and sand dune ecosystems provide some degree of physical protection against storms, and the erosive forces of high tides and storm surges.

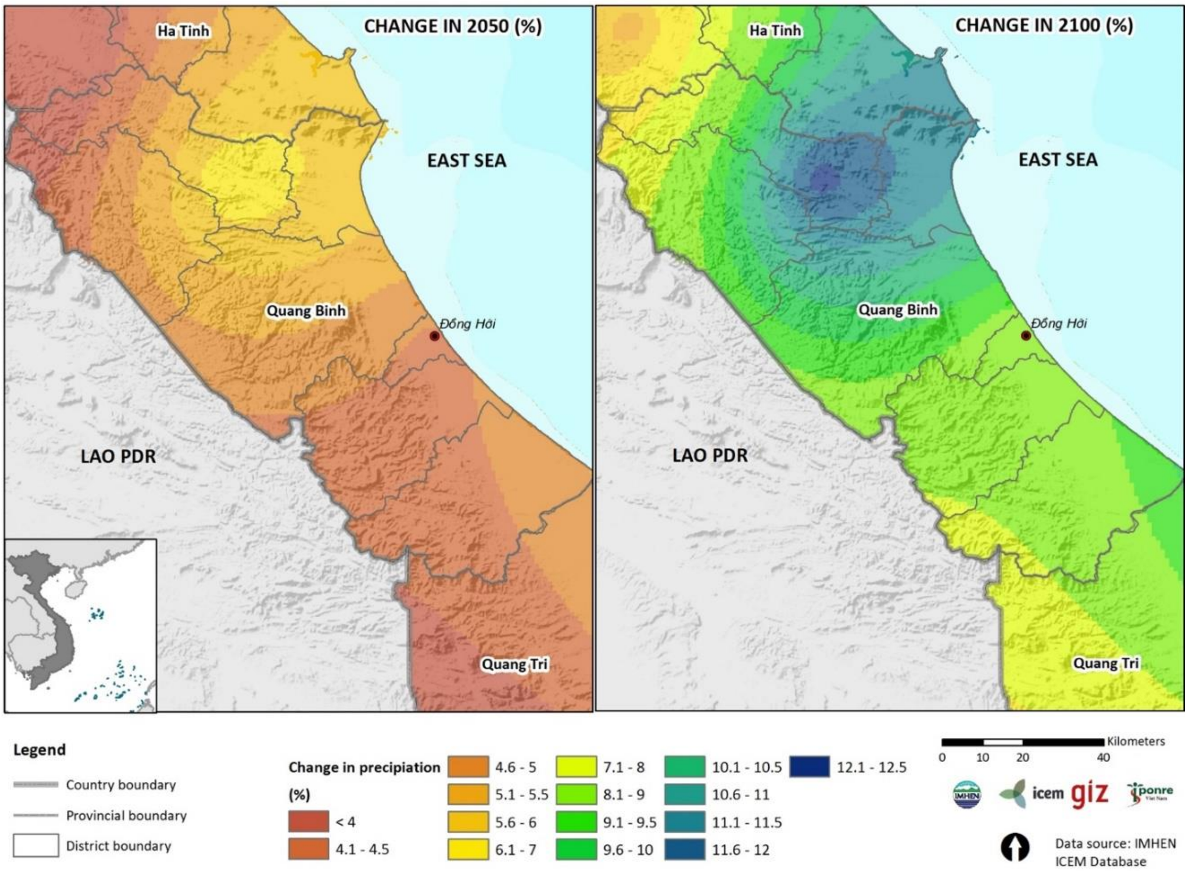
At the moment there is no information on coral reefs and sea-grass in Quang Binh on which to base a discussion of their role in protecting coastal infrastructure. The remaining areas of mangroves are also rather limited and degraded and will only provide very localized protection in some small areas. Sandy shorelines make up the largest proportion of coastal central and southern Quang Binh that is the most affected by storms. On these sandy shorelines, coastal dunes represent the last line of defense against erosion as well as limiting the landward intrusion of waves, oceanic inundations and wind and salt spray associated with storms. Where there is an inadequate dune, properties and facilities near the back of the beach may be subject to inundation from the ocean, and to structural damage from wave attack, undermining by foreshore erosion, and to sand drift, which is already a major problem in Le Thuy District and other places.

Climate change may increasingly create abnormal and hard to predict storm conditions which will affect passenger and cargo flights through Quang Binh province, increasing the flight operating cost and creating impacts on flight safety.

7.1.3.2. IMPACT OF ADDITIONAL AND MORE INTENSE RAINFALL IN THE RAINY SEASON, AND MORE DAYS WITH >50MM RAINFALL

With the changes in weather in the future, overall rainfall will increase in the rainy season and will be more intensely concentrated in a shorter period, with the number of heavy rainfall days also increasing. By 2050 there may be 4-8% more rain in the period of June-August and by 2100 this could rise to 10-12%. The increase will not be evenly distributed across the province (see Figure 7.2).

Map 7.1: Changes in precipitation (June-August) in Quang Binh 2050 and 2100



7.1.3.3. IMPACTS ON AGRICULTURE, FORESTRY AND FISHERIES

Periods of prolonged drought followed by sudden heavy rainfall are already a commonly experienced weather pattern in Quang Binh. The resulting sudden influx of rainwater into estuaries can cause a sudden drop in salinity with severe impacts on the brackish and salt water aquaculture sector of the province as shrimps and other aquatic species cannot tolerate the sudden shock, which can cause mass die-offs. This pattern is normally more pronounced when an El Nino period is rapidly followed by a La Nina period, and there have been suggestions that the El Nino-La Nina cycle may happen more frequently even more intensely under climate change scenarios.

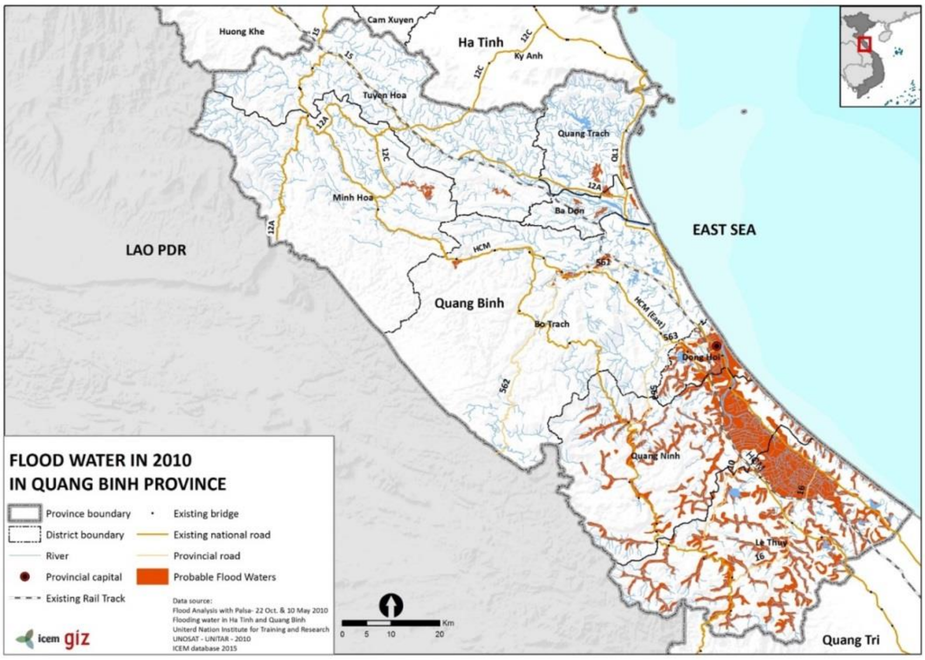
Some drought-stressed crops then exposed to sudden large amounts of rain that leads to rapid growth have a tendency to accumulate hydrogen cyanide (or prussic acid). This can be particularly true for cassava and also for maize, and can be very harmful to people. Cases of people dying after consuming cassava with high levels of prussic acid have been reported from Kenya and the Philippines (UNEP, 2016).

Aflotoxins, molds that can affect plant crops and can cause liver damage and blindness in humans, are also spreading to more areas as climate changes causes these kinds of shifts in weather patterns (UNEP 2016).

Heavy rains can cause devastating flooding of late-summer rice as it is approaching harvest time.

Acacia plantations cover large area of Quang Binh. Short term harvesting cycles (as well as conversion of natural forest to plantations or agriculture, together with illegal logging), contributes more rapid run-off and greater erosion in sloping upland areas, causing flash-flooding in upland areas to happen even more rapidly and more frequently, and shallow landslides to become even worse as watershed forests do not have enough trees to retain soil and slow down run-off. In the 2010 floods, the volume of soil and dirt swept away reached 1,689,000m^3. Without changes to plantation management practices, we could see even larger amounts being swept away by heavier rains in the future.

Map 7.2: Partial mapping of 2010 floods



7.1.3.3.1. *Impacts on natural ecosystems*

The natural terrestrial forest of Quang Binh are moist evergreen formations. Additional heavy rainfall in the rainy season is not likely to have a major impact - especially when the forest is over limestone areas where the water drains very quickly. In some low-lying areas some species may not tolerate extended waterlogging, and may slightly shift their preferred area, but this will not have a noticeable effect on the forest as a whole.

Extensive long-duration floods can cause death of mangrove trees if they are submerged for too long. The remaining mangrove areas are very small, so this could be a significant impact on the remaining mangroves.

Heavy rainfall causes increased inflow of freshwater into estuaries changing the salinity profile which will change distribution of brackish water species. But this will most likely only be a temporary change each time a heavy rainfall event occurs.

7.1.3.3.2. *Impact on rural and urban settlements and infrastructure*

The topography of Quang Binh means that flash floods in upland areas and widespread inundation in lower lying areas, with all the associated impacts that go along with these, will also be increased with heavier rains resulting from climate change. Areas expected to suffer from flash floods and floods are listed in Box 1.

Text box 1: Areas suffering from heavy rainfall and flash floods

According to Quang Binh's Climate Change response and Action Plan 2011-2015, the residential areas and infrastructure in rural areas will continue to suffer from heavy rainfall and flash floods, particularly Tan Hoa, Hoa Tien, and Yen Hoa (Minh Hoa district); Van Hoa, Tien Hoa, Mai Hoa, Chau Hoa, Duc Hoa, Thach Hoa, Phong Hoa, Dong Hoa, Thuan Hoa, and Kim Hoa commune (Tuyen Hoa district); communes near the Gianh River in Quang Trach district (Quang Tien, Quang Trung, Quang Hoa, Quang Loc, Quang Van, Quang Hai, Quang Tân, Quang Thuy, Quang Minh, Quang Son, Canh Hoa, Phu Hoa); Bo Trach district (Son Trach, Hung Trach, Lien Trach communes); Dong Hoi City (Duc Ninh Dong district, Duc Ninh commune); Quang Ninh district (Tan Ninh, Hien Ninh, Duy Ninh, and Ham Ninh commune) as well as central communes in Le Thuy district.

In addition, Thuong Hoa, Trong Hoa, Minh Hoa, and Hoa Hop communes (Minh Hoa district); Kim Hoa, Thach Hoa, Duc Hoa, Phong Hoa, Chau Hoa, and Van Hoa communes (Tuyen Hoa district); Canh Hoa, Phu Hoa, Quang and Hop communes (Quang Trach district); Phuc Trach, Son Trach, and Hung Trach communes (Bo Trach district); Truong Son and Truong Xuan communes (Quang Ninh district) and Lam Thuy, Kim Thuy, and Truong Thuy commune (Le Thuy district) will have increasingly high risks of flash foods.

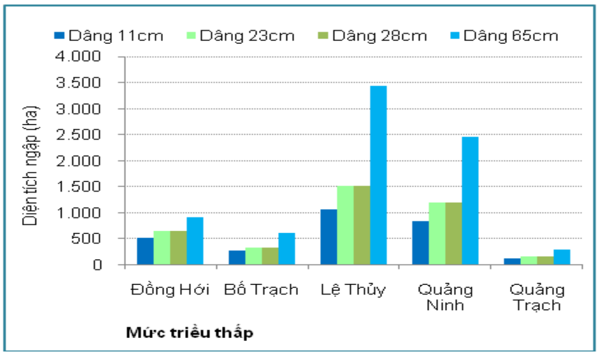
Quang Binh has over 140 reservoirs of various sizes. With increasingly concentrated rainfall in the rainy season, many may not be able to store the full volume of water flowing into them and may be at risk of failure. This could be the case for Vuc Tron, and Tien Lang reservoirs (QuangTrach), Cam Ly and An Ma (Le Thuy), Be (Tuyen Hoa), Vuc Noi and Da Mai (Bo Trach), Phu Vinh (Dong Hoi city), posing significant threats to areas downstream of these reservoirs.

Increased heavy rainfall will threaten to damage many parts of the railway line running through Nam Ly district, Duc Ninh commune (Dong Hoi city), and Mai Thuy commune (Le Thuy district) are at risk of flooding. Landslide risks on roads in mountainous areas will also be increased.

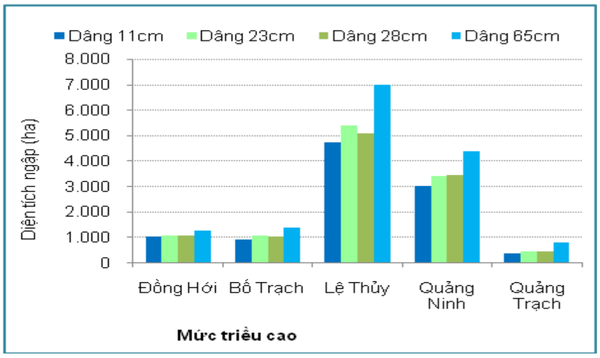
7.1.3.4. IMPACTS OF SEA LEVEL RISE, SALINIZATION AND COASTAL EROSION

According to different climate change and sea level rise scenarios for Quang Binh, inundated areas will evolve as follows during 2020-2100:

Graph 7.1: Inundation caused by sea level rise in Quang Binh - scenario B1

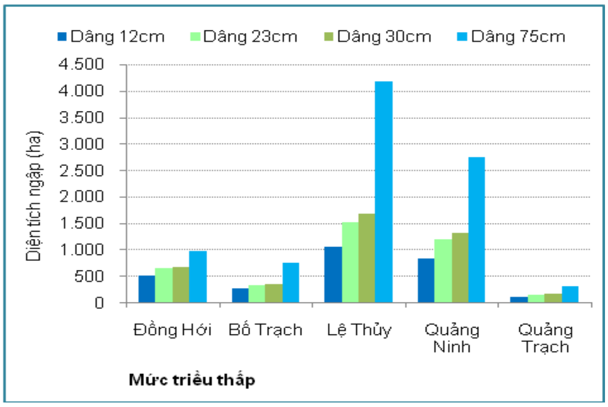


At low tide

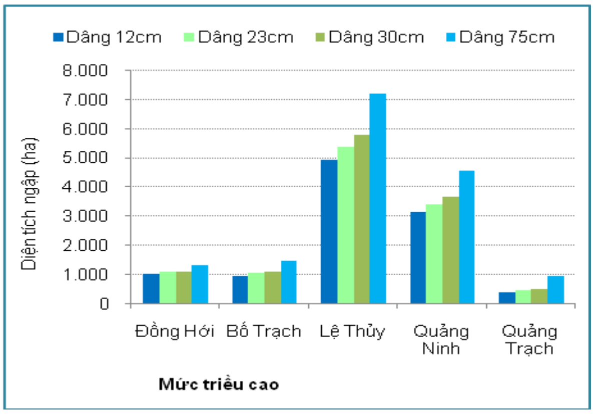


At high tide

Graph 7.2: Inundation caused by sea level rise in Quang Binh scenario B2

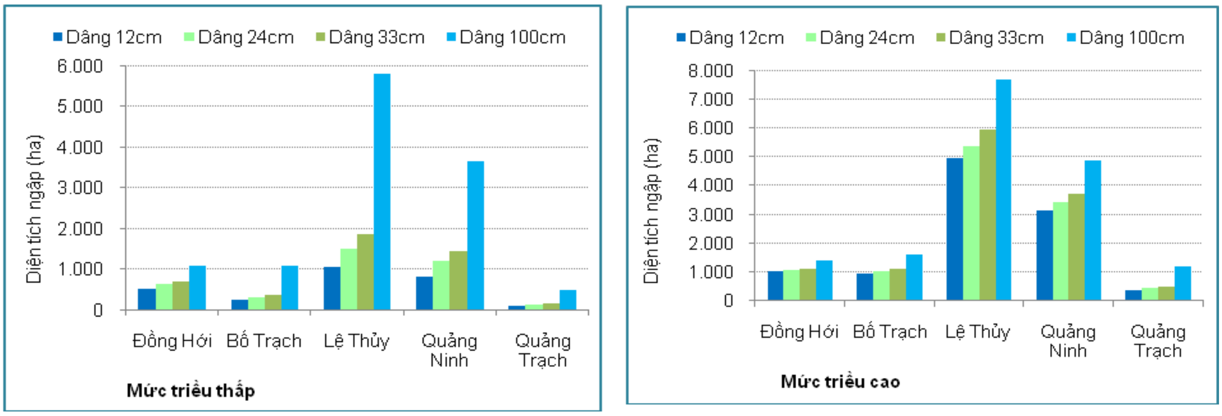


At low tide



At high tide

Graph 7.3: Inundation caused by sea level rise in Quang Binh - Scenario A1F1



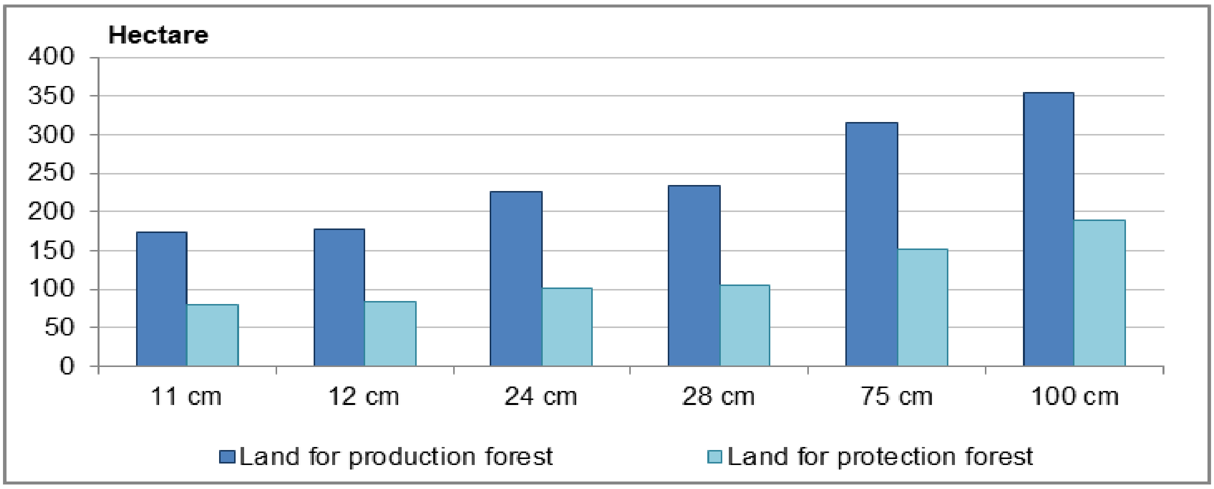
At low tide | At high tide

Under the low emissions scenario (B1): inundated area will cover 0.34 - 1.23% of the province area by 2020; 0.47 - 1.41% by 2040; 0.47 - 1.36% by 2050 and 0.95 - 1.83% by 2100. Under the medium emissions scenario (B2) inundated area will increase from Scenario B1 but not significantly: inundated area will account for 0.34 - 1.29% by 2020; 0.47 - 1.41% by 2040; 0.52 - 1.50% by 2050 and 1.11 - 1.91% by 2100. Under the high emissions scenario (A1FI): inundated area at high tide levels will account for up to 1.29% of the province by 2020 and 2.07% by 2100. The majority of the inundated areas will occur in rice cultivation land, urban land and residential areas, as well as in aquaculture land. Inundated areas in Dong Hoi will be the lowest in terms of volume share, but highest in terms of value share.

7.1.3.4.1. Impacts on Agriculture Fisheries and Forestry

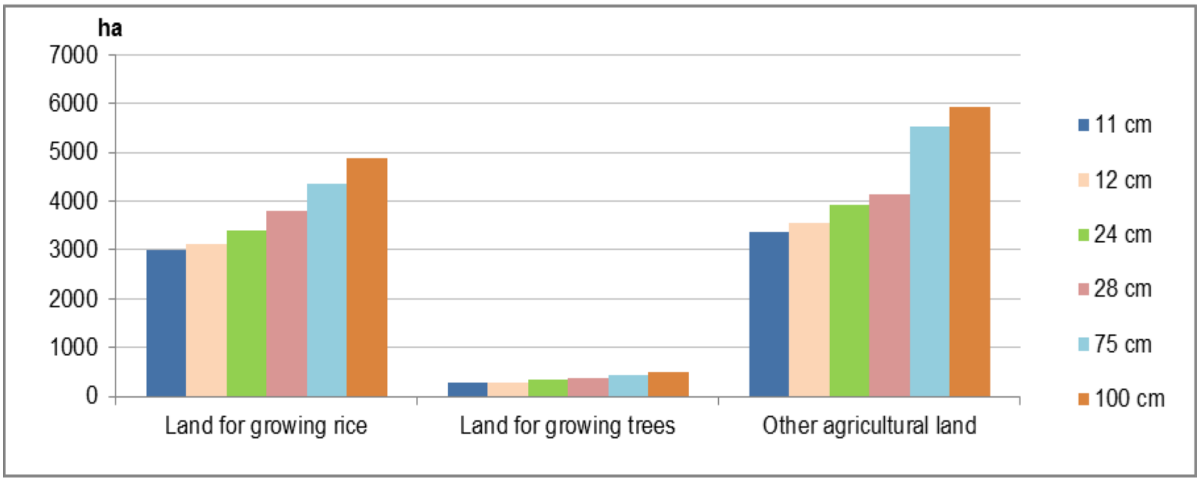
It is forecasted that the most seriously affected area will be the major lowland plain along both banks of the Nhat Le River. This area has many small river branches and the East Sea direction is blocked by high sand dunes along the Nhat Le River. As sea level rises, many coastal fishing villages will disappear, as will some of the Casuarina protection forest ecosystems in Le Thuy and Quang Ninh.

Graph 7.4: Area of forestry land to be submerged by sea level rise



Inundation caused by sea level rise will cause paddy fields along river basins to be seriously salinized, affecting agricultural production.

Graph 7.5: Inundated agricultural land under different scenarios of sea level rise



Sea level rise will foster increased saline intrusion, freshwater and saltwater boundaries will be changed, and saline areas will widen to Chau Hoa, Mai Hoa, and Tuyen Hoa districts. The areas available for fresh water aquaculture in Le Thuy, Quang Ninh and Quang Trach will be reduced. At the same time, sea level rise will facilitate the increased development of brackish and salt-water aquaculture, while the farming area could move deeper into the mainland. Some communes such as Ham Ninh and Duy Ninh (Quang Ninh District); as well as Lien Thuy and Xuan Thuy (Le Thuy district) could change their major land use patterns from cultivation to aquaculture.

7.1.3.4.2. Impacts on Natural Ecosystems

In estuarine and coastal areas, sea level rise will alter the dynamic balance between river and ocean. The inter-tidal area will change, as will the balance of sediment erosion and deposition processes in river-mouths and along the banks of estuaries. The exact amount of inter-tidal habitat lost due to sea level rise in any areas will be determined by a complex combination of local geomorphology and tidal amplitude (Lovelock and Ellison, 2007). Sea level rise will also influence meso-scale habitat connectivity between adjacent estuaries and estuarine mangroves (Munday et al., 2007). Mangroves near Gianh and Nhat Le estuaries will die off in their present locations and will tend to retreat further inland in response to increased salinity and sea level rise. However, they may be impeded by physical barriers including dykes, saline intrusion barriers and other infrastructure.

Coral reefs and sea-grass beds both exist at specific depths appropriate to the level of sunlight penetration they require in the waters they are living in. Sea level rise reduces the amount of sunlight reaching them and therefore reduces their ability to photosynthesize. However, sea-grasses can respond more quickly and grow-up slope to regain their n their “comfort zone” of preferred depth at a rate that exceeds the rate of sea-level rise. For slower-growing corals regaining their comfort zone will take much longer, and will not be able to keep pace with climate change (Bezuijen et.al. 2011). For the already degraded corals of Quang Binh, a combination of sea-level rise and increasing water temperature will likely lead to their complete disappearance.

Changes in inter-tidal habitat areas, changes in connectivity between estuaries and changes in mangrove distribution will in turn affect many important near-shore species dependant on these habitats.

For example, juvenile mackerel inhabit mangrove and intertidal wetlands (FAO, 2011) and they will be particularly vulnerable to the effects of sea level rise on these habitats, particularly as these mangroves are already degraded. Reduced connectivity of habitats between estuaries may also threaten the connectivity of populations of wild mackerel, also reducing their resilience. Blue swimmer crabs - an important species in estuarine and near-shore waters of Quang Binh migrate between estuaries and the open ocean during their adult, larval, and juvenile stages (Kangas, 2000). Their dependence on intertidal habitats during different stages of their life cycles therefore makes them vulnerable to sea level rise. Mussel and cockle species depend on a specific set of depth conditions in which to grow, and they are therefore also vulnerable to changes in sea-level rise.

7.1.3.4.3. Impacts on urban and rural human settlements and infrastructure

When sea level rises by 12cm, most of the inundated areas will be in Duy Ninh and Gia Ninh (Quang Ninh district), Xuan Thuy and Kien Giang (Le Thuy district), Dong Phu and Duc Ninh (Dong Hoi city) and parts of Quang

Trach and Bo Trach district, spreading to Ham Ninh, An Ninh, Tan Ninh (Quang Ninh district), Hoa Thuy, Hong Thuy, Loc Thuy, Phong Thuy, and Lien Thuy (Le Thuy district), Hoan Lao town (Bo Trach district) with high tides.

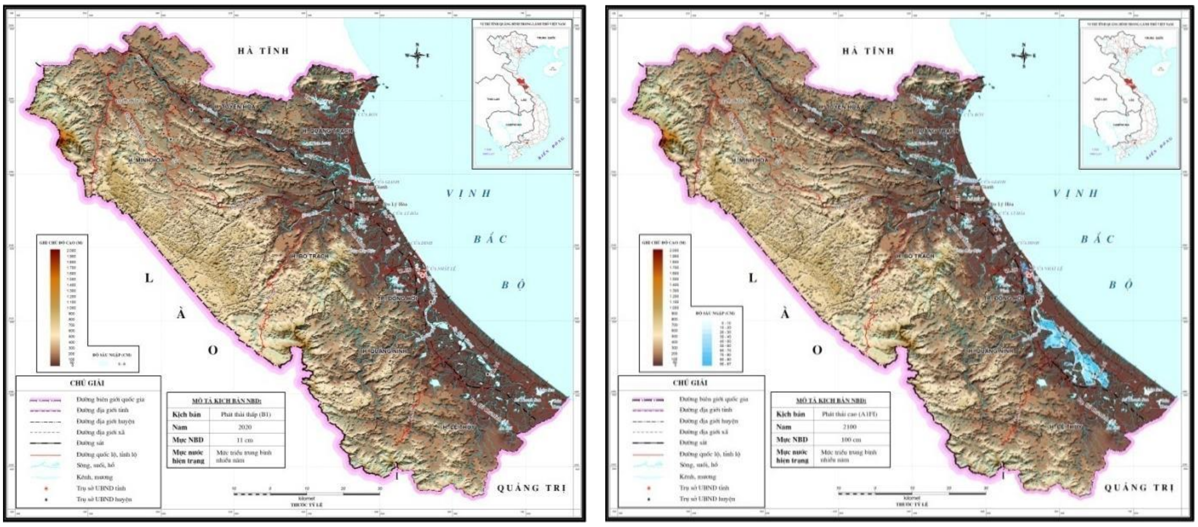
When sea level rises by 24cm inundation will occur in the same places, but covering larger areas, mainly focused on communes along the Kien Giang River in Quang Ninh and Le Thuy districts. Hoan Lao town will only be inundated during high tides in 2020, but by 2040 it will be inundated on an on- going basis even during medium tidal level.

When sea level rises by 33cm: Le Thuy and Quang Ninh districts will be most affected, with the most extensive inundated areas amongst all districts. Most of this inundation will happen in Duy Ninh, Ham Ninh, Tan Ninh, Hien Ninh, An Ninh, Xuan Ninh, Hoa Thuy, An Ninh, Phong Thuy, Lien Thuy, Loc Thuy, and Kien Giang town.

When sea level rises by 100cm, Quang Ninh and Le Thuy districts will still have the highest amount of inundated areas in the province. Compared to the 33cm scenario, inundated areas of Le Thuy will be 3 times greater. Inundated areas in Dong Hoi City, Bo Trach and Quang Trach districts will also increase. Additional inundation will happen mainly in Duong Thuy, Phu Thuy, Vo Ninh and Gia Ninh. Duc Pho and My Chuong rivers will rise and inundate Duc Ninh, Phu Hai, Nam Ly, Dong Phu, and Hai Dinh in Dong Hoi city. By 2100, about one fifth of the area of Dong Hoi city will be inundated.

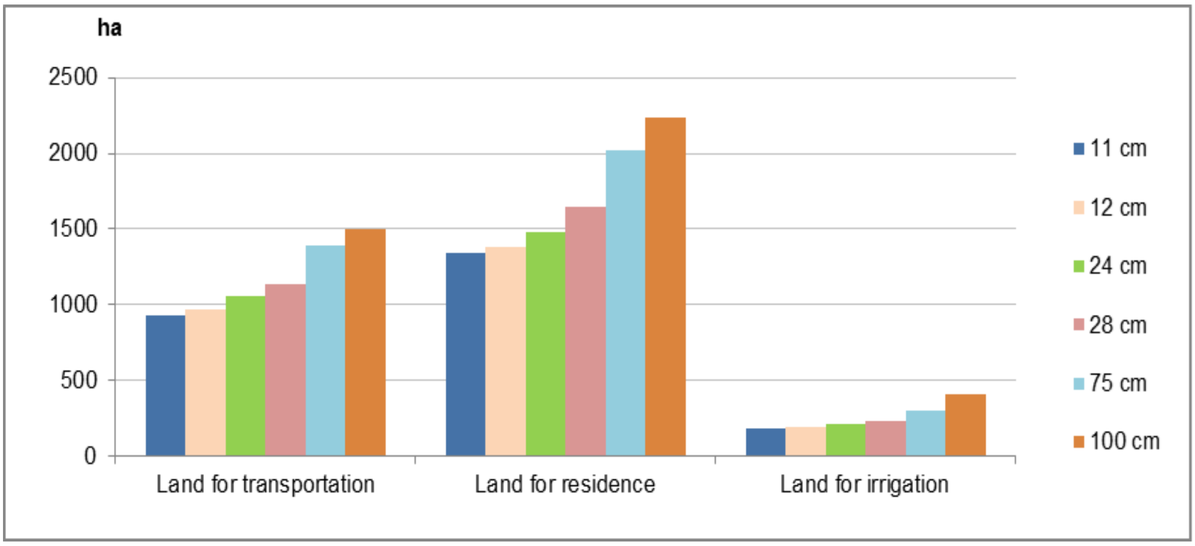
Along large parts of the coastline, thanks to the physical protection provided by high sand dunes, most of this area will not be subject to floods caused by sea level rise with only three exceptions: a small section in the southwest of Su Mountain in Quang Dong commune in Quang Trach district, Canh Duong and Quang Phu communes along the 2 sides of the Roon estuary, and the center of Ngu Thuy Trung commune in Le Thuy district.

Map 7.3: Maps of inundation caused by sea level rise - by 75cm and 100cm corresponding to 2050 and 2100 under scenario A1F1



Under sea level rise scenario A1FI, by 2100 some major transport routes will be inundated such as: provincial road 2 passing Bo Trach district, and the part of national road 1A passing Dong Hoi city, Bo Trach district, Quang Ninh, and Le Thuy. The concrete and steel bridges along national roads 1A, 12A, and provincial roads passing Quang Trach district, Bo Trach, and Le Thuy, including Gianh Bridge, Quang Hai Bridge, An Hoa and Nhat Le Bridge will all be severely affected.

Graph 7.6: Infrastructure land flooded under different sea level rise scenarios



Hon La seaport is strategically and economically important, receiving over 1 million tons of imports from China, and also responsible for transferring over 1.4 million tomes of products to Lao PDR. At present, at high tide period the water level has already reached the port edge, this means that under scenario sea level rise A1F1 by the year 2100, the port and its associated economic cluster will be flooded.

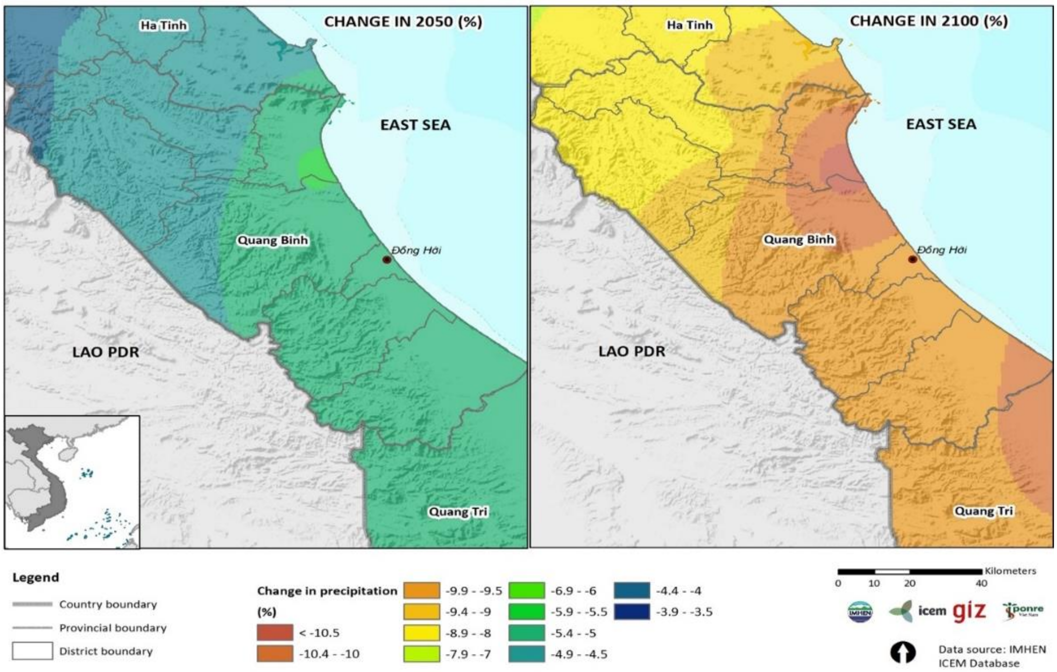
Developing seaside tourism is important for Quang Binh. According to future orientation by 2020, the province will develop luxury entertainment, resort and seaside tourism complexes in Da Nhay, Nhat Le - Quang Phu, Bao Ninh and Hai Ninh in order to attract domestic and international tourists. The first 18 holes of several planned golf courses are intended to be completed in 2016. However, due to the effect of climate change, the tourism sector will have to face the major challenge of sea level rise, as well as other climate change related impacts.

7.1.3.5. IMPACTS OF LONGER AND DRIER DRY SEASONS

By 2050, dry season rainfall during Mar-May may be reduced by 5-7%, and by 2100 there could be as much as an 8-10% reduction (Figure 7.11). The number of dry days will also increase (Figure 7.12). Reduced upstream rain, together with increased temperature that increases evaporation, results in water levels in reservoirs dropping to significantly low levels.

Extended droughts together with sea level rise and increasing salinization plus increased environmental pollution after storms and floods, will make provision of sufficient clean freshwater to meet daily consumption and production needs even more challenging. This will in turn affect production, socio-economic development and people’s lives.

Map 7.4: Changes in precipitation (March-May) in Quang Binh, 2050 and 2100



7.1.3.5.1. Impacts on Agriculture Forestry and Fisheries

The interaction between droughts and sea level rise will be an important factor that will result in salinization of surface and ground water across the whole province becoming an even more serious problem. Places already heavily affected by salinization include the Kien Giang river from Nhat Le estuary to Xuan Thuy commune (Le Thuy district), and the estuaries of Ly Hoa, Roon, Dinh, and Gianh rivers. Salinization results in further freshwater shortages for agricultural production. High levels of evaporation (960- 1,200mm p.a.) coupled with poor ability of coastal sandy land to retain water causes the many coastal areas to already have difficulty in securing sufficient water supply when faced with extended droughts and salinization in estuaries progressively moving deeper inland. Such situations may be experienced more frequently under future climate change scenarios.

In addition, there is a growing annual water demand for sand-based aquaculture. On average, each hectare of aquaculture land would need 30,000m^3 freshwater every year. Thus, some 9,000,000m^3 would be needed for 300ha by 2020. The main water sources for sand- based shrimp farming come from local ground water. Although quite rich, ground water sources in Quang Binh are not evenly distributed at different depth levels. The coastal plain area has narrow but rich ground water sources, but these are usually salinized causing challenges for production and daily life. The midland area has deep ground water sources which are subject to exhaustion during the dry season.

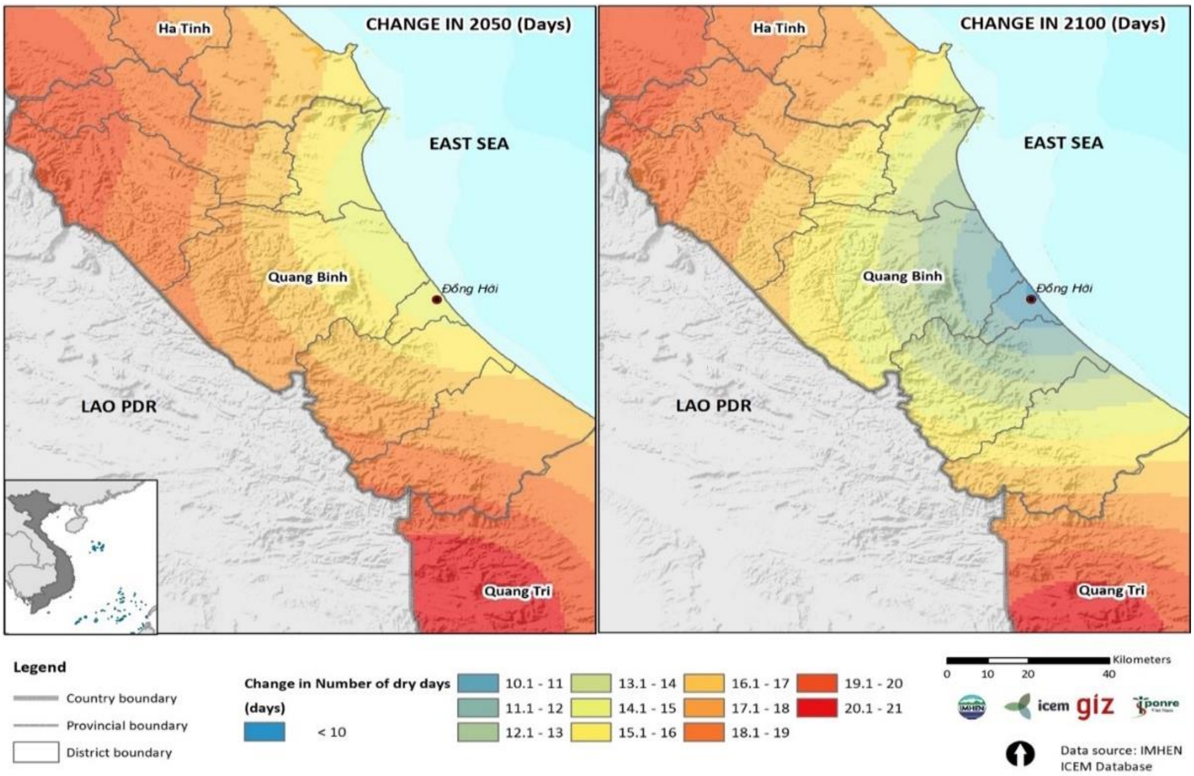
More frequent, intense and prolonged droughts will affect crop production, particularly for spring and early summer rice and other crops.

A longer and drier dry season (together with increased temperature number of very hot days - see next section) will increase the risk of fire in tree plantations. Over a 10 -year period (2000 - 2010), 310ha of plantation forests in Quang Binh were damaged by forest fire (although these were mostly in plantation forests not natural forests). From 2005 - 2010 alone, 45 fires happened with almost 170ha damaged, including pine, acacia, rubber, Dalbergia tonkinensis and Melaleuca quinquenervia, with a total damage of over VND 1 billion. As an example, in the dry season of 2010, at Quang Thuy commune, Quang Trach district, the temperature reached 42 degrees, and in conjunction with the dry and hot wind coming from the west, this sparked a forest fire destroying 5 hectares of ready-to- harvest pine forest. At the same time, at Son Trach commune, Bo Trach district, 2 serious forest fires also occurred. Greater precautions will have to be taken in management of tree plantations to prevent economic losses caused by increased fire risk.

7.1.3.5.2. Impacts on Natural Ecosystems

A longer and drier dry season (together with increased temperature number of very hot days - see next section) will increase the risk of forest fire. Despite this, forest fires are not presently considered as a major problem in Quang Binh, and are not seen as a threat to natural ecosystems. But with climate change bringing prolonged dry periods as well as higher temperatures and more very hot days, combined with the likelihood of more frequent and intense El Nino cycles in the future, thousands of hectares may be at much higher risk, and forest fires will become a matter that warrants increased care and attention.

Map 7.52: Changes in number of dry days in Quang Binh, 2050 and 2100



7.1.3.5.3. Impacts on Rural and Urban Settlements and Infrastructure

In recent years, drought has appeared unexpectedly and in more extreme forms, and already most reservoirs in Quang Binh are not able to supply sufficient water for agricultural production in severe droughts. For example, in 2014 and 2015 rainfall decreased by about 60% and 80% respectively against average amounts, and reservoirs only filled to 30-40% of their capacity in 2014 and 60% in 2015.

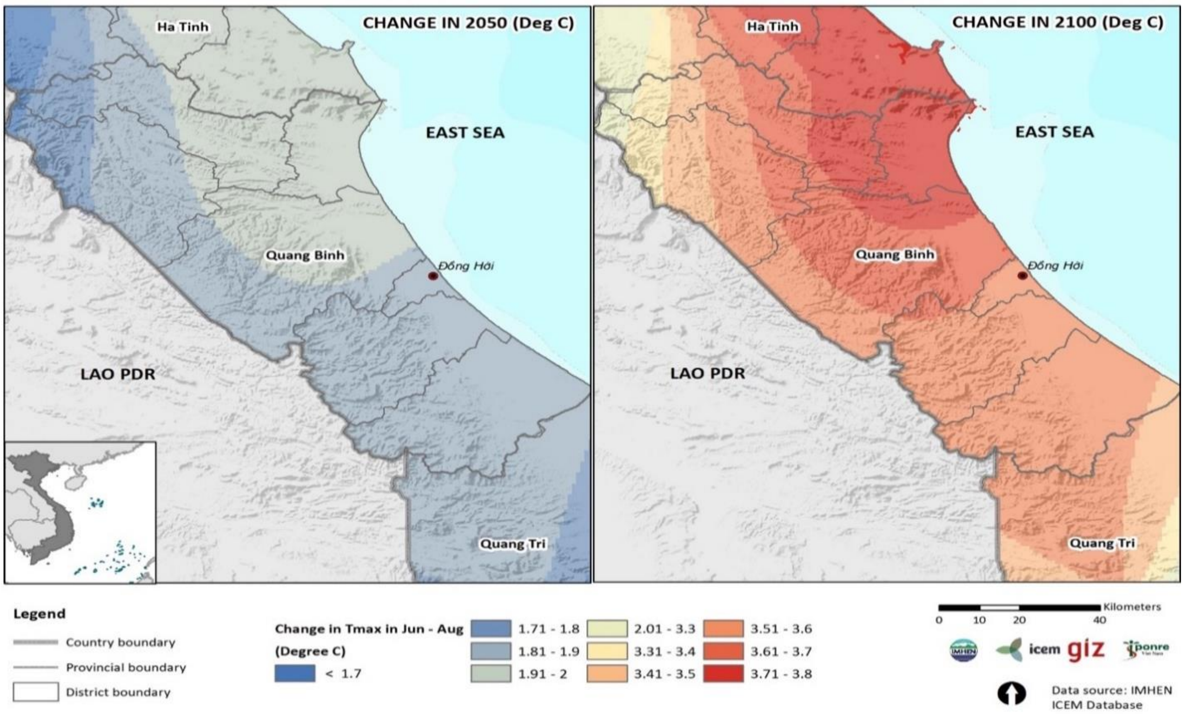
According to the "Water resource plan for Quang Binh by 2020", based on water consumption norms by sector and predicted population and economic growth, water demand for residential, industrial and agricultural use the province has been estimated at 1,655,739m^3/day for 2015 and is expected to rise to 2,179,376m^3/day by 2020. When sea level rises by 100cm (by 2100), it is estimated that 100,000 people living in coastal districts will have serious freshwater shortage during the dry season.

