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:

iponre 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 3

HA TINH PROVINCIAL LEVEL VULNERABILITY ASSESSMENT FOR ECOYSTEM-BASED ADAPTATION

icem A study by ICEM

IMPRINT

Published by

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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

ABREVIATIONS

ADB	Asian Development Bank
ARCC	Ares Capital Corporation
CVCA	Climate Vulnerability and Capacity Assessment
CCA	Climate Change Adaptation
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CBD	Convention on Biological Diversity
CAM	Climate Change Adaption and Mitigation Methodology
CREATE	Climate Resilience Evaluation for Adaptation through Empowerment
CRiSTAL	Community-based Risk Screening tool-Adaptation and Livelihoods
EURAC	European Academy of Bozen/Bolzano
EbA	Ecosystem-based Adaptation
GIZ	Gesellschaft fur Internationale Zusammenarbeit
ISPONRE	Institute of Strategy and Policy on Natural Resources and Environment
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IISD	International Institute for Sustainable Development
ICEM	International Centre for Environmental Management
KEA	Key Economic Asset
LMB	Lower Mekong Basin
MRC	Mekong River Commission
SEZ	Special Economic Zone
PES	Payment for Environmental Service
PLI	Promoting Local Innovation
PRA	Participatory rural appraisal
PROVIA	Programme of Research on Climate Change Vulnerability, Impacts & Adaptation
SES	Socio-Ecological System
TOR	Term of Reference
TESSA	Tools for Eco-system Services site-based Assessment
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
UKCIP	United Kingdom Climate Impacts Programme
VA	Vulnerability Assessment
VASES	Vulnerability Assessment for Socio-Ecological System
WWF	World Wild Fund for Nature

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CHAPTER 1 INTRODUCTION

1.1 Background and objectives of the Vulnerabitity Assessment

This report presents part of the results of a Vulnerability Assessment (VA) of Ha Tinh 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 a selected site in Ha Tinh province. Similar provincial and local VAs were also conducted in Quang Binh province by the same team. The two VA s of Ha Tinh (together with the two VAs of Quang Binh) together form one set of activities in the overall GIZ project "Mainstreaming EbA in Climate Change Adaptation in Vietnam"

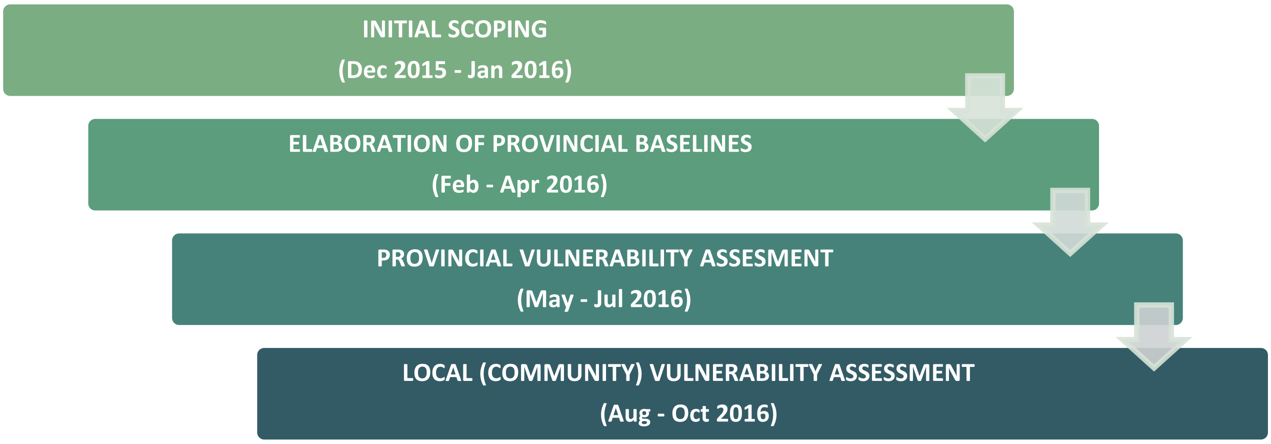
The main objectives of the vulnerability assessment were to analyse all components of vulnerability (exposure, sensitivity, and adaptive capacity); to provide data and recommendations for decision-making on introducing the EbA concept into provincial policies and planning processes; and to provide recommendations 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 debriefing meetings with DONRE in Ha Tinh on 23rd December, after the first field visit to the province, 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 other adaptation measures. 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 Ha Tinh Province through review of available literature, and meetings with a wide range of local authorities as well as some very preliminary site visits. The team conducted the scoping visit to Ha Tinh from 19 - 23 December 2015.