7.1.3.6. IMPACT OF INCREASING TEMPERATURE AND INCREASING NUMBER OF VERY HOT DAYS OVER 35 DEGREES

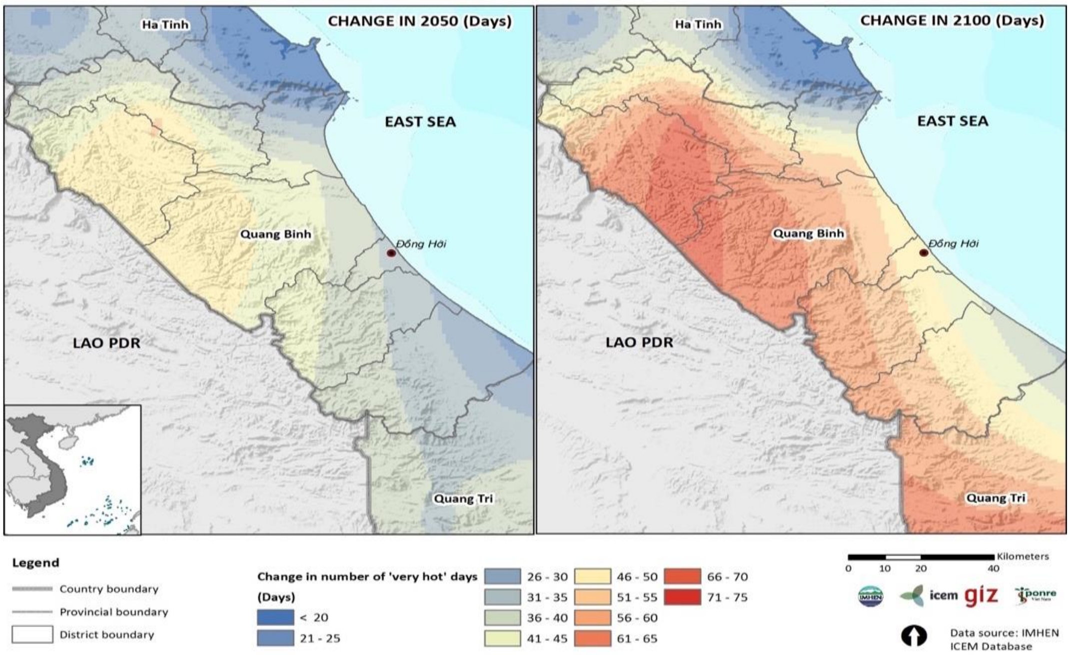
Changes in rainfall patters (more and heavier rain in the rainy season, less rain and longer dry periods and dry days in the dry season) as well as changes in storms and sea level rise cause types of impacts that are mostly seen as disasters (flash floods, floods, costal inundation, droughts). When considering changes in temperature however, sometimes intense heat waves can also be considered as a type of disaster, but more importantly we need to consider the long-term cumulative impacts of temperature increases on the productivity of key species in agriculture forestry and fisheries, as well on natural ecosystems. While these type of changes are not as sudden or dramatic, and do not appear as crises requiring the immediate attention of authorities, over the long-term they will have very significant impacts on the economy of the province and the well-being of its residents.

Average daily maximum temperature during June-August may increase by almost 2^{o}C by 2050, and by almost 4^{o}C by 2100 (Figure 7.13) and the number of very hot days (>35^{o}C) may increase by up to 40 days by 2050, and up to 75 days by 21000 (Figure 7.14).

Map 7.6: Change in average daily max temperature (June-August) in Quang Binh



Map 7.7: Changes in number of hot days in Quang Binh in 2050 and 2100



7.1.3.6.1. *Impacts on Agriculture Forestry and Fisheries*

Annual mean air temperature increased by 0.4°C from 1961 to 2009 in Quang Binh. According to IPCC, in tropical regions, the increase of average temperature has negative impacts on productivity of most kinds of grain and wet rice. If temperature increases by 1°C, maize productivity will decrease 5 - 20% and it could drop by as much as 60% if temperature rises by 4°C. If the temperature increases by 3°C, crops in all areas will face severe threats (Fisher et al., 2002 and Rosenzweig et al., 2001).

In many places rice is already grown at the upper end of its preferred temperature range (22 - 28°C) and in tropical Southeast Asia it has been clearly demonstrated that increasing temperature reduces rice yields (Feng et al 2004). Yield could decline by 10% for each additional degree rise in temperature. The combination of increased temperature and more frequent droughts is likely to make rice growing less and less successful for Quang Binh's farmers in the future. Meanwhile, tuber crops (such as sweet potato and cassava) may enjoy yield increases, as they tend to develop a higher root tuber/trunk ratio with higher temperatures.

Quang Binh province plantation forestry sector mainly focuses on tree species such as acacia, pine, and rubber. Based on temperature, rainfall and altitude comfort zones, 7.53% of the province is currently rated as very suitable for growing pine, 35.23% as suitable and 57.2% as less suitable. As mean temperature increases over time the area suitable for pine will shrink and will shift towards areas of higher elevation where temperatures are still within its comfort zone.

Acacia is a large genus with over 1,300 species widely distributed throughout the tropics and subtropics. Most species are found in the southern hemisphere and the main centre of diversity is located in Australia and the Pacific. Vietnam has over 400,000 ha of Acacia plantations, including over 220,000 hectares of clonal Acacia hybrid (*Acacia mangium × Acacia auriculiformis*) which is now one of the main species for industrial plantations (Kha 2001). Acacia hybrid is found where mean annual temperatures are 12 - 35°C, annual precipitation is 1,200 - 1,850 mm and elevation is 50 - 350 m (Vozzo 2002). In Quang Binh it is grown well within its comfort zone for temperature and elevation, but in areas where rainfall may be somewhat at the higher end of its preference range.

Climate change induced temperature increases and increases in the number of hot days may not have much impact on acacia directly. However increased temperatures may increase the frequency of pest outbreaks, which are are difficult to control, especially in the remote and mountainous areas such as Tuyen Hoa, Minh Hoa, and Quang Ninh.

Brackish-water aquaculture

The pond and cage aquaculture sector makes an important contribution to the provincial economy, and in recent years the aquaculture area has been expanding - especially for commercial shrimp production on sandy soils. Water temperature in estuaries were cage aquaculture is practiced, and water temperature in shrimp ponds both depend completely on the local weather conditions. In the summer, when the air temperature increases in conjunction with the "Lao wind," and water in the river is at a low level so it heats up more quickly, the scorching heat drives up the ambient temperature to levels which may be beyond the tolerance limits of many commercial cage fish species.

Grouper is the most popular cultured fish in Southeast Asia, largely due to their fast growth, acceptance of dry pellet food, successful spawning in captivity, high feed efficiency and very high market value (Boonyaratpaliin, 1997). Grouper cultured in the South China Sea include orange-spotted grouper (Epinephelus coioides), Malabar grouper (E.malabaricus), giant grouper (E. lanceolatus), tiger or brown-marbled grouper (E. fuscoguttatus) (Kongkeo et al., 2010). Grouper can only be cultivated in cages, with seed mainly collected from the wild, although limited artificial spawning and larva rearing techniques have been developed since 1993 (FAO, 2011).

Seabass (Lates calcarifer) - known as Barramundi in some parts of the Asia-Pacific region, can be cultivated in earthen ponds, cages and pens (FAO, 2011). Seabass are a fast growing fish, tolerant of many coastal conditions such as fluctuating salinity and turbidity, as well as rough handling and the crowded conditions of aquaculture cages (Boonyaratpaliin, 1997) Snapper species (Lutjanus spp.) command a high price similar to both Grouper and seabass species, and are also popular.

Temperature during larval rearing of seabass and grouper have a great effect on health and survival of both of these species (Boonyarat- paliin, 1997). It has been shown that cultured groupers can tolerate temperatures from 22-28 °C, and at temperatures under 15°C they will not feed (Boonyaratpaliin, 1997). There is limited information available on exact upper thermal tolerances on any of the seabass, grouper or snapper spp. However, according to Katersky and Carter (2005) seabass can be cultured over a wide range of temperatures. Seabass appear to be more tolerant of higher temperature than other cultured species, with an increased survival rate of 66.4% from 11.3% when temperatures were increased from 27-29°C to 34-35°C in experiments by Ruangpanit and Kongkumnerd (1992). In summary there is very little scientific information on which to conduct an assessment of how increased temperatures will impact cage aquaculture, however overall it seems that seabass may be more resilient than other commonly cultures species.

Reduced river flows in the dry season combined with sea level rise will increase salinity further up the estuaries, increasing the area suitable for brackish water cage fish aquaculture.

Theoretically at least, higher temperature means that shrimp can grow faster and to a larger size. However, several other factors associated with increased temperature can counteract this. Firstly, with higher temperatures evaporation of water from shrimp ponds increases, concentrating the salinity and changing the pH and this can have negative impacts on shrimp growth. Secondly higher temperatures encourage algal growth in the ponds and this can deprive shrimp of oxygen. Thirdly, at very high temperatures shrimp stop eating their food. Finally, disease is more prevalent with higher temperatures, and outbreaks of Early Mortality Syndrome (EMS) can be more devastating (Handisyde, et. al., 2006). Prawn farmers will need to manage their ponds more carefully, and should consider planting trees around their ponds to both provide physical protection, and shade to reduce surface water temperature.

Freshwater aquaculture

Fresh water cage fish aquaculture which is mainly concentrated in the upper areas of the Gianh River in Minh Hoa commune, as well as in Le Thuy, Quang Ninh and Quang Trach, will suffer similar impacts of increased temperature. Alternating the raising of fish in rice fields with one crop of paddy rice, is practiced in some areas where rice yields are relatively low. This activity will similarly be impacted by high water temperatures and increased evaporation in the dry hot season. Farmers may shift to do it in the rainy season instead but in this case have to put protective nets around the fields to avoid the fish being flushed out during floods.

Freshwater pond aquaculture involves a number of species, but the snake-head fish is the most abundant in Quang Binh. Snake-head fish are very resilient to poor conditions including high temperature, low water levels and low oxygen supply.

In the last 10 years it has increasingly being grown in simple ponds dug in sandy areas where the water table is very high. While the net balance between annual rainfall and evaporation in the coastal area would not leave enough water in the pond for aquaculture in normal circumstances, the high water table means water simply seeps into the pond. Every couple of months the farmers pump out the waste water from the ponds, and new ground water seeps in to replace it However some reports have suggested that with wide-scale adoption of this approach in the last decade, the water table is already starting to decline and pond water depth in some places - e.g. in Ton Hai village of Nguy Thu Bach commune - is becoming too shallow to successfully raise the fish

Near-shore fisheries

Small pelagic species including mackerel, squid, sardines and anchovies are important to the near-shore fishing communities of Quang Binh Province. There is evidence that climate trends affect the production of the species that make up some of the major inshore pelagic fisheries of the world, and we should expect to see similar climate change effects on fish production in Quang Binh as well. The type of climate variability or change that affects each species varies depending on the aspect of climate that is important to the life history of the particular species. Although ocean conditions in spawning and first feeding areas play a critical role, unfortunately, the precise mechanisms linking climate trends to production are poorly understood. While we can expect that major fluctuations in the abundances of key species and their fisheries will occur in the future, we still lack an ability to forecast changes in trends that are useful to management (Beamish, 2008)

Analysis of overall trends in proportion of different species making up the catches of inshore fishermen compared with climate changes, are not yet available, either for Vietnam in general of for Quang Binh in particular, but we may expect to see patterns similar to what is happening in other nearby countries. As an example, in Korea, in recent years the portion of small pelagic fish species (anchovy, Japanese sardine, mackerels and common squid) has been increasing, and now makes up 60 to 70% of the total catch. Common squid has been increasing with warming waters since the 1990s, and alone now accounts for 20 to 25% of the total catch (Kim and Kang, 2000).

Sardines and Anchovies

Sardine and anchovy populations are well recognized as responding synchronously and rapidly to changes in their ocean environment (Kawasaki, 1983). In many ecosystems around the world, abundance of anchovy follows trends that are opposite to those of the sardine. In the 1950s and 1960s, anchovy abundance was large when sardine abundance was small. This pattern switched in the late 1970s and 1980s, reversing again in the 1990s (Chavez et.al., 2003). It is expected that similar patterns might be seen in Quang Binh.

The alternating cycles of abundance seem to occur in response to large-scale, climate changes relating to a combination of ENSO events and Pacific Ocean decadal oscillations. Sea surface temperature (SST) effects on early growth rates may be the key factor, with anchovy responding better to increased temperature (Takahashi et al., 2004; Takasuka et al., 2004, 2007). Seasonal and long-term trends of the size of yolk-sac larvae, embryonic mortality, egg production, and spawning stock biomass of anchovy have also been correlated with changes in spring warming, summer cooling, and zooplankton biomass (Kim, 1992; Kim and Lo, 2001). Variation in oceanographic conditions also affects the adult migration route and the distribution of eggs and larvae.

Mackerel

In general, rapid or dramatic increases in temperature above normal maximum temperatures are expected to have significant effects on overall viability of some pelagic fish populations (Munday et al., 2008). Fish are particularly sensitive to temperature changes during their early life histories. Warming can have either a positive or negative effect on egg production, depending on whether the target fish species is close to its thermal optimum. An increase in temperature of 1-3°C could shorten the incubation period of eggs for pelagic spawning (Munday et al., 2007).

The Indo-Pacific Mackerel (Rastrelliger brachysoma) is a shallow pelagic species of major economic and food security importance. Mackerel spawn offshore however after egg hatching juvenile mackerel travel onshore via currents to develop in mangrove/wetland environments (Venkataraman, 1970). There is very little information about the temperature specific impacts of climate change on this species and their adaptive capacity, however, a study by Pradhan and Reddy (1962) carried out over 50 years ago, shows that mackerel may well be highly vulnerable to changes in temperature. As seas warm, they may be expected to shift their distribution to stay within their temperature comfort zone.

Squid

Squid have a flexible life history which is a result of the highly responsive nature of their growth to temperature changes (Pecl and Jackson, 2008). Tropical squid that grew through periods of warming water temperatures grew 9% faster than squid that grew through periods of cool water temperatures (Jackson and Moltschaniwskyj, 2002). It has been suggested that squid will thrive in the face of a global warming of the seas, with increased growth rates, accelerated life histories and rapid turnover in populations, which could potentially lead to population expansion at the expense of slower growing teleost competitors (Jackson, 2004). However, under continued temperature elevation there will likely come a point where growth rates start to decrease as metabolic costs continue to escalate and growth potential is subsequently reduced (Pecl and Jackson, 2008).

Blue Swimming Crab

The Blue swimmer crab (Portunus pelagicus) also known as sand crabs, are an economically very important species which are widely caught and cultivated across the Indo-Pacific region (FAO, 2011). They are ideal aquaculture species due to their ease and frequency of spawning in captivity (Andres et al., 2010). They are found in estuaries and inshore marine waters in the wild (Kangas, 2000) and constitute an important species in near-shore fisheries in Quang Binh. They are opportunistic, bottom-feeding carnivores and scavengers which means they will be less sensitive to climate related impacts on their food supply than more specialist feeders.

Extremes in water temperature are likely to have significant effects both on survival of larvae and adult blue swimmer crabs as well as affecting growth and reproduction (Hutchings et al., 2007). A sea surface temperature rise would likely increase developmental rate overall, resulting in a net increase in productivity. As with other marine and freshwater species however, these increases would only occur within the thermal tolerance of the individual species. For blue swimmer crabs this has been shown in laboratory settings to be around 39.5^{o}C (Neverauskas and Butler, 1982). Specific thermal tolerances for blue swimmer crab in the wild in Quang Binh are however completely unknown.

7.1.3.6.2. Effects on Natural Ecosystems

Coastal Ecosystems

Coastal systems supply disproportionate ecological services and benefits to human society (Barbier et al., 2011), and coastal waters have warmed faster than those of the open oceans (Lima & Wethey, 2012).

Effects of temperature related effects on coral reefs are highly visible and extensively documented (Veron et al., 2009). Small increases (1-2°C) in sea temperature above the long-term summer maxima destabilizes the relationship between host corals and their symbiotic zooxanthellae algae on which they rely for energy and growth (Veron et al., 2009), resulting in coral bleaching. Increased water temperature also has the potential to affect both the reproductive output of parental colonies, and the success of early coral life stages in corals (Hoegh-Guldberg et al., 2007).

Up to a certain point, higher water temperature may increase the growth rate of sea-grasses. However, sea-grasses have thermal tolerance limits beyond which mortality occurs. Sea-grass species thermal tolerance limits for Quang Binh are unknown. Similarly the different tree species making up mangrove forests, each have their own specific tolerance limits, but these are largely unknown.

Terrestrial Ecosystems

Rich natural forest areas of the province are mainly concentrated in 3 main areas: PNKB National Park, the area from Khe Ve to Mu Gia in Minh Hoa, and parts of Lam Thuy in Le Thuy district next to the border with Laos. The species composition of the different forest types of both tropical and sub-tropical moist evergreen broadleaf forests, as well as coniferous forests, found at different altitudes, and either over limestone or not over limestone is determined by the range of preferred conditions (comfort zones) of each of the individual species that make up the plant community in each forest type. The response of species to increased temperature will be to shift either by altitude or latitude to a place where the climate conditions are still within their comfort zone. In general, for every one degree change in temperature a move of between 100 - 200m to higher altitude (depending on moisture conditions) or a move of 35km towards the poles is required to find a place with the same original temperature conditions.

The large areas of forest remaining in the province provide a good opportunity for the various different types of forest habitat to be able to persist despite future temperature increases, but it will be important to maintain both latitudinal and altitudinal corridors connecting different forest patches across the landscape to facilitate the natural shifts in species distribution in response to temperature change.

7.1.3.6.3. Impacts on urban and rural settlements and infrastructure

Urban centres create well known heat island effects, having temperatures that are already 2 - 3 degrees higher than less urbanized areas. Increased temperature and increased number of hot days resulting from climate change may push temperatures in Dong Hoi and other towns to unbearable levels at certain periods. Heat stress can directly cause sickness and in some cases even death. It can also increase the frequency of other diseases. Very hot days can melt the tarmac on roads.

7.2 SUMMARY AND CONCLUSIONS

According to plausible climate change scenarios for Quang Binh, we can expect the following major challenges to occur, all of which will become increasingly more pronounced as time progresses:

- Increasingly strong and more unpredictable storms will cause physical damage to aquaculture areas and crop fields as well as to human settlements and infrastructure along the coastline and throughout the lowland plains, but particularly in the central and southern parts of the province.
- Water turbidity caused by storms will impact coral reefs and sea-grass areas, and strong winds associated with storms will increase blowing and flowing sand as well as damaging rubber tree plantations if they are close to the coast.
- Increased rainfall in the rainy season, and increased number of days with very high rainfall will cause increased erosion, shallow landslides and flash floods in the upland areas, especially Minh Hoa and Tuyen Hoa and more widespread, more prolonged and more damaging inundation in the lowlands - particularly along both banks of the Gianh River in a number of communes in Quang Trach, Bo Trach, Quang Ninh and Le Thuy Districts.
- Rapid and massive inflows of water into reservoirs will also raise concerns about reservoir safety.
- Sudden drops in salinity in brackish water areas caused by massive inflows of freshwater will lead to large-scale die-off of brackish water aquaculture species and prolonged freshwater inundation may kill off mangroves - this will be an important challenge in the Gianh and Nhat Le estuaries.
- Sea-level rise will progressively inundate increasingly large areas, as seas continue to rise year after year, and will also result in saline intrusion penetrating further inland. Quang Ninh and Le Thuy will be severely impacted before other distrits, and will be the most impacted under all SLR scenarios. It is expected that Ham Ninh and Duy Ninh communes in Quang Ninh as well as Lien Thuy and Xuan Thuy communes in Le Thuy will need to start to shift livelihoods from crop growing to brackish-water aquaculture before 2030.
- By 2100 Hon La seaport and its associated economic cluster as well as some major transport routes will be permanently inundated.

- A longer dry season with more dry days and more very hot days will increase risks of fires in both plantations and natural forests - particularly in Quang Trach and Bo Trach Districts.
- It will also result in increasing frequency and severity of droughts which damage crop production (especially spring and early summer rice) and will lead to problems in securing a year round water supply, especially in the coastal sandy areas of Quang Ninh and Le Thuy.
- Increased air temperature will stimulate some species to shift their distribution pattern to regain a temperature regime inside their comfort zone - either by moving further north, moving to higher altitudes or a combination of both.
- Sea water temperature increases will increase coral bleaching events, although sea-grass productivity may increase (up to a point) and temperature change impacts on mangroves are as yet unclear
- Productivity of squid, blue swimming crab, sea-bass and anchovy are likely to increase (up to some unknown threshold), while that of grouper, mackerel and sardine are likely to decrease as the sea gets increasingly warmer.

Without significant, concerted and continuous investments and efforts to address the key issues above, overall climate change is likely to slow down economic growth and negatively affect quality of life in Quang Binh. Natural resources will be more degraded, food production will be reduced, and the impacts of natural disasters will be magnified. The coastal and rural poor (including ethnic minorities in upland areas) with livelihoods most dependent on natural resources, will be the most vulnerable to these changes. In the worst case scenario, recent gains in poverty alleviation may be reversed. Consequently, labour migration, which is already significant may continue to increase, and social problems may become more prevalent. These issues must be given serious attention before it is too late. Key interventions should therefore include:

EbA interventions for sand dunes ecosystems and coastal forests

- An overall provincial management plan should be developed for the sand dune ecosystems of Quang Binh - this should include zoning of the sand dunes for different activities, and should identify core protection zones, as well as restoration zones in order to maintain the physical protection functions the dunes provide.
- Protection Forest planting on the landward side of the dunes should use a multi-species approach, not just casuarina - at the same time all remaining natural native species coastal forests should be identified and mapped and a plan should be developed for management and restoration of these areas, as well as identifying new areas for planting a more diverse selection of native coastal species. Together these interventions will better control blowing and flowing sand. To support this, nurseries for native species should be established and training provided in propagation and care of a wide range of native coastal species.
- To address the issues of likely future water shortages in coastal areas, an assessment of the actual underground water supply in the sand dune ecosystem should be carried out, and compared with future projected water demand for all planned uses (golf courses, vegetable growing, aquaculture, domestic consumption).

EbA interventions for terrestrial forests and plantations

- For production forest that are acacia plantations, a gradually shift from short term harvesting cycles of around 7 years to longer cycles of around 15 years or more should be promoted, and harvesting at any age should be done in a larger number of smaller patches (rather than a smaller number of larger patches) that are separated from each other by sizeable non-harvested areas. Strips of non-harvested trees should be left every 50m or so on steep slopes and as a riparian buffers along water courses. All these interventions will help reduce erosion and land-slide risk that may become more severe with climate change. This in turn will reduce the severity of flash floods, of downstream inundation and of siltation and shallowing of reservoirs.
- More effort and resources should be focused on fire prevention in both natural forests and plantations, including education of visitors about proper disposal of cigarettes, effective use of fire-breaks, etc.
- Research should be carried out on temperature and rainfall “comfort zones” and thresholds for key natural forest and plantation timber species.

- Forest corridors connecting forest patches in the larger landscape should be identified and maintained along both altitudinal and latitudinal gradients to facilitate the movement of species over time in response to climate change.
- Restoration and improvement of degraded areas (and secondary forest where selective logging had previously taken place), including in the PNKB buffer zone and corridor areas, should use native species that are selected for their suitability to the future climate conditions.

Climate-smart Agriculture

- SRI rice farming should be further promoted in appropriate areas and production shifted from rice to less water intensive crops in areas with no or limited irrigation potential and likely to suffer from future droughts and water shortages.
- Crop calendars should be modified to account for changing climate, and rubber plantations located further inland.
- Studies should be conducted into the temperature and rainfall tolerances of key crop species. If continued production of some species will be unsuitable in the changed climate conditions, plans should be made to promote and support the introduction of alternative species more suited to the new climate conditions.
- Agriculture on steep slopes > 35% should be avoided; where it already takes place, promote soil and water conservation methods to maintain fertility while slowing down run-off and reducing erosion.

Climate-proofing urban and rural settlements and infrastructure

- A number of approaches to climate proofing transport infrastructure are already being implemented in Quang Binh, and these should be continued and expanded:
  - Widening of bridges to take account for increased rainy season river flows;
  - Raising the height of roads to take account of increased depth of future floods;
  - Increasing number and size of culverts under roads to increase transparency of roads to more frequent floods and thereby reduce flood damage to roads;
  - Planting shade trees along roads to reduce road surface temperature and prevent tarmac from melting on hot summer days.
- Employ eco-engineering options for slope erosion control in road construction.
- Ensure the protection of all remaining small lakes/wetlands within Dong Hoi City. They provide valuable flood management, water supply and purification as well as micro-climate regulation services. They should not be filled-in and built upon. Instead they can be developed for recreational, educational and scenic benefits.
- Apply SUDS (sustainable urban drainage) methods in all future urban development planning - maximising natural drainage, to reduce the impact of floods. Apply the 1:4 rule for all construction: for every development each 1m2 of planned concrete surface must be accompanied by 4 m2 of natural surface.
- Plant trees along all streets, increase urban open spaces and create more parks to all provide shade, reduce the heat island effect and reduce heat stress on inhabitants.

In the following chapters, more detailed vulnerability assessments are made of selected priority Socio-Ecological Systems (SESs), and more specific detailed EbA recommendations are made for those priority SESs.

7.3 REFERENCES

ACIAR 2004 *Acacia* hybrids in Vietnam. Centre for International Economics, Canberra and Sydney, Australia.

Asian Development Bank (2014) *Urban Environment and Climate Change Adaptation Project IE131001410-06-RP-103C*

Barbier EB, Hacker SD, Kennedy C, Koch EW, Stier AC, Sillman BR (2011) The value of estuarine and coastal ecosystem services. *Ecological Monographs*, 81, 169–193.

Beamish, R.J., ed. (2008), Impacts of Climate and Climate Change on the Key Species in the Fisheries in the North Pacific. *Working Group on Climate Change, Shifts in Fish Production, and Fisheries Management* North Pacific Marine Science Organization (PICES), B.C., Canada

Bezuijen, M. R., Morgan, C., Mather, R.J. (2011). A Rapid Vulnerability Assessment of Coastal Habitats and Selected Species to Climate Risks in Chanthaburi and Trat (Thailand), Koh Kong and Kampot (Cambodia), and Kien Giang, Ben Tre, Soc Trang and Can Gio (Vietnam). Gland, Switzerland: IUCN.

Chavez, F.P., Ryan, J., Lluch-Cota, S.E. and Niquen, C.M. 2003. From anchovies to sardines and back: Multidecadal change in the Pacific Ocean. *Science* 299: 217–221.

Choo, H.S. and Kim, D.S. 1998. The effect of variations in the Tsushima warm currents on the egg and larval transport of anchovy in the southern sea of Korea. *J. Korean Fish. Soc.* 31: 226–244.

Central Committee for Flood and Storm Control (CCFSC) under the Ministry of Agriculture and Rural Development (MARD)

Dugan JE, Defeo O, Jaramillo E, et al. (2010) Give beach ecosystems their day in the sun. *Science*, 329, 1146.

FAO Fishery Information Data and Statistical Unit. 2006. Total production 1950–2004. FISH STAT Plus Universal Software for Fisheries Statistical Time Series. Food and Agriculture Organization for the United Nations. Available at http://www.FAO. org/fi/statist/FISOFT/FISHPLUS.asp.

Figueiredo, N., Carranca, C., Trindade, H.' Pereira, J., Goufo, P., Coutinho, J., Marques, P., Maricato, R (2014) Elevated carbon dioxide and temperature effects on rice yield, leaf greenness, and phenological stages duration. The International Society of Paddy and Water Environment Engineering and Springer Japan.

Hai, P.H., Hardwood, C., Beadle, C., Huong, V.D. and Trieu, D.T. 2005 Genetic materials and silvicultural techniques in plantation grown Acacias for sawn timber products. CSIRO technical report. Commonwealth Scienti c and Industrial Research Organisation, Canberra, Australia.

Horie, T., Baker, J. T., Nakagawa, H., Matsui, T. & Kim, H. Y. (2000) in *Climate Change and Global Crop Productivity*, eds. Reddy, K. R. & Hodges, H. F. (CAB International, Wallingford, U.K.), pp. 81-106.

Kawasaki, T. 1983. Why do some pelagic fishes have wide fluctuations in their numbers? FAO Fish. Rep. 291, pp. 1065–1080.

Kha, L.D. 2001 Studies on the use of natural hybrids between *Acacia mangium* and *Acacia auriculiformis*, Vietnam. Agricultural Publishing House, Hanoi, Vietnam.

Kha, L.D. 2006 Role of *Acacia* hybrids in the reforestation programme in Vietnam. Research Centre for Forest Tree Improvement, Forest Science Institute of Vietnam, Hanoi, Vietnam.

Kim, J.Y. 1992. Relationship between anchovy, *Engraulis japonica*, egg and larval density and environmental factors in the eastern waters of Korea. *Bull. Korean Fish. Soc.* 25: 495–500.

Kim, J.Y. and Kang, Y.J. 1992. Spawning ecology of anchovy *Engraulis japonica*, in the southern waters of Korea. *Bull. Korean Fish. Soc*. 25: 331–340.

Kim, J.Y. and Lo, N.C.H. 2001. Temporal variation of seasonality of egg production and the spawning biomass of Pacific anchovy, *Engraulis japonicus*, in the southern waters of Korea in 1983–1994. *Fish. Oceanogr.* 10: 297–310.

Kim, J.Y., Kim, S., Choi, Y .M. and Lee, J.B. 2006. Evidence of density dependent effects on the population variation of Pacific sardine (*Sardinops melanostictus*) off Korea. *Fish. Oceanogr.* 15: 345. doi:10.1111/j.1365-2419.2006.00413.x

Lima FP, Wethey DS (2012) Three decades of high-resolution coastal sea surface temperatures reveal more than warming. *Nature Communications*, 3, 704.

Matthews, R. B., Kropff, M. J., Horie, T. & Bachelet, D. (1997) *Agric. Syst.* 54 , 399-425.

MONRE (2012) *Climate Change and Sea Level Rise Scenarios for Vietnam*. MONRE, Hanoi.

Morimoto, H. 1998. Maturation. pp. 45–53, *in* Stock Fluctuations and Ecological Changes of the Japanese Sardine, *edited by* Y. Watanabe and T. Wada, Koseisya-Koseikaku Co., Tokyo. (in Japanese)

Nguyen et al. (2013): Meteorological and hydrological regime of Quang Binh. Science and Technics Publishing House.

Nguyen, T.T., Coulier, M., Nhu, O.L., Wilderspin, I (2012) *A preliminary analysis of disaster and poverty data in Quang Binh Province,* Vietnam, UNDP.

O'Connor MI, Selig ER, Pinsky ML (2012) Toward a conceptual synthesis for climate change responses. *Global Ecology and Biogeography*, 21, 693–703.

Peng, S., Huang, J., Sheehy, J.E., Laza, R.C., Visperas, R.M., Zhong, Z., Centeno, G.S.,, Khush, G.S., , and Cassman, K.G (2004) *Rice yields decline with higher night temperature from global warming* Proceedings of the National Academy of Sciences

Peters, D. B., Pendleton, J. W., Hageman, R. H. & Brown, C. M. (1971) *Agron. J.* 63, 809

Poloczanska ES, Brown CJ, Sydeman WJ, et al. (2013) Global imprint of climate change on marine life. *Nature Climate Change*, 3, 1-7.

Quang Binh Province’s action plan in response to climate change and sea level rise for 2011-2015 and orientation towards 2020

Schlacher TA, Thompson L (2013) Environmental control of community organisation on ocean-exposed sandy beaches. *Marine and Freshwater Research*, 64, 119 - 129.

Schoeman, D S, Schlacher, T, Defeo, Omar (2014) *Climate- change impacts on sandy-beach biota: crossing a line in the sand.*

Southern Natural Resources and Environment Company (2010*), Action plan in response to climate change in Quang Binh Province in 2011-2015, and vision to 2020.*

Takahashi M., Nishida H. and Yatsu, A. 2004. Preliminary study of growth of larval and early juvenile Japanese sardine in the Kuroshio-Oyashio transition region. PICES 13th Annual Meeting, p. 231. (Abstract)

Takasuka A., Oozeki Y., Aoki I., Kimura R., Kubota H. and Yamakawa T. 2004. Differential optimal temperatures for growth of larval anchovy and sardine: A potential mechanism for regime shifts? PICES 13th Annual Meeting, p. 27. (Abstract)

Takasuka, A., Oozeki, Y. and Aoki, I. 2007. Optimal growth temperature hypothesis: Why do anchovy flourish and sardine collapse or vice versa under the same ocean regime? *Can. J. Fish. Aquat. Sci.* 64: 768-776.

Thang, T.N., and Duong, D.T., *Evaluation of the drought and high temperature tolerance of Acacia crassicarpa varieties in the central coastal region, Vietnam*. Undated/unpublished report

UNDP (2009) *Risk knowledge fundamentals: Guidelines and lessons for establishing and institutionalizing disaster loss databases*, United Nations Development Programme, Regional Centre, Bangkok, Thailand.

Vozzo, J.A. 2002 Tropical tree seed manual, USDA Forest Service Agriculture Handbook 721. Washington D.C. p. 899.

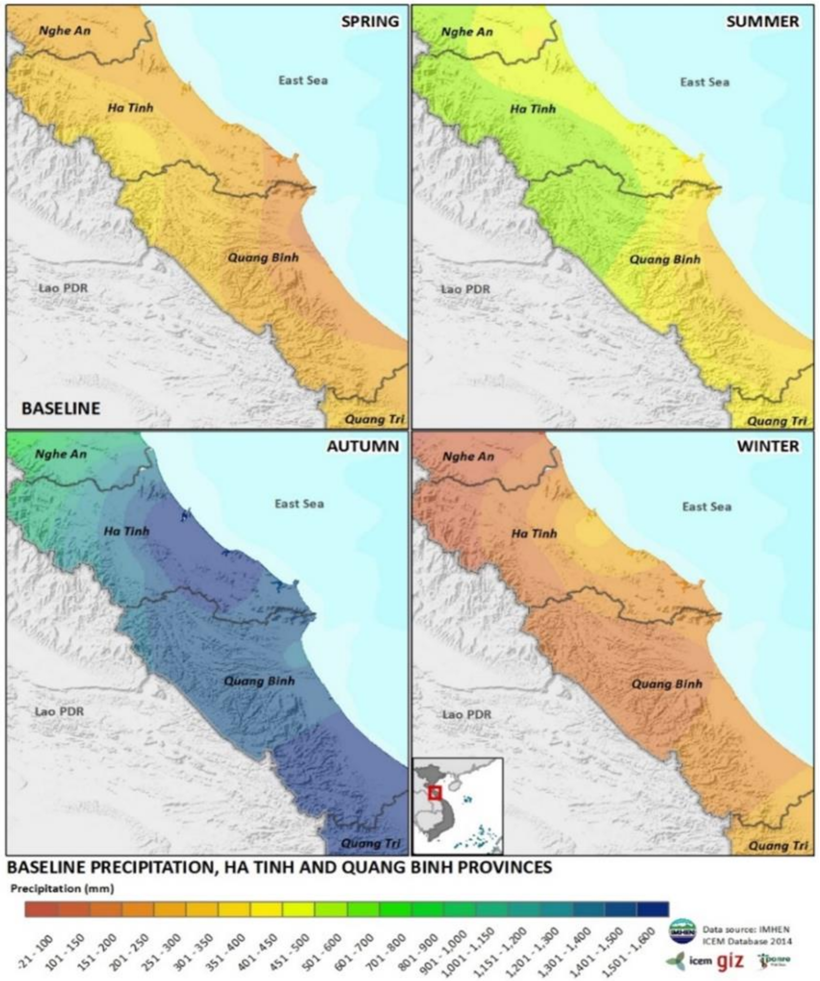
Zhu, D. 1991. Japanese anchovy. pp. 453-484 *in* Marine Fisheries Biology, *edited by* J. Deng and Q. Zhao, Agriculture Press.

Zhu, D. and Iversen, S.A. (*Eds.*). 1990. Anchovy and other fish resources in the Yellow Sea and East China Sea. November 1984 - April 1988, Fisheries Investigations by R/V “Bei Dou”. *Mar. Fish. Res.* 11: 1-143.

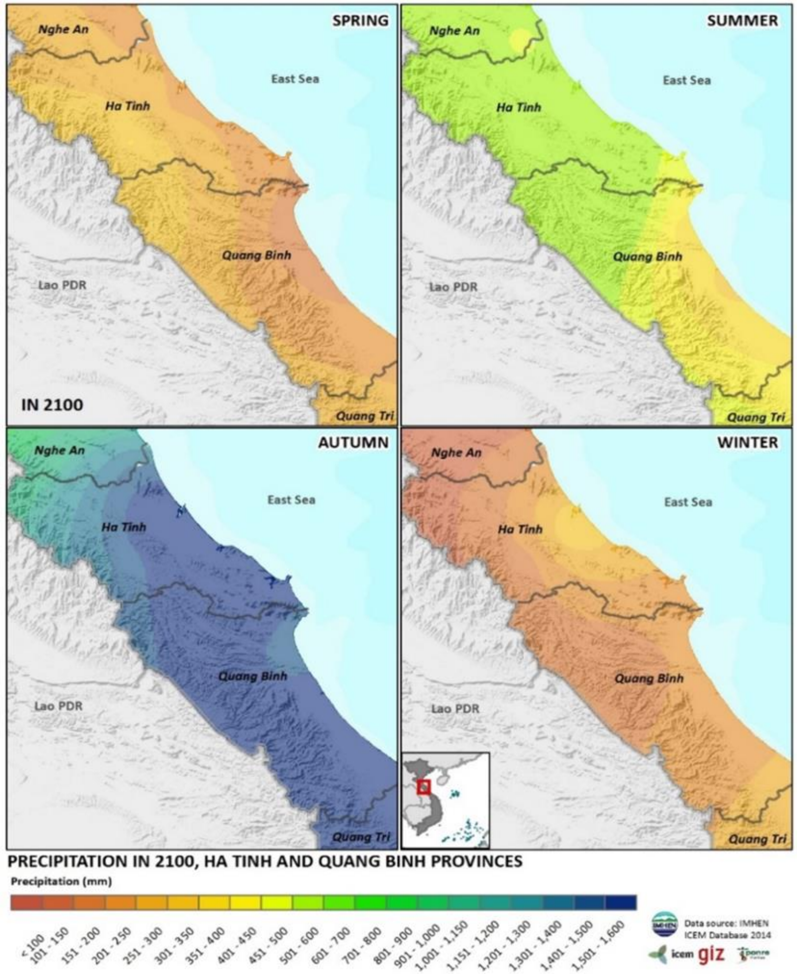
ANNEX 7.I: CLIMATE CHANGE MAPS FOR QUANG BINH UNDER THE MEDIUM EMISSIONS SCENARIO (B2)

1a: Annual seasonal maximum temperature: (i) Baseline and (ii) 2100

(i) Baseline

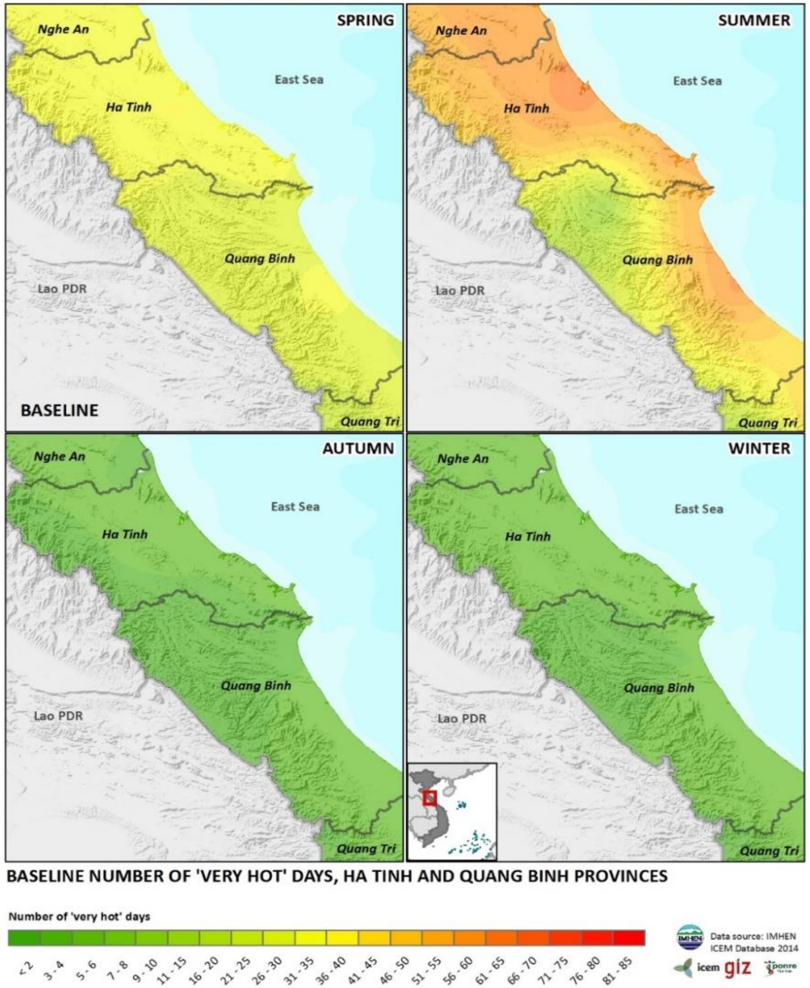


(ii) 2100

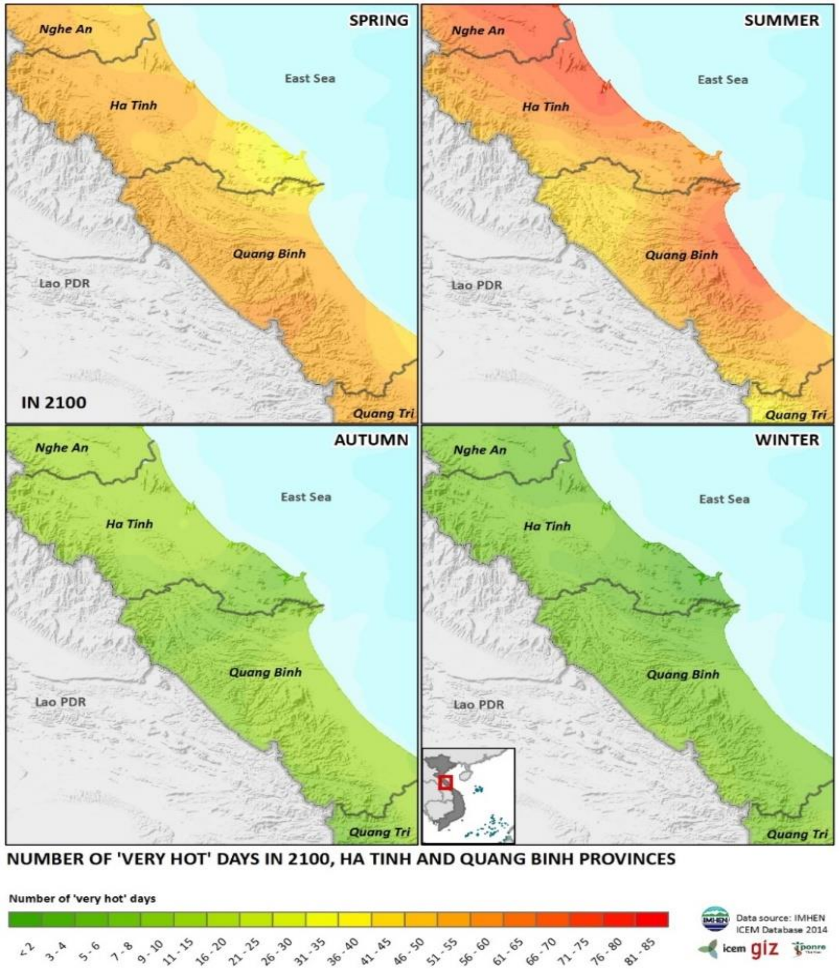


1b: Seasonal change in very hot days (>35 oC), (i) Baseline and (ii) 2100.

(i) Baseline

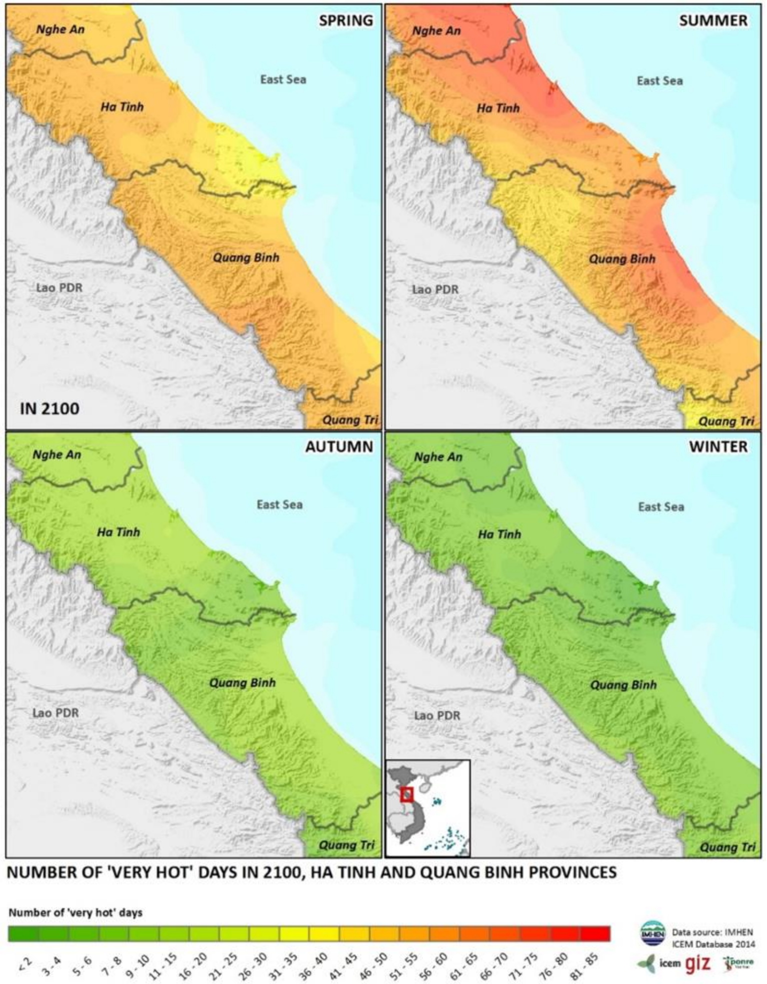


(ii) 2100

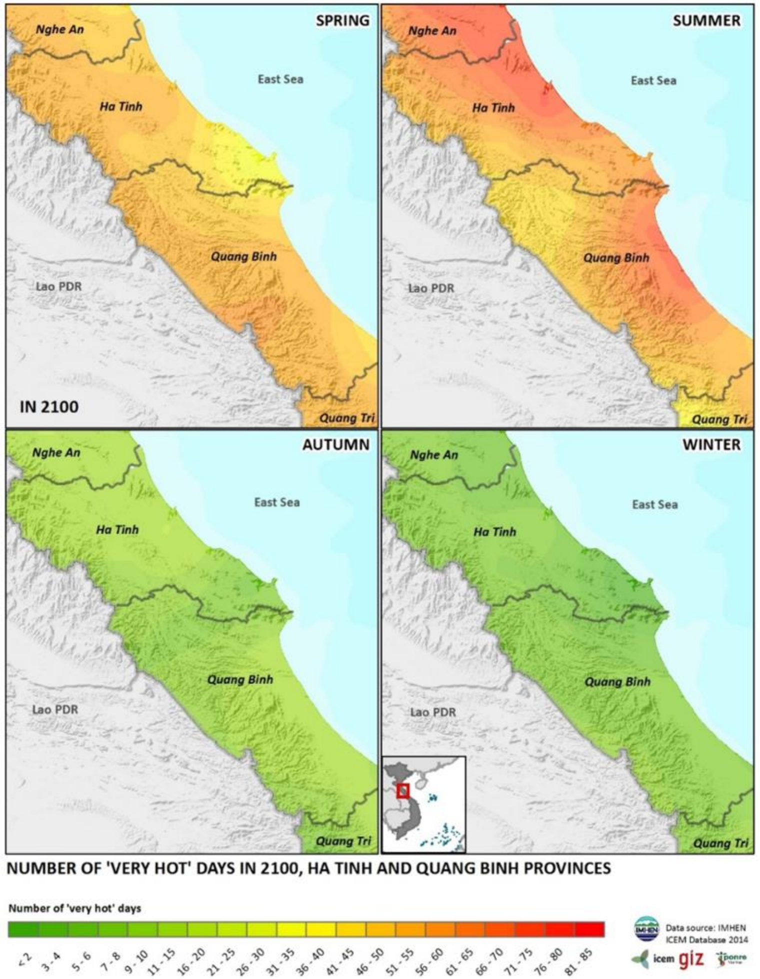


1c: Seasonal Incidence of Very hot days, (i) Baseline and (ii) 2100

(i) Baseline

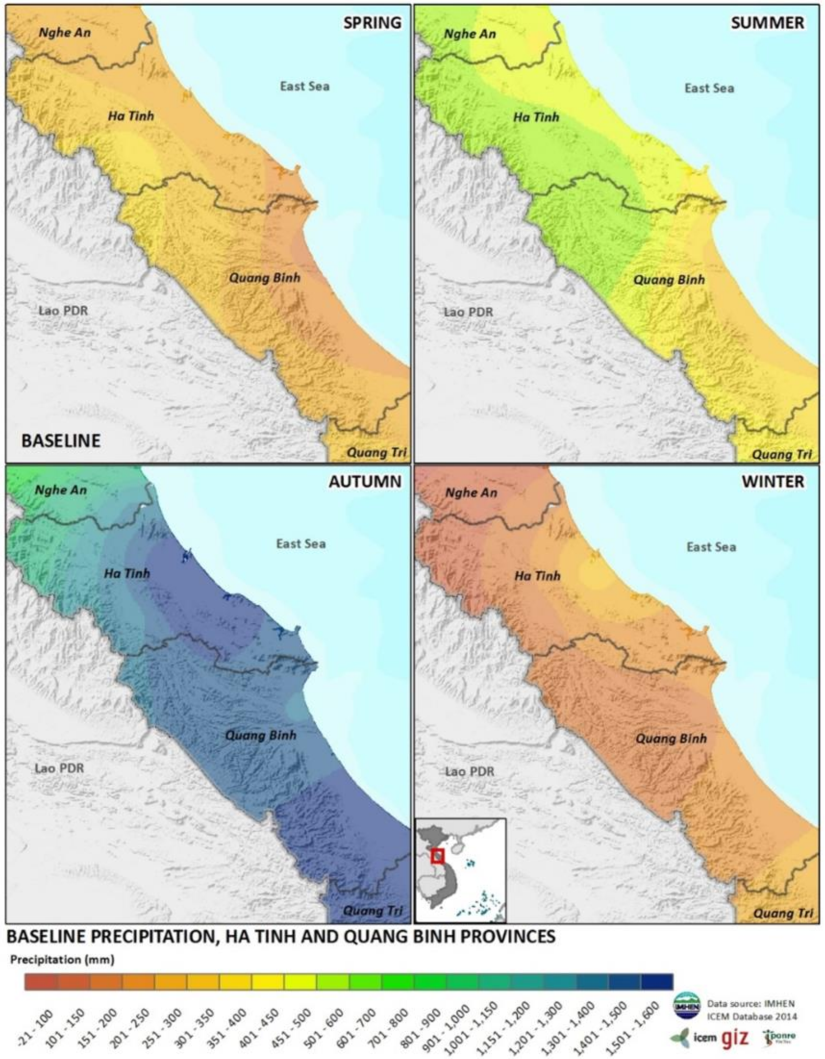


(ii) 2100

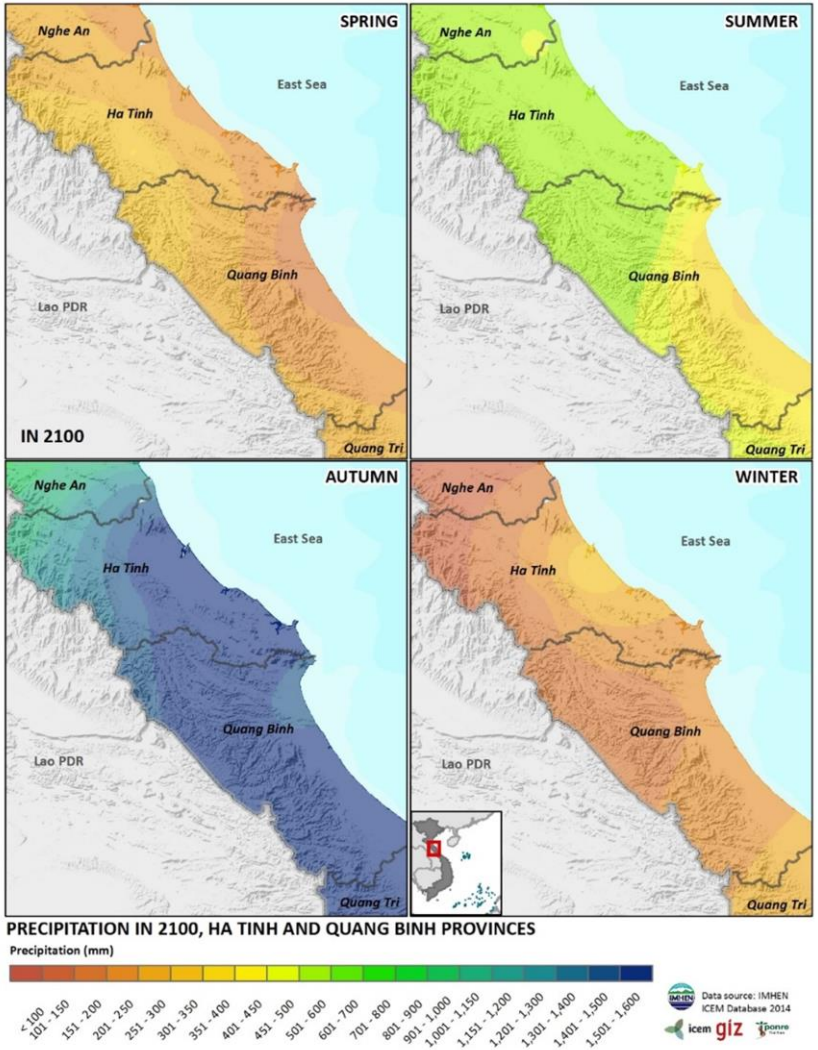


2a: Seasonal Average Precipitation in Ha Tinh and Quang Binh, (i) Baseline (1980-1999) and (ii) 2100

(i) Baseline (1980 - 1999)

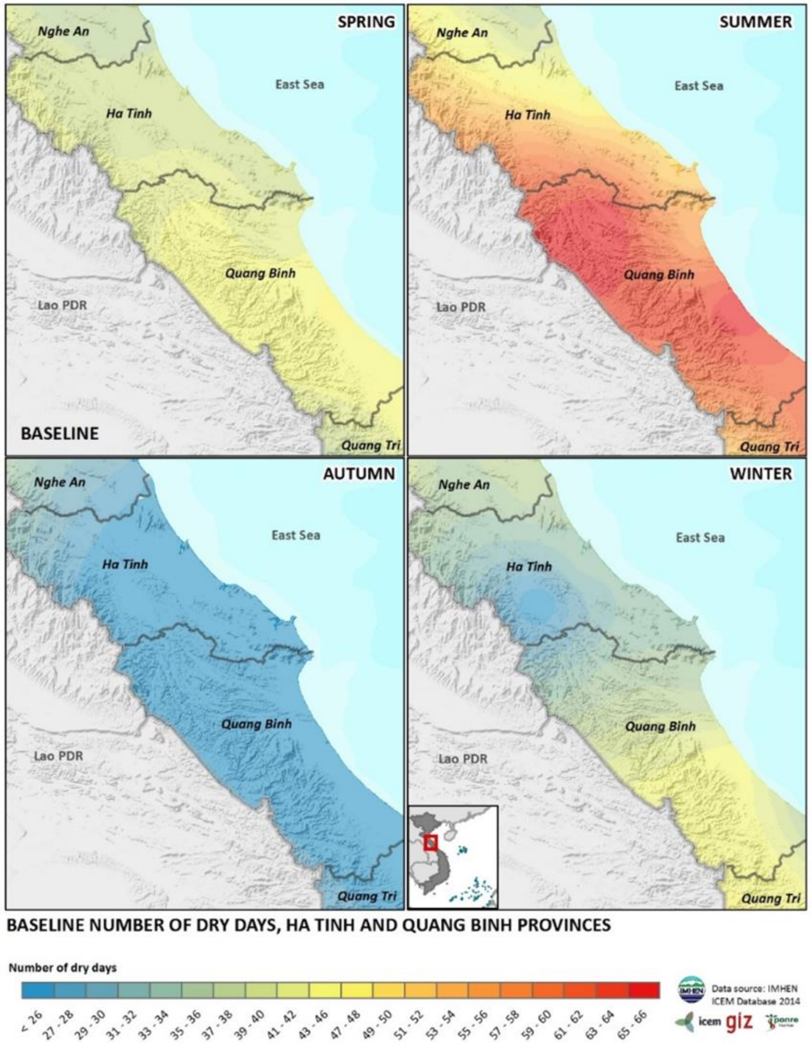


(ii) 2100

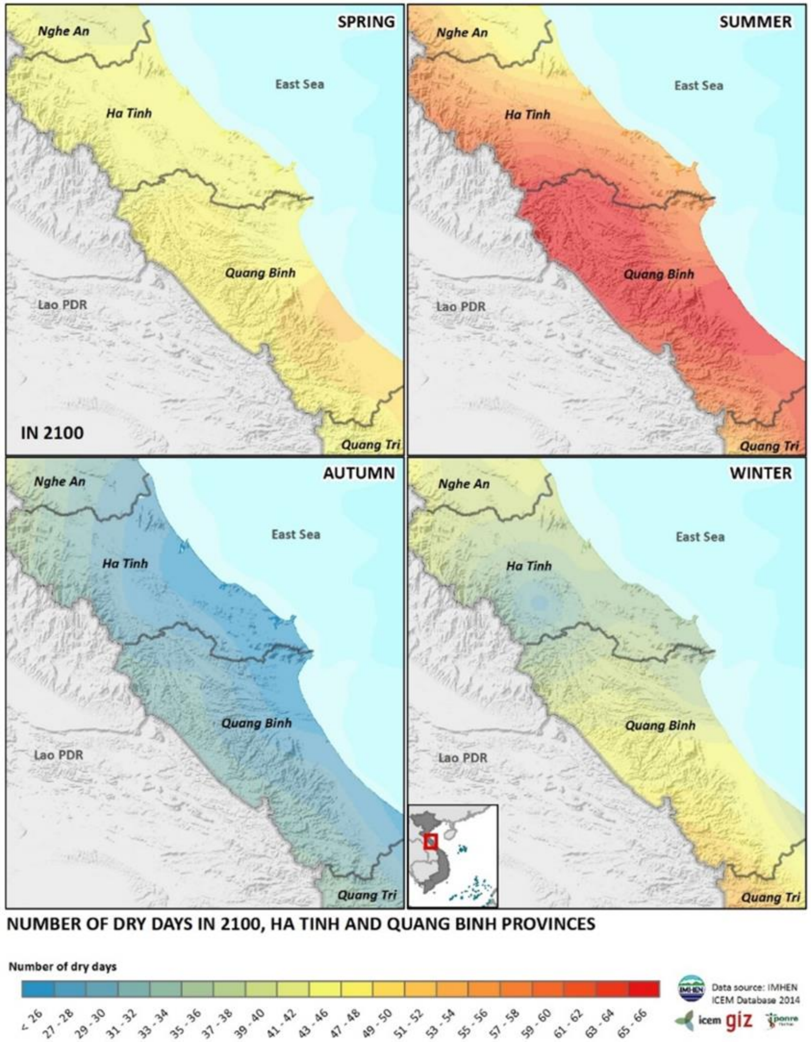


2b: Seasonal number of dry days, (i) Baseline (ii) 2100

(i) Baseline



(ii) 2100



ANNEX 7.II: ALL SEC CLIMATE CHANGE

SES	Avg Tmax Summer change in 2050 (C			Avg Tmax Summer change in 2100 (C			No. hot days (>35C) change in 2050			No. hot days (>35C) change in 2100			Rainfall change (6-8) in 2050 (%)			Rainfall change (6-8) in 2100 (%)			Rainfall change (3-5) in 2050 ((%)			Rainfall change (3-5) in 2100 (%)			Rainfall change (9-11) in 2050			Rainfall change (9-11) in 2100			No. dry days change in 2050			No. dry days change in 2100		
CODE	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN	MIN	MAX	MEAN
1a	1.8	1.8	1.8	3.5	3.5	3.5	23	24	23	34	35	34	4.9	5.0	5.0	9.4	9.5	9.5	-5.3	-5.2	-5.3	-10.1	-10.1	-10.1	3.8	4.0	3.9	7.4	7.6	7.5	17	17	17	15	15	15
2a	1.9	1.9	1.9	3.6	3.7	3.6	28	37	33	40	48	44	4.4	5.4	4.7	8.5	10.3	9.0	-5.5	-5.1	-5.2	-10.5	-9.7	-9.9	2.4	3.0	2.6	4.6	5.8	5.1	14	16	15	10	12	11
3a	1.9	1.9	1.9	3.6	3.6	3.6	40	40	40	54	55	55	4.6	4.7	4.7	8.8	9.0	8.9	-5.2	-5.1	-5.1	-9.9	-9.9	-9.9	2.8	2.8	2.8	5.4	5.4	5.4	16	16	16	12	12	12
3c	2.0	2.0	2.0	3.7	3.8	3.7	20	24	21	22	28	24	5.8	5.8	5.8	11.1	11.1	11.1	-5.3	-5.2	-5.2	-10.1	-9.9	-10.0	2.8	2.8	2.8	5.4	5.4	5.4	15	15	15	13	14	14
4a	1.7	1.9	1.8	3.3	3.6	3.5	42	49	47	52	66	64	3.9	5.4	4.8	7.4	10.3	9.2	-5.1	-4.5	-4.8	-9.8	-8.6	-9.2	3.2	3.4	3.4	6.1	6.6	6.5	17	19	18	14	19	17
4b	1.8	1.9	1.9	3.4	3.6	3.6	42	46	44	57	63	60	4.4	5.0	4.8	8.4	9.6	9.2	-5.2	-4.6	-5.0	-9.9	-8.8	-9.7	2.9	3.4	3.1	5.6	6.6	6.0	16	19	17	13	18	14
5a	1.7	1.9	1.8	3.2	3.6	3.5	34	48	41	41	63	56	3.4	4.7	4.2	6.5	9.0	8.0	-5.2	-4.3	-4.9	-9.9	-8.3	-9.4	3.2	4.2	3.5	6.1	8.1	6.7	17	20	19	14	19	17
5b	1.8	1.9	1.9	3.4	3.7	3.6	34	49	47	48	66	63	4.4	5.7	5.0	8.4	10.9	9.7	-5.2	-4.6	-5.0	-10.0	-8.8	-9.5	2.9	3.4	3.2	5.6	6.6	6.2	16	19	17	13	18	15
5c	1.9	2.0	1.9	3.6	3.7	3.6	33	40	36	47	51	49	4.4	6.1	5.3	8.5	11.7	10.1	-5.1	-5.0	-5.1	-9.9	-9.6	-9.7	3.1	3.3	3.2	6.1	6.4	6.2	16	17	17	14	15	14
5d	1.9	1.9	1.9	3.5	3.6	3.6	34	47	43	51	65	60	4.2	4.7	4.5	8.0	9.0	8.6	-5.1	-4.9	-5.0	-9.9	-9.5	-9.7	3.1	4.0	3.4	5.9	7.7	6.5	17	19	18	13	17	15
5f	1.7	2.0	1.9	3.2	3.8	3.6	18	50	39	17	68	53	3.4	6.4	4.8	6.4	12.2	9.2	-5.5	-4.4	-4.9	-10.6	-8.4	-9.5	2.5	4.3	3.3	4.8	8.2	6.2	14	20	18	10	19	16
5g	1.8	2.0	1.9	3.4	3.8	3.6	26	49	35	37	65	48	3.8	6.4	4.9	7.2	12.2	9.5	-5.3	-4.6	-5.0	-10.2	-8.7	-9.6	2.9	3.9	3.4	5.5	7.4	6.5	15	19	17	13	19	15
6a	1.9	1.9	1.9	3.6	3.6	3.6	37	40	39	50	54	52	4.5	4.8	4.6	8.7	9.2	8.9	-5.2	-5.1	-5.2	-10.0	-9.8	-9.9	2.6	2.8	2.7	4.9	5.3	5.2	15	16	15	11	12	12
6b	1.8	1.9	1.9	3.5	3.7	3.6	41	50	48	52	67	63	4.3	6.4	5.2	8.3	12.3	10.0	-4.8	-4.6	-4.6	-9.1	-8.8	-8.9	3.0	3.3	3.2	5.8	6.4	6.2	17	19	19	16	18	17
6c	1.9	1.9	1.9	3.7	3.7	3.7	43	45	44	58	61	60	5.3	5.7	5.5	10.2	10.9	10.5	-5.3	-5.1	-5.2	-10.1	-9.7	-9.9	3.0	3.2	3.1	5.7	6.1	5.9	16	17	16	13	15	14
8a	1.8	2.0	1.9	3.5	3.8	3.6	22	44	33	25	59	44	4.4	6.0	5.0	8.4	11.4	9.7	-5.6	-5.0	-5.2	-10.7	-9.6	-10.0	2.4	3.7	3.0	4.6	7.1	5.7	14	17	15	10	16	13
9a	1.9	2.0	1.9	3.6	3.7	3.7	37	43	40	49	58	54	4.7	5.5	5.1	9.0	10.5	9.8	-5.4	-5.2	-5.3	-10.4	-10.0	-10.2	2.6	3.0	2.8	5.0	5.8	5.3	14	16	15	11	13	12
9b	1.9	2.0	1.9	3.6	3.8	3.7	32	43	37	45	57	49	4.4	5.7	4.9	8.4	11.0	9.4	-5.6	-5.1	-5.3	-10.8	-9.7	-10.1	2.4	3.1	2.7	4.6	6.0	5.1	14	16	15	10	13	11
9c	1.8	2.0	1.9	3.5	3.8	3.6	19	41	29	22	54	39	4.4	5.8	5.1	8.5	11.1	9.8	-5.6	-5.1	-5.3	-10.8	-9.8	-10.1	2.4	3.9	2.9	4.6	7.6	5.6	14	17	15	10	15	12
9d	1.8	2.0	1.9	3.5	3.8	3.6	22	38	29	33	50	40	4.4	5.8	5.0	8.5	11.2	9.6	-5.6	-5.1	-5.3	-10.7	-9.8	-10.1	2.5	3.9	3.2	4.8	7.6	6.2	14	17	16	10	15	13
9e	1.9	2.0	1.9	3.5	3.8	3.6	27	35	31	39	47	43	4.5	5.7	4.8	8.6	10.9	9.2	-5.5	-5.1	-5.2	-10.6	-9.8	-10.0	2.6	3.2	2.8	4.9	6.2	5.5	14	16	15	11	13	12
9f	1.8	1.8	1.8	3.5	3.5	3.5	26	26	26	37	37	37	4.8	4.8	4.8	9.2	9.2	9.2	-5.2	-5.2	-5.2	-10.0	-10.0	-10.0	3.6	3.6	3.6	7.0	7.0	7.0	17	17	17	14	14	14
11a	1.9	1.9	1.9	3.6	3.7	3.6	41	44	42	55	59	57	4.9	5.0	4.9	9.3	9.6	9.5	-5.2	-5.2	-5.2	-10.1	-9.9	-10.0	2.8	3.0	2.9	5.4	5.8	5.6	15	16	16	12	13	13
10c	1.8	1.8	1.8	3.4	3.4	3.4	43	46	44	55	59	57	4.1	4.4	4.3	7.9	8.4	8.2	-4.6	-4.5	-4.5	-8.8	-8.7	-8.7	3.2	3.4	3.3	6.2	6.5	6.3	19	19	19	18	19	18
11d	1.9	1.9	1.9	3.6	3.6	3.6	32	33	32	43	44	44	4.4	4.5	4.4	8.4	8.5	8.5	-5.1	-5.1	-5.1	-9.8	-9.7	-9.8	2.4	2.7	2.6	4.7	5.2	5.0	15	15	15	10	11	11
11h	1.9	1.9	1.9	3.5	3.6	3.6	28	31	30	39	43	41	4.5	4.6	4.6	8.6	8.9	8.7	-5.2	-5.1	-5.1	-9.9	-9.8	-9.9	2.7	3.2	2.9	5.2	6.1	5.6	15	16	15	11	13	12
River-l	1.8	2.0	1.9	3.5	3.8	3.7	19	49	35	21	66	47	4.3	6.3	5.1	8.3	12.1	9.8	-5.6	-4.7	-5.2	-10.8	-8.9	-10.0	2.4	4.0	3.0	4.6	7.7	5.8	14	19	16	10	17	13

CHAPTER 8 ADAPTIVE CAPACITY IN CLIMATE CHANGE VULNERABILITY ASSESSMENTS: QUANG BINH

8.1 INTRODUCTION

The present chapter discusses an important element in the vulnerability to climate change equation - adaptive capacity - and presents an overview of it, at the provincial level, in Quang Binh. A detailed study of provincial adaptive capacity was beyond the scope of the EbA assignment, so this exploration has involved a brief overview of policy and related literature, and semi-structured interviews with a small number of key informants, principally in DARD and DONRE, but also in other key departments as well as observations by members of the current study team. The findings presented here should be considered provisional, and provincial partners are encouraged to provide additional information and make corrections where needed. The impressions gained here have been used to inform the SES vulnerability assessments presented in Chapter 9.

The chapter begins with a brief review of key concepts relating to adaptive capacity. Since these concepts are complex and in some cases disputed, a fuller treatment is provided in the annex to this chapter. The next section outlines the approach to adaptive capacity taken in the provincial- and local-level studies of this vulnerability assessment. The indicative findings of provincial-level assessment of adaptive capacity follow - first examining relevant national level structures and policies and then looking in as much detail as was possible at the level and nature of the present adaptive capacity in Quang Binh. The chapter ends with a brief discussion, conclusions and recommendations.

8.1.1. Key concepts

To understand adaptive capacity and assess it for the EbA vulnerability study and, ultimately, to enhance it, it is useful to consider: i) what we mean by adaptation; ii) what is adaptive capacity; iii) what constitutes "successful adaptation" or a well-adapted community, or system; and iv) how do we build adaptive capacity?

The following definitions are used in this study:

8.1.1.1. ADAPTATION

Adaptation may be defined as:

"*The adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation is a process and not an outcome*" (GiZ/WRI 2011).

Adaptation is a process because climate change is on-going and thus the need to adjust to it is also continuing; therefore, no outcome is likely to be final. Though individual adaptation interventions might have an end-state in mind, this is likely only to be an interim state, and further change is likely to be needed in the future. Uncertainty is inherent in adaptation, as it is in climate change, and it is thus the "capacity to adapt", or keep adjusting that is the most important.

The questions of "who adapts" or "whose adaptive capacity" are important ones. Basically, everyone needs to adapt and develop their adaptive capacity, but different stakeholders have different roles in making adaptation work. In the context of this EbA study, adaptive capacity of government stakeholders at the provincial level is considered here, and that of local level stakeholders in case studies.

8.1.1.2. ADAPTIVE CAPACITY

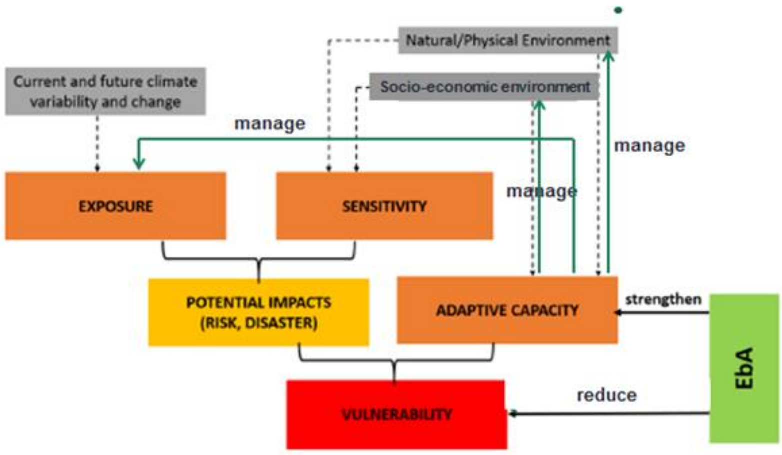
Adaptive Capacity is defined in different ways depending on the context. In the context of climate change, it has been defined as:

"*The potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts*" *(from Smit et al., 1999)*[14].

For the EbA vulnerability assessments the "system" in question, and unit of analysis, is the socio-ecological system (SES), as shown in Figure 8.1. The socio-ecological system concept puts people front and centre in the analysis. It reflects the understanding that climate change is a human issue: people are the cause of climate change, the victims of it, and human capacity to adapt is key to successful approaches to it.

[14] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=650

Figure 8.1: Capacity in Climate Change Vulnerability Assessment for EbA



Source: adapted from GIZ, Adelphi and EURAC 2013, based on IPCC 2007

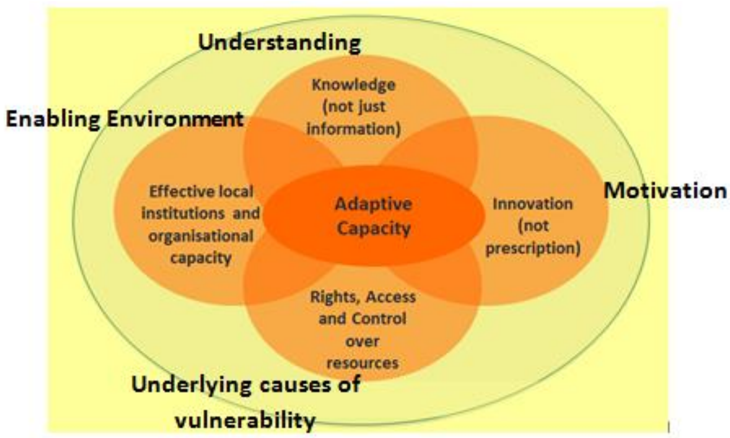
Adaptive Capacity of Species and Ecosystems

Some EbA assessments include an analysis of the "adaptive capacity" of species and ecosystems (Tuan et al (eds) 2012). In the ecological literature (Gunderson and Holling 2002) adaptive capacity is the ability of a living system to adjust responses to changing internal demands and external drivers in the short term; in the longer term, it is the system's "evolutionary potential". Three different levels are identified. For species, potential is determined by genetic diversity; for ecosystems, it is their biodiversity or complement of species; and at landscape or biome level, it is the mosaic of different ecosystems present, their connectivity and patch size.

While the concepts of adaptive capacity of species and ecosystems are relatively straightforward, in practical terms, they are very difficult to assess, particularly in a short study such as this. Simply too little is known about the ecosystems and species concerned, and even if such knowledge existed, the modelling required to predict changes would be impossibly complex. Further, in this EbA assessment, we are dealing with socio-ecological systems - in which the natural ecosystems have been radically transformed as a result of the decisions, technologies and actions of human beings.

In the present analysis, then, "adaptive capacity" is explicitly understood as a human/social phenomenon. While an inherent characteristic of ecosystems is that they can change fundamentally in response to shocks and trends, and reach new stable points, in terms of identifying EbA actions, we are more interested in peoples' capacity to manage the ecosystem and direct the change (e.g. through application of human, technological, and financial capital) and the capacity and political will of governance entities to deploy those resources. Notwithstanding these practical constraints, some useful principles do emerge, which can be usefully applied when considering adaptation to climate change. These include the idea of maintaining and promoting diversity at all levels and the need for flexibility, to maximise and capitalise on the options open in socio-ecological systems, in the face of an uncertain future.

Figure 8.2: Elements of Adaptive Capacity



Source: CARE (2009) CVCA Handbook

For the purposes of this study, adaptive capacity is essentially:

"the broad set of enabling traits, possessed by people, to manage the exposure and sensitivity of their socio-ecological system, either for the increased resilience of the system to changing climatic circumstances, or for its transformation to a new regime that is better suited to new climatic circumstances".

Having understood adaptive capacity as it relates to exposure, sensitivity and vulnerability it is useful to consider what it actually consists of. CARE, in its approach to community-based adaptation identifies four main elements of adaptive capacity, as shown in Figure 8.2.

Perhaps the most important element shaping the adaptive capacity of individuals, households and communities is their access to and control over livelihood resources or "assets": natural, human, social, physical and financial[15]. Simply put, the greater the access and control of these assets, the wider the potential options available and greater the potential adaptive capacity. Further, it is in the lack of these assets or capitals that we see the links between adaptive capacity, vulnerability to climate change and poverty, and the disadvantages suffered by women and other vulnerable groups.

From the EbA perspective, "natural capital" is of central importance. EbA seeks to promote adaptive capacity by enhancing peoples' ability to manage and care for the natural ecosystems and the environmental services they provide.

Access to resources is clearly not enough on its own. People must understand the climate challenge facing them, and have ideas about what to do. These are "knowledge" and "innovation" respectively. Knowledge is more than getting the information and knowing the facts about climate change. It must be accompanied by understanding the importance of ecosystems to livelihoods, the need for action, and the motivation to act. Innovation implies ability to devise new solutions. Communities in Vietnam have been coping with various extreme climate events for centuries, providing good preparation for climate change. However, climate change demands new solutions - looking further into an uncertain future.

Finally, there must be an "enabling environment" for adaptation: the policies and programmes of government that open up what people are able or encouraged to do; the organisations at all levels that support peoples' adaptation and or manage wider adaptive interventions.

Drawing on all these definitions, building Adaptive Capacity is arguably the key element and ultimate objective of climate change adaptation work. It is thus an important factor in the present provincial-level EbA vulnerability assessment and the efforts to identify the socio-ecological systems most in need of adaptation action and select particular local-level sites for more detailed assessment.

8.1.1.3. WHAT IS "SUCCESSFUL ADAPTATION"?

At a very basic level, a successful adaptation is one that has established goals over a range of future climate scenarios and is effective in meeting them, producing benefits that outweigh costs - financial, physical, human, or otherwise (Smit et al., 2001). At higher levels, a successful adaptation would be one that has addressed cost-effectiveness, efficiency, the distribution of benefits, the legitimacy of the adaptation, sustainability, global and intergeneration equity and the resonance of adaptation with cultural norms and collectively held community values. With such a complex concept, inevitably, finding a workable definition of successful adaptation is always going to be contested (Adger and Vincent, 2005).

8.1.1.4. BUILDING ADAPTIVE CAPACITY

As discussed above, the question of "who adapts" is important, and so equally important is the question "whose adaptive capacity". In the face of climate change, to a very large extent, everyone, civil society, private sector and government needs adaptive capacity, but the nature of the adaptive capacity in each group will be configured somewhat differently.

The CARE schema also helps us to understand what building adaptive capacity entails:

- Actions to address the underlying causes of vulnerability, which are largely the same as those underlying poverty: enhancing access to essential livelihood assets, and increasing livelihood diversification.
- Actions to promote knowledge and understanding of climate change challenges, including the inherent uncertainty climate change entails, the need to maintain diversity and remain flexible, and the motivation of key stakeholders to take action.

[15] See DFID Sustainable Livelihoods Guidance Sheets for more details on livelihood assets. http://www.eldis.org/vfile/upload/1/document/0901/section2.pdf

- Actions to promote, encourage, and support stakeholders to devise innovative, locally appropriate and integrated solutions to anticipate the threats of climate change, moving on from mere reactive coping to immediate hazards, or top-down prescriptions.
- Actions to improve the institutional and organisational environment: enabling policy for climate change adaptation, at local as well as national level, particularly relating the three points above, including actions on fundamental issues such as gender and then need for participatory engagement with all stakeholders

These points can guide the adaptation work of a wide range of stakeholders, from communities, through CBOs, NGOs, government agencies at all levels, and international donors. The focus of CCA must not just be on the practical adaptation "interventions" (like SRI, improved watershed management, diversification of livelihoods) but on the processes of reducing vulnerability and building adaptive capacity that underpin the interventions and promote the sustainability of adaptation, in the long term.

8.1.2. Adaptive Capacity in the EbA Vulnerability Assessment

For the EbA Vulnerability Assessment, adaptive capacity needs to be considered at both stages of the study: first at the provincial level stage, and then again at the local level. We use the CARE graphic to structure the analysis. Although it was developed to help understand community-based adaptation, with slight modifications it can equally be employed to inform adaptation interventions at any level. The approach at each level is outlined below.

8.1.2.1. ADAPTIVE CAPACITY IN THE PROVINCIAL-LEVEL VULNERABILITY ASSESSMENT

The objectives of the provincial-level VA are to identify the province's socio-ecological systems (SES) and assess the vulnerability of each, to provide a basis for prioritising sites for further work and for making provincial-level EbA recommendations. The unit of analysis for considering adaptive capacity thus should also be the SES. While it has been suggested that, like ecosystems, SES will exhibit the tendency to change to their function and structure, when certain thresholds are exceeded and system feedbacks change, our understanding of what would be highly complex shifts is currently only rudimentary or speculative. Further, given that adaptive capacity is essentially a human characteristic, and that the provincial-level VA relies entirely on secondary data and limited engagement with provincial level government stakeholders - this adaptive capacity assessment is focused on the provincial government. The capacity of government at the national and district levels are undoubtedly of importance, but beyond the scope of this study. Time permitting, commune government capacity can be picked up on during the local-level VA (see below).

CARE's four "elements" are used to structure the provincial-level adaptive capacity assessment:

Effective Institutions and Organisations: The government agencies that are responsible for climate change policy and action, their main policies, strategies, plans and programmes, and how effective they are individually, and how well they coordinate with each other.

Knowledge and Innovation: For most government actions, a collective understanding is expressed in it policies, strategies, plans and programmes. Vietnam's policy framework for climate change is thus given some consideration. However, concrete climate change related knowledge is a different thing, and much less widespread. It is important to identify the extent to which it exists, where this actually lies (who knows and understands what) and how this understanding is used. It must also include awareness of key climate change concepts - such as uncertainty and risk. For government, "knowledge" must also include the ability to generate relevant knowledge - that is research - and turn it into new and locally-appropriate action - that is "innovation". Which sectors and climate change related threats attract the most research, interest and application. EbA is an innovation - how well do government institutions embrace, explore and tailor new ideas.

Resources: How the government allocates funds for climate change related actions.

8.1.2.2. ADAPTIVE CAPACITY IN THE LOCAL-LEVEL VA

The objectives of the local-level vulnerability assessment are to identify and propose solutions to specific climate adaptation problems, in priority SES identified in the provincial-level assessment. An equally important objective of this initiative at both the provincial and local-levels is to demonstrate workable, replicable methodologies that can be applied in the demonstration provinces and elsewhere in Vietnam and perhaps the region. At the local-level, a key part of this methodology is engaging with local level stakeholders. Participatory exercises are employed to understand peoples' present adaptive capacity, and at the same time to raise their awareness of climate change and begin strengthening their capacity to work together to adapt to the challenges ahead.

The same four "elements" of adaptive capacity are assessed at the local level amongst the commune government and the villagers, and other key stakeholders, depending on the SES (eg Forest Protection Management Board [FPMB], Vietnam Border Defence Force, commercial companies, etc.).

8.2 CURRENT ADAPTIVE CAPACITY AT THE PROVINCIAL LEVEL

As mentioned above, the focus on this section is on provincial adaptive capacity, but to provide context, it begins with a brief review of the national organisational structures and policies for CCA to which provincial actions respond, and to the closely linked programmes in Disaster Risk Reduction.

8.2.1. National Organisational Structures and Policies for Climate Change Adaptation and Disaster Risk Reduction

Adaptive capacity for climate change adaptation in Quang Binh is strongly shaped by institutions and policies at the national level. Figure 8.3 shows how Vietnam's response to climate issues is structured, and Figure 8.4 presents the national policy framework for climate change.

8.2.1.1. NATIONAL ORGANISATIONAL STRUCTURES

The Prime Minister has ultimate responsibility for Climate Change and is advised by a National Committee on Climate Change (NCCC), established in 2011 and comprised of members from all key ministries[16]. The NCCC itself, has its own Advisory Team. The Ministry for Natural Resources and the Environment (MONRE) is the government's focal point and lead technical agency for climate change issues, both internationally and nationally. Internationally, MONRE coordinates Vietnam's participation in multi-lateral environmental agreements, such as the United Nations Framework Convention on Climate Change (UNFCCC) and its related Protocols. Nationally, MONRE hosts the Standing Committee of the NCCC and both the Standing Committee and the Project Management Unit of Vietnam's key climate change programme - the National Target Programme to Respond to Climate Change (NTPRCC). It includes key technical agencies related to climate change, notably the Institute of Meteorology, Hydrology and Environment (IMHEN) and the Institute for Strategy and Policy on Natural Resources and the Environment (ISPONRE). MONRE has a role to guide and coordinate the climate change work of other line ministries at national and provincial levels. However, there are also lines of communication between the Line ministries upward with the NCCC and downward with their own provincial departments. This creates some coordination issues that will be discussed below.

MARD, given its mandate for agriculture and rural development, also has a major role to play in climate change adaptation and mitigation. The other key Ministries are Construction, Industry and Trade, Transport, as well as Planning and Investment and Finance.

8.2.1.2. NATIONAL POLICY FRAMEWORK FOR CLIMATE CHANGE

The expression of Vietnam's highest political will relating to climate change is found in Resolution No 24 (2013) of the Communist Party Central Committee on "Proactively responding to climate change, boosting resource management and environmental protection".

Vietnam's key policy, the National Climate Change Strategy, was set out by MONRE in 2008 and approved in 2011. This was followed by the key national programme, the National Target Programme for Responding to Climate Change, with a budget of USD 93.5 million up to 2015. The Support Program to Respond to Climate Change (SP-RCC) was set up at the same time to mobilise and coordinate resources from international donors for the NTP-RCC. USD 620 million was provided in the first three years, from a number of bilateral and multilateral donors including WB, UNEP, FAO, JICA, AFD, AUSAID, Korea and BMU. Its funds are allocated through a process guided by managed by MONRE. Ministries and localities submit projects and requests for funding, and following inter-ministerial consultations, these are compiled into a prioritized list and submitted to the Ministry of Planning and Investment (MPI) and the Ministry of Finance (MOF). The NTP-RCC and its Support Program were renewed in 2011 and again in March 2016.

The NTP-RCC has 8 sub-programmes:

1. Assessing the impacts of climate change
2. Identifying appropriate responses
3. Developing a scientific-technical programme

[16] MARD, MONRE and National Defence , public security, Information and communication, Transport , Industry and Trade, Planning and investment, Finance, Education and Training, Health, MOLISA

4. Strengthening capacity and the policy framework in the relevant organisations and institutions
5. Raising awareness across the country
6. Enhancing international cooperation
7. Mainstreaming the NTP across all sectors
8. Developing Specific action plans to respond to climate change (all ministries, sectors, localities).

As such, the NTP is often referred to as a "strategy to develop a strategy". In the first period, many important policies and plans were developed: National Strategy on Climate Change (2011), National Action Plan on Climate Change (2012), National Strategy on Green Growth (2012), Party Central Committee Resolution on responding to climate change (2013), protection of natural resources and environment (2013).

The breakdown of expenditure for the NTP-RCC is:

(i) about 72% goes to environmental research and governance, as well as training and education activities;

(ii) 20% goes to specific sectors, including agriculture, social affairs and industry; and

(iii) 8% is given directly to the 64 Peoples' Committees at provincial and municipal levels, to address local priorities.

In 2008, MARD was one of the first ministries to issue its specific action plan, in the Action Plan Framework for Adaptation to Climate Change in the Agriculture and Rural Development sector, period 2008 - 2020. It has five main objectives:

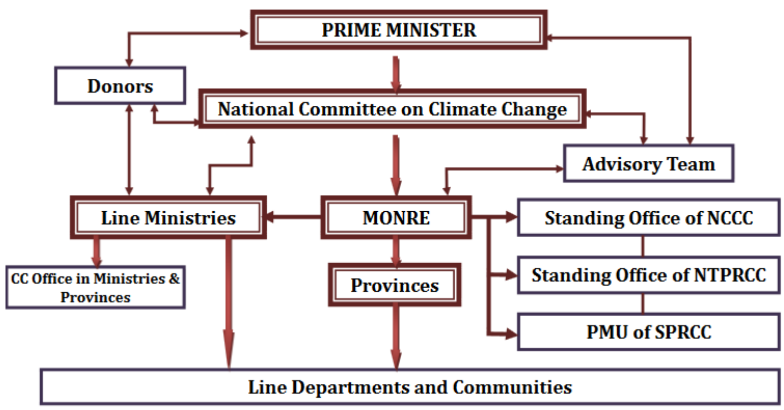
- Ensure the safety of all residents, particularly in the Northern Delta, Mekong River Delta and Central Coastal Zone.
- Ensure stable production of agriculture, forestry, fisheries and salt, with an emphasis on low emissions and sustainability
- Ensure food security through maintaining 3.8m ha of paddy (3.2m with at least 2 crops per year)
- Ensure the safety of the dyke system and other civil works for disaster prevention and mitigation
- Maintain economic growth rate and poverty reduction and GHG emissions reduction rates of 20% in each 10 year period.

Many of its proposed actions relate to infrastructure development.