Five days were spent in the province, three days meeting with key government agencies1 and two days making field visits to important ecosystems. In Ha Tinh, the Vung Anh industrial zone was seen from a distance and visits were made to vegetable growers and restored mangroves around Ha Tinh, and to the Vu Quang National Park

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

and to the construction site of new dam that will flood 3,000 ha of it. The full itinerary and 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.

In particular, in the scoping part of the VA process, the team focused on

a) 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.

b) 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.

c) 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; for the province (Chapters 2, 3, 4 of this report). Based on these, a complete list of SESs is identified and an SES profile is also developed (Chapter 5 of this report). The climate profile (Chapter 6) provides the final part of the baseline.

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 Ha Tinh (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 Ha Tinh - 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 Ha Tinh, 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 Ha Tinh, 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 Ha Tinh 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 Ha Tinh. This Chapter presents the methods and outcomes of the work on Socio-Ecological System (SES) carried out involving four main steps

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

Chapter 6 - Climate profile

This chapter provides information on the current climate of Ha Tinh, 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 6 provided an overview of the climate of Ha Tinh and the history of climate-related disasters in the province, Chapter 7 now looks at likely future climate changes and their potential impact on Ha Tinh 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 Ha Tinh. 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 HA TINH PROVINCE, DECEMBER, 2015

19-Dec-15 (afternoon) People's Committee of Thach Lien commune, Thach Ha District	Nguyen Van Binh	President of Thach Lien Commune, Thach Ha District
	Pham Huy Luan	Vice President of Thach Lien Commune
	Nguyen Dinh Cung	Farmer Association of Thach Lien Commune
	Vuong Kha Xuan	Farmer
	Mrs. Hanh	Farmer
20-Dec-15 Vu Quang NP	Mr. Anh	Technical Department, Vu Quang National Park
21-Dec-15 (morning) Ha Tinh PPC, DONRE	Phan Lam Son	Deputy Director, Ha Tinh DONRE
	Nguyen Trong Hiep	Ha Tinh DONRE
	Nguyen Manh Ha	Ethnic Office, Office of Ha Tinh People's Committee
	Tran Van Hung	Ha Tinh DARA
	Bui Duc Dai	Vice Director of Ha Tinh Transport Depatment
	Nguyen Cao Quy	Ha Tinh DOLISA
	Pham Van Tuong	Ha Tinh DOC
	Dang Huu Binh	Ha Tinh DONRE
	Mr. Long	Ha Tinh DPI
	Tran Duy Hanh	Ha Tinh DOLISA
21-Dec-15 (Afternoon) Ha Tinh DPI	Hoang Duc Son	Vice Director of Ha Tinh DPI
	Mr. Long	Head of Economic Office, Ha Tinh DPI
	Mr. Ha	Economic Office, Ha Tinh DPI
22-Dec-15 PPC office	Nguyen Dinh Tuan	Head of Ethenic Office, Office of Ha Tinh People's Committee
	Nguyen Manh Ha	Deputy Head of Ethenic Office, Office of Ha Tinh People's Committee
22/12/2015 Ha Tinh DOT	Bui Duc Dai	Vice Director of Ha Tinh DOT
	Tran The Hung	Transport Management Office, Ha Tinh DOT
	Ho Thanh Binh	Vice Director of Transport PMU
	Tran Xuan Hung	Transport PMU
	Nguyen Nhu Hieu	Transport PMU
	Nguyen Cao Quy	Deputy Head of Office, Ha Tinh DOT
22-Dec-15 (Afternoon) Ha Tinh DARD	Le Xuan Nam	Head of Planning Office, Ha Tinh DADR
	Bui Le Bac	Sub Dyke Department
	Ngo Duc Hoi	Sub Irrigation Deparment
	Nguyen Cong To	Sub Forestry Department
	Mr. Hung	Sub Veterinary Department
	Mr. Phong	Sub Plant Protection Department
	Nguyen Xuan Linh	Sub Forestry Protection Department
	Cu Thanh Hai	Sub Forestry Department
23-Dec-15 Ha Tinh DOC	Pham Van Tinh	Vice Director of Ha Tinh DOC
23-Dec-15 Ha Tinh DoIC	Nguyen Hien Luong	Vice Director of Ha Tinh DOIC
	Le Duc Hai	Deputy Head of Enterprise Management Office
	Pham Thi Que	Deputy Head of Commercial Office
	Le Duc Hung	Power Management Office
	Nguyen Khac Hung	Head of Environmental Safety Technique Dept
23-Dec-15 (Afternoon) Ha Tinh DOLISA	Nguyen Xuan Thong	Vice Director of Ha Tinh DOLISA
	Le Thi Thuy Nhan	Deputy Head of Social Protection Office
	Tran Duy An	Social Protection Office
	Mr. Nam	Social Protection Office

ANNEX 1.II: SEMI-STRUCTURED QUESTIONNAIRE 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 (Primary – Agriculture, Forestry, Fishery and Mining; Secondary - Manufacturing industry, Construction, Energy, and Transport; Tertiary – Services and Tourism)

3.1. For 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. For 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

7.1. Governent

- 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 has 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.?)

7.2. 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 HA TINH FOR EBA

2.1. Introduction

Chapter 2 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 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 for Ha Tinh 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 processes that affect vulnerability

Local-level processes	Processes at higher levels
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

The present Chapter examines the social dimensions of EbA in Ha Tinh, including the contextual information at the Provincial level that any provincial department should keep in mind in analysing and planning for CCA or EbA. It also examines the key parameters used in this study to develop and describe the SES. Together with Chapters 3 and 4 on ecological and economic factors, this information will contribute to the identification and classification of the main SES for Ha Tinh. Like chapters 3 and 4, this social profile is based on existing data made available to the study by the different departments of the provincial government. Complete and recent population and poverty data were not available so the maps presented are out-of-date.

2.2. Key Social Factors for the Provincial-Scale Analysis 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 Ha Tinh. The provincial-level study is intended to use secondary data only, and 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 at this level. Other factors will be examined at the local-level assessment of actual local vulnerability and adaptive capacity, supported by primary data collection where necessary, as shown in Table 2.2. 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 2.2: Social analysis at the provincial- and local-levels of assessment

Provincial-level assessment	Local-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:

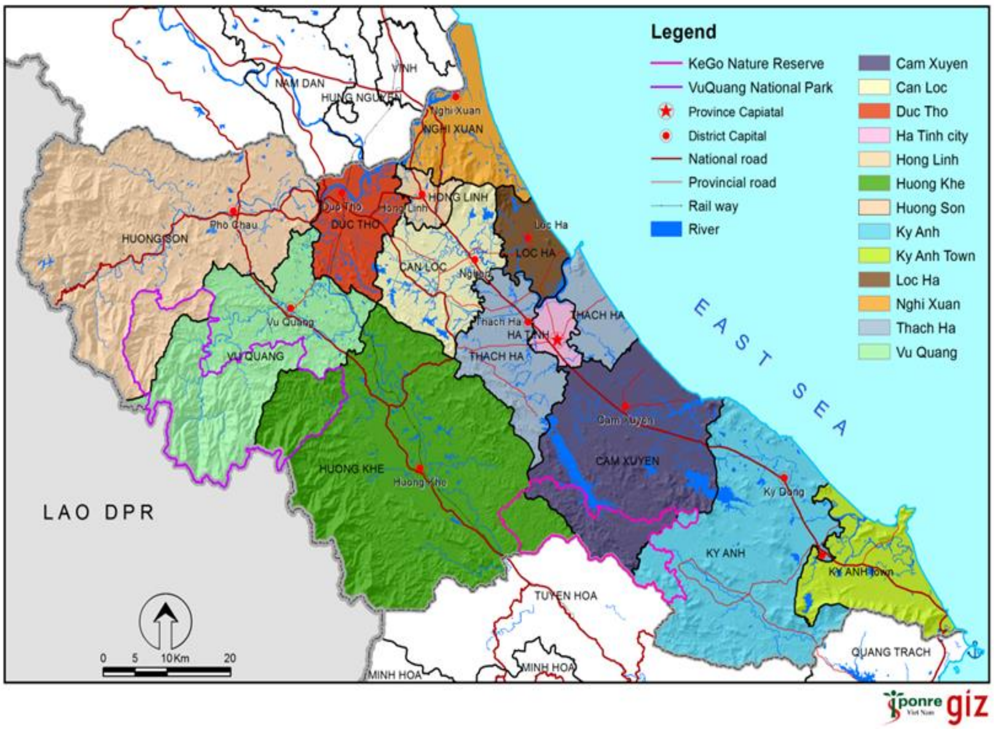
- Now, and in the future, how many people in Quang Binh will be affected by climate change?
  - Where do they live?
  - What are the trends in population? What factors contribute to this?
- Which social groups will be most vulnerable to climate change? Where do they live?
- Which livelihoods are most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

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

2.2.2. Administration and Governance

Ha Tinh Province comprises one city, two urban districts (towns), 10 rural districts, and a total of 262 communes. In 2015, Ky Anh town was elevated to an urban district, but does not yet appear in official statistics. Map 2.1 shows these districts and their administrative centres.