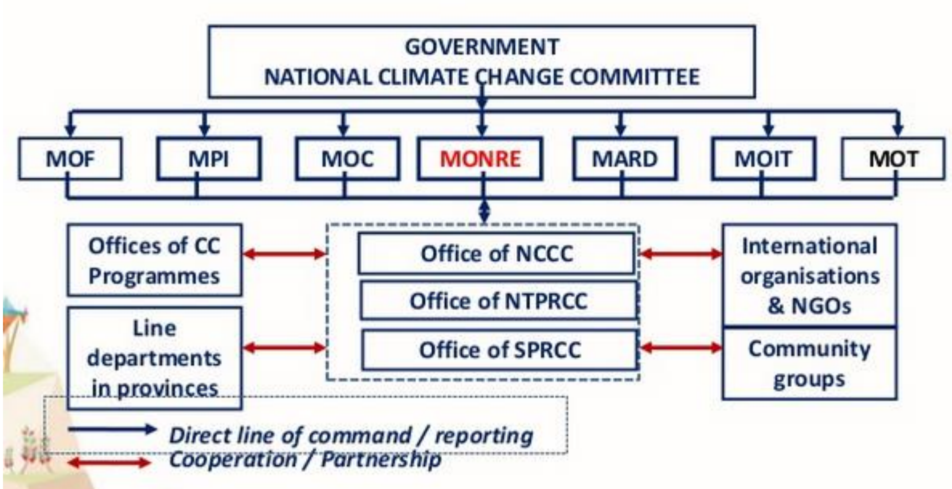
MARD is also responsible for Disaster Risk Reduction work (see below).

Between 2010 and 2013 all 63 provinces and centrally-run cities issued their own climate change response action plans (CCRAP). Quang Binh prepared its CCRAP in 2011 and it was being renewed in 2015-16.

Figure 8.3: Vietnam's Institutional Structures relating to Climate Change



Source: Nhat 2015



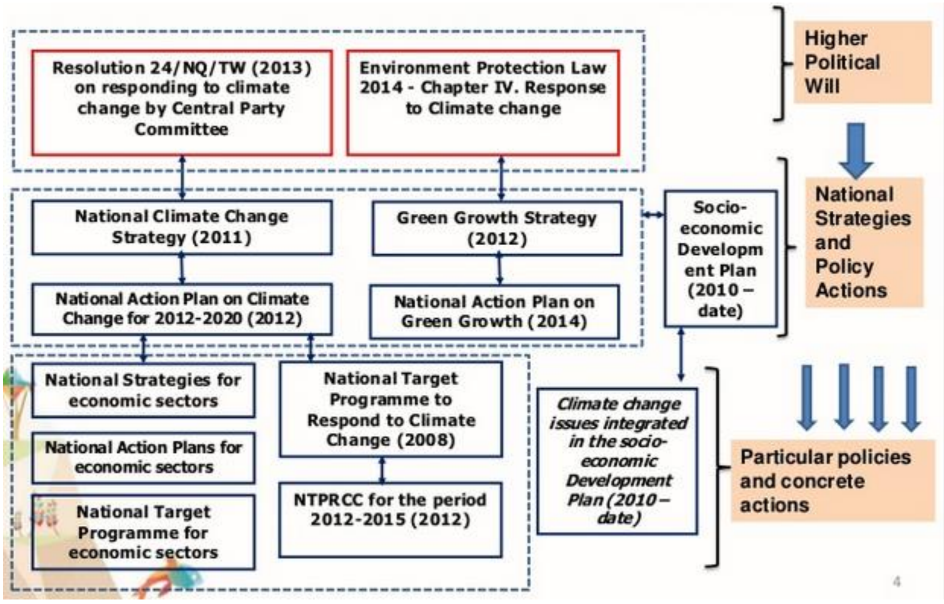
Source: Nhat (2016)

8.2.1.3. NATIONAL DISASTER RISK REDUCTION STRUCTURES AND PROGRAMMES

The National Strategy for Natural Disaster Response, Prevention and Mitigation to 2020 was developed by MARD, in collaboration with the Ministry of Defense and other agencies and approved by the PM in 2007. It broadly responds to requirements under the UNFCCC, Kyoto Protocol, Hyogo Framework for Action17 and the ASEAN Agreement on Disaster Management and Emergency Response. It is managed by MARD's Disaster Management Center of the Directorate for Water Resources, established in 2010. MARD hosts the Standing Office for the Central Committee for Flood and Storm Control (CCFSC). Natural disaster prevention and control plans are elaborated at local, ministerial and national levels every 5 years corresponding to socio-economic development plans, and adjusted annually. Much of the practical work focuses on the construction and maintenance of reservoirs, irrigation systems and dykes.

The Central Steering Committee for Natural Disaster Prevention and Flood Control is responsible for disaster response, in coordination with the National Committee for Search and Rescue. Implementation of the response is handled locally, through provincial Disaster Management Departments (DMD).

Figure 8.4: Vietnam's National Policy Framework Responding to Climate Change



Source: Nhat (2015)

[17] The Hyogo Framework for Action is a 10-year plan of the UN Office for Disaster Risk Reduction to make the world safer from natural hazards. HFA II was recently agreed in 2015

8.2.2. Adaptive Capacity at Provincial Level in Quang Binh

8.2.2.1. ORGANISATIONAL STRUCTURES, POLICIES AND PLANS FOR CCA AND DRR

Provincial institutions engaged on climate change include Departments, Standing Agencies and Steering Committees, as at national level, and more specifically commanding committees, carrying out implementation. Together with policies and plans (and resources) - these configure the “enabling environment” for climate change adaptation.

8.2.2.1.1. Department of Natural Resources and the Environment (DONRE)

In Quang Binh, DONRE is the Standing Agency for the implementation of the NTP-RCC in the province. However, the province does not yet have Provincial Steering Committee for Climate Change related to the NTP[18], and only in 2016 did DONRE establish a dedicated unit to manage climate change issues. This unit, Climate Change and Hydrometeorology, currently has 3 staff members.

DONRE’s primary role is to prepare and manage the Provincial Climate Change Responding Action Plan (CCRAP), under the NTP-RCC. The CCRAP, which covers all economic sectors, was prepared in 2011 for the period to 2015 with VND 1 billion central government funding and is currently (June 2016) being updated. Consultants are hired to do the work, under the supervision of DONRE, and the process includes consultations with other departments. The plan incorporates 36 separate projects and programmes. Projects are implemented by the relevant departments, and DONRE supervises and monitors implementation, with the collaboration of MPI and MoF. However, as of December 2015, none of the projects included in the CCRAP had been funded.

DONRE sub-departments manage some climate-related data collection. Sea and Islands collects some seawater chemistry data from a limited number of inshore sites, but it is not clear whether this contributes to climate change analyses. Seawater temperature is not monitored. The division of Climate Change and Hydro-meteorology manages three weather stations, in Dong Hoi, Tuyen Hoa and Ba Don, and several hydrological stations on the main rivers.

8.2.2.1.2. Department of Agriculture and Rural Development (DARD)

The provincial Department for Agriculture and Rural Development (DARD) has been one of the first to establish its own Climate Change Action Plan, in response to the MARD. It also hosts the provincial Steering Committee for Storms and Flood Prevention and a Steering Committee for Search and Rescue, both located in the Irrigation and Flood Control sub-department of DARD.

DARD does not have a dedicated climate change unit, but “mainstreams” climate change in all its divisions. Forestry Division has 5 staff dedicated to climate change (including REDD+).

In 2015, with support from JICA, DARD embarked on the programme “Building Disaster Resilient Societies in Vietnam 2016-2020 and vision to 2030”, which aims to strengthen the resilience of society against water-related natural disasters through integrated flood management (IFM) systems. The project covers all sectors, so an inter-departmental steering committee and working group were established to draw up a plan, which has now been approved by the PPC.

Despite these moves, climate change adaptation does not appear well integrated into DARD’s annual plans (DARD 2016). Mention is made of El-Nino, and expected drought - but these short-term phenomena are not contextualised in terms of climate change. Plans do include introduction of fast-maturing rice varieties, the scaling-up of SRI rice techniques, or switching from rice to less water demanding crops - but medium-longer term trends and measures are not suggested. The focus of planning remains on increasing production, modernising techniques and general sectoral restructuring, although this latter task does call for greater attention to climate change.

Agricultural development and extension services

The extension system in Vietnam is vertically organised - there is a National Agricultural Extension Centre (under MARD), a provincial centre (under DARD) and extension stations at district (also under DARD). Typically, one extension agent is responsible for two or three communes, but in the mountains, it may be one for one.

MARD has a Crop Production Department, and Science Technology and Environment Department, both contributing to developing adaptation solutions. At the provincial level the Economy and Technology sub-department handles technical issues. Most decisions on adaptation measures are made at national level.

[18] NB. There are 46 different steering committees overseen by the Quang Binh PPC. So – a Steering Committee does not necessarily produce real focus on critical issues.

Provinces develop their own CAPs, depending on the principal threats of drought and salinization. MARD has a dedicated office of Climate Change Adaptation, as well as staff in all the relevant divisions and units, but as discussed above, adaptation is mainstreamed at the provincial level, and staff are less specialised. Extension agents work with local farmers' unions and the system is able to deliver tailored technical advice, for instance, on crop calendars, as well as inputs, such as improved seeds, and subsidised fertilisers and pesticides, which enable farmers to make the changes recommended by government. Government officers thus have a lot of power to get policies implemented. This is usually positive, but can also be damaging if recommendations are not fully evidence-based.

8.2.2.1.3. Coordination

Coordination amongst the provincial departments, and particularly between DONRE and DARD, is not strong. This is understandable, given the history of "vertical approaches" in Vietnam's economic development, and the proliferation of different sectoral and thematic plans. Central government is now insisting on the "One Plan" approach, which should simplify the process of coordination and enable CCA objectives to be fully integrated in the SEDP.

The Department of Planning and Investment is tasked with coordinating all NTPs, including that for Responding to Climate Change. On their recommendation, the provincial steering committee on climate change has not yet been formed.

Finally, an element of coordination and the "enabling environment for adaptation" that remains weak in Quang Binh, and indeed most of Vietnam, is engagement with local communities. The government remains very "top down" and in charge of economic development. However, for climate change - it is essential that individuals, households, and communities develop the capacity to understand their situation and challenges of climate change and themselves become able to adapt - because climate change adaptation is a long-term enterprise.

8.2.2.2. KNOWLEDGE AND UNDERSTANDING

8.2.2.2.1. Of Climate Change and Adaptation Issues

Quang Binh's long experience of climate-related disasters (typhoons, floods, droughts) has given many government officials a solid foundation of knowledge and understanding for climate change and considerable capacity and will to act. However, as with the general approach to development, efforts are largely sectorally and even sub-sectorally driven and there has been a strong emphasis on "hard" infrastructure-based solutions, such as dykes, sea walls, reservoirs and irrigation systems. A notable exception to this is the Agriculture Division of DARD, which implements a lot of softer solutions involving substitution of different varieties and crops with better tolerances to various climate challenges, shifting of crop calendars, Sustainable Rice Intensification (SRI), removing salinised land from paddy rice cultivation, and the like.

The National Climate Change Action Plan was only produced in 2008, so climate Change remains a relatively new area of government concern. As discussed above, most provincial departments still do not have staff who are fully trained in or dedicated full-time to climate change issues. DONRE has a climate change unit staffed by three people. DARD states that climate change is "mainstreamed", meaning there are few dedicated staff. But since all their activities relate to climate and weather, there is a lot of "learning by doing".

Some projects, including JICA Integrated Flood Management Project and the present EbA Mainstreaming Project, provide some training courses on CC and CCA, but these are often very short and narrowly focused, and follow-up is limited. Generally speaking, training on climate change issues is the purview of donor projects. So, for the most part, knowledge and understanding of climate change issues are partial, and more importantly, under-utilised. Consultants are often employed to carry out technical work, such as the preparation of the CCRAP. Although government (DONRE) has a role in supervising the work, opportunities for real learning by provincial staff are reduced. It has been said (ref) that this implies that CCA capacity building should focus on consulting companies - but this neglects the vital role that government staff play in supervision and above all, decision-making - both of which require considerable capacity.

Knowledge and understanding problems include finding problems where they do not really exist, or blaming particular events and impacts on climate change, when they are caused by other factors. For instance the declining capture fishery is more a product of over-fishing and habitat destruction than it is about climate change.

Another important problem affecting understanding of climate change issues is Vietnam's vertical system of governance within line agencies and the resultant tendency for "silo thinking" and action. Awareness of climate change as an overarching issue on which all departments need to collaborate and coordinate is growing slowly.

Even within a sector, it is not clear that the different objectives of sectoral plans are mutually compatible or compatible with climate change adaptation and mitigation. The central importance of sound land-use planning for climate change adaptation and mitigation does not appear to be understood.

8.2.2.2.2. Of EbA

EbA is a relatively new approach to climate change adaptation, so if local government is not fully aware of it, that is understandable. Under the present "EbA Mainstreaming" project, GiZ has conducted a two-week Training of Trainers in EbA for training organisations. These trainers will be responsible for the majority of the training under the project. Meanwhile, in 201? GiZ also held a 3.5-day training focused on how to integrate adaptation, and particularly EbA, into development planning, for provincial staff from Quang Binh and Ha Tinh.

From the experience of the present assignment, it is difficult to gauge provincial capacity relating to EbA. It is a challenging topic that requires "learning by doing". Staff of various departments participated in project workshops and received reports, but no written comments have been forthcoming. It is notable that in early 2016, the updating of the CCRAP for Quang Binh was initially proceeding without reference to EbA. A special consultant had to be recruited to provide the needed integration. Quang Binh's SEDP 2011-2015 made only one reference to climate change and no reference to the need for adaptation. The updated SEDP is not yet available for review.

The National Climate Change Strategy policies talk about securing food, water and livelihoods and protecting natural resources, but treat these like a list of independent elements. EbA recognises that they are linked, and livelihoods cannot be secured unless natural ecosystems and SES are managed consciously and effectively in the context of climate change

8.2.2.3. ACTIONS AND INNOVATIONS

Vietnam's vertical system of governance means that most of the interventions and innovations for climate change come from the centre, notably MONRE and MARD. A province's role is largely to echo those initiatives at the local level, or to implement instructions and there is a tendency to wait for those instructions. The greatest provincial role is in the preparation of the CCRAP, but the projects developed tend to follow priorities and formats introduced from the centre. There is some tendency to relabel routine actions as climate change adaptation, sometimes inappropriately. For instance, Sub-Committee on Ethnic Minority Affairs (SCEMA) cited promoting paddy rice cultivation amongst ethnic minorities as an adaptation action, but these efforts have been going on for over a decade, with little success, in attempt to reduce swidden cultivation and assimilate ethnic minorities into the cultural mainstream. Many other such routine interventions are appropriate for climate change adaptation, but cannot be considered innovative. As mentioned above, the vast majority of climate change adaptation projects involve hard infrastructure.

The sections below provide an overview of what the EbA team was able to learn of Quang Binh's climate change adaptation actions to date. Further collaboration with provincial departments is required to complete this analysis.

8.2.2.3.1. DARD

DARD is probably the most active of all provincial line agencies in climate change adaptation, due to its mandates in the key productive sectors of crop production, forestry, aquaculture and fisheries and in water management. Table 8.1 summarises the climate change adaptation work of DARD's divisions.

Table 8.1: Climate change related work and staff of DARD's divisions

Division of DARD	CCA work	Staff
Forestry	Role of forest is crucial – not only provisioning, but for environmental protection. Provides direct support to forest management. Big programmes including REDD+ and JICA coastal forest protection programme. National government coastal forest programme. 35-37 billion VND /year for sustainable forest protection and development programme from national budget. Two companies in VN (one is Long Dai in QB) who have FSC certification.	5-7 staff specifically on CC
Agriculture	Many phenomena – storm intensity and frequency, drought related to ENSO have severe impacts to agriculture production. Cold spells still happen, killing many livestock. Saline intrusion caused loss of 40ha pf paddy rice. No specific or separate adaptation programmes but integrate into other options: 1) adjust crops and seasonal calendar Winter-Spring and Summer-Autumn can be affected by cold spells and floods respectively; 2) Shift to maize or other crops with lower water demand and higher tolerance – programme introduced by MARD; 3) new techniques – integrated pest management, SRI supported by SNV – pay special attention 40% reduction of pesticide and water but yield higher, and emissions reduced. Near future will apply drip irrigation (Israel style) and greenhouse planting for more controlled environment. Study on finding drought and cold tolerant species. Will develop agriculture plan to reduce CC impacts because many activities such as fertilisers use, paddy rice, etc contribute to GHG emissions. Green and clean to reduce use of natural resources and address CC	7 staff; all contribute to planning all of the work
Aquaculture	Severely impacted sector. Some solutions: Policy – 1) restructuring aquaculture sector including CCA Options; 2) production plan by ecosystems – e.g. freshwater fish; shrimp on sandy areas; sustainable brackish water fish; Annual plan to implement restructuring, Some pilots to enhance ecosystem services – fish and rice working really well. In areas showing some environmental degradations, shift from intensive shrimp to one shrimp and one fish crop. Or one shrimp and algae for gelatine (agar) production	5 staff trained in aquaculture, none assigned specifically to CC adaptation
Irrigation and flood control	Restructure programme to include CCA but outputs not yet as clear as expected, because only developed recently. Focus on engineering works like dykes and irrigation reservoirs. Targeted to repair or upgrade many reservoirs for irrigation purposes but budget is very limited. Also have goal to put monitoring equipment in all reservoirs for flood forecast and prevention. No separate packages, all integrated to other programmes. No provincial budget allocated to CCA for them. All supported by other donors.	No specialised staff

8.2.2.3.2. Other departments

Some information on the climate change adaptation actions taken by other departments in Quang Binh are presented in Table 8.2.

Table 8.2: Climate change adaptation actions and capacity building of different provincial departments

Department	Climate Change Adaptation Actions	Climate Change Adaptation Capacity Building
Standing Committee on Ethnic Minority Affairs (SCEMA)	No specific CCA analysis or actions in EM villages. Besides some effort to introduce paddy rice as substitute for hill rice.	No training yet, due to lack of funds. Staff participated in a DONRE consultation on climate change training in 2009, but nothing has happened since.
PNKB	Actions only related to projects, since no provincial funding. No unit exists in PNKB management structure. CC not explicitly integrated in Buffer Zone or National Park management plans – but implicitly. No stand-alone lens. No climate stations within the park, but some GIS related CC research.	
Department of Planning and Investment	Theoretically DPI is responsible for integrating climate change into provincial development, linked to its important role in preparing the SEDP. Climate change is not yet integrated into SEDP, but will be for the 2016-2020. DPI cannot drive implementation. It has a role in reviewing CC related projects, but does not do the appraisal.	MPI has issued a circular for integrating CC into planning for consultation. Also, Guidelines and handbook for green growth. 2013. DPI has not had specific training in CC issues.
Department of Transport	Impact of CC on Transport sector is complicated and Central Region most severely affected. QB has an annual workplan for spot checks on damage and to anticipate problems, and has financial support from higher level to address problems.	DoT receives guidelines from MoT, but has to apply to local context. Sometimes initiatives and innovation come from the local level.
Department of Labour, Invalids and Social Affairs	The needs to integrate CCA in poverty reduction support programme and to stop doing poverty reduction in an environmentally destructive way are recognized, but nothing comprehensive is done, due to lack of funds.	n/a
Department of Industry and Trade	DoIT operates under PPC as an advisory body on industrial and trade management. It supports the PPC in development of strategies and manages the electricity system and industrial and trade-related infrastructure.	DoIT receives CCA information through many channels, including MOIT, DONRE and the PPC.
Department of Construction	Construction Law does not integrate climate change. Project related actions only, including flood-resilient housing – floating on plastic barrels or elevated on posts. Conducts resettlement planning for flood prone areas – but lacks funding	n/a

8.2.2.4. RESOURCES

Quang Binh is a budget deficit province which receives most of its funds (65%) from central government. Resources for climate change related work are said to be quite limited, but it was not possible to get even rough estimates of the funds provided by central or provincial government, donors and NGOs, or to establish a framework for understanding the adequacy of those funds. The main sources of funding are the SPRCC and

Ministerial budgets. A lot of the funds are apparently released in relation to specific projects, which go the national level for approval. A lot of climate related work gets integrated in other packages.

The Quang Binh CCRAP 2011-15 requested a budget of USD 210 million for 55 different projects, but apparently none was implemented. The updated CCRAP 2016-2020 has a budget of around VND USD 193 million, 95% of which is earmarked for “hard” infrastructure based projects.

For the purposes of this study, it is accepted that funding is a serious constraint on climate change adaptation actions, and thus on provincial “adaptive capacity”.

8.3 DISCUSSION

The original TOR and input schedule for the present study did not provide scope for a focused examination of adaptive capacity. The importance of the issue emerged as the study progressed, and has now been explored as far as was possible. Rather than employing a systematic methodology, this exploration has involved a brief overview of policy and related literature, semi-structured interviews with a small number of key informants, principally in DARD and DONRE, but also in other key departments, and team experience and observations. Thus, the findings here should be considered provisional and a more in-depth study should be undertaken, followed by a specific programme of capacity building.

Based on the above analysis, a number of strengths and weaknesses of Quang Binh’s provincial government “adaptive capacity” can be seen. Appropriate knowledge and understanding of climate change and EbA exist, but there are few staff dedicated to climate change, and training is quite ad hoc and focused on specific issues, so for most staff, knowledge and understanding are only partial. Further, with the outsourcing of technical tasks and limited funding for projects, knowledge is not put into practice often enough to develop into real understanding and to provide opportunities for innovation. As a result, there remains an over-emphasis on hard infrastructure solutions to problems.

The agriculture sector, in particular, is well-organised and the provincial extension services are able to stimulate change amongst farmers quite rapidly, adjusting crop calendars, crop varieties and even crop types, season by season. It is unclear how well these messages are linked to regional or provincial weather forecasts. Further, many adaptation decisions are taken at the national level, and this powerful vertical system can lead to less appropriate recommendations being pursued, or the development whims of senior provincial or national PPC officials holding sway. There is still an impulse in rural development for the “one village one product” approach. In the era of climate change and the imperative to diversify livelihoods, this approach needs serious rethinking.

Although there are various plans and initiatives in climate change adaptation in Quang Binh, a Provincial Committee for Climate Change is still lacking and climate change is not yet integrated into the SEDP. Thus coordination is lacking and a degree of “silo thinking” can be detected. As a result, actions in one sector can produce problems for adaptation in other sectors, and potential synergies can be missed. Forestry and water supply, two key activities of the lower hills of Quang Binh provide a good example. Current short-rotation forest crops in the catchments of important reservoirs cause soil erosion which leads to sedimentation of the reservoirs. Similarly, regulation of river flows for irrigation and flood control leads to drastic reductions in river flows, which increases saline intrusion and degrades the mangroves that act as nurseries for various important fisheries species.

Against this generalised provincial background, adaptive capacity also varies from SES to SES. This largely reflects the priority given by the national and provincial governments to the particular commodity produced in an SES. Thus, SES 6a - lowland floodplain paddy rice cultivation probably exhibits the best “provincial” adaptive capacity because rice is the national staple food, the basis of livelihoods for a large proportion of the population, and an important export crop and so has received a lot investment over the years. The agricultural extension system is closely geared to the needs of this crop and the impacts of climate change related phenomena such as drought and salinization have received a lot of attention from government, donors and NGOs, alike. At the other extreme, is SES 5 a, ethnic minority upland swidden cultivation and forest product collection. There is almost no research on the hill rice varieties that ethnic minorities cultivate. What little agricultural extension is offered is focused on converting minorities to paddy rice cultivation - however culturally inappropriate and problematic it is in upland environments. However, from the local-assessments of this study, it appears that their traditional system of intercropping varieties with different ripening periods and phasing the sowing of different plots across the growing season, is wonderfully intricate and accommodates a lot of variability in the weather. Forest product collection is largely discouraged by government agencies.

Relative poverty also affects the “adaptive capacity” related to different SES. Poverty is correlated with geography and population. So, SES associated with the more prosperous lowland communes have a suite of capacity-related advantages, from transport, communication, services, to better education and health. Thus, key elements of adaptive capacity - such as knowledge, resources, ability to innovate, local organisation are all likely to be stronger

8.4 CONCLUSION AND RECOMMENDATIONS

The provincial government of Quang Binh has the foundations of "adaptive capacity" for dealing with climate change.

Following the development of the policy framework at the national level from 2008 onwards, the institutions and policies that help configure an "enabling environment" for climate change are now in place at provincial level in Quang Binh. An important exception is the Provincial Steering Committee for Climate Change, and its absence is probably one main reason why coordination amongst institutions is not as good as it should be.

Recommendation: Establish the Provincial Steering Committee for Climate Change as soon as possible. Task them with implementing the recommendations below.

The tendency for "silo thinking" and the proliferation of plans by different governments departments promotes the attitude that "someone else is doing climate change" thereby intensifying the already considerable challenges of sharing knowledge and integrating action for effective climate change adaptation.

Recommendation: There is an urgent need increase government awareness of the centrality of climate change issues and the need to re-orientate development strategies accordingly. An important step is to integrate climate change actions, including donor projects, into the provincial SEDP. Another important step is to develop consensus land-use plans among the different economic sectors which comprehensively addresses climate change vulnerabilities, and then ensure the plans are properly enforced.

Vietnam's vertical system of governance means that most of the interventions for climate change come from the centre, notably MONRE and MARD. Some are innovative - emerging from research and development, but most are "business as usual" hard infrastructure solutions. A province's role is largely to echo those initiatives at the local level, or to implement instructions and there is a tendency to wait for those instructions and funds, reducing the province's scope for innovation and autonomous action. One of a province's main tasks is the preparation of CCRAP - but this is outsourced to consultants and there is an element of "box ticking" about the exercise. In the first CCRAP, IHMEN climate data is used, along with the provincial SEDP and DRR related information, but real analysis is lacking and so the proposed projects did not really reflect the background evidence and many projects are conventional development, relabelled as CCA. Innovation is limited and the province is thinking primarily about hard infrastructure solutions. It will be interesting to read the updated CCRAP, and see whether analysis has progressed and the links between evidence and action are now stronger.

Adaptation knowledge certainly exists in Quang Binh - however, training on climate change has tended to be *ad hoc* and donor project-related. Further, because funding at provincial levels is very limited, and technical tasks get outsourced to consultants, provincial staff get little opportunity for the all-important "learning by doing". There is an emphasis on tasks and projects but not on building the real capacity at local levels (provincial down to communities) needed to develop innovations and sustain adaptation efforts.

Recommendation: All climate change projects engaging consultants should include provincial government staff as active team members.

Recommendation: All departments need a small cadre of well-trained staff dedicated full-time to climate change issues, as well as well-informed general staff, to ensure effective coordination of climate change actions. In collaboration with main donors, develop a comprehensive training programme on climate change mitigation and adaptation including, EbA for wide range of provincial officials. As part of this process, conduct a KAP (Knowledge, Attitudes, Perceptions) study with government officials, as a basis for designing an intensive climate change training programme including the practical exercises in vulnerability assessment, identification of adaptation options and detailed project design, followed by project implement. (IF an external consultant team is used, ensure inclusion of provincial staff on the team.)

Recommendation: For EbA and for CCA more generally, adaptive capacity represents a set of vital competencies - and needs to be built at all levels. The focus must be on adaptive capacity rather than simply on adaptation actions and, at the provincial level, work is needed in all four areas: building real knowledge, innovation, and effective institutions, supported by sufficient resourcing.

The objective of this chapter has been to focus attention on the issue of adaptive capacity. This review has been very preliminary and much of the information needed for designing an appropriate response has been lacking. It is hoped that more detailed studies will be conducted as a result and greater efforts made to raise adaptive capacity in Quang Binh.

8.5 REFERENCES

Adger WN et al 2004. New Indicators of Vulnerability and Adaptive Capacity. Tyndall Centre for Climate Change.

Adger WN and PM Kelly 1999. Social vulnerability to climate change and the architecture of entitlements. *Mitigation and Adaptation Strategies for Global Change 4*: 253-266.

CARE 2009. Climate Vulnerability and Capacity Assessment Handbook.

Carpenter, S. R., and W. A. Brock. 2008. Adaptive capacity and traps. *Ecology and Society* 13(2): 40. [online] URL: http://www.ecologyandsociety.org/vol13/iss2/art40/

Gebert R and Trang Hieu Tuong 2011. Report of study on gender, poverty and ethinicity in Phong Nha – Ke Bang national park buffer zones communes, Quang Binh province, Việt Nam. GIZ.

Gunderson LH and CS Holling, (eds) 2002. Panarchy: Understanding Transformations in Human and Natural Systems. Island Press, Washington

Kates *et al.*, 1985

McElwee P et al. 2010. The Social Dimensions of Adaptation to Climate Change in Vietnam. World Bank Discussion Paper 17. Washington DC.

Le Minh Nhat 2015. Policy Innovations and Challenges in Response to Climate Risks. Presentation at Climate Vulnerable Forum Regional Workshop: Asia 20-21 May 2015 Manila, Philippines.

Quang Binh PC, 2011. Socio-economic development plan to 2020.

Quang Binh PC 2012. Quang Binh Socio- Economic to 2020 Master Plan and vision to 2050.

Quang Binh PC 2012b. Strategic Management Plan 2013-2025, Phong Nha-Ke Bang National Park, The World Heritage Site

Quang Binh PC, 2014. Quang Binh implementation report of Socio-economic situation 2014 and socio-economic plan for 2015.

Quang Binh SO, 2014. Quang Binh Statistical yearbook 2013.

Quang Binh PC 2015. Report of implementation of National target programs in Quang Binh 2011-2015.

Quang Binh Department of Ethnic Minorities 2008. Handbook on Ethnic Minority groups.

Rayner and Malone1998

Bach Tan Sinh 2010. Scoping Assessment on Climate Change Adaptation in Vietnam Summary October 2010. REGIONAL CLIMATE CHANGE ADAPTATION KNOWLEDGE PLATFORM for Asia.

Smyle J and R Cooke 2011. Climate Change Analysis and Adaptation Responses. Prepared for Informing IFAD's Country Strategic Opportunities Program 2012 – 2017 for Vietnam. IFAD Working Paper. Hanoi.

Thang N T 2011. Policy on Climate Change in Vietnam. Presentation in Han Noi, Institute of Strategy and Policy on Natural Resources and Environment (Isponre), Vietnam.

Tuan LA, Du LV and T Skinner (eds) 2012. Rapid Integrated and Ecosystem-based Assessment of Cliimate Change Vulnerability and adaptation for Ben Tre Province, Vietnam. WWF.

UNDP 2012a. A preliminary analysis of disaster and poverty data in Quang Binh province, Vietnam.

UNDP 2012b. Sustainable poverty reduction and natural disaster risk management in central coastal region: lessons learned and policy implications.

ANNEX 8.I: BACKGROUND ON CONCEPTS OF ADAPTION AND ADAPTIVE CAPACITY

1. ADAPTATION

Adaptation may be defined as:

"*The adjustment of natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation is a process and not an outcome*" (GiZ/WRI 2011).

Adaptation is a process because climate change is on-going and thus the need to adjust to it is also continuing; therefore, no outcome is likely to be final. Though individual adaptation interventions might have an end-state in mind, this is likely only to be an interim state, and further change is likely to be needed in the future. Uncertainty is inherent in adaptation, as it is in climate change, and it is thus the "capacity to adapt", or keep adjusting that is the most important.

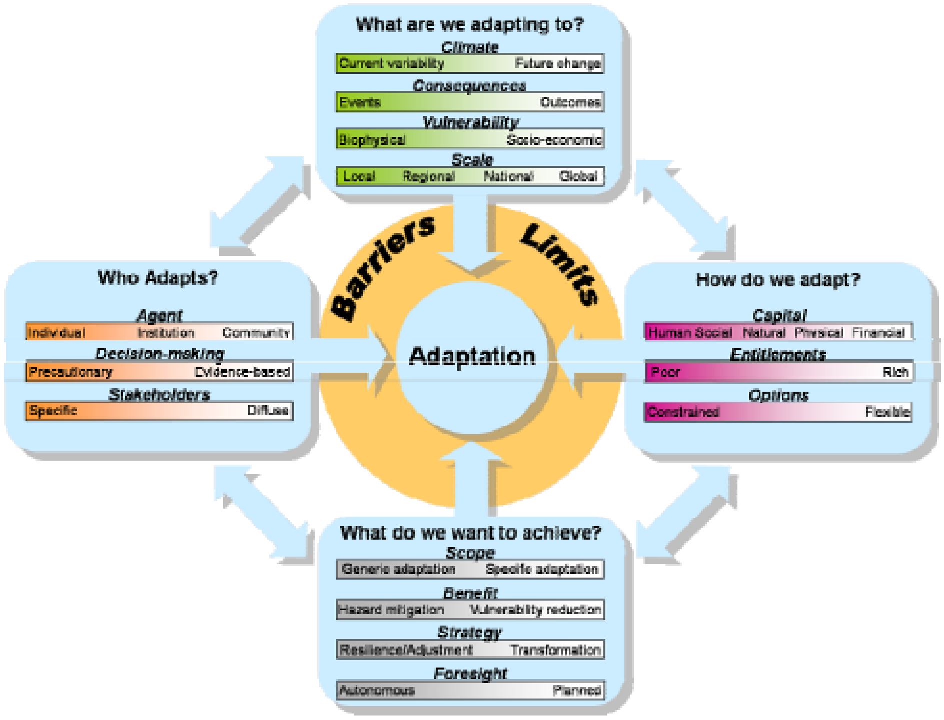
Adaptation is often conflated with "resilience", but whereas adaptation is a process of change, resilience is a characteristic or condition of a system. Resilience implies the ability to better withstand impacts and to more quickly re-establish an original state after a disturbance. Resilience is determined by a combination of exposure and sensitivity. As one approach to adaptation to climate change, we can seek to increase or build resilience of systems by managing some aspects of exposure and sensitivity. But each system will have its own resilience thresholds, after which further adjustments to climate impacts are not effective (this is one kind of limit to adaptation). The other part of the adaptation process is better understood as the transformative change to a new regime. In many cases appropriate adaptation planning will involve a strategic combination of both building resilience, and of fostering transformative change.

In developing economies, there is typically a significant degree of overlap between adaptation measures and development activities. Many adaptation measures have a development component, implicitly or explicitly, and sometimes the development component provides the incentive necessary for people to adopt the adaptation measure. More importantly, to promote effective adaptation, it will often be necessary to address non-climate stressors that are already having significant negative impacts on development. These are the "underlying causes of vulnerability", such as discussed below (see Figure 8.7). An example would be attempting long-term adaptation measures in the fisheries sector while the resource is being degraded by overfishing and pollution. Better, is for adaptation measures to be integrated (mainstreamed) in development: this represents true "adaptive capacity".

Adaptation efforts are often dogged by the inherent uncertainty in climate change projection models. In response, often promoted are "no-regrets" climate adaptation strategies: practices that are beneficial even in the absence of climate change, and where the costs of adaptation are relatively low when compared to the results of the adaptations. In many locations, the implementation of "no-regrets" options constitutes an efficient first step in a long-term adaptation strategy. Examples would include scaling back groundwater use to sustainable levels, or switching from one crop to another equally productive but less sensitive crop.

Adaptation is complex. Figure 8.5 sets out four sets of key determinants of adaptation processes, essentially the "who, what, how and why" of adaptation, each with multiple dimensions that need to be considered when assessing adaptive capacity and designing a particular adaptation intervention.

Figure 8.5: Dimensions and determinants of adaptation



This helps explain why adaptation interventions take so many different forms: conventional climate change adaptation typically focuses on larger scale infrastructure that ultimately reduces sensitivity or exposure to climate impacts; community-based adaptation focusing comprehensively on specific local climate challenges and largely mobilising local solutions, and with the present project ecosystem-based adaptation, aimed at harnessing natural ecosystems and their services to address specific climate change vulnerability issues.

The questions of "who adapts" or "whose adaptive capacity" are important ones. Basically, everyone needs to adapt and develop their adaptive capacity, but different stakeholders have different roles in making adaptation work.

1.1. Adaptive Capacity

Adaptive Capacity is defined in various ways. In generic definitions, it refers to:

"*The capacity of a system to adapt if the environment where the system exists is changing*".

In the context of climate change, it has been defined as:

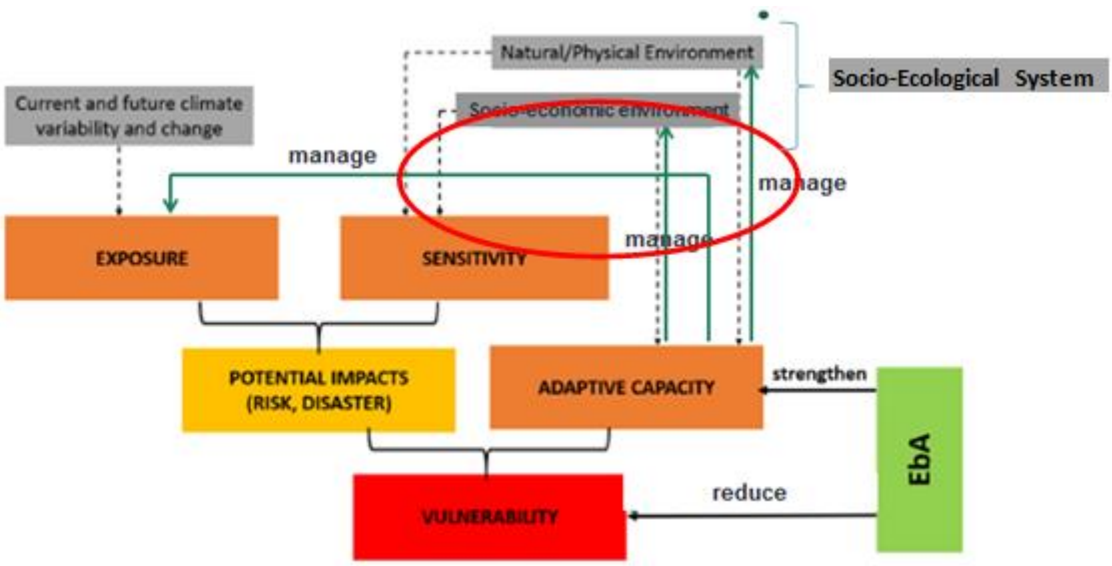
"*The potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts*" *(from Smit et al., 1999)*[19].

The suitability of these different definitions of adaptive capacity to a particular context depends largely on the object of the adaptation; thus the generic definitions use the term "systems". For the EbA vulnerability assessments the unit of analysis is the socio-ecological system (SES), as shown in Figure 8.6. The socio-ecological system concept puts people front and centre in the analysis. It reflects the understanding that climate change is a human issue: people are the cause of climate change, the victims of it, and human capacity to adapt is a big part of the solution to it.

---

[19] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=650

Figure 8.6: Adaptive capacity in climate change vulnerability assessment for EbA



Source: adapted from GIZ, Adelphi and EURAC 2013, based on IPCC 2007

Figure 8.6 also illustrates that our understanding of adaptive capacity for climate change is closely related to our understanding of other key terms exposure, sensitivity and vulnerability. As set out in Chapter 1, exposure is defined as the extent to which an entity (e.g. region, resource or community) experiences changes in climate. It is characterised by the magnitude, frequency, duration and/or spatial extent of a weather event or pattern. Due to geographic location, some places are more exposed to climate changes and extremes than others. Sensitivity is the degree to which the entity is affected by, or responsive to, climate changes. Although most organisms operate within tolerance limits, those of some species are broader than others. Since exposure is mediated by sensitivity, the term impact is used to express actual effect. Vulnerability is the extent to which the entity suffers damage as a result of the impact, but it too is mediated, this time by adaptive capacity. Simply put, the greater the adaptive capacity, the lower the vulnerability. Adaptation is often expressed simply in terms of “decreasing sensitivity or reducing exposure” to climate threats (see Figure 8.6), or as mentioned above, it can also be about a managed transformation of the system. However, either of these types of adaptation can only be achieved through peoples’ ability to understand particular climate change problems and their ability and willingness to manage strategically their biophysical and socio-economic environments (SES) to address those problems and reduce vulnerability - i.e. their adaptive capacity.

Adaptive Capacity of Species and Ecosystems

Some EbA assessments include an analysis of the “adaptive capacity” of species and ecosystems (Tuan et al (eds) 2012)[20]. In the ecological literature (Gunderson and Holling, 2002; Carpenter and Brock 2008) adaptive capacity is the ability of a living system to adjust responses to changing internal demands and external drivers in the short term; in the longer term, it is the system’s “evolutionary potential”. Three different levels are identified. For species, potential is determined by genetic diversity; for ecosystems, it is their biodiversity or complement of species; and at landscape or biome level, it is the mosaic of different ecosystems present, their connectivity and patch size.

Different species, and different genotypes within species, have different “comfort zones” with respect to different climate and other biophysical variables; they have different “tolerances” and different “thresholds” beyond which they cannot survive in a certain place under certain conditions for an extended period. Typically, the greater the genetic diversity within the species, the wider are the tolerances and higher the thresholds, and

[20] In contrast to “adaptive capacity”, socio-ecological systems can also exhibit “adaptive traps” (Carpenter and Brock 2008). *“In a social–ecological rigidity trap, strong self-reinforcing controls prevent the flexibility needed for adaptation. In the model, too much control erodes adaptive capacity and thereby increases the risk of catastrophic breakdown. In a social–ecological poverty trap, loose connections prevent the mobilization of ideas and resources to solve problems. In the model, too little control impedes the focus needed for adaptation. Fluctuations of internal demand or external shocks generate pulses of adaptive capacity, which may gain traction and pull the system out of the poverty trap*”.

the greater the likelihood the species will survive. However, in terms of the analytical framework presented in Figure 8.6, all these things (comfort zones, tolerances, thresholds) are more aspects of species' "sensitivity", than adaptive capacity. Ultimately, a new species may be formed, distinct from its parent, and better suited to the new conditions, but this will be highly unpredictable and typically take place on a time-scale beyond that useful for addressing our current climate change challenges.

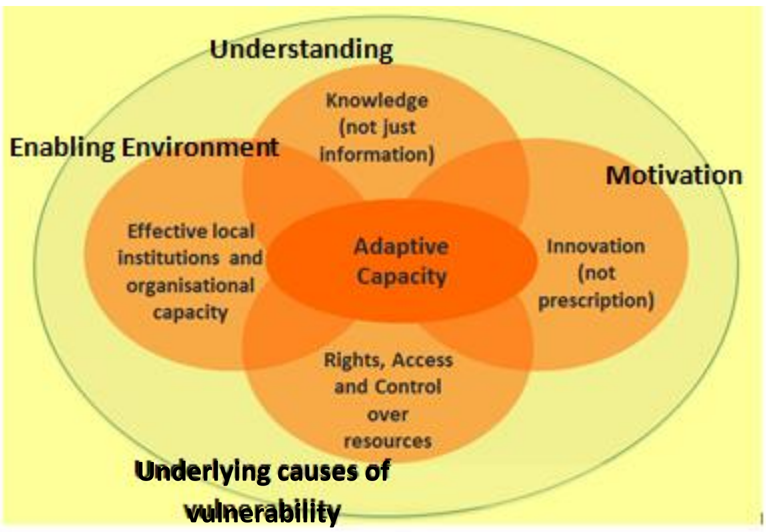
Ecosystems are characterised, biologically, by their assemblage of species, and by their configuration within wider landscapes. Ecosystems adjust to the loss of species. As climate change is a continuing and cumulative process, over time additional species will continue to be locally extirpated. The most sensitive species are lost first, followed by the less sensitive species. The ecosystem will continue to adjust to the loss of more species as it gradually becomes a simpler, less diverse system. At some point presumably so many species, or certain keystone or umbrella species, will be lost from the ecosystem that it will collapse or undergo some fundamental transformation to another type of system. As with species evolution, this will be highly unpredictable and taken place in the much longer term.

Ecosystems that originally had higher species and genetic diversity, larger patch size, greater connectivity between patches in the landscape, more functional redundancy in the system, etc) will presumably take longer and will be able to tolerate greater loss of species, before they reach the point of collapse/transformation. This equates to "resilience", discussed above.

While the concepts of adaptive capacity of species and ecosystems are relatively straightforward, in practical terms, they are very difficult to assess, particularly in a short study such as this. Simply too little is known about the ecosystems and species concerned, and even if such knowledge existed, the modelling required to predict changes would be impossibly complex. Further, in this EbA assessment, we are dealing with socio-ecological systems - in which the natural ecosystems have been radically transformed

In the present analysis, then, "adaptive capacity" is explicitly understood as a human/social phenomenon. While an inherent characteristic of ecosystems is that they can change fundamentally in response to shocks and trends, and reach new stable points, in terms of identifying EbA actions, we are more interested in peoples' capacity to manage the ecosystem and direct the change (e.g. through application of human, technological, and financial capital) and the capacity and political will of governance entities to deploy those resources. Notwithstanding these practical constraints, some useful principles do emerge, which can be usefully applied when considering adaptation to climate change. These include the idea of maintaining and promoting diversity at all levels and the need for flexibility, to maximise and capitalise on the options open in socio-ecological systems, in the face of an uncertain future.