Figure 2.1: Administrative Units of Ha Tinh province



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 262 communes across the 10 district-level units. There are between 12 and 32 communes under each district, and between around 2500 and 6250 people in each commune. The montane commune authorities are responsible for fewer people, but as shown in the next section, settlements are spread out across a larger area and generally harder to access.

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.

2.1.3.1. Current Situation

The last census in 2009 recorded a total population for Ha Tinh of 1,223 million people and by 2013 this was estimated to have grown to 1,261 million. Ha Tinh is thus the 25th most populous province in Vietnam, accounting for 1.4% of the total population (2015 estimate[2]. As will be discussed in more detail in the Economic Profile, Ha Tinh is one of the poorest provinces in Vietnam.

[2] https://www.citypopulation.de/Vietnam.html

Table 2.3: Population-related statistics for the districts of Ha Tinh, 2013

Name of city/district	Area		No. communes	Population			
	hectares	%		Total	%	persons/km²	persons/ commune
Total	599,782	100	262	1,249,100	100	208	4768
Urban Areas							
Ha Tinh city	5663	0.9	16	95,060	7.6	1678	5941
Hong Linh town	5855	1.0	6	37,720	3.0	644	6287
Rural Districts							
Huong Son	110,415	18.4	32	115,910	9.3	105	3622
Duc Tho	20,249	3.4	28	104,750	8.4	517	3741
Vu Quang	63,821	10.6	12	29,760	2.4	47	2480
Nghi Xuan	22,004	3.7	19	97,290	7.8	442	5121
Can Loc	30,248	5.0	23	130,030	10.4	430	5653
Huong Khe	126,350	21.1	22	102,000	8.2	81	4636
Thach Ha	35,443	5.9	31	131,560	10.5	371	4244
Cam Xuyen	63,928	10.7	27	142,300	11.4	223	5270
Ky Anh*	104,143	17.4	33	181,380	14.5	174	5496
Loc Ha	11,663	1.9	13	81,350	6.5	698	6258

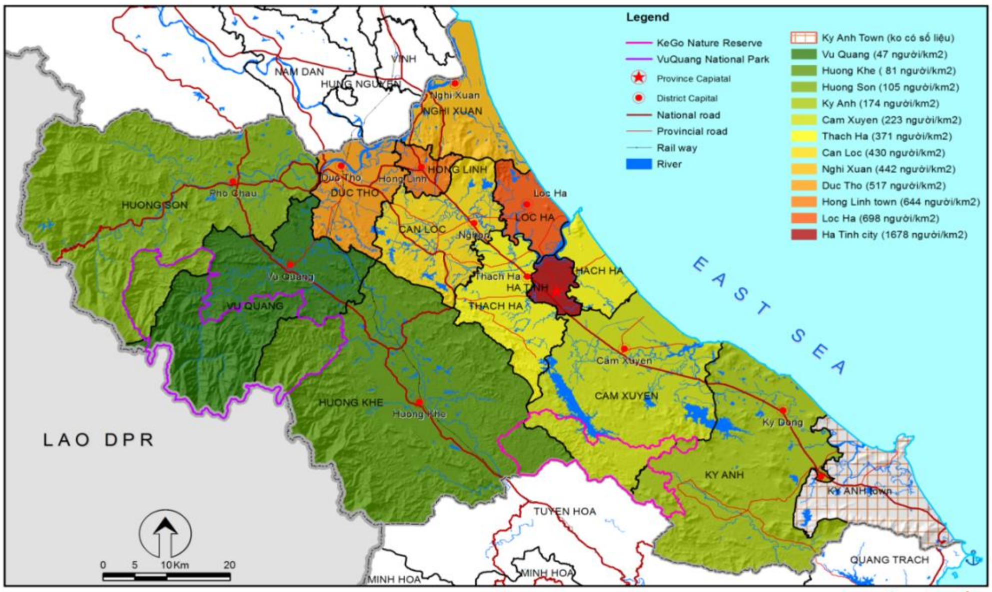
** now elevated to town status, distribution between town and district not available*

Source: Ha Tinh Statistical Yearbook 2014

The overall population density is 208 persons/km^2, but Table 2.3, and more graphically Maps 2.2 and 2.3 show that there are very distinct patterns in population distribution, which have implications for climate change adaptation, as they have for many other dimensions of development and governance.

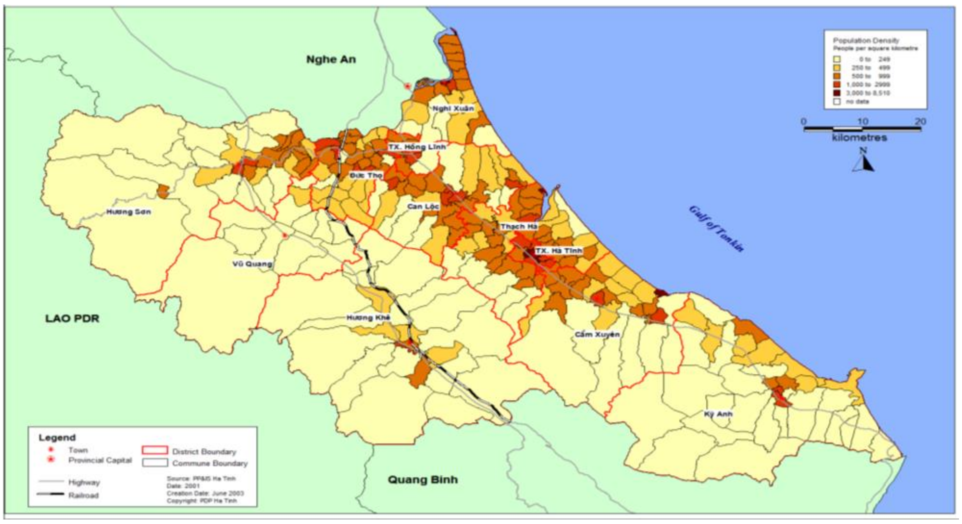
It is well known that the majority of Ha Tinh's population (~ 80%) is concentrated in lowland areas, broadly mirroring the distribution of paddy rice cultivation areas, the location of the provincial capital and the route of the main national road 1A. District population densities here range from nearly 170 persons/km^2 in the provincial capital to 50-80 persons/km^2 in the least dense rural districts. Arguably, this lowland population is most exposed to some of the most extreme climatic events - tropical storms, tidal surges, saline intrusion.

Figure 2.2: District population density, Ha Tinh, 2015



Maps 2.3 (commune level population density) and Map 2.4 (urban and rural settlement pattern) show that other concentrations of population are found in the broad upland valley of Ngan Sau River, which is also the corridor for the national railway, and the inland valley of the Ngan Pho River in the north of the province, in the road corridor to Laos.

Figure 2.3: Population density of Ha Tinh, by commune, 2001



The large number of small densely populated communes in the lowlands contrasts with the large sparsely populated districts in the upland areas. In Huong Khe district, the average population density is less than 50 persons/km^2. Of course, this reflects the large area of uninhabited forest in the upland districts. Settlements here may still be quite concentrated in river valleys or other transport routes. While in many other provinces, these montane districts are typically populated by ethnic minorities, in Ha Tinh, over 98% of the population is Kinh (see below). The people inhabiting the narrow inland valleys are subject to flash flooding and cold snaps, and on the mountain slopes to landslides, drought, high temperatures and hot winds from Laos.

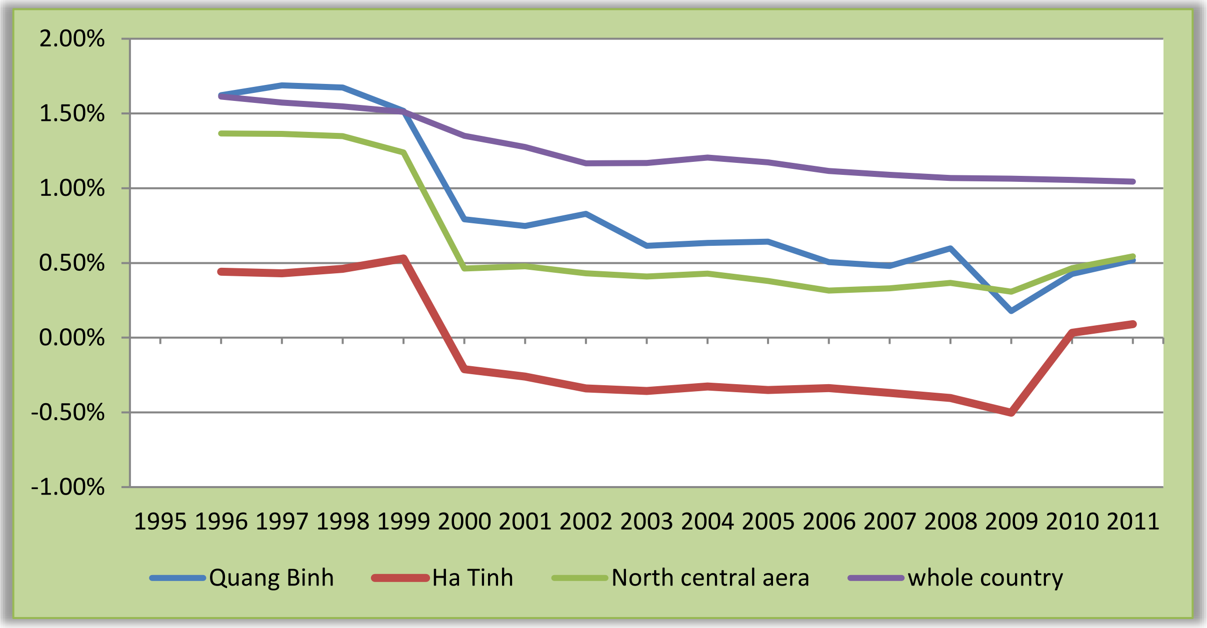
The two urban districts, Ha Tinh and Hong Linh, account for 7.6% and 3% of the total population respectively. Overall, about 16 % of the provincial population is urban, including the district headquarters and 84% rural (Statistics Office, Ha Tinh, 2015).