Figure 8.7: Elements of adaptive capacity



Source: CARE (2009) CVCA Handbook

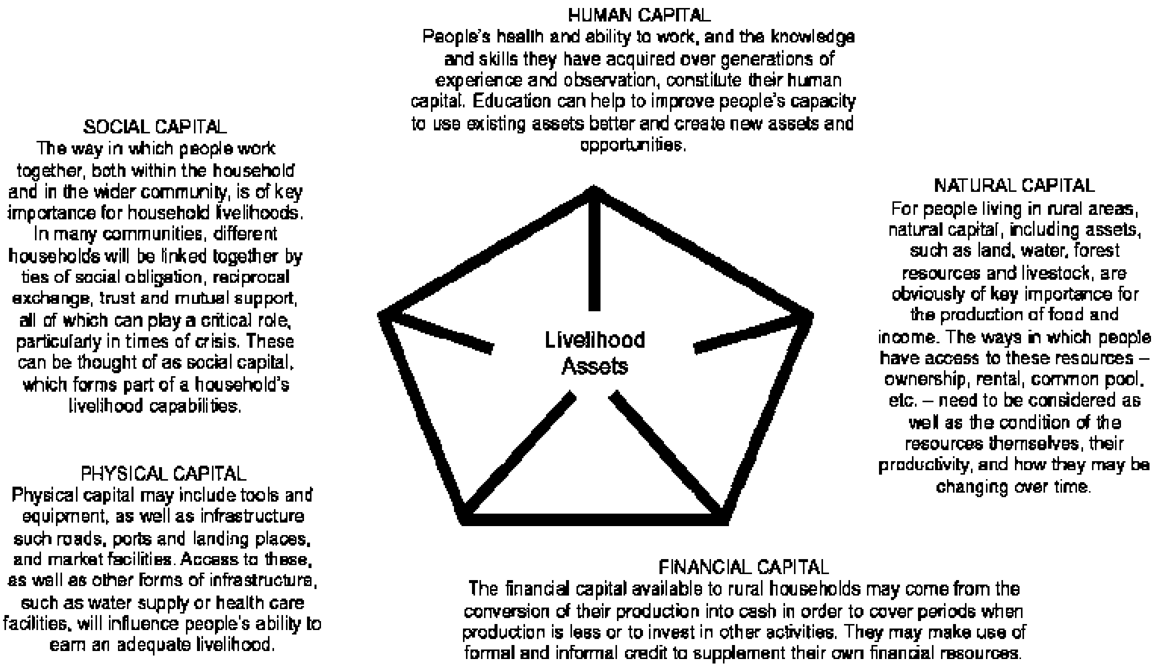
For the purposes of this study, adaptive capacity is essentially:

"the broad set of enabling traits, possessed by people, to manage the exposure and sensitivity of their socio-ecological system, either for the increased resilience of the system to changing climatic circumstances, or for its transformation to a new regime that is better suited to new climatic circumstances".

Having understood adaptive capacity as it relates to exposure, sensitivity and vulnerability it is useful to consider what it consists of. CARE, in its approach to community based adaptation identifies four main elements of adaptive capacity, as shown in Figure 8.7.

Perhaps the most important element shaping the adaptive capacity of individuals, households and communities is their access to and control over livelihood resources or "assets": natural, human, social, physical and financial[21]. These are described in Figure 8.8, below. Simply put, the greater the access and control of these assets, the wider the potential options available and greater the potential adaptive capacity. Further, it is in the lack of these assets or capitals that we see the links between adaptive capacity, vulnerability to climate change and poverty, and the disadvantages suffered by women and other vulnerable groups.

Figure 8.8: Livelihood assets or capitals



Source: http://www.fao.org/docrep/006/y5084e/y5084e04.htm

From the EbA perspective, "natural capital" is of central importance. EbA seeks to promote adaptive capacity by enhancing peoples' ability to manage and care for the natural ecosystems and the environmental services they provide.

Access to resources is clearly not enough on its own. People must understand the climate challenge facing them, and have ideas about what to do. These are "knowledge" and "innovation" respectively. Knowledge is more than getting the information and knowing the facts about climate change. It must be accompanied by understanding the importance of ecosystems to livelihoods, the need for action, and the motivation to act. Innovation implies ability to devise new solutions. Communities in Vietnam have been coping with various extreme climate events for centuries, providing good preparation for climate change. However, climate change demands new solutions - looking further into an uncertain future.

Finally, there must be an "enabling environment" for adaptation: the policies and programmes of government that open up what people are able or encouraged to do; the organisations at all levels that support peoples' adaptation and or manage wider adaptive interventions.

Drawing on all these definitions, building Adaptive Capacity is arguably the key element and ultimate objective of climate change adaptation work. It is thus an important factor in the present provincial-level EbA vulnerability

[21] See DFID Sustainable Livelihoods Guidance Sheets for more details on livelihood assets. http://www.eldis.org/vfile/upload/1/document/0901/section2.pdf

assessment and the efforts to identify the socio-ecological systems most in need of adaptation action and select particular local-level sites for more detailed assessment.

1.2. What is "successful adaptation"?

At a very basic level, a successful adaptation is one that has established goals over a range of future climate scenarios and is effective in meeting them, producing benefits that outweigh costs - financial, physical, human, or otherwise (Smit et al., 2001). At higher levels, a successful adaptation would be one that has addressed cost-effectiveness, efficiency, the distribution of benefits, the legitimacy of the adaptation, sustainability, global and intergeneration equity and the resonance of adaptation with cultural norms and collectively held community values. With such a complex concept, inevitably, finding a workable definition of successful adaptation is always going to be contested (Adger and Vincent, 2005).

1.3. Building Adaptive Capacity

As discussed above, the question of "who adapts" is important, and so equally important is the question "whose adaptive capacity". In the face of climate change, to a very large extent, everyone, civil society, private sector and government needs adaptive capacity, but the nature of the adaptive capacity in each group will be configured somewhat differently.

The CARE schema also helps us to understand what building adaptive capacity entails:

- Actions to address the underlying causes of vulnerability, which are largely the same as those underlying poverty: enhancing access to essential livelihood assets, and increasing livelihood diversification.
- Actions to promote knowledge and understanding of climate change challenges, including the inherent uncertainty climate change entails, the need to maintain diversity and remain flexible, and the motivation of key stakeholders to take action.
- Actions to promote, encourage, and support stakeholders to devise innovative, locally appropriate and integrated solutions to anticipate the threats of climate change, moving on from mere reactive coping to immediate hazards, or top-down prescriptions.
- Actions to improve the institutional and organisational environment: enabling policy for climate change adaptation, at local as well as national level, particularly relating the three points above, including actions on fundamental issues such as gender and then need for participatory engagement with all stakeholders.

These points can guide the adaptation work of a wide range of stakeholders, from communities, through CBOs, NGOs, government agencies at all levels and international donors. The focus of CCA must not just be on the practical adaptation "interventions" (like SRI, improved watershed management, diversification of livelihoods) but on the processes of reducing vulnerability and building adaptive capacity that underpin the interventions and promote the sustainability of adaptation, in the long term.

CHAPTER 9 VULNERABILITY ASSESSMENTS OF PRIORITY SESS IN QUANG BINH

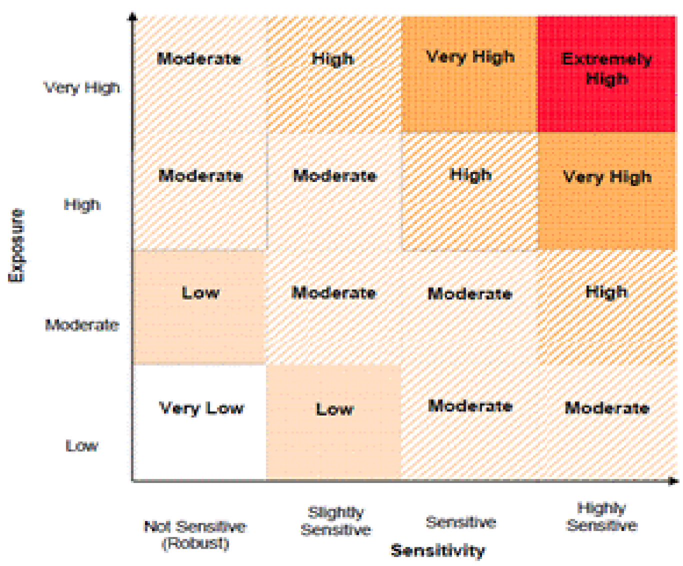
9.1 VULNERABILITY RANKING OF TOP 10 SESS IN QUANG BINH

In Chapter 7, seven specific measures of climate change were identified under the four broad areas of changes in precipitation, temperature, storms, and sea level rise. In this chapter, the results of a detailed assessment of climate change vulnerability each of the top 10 (of the total 41) SESs in Quang Binh are presented. For each top-10 SES, exposure and sensitivity to each of the 7 climate change measures was assessed, using secondary information and expert judgment of the team members. Exposure was plotted against sensitivity to give an overall category for impact as in the matrix shown in Figure 9.1.

Chapter 8 provided a detailed discussion of adaptive capacity. This chapter presents the results of the adaptive capacity assessment of the top 10 SESs. Once again adaptive capacity was considered for each of the 7 climate change parameters and scores assigned as they were for exposure and sensitivity to each of those factors.

Scores for impact were then plotted against scores for adaptive capacity to give an overall score for vulnerability for each of the 7 climate parameters, for each SES, using the matrix shown in figure 9.2. The mean of these 7 vulnerability scores for each SES was then used as the overall vulnerability score (or average vulnerability score) for each SES. The vulnerability scores for the top 10 SESs are provided in Table 9.1. The full vulnerability analysis for each of the 10 SESs is provided in Annex 9.I.

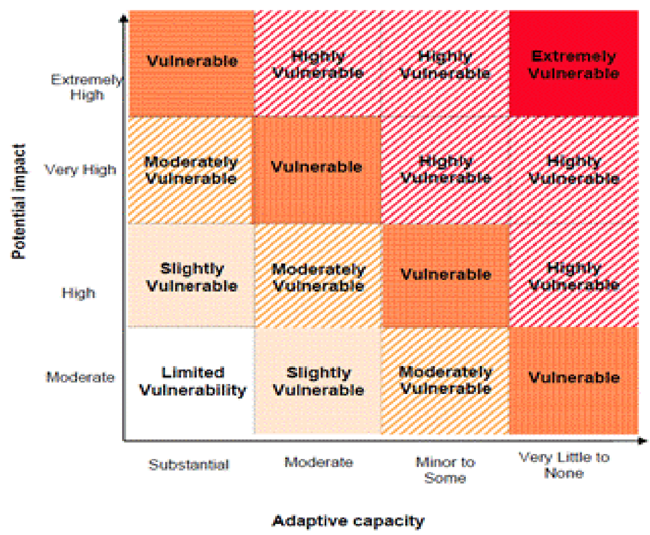
Figure 9.1: Potential Impact matrix



In which:

0.0 - 0.99 = Limited/Slightly vulnerable
1.0 - 1.99 = Moderately vulnerable
2.0 - 2.99 = Vulnerable
3.0 - 3.99 = Highly Vulnerable
4.0 - 5.00 = Extremely Vulnerable

Figure 9.2: Vulnerability matrix



In which:

0.0 - 0.99 = Limited/Slightly vulnerable
1.0 - 1.99 = Moderately vulnerable
2.0 - 2.99 = Vulnerable
3.0 - 3.99 = Highly Vulnerable
4.0 - 5.00 = Extremely Vulnerable

Table 9.1: Ten most important SESs in Quang Binh and their vulnerability scores

SES Importance Rank	Name of SES	Mean vulnerability score for 7 climate factors	Vulnerability Rank
8	Upland Ethnic minority swidden cultivation	4.0	1
2	Kinh smallholder mixed paddy and tree crops	3.4	2
1	Kinh smallholder coastal floodplain irrigated paddy rice cultivation	3.4	2
10	Irrigation/ hydropower reservoirs and related infrastructure	3.3	4
5	Kinh small-holder/commercial shrimp aquaculture on sand dunes	3.3	4
7	Kinh inshore capture fishermen (estuary to 6 km offshore)	3.1	6
6	Forest PMB on coastal sand dunes and sand	3.1	6
9	Hilly forest commercial rubber estates	2.8	8
3	Phong Nha-Ke Bang NP and WHS	2.7	9
4	Lowland Moist TRF State Forest Enterprise	2.7	9

9.2 KEY RESULTS AND RECOMMENDATIONS FOR EACH SOCIO-ECOLOGICAL SYSTEM

Key information on ecosystem services, vulnerabilities, and recommended EbA actions for each of the top-10 priority SESs is provided below.

In identifying appropriate EbA actions, it is worth considering Figure 9.3. Without the blue arrows, figure 4 represents the understanding of the components of vulnerability that has been popular sine the IPCC first presented the idea that vulnerability is a function of (Exposure X Sensitivity)/Adaptive capacity. EbA actions are intended to reduce vulnerability. They can do this primarily by strengthening adaptive capacity. The addition of the blue arrows to Figure 9.3 shows how strengthened adaptive capacity can be deployed to take action in regard to both the natural/physical environment, and the social environment which together can help manage issues of sensitivity in SESs; and also how strengthened adaptive capacity can take action to manage exposure in SESs. Management of exposure, and management of sensitivity, mediated through increased adaptive capacity, combine to reduce overall vulnerability.

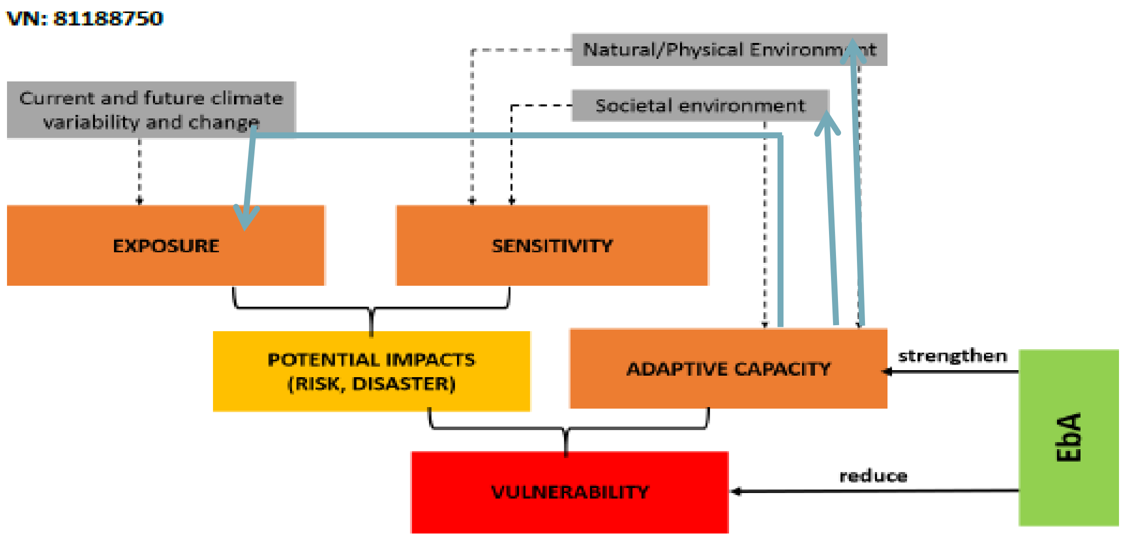
The intention is to provide and to prioritise reasonable EbA related adaptation measures. These recommendations are supported by explanations of why they are necessary and important, giving some indication of what benefits they will provide, and an indication of appropriate phasing/timing for their implementation.

The proposed EbA measure include some which address shocks, and some which address stresses, caused by, or exacerbated by climate change. They do not relate only to disasters caused be extreme climate events, but also to the cumulative stresses on systems derived from accumulation of continuing directional change (in temperature, rainfall patterns, sea level rise, and storm patterns) that will modify or in some cases transform these systems.

Some care has been taken not to label things as EbA if they do not clearly meet the definition, as this would will create (or add to existing) confusion about EbA approaches. Nevertheless, we have attempted to be pragmatic - good interventions do not always have to be about something that is 100% pure EbA and nothing else. In this context:

- Some recommendations relate to “Climate Smart” agriculture. These may include a mixture of EbA and non-EbA elements, but are best considered together as a package of interventions
- Some recommendations relate to “Climate-proofing” infrastructure investments. Bioengineering interventions may be considered as part of this - and in some cases as “stepping stones” necessary as part of the process to help bring back nature so that additional future ecosystem service benefits can be obtained.

Figure 9.3: Pathways of EbA action in socio-ecological systems



Source: adapted from GIZ, Adelphi and EURAC 2013, based on IPCC 2007

9.2.1. Quang Binh SES: Phong Nha Ke Bang 1-5

Ecosystem Services

Phong Nha Ke Bang (PNKB) National Park SES cluster is the single biggest area of healthy natural ecosystems, and the single biggest provider of ecosystem services in Quang Binh Province. It plays a major role in provision and regulation of water supply on which many downstream activities are dependent. It contributes significantly to tourism in the province - both domestic and international tourism, as its World Heritage status has made PNKB well-known all around the world. It also plays a very significant role in carbon sequestration and carbon storage, as well as micro-climate regulation. It may also provide significant pest control and pollination services to agricultural areas close to the forest, depending on the particular crops being grown.

Main Vulnerabilities

The large area of forest in PNKB, its species rich diversity, and connectivity within the landscape, all ensure that overall the vulnerability of PNKB is relatively low in general, when compared with many of the other SESs in the province. Its elevation and distance from the coastline reduce the impacts of storms and sea level rise. However, there are some specific aspects of vulnerability related to temperature and precipitation changes that should be considered.

In response to increasing temperature, species that are already close to the threshold of their temperature tolerances would have to shift their distribution to stay within their comfort zone and continue to survive. For every one degree of increase in temperature this would normally mean affected species moving either 35km further north, or moving to 100-200 metres higher altitude (or perhaps some combination of the two options). For species presently suited to conditions at the highest elevations in PNKB, this would leave them nowhere to go, as temperature heats up. For species that will need to migrate further northwards outside the present northern boundary of PNKB, the land-use pattern of that area will determine whether there is an opportunity for them to move successfully or not.

Longer hotter dry seasons, and the increasing number of very hot days will increase the risk of forest fire, especially in the very dry limestone areas. While this has not been considered as a major issue in the past, it will be of growing concern in the future. On the other hand, with wetter rainy seasons and more intense rainfall events, erosion and land-slide risk may also increase.

Possible EbA and related Interventions

In a general sense, vulnerability can be reduced by removing or reducing non-climate stressors thereby increasing the resilience of PNKB. That is to say, to be in the best condition to be able to deal with the new threats brought by climate change, it is important to first minimize the existing threats and deal with them effectively. In this case, the immediate priority is to continue to improve management of the National Park in line with its updated management plan, and including a specific focus on:

- Effective enforcement against illegal logging and wildlife poaching
- Improving forest fire prevention (including through visitor awareness-raising)
- Strengthening the relationship between park management and local communities
- Improving visitor education services and outreach into buffer zone communities

In addition, restoration and improvement of degraded areas (and secondary forest where selective logging had previously taken place), should be carried out using native species that are selected for their suitability to the future climate conditions. Further research should also be carried out to identify likely hot spots for erosion and landslides within the national park, and contingency plans should be developed to address these.

Over the medium term, detailed research should be undertaken on key species-especially endemics and endangered species for which PNKB is a key stronghold (such as Calocedris), to understand their temperature and rainfall comfort zones and tolerance thresholds, and to develop specific management responses to ensure their continued survival.

Longer-term planning should ensure connectivity of PNKB to other forests in the larger landscape is maintained (or restored where necessary) along both altitudinal and latitudinal gradients to facilitate the movement of species over time in response to climate change. Collaboration with Lao PDR should be continued and strengthened, to develop effective management of the trans-boundary landscape of Phong Nha Ke Bang-Hin Nam No protected areas, which will further strengthen resilience.

Plans should be put in place to ensure land use in areas up to 35-70km north of PNKB (and/or north of HNN in Lao PDR) will be managed in a way that will allow for the necessary migration of species responding to climate change. This could be achieved through development of a corridor of different land-uses, including production forest, protection forest, and agroforestry areas with appropriate species, linking PNKB to Vu Quang National Park in Ha Tinh province.

To facilitate all of the above there needs to be a very strong relationship between the PNKB Management Board and the District, Commune and village authorities in the buffer zone area around the park, as well between the PNKB Management Board and the PPC.

The composition, organizational structure and functioning of the Management Board and personnel of PNKB should be assessed and recommendations made for revisions to help achieve this. For example, personnel should be clearly assigned to specialist units with different functions of patrolling and enforcement; community outreach and engagement; research survey and monitoring; as well as visitor management and administration. Climate Change Adaptive Capacity training should be provided to all park management personnel.

9.2.2. Quang Binh SES: State Forest Enterprise (SFA)/State Forest Companies

Ecosystem Service

Forest Companies under the former State Forest Enterprise (now referred to as Single Member Company) are managing large areas of natural forest (as well as plantations) and these are also providing significant ecosystem services to downstream areas, similar to those described above for PNKB. The Truong Son Company has achieved Forest Stewardship Certification (FSC) certification for 25,000 hectares of natural forest under its management, and plans to extend this to additional areas in the coming years.

Main Vulnerabilities

The vulnerabilities of the production forest are also similar to those described for PNKB above. Fire hazards may be even greater, because some of the area is single species acacia plantations. In the natural forest, fire risk is high because of different groups (e.g. rattan harvesters) camping in the forest for several weeks at a time on their collecting trips

Potential EbA and related interventions

The overall recommendation is to manage production forest in Quang Binh more effectively and appropriately for a combination of both economic and ecosystem service benefits (not just economic benefits alone). An updated production forest management plan should be developed by each company managing production forest. In these updated plans, for the part that is natural forest, the following should be carried out:

In the short-term:

- existing harvesting and production plans should be updated and revised to take into account climate change considerations
- more effort and resources should be focused on forest fire prevention, including education of people going into the forest for other purposes - such as approved rattan collectors, and effective use of fire-breaks, etc.
- restoration and improvement of degraded areas (and enrichment planting where selective logging has already taken place), should use native high value timber species that are selected for their suitability to the future climate conditions

While over the medium to longer term:

- research should be carried out on temperature and rainfall "comfort zones" and thresholds for key high value native timber species
- efforts should be continued to achieve FSC Certification for additional areas of natural production forest, as this demands a high standard of management and sustainability

For the part of the production forest estate that is acacia plantation, in the short-term, harvesting practices should be changed so that:

- harvesting is done in a larger number of smaller patches (rather than a smaller number of larger patches) that are separated from each other by sizeable non-harvested areas.
- strips of non-harvested trees are left every 50m or so on steep slopes and as a riparian buffers along water courses.

Over the longer-term, the focus should be on adding more value - producing trees mainly for sawn timber and timber for garden furniture, rather than for pulp. (Some pulp can still be produced from poles cut during routine thinning of the plantation after 3-4 years).

- a gradual shift should occur from short term harvesting cycles of around 7 years to longer cycles of around 15 years or more
- a feasibility study and cost-benefit analysis should be conducted to support this transition.

These interventions together will help reduce erosion and land-slide risk that may become more severe with climate change, as well as helping maintain soil fertility and reducing fire risk. They will improve the watershed services of the forest, while also increasing the economic value of production.

Once again, all personnel working for forest companies should be given climate change training.

9.2.3. Quang Binh SES (5a): Upland Ethnic Minority Swidden Cultivation and forest product collection.

Ecosystem Services

The forest is critically important especially for providing sufficient and clean water supply, and fuel-wood for the ethnic minorities. It is also highly important for their religious and spiritual activities, and provides them with important amounts of some wild foods as well as timber for building materials. Agricultural fields close to the forest may benefit from close proximity of insect and animal pollinators, and biological pest control. Seed dispersal by forest species assists rapid regeneration of fallow fields, which is becoming increasingly important as the fallow cycle has now been reduced to 5 years or less.

Main vulnerabilities

Upland rice and other crops are very vulnerable to drought as there is no reservoir and irrigation water supply. These upland areas are also vulnerable to storms, strong winds and flash floods. Flash floods and landslides can block road access and cut them off from outside contact for extended periods. In winter they are also very vulnerable to cold snaps that can lead to the death of significant numbers of livestock.

Potential EbA and related interventions in this SES:

In the short-term:

- Improve soil and water conservation practices especially on steep slopes where field crops are grown, through contour planting, alley cropping, mulching, etc.

- Begin enrichment planting of high value timber and NTFPs in community managed forests
- Establish community-based management groups to for sustainable harvesting of NTFPs such as rattan for local use and income generations

In the medium-longer term:

- Assess the possibilities for returning to a system of fallows that are longer than 5 years, and develop a plan for implementation wherever possible (this will improve the soil formation and soil erosion protection services as well as nutrient cycling and water cycling)
- Assess the feasibility of introducing a PES or REDD+ type scheme, and develop a plan for implementation wherever feasible (this will increase the value of the carbon storage service of the forest to the ethnic forest-dwellers)
- Assess the appropriateness of terracing some slopes, and implement if appropriate

9.2.4. Quang Binh SES (5b): Kinh smallholder mixed paddy cultivation + tree crops (acacia, citrus, rubber, tea

Ecosystem Services

This SES is highly dependent on ecosystem services from other SESs, especially upstream watersheds and natural forests which are a source of water supply, and some physical protection, as well as pollination and pest control services of varying importance (depending on distance away from the forest). Tree crops planted in this SES, while not being natural ecosystems, nevertheless can provide some types of beneficial ecosystem services including provision of some building materials and fuel-wood, as well as nitrogen-fixation in soils by acacia and some protection from erosion (although this is reduced by the short-term harvesting rotation cycle of the plantations). The rice fields themselves may still supply some natural foods in the form of wild fish. Crabs and frogs etc. that can live in the rice fields (although increasing use of chemicals in rice-growing will reduce this wild food supply)

Main vulnerabilities

Cultivation of rice and other field crops is vulnerable to droughts in the dry season (especially in areas without access to irrigation), and also to storms and floods late in the growing season. Acacia trees are generally tolerant of high temperatures, but nevertheless the risk of forest fire may increase, as well as the risk of crop and tree diseases. Citrus fruit trees may be more vulnerable to changes in temperature and rainfall patterns, while rubber is vulnerable to damage by strong winds and storms.

Potential EbA interventions in this SES could include:

In the short -medium term:

- Increase the diversity of species used as tree crops and in tree plantations (this would also increase diversity of animals and plants that can live in the plantations and orchards, and will increase natural pollination and biological pest control services)
- When harvesting tree crops leave some tress standing along the edges of rivers and streams (this will improve the water supply and water quality services)
- Apply soil and water conservation practices when growing upland crops and citrus trees especially on steep slopes through contour planting, alley cropping, mulching, etc.
- Introduce land cover crops that fix nitrogen and help soil fertility
- Change cropping pattern and adapt cropping calendar to suit changing conditions
- Substitute crop varieties for more tolerant types
- Introduce SRI rice where appropriate

In the medium-long term

- Increase the duration of the harvest cycle for acacia (this will improve the soil fertility and soil erosion protection services)
- Investigate possibility of group certification for FSC for smallholders (this will provide an incentive to increase duration of harvest cycle - see above)

- Consider moving out of rice and growing only less water demanding crops such as cassava and maize

9.2.5. Quang Binh SES 5c Commercial rubber plantations in hilly areas

Ecosystem Service

Rubber plantations have a somewhat limited dependence on ecosystem services, other than requirements for a certain amount of soil fertility.

Main Vulnerabilities

Rubber plantations are vulnerable to damage by storms and strong winds, and there have been several times in the past when large areas of rubber plantations were damaged in this way in Quang Binh, most recently in 2010.

Rubber is also vulnerable to extended drought and to high temperatures which can damage trees. In extended periods of large volumes of rainfall, latex production is also reduced.

Possible EbA and related Interventions include:

Avoid storm and wind damage to rubber plantations by

- Locating plantations in sheltered areas protected from wind and storm damage
- Planting windbreaks of other trees

9.2.6. Quang Binh SES 6a Kinh Irrigated paddy rice in coastal plains

Ecosystem Service

This SES is ultimately dependent on upstream forest ecosystems for water supply for rice growing, although this is provided through a system of reservoirs and irrigation canals. The rice fields themselves may still supply some natural foods in the form of wild fish, crabs and frogs etc. that can live in the rice fields (although increasing use of chemicals in rice-growing will reduce this wild food supply)

Main Vulnerabilities

Paddy rice is vulnerable to drought, but if irrigation water supply is adequate, this risk can be effectively addressed. However, in Quang Binh in some years the drought is so intense that there is not enough water in the reservoirs to meet all of the irrigation needs.

Paddy rice is also vulnerable to storm damage and flooding when it is ripe and about to be harvested.

Rice productivity also declines as temperature increases

In Quang Binh in particular, paddy rice growing land in coastal floodplains is also at risk of increasing salinization as saline intrusion penetrates further upstream from river mouths, and seeps under dykes into agricultural fields.

Possible EbA and related Interventions

Restoring environmental flows in rivers would help to reduce saline intrusion and salinization of rice fields. This is the major EbA action of relevance to this SES.

In addition, a number of “climate-smart agriculture” initiatives are already being promoted in the province, and these should be continued and expanded. These include introducing the System of Rice Intensification (SRI) rice growing techniques which can significantly reduce water use in paddy rice growing (as well as reducing the use of fertilizers and pesticides) thereby reducing demand for irrigation water, especially in the dry season. SRI does however require more intensive management of the fields and has an increased labour demand for weeding.

Shifting the crop calendar and using rice varieties with shorter growing periods (less than 100 days) is also an effective strategy to reduce risk of storm and flood damage in late summer.

Growing of ratoon rice allows a second harvest to occur in as little as 45 days after the previous harvest. While productivity may only be around 65% of the previous harvest, all input costs (for preparation of seedlings, ploughing fields, fertilizer, pesticides) are reduced, resulting in relatively high profitability for the farmer. Ratoon rice grows well in low-lying areas where there is plenty of soil moisture remaining after the first harvest. It is particularly popular in Le Thuy district, where ratoon rice is grown after harvesting of the winter-spring rice crop and before the early summer crop.

Climate Smart Agriculture

To support climate change adaptation across multiple agriculture-related SESs (including 5a, 5b, 5c, and 6a, all discussed above), it is recommended that a Climate Smart Agriculture (CSA) Strategy and Action plan should be developed for Quang Binh province, and support should be provided for farmers in the transition to CSA.

This can build on a number of existing pilot activities that have already been started in the province, including:

- Adoption of SRI rice farming and ratoon rice in appropriate areas
- Shifting out of rice to less water intensive crops in areas with no or limited irrigation potential
- Soil management and improved sustainability of cassava production
- Improved housing and bedding for livestock
- Relocation of rubber plantations to areas less likely to be impacted by storms and strong winds
- Shifting of crop calendar to take account of changing climate conditions

However, a fully-fledged approach to CSA needs to go beyond individual activities and requires an integrated programme to develop the appropriate technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. The major benefits of CSA include increasing productivity and the resilience of agricultural systems, reducing GHG emissions or enhancing carbon sequestration, and managing interfaces with other land uses. CSA has three main pillars: (1) sustainably increasing agricultural productivity and incomes; (2) adapting and building resilience to climate change; and (3) reducing and/or removing greenhouse gas emissions; and it integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges (FAO, 2012).

An holistic approach to CSA in fact requires farmers to be weather smart; water smart; carbon smart; nitrogen smart; energy smart, knowledge smart, and income smart.

Weather Smart: For farmers, information of near-term weather events goes a long way in planning for climate-resilient agricultural production. Farmers can be linked to weather information and value- added agro-advisories through radio broadcasts, televisions, newspapers and mobile phone voice messages. Farmers can use index-based insurance schemes to cover risks associated with changes in rainfall and temperature at different stages of crop growth.

Water Smart: Resilient water management practices which enhance the efficiency and productivity of water are critical climate- smart interventions. These could include aquifer recharge, rainwater harvesting, community management of water, mechanized land levelling, water conservation, drip irrigation and on-farm water management practices.

Carbon Smart: Soil organic carbon helps mitigate climate change and improve soil fertility. Carbon content in the soil can be increased through agricultural practices such as agroforestry, crop–livestock system, croptree system, conservation tillage, diversified land-use systems and residue management.

Nitrogen Smart: Farmers can use leaf-color charts and site-specific nutrient management to decide on the most appropriate dosage of nitrogen fertilizers for their crops and livestock management. This saves on costs and also cuts down GHG emissions.

Energy Smart: This involves the use of fuel-efficient agro- machineries, residue management and reduced tillage as interventions to conserve energy and reduce GHG emissions. In some cases, biogas systems are promoted using manure slurry from intensive dairy enterprises as part of the portfolio of innovations.

Knowledge Smart: Partner organizations arrange cross-site visits of farmers to analogue sites and to other areas practicing CSA.

Studies should be conducted into the temperature and rainfall tolerances of key species. If continued production of some species will be unsuitable in the changed climate conditions, plans should be made to promote and support the introduction of alternative species more suited to the new climate conditions. One innovative approach is crowdsourcing seeds. A large number of farmers are provided with seed packets of adapted varieties to evaluate those best suited to their local conditions. They provide feedback to researchers to help them develop better varieties (Aggarwal et al. 2013).

Income Smart: Finally, diversification of rural household economies should be promoted to enhance resilience and lower the risks inherent in depending on few sources of income.

9.2.7. Quang Binh SES: PFMB9: Protection Forest Management Board coastal protection forest in sand dunes and sandy areas

Ecosystem Services

Sand dune ecosystems provide significant physical protection from storms and protection from sea level rise. They also provide a very important function in filtering rain water and storing underground water, providing a critical dry season water supply. Natural vegetation of sand dunes areas can provide grazing for livestock and some edible and medicinal plants used by people. Sand dune ecosystems are very dynamic areas, but if ecological processes are occurring naturally, then on the landward side of the system mature tree cover eventually stabilizes the movement of sand. Intact sand dune ecosystems are now very rare. Quang Binh has very significant sand dune areas, although these have been significantly degraded by development of human settlements, cutting down of the original tree cover, and conversion to a number of different land-uses including commercial shrimp ponds and vegetable growing. Heavy sands mining for titanium has also removed tree cover from large areas of sand dune systems and sandy areas.

The coastal protection forest today is almost exclusively plantations of introduced species – mainly *Casuarina equisetifolia,* and some acacia. While these trees provide some physical protection, air quality maintenance, climate buffering and fuel biomass services, these are not services from a natural ecosystem. The original coastal forests were more diverse and would have provide these services more effectively. Coastal protection forest is dependent on ground water supply that may largely be determined by the sand dune ecosystem and tree cover within the SES itself.

In coastal areas where there are still remnant patches of natural forest including melaleuca forest and other types, it can clearly be seen that the diverse multi-layered, multi-species vegetation provides better physical protection from winds and storms, and together with the more abundant ground cover vegetation that occurs in these forests, is much better at stabilizing movement of sand. Soil formation under these natural forests is much better than under casuarina plantings. These forests also provide more ecosystem service benefits to local communities including firewood, edible plants and medicinal plants (casuarina only provides firewood), and have much greater biodiversity "co-benefits" Finally, natural forests are more effective at reducing erosion and filtering and reducing land-based water pollution flowing into the sea.

Main vulnerabilities

Increased evapo-transpiration with higher temperature, and reduced rainfall in the dry season increases the risk of drought - especially on sandy soils where temperature increases quickly and soil water retention is poor. Reduction in soil water availability and a decline in the water table can lead to the death of casuarina and acacia trees, even large mature trees if the roots cannot penetrate deeply enough to find water. Although both casuarina and acacia are tolerant of high temperatures, the risk of forest fire will be increased with climate change. Coastal plantation forests of mainly casuarina and some acacia are also vulnerable to storm damage and can be blown over by strong winds. The harsh conditions of drought and strong winds also make it difficult to successfully replant these areas. Higher intensity rainfall events in the rainy season will also lead to increased erosion.

Sand dunes are extremely dynamic systems. Natural vegetation cover including native species trees at the landward side of sand dune ecosystems helps to stabilize moving sand, and reduces blowing and flowing sand. However, in their current very degraded state, the sand dune ecosystems of Quang Binh have become the source of major problems of blowing and flowing sand, causing significant damage to housing and agricultural fields of communities living just inland from the dunes. In 2016, construction of the first two of a possible planned 12 golf courses has already started construction in the sand dunes of Quang Binh, as part of broader plans for tourism development. Golf courses require significant amounts of water, and often use significant amounts of fertilizer and herbicides, residues of which can also run off and contaminate the water supply, and careful attention should be paid to management of these issues.

Possible EbA interventions include:

In order to improve physical protection from storms, reduce blowing sand, improve soil formation, improve ground water function and reduce coastal erosion, while also contributing to biodiversity conservation, all remaining natural coastal forests should be clearly identified and existing maps regularly updated; and a provincial Action Plan should be developed. The Provincial Action Plan for Conservation and Restoration of Natural Coastal Forests and Sand Dunes should include the following key actions:

- Implementing a communication, education and public awareness programme to increase understanding of the value and importance of natural coastal forest and sand dune ecosystems
- Establishing community based management systems for all remaining areas of native species coastal forest
- zoning of the sand dunes for different activities (aquaculture, tourism, etc) including identification of core protection zones, as well as restoration zones
- Core protection zones should include a series of regular sections of dunes with intact dune ecosystems running in strips perpendicular to the shoreline, from the beach to the landward end of the dune system. No settlements or permanent activities should be allowed in these areas.
- Restoration of native ground vegetation (beach morning glory, grasses, sedges, etc.) should be carried out in the restoration zones of the sand dune ecosystem
- Construction of tree nurseries and provision of training for propagation and care of native species, to provide seedlings for new planting areas
- Use of native species for enrichment planting of existing casuarina and acacia coastal protection forests
- Use of native species instead of casuarina and acacia in all new coastal protection forest planting
- Investigate the total ground water supply availability and compare with likely future demands (including for golf-course development) and consider introducing livelihood options that use less water if necessary (e.g. growing native species of grass on the dunes and cutting it for fodder for stall-fed livestock-raising)
- Research should be carried out and practical solutions developed on how to improve the effectiveness of tree planting on former heavy sands mining areas
- A feasibility study should be carried out for development of eco-tourism and environmental education programmes in the sand dune ecosystems

In addition to this the company developing the golf courses should be engaged proactively to identify how they can support restoration and management of the dune ecosystem (for example they will plant a lot of trees for the golf course, they could select important native species, and they themselves could establish tree nurseries for native species).

9.2.8. Quang Binh SES (9c): Commercial shrimp pond aquaculture on sandy areas

Ecosystem Services

This SES is critically dependent on two things - underground abundant and good quality water supply within the SES, for freshwater input, and commercial feed based on “trash fish” from other coastal and marine SESs. Any remaining natural forest together with planted coastal protection forest, provides some physical protection from storm damage, and polluted waste water is released directly untreated into the surrounding environment.

Main Vulnerabilities

This SES is vulnerable to drought, which will cause salinity of ponds to increase as well as heavy rainfall events that will cause salinity to suddenly decrease. Both can cause sudden shocks that can harm or kill the cultured species (especially prawns). Increased temperature on the one hand encourages the growth of prawns that will develop faster and grow bigger in warmer water, but on the other hand increased temperature also increases of algae that depletes oxygen supply, reducing growth of the prawns, and increasing temperature also increases the risk of disease outbreaks. If the temperature is too hot the prawns will stop feeding. Storms can also result in physical damage to the facilities.

Possible EbA and other interventions include:

- Reduce physical damage from storms and reduce impacts of high temperatures by restoring natural beach vegetation around ponds to provide physical protection and shade
- Investigate drought impacts on ground water supply and assess future demand (from aquaculture, vegetable growing and tourism development) to develop appropriate management
- Improve management of waste water discharges to reduce pollution of sea water and impacts on fisheries
- Conduct a study on the feasibility of introducing organically-farmed high value prawn, as has been done successfully in Ca Mau province

C.P. Vietnam Corporation that has major shrimp farm business interests in the coastal zone of Quang Binh especially in Quang Ninh District and should also be approached for support for this work through its CSR programme.

9.2.9. Quang Binh SES (10a): Kinh inshore capture fisherman in delta and marine areas up to 6 nautical miles offshore

Ecosystem services

The SES depends provides significant catches of near-shore pelagic fish, shellfish, prawns and crab, depending on good quality water in the coastal area. The SES also absorbs large amounts of carbon dioxide which is dissolved in the sea, but this is causing increasing problems of acidification, which has serious impacts on marine life. The SES provides some waste recycling and detoxification services, but it can be overwhelmed by sudden influxes of large levels of pollution or highly toxic substances, that can have huge impacts on marine life. Coastal habitats including coral, sea-grass and mangroves support fisheries productivity by providing critical spawning, nursery and feeding grounds for a wide range of species during different periods of their life-cycle.

Main vulnerabilities

The SES is vulnerable to storms that make fishing dangerous or impossible. Good storm forecasting means that fishermen know when storms are coming and can stay at home. But their homes and boats can still be damaged by the storms. Sea level rise and coastal erosion may also require them to relocate their houses at some point. Storms can cause physical damage to mangroves, sea grass and coral reefs. Increased water turbidity from storms and run off from heavy rains can also affect penetration of sunlight necessary for corals and sea grass. Surface, water column and bottom water temperature increases may have many effects, including increased risk of algal bloom, and depletion of oxygen supply, as well as impacts on the life-cycle and migration of important fish species. Some fish species such as sardines are already arriving earlier in the year as temperature is warming earlier in spring. If water temperature continues to increase, sardine productivity may decrease over time, but in contrast, anchovy production is likely to increase. Mackerel may migrate to cooler waters. Squid productivity may also increase with warming water and it may provide an increasing proportion of the catch over time. Increasing temperature is a critical issue for coral, with elevated water temperatures beyond a few days causing corals to expel their symbiotic algae. This results in the well-known phenomenon of coral bleaching. Increasing acidification causes problems especially for shell-fish and coral as it is harder to secrete calcium carbonate to build shells and coral structures at lower pH.

Near-shore coastal fisheries in Quang Binh are already under severe stress, which decreases their resilience, making them even more vulnerable to the effects of climate change. The number of fishermen and fishing boats has increased significantly over the last 20 years, engine power has increased, fishing gear has improved and many now use fish finder devices.

Recent mass fish deaths in 4 coastal provinces including Quang Binh, starting in April 2016, have dealt an additional serious blow to fisheries. Speculation is rife that the mass fish die-off resulted from phenol poisoning from the discharge of a huge amount of carbolic acid (an industrial cleaning agent) from the Formosa plant at the Vung Ang Special Economic Zone in Ha Tinh province, but no conclusive statement or report on the investigation of the issue has yet been provided by the government, despite engaging a number of research institutes to assess the situation.

It is also possible that a combination of coastal pollution from other sources including aquaculture and domestic waste water; an extended period of elevated water temperature, and associated significant movement of benthic sediment into the water column also contributed to create a “perfect storm” of deadly conditions for the fish. Media reports have suggested over 2,000 fishing households were directly affected in Quang Binh, with initial losses estimated at over 115 billion VND. (See list of media articles is provided at the end of this report). Government advice against the sale of seafood in hotels and restaurants in Quang Binh, in place since the incident, was lifted on 16th June 2016.

While the mangrove area in the province has steadily declined (despite some efforts at replanting) almost nothing is known about the extent and condition of sea-grass and coral reefs in Quang Binh. The provincial Seas and Islands Department within DONRE has no data at all on these critical habitats.

Possible EbA and other related interventions include:

- Assess fish stocks of key species and monitor them on a regular basis

- Improve fisheries management through community-based management initiatives, a systems of quotas, and limiting the number of fishing vessels to that appropriate to the availability of stocks and catch quotas
- Identify, map and survey all coral reefs and sea-grass beds in Quang Binh Province
- Invest in major efforts for improved management and restoration of mangroves, sea-grass and coral reefs
- Restore native species coastal forest to reduce land-based water pollution flows to the sea and reduce coastal erosion
- Over the longer-term, research water temperature impacts on key fisheries species

9.2.10. Quang Binh SES 10c: Small and large-scale beach tourism development

Ecosystem Service

This SES is critically dependent on fresh water supplies, and seafood supplies originating from other adjacent SESs. Nearby coastal forest is also important for physical protection from storms and blowing sand, and may provide some micro-climate regulation. However, coastal forest is nowadays almost exclusively casuarina plantations. Original natural diverse species coastal forest would be more effective at providing these services.

Main Vulnerabilities

Increasing temperature and increasing number of hot days do not necessarily create vulnerability directly in this SES, as most of the tourists are coming to enjoy a beach holiday and hot weather is part of that experience. However, temperature effects on fisheries productivity in other SESs may have an indirect impact on this SES as the other main attraction for tourists is coming to Quang Binh to enjoy fresh seafood, and if supply is reduced, this could limit tourism growth.

Tourism creates significant demand for fresh water, and therefore tourism development is vulnerable to drought. Existing reservoirs in Quang Binh may ensure there is adequate water supply in most years, but in the worst drought years reservoirs are only filled to a very low level and may not be able to meet all of the needs for the tourism sector as well as domestic use and the increased demand for agricultural irrigation water in times of drought.

Tourism infrastructure (hotels, restaurants, access roads and bridges) is also vulnerable to damage caused by strong winds and storms, as well as to flood damage caused by storms and increases in heavy rainfall in the rainy season.

Use of plastic bags and other forms of plastic, and management of plastic waste is a huge issue. In many coastal communities in Quang Binh waste is simply dumped by the side of the road near to the beach. Plastic bags block drainage channels, increasing the impact of floods, and plastic waste gets into the sea where it is responsible for the deaths of vast numbers of marine creatures. Use of plastic increases with increasing tourists visiting the area. Recent reports have shown that together just five countries - China, Vietnam, Thailand, Indonesia and the Philippines - are responsible for over 60% of all the plastic waste in the world's oceans. Quang Binh small and large-scale tourism is just as much a part of this problem as anywhere else.