2.1.3.2. Population trends

The population of Ha Tinh has fluctuated over the last 15 years. Between 2000 and 2010, the population actually dropped from 1.273 million to 1,223 million (-0.36 %), largely due to labour migration to other provinces in Vietnam and abroad (Figure 2.1). Discounting migration during this period, the population was estimated to have grown at a rate of 0.8% pa.

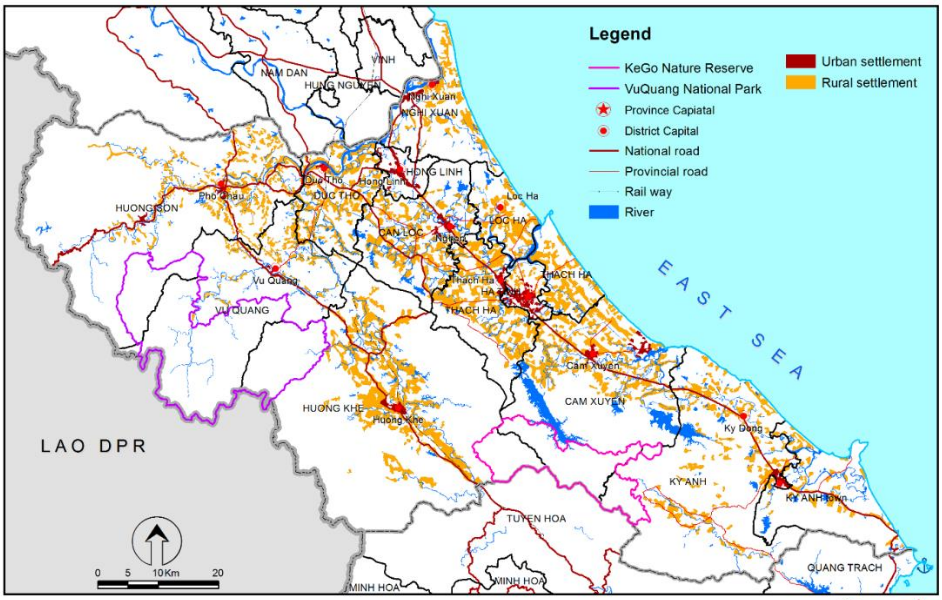
Between 2010 and 2013, the total population grew again to 1,249 million, largely due to the development of the Ky Anh industrial zone and continuing growth of Ha Tinh City, but this only equates to about 0.6% pa[3].

Figure 2.4: Annual population growth rates in Quang Binh, Ha Tinh, North Central region and Vietnam between 1995-2011