Possible EbA and related interventions could include:

Climate proofing tourism infrastructure including:

- Planting windbreak trees to protect buildings from strong winds and storms
- Applying SUDS (sustainable urban drainage systems) in all future tourism development planning - maximising natural drainage. Apply the 1:4 rule: every development of 1m2 of planned concrete must be accompanied by 4 m2 of natural surface
- Using eco-engineering options to protect coastal roads from erosion
- Planting shade trees along roads to reduce road surface temperature and prevent tarmac from melting on hot summer days, and to provide shade for tourists
- Widening of bridges to take account for increased rainy season river flows
- Raising the height of roads to take account of increased depth of future floods
- Increasing the number and size of culverts under roads to increase transparency of roads to more frequent floods and thereby reduce flood damage to roads

Supporting best practices in the tourism industry, including:

- Introducing programmes on water conservation, more efficient use of water and water recycling in hotels and resorts
- Campaigning to reduce use of plastic bags
- Introducing simple sustainable seafood consumption guidelines, and educating restaurant owners and tourists
- Improving solid waste and waste water management for small enterprises along the beaches

In addition, in Dong Hoi in particular, there are a number of urban and peri-urban wetlands. They provide valuable flood management, water supply and purification as well as micro-climate regulation services. They mustn't be filled in and built upon. Instead they can be developed for recreational, educational and scenic benefits that will provide additional attractions for visitors, as well as benefits for local people.

9.2.11. Quang Binh SEA 11a Irrigation Reservoirs and Associated Infrastructure

Ecosystem Services

All reservoirs depend on the inflow of water from the watersheds from forest SESs upstream of their location. The reservoirs are then used to regulate the flow of water to other downstream SESs, through irrigation canals, as well as through the water they release into the natural river channel below the reservoir.

Main Vulnerabilities

Reduced rainfall in the dry season will reduce the water inflow to reservoirs. On the other hand, prolonged periods of intense rainfall in the rainy season can quickly fill reservoirs to their safe limits, and raise the possibility of dam failures. Intense rainfall in the watershed areas can also increase erosion and the flow of sediment into the reservoir, which will cause shallowing of the reservoir as it fills in with sediment. This will reduce the effectiveness of the reservoir, as well as shortening its overall working life. The reservoir facilities may also be vulnerable to physical damage from strong winds and storms.

Possible EbA and related Interventions include:

- Protect reservoir infrastructure from physical damage from storms through planting of wind-breaks
- Increase working life of reservoirs by reducing sediment inflow through improved watershed management
- Install of large areas floating solar cells on reservoir surfaces to generate electricity and reduce evaporation losses
- Conduct scenario planning exercises for future water demand (including climate change considerations) in the area supplied by each reservoir

In addition, Quang Binh should develop a provincial integrated water resource management plan which should incude:

- Consideration of renaturation of some rivers or river stretches, potentially involving removal of some dykes, revetments and other barriers, to allow water to flow more naturally, meandering in the valleys and across floodplains, and restoring “environmental flows” and natural wetland habitats to help slow and absorb flood waters, recharge ground water, combat saline intrusion, and purify water supply, for the benefit of all downstream SESs.
- In rivers where saline intrusion barriers already exist studies should be conducted to identify the optimal operation of the gates for multiple benefits - not only to reduce upstream saline intrusion but also to allow downstream sediment transport, migration of fish, and the continued survival of estuary mangroves. Community-based committees with representative from both upstream and downstream of the barriers should be established to manage their operation.
- In other rivers studies should be conducted to investigate alternatives including introduction of more saline-tolerant rice varieties or transition out of rice-growing into brackish-water aquaculture livelihood activities.

9.3 SUMMARY EBA INTERVENTIONS RECOMMENDED FOR EACH SES

Table 9.2 presents a summary of 39 specific interventions, identifying for each one, which SESs it applies to; who are the lead agencies for implementation; the appropriate time frame, and the level of priority.

Table 9.2: EbA and related interventions for priority SESs in Quang Binh

#	INTERVENTION	SES	LEAD	Time frame	Priority
1	Implement strict enforcement against illegal logging and wildlife poaching	PNKB 1-5 SFE 5	PNKB MB and Forest Companies	S-M	1
2	Improve forest fire prevention, including through education	PNKB 1-5 SFE 5	PNKB MB and Forest Companies	M-L	2
3	Restore degraded/previously logged areas with important/high value native species suitable to changing climate	PNKB 1-5 SFE 5	PNKB MB and Forest Companies	M-L	2
4	Conduct research on comfort zones and tolerance thresholds of endemic, endangered, and high value species	PNKB 1-5 SFE 5	PNKB MB and Forest Companies	L	3
5	Improve visitor education and interpretation services	PNKB 1-5	PNKB MB	S-M	3
6	Improve outreach with buffer zone communities	PNKB 1-5	PNKB MB	S-M	2
7	Update harvesting plans taking into account climate change issues	SFE5	Forest companies	M-L	2
8	Prepare for FSC Certification of additional natural forest not yet certified	SFE5	Forest companies	M	1
9	Plan transition to shift acacia plantations from 6-7year rotation to 15 year + rotation for production of higher value timber products	SFE5	Forest companies	M-L	1
10	Improve soil and water conservation practices especially on steep slopes where field crops are grown, through contour planting, alley cropping, mulching, etc.	5a	DARD extension services	S	1
11	Conduct enrichment planting of high value timber and NTFPs in community managed forests	5a	DARD extension services	M	2
12	Assess the feasibility of introducing a PES or REDD+ type scheme, and develop a plan for implementation wherever feasible	5a	DARD	L	3
13	Assess the appropriateness of terracing some slopes, and implement if appropriate	5a	DARD	L	3
14	Locate rubber plantations in sheltered areas protected from wind and storm damage and plant windbreaks of other trees to provide physical protection	5c	Commercial rubber enterprises	S	2
15	Continue to promote wider adoption of SRI rice, growing of Ratoon rice, use of shorter maturing rice varieties and diversification of household economy	6b	DARD Agriculture Extension services	S-M	2
16	Implement a communication, education and public awareness programme to increase understanding of the value and importance of natural coastal forest and sand dune ecosystems	PFMB9,9a,9c	DONRE	S	1
17	Establish community based management systems for all remaining areas of native species coastal forest	PFMB9	PFMB	S-M	1
18	Zone the sand dunes for different activities (aquaculture, tourism, etc.) including identification of core protection zones, as well as restoration zones and restore of native ground vegetation in the restoration zones of the sand dune ecosystem	PFMB9, 9a,	PFMB/PPC	S-M	1
19	Construct tree nurseries and provide training for propagation and care of native species, to provide seedlings for new planting areas	PFMB9, 9a, 9c	PFMB	S-M	2
20	Use native species for enrichment planting of existing casuarina and acacia coastal protection forests and instead of casuarina and acacia in all new coastal protection forest planting	FPMB9, 9a	PFMB	S-M	2

#	INTERVENTION	SES	LEAD	Time frame	Priority
21	Conduct research and identify practical solutions on how to improve the effectiveness of tree planting on former heavy sands mining areas	PFMB9	DONRE	M-L	3
22	Investigate ground water supply availability and compare with likely future demands	PFMB9,9a, 9c	DARD water resources department	M-L	2
23	Conduct feasibility study for development of eco-tourism and environmental education programmes in the sand dune ecosystems	PFMB9, 9a 9c	DONRE and Department of Tourism	M-L	3
24	Restore natural beach vegetation around aquaculture ponds	9a	Commercial enterprises	S	2
25	Improve management of waste water discharges from aquaculture ponds	9a	Commercial enterprises	S	1
26	Assess fish stocks of key species and monitor on a regular basis	10a	DARD fisheries department	M-L	2
27	Establish community-based fisheries management, reduce number of vessels and establish catch quotas	10a	DARD fisheries department	M-L	2
28	Research water temperature impacts on key species fisheries species	10a	DARD fisheries department	L	3
29	Identify, map and survey all coral reefs and sea-grass beds and develop plan for conservation and restoration	10a	Seas and islands, DONRE	S	1
30	Plant windbreak trees to protect tourist hotels	10c	Commercial enterprises	S	3
31	Apply 1:4 ratio rule for concrete surface are and natural vegetation in tourism infrastructure developed	10c	Commercial enterprises	M	2
32	Use eco-engineering to protect coastal roads from erosion, plant shade trees along roadsides, and widen bridges and increase culverts to reduce flood damage	10c	Department of transport	M-L	2
33	Introduce water efficiency and conservation programmes in hotels	10c	Commercial enterprises	S	3
34	Implement continuous campaign to reduce use of plastic bags	10c	DONRE	S	2
35	Introduce sustainable seafood guidelines	10c	DARD fisheries department	M-L	3
36	Improve solid waste and waste water management for small and microenterprises along the beach	10c	Commercial enterprises	S	1
37	Reduce sediment inflow to reservoirs through improved watershed management	11a	PNKB MB, Forest companies	M-L	2
38	Consider installation of floating solar cells on reservoirs	11a	Reservoir managers	L	3
39	Develop provincial Integrated Water Resource Management Plan	11a	DARD	M	1

9.4 CONCLUSIONS

Vulnerability assessments were conducted for the top 10 priority Socio-ecological systems (SESs) in Quang Binh Province. Taking into account aspects of exposure, sensitivity and adaptive capacity, vulnerability scores were assigned for each of 7 different climate change parameters in each SES. The mean of the 7 scores in each SES was taken as the overall vulnerability score for that SES. Based on the identified vulnerabilities, a total of 39 appropriate Ecosystem-based and other related adaptation interventions were suggested, specifically identified to each SES.

One main advantage of using the SESs as entry points for vulnerability assessments and identification of EbA interventions is that it facilitates thinking outside of traditional silos of purely social, ecological or economic issues and encourages the identification of interventions which may require collaboration between multiple agencies. Another advantage is that the scale of SESs provides a convenient intermediary step between "whole of province" and "community" scales.

Taking the SES map together with the EbA recommendations for a specific SES, enables provincial level government staff to see in which parts of the province each recommendation should be applied.

Mainstreaming these recommendations into provincial planning, and accessing budgets to address them, are addressed in the final chapter of this report.

9.5 REFERENCES

Spatial covariance between biodiversity and other ecosystem service priorities. *Journal of Applied Ecology* 46(4):888-896. http:// dx.doi.org/10.1111/j.1365-2664.2009.01666.x

Aggarwal P, Zougmoré R and Kinyangi J. 2013.Climate-Smart Villages: A community approach. *https://cgspace.cgiar.org/.../CCAFSClimate- SmartVillages2013.pdf*

Angelstam, P., M. Grodzynskyi, K. Andersson, R. Axelsson, M. Elbakidze, A. Khoroshev, I. Kruhlov, and V. Naumov. 2013. Measurement, collaborative learning and research for sustainable use of ecosystem services: landscape concepts and Europe as laboratory. *Ambio* 42(2):129-145. http://dx.doi.org/10.1007/ s13280-012-0368-0

Baumann, M., T. Kuemmerle, M. Elbakidze, M. Ozdogan, V. C. Radeloff, N. S. Keuler, A. V. Prishchepov, I. Kruhlov, and P. Hostert. 2011. Patterns and drivers of post-socialist farmland abandonment in western Ukraine. *Land Use Policy* 28(3):552-562. http://dx.doi.org/10.1016/j.landusepol.2010.11.003

Carpenter, S., B. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: Resilience of what to what? *Ecosystems* 4(8):765-781. http://dx.doi.org/10.1007/s10021-001-0045-9

Carpenter, S. R., and W. A. Brock. 2008. Adaptive capacity and traps. *Ecology and Society* 13(2): 40. [online] URL: http://www. ecologyandsociety.org/vol13/iss2/art40/.

Carpenter, S. R., C. Folke, A. Norström, O. Olsson, L. Schultz, B. Agarwal, P. Balvanera, B. Campbell, J. C. Castilla, W. Cramer, R. DeFries, P. Eyzaguirre, T. P. Hughes, S. Polasky, Z. Sanusi, R. Scholes, and M. Spierenburg. 2012. Program on ecosystem change and society: an international research strategy for integrated social-ecological systems. *Current Opinion in Environmental Sustainability* 4(1):134-138. http://dx.doi.org/10.1016/j.cosust.2012.01.001

Carpenter, S. R. 2003. *Regime shifts in lake ecosystems: pattern and variation.* Excellence in Ecology Series Number 15. Ecology Institute, Oldendorf/Luhe, Germany.

Carpenter, S. R., and W. A. Brock. 2004. Spatial complexity, resilience and policy diversity: fishing on lake-rich landscapes. *Ecology and Society* 9(1): 8. [online] URL: http://www.ecologyandsociety.org/vol9/iss1/art8/.

FAO. 2012. Food security and climate change. A report by The High Level Panel of Experts on Food Security and Nutrition

Folke, C. 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16(3):253-267. http://dx.doi.org/10.1016/j.gloenvcha.2006.04.002

Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30:441-473. http://dx.doi.org/10.1146/ annurev.energy.30.050504.144511

Folke, C., Å. Jansson, J. Rockström, P. Olsson, S. R. Carpenter, F. S. Chapin III, A.-S. Crépin, G. Daily, K. Danell, J. Ebbesson, T. Elmqvist, V. Galaz, F. Moberg, M. Nilsson, H. Österblom, E. Ostrom, Å. Persson, G. Peterson, S. Polasky, W. Steffen, B. Walker, and F. Westley. 2011. Reconnecting to the biosphere. *Ambio* 40 (7):719-738. http://dx.doi.org/10.1007/s13280-011-0184-y

Hanspach, J., T. Hartel, A. I. Milcu, F. Mikulcak, I. Dorresteijn, J. Loos, H. von Wehrden, T. Kuemmerle, D. Abson, A. Kovács- Hostyánszki, A. Báldi, and J. Fischer. 2014. A holistic approach to studying social-ecological systems and its application to southern Transylvania. *Ecology and Society* 19(4): 32. http://dx.doi.org/10.5751/ES-06915-190432

Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4:1-23.

Holling, C. S. 1986. The resilience of terrestrial ecosystems: local surprise and global change. Pages 292-317 *in* W. C. Clark and R. E. Munn, editors. *Sustainable development of the biosphere.* Cambridge University Press, Cambridge, UK.

Holling, C. S. 2001. Understanding the complexity of economic, ecological, and social systems. *Ecosystems* 4:390-405.

ISPONRE (2013) Operational Framework for Eba in Vietnam

Liu, J. G., T. Dietz, S. R. Carpenter, M. Alberti, C. Folke, E. Moran, A. N. Pell, P. Deadman, T. Kratz, J. Lubchenco, E.

Ostrom, Z. Ouyang, W. Provencher, C. L. Redman, S. H. Schneider, and W. W. Taylor. 2007. Complexity of coupled human and natural systems. *Science* 317(5844):1513-1516. http://dx.doi. org/10.1126/science.1144004

Qiu, J., and M. G. Turner. 2013. Spatial interactions among ecosystem services in an urbanizing agricultural watershed. *Proceedings of the National Academy of Sciences* 110 (29):12149-12154. http://dx.doi.org/10.1073/pnas.1310539110

Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. J. Schellnhuber, B. Nykvist, C. A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society* 14(2): 32. [online] URL: http:// www.ecologyandsociety.org/vol14/iss2/art32/

Rounsevell, M. D. A., B. Pedroli, K.-H. Erb, M. Gramberger, A. G. Busck, H. Haberl, S. Kristensen, T. Kuemmerle, S. Lavorel, M. Lindner, H. Lotze-Campen, M. J. Metzger, D. Murray-Rust, A. Popp, M. Pérez-Soba, A. Reenberge, A. Vadineanu, P. H. Verburg, and B. Wolfslehner. 2012. Challenges for land system science. *Land Use Policy* 29(4):899-910. http://dx.doi.org/10.1016/ j.landusepol.2012.01.007

Scheffer, M., F. Westley, W. Brock, and M. Holmgren. 2002. Dynamic interaction of societies and ecosystems: linking theories from ecology, economy and society. Pages 195-235 *in* L. H. Gunderson and C. S. Holling, editors. *Panarchy: understanding transformation in human and natural systems.* Island Press, Washington, D.C., USA.

Walker, B. H., and R. L. Lawson. 2006. Case studies in resilience: fifteen social-ecological systems across continents and societies. The Resilience Alliance. Available online at: http://www.resalliance.org/1613.php.

Walker, B. H., and J. A. Meyers. 2004. Thresholds in ecological and social-ecological systems: a developing database. *Ecology and Society* 9(2):3 [online] URL: http://www.ecologyandsociety.org/vol9/iss2/art3/.

Walker, B., L. Gunderson, A. Kinzig, C. Folke, S. Carpenter, and L. Schultz. 2006. A handful of heuristics and some propositions for understanding resilience in social-ecological systems. *Ecology and Society* 11(1): 13. [online] URL: http://www.ecologyandsociety. org/vol11/iss1/art13/

WWF (2012) rapid Integrated and Ecosystem-bases Assessment of Climate Change Vulnerability and Adaption for Ben Tre province Vietnam.

9.6 SELECTION OF MEDIA REPORTS ON MASS FISH DEATHS

http://tuoitre.vn/tin/kinh-te/thi-truong/20160610/phat-hien-chat-cuc-doc-trong-ca-nuc-dong-lanh-tai-quang-tri/1116058.html

https://dathanhdoson.com/2016/06/10/extremely-toxic-chemical-discovered-in-frozen-anchovies-in-quang-tri-new-tuoi-tre-article-translated/

http://www.asiasentinel.com/politics/fish-kill-test-vietnam-new-regime/

http://thediplomat.com/2016/04/vietnam-fish-deaths-cast-suspicion-on-formosa-steel-plant/

http://www.voanews.com/content/vitenam-media-ties-massive-fish-kill-to-formosa-plastics-steel-unit/3304801.html

http://www.theguardian.com/environment/2016/apr/21/vietnam-investigates-mass-fish-deaths-pollution

http://www.reuters.com/article/us-vietnam-formosa-plastics-environment-idUSKCN0XO18L

http://www.reuters.com/article/us-vietnam-formosa-plastics-environment-idUSKCN0XS0U6

http://www.tienphong.vn/xa-hoi/vuong-quoc-chim-da-chet-997957.tpo

https://www.youtube.com/watch?v=36LEH3CI3bg

ANNEX 9.I

SES: 1P (1a, 2a, 3a, 4a) - PNKB World Heritage Site and National Park

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.8 degree C in 2050, 3.5 degree in 2100	3	*High and medium mountain (300-700-1200)* *It would be hotter in limestone area during hot season and colder in cold season*	3	*Coniferous can adapt oneself to dry/waterless for long time* *High biodiversity (forest types)*	3	4	*Well-management by PNKB NP;* *Existing of Ranger stations; Forest patrol regularly (reduce the threads)* *High biodiversity*	3
Number of Dry days increase 17 days in 2050, 15 days in 2100, Number of hot days > 35°C also increase 23 - 24 days in 2050, 34 - 35 days in 2100	3	*High and medium mountain (300-700-1200)* *It would be hotter in limestone area during hot season and colder in cold season*	3	*Coniferous can adapt oneself to dry/ waterless for long time* *High biodiversity (forest types)*	3	4	*Well-management by PNKB NP;* *Existing of Ranger stations; Forest patrol regularly (reduce the threads)* *High biodiversity*	3
Temperature will increase faster and earlier in Spring	3	*Shorter duration* *Heat and drought level rise*	3	*Increase the risk of insect development, destructive plant diseases*	3	4	*Well-management by PNKB NP;* *Existing of Ranger stations; Forest patrol regularly (reduce the threads)* *High biodiversity*	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5% in 2050, 9 - 10% in 2100; FLOOD RISK	3	*High elevation* *Limestone area - so water can be withdrawal fast*	2	*High biodiversity*	3	4	*Well-management by PNKB NP;* *Existing of Ranger stations; Forest patrol regularly (reduce the threads)* *High biodiversity*	3
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100 - DROUGHT RISK	4	*Low humidity* *Lack of water*	3	*High biodiversity of forest types, plants and animals, geology, cave system* *Animal can migrate*	4	4	*Well-management by PNKB NP;* *Existing of Ranger stations; Forest patrol regularly (reduce the threads);* *High biodiversity*	3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	*The wind speeds reduced (far from coast & High elevation)* *Lime stone - less flood*	2	*Natural forests* *High elevation* *High biodiversity*	3	4		3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	*High elevation* *Far from the sea*	1	*High elevation* *Far from the sea*	1	5	*High elevation > 700m*	1
	2.9		2.4		2.9	4.1		2.7

SES: 5c - Kinh smallholder inland valley paddy cultivation + tree crops (acacia, citrus, rubber, tea)

CLIMATE CHANGE RISKS (2050 & 2100)	Expos-ure	Explanation (E)	Sensiti-vity	Explanation (S)	Impa-ct	Adapt-ive Capa-city	Explanation (AC)	Vulnera-bility
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.9 - 2 degree C in 2050, 3.6 - 3.7 degree C in 2100	5	*Temperature increase cause shorten crop duration, shorten of hydrate carbon synthesis, reduce crop yield* *More disease and new diseases* *Impact on flowering, polling, evapotranspiration and hydrate accumulation process*	4	*More evaporation and evapotranspiration, crops require more water, strongly impacts on metabolically processes* *Hilly land planting tree crops facing with drought more frequency* *Change micro climate and change crop grow rate and crop distribution*	5	3	*Farmer can use suitable crop varieties from hot regions* *Use net to protect pomelo and oranges*	5
Number of Dry days increase 16 - 17 days in 2050, 14 - 15 days in 2100, Number of hot days > 35°C also increase 33 - 40 days in 2050, 47 -51 days in 2100	4	*High risk for crop tolerate with short dry time* *Soil moisture go down below wilting point, plant die* *Reduce crop yield when drought period coincide with tellering and flowering period*	5	*Drought will be more often damaging crop* *Some crop will be not suitable* *Hybrid and new varieties of cattle and poultry very sensitivity with CC*	5	2	*t is hard to adapt this condition* *Need to have better water resource management* *Need to have drought tolerable varieties to adapt drought*	5
Temperature will increase faster and earlier in Spring	4	*Tree crops will start earlier* *Some tree crops will not suitable* *Some vegetable and temperature crops will not be suitable*	3	*Some crop change season earlier* *Redistribution of land use*	4	2	*Also hard to adapt this condition because it change crop growing pattern* *Need a lot of experience and knowledge to control crop growing and seasoning*	4
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 9 - 12% in 2100;	4	*Higher rainfall is good for crop production* *Rainfall will increase cause flood rick to valley paddy rice and other agriculture and aquaculture in lowland area?*	3	*Crop grow better* *More rainfall during flowering time may rotten pollen of citrus* *More rainfall during rainy season may cause nutrient leaching and erosion in citrus land, lack nutrient at the end of season,*	4	5	*Use high yield and quality crop varieties to optimal crop production in higher rainfall condition*	3

CLIMATE CHANGE RISKS (2050 & 2100)	Expos-ure	Explanation (E)	Sensiti-vity	Explanation (S)	Impa-ct	Adapt-ive Capa-city	Explanation (AC)	Vulnera-bility
		Infrastructure development (new road, dam, new rural program,..) cause fragmentation of land cover/vegetation/forest and more exposure from rainfall increase		*lower citrus quality*				
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	5	*Drier dry season has strong impact to tree crop because tree crop grow very slowly* *Drier dry season may lead to longer drier period, associated with soil moisture content drop below wilting point, some crop die* *Need more irrigation, increase cost*	4	*Soil will be degraded, lower productivity* *Some crop may not suitable and farmer have to change crop and crop calendar* *May cause some delay growing during very low soil moisture content*	5	1	*Need to have more reservoirs for water resources management* *Need to change to higher drought tolerable* *Need to irrigation, improve irrigation method to save water, need increase more fertilizer because drought lower fertilizer use efficiency*	5
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	*Tropical low pressure happen yearly* *Average 1 storm in 2 years*	2	*Later storm season may impact on mature periods of citrus and tea* *Later storm season me associated with later rainfall, good for tea and fruit tree* *Small storm (level <7) may not impact tree* *Strong typhoon may break tree (i.e. extreme typhoon in 2013 break a lot of rubber)*	3	2	*Need to find more option for avoiding negative impacts of strong wind breaking tree crop, especially rubber and citrus* *Need to have better field design with wind break line, reduce damages from strong wind*	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	*These area is deeply in mainland, so not impacted by sea level rise*	1	*Not impact on this land use*	1	5	*Not impacted*	1
	3.9		3.1		3.9	2.9		3.7

SES 6a - Kinh smallholder lowland coastal floodplain paddy rice cultivation

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensiti-vity	Explanation (S)	Impa-ct	Adapti-ve Capa-city	Explanation (AC)	Vulner-ability
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.9 degree C in 2050, 3.6 degree C in 2100	4	*Low land - low altitude, high temperature, flat, large area of the same land-use ;* *More evaporation and evapotranspiration;* *More exposure in Spring Summer crops, less in Autumn Winter;*	4	*Temperature increase cause shorten crop duration, shorten of hydrate carbon synthesis, reduce crop yield* *More disease and new diseases* *Impact on flowering, pollen, evapotranspiration and hydrate accumulation process crops require more water, strongly impacts on metabolically processes* *Crops facing with drought more frequency* *Change micro climate and change crop grow rate and crop distribution*	4	3	*Farmer can use suitable crop varieties from hot regions* *Agriculture extensions* *SRI rice* *RATOON rice* *Change to other crops*	4
Number of Dry days increase 15 days in 2050, 12 days in 2100, Number of hot days > 35°C also increase 37 - 40 days in 2050, 50 - 54 days in 2100	4	*Low land - low altitude, high temperature, flat, large area of the same land-use ; More evaporation and evapotranspiration;* *More exposure in Spring Summer crops, less in Autumn Winter;*	4	*Drought will be more often damaging crop; Some crop will be not suitable* *High risk for crop tolerate with short dry time; Soil moisture go down below wilting point, plant die* *Reduce crop yield when drought period coincide with tellering and flowering period*	4	3	*Improve irrigated system to adapt this situation* *Existing irrigation system can supply 80% water resource* *There are some drought tolerable varieties to adapt drought but at certain level* *Need pay more for irrigation*	4
Temperature will increase faster and earlier in Spring	4	*Some negative impacts of return warm spring (reduce rice yield strongly)* *Earlier appear diseases and pest*	3	*Some crop have to change season earlier* *Damaging crops*	4	2	*Also hard to adapt this condition because it is hard to change crop immediate fast weather changes* *Few experiences to control crop growing and seasoning when weather changed* *Redistribution of land use*	4
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 9 - 12% in 2100;	1	*Higher rainfall is good for crop production* *Flood risk is very high for summer -autumn*	2	*Crop grow better* *More rainfall during flowering time may rotten pollen of some vegetables*	2	5	*Use high yield and quality crop varieties to optimal crop production in higher rainfall condition*	2

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensiti-vity	Explanation (S)	Impa-ct	Adapti-ve Capa-city	Explanation (AC)	Vulner-ability
		crop (harvest). Winter-spring (planting)		*More rainfall during rainy season may cause nutrient leaching*				
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 9% in 2100	4	*Drier dry season has strong impact* *May lead to saline intrusion and salinity*	4	*Soil will be degraded, lower productivity* *Some crop may not suitable and farmer have to change crop and crop calendar* *May cause some delay growing during very low soil moisture content*	4	2	*Need to re-design or construct new irrigation system and look for more water resource* *Need to change to higher drought tolerable rice varieties* *Apply new method to save water, need increase more fertilizer because drought lower fertilizer use efficiency;* *Need more irrigation, increase cos*	4
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	2	*July - November (storm)* *Crop harvest (April & July)* *1/2 frequency direct storm but high frequency if indirect storm& low tropical pressure*	4	*Later storm season may impact on summer rice at mature period* *High risk due to high uncertainty forecast* *Strong typhoon associated with heavy rainfall cause flooding and loosing harvest*	3	3	*Need to setup optimal crop calendar to avoid risk from typhoon* *Need to have smart action on harvesting to rescue rice from falling*	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	4	*Near the coast, low land, risk of saline intrusion and make drought because of saline river water, no fresh water for irrigation* *Widespread of saline soil*	4	*Degrading soil quality, reducing rice production • Many rice varieties will not be suitable to soil and need to change to higher saline tolerable varieties* *Salt intrusion make river and irrigation system water salty, difficult for irrigation, especially saline soil and acid sulphate soils* *Kill some rice when salt content higher than 4 ppm*	4	4	*Have barrier to prevent salt water intrusion* *Good dykes to protect cropping from high sea level* *Have Saline tolerable rice varieties with high yield and quality*	3
	3.3		3.6		3.6	3.1		3.4

SES: 6b - Kinh smallholder floodplain-hills transition: paddy rice + mixed farming, tree crops

CLIMATE CHANGE RISKS (2050 & 2100)	Expos-ure	Explanation (E)	Sensiti-vity	Explanation (S)	Impact	Adapti-ve Capa-city	Explanation (AC)	Vulnerab-ility
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.9 degree C in 2050, 3.6 degree C in 2100	4	*Temperature increase* *Higher Evaporation*	4	*More evaporation & evapotranspiration, crops require more water, strongly impacts on metabolically processes* *All terraces rice and Hilly land planting tree crops facing with drought more frequency* *Risk of more disease and new diseases* *Impact on flowering, polling, evapotranspiration and hydrate accumulation process; This SES occupies large land use area of Quang Binh and impact to livelihood of 1/3 households of the province.* *Change micro climate and change crop grow rate and crop distribution; many change of land use, change of crop rotation, change of plant and animal varieties,...may be make more sensitivity.*	4	3	*Farmer can use suitable crop varieties from hot regions* *High temperature can shorten crop duration, shorten of hydrate carbon synthesis, reduce crop yield* *Land-use change*	**4**
Number of Dry days increase 17 -19 days in 2050, 16 -18 days in 2100, Number of hot days > 35^{o}C also increase 41 - 50 days in 2050, 52 - 67 days in 2100	4	*High risk for crop tolerate with short dry time* *Soil moisture go down below wilting point, plant die* *Reduce crop yield when drought period coincide with tellering and flowering period*	5	*Drought will be more often damaging crop* *Small reservoirs will be emptied before rain season, spring season will be lack of irrigation water* *Need payment more for irrigation*	5	2	*It is hard to adapt this condition* *This regions have quite good water resource management* *There are some drought tolerable varieties to adapt*	5
Temperature will increase faster and earlier in Spring	4	*Tree crops will start earlier* *Some tree crops will not suitable* *Some vegetable and temperate crops will not be suitable*	3	*Tree crops have sensitive with early season* *Rice also sensitive with early season and normally have very low yield in warm spring rice* *Many crops will not be suitable to new climate conditions*	4	2	*Also hard to adapt this condition because it change crop growing pattern* *Need a lot of experience and knowledge to rice season seasoning and fruit trees*	4
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 8 - 12% in 2100;	2	*Higher rainfall is good for crop production*	3	*Crop grow better* *More rainfall during flowering time may rotten pollen of fruit tree* *More rainfall during rainy season may cause nutrient leaching and erosion on hilly*	3	5	*Use high yield and quality crop varieties to optimal crop production in higher rainfall condition*	2

CLIMATE CHANGE RISKS (2050 & 2100)	Expos-ure	Explanation (E)	Sensiti-vity	Explanation (S)	Impact	Adapti-ve Capa-city	Explanation (AC)	Vulnerab-ility
				land and terraces rice, lack nutrient at the end of season				
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 9% in 2100	5	*Drier dry season has strong impact to tree crop because tree crop grow on hilly land* *Drier dry season may lead to longer drier period, associated with soil moisture content drop below wilting point, some crop die* *Rice on terraces also impacted by long dry periods*	4	*Soil will be degraded, lower productivity* *Some crops may not suitable and farmer have to change crop and crop calendar* *May cause some delay growing during very low soil moisture content*	5	1	*Need to have more reservoirs for water resources management* *Need to change to higher drought tolerable* *Need to irrigation, improve irrigation method to save water, need increase more fertilizer because drought lower fertilizer use efficiency*	5
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	*Small storm (weaker level 7) may not impact tree* *Strong typhoon may break tree (i.e. extreme typhoon in 2013 break a lot of tree crops)*	4	*Later storm season may impact on mature periods of fruit trees* *Later storm season may associated with later rainfall, good for tea and fruit tree monoculture such as rubber, acacia, pepper, cashew plantation may be make more sensitivity from CC*	3	2	*Need to find more option for avoiding negative impacts of strong wind breaking tree crop, especially fruit crops* *Need to have better field design with wind break line, reduce damages from strong wind*	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	*These area is allocated on terraces and hilly land, so not impacted by sea level rise*	1	*Not impact on this land use*	1	5	*The area is not impacted by sea level.*	1
	3.3		3.4		3.6	2.9		3.4

SES: 5a: 5a - Upland Ethnic minority small holder swidden cultivation and forest product collection

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.7 - 1.9 degree C in 2050, 3.2 - 3.6 degree C in 2100	5	Temperature increases. More serious with Laos wind	5	Upland rice, maize, vegetable would be die because of hot. It's more serious with Laos wind.	5	3	It would be changed to other trees like cassava, but it would cause risk of food security.	5
Number of Dry days increase 17 - 20 days in 2050, 14 - 19 days in 2100, Number of hot days > 35oC also increase 34 - 48 days in 2050, 41 - 63 days in 2100	5	draught become more serious	5	There are no irrigation system and reservoir. Draught cause rice, maize, vegetable die, and plantation trees grow slowly. Lack of drinking water	5	2	It requires high investment for irrigation system.	5
Temperature will increase faster and earlier in Spring	5	Hot season come earlier in dry season.	5	Temperature increase in Spring when starting rice season cause rice grow slowly. Temperature decrease in winter cause rice and cattle die	5	2	It would be changed to other trees like cassava, but it would cause risk of food security.	5
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 3-5% in 2050; 7 - 9% in 2100;	4	High land field, sloping land are at high risk	4	Heavy rain cause flash flood, and slide land, erosion	4	2	No solution in poor areas	4
Dry season will be drier, Rainfall of Spring will	5	Draught comes earlier	5	Draught cause rice, maize, vegetable die,	5	2	It would be changed to other trees like	5

decrease 5% in 2050, 8 - 10% in 2100				and plantation trees grow slowly. Lack of drinking water			cassava, but it would cause risk of food security.	
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	Tropical low pressure happen yearly Average 1 storm in 2 years Far from the sea. Strong storm does not often come	4	Serious impact by strong storm. Storm No. 10 in 2013 so serious. 80% roofs flow out. 80% rubber of farm was broken.	3	3	No solution especial in poor areas	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1		1		1	5		1
	4.0		4.1		4.0	2.7		4.0

SES 10c - Small and large scale beach tourism enterprises

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.8 degree C in 2050, 3.4 degree C in 2100	4	Temperature increase out door and sand areas.	4	Summer is season for tourism. Tourists spend their time out door. it cause increasing of power for air conditioner, and water using; Human is sensitive with high temperature	4	3	It need time and budget to change the way of power and water using to environmentally friendly	4
Number of Dry days increase 19 days in 2050, 18 days in 2100, Number of hot days > 35°C also increase 43 - 46 days in 2050, 55 - 59 days in 2100	4	Dry often comes with high temperature. Air becomes hot and dry.	4	It causes increasing of power using for air conditioner, and water using. May suffer risk of lack of water using	4	2	Tourism is the most water using sector. It affects ground water resource. Waste water also is problem cause pollution.	4
Temperature will increase faster and earlier in Spring	2	Hot and dry season come earlier.	2	Tourism may start earlier	2	3	Tourism start earlier, spend more power, water, discharge more water and solid waste	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4% in 2050; 8% in 2100;	2	Temperature be cooler in hot season. More rain more water.	2	Increase rain may provide more ground water Risk of flood and storm surge	2	2	No response	3
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 9% in 2100	3	It is dry in sand areas.	4	May suffer lack of water in dry season	3	4	Quang Binh has many freshwater lakes and reservoirs; Water resources are plenty. Protection forest is reducing.	3
STORM/ WIND/ TYPHOON *Higher speed (intensity)/ stronger* *Difficult to forecast the storm frequency* *Storm season will come later*	4	Near the shoreline, impact directly from storm	4	Hotel and other tourism constructions would be damaged and destroyed. Flood and storm surge	4	3	Require high investment and technology	4
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	4	Near the shoreline, impact directly from sea level rise.	4	Hotel and other tourism constructions would be damaged destroyed.	4	2	Require high investment and technology	4
	3.3		3.4		3.3	2.7		3.6

SES 8a - Kinh cage and pond aquaculture in estuary, mangrove, mudflat areas

CLIMATE CHANGE RISKS (2050 & 2100)	Exposu-re	Explanation (E)	Sensitiv-ity	Explanation (S)	Impa-ct	Adapti-ve Capaci-ty	Explanation (AC)	Vulnerabil-ity
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.8 - 2.0 degree C in 2050, 3.5 - 3.8 degree C in 2100	4	▪ *Ponds Temp. increase ; Location in estuary* ▪ *Low elevation - high temperature* ▪ *Increasing salinity*	3	▪ *Mangrove is not so sensitivity but aquaculture life in mangrove ecosystem and mudflat areas is* ▪ *Temp. increase:* *- Shrimp stop eating, move to bottom water layer, decrease, shrimp die* *- Increase algal cyanophyta (tảo lam), dinophyta (tảo giáp)* *- Poor Oxygen in water* ▪ *Sea fish appear in mangrove in river mouth because of increasing salinity (Platycephalus indicus - C. Chai, Siganus spp. Dia, Glossogbius spp. Bong, Leiognathus equulus spp. Liet ...)*	4	2	▪ *Local people expanding their cultivation land and cuting mangrove for land use purpose change* ▪ *Increasing oxygen to water in pond* ▪ *Poor mangrove restoration and restore estuary and mudflat mangrove ecosystem*	4
Number of Dry days increase 14 - 17 days in 2050, 10 - 16 days in 2100, Number of hot days > 35°C also increase 22 - 44 days in 2050, 25 - 59 days in 2100	2	▪ *Temperature increase but not serious to mangrove* ▪ *Higher temperature may cause dead shrimp in pond and enlarge mudflat areas*	3	▪ *Mangrove is not so sensitivity but aquaculture life in mangrove ecosystem and mudflat areas is some natural shrimp and other fishes, aquatic life's change*	3	2	▪ *Need restoration mangrove forest* ▪ *Estuary and mudflat protection*	3
Temperature will increase faster and earlier in Spring	3	▪ *Life circle of the fish; Mangrove is evergreen tree species, it is better when Spring come earlier* ▪ *Temperature of water surface is hotter and salinity increase*	4	▪ *Natural species composition may change* ▪ *Food chain may change* ▪ *Some sea fish appear in estuary earlier replace living areas of fresh water fish such as Leiognathus spp., Saurida tumbil (mối) in estuary and deeper in river mouth* ▪ *Shrimp growth up faster in early Spring but when temp. increase higher and faster shrimp stop eating because poor oxygen in water*	3	2	▪ *Restore ecological system* ▪ *Shrimp can be put earlier*	3
PRECIPITATION (RAINFALL)								

CLIMATE CHANGE RISKS (2050 & 2100)	Exposu-re	Explanation (E)	Sensitiv-ity	Explanation (S)	Impa-ct	Adapti-ve Capaci-ty	Explanation (AC)	Vulnerabil-ity
Higher rainfall in rainy season; Rainfall in Summer will increase 4 - 6% in 2050; 8 - 11% in 2100;	4	▪ *Change water salinity* ▪ *High risk of flood* ▪ *Reduce temperature of ponds* ▪ *pH water reduce by heavy rain*	5	▪ *Shrimp molting because of pH decrease* ▪ *Fresh water fish replace of sea water fish in water mouth water surface* ▪ *Water salinity cause some change biome and food chain* ▪ *Change species composition*	5	3	▪ *Water reservoir in upland may manage water flow regime*	5
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	▪ *More temperature more water: good for mangrove and estuary biome* ▪ *Increase water salinity*	3	▪ *Mangrove is not so sensitivity but aquaculture life in mangrove ecosystem and mudflat areas is* ▪ *Temperature increase:* *- Shrimp stop eating, move to bottom water layer, diseases increase, shrimp die* *- Increase algal cyanophyta (tảo lam), dinophyta (tảo giáp)* *- Poor Oxygen in water* ▪ *Sea fish appear in mangrove in river mouth because of increasing salinity (Platycephalus indicus - C. Chai, Siganus spp. Dia, Glossogbius spp. Bong, Leiognathus equulus spp. Liet ...)*	4	3	▪ *Need good estuary ecological management strategy of local authorities*	4
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	▪ *Trees break by strong wind* ▪ *Change water flow in estuary* ▪ *Mangrove also play the role of wind break* ▪ *Reducing pH* ▪ *Reducing salinity*	5	▪ *Strong wind cause mangrove damage and change water flow* ▪ *No more intensive shrimp pond in this season but extensive is still some* ▪ *Shrimp may die because of low pH, low salinity* ▪ *Appearing fresh water fish in mangrove and estuary tidal areas*	5	3	▪ *It needs detail and intensive mangrove in estuary restoration and annual maintaining*	5
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	4	▪ *Increase water salinity*	3	▪ *High salinity cause increase algae in water and hurt shrimp* ▪ *Change pH in mangrove cause change algae and more sea fish in mangrove* ▪ *Change areas of mangrove and mudflat…*	4	3	▪ *It needs detail and intensive mangrove in estuary restoration and annual maintaining*	4
	3.6		3.7		4.0	2.6		4.0

SES 10a - Kinh inshore capture fishermen in delta and marine areas 6 nautical iles offshore

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
TEMPERATURE								
Hot season will be hotter and longer; will increase 2 - 2.5 degree C in 2050, 3.6 degree in 2100	2	▪ *Sea surface temperature would increase a little* ▪ *Increasing salinity in surface water* ▪ *Low oxygen in sea surface and bottom water*	2	▪ *Increasing algae's and blome algae in water* ▪ *Change pH bottom water* ▪ *Bottom water fish may die*	2	3	*Dry fish processing*	3
Number of Dry days increase, Number of hot days > 35°C also increase	2	▪ *Increasing temperature water surface* ▪ *Increasing salinity* ▪ *Low oxygen in water*	2	▪ *Change water surface with by algae density and sediment* ▪ *Increasing algae's and blome algae in water* ▪ *Change pH bottom water* ▪ *Bottom water fish may die*	2	3	*No actions*	3
Temperature will increase faster and earlier in Spring	3	▪ *Temperature surface water increase* ▪ *Seasonal fish come early in spring such as Apogen aureus, Encrasicholina zollengeri, Anodontostoma chacunda come earlier*	2	*Change pH bottom water*	3	3	*No actions*	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5	2	*Change pH water surface*	2	▪ *Heavy rain may cause loss fishes* ▪ *No fish in heavy rain*	2	3	*No actions*	3

- 10% in 2050; No. heavy rains (>50mm) increase								
Dry season will be drier, Rainfall of Spring will decrease 4 - 9% in 2050	1	*Not so exposure with fish in the sea*	2	*It may change some fishes in surface water*	2	3	*Change fishing tools*	3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	5	*No exposure to the offshore fish*	5	*Typhoon change water flow and bottom fish*	5	3	*Typhoon preventionplan*	5
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	*No exposure*	1	*No sensitive*	1	3	*No actions*	2
	2.3		2.3		2.4	3.0		3.1

SES 9b - Kinh small scale vegetable growing on sand

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adapt-ive Capa-city	Explanation (AC)	Vulnera-bility
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.9 - 2 degree C in 2050, 3.6 - 3.8 degree C in 2100	3	▪ *A bit impact on vegetable with small yield reduction because vegetable has short duration* ▪ *More disease and new diseases* ▪ *Impact on flowering, polling, evapotranspiration and hydrate accumulation process, especially for squash family*	3	▪ *More evaporation and evapotranspiration, crops require more water, impacts on metabolically processes* ▪ *Vegetable facing with drought more frequency* ▪ *Change micro climate and change vegetable distribution*	3	3	▪ *Farmer can use suitable crop varieties from hot regions* ▪ *Some high tech farm can control temperature well*	3
Number of Dry days increase 14 - 16 days in 2050, 10 - 13 days in 2100, Number of hot days > 35°C also increase 32 - 43 days in 2050, 45 - 57 days in 2100	5	▪ *High risk for vegetable because it will be spend energy for respiration, reduce quality* ▪ *Soil moisture go down below wilting point, need more irrigation* ▪ *Reduce vegetable yield and quality when drought period coincide with ripening time*	5	▪ *Drought will be more often damaging vegetable* ▪ *Water resources in sand area will be reduced quickly* ▪ *Need payment more for irrigation*	5	3	▪ *It is hard to adapt this condition* ▪ *This regions have limited water resource* ▪ *There are some drought tolerable vegetable to adapt*	5
Temperature will increase faster and earlier in Spring	5	▪ *Winter vegetable will be end earlier, reduce productivity* ▪ *Some vegetable will not be suitable* ▪ *Some vegetable and temperate crops will not be suitable*	3	▪ *Vegetables have sensitive with early season* ▪ *Vegetable season will also be changed* ▪ *Some vegetable will not be suitable to new climate conditions*	4	2	▪ *Also hard to adapt this condition because it change vegetable and calendar* ▪ *Need a lot of experience and knowledge to vegetable seasoning*	4
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4 -6% in 2050; 8 - 11% in 2100;	2	▪ *Higher rainfall is good for some vegetable but not good for some other e.g. salad, tomato, melon (we call sun is good for melon but rain is good for rice)*	2	▪ *Some vegetable for harvesting leaf, root will grow better, but melons, tomato, potato will be impacted* ▪ *More rainfall during vegetable flowering time may rotten*	2	3	▪ *Use high yield and quality vegetable varieties and vegetable suitable to higher rainfall condition*	3

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
				pollen ▪ *More rainfall during rainy season may cause nutrient leaching and erosion on hilly land and terraces rice, lack nutrient at the end of season*				
Dry season will be drier, Rainfall of Spring will decrease 5 - 6% in 2050, 10 - 11% in 2100	5	▪ *Drier dry season is not good for vegetable because vegetable need a lot of water* ▪ *On sandy lands, wilting point is very high and time to reach wilting point is fast. Drier means time to reach wilting point earlier, plant die faster*	4	▪ *Soil will be degraded, lower productivity* ▪ *Some crops may not suitable and farmer have to change crop and crop calendar* ▪ *May cause some delay growing during very low soil moisture content*	5	2	▪ *Need to have more water resources* ▪ *Need to introduce higher drought tolerable vegetable* ▪ *Need to irrigation, improve irrigation method to save water, need increase more fertilizer because drought lower fertilizer use efficiency*	5
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	▪ *Vegetable is high exposure on storm because it will be crashed and fall and easy to die, attached by diseases* ▪ *Strong wind bring a lot of solid waste the field* ▪ *Associated with heavy rainfall under violence wind, damaging vegetable*	2	▪ *Later storm season may impact on winter vegetable* ▪ *Later storm season may associated with later rainfall, destroy vegetable bed and new planted vegetable*	3	2	▪ *Rich farm can adapt better poor farm* ▪ *Need to have better field design with to reduce damages from strong wind*	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	3	▪ *These area is allocated on very near seas shore and river bank, quickly influenced by salinity intrusion and sea water flood* ▪ *Some area, vegetable will not be suitable and have to change another crops*	4	▪ *Vegetable sensitive with high pH and salt content* ▪ *Vegetable sensitive with drought sand, lack of fresh water*	4	2	▪ *Irrigated area can adopt but only for rich farm, high tech farm*	4
	3.9		3.3		3.7	2.4		3.9

SES 9C - Commercial pond aquaculture on sand areas

CLIMATE CHANGE RISKS (2050 & 2100)	Expo-sure	Explanation (E)	Sensit-ivity	Explanation (S)	Imp-act	Adaptive Capacity	Explanation (AC)	Vulnera-bility
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.8 - 2 degree C in 2050, 3.5 - 3.8 degree in 2100	4	▪ *Location: on sand area - little vegetation* ▪ *Hotter - higher evaporation* ▪ *Ponds temperature increase ;* ▪ *Low elevation - high temperature*	5	▪ *Shrimp is very sensitive with temperature change*	5	2	▪ *Low adaptive capacity (required high investment, and technology)* ▪ *Change the time for putting the juveniles*	5
Number of Dry days increase 14 - 17 days in 2050, 10 - 15 days in 2100, Number of hot days > 35°C also increase 19 - 41 days in 2050, 22 - 54 days in 2100	3	*Shrimp farming by seasonally*	4	*Shrimp season starting depends on the temperature high enough*	3	2	▪ *Low adaptive capacity (required high investment, and technology)*	3
Temperature will increase faster and earlier in Spring	2	▪ *Shrimp season start earlier and longer*	2	▪ *Shrimp season starting depends on the temperature high enough*	2	3	▪ *Change the crop cycle*	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4 - 6% in 2050, 9 - 11% in 2100;	3	▪ *The impacts happens only when extreme high rainfall* ▪ *Reduce the pH level* ▪ *Salinity would be changed*	5	*Shrimp is very sensitive with the change of salinity concentration & pH level - that easily diluted by rain water*	4	3	▪ *Medium capacity to adapt (e.g. pumping equipment)*	4
Dry season will be drier, Rainfall of Spring will decrease 5 - 6% in 2050, 10 - 11% in 2100	2	*Higher evaporation -> need more water input - Lack of freshwater input*	2	*Shrimp is very sensitive with the change of salinity concentration & pH level but it can be solved by adding fresh water*	2	3	*Near the sand-dune - the people can get freshwater*	3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	5	▪ *Near the shore - direct impact* ▪ *High rainfall - high risk of harvest loss totally*	5	▪ *Storm may cause the shrimp die immediately* ▪ *Take longtime to recover/ rebuild*	5	3	▪ *The infrastructure is not concreate* ▪ *Limitation of budget*	5
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	3	▪ *Location: on sand, near the coast* ▪ *1m rising MSL* ▪ *Salt/ sea water*	3	▪ *Change the salinity concentration, pH and water environment - impact the growth rate and distribution of shrimp and fish* ▪ *More land for aquaculture* ▪ *Higher opportunity & MSL* ▪ *Easy to take salt water to ponds* ▪ *Some areas would be lost or rebuild the bunds;* ▪ *Flood risk*	3	2	▪ *Improvement dyke system* ▪ *Improvement flood gate system* ▪ *Limitation of budget*	3
	3.1		3.7		3.4	2.6		**3.7**

SES 11a - Irrigation and hydropower reservoirs and related infrastructure in Tropical BL Forest < 700 m

CLIMATE CHANGE RISKS (2050 & 2100)	Expo-sure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulner a-bility
TEMPERATURE								
Hot season will be hotter and longer; Summer average maximum temperature will increase 1.9 degree C in 2050, 3.6 degree C in 2100	3	Higher water requirement Higher evaporation	3	Water required at intake slightly increased Less water come into the reservoirs	3	3	Budgets for maintenances, improvement are limited	3
Number of Dry days increase 15 - 16 days in 2050, 12 - 13 days in 2100, Number of hot days > 35°C also increase 41 - 44 days in 2050, 55 - 59 days in 2100	4	Higher water requirement Higher evaporation	3	Less water come to the reservoirs & infrastructure Lower soil moisture in catchment	4	3	Budgets for maintenances, improvement are limited	4
Temperature will increase faster and earlier in Spring	3	Water level would be impacted earlier due to evaporation	2	Less water come to the reservoirs & infrastructure Lower soil moisture in catchment	3	3	Budgets for maintenances, improvement are limited Change crop season or change the crop species	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5% in 2050; 9% in 2100;	4	More water would be supplied High risk of overflow	4	Risk flood, Risk of dam security A chance to get more water	4	3	Budgets for maintenances, improvement are limited Ununiformed investment Lack of equipment's to measure rainfall	4
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	Lacking water during dry seasons seriously	4	Lacking water during dry seasons seriously	4	3	Budgets for maintenances, improvement are limited Change crop season or change the crop species	4
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	Tropical low pressure happen yearly Average 1 storm in 2 years Would cause high rainfall, flood, flash flood, landslide	4	Dam security High risk of overflow Would cause high rainfall, flood, flash flood, landslide Risk of dam broken	4	3	Budgets for maintenances, improvement are limited Storm warning system Storm forecast has not high accurate	4
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	Would not impact	1	Far from sea, high elevation	1	5	Higher elevation	1
	3.3		3.0		3.3	3.3		3.3

CHAPTER 10 SUMMARY FINDINGS AND MAINSTREAMING

10.1 SUMMARY OVERVIEW OF THE REPORT

Chapter 1 introduced the objectives and major tasks of the vulnerability assessment, as well as additional guidance provided during the initial stages of implementation. It also introduced the four stages of the work - scoping; baseline; provincial vulnerability assessment; and local (community) vulnerability assessment.

The outputs from the scoping and baseline parts of the work have been presented in chapters 2-6 as a Social profile; Ecological Profile; Economic Profile; Socio-ecological profile; and Climate Profile of Quang Binh.

The social profile (Chapter 2) discusses issues related to population, poverty, labour, migration, and ethnicity. It identifies that some of the poorest people living along the coastline, as well as the poor ethnic minorities in the upland areas, are the people most vulnerable to climate change.

The ecological profile (Chapter 3) identifies the main ecosystems found in Quang Binh, and provides information about their current extent, status, trends, and the challenges they are facing. It identifies that many of the terrestrial forest ecosystems still exist in relatively large and interconnected areas, providing them with a fairly high level of resilience to climate change, and enabling them to continue to supply significant ecosystem services that support a number of livelihoods and economic activities. On the other hand, many of the estuarine and coastal ecosystems such as melaleuca and mangrove forests are highly degraded and only exist in small disconnected remnant patches. As such they only provide very limited ecosystem service benefits to local communities, and at the same time have very low resilience to climate change impacts.

The economic profile (Chapter 4) discussed the main economic sectors that contribute to the GDP of the province, as well as to generating employment and ensuring food security. From the perspective of climate change the natural resource-based sectors (agriculture, forestry and fisheries) are more vulnerable to climate change impacts, while at the same time are more amenable to the implementation of EbA solutions.

The SES profile (Chapter 5) introduced the major innovation of defining, identifying, mapping and prioritizing Socio-ecological systems (SESs) across the entire province. In total 41 different SESs were identified and mapped. Using 12 criteria, the top 10 highest ranking SESs were identified for further work on vulnerability assessment. Together these 10 SESs account for 60% of the land area of the province, and all of its near-shore coastal waters.

The climate profile (Chapter 6) provided information on the current climate of the province, and the history of climate-related disasters over the previous 2-3 decades. It identifies that the coastal districts of the province - and particularly Le Thuy and Quang Ninh Districts, have been the most frequently and hardest hit by a range of climate-related disasters, including storms, floods and droughts

Chapter 7 investigated likely Climate Change-related impacts. Seven specific climate-related parameters were identified (average temperature; number of very hot days; number of dry days; rainfall in the dry season; rainfall in the wet season; storms; sea-level rise). Using the 2012 officially approved MONRE/IMHEM scenarios, supplemented by the original work of the consultancy team, likely changes in each of these 7 parameters were identified for 2030; 2050; and 2100. Based on this, possible impacts on different sectors were identified and discussed.

Chapter 8 focused on adaptive capacity - particularly of government agencies at the provincial level, as well as addressing the more difficult concept of adaptive capacity of ecosystems, and identified areas where further capacity still needs to be developed.

Chapter 9 presented results of the more detailed vulnerability assessment of the top10 priority SESs for Quang Binh. For each of the top 10 SESs, exposure, sensitivity and adaptive capacity were scored individually in relation to each of the 7 climate parameters. The vulnerability scores for each of the 7 parameters were averaged to give an overall vulnerability score for each SES. Furthermore 39 proposed interventions to address vulnerability in these SESs were provided with suggestions for timeframe, lead agency and level of priority

10.2 MAINSTREAMING RECOMMENDATIONS

In addition to identifying the 39 recommendations provided in Chapter 8, it is important to consider the bigger picture of carrying the recommendations forward through mainstreaming them in provincial planning processes and other relevant mechanisms. In this regard, there are a number of important considerations:

State agencies and State-controlled Companies directly manage large areas of the province, and are directly responsible for significant economic activity in priority SESs (e.g. SFE 5). Important state infrastructure - roads, railways, ports, reservoirs are also at risk of damage from climate change. Of these, irrigation reservoirs and associated infrastructure are extremely important in providing the water supply that maintains the resilience of a number of other SESs. The State therefore has the responsibility take a lead role in implementing EbA, and could start with pilots in SES 11a and SES SFE 5.

At the same time, the province needs to take a province-wide approach to climate change adaptation and the mainstreaming of EbA in which:

- Effective land-use planning and enforcement are key.
- The Socio-Economic Development Plan (SEDP) and the Land-Use Plan are recognized and used as the critical planning documents for mainstreaming CCA.
- Strategic Environmental Assessments (SEA) which incorporates climate change considerations are conducted on the SEDP as a whole as well as all major sector development plans.

Provincial Planning

- Climate change mitigation and adaptation actions should be considered together with diaster risk reduction, using EbA principles, and all three aspects integrated into provincial development planning, particularly into the Social and Economic Development Plans.
- Together with this, QB PPC should seek to increasingly shift economic development planning away from its recent focus on GDP growth and technology alone, - to also consider issues related to job creation, food security, quality of life, and above all sustainability.
- This planning shift should be based on a spatial approach - land use planning, that incorporates climate change considerations; recognises the need for care and efficiency in the use of natural resources (especially water); and protects remaining natural habitats unless development is critically important with no alternative sites.
- This approach should be to avoid destruction or radical alteration and simplification of natural ecosystems in pursuit of economic development and CCA; work with nature, not against it; consider the wider environmental context of any development; rehabilitate and use degraded lands before converting natural habitats.
- In doing so, QB PPC and DPI, supported by DONRE should understand and apply the full range of values of ecosystems - so they do not bear the cost of “production efficiencies” elsewhere in the economy, or other externalities.
- The PPC and all provincial sector agencies should similarly resist the impulse to develop infrastructure-based solutions; if they are unavoidable, then consider the other environmental impacts of the infrastructure and “green the infrastructure” through environmentally-aware design, location, and operation of the infrastructure.
- To support this approach, PPC needs to make screening of all projects and development plans for CCA/EbA and general environmental sustainability a compulsory requirement. PPC supported by DONRE should take the lead in promoting/insisting upon “environmentally responsible development” across the board.
- In addition, all provincial agencies should recognise that participation of local communities in planning is essential for developing appropriate and sustainable approaches to CCA; solutions should not be imposed on people by government officials - however well-meaning. Solutions should build on what local people know and are already doing.

Inter-agency collaboration

- PPC should emphasize a multi-agency integrated response to climate change as part of a long-term strategic approach to sustainable development s in Quang Binh.
- PPC should highlight the requirement for inter-department coordination and collaboration to promote development of a low-carbon economy; data exchange and sharing; capacity building for provincial government personnel on CC, CCA, and EbA; and practical steps to integrate CC considerations into planning processes.
- PPC should ensure that an effective multi-agency platform and mechanism exists for integrated planning.
- PPC should ensure free and open sharing between sectors and with partners of digital data, maps and other information required for coherent planning, implementation and monitoring of measures to mitigate and adapt to climate change.

- Proposed CC response actions put forward by each agency must indicate which CC risks, e.g. sea level rise, flash floods, land slide, drought, etc. will be addressed by respective proposed actions, and these should be supported by feasibility studies and cost-benefit comparisons of the proposal with other altternatives. All proposals should be screened for possible maladaptations.

Building Adaptive capacity

Adaptive capacity at the provincial level in Quang Binh is reflected in the level of knowledge and understanding of local officials on climate change issues (varied); the policies and processes for developing Climate Change Resilience and Adaptation Plans (outsource to consultants), the extent to which major development plans have considered climate related issues in their design (varied), screening of development plans for maladaptation (non-existent) and multi-agency collaboration in planning (of rather limited effectiveness). Further capacity development on climate change adaptation and resilience building, and especially on EbA options is clearly needed before these things can be effectively mainstreamed.

10.3 BUDGET FOR IMPLEMENTATION OF EBA INTERVENTIONS

Presently, hard infrastructure projects account for 98.5% of the total budget in the proposed CCRAP. This imbalance needs to be addressed, giving much more emphasis to soft measures and green infrastructure. In addition, central budgets make up a major part of the proposed budget in the CCRAP, and mostly focus on hard infrastructure. More needs to be done to influence allocation of central budgets for soft measures, and to identify larger budgets at the provincial level Some of this can come from important ODA projects for restoration and sustainable forest management from JICA, IFAD, WB, and KFW as stipulated in Quang Binh's medium-term public investment plan for 2016 - 2020.

In addition, DONRE should work closely with DPI through support from MONRE and MPI to attract additional international funding for EbA projects in Quang Binh. The PPC of QB, through DPI and DONRE should additionally explore non-traditional sources of funding such as collaboration with the private sector, including innovative mechanisms such as Biodiversity Offsets, Payment for Ecosystem Services and Corporate Social Responsibility (CSR) funding.

Initial targets could include:

- working with tourism-related facility developers (especially golf-courses) in the sand dunes of Southern Quang Binh, to engage them in providing support for restoration of native tree species in sandy areas. Certainly they will be planting many trees around the golf courses anyway, and there is absolutely no reason why these cannot be native species - but somebody needs to engage with them and encourage them to do this.
- working with CP Vietnam Co. Ltd. to provide support for planting of native tree species around shrimp ponds, and to look into the possibility of introducing organic shrimp production as has been done by IUCN/SNV working with Minh Phu Seafood Company in Ca Mau province.
- working with cement companies to provide support for improved management of conservation areas, as a biodiversity offset for the unavoidable destruction their operations cause to the karst landscape - there is a good model of this with Holcim Vietnam in Kien Giang province.

Other major new sources of climate change related funding such as the GCF, are just starting to come on line in Vietnam. Quang Binh already suffers from severe climate-related disasters, and this is only likely to get worse under expected climate change scenarios. At the same time there are major opportunities to use ecosystem-based adaptation approaches to build resilience in a number of important socio-ecological systems in Quang Binh.

In order to try and start to develop some of these opportunities, two detailed concept notes have been prepared. These are attached as Annex I and Annex II.

10.4 SITE SELECTION FOR MICRO-LEVEL ASSESSMENT

Natural resource based livelihoods are generally more vulnerable to climate change, because of their high degree of exposure and sensitivity. Agriculture, Forestry and Fisheries (AFF) only contributes 24% to GDP but uses 90% of province land and employs 65% people in Quang Binh.

Poorer people are also more vulnerable to climate change because they have limited opportunity to invest in changing and adapting their livelihood activities (low adaptive capacity). They also tend to be working in the already highly exposed and vulnerable sectors (AFF) as well as living in exposed areas, in relatively poor quality (more sensitive) housing. Almost one third of the population of Quang Binh is categorised as poor and near poor.

Coastal near-shore fishing communities and rural upland communities (especially ethnic minorities), are amongst the poorest in the province, and at the same time are the most highly dependent on natural resource based livelihoods (making them doubly vulnerable). SES 5a and SES 10a are therefore two of the most highly vulnerable SESs, and should be prioritised for further assistance

Based on discussions about the vulnerability ranking in a provincial workshop on 10 June 2016, the recommended sites to be considered for micro-assessments were as follows:

- Ngu Thuy Bac commune - Le Thuy district - SES 9a/10a: Coastal sand dune protection forest and Kinh small-scale near-shore fishing
- Tay Trach commune - Bo Trach district - SES 5b: Transition area of paddy rice + cash crops + plantation (Acacia) Kinh people (5b)
- Thuong Trach commune - Bo Trach district - SES 5a: Upland cultivation and collection/harvesting of forest products of ethnic minority people (5a)
- Finally, villages in Ngu Thuy Bac and Thuong Trach were selected for implementation of the community-level vulnerability assessments. The results of those assessments are presented in a separate report

10.5 MONITORING, EVALUATION AND LEARNING FROM EBA IMPLEMENTATION

The EbA and other adaptation measures eventually selected for implementation in Quang Binh should ideally be robust to a wide range of conditions plausible under a future climate. However, effectiveness (i.e., reduced vulnerability and maintained resilience) is not guaranteed and many uncertainties remain. Long-term adaptation therefore requires adaptive management and continual learning, which in turn require good monitoring systems and good knowledge management systems, which must be conceived and established early in the life-cycle of the adaptation initiative.

Monitoring and evaluation activities set baselines, define indicators, measure short and long-term progress in adaptation interventions, identify evolving exposure and sensitivity as well as highlighting continuing unresolved impacts of climate change. The qualitative and quantitative metrics needed should be well defined with clear collection procedures, understood by all those involved and (if possible and appropriate) linked with the country's existing national adaptation monitoring and evaluation processes. Ideally, the metrics used should be few in number, easy to collect on a continuing basis, leverage existing data sets wherever possible and fit with other monitoring and review processes.

Monitoring and Evaluation activities themselves can also be designed as a participatory learning experience in their own right, in which case the process can be referred to as "Monitoring, Learning and Evaluation (MLE)". A good model for this kind of approach can be found in the IUCN/UNDP programme "Mangroves for the Future" (MFF). MFF implements an MLE Process with community-level projects that fosters cross-learning between different initiatives while at the same time directly exposing policy-makers to on the ground issues and interventions.

The use of similar indicators across projects and a willingness to share information within and across agencies and between provinces will make it possible for new projects to build on the collective experience of EbA within Vietnam. Such collective learning will improve the application of EbA actions across a wide-range of situations.

10.6 BIBLIOGRAPHY: IMPORTANT POLICY/DECISION DOCUMENTS AND PROVINCIAL REPORTS

Action Program No. 13-CTr/TU dated 10/09/2007 of Quang Binh Provincial Party about Vietnam's Marine Strategy until 2020;

Center for Sea Islands Natural Resources and Environment Planning, Survey and Assessment, 2013. The field survey report in Quang Binh.

Center for Sea Islands Natural Resources and Environment Planning, Survey and Assessment, 2013. The investigation report of current utilization of resources and protection of the marine environment in Quang Binh province through questionnaires.

Center for Sea Islands Natural Resources and Environment Planning, Survey and Assessment, 2013. Collection of thematic reports under the project "Building a Strategy and Action Plan for the coastal areas integrated management of Quang Binh in the period 2012-2020, vision 2030".

Decision No. 351/QD-UBND dated 26/02/2008 of Provincial People's Committee about the issuance of the action program to implement the Resolution 27/2007/NQ-CP dated 30/5/2007 of Government and action program No. 13-CTr/TU dated 10/09/2007 of Quang Binh Provincial Party about Vietnam's Marine Strategy until 2020;

Decision No. 127/QD-BCD dated 21/11/2012 of Sea Islands Steering Committee about promulgating the Sea Islands Activities Program of Quang Binh province;

Decision No. 58/QD-UBND dated 07/01/2011 of Quang Binh Provincial People's Committee about the approval of the coastal integrated management project of Quang Binh province in the period 2011 – 2020, vision 2030;

Decision No. 952/QD-TTg dated 23/6/2011 of Prime Minister about the approval of master plan of socio-economic development of Quang Binh province until 2020;

Decision No. 3341/QD-UBND dated 21/12/20111 of Provincial People's Committee about the establishment of the Sea Islands Steering Board of Quang Binh Province;

Decision No. 95/QD-BCDBD dated 28/8/2012 of chairman of the Sea Islands Steering Board of Quang Binh province about insuance of the

Decision No. 106/QD-BCDBD dated 25/09/2012 of Chairman of Sea Islands Steering Board of Quang Binh Province about establishment of assistant team to Sea Islands Steering Board of Quang binh Province;

Decision No. 16/2009/QD-UBND dated 14/09/2009 of Quang Binh Provincial People's Committee about issuance of the regulations of functions, missions, powers and organizational structure of Department of Natural Resources and Environment of Quang Binh Province;

Hydrometeorological Center. Synthesis report of the project Hydrometeorological data collection and revision of Quang Binh province from 1956 to 2005.

Le Thuy District People's Committee, 2005. Statement of general planning adjustment for Kien Giang town building - Le Thuy District.

National Ethnic Committee Decision 447/2013 on the extremely difficult communes, group 1-3 in the mountainous and ethnic areas

Prime Minister, the 2008. Decision on approval of the planning of Hon La economic zone development of Quang Binh province.

Prime Minister, 2011. Decision on approval of the planning of overall socio-economic development of Quang Binh province until 2020.

Prime Minister, 2015 Decision on the new near/poverty criteria for 2016-2020

Quang Binh Department of Industry and Trade, 2011. Report on the implementation of tasks in 2010 and plans to industry and trade in 2011.

Quang Binh Department of Industry and Trade, 2011. Planning for industrial development in Quang Binh province until 2020.

Quang Binh Department of Science and Technology, 2009. Assessing the potential water source, utilization tendency for serving industrial production and activities of Hon La seaport industrial zone in Quang Binh province.

Quang Binh Department of Agriculture and Rural Development, 2008. Report on planning of forest protection and development in Quang Binh province during the period 2008-2020.

Quang Binh Department of Agriculture and Rural Development, 2009. Master plan for agricultural development in Quang Binh province until 2020.

Quang Binh Department of Agriculture and Rural Development, 2009. Master plan for aquaculture development in Quang Binh province until 2020.

Quang Binh Department of Agriculture and Rural Development, 2012. Planning on exploitation and protection of fishery resources in Quang Binh by 2020.

Quang Binh Department of Agriculture and Rural Development, 2010. Synthesis report of result of the KN national program in 2010.

Quang Binh Department of Natural Resources and Environmental, 2010. Synthesis Report "Land Use planning until 2020 and plan to use the land for the early 5 years (2011- 2015) of Quang Binh province."

Quang Binh Department of Natural Resources and Environmental, 2010. Development of an action plan to response to climate change in Quang Binh province until 2020.

Quang Binh Department of Natural Resources and Environmental, 2011. Report on the result of environmental monitoring of Quang Binh province in 2011.

Quang Binh Department of Culture, Sports and Tourism, 2009. Synthesis report of master plan for tourism development in Quang Binh province until 2020 and vision 2025.

Quang Binh Department of Culture, Sports and Tourism, 2011. Report of tourism activities in 2011; key tendency in 2012.

Quang Binh Provincial People's Committee, 2009. Synthesis report of the overall planning of socio-economic development of Quang Binh province until 2020.

Quang Binh Provincial People's Committee, 2009. Directive on the plan developing of 5-year socio-economic development 2011-2015.

Quang Binh Provincial People's Committee, 2011. Decision on issuance of the socio-economic infracstructure development program of Quang Binh province in the period 2011-2015.

Quang Binh Provincial People's Committee, 2011. Decision on issuance of industry development program of Quang Binh province in the period 2011-2015.

Quang Binh Provincial People's Committee, 2012. Implementation plan of national target program to response to climate change in Quang Binh Province in the period 2013-2015.

Quang Binh Provincial People's Committee, 2012. Report of socio-economic status of Quang Binh province in 2012.

Quang Binh Provincial People's Committee, 2012. Decision on the approval of human resource development planning of Quang Binh province in the period 2011-2020.

Quang Binh Provincial People's Committee, 2013. Decision on the approval of overall socio-economic development planning of Le Thuy, Quang Ninh, Dong Hoi, Quang Trach, Bo Trach districts/cities until 2020.

ANNEX 10.I: Concept note for a feasibility study for a project on improved fisheries management and restoration of critical habitats in three coastal communes of Le Thuy district in Quang Binh province

Suggested Timeframe of Feasibility Study: Jan - Jun 2017

Suggested Timeframe for implementation: Jul 2017 - Jun 2021

1. LOCATION OF THE PROJECT

Three communes of Le Thuy District in Quang Binh Province on the north-central coastline of Vietnam.

2. BACKGROUND

2.1. The Fisheries Sector and challenges it faces

The fisheries sector of Vietnam plays an important role in the social and economic development of the country. Active in 28 coastal provinces home to 53% of the national population, the fisheries sector has accounted for nearly 6% of GDP, 10% of total employment and 8% of export products. Its share of GDP is similar to that of the garments/textile industry, while its share of net foreign exchange earnings is much higher given that some important export sectors (e.g., garments, footwear, and furniture) depend on high import content. (Additional information on the fisheries sector is provided in Annex I).

Small scale fisheries are particularly important in providing food and income for large numbers of poor and near-poor families living along the coastline. At present, the small scale fishery in Vietnam accounts for more than 95% of total fishing boats, 90% of the fisheries labour force and nearly two thirds of production and value.

Small-scale fisheries are defined as those that use non-powered boats or motorized boats with an engine of less than 90 HP. There are currently over 100,000 such boats operating in Vietnam. The vast majority are long-tail or stationary 1 - cylinder diesel engines of less than 20HP mainly of Chinese and Japanese make, which operate directly from the beach without using harbour facilities.

The typical small scale fishing operation is labour-intensive and confined to near-shore waters. (The legal definition of near-shore is up to 6 nautical miles, but in practical terms small-scale fishing is probably limited more by water depth than distance from the shore - operating mostly in depths of less than 50m). Common small scale fishing gear include beach seines, gillnets, lift nets, push nets, trawls, cast nets, traps, hooks, lines, set nets and trammel nets.

Live reef fishing is also a significant sector, but few data are available on production, either of aquarium fish or of live reef fish for the Chinese market. The main species targeted include groupers, snappers and lobster, either wild caught, or wild caught and grown in cages.

There are clear signs that the past growth of the country's marine capture fisheries is unsustainable. Volume growth has nearly halted in recent years, except with respect to lesser value fish species. Productivity is declining and the share of 'trash fish' and small- sized fish in the landed catch is increasing. Climate change is now adding additional threats to the fisheries sector. Coastal systems generally supply disproportionately high ecological services and benefits to human society compared with many terrestrial systems (Barbier et al., 2011), and more than half of the reported climate impacts synthesized from around the world by Poloczanska et al. (2013) came from coastal systems. Climate-related changes in water temperature, turbidity, salinity and acidity as well as sea-level rise will affect both the critical coastal habitats that underpin fisheries productivity, and will also impact some of the key fisheries specie directly as well.

The fisheries sector is specifically challenged by a number of key problems, namely:

- Total capture has reached a plateau, and capture per unit effort is declining
- The proportion of trash fish in the catch is increasing
- Fisheries regulations are difficult to enforce
- Near-shore fisheries in particular are an open access resource and coastal habitats including mangrove forests, coral reefs and sea-grass beds on which the productivity of (especially) near-shore fisheries directly depends have been badly degraded

These issues are discussed in more detail below.

Capture Volume is levelling off and CPUE is declining

Marine capture fisheries production increased steadily from 1981 to 1999 (Fig. 2), posting a nearly three-fold increase from 419,740 t in 1981 to 1,212,800 t in 1999. However, average catch per unit effort (CPUE) declined over the same period because the annual increases in production were obtained through greater than proportional increases in total horsepower. Over the two decades, total horsepower increased more than five-and-a-half fold from 45,3871HP in 1981 to 251, 8493 HP in 1999. CPUE declines were observed in specific fishing grounds (Vinh et al. 2001) as follows: the CPUE declined from 1.34 to 0.34 t·HP-1·year-1 in the Gulf of Tonkin (1985 - 97); from 1.06 to 0.66 t·HP-1·year-1 in the Central area (1986 - 91); and from 2.05 to 1.20 t·HP-1·year-1 in South Vietnam (1985 - 88).

Between 2000 and 2010, the sector continued to grow at an average annual rate of 13.6% in volume terms and 10.4% in value terms. Capture fisheries production in 2010 was estimated at 5.2 million tons. While two-thirds of production is consumed domestically, export value still reached $5 billion in 2010 (up from $1 billion in 1999). The HP of the fishing fleet continued to grow twice as fast as the increase in production during this period.

According to assessments in the early 2000s, the standing stock of pelagic fishes in Vietnam waters was about 2.0 million t, while the exploitation potential was 0.8 million t·year-1 (Table 10.1). Of this potential yield, 0.69 million t·year-1 was estimated for small pelagic species and 0.12 million t·year-1 for oceanic pelagics (Chung et al. 2001). The largest pelagic stocks are found off the southeast and central region of Vietnam (Vinh and Thu 1997).

Table 10.1: Estimates of standing stock and potential yield of pelagic resources in Vietnam waters

Region	Pelagic Resources	Standing Stock (t)	Potential yield (t-year^{1})
Gulf of Tonkin	Small pelagics	390,000	156,000
Central region	Small pelagics	500,000	200,000
Southeast region	Small pelagics	524,000	209,600
Southeast region	Small pelagics	316,000	126,000
Sea Banks	Small pelagics	10,000	2,500
Offshore Region	Oceanic pelacis (*)	(300,000)	(120,000)
TOTAL		2,040,000	814,100

Proportion of Trash Fish in catches is increasing

“Trash fish” or by-catch landings are estimated at 33 percent of total marine fish landings. Southern fisheries have the highest proportion of trash fish (averaging around 60% of the catch), compared to 5% in the central region and 14% in the northern region. “Trash fish” is composed of over 100 different species (mostly fish but also some molluscs, crustaceans and echinoids).

Most of this is consumed locally or used in the production of fish sauce or used as an aquaculture feed or aquaculture feed ingredient. Excessive ‘trash fish’ harvests are removing the seed and fingerlings of many valuable species, thus contributing to the depletion of coastal resources.

Enforcement of regulations is not as effective as needed

Minimum mesh size in marine fishing gear are set for 5 species specifically; sardine, anchovy, mackerel, shrimp, and lobster. Also an increase in engine power affects the appropriate minimum mesh size (see Table 10.2). Monitoring and enforcement of mesh size regulations is problematic, and use of illegal small mesh net sizes certainly contributes to the high proportion of trash fish being landed.

Table 10.2: Minimum mesh sizes for different fishing gear

No.	Type of fishing gear	Minimum mesh size (mm)
1	Sardine gillnet	28
2	Mackerel gillnet	90
3	Shrimp trammel net	44
4	Shrimp gillnet	44
5	Lobster gillnet	120
6	Anchovy seine net; Anchovy surrounding net	10
7	Fish trawl	
8	For vessel having engine <60 For vessel having engine from 60 to 150Hp	28 34

Open-access nature of the resource results in over-fishing and contributes to degradation of key habitats

Throughout Vietnam, overfishing is especially evident in the near- shore areas, which are the primary source of livelihood for most of the poor or near poor coastal communities. Most of the fishing gears that are being used violate current regulations related to mesh size leading to a high proportion of trash fish in landings. The near-shore fisheries are experiencing a classic 'tragedy of the commons' phenomenon, as too many fishers are now competing over an insufficient and dwindling "open access" resource, while also contributing to marine habitat destruction. The short-term incentives for individual fishers are incompatible with the longer term interests of the coastal communities and the needs for sustainable resource management. The combination of over capacity and destructive fishing practices is taking a heavy toll on biodiversity, the quality of resources, and the viability of livelihoods of many coastal communities.

2.2. Fisheries in Quang Binh Province

In Quang Binh in 2011 there were 4,927 fishing boats, including 3,299 <20 HP; 395 of >20<50 HP; 458 of >50<90 HP; 754 of >90<250 HP and 21 of >250<400HP. Recent policy has been to try and reduce the number of small-scale fishing boats by around 300 each year. In meetings with DARD in December 2015 it was mentioned that the current number of boats <90HP in Quang Binh was around 3,000 (compared with 4,152 from 2011 figures above) suggesting that this policy has indeed been effective over the last 4 years.

While no specific in-depth studies have been carried out in Quang Binh Province, there is no reason to assume that the situation here is any different from the pattern across the the rest of the country. It is safe to say that near-shore coastal fisheries in Quang Binh are already under severe stress. Compounding this, recent mass fish deaths in 4 coastal provinces including Quang Binh, starting in April 2016, have dealt an additional serious blow to fisheries. Speculation is rife that the mass fish die-off resulted from phenol poisoning from the discharge of a huge amount of carbolic acid (an industrial cleaning agent) from the Formosa steel plant at the Vung Ang Special Economic Zone in Ha Tinh province, but no conclusive statement or report on the investigation of the issue has yet been provided by the government, despite engaging a number of research institutes to assess the situation. It is also possible that a combination of coastal pollution from other sources including aquaculture and domestic waste water; an extended period of elevated water temperature, and associated significant movement of benthic sediment into the water column also contributed to create a "perfect storm" of deadly conditions for the fish. Media reports have suggested over 2,000 fishing households were directly affected in Quang Binh, with initial losses estimated at over 115 billion VND. Government advice against the sale of seafood in hotels and restaurants in Quang Binh, in place since the incident, was lifted on 16th June 2016.

2.3. Fisheries in Le Thuy District

Le Thuy District in southern Quang Binh, includes three coastal communes, home to a 2,700 households or 9,500 people along a 30 km shoreline. These 3 communes have 927 fishing boats of less than 20 HP. The poverty rate (based on the new 2016 criteria) is over 20%. According to district officials, fisheries yields in these three communes are declining, and fisheries based livelihoods are no longer sufficient to meet income needs. As a result, 728 people have migrated out of the area to look for work elsewhere - they are mostly young men who are working as wage labour fishers on larger offshore fishing boats in other provinces. It was noted that:

- The number of boats has increased and the equipment used has improved over time, while the fishing grounds have remained the same.
- Fishing grounds are now very crowded, including with competition from fishers from other areas as well.

- Price of fish has increased so although catch (or catch per person) may have declined, the income obtained from the catch has remained relatively constant.
- But as the country has developed, living standards and expectations have risen, so whereas in the past this amount of income from fisheries may have been considered sufficient to meet needs, now it is not.

The fishing communities in these three communes also gain additional income from raising livestock (poultry, pigs and cattle); growing some crops in sandy soils - especially sweet potato as well as some peanuts and melons. Since 2006 many households have exploited the naturally high water table on the dunes and excavated ponds for raising the freshwater snakehead fish.

2.4. Ngu Thuy Bac Commune

The commune occupies an area of 14.7km x 2.5km, with 1,029 households, home to 4,142 people spread across 5 villages (Bac Hoa, Tan Hoa, Tan Hai, Tan Thuan and Trung Thanh. Around 99 households are classed as poor, and another 117 as near-poor. The commune catches around 1,720 tons of fish each year, and a further 247 tons of snake-head fish is raised in freshwater ponds. Around 30 hectares are planted with sweet potato, and there are about 200 cows and 22,000 poultry, as well as pigs.

There are 348 boats of less than 24 HP. About 100 boats are larger 1-2 tons, capable of fishing for mackerel at a distance of up to 20 nautical miles from the coast. There are 3 ice plants in the commune and 7 refrigerated/ice trucks of 2-2.5 tons. 145 people work as traders.

Rapid visits were made to Tan Hai and Bac Hoa villages, and a three -day participatory micro-level vulnerability assessment was carried out in Tan Hai village in Ngu Thuy Bac Commune of Ley Thuy District in June 2016. Information from the villagers gathered through activities including focal group discussions, historical timelines, seasonal calendars and community mapping, confirmed the trends over the last 1-2 decades of increasing numbers of fishers, increasing horsepower of the fishing fleets, use of more modern equipment such as fish-finding devices, and a declining CPUE. All of this has significantly decreased the resilience of near-shore fisheries, making them even more vulnerable to the new and additional risks now posed by climate change.

2.5. Climate-related hazards

Quang Binh is already one of the most climate hazard prone provinces in Vietnam. The province is particularly vulnerable to storms, floods, whirlwinds, river bank and beach erosion and salinity intrusion. During the rainy season, storms and tropical low pressure systems often cause heavy rains, storm surges, and tidal floods. Coastal districts in Quang Binh - especially small-scale fishing communities in - Le Thuy, Quang Ninh, Quang Trach, Bo Trach, and Dong Hoi City are particularly exposed to the direct impacts of storms. Fishing during the storm seasons is usually dangerous for fishermen. The highest recorded damage was in 1995 inflicted by the 11th hurricane with a total of 564 vessels sunk or damaged. Most of these hazards will increase under climate change predictions.

In addition to physical damage to boats, homes and other infrastructure, together with any associated injury and loss of life, climate impacts on near-shore fisheries in Quang Binh will result from a combination of two aspects - impacts on the coastal habitats that are essential in supporting fisheries (mangroves, coral reefs, sea-grass beds, mud-flats, etc) and impacts on the important fisheries species themselves.

2.6. Climate Impacts on Coral Reefs, Sea-grass Beds and Mangrove Forest

While mangrove area in the province has steadily declined (despite some efforts at replanting) almost nothing is known about the extent and condition of sea-grass and coral reefs in Quang Binh. The provincial Seas and Islands Department within DONRE has no data at all on these critical habitats. So we know almost nothing about the state of these key resources even before trying to consider climate change impacts.

Around the world, coastal waters have warmed faster than those of the open oceans (Lima & Wethey, 2012). Though the Seas and Islands Division of DONRE was not able to supply any specific information on warming of coastal waters in Quang Binh, we can assume it happening here just as in other areas.

Effects of temperature related effects on coral reefs are highly visible and extensively documented (Veron et al., 2009). Small increases (1-2°C) in sea temperature above the long-term summer maxima destabilises the relationship between host corals and their symbiotic zooxanthellae algae on which they rely for energy and growth (Veron et al., 2009), resulting in coral bleaching. Increased water temperature also has the potential to affect both the reproductive output of parental colonies, and the success of early coral life stages in corals (Hoegh-Guldberg et al., 2007).

Up to a certain point, higher water temperature may increase the growth rate of sea-grasses. However, sea-grasses have thermal tolerance limits beyond which mortality occurs. Sea-grass species thermal tolerance limits for Quang Binh are unknown.

Coral reefs and sea-grass beds both exist at specific depths appropriate to the level of sunlight penetration they require in the waters they are living in. Sea level rise reduces the amount of sunlight reaching them and therefore reduces their ability to photosynthesize. However, sea-grasses can respond more quickly and grow-up slope to regain their n their “comfort zone” of preferred depth at a rate that exceeds the rate of sea-level rise. For slower-growing corals regaining their comfort zone will take much longer, and will not be able to keep pace with climate change. (Bezuijen et.al. 2011). For the (presumably) already very degraded corals of Quang Binh, a combination of sea-level rise and increasing water temperature may likely lead to their complete disappearance.

In estuarine and coastal areas, sea level rise will alter the dynamic balance between river and ocean. The inter-tidal area will change, as will the balance of sediment erosion and deposition processes in river-mouths and along the banks of estuaries. The exact amount of intertidal habitat lost due to sea level rise in any areas will be determined by a complex combination of local geomorphology and tidal amplitude (Lovelock and Ellison, 2007). Sea level rise will also influence meso-scale habitat connectivity between adjacent estuaries and estuarine mangroves (Munday et al., 2007).

Mangroves near Gianh and Nhat Le estuaries will die off in their present locations and would naturally tend to retreat further inland in response to increased salinity and sea level rise. However, they may be impeded by physical barriers including dykes, saline intrusion barriers and other infrastructure. Mangrove trees can also be damaged by strong winds and storms. Extensive long-duration floods can cause death of mangrove trees if they are submerged for too long.

Storms and floods create highly turbid conditions which limit light availability for sea-grasses and have caused declines of sea-grass populations in other tropical regions (Shaffelke et al., 2005; Waycott et al., 2007). Sea-grasses are particularly vulnerable to these changes and to physical disturbance resulting from sediment movement (erosion and deposition), turbulent water motion and storm surges (Waycott et al., 2007). Flooding from severe storm events reduces salinity and increase turbidity, creating difficult and often fatal conditions for sea-grasses to grow in (Waycott et al., 2007).

Coral reefs are also impacted by turbid conditions reducing sunlight penetration. They can also suffer physical damage from very strong storm surges, but are not as sensitive to this as sea-grass.

Detrails of climate chane impacts on some key near-shore fishery species are provided in Annex II.

3. CURRENT POLICIES AND MANAGEMENT OF THE FISHERIES

Since 1998 the Vietnamese government has pursued a policy of making preferential loans available to fishermen to upgrade their vessels and install modern equipment and efficient fishing gear so they can fish further offshore. The government has also invested in harbour infrastructure to support offshore fisheries landings. Private businesses (including foreign-invested businesses) exploiting offshore fisheries are given tax relief during the first 3 years of business.

However, in the three coastal communes of Le Thuy District, uptake of the government support offered to upgrade fishing boats and to move to offshore fishing has been rather limited. Different informants identified a number of probable reasons, including:

- Even with government long-term soft loans and subsidies, the fishers have to put in at least 10% of their own money, and many of them simply do not have the cash available.
- There is a concern that even the offshore fishing grounds are not that good so the return on investment may not be worth it.
- There is no local harbor for big fishing boats - the nearest one is in Danang.
- local practice is for fishers to go out around 5pm and return to shore around 4 a.m. - with bigger boats they would have to change their behavior patterns and spend longer periods at sea.

The ability of local government to support sustainable management of near-shore fisheries is extremely limited. At the Quang Binh provincial level DARD was not able to provide any specific or detailed information on quantities of different species being caught in a single year - never mind patterns of change in catch composition over time. At the same time DONRE (Seas and Islands Division) was not able to provide any information on coral reefs or sea-grass beds anywhere in the province - despite the fact that they are supposed to manage any exploitation of these resources.

It seems that the province currently lacks the capacity to effectively manage coastal habitats and fisheries for sustainable production - even without considering climate change. It would therefore be difficult to start immediately trying to address climate related issues in near-shore fisheries without first putting in place better management of coastal habitats and better fisheries management. In other words there is a substantial/considerable "adaptation deficit" that needs to be addressed first, before moving forwards into climate change adaptation.

4. THE PROJECT CONCEPT

4.1. Rationale

The proposed project is intended to address some of the key challenges limiting resilience of the near-shore fisheries sector and fishing livelihoods (identified above) in Le Thuy District.

It is believed that effective co-management systems could help enforce regulations and improve sustainability of near- shore fisheries. Fisheries co-management pilots in Vietnam have so far been implemented in closed systems (e.g., lagoons, reservoirs), but have not been tried in open access areas such as near-shore fisheries. Decree No. 33/2010/ND-CP issued by the government in 2010 explicitly assigns open access coastal areas to local authorities and fishing communities to implement a partnership of co-management models. To translate this into action, local fishing communities, as well as local authorities, would need support to strengthen their capacity to carry out their new responsibilities.