Source: GSO

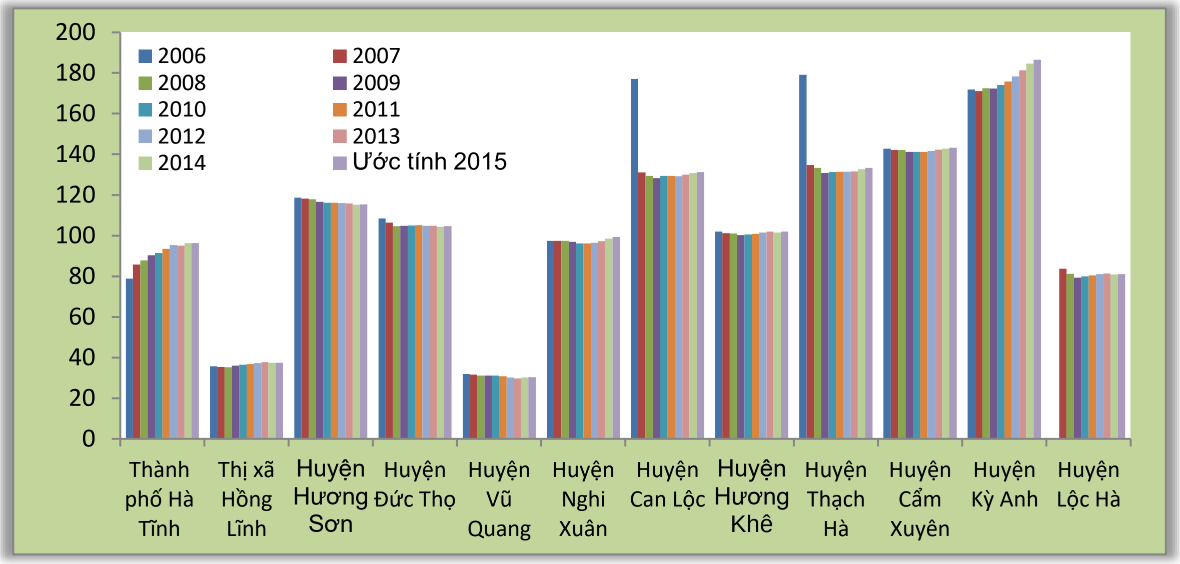
Figure 2.5: Rural and urban settlement pattern, Ha Tinh



[3] Figures for 2011, 2013 taken from General Statistics Office website. 0.42- 0.48% pa https://www.gso.gov.vn

Patterns of population growth vary across the province. The urban population grew by 21% between 2006 and 2014, while the rural population fell by 2% during the same period. In the last few years, it has been growing at 1.3% pa while the rural population, particularly in Vu Quang, Huong Son and Duc Tho, continues to decline (Figure 2.2).

Figure 2.6: Population growth rate in Ha Tinh, by district, 2006-2015



Source: Ha Tinh Socio-economic Development Report, 2006-2015

Ha Tinh has one of highest rates of labour migration in the country. Between 2001 and 2010 over 51,000 people migrated from the province for work, representing nearly 10% of the workforce. About 35,000 of these migrants participated in MOLISA's international cooperation programme for job creation through sponsored migration, which ran from 2001-2010. The remaining 16,000 are spontaneous migrants (DOLISA pers comm). In 2010, it was estimated that migrant remittances were equivalent to one-third of provincial export earnings. About half of migrants go to Ho Chi Minh City, Danang or Ha Noi, the other half going overseas to elsewhere in Asia (Malaysia, Taiwan, Korea and Japan) or Arab countries (Libya, Saudi Arabia, Qatar) (Figure 2.1). Over 80% of those migrating abroad came from five lowland districts: Ky Anh, Can Loc, Nghi Xuan, Cam Xuyen and Thach Ha (SEDP 2012). These districts are densely populated, but do not have the highest levels of poverty. There are no data on returning migrants or their subsequent employment and economic performance.

At the same time, the Vung Anh economic zone is attracting labour from other parts of Vietnam, and even foreign workers. Of the 40,000 jobs created, half are taken by workers from Ha Tinh, around 8000 by workers from Taiwan, China and Korea, and the rest from other parts of Vietnam. Many of the jobs are in construction and will end once the site has been developed.

At the same time, the Vung Anh economic zone is attracting labour from other parts of Vietnam, and even foreign workers. Of the 40,000 jobs created, half are taken by workers from Ha Tinh, around 8000 by workers from Taiwan, China and Korea, and the rest from other parts of Vietnam. Many of the jobs are in construction and will end once the site has been developed.

Thus, current population growth is not high enough to exert significant pressure on natural resources, but it is difficult to predict future scenarios, particularly over long time periods. Nevertheless, to accompany the climate change predictions used in this study (see Chapter 6), it can be noted that the current growth rate of approximately ~ 0.4% pa means the provincial population would increase to 1,336,811 by 2030, to 1,447,919 by 2050 and to 1,767,786 by 2100. More significantly, if the same geographic patterns of growth continue, most of this population growth is likely to be in the lowlands particularly urban areas, and at the expense of agricultural land.