Co-management of fisheries could also be supported by participatory identification and mapping of coral reefs and sea-grass beds, and development of an action plan for improved management of these critical habitats including restoration programmes where needed.

The proposed project therefore aims to establish a sound basis of evidence for sustainable fisheries management and then institutionalise fisheries co-management, including improved protection and restoration of coral reefs and sea-grass beds, in 3 coastal communes of Le Thuy District in Quang Binh Province - as a necessary precondition for future climate change adaptation work.

4.2. Proposed Objectives

Overall Objective:

Resilience of near-shore fishing communities in 3 coastal communes of Le Thuy District, and the fisheries on which they depend strengthened through improved ecosystem-based fisheries management.

4.2.1. SPECIFIC OBJECTIVE 1

Co-Management systems for near-shore fisheries established in all villages of the three communes.

4.2.2. SPECIFIC OBJECTIVE 2

Ecological condition/health of coral reefs and sea grass beds and their role in the productivity of the near -shore fishery assessed; and appropriate strategy/action plans developed to restore their health/functioning.

4.3. Expected Outputs (deliverables)

4.3.1. OUTPUTS FOR OBJECTIVE 1

- Participatory catch monitoring system established and annual reports produced from year two onwards to enable changes in catch amount and relative species composition; as well as times of arrival and departure of seasonally migrating stocks, to be tracked over time by the community and local government officers responsible for fisheries management.
- Co-management agreements negotiated and signed with all coastal villages in the three communes, including elements such as no-take areas, or closed season periods to allow for stock recovery and to match fishing effort with available productivity.

4.3.2. OUTPUTS FOR OBJECTIVE 2

- Alll coral reefs and sea-grass beds in Quang Binh Province identified and mapped and their status/health assessed.
- Action Plan for restoration of coral reefs and sea-grass beds developed with specific actions, timelines and budgets.

4.4. Methods

4.4.1. METHODS FOR OBJECTIVE 1

Participatory workshops and dialogue processes with communities. Design participatory catch monitoring protocols, instruments and reporting formats. Pilot test monitoring systems, and review experience, make necessary changes as appropriate. Roll-out for full implementation. Discuss, negotiate and agree vision, goals structure, functions and governance aspects of the co-management system before formally establishing it.

4.4.2. METHODS FOR OBJECTIVE 2

Work with local fishers to identify preliminary location of coral reefs and sea-grass beds. Follow up with dive surveys for coral reefs and manta-tow snorkel surveys of sea-grass areas to map accurate location, extent and condition of the habitats. Identify key areas for strict protection, and areas for restoration. Develop Action plan for protection and Restoration.

4.5. Roles and responsibilities in the project:

The local fishing communities in the three communes are the key stakeholders for the project. Work on fisheries co-management should be supported by DARD Fisheries Division, and work on coral reef and sea grass protection and restoration should be supported by DONRE Seas and Islands Division. However outside technical expertise will be needed to assist with all aspects of the project, especially the dive surveys and participatory fisheries monitoring.

4.6. Feasibility Assessment

GIZ should support a feasibility assessment that would review the need for, as well as the rationale and logic of the proposed project, clarify the objectives, outcomes and outputs, and assess the interest and capacity of key actors to implement the project (local communities, DARD Fisheries Division; DONRE Seas and Islands Division). The Feasibility Assessment should also specify detailed activities, timeline and budget estimate after discussion with the key actors, using a format something like the following:

No.	Activities	Time-frame	Lead Responsibility	Deliverables
1	Activities for Objective 1		DARD Fisheries Division + external technical expertise	
1.1.				
1.2				
1.3				
2	Activities for Objective 2		DONRE Seas and Islands Division + external technical expertise	
2.2				
2.2				
2.3				

5. REFERENCES

Beamish, R.J., ed. (2008), Impacts of Climate and Climate Change on the Key Species in the Fisheries in the North Pacific. *Working Group on Climate Change, Shifts in Fish Production, and Fisheries Management* North Pacific Marine Science Organization (PICES), B.C., Canada.

Bezuijen, M. R., Morgan, C., Mather, R.J. (2011). A Rapid Vulnerability Assessment of Coastal Habitats and Selected Species to Climate Risks in Chanthaburi and Trat (Thailand), Koh Kong and Kampot (Cambodia), and Kien Giang, Ben Tre, Soc Trang and Can Gio (Vietnam). Gland, Switzerland: IUCN.

Chavez, F.P., Ryan, J., Lluch-Cota, S.E. and Niquen, C.M. 2003. From anchovies to sardines and back: Multidecadal change in the Pacific Ocean. *Science* 299: 217-221.

Choo, H.S. and Kim, D.S. 1998. The effect of variations in the Tsushima warm currents on the egg and larval transport of anchovy in the southern sea of Korea. *J. Korean Fish. Soc.* 31: 226-244.

Chung, B.D., C. T. Vinh and N. H. Duc. 2001. Marine fisheries resources - Basic development of marine fisheries industry in Vietnam, p. 200 - 210. *In* Proceedings of Marine Fisheries Research, Volume II. Research Institute for Marine Fisheries, Ministry of Fisheries, 560 p.

FAO (2005) Fisheries Information for Vietnam

FAO Fishery Information Data and Statistical Unit. 2006. Total production 1950–2004. FISH STAT Plus Universal Software for Fisheries Statistical Time Series. Food and Agriculture Organization for the United Nations. Available at http://www.FAO. org/fi/statist/FISOFT/FISHPLUS.asp.

Kawasaki, T. 1983. Why do some pelagic fishes have wide fluctuations in their numbers? FAO Fish. Rep. 291, pp. 1065-1080.

Kim, J.Y. 1992. Relationship between anchovy, *Engraulis japonica*, egg and larval density and environmental factors in the eastern waters of Korea. *Bull. Korean Fish. Soc.* **25**: 495–500.

Kim, J.Y . and Kang, Y .J. 1992. Spawning ecology of anchovy *Engraulis japonica*, in the southern waters of Korea. *Bull. Korean Fish. Soc*. **25**: 331-340.

Kim, J.Y. and Lo, N.C.H. 2001. Temporal variation of seasonality of egg production and the spawning biomass of Pacific anchovy, *Engraulis japonicus*, in the southern waters of Korea in 1983–1994. *Fish. Oceanogr.* **10**: 297-310.

Kim, J.Y., Kim, S., Choi, Y .M. and Lee, J.B. 2006. Evidence of density dependent effects on the population variation of Pacific sardine (*Sardinops melanostictus*) off Korea. *Fish. Oceanogr.* **15**: 345. doi:10.1111/j.1365-2419.2006.00413.x

Long, N. 2000. Technical report on socio-economic profile, fleet operational dynamics and bio-economic modelling of Vietnamese fisheries. Project technical report. ADB-RETA 5766 Project - "Sustainable management of coastal fish stocks in Asia". Research Institute of Marine Products, Haiphong, July 2000. 49 p.

Morimoto, H. 1998. Maturation. pp. 45–53, *in* Stock Fluctuations and Ecological Changes of the Japanese Sardine, *edited by* Y. Watanabe and T. Wada, Koseisya-Koseikaku Co., Tokyo. (in Japanese).

Son, D.M. and P. Thuoc 2003. Management of Coastal Fisheries in Vietnam, p. 957 - 986. *In* G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R.A. Valmonte-Santos, C. Luna, L. Lachica-Aliño, P. Munro, V. Christensen and D. Pauly (eds.) Assessment, Management and Future Directions for Coastal Fisheries in Asian Countries. WorldFish Center Conference Proceedings 67, 1 120 p.

Takahashi M., Nishida H. and Yatsu, A. 2004. Preliminary study of growth of larval and early juvenile Japanese sardine in the Kuroshio-Oyashio transition region. PICES 13th Annual Meeting, p. 231. (Abstract).

Takasuka A., Oozeki Y., Aoki I., Kimura R., Kubota H. and Yamakawa T. 2004. Differential optimal temperatures for growth of larval anchovy and sardine: A potential mechanism for regime shifts? PICES 13th Annual Meeting, p. 27. (Abstract).

Takasuka, A., Oozeki, Y. and Aoki, I. 2007. Optimal growth temperature hypothesis: Why do anchovy flourish and sardine collapse or vice versa under the same ocean regime? *Can. J. Fish. Aquat. Sci.* **64**: 768–776.

Vinh, C.T. and V.H. Thu. 1997. Small pelagic fisheries of Vietnam. Paper presented at Third Regional Workshop on shared stocks in the South China Sea Area. Kuala Terengganu, Malaysia. 6 - 8 October 1997.

Vinh, C.T. and V.H. Thu. 1997. Small pelagic fisheries of Vietnam. Paper presented at Third Regional Workshop on shared stocks in the South China Sea Area. Kuala Terengganu, Malaysia. 6 - 8 October 1997.

World Bank - Fisheries Sector Report Vietnam, 2004.

Zhu, D. 1991. Japanese anchovy. pp. 453–484 *in* Marine Fisheries Biology, *edited by* J. Deng and Q. Zhao, Agriculture Press.

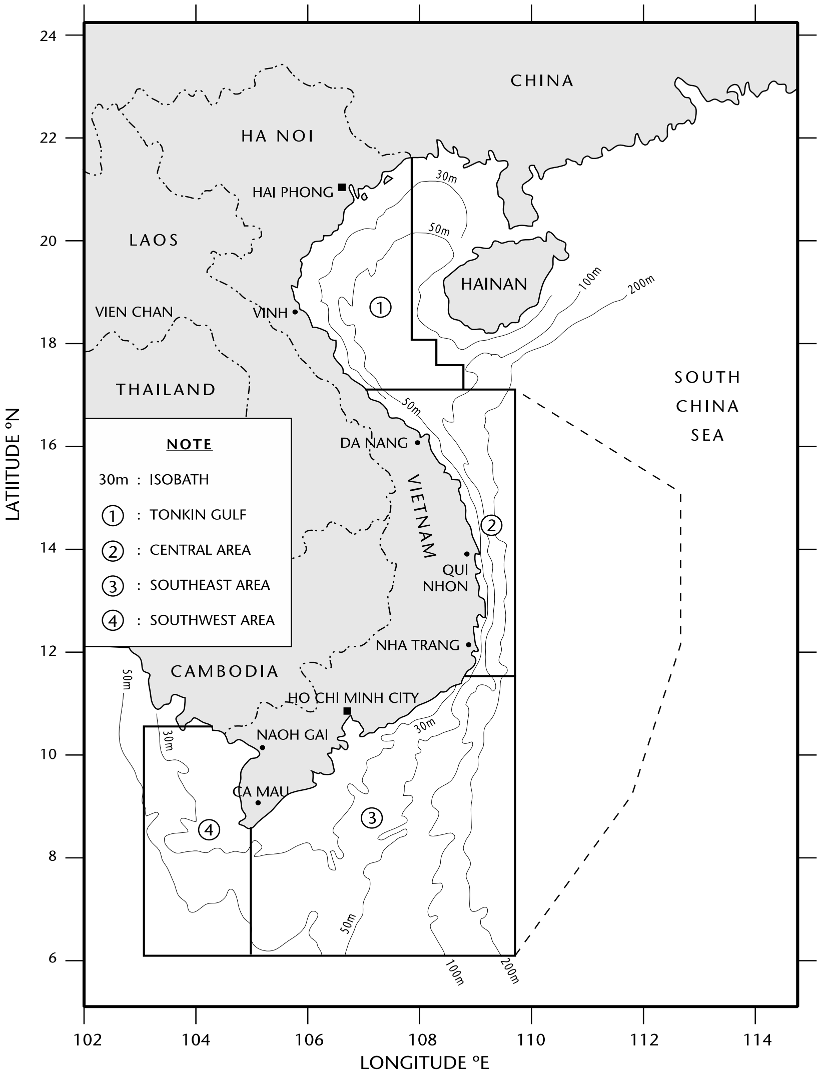
Zhu, D. and Iversen, S.A. (*Eds.*). 1990. Anchovy and other fish resources in the Yellow Sea and East China Sea. November 1984 – April 1988, Fisheries Investigations by R/V "Bei Dou". *Mar. Fish. Res.* **11**: 1-143.

5.1. Annex 1: The Fisheries Sector in Vietnam

The continental shelf of Vietnam, where coastal fisheries operate, is wide and shallow in the north and south, and narrower with a steeper slope in the central region. The coastal marine environment is divided into four regions based on their hydrological regimes, namely, the Gulf of Tonkin; central region; southeast region; and southwest region (see Figure 10.1). The Gulf of Tonkin spans an area of 140,000km^2 and is shared by Vietnam and China. The Gulf is relatively shallow, mostly less than 50 m depth and has a relatively flat bottom with muddy to sandy substrate. In the central region however, the depths drop steeply to 200 - 500m within 30 to 50km off the coast. Quang Binh is located in the southern part of the Gulf of Tonkin region, close to the border with the central region.

In general, surface currents in Vietnam, which are induced by the monsoon winds, flow from north to south in winter and reverse direction in summer. Water temperature and salinity vary according to season and location. Average sea surface temperatures usually range from 21 to 26^{o}C. These are generally high in the south and low in the north, especially in January-February, when air temperatures in the north drop to 15 - 16^{o}C. In August, when temperatures are highest, sea surface temperatures range from 28 - 29^{o}C (Thuoc and Long 1997).

Map 10.1: Fisheries regions of Vietnam



5.2. Annex II: Climate change impacts on some key species in near-shore fisheries

Small pelagic species including mackerel, squid, sardines and anchovies are important to the near-shore fishing communities of Quang Binh Province. There is evidence that climate trends affect the production of the species that make up some of the the major inshore pelagic fisheries of the world, and we should expect to see similar climate change effects on fish production in Quang Binh as well.

The type of climate variability or change that affects each species varies depending on the aspect of climate that is important to the life history of the particular species. Although ocean conditions in spawning and first feeding areas play a critical role, unfortunately, the precise mechanisms linking climate trends to production are poorly understood. While we can expect that major fluctuations in the abundances of key species and their fisheries will occur in the future, we still lack an ability to forecast changes in trends that are useful to management (Beamish, 2008).

In general, rapid or dramatic increases in temperature above normal maximum temperatures are expected to have significant effects on overall viability of some pelagic fish populations (Munday et al., 2008). Fish are particularly sensitive to temperature changes during their early life histories. Warming can have either a positive or negative effect on egg production, depending on whether the target fish species is close to its thermal optimum. An increase in temperature of 1-3°C could shorten the incubation period of eggs for pelagic spawning (Munday et al., 2007).

Analysis of overall trends in proportion of different species making up the catches of inshore fishermen are not yet available, either for Vietnam in general of for Quang Binh in particular, but we may expect to see patterns similar to what is happening in other nearby countries. As an example, in Korea, in recent years the portion of small pelagic fish species (anchovy, Japanese sardine, mackerels and common squid) has been increasing, and now makes up 60 to 70% of the total catch. Common squid has been increasing with warming waters since the 1990s, and alone alone now accounts for 20 to 25% of the total catch (Kim and Kang, 2000).

5.2.1. SARDINE AND ANCHOVY

Sardine and anchovy populations are well recognized as responding synchronously and rapidly to changes in their ocean environment (Kawasaki, 1983). In many ecosystems around the world, abundance of anchovy follows trends that are opposite to those of the sardine. In the 1950s and 1960s, anchovy abundance was large when sardine abundance was small. This pattern switched in the late 1970s and 1980s, reversing again in the 1990s. (Chavez et.al., 2003). It is expected that similar patterns might be seen in Quang Binh.

The alternating cycles of abundance seem to occur in response to large-scale, climate changes relating to a combination of ENSO events and Pacific Ocean decadal oscillations. Sea surface temperature (SST) affects on early growth rates may be the key factor, with anchovy responding better to increased temperature (Takahashi et al., 2004; Takasuka et al., 2004, 2007). Seasonal and long-term trends of the size of yolk-sac larvae, embryonic mortality, egg production, and spawning stock biomass of anchovy have also been correlated with changes in spring warming, summer cooling, and zooplankton biomass (Kim, 1992; Kim and Lo, 2001). Variation in oceanographic conditions also affects the adult migration route and the distribution of eggs and larvae.

5.2.2. MACKEREL

The Indo-Pacific Mackerel (Rastrelliger brachysoma) is a shallow pelagic species of major economic and food security importance. Mackerel spawn offshore however after egg hatching juvenile mackerel travel onshore via currents to develop in mangrove/inter-tidal wetland environments (Venkataraman, 1970; FAO, 2011). Juvenile mackerel will therefore be particularly vulnerable to the effects of sea level rise on these habitats, particularly if these mangroves and other habitats are already degraded. Reduced connectivity of habitats between estuaries may also threaten the connectivity of populations of wild mackerel, also reducing their resilience.

There is very little information about the temperature specific impacts of climate change on this species and their adaptive capacity, however, a study study by Pradhan and Reddy (1962) carried out over 50 years ago, shows that mackerel may well be highly vulnerable to changes in temperature. As seas warm, they may be expected to shift their distribution to stay within their temperature comfort zone.

5.2.3. SQUID

Squid have a flexible life history which is a result of the highly responsive nature of their growth to temperature changes (Pecl and Jackson, 2008). Tropical squid that grew through periods of warming water temperatures grew 9% faster than squid that grew through periods of cool water temperatures (Jackson and Moltschaniwskyj, 2002). It has been suggested that squid will thrive in the face of a global warming of the seas, with increased growth rates, accelerated life histories and rapid turnover in populations, which could potentially lead to population expansion at the expense of slower growing teleost competitors (Jackson, 2004). However, under continued temperature elevation there will likely come a point where growth rates start to decrease as metabolic costs con- tinue to escalate and growth potential is subsequently reduced (Pecl and Jackson, 2008).

5.2.4. BLUE SWIMMING CRAB

The Blue swimmer crab (*Portunus pelagicus*) also known as sand crabs, are an economically very important species which are widely caught and cultivated across the Indo-Pacific region (FAO, 2011). They are ideal aquaculture species due to their ease and frequency of spawning in captivity (Andres et al., 2010). They are found in estuaries and inshore marine waters in the wild (Kangas, 2000) and constitute an important species in near-shore fisheries in Quang Binh. They are opportunistic, bottom-feeding carnivores and scavengers which means they will be less sensitive to climate related impacts on their food supply than more specialist feeders.

Blue swimmer crabs migrate between estuaries and the open ocean during their adult, larval and juvenile stages (Kangas, 2000). Their dependence on intertidal habitats during different stages of their life cycles therefore makes them vulnerable to sea level rise. Extremes in water temperature are likely to have significant effects both on survival of larvae and adult blue swimmer crabs as well as affecting growth and reproduction (Hutchings et al., 2007). A sea surface temperature rise would likely increase developmental rate overall, resulting in a net increase in productivity. As with other marine and freshwater species however, these increases would only occur within the thermal tolerance of the individual species. For blue swimmer crabs this has been shown in laboratory settings to be around 39.5 degrees C (Neverauskas and Butler, 1982). Specific thermal tolerances for blue swimmer crab in the wild in Quang Binh are however completely unknown.

ANNEX 10.II: CONCEPT NOTE FOR IMPLEMENTATION OF "MANAGEMENT AND RESTORATION OF NATIVE SPECIES COASTAL PROTECTION FORESTS IN QUANG BINH PROVINCE"

Timeframe: Jan 2017 - Dec 2021

Overall Budget: tbc

1. LOCATION OF THE PROJECT

Quang Binh Province, with pilot sites in Le Thuy, Quang Ninh and Quang Trach Districts.

2. BACKGROUND

2.1. General Climate Hazards in Quang Binh

Quang Binh is one of the most hazard prone provinces in Vietnam. The province is particularly vulnerable to storms, floods, whirlwinds, river and sea bank erosion and salinity intrusion. During the rainy season, storms and tropical low pressure systems often cause heavy rains and tidal floods, resulting in inundation in lowland regions and flash floods in mountainous and hilly areas. Due to the particular topography of the province, all the rivers of Quang Binh are relatively short and steep. When storms bring heavy rains, then combined with the nature of the river system this often results in floods with a very rapid onset with high velocity flows and high erosive power. Other types of natural hazard in the Province include whirlwinds, blowing sand and salinity intrusion.

Coastal districts in Quang Binh - including Le Thuy, Quang Ninh, and Quang Trach, are particularly exposed to the direct impacts of storms - especially residential, tourism, small-scale fisheries aquaculture and seafood processing areas concentrated along the coastline and in river mouths.

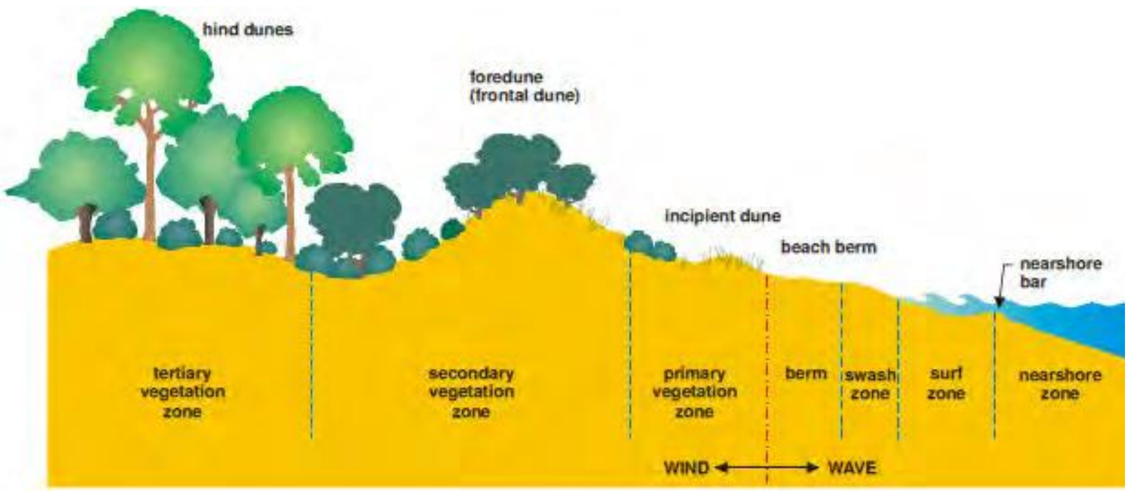
Vo Ninh, Gia Ninh and Hai Ninh communes in Quang Ninh District are seriously affected by blowing sand. During storm seasons, yards and gardens and even houses are covered with sand. Many families have to evacuate or relocate themselves, either temporarily or permanently. Many roads connecting villages are covered by sand, restricting accessibility. In Hong Thuy, Thanh Thuy, Cam Thuy, Hung Thuy, and Sen Thuy communes of Le Thuy district near National Road 1A, rain with even relatively light intensity can already fill streams with water and cause sand to flow at high speed and cover arable land. It is estimated that each commune loses 2ha/year on average. As a result of the 2010 flood in Le Thuy, many areas suffered sand deposited up to 1.5m high, and people had to abandon their fields which were no longer arable. Many parts of concrete roads along the coastline were cracked and damaged by these unexpected events. Coastal residents were also caught by surprise by the formation of streams on sand dunes and suffered significant damage when floods occurred.

Climate change is expected to bring increasingly unpredictable storms with stronger winds causing sand blows to occur more frequently and more severely in areas along the coast in two districts - Quang Ninh and Le Thuy, increasingly affecting daily life and agricultural production of local residents. With climate change, stronger winds will blow more sand into houses and fields will also be increasingly covered with sand. The effort required to dig up the sand to reclaim arable land area after the storm season will increase over time with climate change.

2.2. Coastal Sand Dune Systems in Quang Binh

The three coastal communes of Ngu Thuy Bac, Ngu Thuy Trung and Nguy Thuy Nam have significant sand dune areas which are the source of some of the blowing sand, while these communes themselves are less affected by its impacts. Coastal dunes are accumulations of wind-blown sand located behind the beach. Typically, an undisturbed beach will be backed by a fore-dune (also known as a frontal dune) and hind dunes. Vegetation cover is a crucial element of dune landscapes. Wind velocity is generally reduced by plant cover, encouraging deposition and trapping of wind borne sand. Sand dune ecosystems are very dynamic areas, but if ecological processes are occurring naturally, then on the landward side of the system mature tree cover eventually stabilizes the movement of sand.

Figure 10.1: Typical features of a dynamic beach system



Source: Coastal Dune Management, Land & Water Conservation Department, NSW, 2001

The presence of a stable dune system provides a natural physical defense mechanism against coastal storm hazards and sea level rise. Sand dune ecosystems also provide a very important function in filtering rain water and storing underground water, providing a critical dry season water supply. Natural vegetation of sand dunes areas can provide grazing for livestock and some edible and medicinal plants used by people.

2.3. Coastal Protection Forest in Quang Binh

About 2.5 % of the area of Quang Binh Province (about 20,000 hectares) is designated as protection forest on sand dunes, but natural sand dune systems and other types of natural coastal vegetation communities are nowadays very rare. In much of the coastal dune systems of Le Thuy and Quang Ninh Districts, natural vegetation has been extensively removed or degraded by development of human settlements, cutting down of the original tree cover, and conversion to a number of different land-uses including commercial shrimp ponds and vegetable growing. Heavy sands mining for titanium has also removed tree cover from large areas of sand dune systems and sandy areas.

The importance of coastal forests in the context of climate change has been recognized at the highest level in Vietnam through the Prime Minister's Decision No. 120/QD-TTg on Protection and Development of Coastal Forests to cope with climate change (see Annex I for full details). However, the coastal protection forest in Quang Binh today is almost exclusively plantations of introduced species - mainly Casuarina equisetifolia, and some acacia. While these trees provide some physical protection, air quality maintenance, climate buffering and fuel biomass services, these are not as effective as services from a natural ecosystem. The original coastal forests were more diverse and would have provided these services more effectively.

Figure 10.2: New plantation in Le Thuy, 2016

Despite ongoing efforts to stabilize the dunes through planting of casuarina and acacia, the problem of blowing sand and flowing sand that impacts infrastructure and settlements inland of the dunes is likely to continue and may get worse with climate change. The sparse coverage of casuarina coastal protection plantation forests is incapable of sufficiently protecting the area from wind and blowing sand.

Map 10.2: Sand-dune landscape in Le Thuy district

Ngu Thuy Bac Commune fishing villages:
Trung Hoa
Tan Thuan
Tan Hai

Cam Thuy Commune, blowing and flowing sand

Casuarinas nearer to the sea are exposed to strong wind and sea waves and are left with bare roots. Further inland many have a creeping form rather than growing as an upright tree. Both casuarinas and acacias are also vulnerable to storm damage and can be blown over by strong winds.

Figure 10.3: Poor quality casuarina forest in Quang Ninh

2.4. Coastal protection forest, groundwater and drought

Coastal protection forest is dependent on ground water supply that may largely be determined by the sand dune ecosystem and vegetation cover within the landscape. Climate change is likely to bring hotter dry season temperatures and longer and drier dry seasons. Reduced rainfall in the dry season coupled with high evaporation (960 - 1,200mm p.a.) and transpiration caused by higher temperature, increases the risk of drought - especially on sandy soils where temperature increases quickly and soil water retention is poor. Reduction in soil water availability and a decline in the water table can lead to the death of casuarina and acacia trees - even large mature trees if the roots cannot penetrate deeply enough to find water. In addition, there is a growing annual water demand for sand-based aquaculture. On average, each hectare of aquaculture land would need 30,000m^3 freshwater every year. Thus, some 9,000,000m^3 would be needed for 300ha by 2020. The main water sources for sand- based shrimp farming come from local ground water.

Although both casuarina and acacia are tolerant of high temperatures, the risk of forest fire will be increased with climate change. On the other hand, higher intensity rainfall events in the rainy season will also lead to increased erosion.

Figure 10.4: Forest fire in Bao Ninh commune, 2015

2.5. Advantages of natural (native species) Coastal Forest

In coastal areas where there are still remnant patches of natural forest including melaleuca forest and other types, it can clearly be seen that the diverse multi-layered, multi-species vegetation provides better physical protection from winds and storms, and together with the more abundant ground cover vegetation that occurs in these forests, is much better at stabilizing movement of sand. Soil formation under these natural forests is much better than under casuarina plantings. These forests also provide more ecosystem service benefits to local communities including firewood, edible plants and medicinal plants (casuarina only provides firewood), and have much greater biodiversity "co-benefits" Finally, natural forests are more effective at reducing erosion and filtering and reducing land-based water pollution flowing into the sea, as well as maintaining the ground water supply.

Figure 10.5: Melaleuca forest in Vinh Son village, Quang Dong commune

3. OVERALL DESCRIPTION AND RATIONALE OF THE PROJECT

To increase resilience of coastal communities and the landscapes they inhabit, in the face of increasing climate hazards from storms and strong winds, sea-level rise, and dry season drought, the project intends to improve protection and management of remaining natural costal forests, and embark on a new programme of restoring sand-dune and other coastal landscapes by large-scale replanting of native species. The project will start with a concerted campaign to increase awareness and understanding of the value and importance of native species in sandy areas - amongst communities, commune officials, district officials and provincial line agencies including DONRE, DARD, DPI, etc. All remaining patches of native coastal vegetation will be identified and mapped through surveys, after which the project will facilitate consultation and dialogue processes between the PFMB and local communities to establish workable models of co-management systems. The project will support the establishment of nurseries to produce seedlings of native species, and will provide skills training in nursery management, care of native species, ecological planting techniques, etc. At least three pilot areas will be identified and replanted with native species. The key agencies for implementation will be Hue University, DONRE, DARD and FPMB.

4. OBJECTIVES

Overall Objective:

Management and restoration of native species coastal forests in Quang Binh Province improves physical protection against storms, sea-level rise, coastal erosion, blowing sand, and flowing sand, as well as enhancing soil quality ground water condition, for the benefit of local livelihoods and the provincial economy.

4.1. *Specific objective 1:* Awareness and understanding of the value and importance of natural species coastal forest is noticeably improved at community, commune, district and provincial level.

4.2. *Specific objective 2:* All areas of remaining natural forest are identified and mapped and co-management arrangements established between Forest Protection Management Boards (FPMB) and local communities in at least 3 pilot areas.

4.3. *Specific objective 3:* Native species propagated in local nurseries are used for successful planting of coastal protection forests in at least 3 pilot areas identified for restoration.

5. METHODS

5.1. *Methods for objective 1:* Preparation and publication of manual/hand-book, on 250+ native species of sandy areas; awareness raising campaign; training workshops.

5.2. *Methods for objective 2:* Google Earth + ground-truth surveys/on the ground mapping. Key informant discussions; community dialogue and participatory workshops to agree on the co-management mechanism, election of village committee, etc.

5.3. *Methods for objective 3:* Feasibility studies to identify areas suitable for tree planting with native species; construction of nurseries; training in propagation, care, planting, and follow-up care; monitoring of survival and evaluation of success.

6. EXPECTED OUTPUTS (DELIVERABLES)

6.1. Outputs for objective 1

- Set of awareness-raising/campaigning materials.
- Training curricula for different target groups (commune officials, PFMB, DARD, PPC, etc.
- Pre-test/post-test instruments for assessing awareness and understanding of the importance and value of native species before and after training.
- Manual/hand-book on native species of sandy areas.
- Study visit programme and study visit reports.

6.2. Output for objective 2

- Digital and hard copy maps of all remaining areas of natural coastal forest types in the province.
- Reports of community consultation and dialogues around the establishment of co-management arrangements.
- Co-management agreements between PFMB and local communities signed and approved for at least three pilot areas.
- 6 monthly monitoring and annual evaluation reports prepared on the effectiveness of implementation of co-management arrangements.

6.3. Outputs for objective 3

- Report on restoration feasibility assessment, identification of pilot sites and recommended species to be used.
- At least three community nurseries established and producing the required types and numbers of seedlings after appropriate training has been provided.
- At least 3 pilot areas planted with native species, with appropriate post-planting care provided, and achieving acceptable survival rates.
- Monitoring and evaluation reports produced.

7. DETAILED ACTIVITIES, RESPONSIBILITIES AND ESTIMATED BUDGET (TO BE COMPLETED DURING FEASIBILITY STUDY)

No.	Activities	Time Frame	Budget	Deliverable	Responsible Lead/Other
1	Activities for Objective 1				
1.1.				Sets of awareness raising materials distributed to 18 communes, 6 districts and at the provincial level (PPC, DPI, DONRE, DARD, PFMB)	Hue Univ./DONRE
1.2				Set of training curricula	Hue Univ./DONRE
1.3				Training delivered to different groups, and pre-test/post-test training reports	Hue Univ./DONRE
1.4				Manual/hand-book on native species of sandy areas	Hue Univ./DONRE/DARD
1.5				Study Visit reports	DARD
2	Activities for Objective 2				
2.2				Digital and hard copy maps of remaining natural sandy area forest	Hue Univ./DARD
2.2				Reports of community consultations and dialogues	Hue Univ./PFMB
2.3				Three approved co-management agreements	PFMB
2.4				Co-management implementation monitoring and evaluation reports	Hue Univ./PFMB
3	Activities for Objective 3				
3.1				Feasibility Assessment Report and identification of 3 pilot sites	Hue Univ./PFMB
3.2				Three native species nurseries established	Hue University/PFMB
3.3				Planting carried out in three areas	PFMB
3.4				Monitoring and evaluation reports on success of planting	Hue University/PFMB

PM Decision No. 120/QD-TTg on Protection and development of Coastal Forests to cope with climate change

THE PRIME MINISTER -------	SOCIALIST REPUBLIC OF VIETNAM Independence - Freedom - Happiness ---------------
No. 120/QĐ-TTg	*Hanoi, January 22, 2015*

DECISION

APPROVING THE PROJECT ON PROTECTION AND DEVELOPMENT OF COASTAL FORESTS TO COPE WITH CLIMATE CHANGE IN 2015-2020 PERIOD

THE PRIME MINISTER

- *Pursuant to the Law on Government organization dated December 25, 2001;*
- *Pursuant to the Law on Protection and Development of Forests dated December 03, 2004;*
- *Pursuant to Resolution No. 24-NQ-TW of the 7th Conference of the 11th Central Party Committee on proactive responses to climate change, enhancing natural resource management and environmental protection;*
- *Pursuant to the Prime Minister's Decision No. 18/2007/QĐ-TTg dated February 05, 2007 approving strategy for forestry development in 2006 - 2020 period;*
- *Pursuant to the Prime Minister's Decision No. 57/QĐ-TTg dated January 09, 2012 approving plan for protection and development of forests in 2011 - 2020 period;*
- *Pursuant to the Prime Minister's Decision No. 1474/QĐ-TTg dated October 05, 2012 approving national action plan for climate change in 2012 - 2020 period;*
- *At the request of the Minister of Agriculture and Rural Development*

HEREBY DECIDE:

Article 1. Approve "The project on protection and development of coastal forests to cope with climate change in 2014 - 2020 period" (hereinafter referred to as the Project) as follows:

1. Viewpoints

- Management, protection and development of coastal forests are key and urgent tasks for preventing and fighting natural disasters, coping with climate change and rising sea in accordance with forestry development strategy in 2006 - 2020 period, ensuring sustainable development, harmonizing interests of the country with localities, organizations and individuals that take part in the management, protection and development of forests, and at the same time satisfying Vietnam's commitments to environmental protection and coping with climate change as a signatory of the Convention and International Agreement;
- The State shall prioritize allocation of resources from state budget in combination with other investment capitals, mobilization of social resources for the protection and development of coastal forests;
- The State shall create beneficial mechanism and policies to attract economic sectors, households and residential communities to take part in the investment in protection and development of coastal forests.

2. Objectives

a. General objectives

Promote protection function of coastal forests to cope with climate change and rising sea, alleviate natural disasters, protect sea dykes, infrastructure, conserve biodiversity; make a contribution toward socio-economic development and reinforcement of national defence and security;

b. Particular objectives

- Protect existing coastal forests with an area of 310,695 ha;
- Develop 46,058 ha to increase total area of coastal forests to the year 2020 up to 356,753 ha with coverage from 16.9% (in 2014) to 19.5% to the year 2020

3. Contents of the Project

a. Protect existing coastal forests with an area of 310,695 ha;
b. Restore 9,602 ha of poor quality forests;
c. Develop 46,058 ha, of which:

- 37,008 ha as protective forests and specialized forests that are comprised of 29,500 ha as mangrove forest and 7,508 ha as wind and sand break forests;

- 9,050 ha as production and protective forests;

d. Coastal dispersed forests: 23.5 million trees

4. Demands for capital and capital sources

a. Demand for capital

- Total demand for capital for the implementation of the Project in 2014 – 2020 is VND 5,415 billion (VND 902.5 billion per year on average), of which:
  + Forest protection on a contractual basis: VND 412, 7 billion;
  + Forest restoration: VND 288.1 billion
  + Forest restoration: VND 288.1 billion
  + Scattered trees: VND 235 billion
  + Others: VND 1,292.4 billion
- Allocated from sources as follows:
  + State budget: VND 3,791.3 billion (70%)
  + ODA capital: VND 1,397.5 billion (25.8%)
  + Other legal sources: VND 226.2 billion (4.2%)

b. Capital sources:

- State budget: The plan for protection and development of forests in 2011 - 2020 period under the Prime Minister's Decision No. 57/QĐ-TTg dated January 09, 2012; National target program for climate change in 2012 – 2015 period under the Prime Minister's Decision No. 1183/QĐ-TTg dated August 30, 2012; the supporting program for coping with climate change (SP – RCC); Target program for coping with climate change in 2016 - 2020 period;
- Investment program for reinforcement, protection and upgrading of sea dikes under the Prime Minister's Decision No. 58/2006/QĐ-TTg dated March 14, 2006 and Decision No. 667/QĐ-TTg dated May 27, 2009

c. ODA capital

d. Other legal sources: receipts from forest environmental services; budget for planting alternative forests by organizations specializing in changing forest use purposes; investment capital from organizations, households and individuals

5. Investment projects for protection and development of forests in 2011 – 2020 period

- Plan for protection and development of forests in 2011 – 2020 period: 44 projects;
- National target program and supporting program for coping with climate change: 50 projects;
- Program for reinforcement, protection and upgrading of sea dikes: 37 projects;
- International cooperation projects: 14 projects;
- Projects from other capital sources: Projects on forestation for replacement and production by organizations and individuals;

Expected area for prioritized forestation projects: 55,660 ha; Of which:

- New development: 46,058 ha;
- Restoration: 9,602 ha;

(List of investment projects with capital sources mentioned in Appendices I, II, II, III, IV and V)

6. Implementation solutions

a. Land:

- Planning for protection and development of coastal forests must be associated with planning for land use to the year 2020, ensure long-term stability and defined on the map and in the field; conversion of use purposes for forests and coastal forest land into other purposes must be tightly controlled;
- Checking and recovering areas of land within sea dike protection corridors or within forestry development planning that are illegally used or used with wrong purposes by organizations and individuals;
- Step up assigning the task of forest protection on a contractual basis to economic sectors, communities and households for the protection and development of coastal forests;
- Encourage forms of association with residents such as land lease, contribution of capital by land use rights for forest development under the planning in combination with aquaculture and forestry combined and ecotourism

b. Investment mechanism

- Investment budget for protection and development of coastal forest is used in combination with other sources; Of which, central budget is only reserved for coastal provinces yet to be able to balance budgets; Other provinces and cities that are able to balance their budgets shall be responsible for allocating budgets from local budget, mobilizing international assistance, credit loans and other sources for the implementation of the tasks as prescribed in the Project;

- Level of investment in protection and development of coastal forests
  + Level of investment in zoning for forest regeneration and protection of protective and specialized forests on a contractual basis shall be 1.5 times the contracted job for protection of headwater forests as prescribed. Specific piece work shall be decided by People's committees of provinces in accordance with actual circumstances of the locality;
  + Level of investment in new development, addition and restoration of protective and specialized coastal forests shall follow the design and cost estimates approved by competent agencies on the basis of current economic and technical norms in accordance with specific implementation conditions of each locality;
  + Other investment items (biodiversity conservation; tallying and monitoring coastal forest developments; scientific research; planting scattered trees; propaganda and education...) shall be implemented according to projects and plants approved by competent authorities.

c. Science and technology

- Determine types of trees suitable for regional and local conditions; formulate technical regulations and standards for development and restoration of wind and sand break forests; develop breakwater mangrove forests and solutions for fighting erosion at estuaries and along the coasts;
- Develop general, sustainable and effective cultivation models (forestry, aquaculture, forestry and agriculture combined) to replace low-productive extensive farming models; develop and make appropriate use of non-woody forest products associated with protection and development of coastal forests;
- Study technological solutions to enhance quality of coastal forests, ensure forest formation, cope with pests and forest fire;
- Construct the system of monitoring and determining the amount of carbon, coastal forest ecology services to mobilize receipts serving sustainable development of forests;
- Apply advanced remote sensing technology, geographic information system, information technology to management, prediction, assessment and monitoring of coastal forest development and natural disasters;

d. Propaganda, education and enhancement of capacity

- Intensify propaganda, education and enhancement of awareness of people from all social strata about role and function of coastal forests as well as responsibilities of organizations and individuals for protection and development of coastal forests; Intensify expansion of forestry, fishery and agriculture;

e. Mechanism and policies

- Carry out a study and formulation of beneficial mechanism and policies on coastal forests to encourage all social strata to take part in the protection and development of coastal forests making a contribution toward accomplishing objectives and tasks of the Project

7. Implementation

a. Ministries or central agencies:

- The Minister of Agriculture and Rural Development:
  + As a permanent agency for the Project, shall preside over and cooperate with ministries, agencies and coastal provinces in implementing the Project successfully;
  + Preside over and cooperate with ministries and sectors in the examination and assessment of investment projects for protection and development of coastal forests in localities;
  + Carry out a study and formulation of policies on management, protection and development of coastal forests, make the submission to the Prime Minister for approval;
  + Inspect, supervise and speed up the implementation of the Project; play a role as a central agency in compilation of performance results and make the report to the Prime Minister;
  + Promulgate technical instructions regarding management, protection and development of coastal forests;
  + Preside over and cooperate with ministries, sectors and localities in running the check over the list of projects prioritized for protection and development of coastal forests for allocation of investment capital in annual programs and plans and the entire 2015 - 2020 period;

For difficulties that arise during the implementation of the Project, the Ministry of Agriculture and Rural Development shall preside over and cooperate with relevant ministries and sectors in handling issues within competence or make the report to the Prime Minister on ultra vires issues;

- The Ministry of Planning and Investment
  + Preside over and cooperate with the Ministry of Finance and the Ministry of Agriculture and Rural Development in balancing capital demands for the implementation of the Project;
  + Cooperate with the Ministry of Agriculture and Rural Development in bringing projects on protection and development of coastal forests into the list of projects prioritized to use international assistance and loans (WB, ADB, KfW,...);

  + Cooperate with the Ministry of Agriculture and Rural Development in carrying out the inspection, supervision and speeding up the implementation of the Project;
- The Ministry of Finance:
  + Preside over and cooperate with the Ministry of Planning and Investment, the Ministry of Agriculture and Rural Development in guaranteeing non-business capital sources for forest regeneration zoning, forest protection on a contractual basis, scientific research and monitoring development of coastal forests under this Project;
  + Instruct and manage use of capital sources for the implementation of the Project within functions and duties and applicable regulations;
- The Ministry of Natural Resources and Environment:
  + Cooperate with the Ministry of Agriculture and Rural Development and localities in running the check over the list of projects related to protection and development of coastal forests by capital sources for climate change and making the report to the Ministry of Planning and Investment, the Ministry of Finance for compilation and submission to the Prime Minister;
  + Cooperate with localities in directing and checking planning and plans for coastal land use, ensuring long-term stability and purposeful use; providing guidance to localities on inspection and recovery of lands within dike protection corridors, lands under coastal forest development planning that are illegally used, unproductively developed or wrongly used by organizations and individuals...for restoration of forests;
- Other ministries and sectors shall carry out the implementation of the tasks as prescribed in the Project within assigned functions and duties.

b. People’s committees of coastal provinces:

- Direct the formulation of the province’s planning and plans for protection and development of coastal forests in 2015 - 2020 period and a vision to 2030;
- Direct, check and formulate investment projects on protection and development of coastal forests by capital sources, make the submission to the Ministry of Agriculture and Rural Development for examination and verification before approval;

c. Direct and check the planning and plans for land use; be determined to recover areas of land within dike protection corridors, areas of land under coastal land development planning invaded, illegally used, wrongly and unproductively developed by organizations and individuals for the restoration of forests as prescribed;

d. Organize the implementation, inspection and monitoring of approved projects on protection and development of coastal forests; make annual reports on performance result to the Ministry of Agriculture and Rural Development for compilation and submission to the Prime Minister;

e. Direct propaganda, education and enhancement of awareness of people from all social strata about role and function of coastal forests; mobilize people and economic sectors to actively participate in the protection and development of coastal forests to cope with climate change; organize management and protection of coastal forests under applicable regulations

Article 2. This Decision takes effect since the signing date.

Article 3. Ministers, heads of ministerial-level agencies, heads of governmental agencies, presidents of People’s committees of central-affiliated cities and provinces shall be responsible for executing this Decision./.

PP THE MINISTER
DEPUTY MINISTER

Hoang Trung Hai