2.2.4. Vulnerable groups

2.1.4.1. 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[4]. Poverty is multi-dimensional[5] and different aspects of poverty contribute to 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, Ha Tinh is amongst the poorer provinces in Vietnam, with 23.1% of the population counted as poor in 2010 compared to an average of 14.2% nationally, and 20.4% in the North Central region. Further, many more households are "near poor". In 2013, when 14.2% of households were "poor", a further 15.3% of households were "near poor" (2013). The resultant total of 29.5% is quite high - compared to the national total of 18%. Further, it is persistently high - while some households may escape absolute "poverty", fewer escapes "near poverty" and the near poor are at risk of falling back into poverty. It is widely accepted that extreme climatic events and climate change are exactly the kind of stressor that causes people to fall back into poverty, but provincial data demonstrating this, is lacking. Table 2.4 compares poor and near poor households over three years, showing how the number of poor households has declined significantly, while the near poor households have remained the same.

Reasons given for Ha Tinh's 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. The area faces severe storms, floods regularly, and experiences both cold spells in winter and periods of extreme heat in summer.

Table 2.4: Poor and near poor households in Ha Tinh, 2010-2013

Status	2011		2012		2013	
	No. of households	%	No. of households	%	No. of households	%
Poor	80180	23.9	54449	17.4	45767	14.2
Near poor	57521	16.5	57252	16.2	53547	15.3
TOTAL	137701	40.4	111701	33.6	99314	29.5

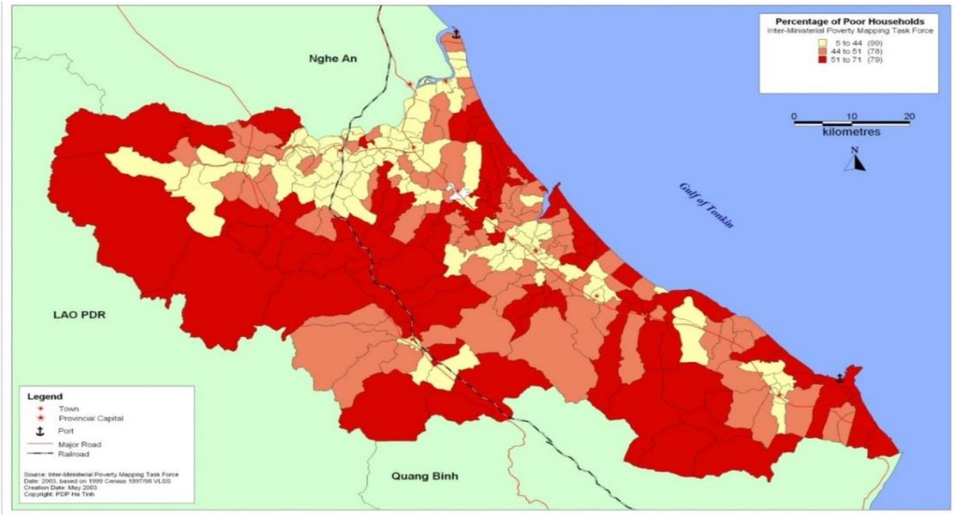
Source: National Target Program for sustainable poverty reduction 2013

In Ha Tinh, the poverty rate is highest in the mountain and immediate coastal districts, and lowest in the densely populated rice growing areas. Map 2.5 presents the best available data, but this is from 2003. However, the incidence of poverty remains highest in the lowlands, due to the density of the population.

[4] In Vietnam, 'poverty' has been 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).

[5] 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).

Figure 2.7: Poverty rate of communes in Ha Tinh (% poor households), 2003



Poverty is now primarily a phenomenon of remote rural areas - the inland districts of Huong Khe, Vu Quang and Huong Son. Ethnic minorities are said to experience the highest levels of poverty, but ethnic populations in Ha Tinh are low (see below) and provincial poverty data is not disaggregated to demonstrate this. It is also most prevalent amongst farmers and amongst fishing families (see below). 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 account is lacking.

The main reasons for household poverty in Ha Tinh are given as:

- Lack of 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

Unemployment rates are approximately 4% of the workforce (2010).

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

Poverty alleviation

The most recent data for poverty alleviation in Ha Tinh, shows the poverty rate decreasing from 23.9% in 2010, to 5.8% in 2015. The near poor rate declined from 17.6% to 8.9% in the same period. (DOLISA pers comm)

Poverty alleviation in Ha Tinh, as in the rest of 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).

All 7 ethnic minority communes in Ha Tinh have been included in P135, but despite big investments, the core problems of sustainable economic production have not been fixed (Ethnic Minority unit of PPC, pers comm).

Poverty alleviation in Ha Tinh is built around developing and promoting household economic models, with over 9000 models in operation. In Agriculture, Forestry and Fisheries, fifteen models have been developed, including six crop-based, eight livestock based and one for fish sauce. The PPC reports that the models have created over 500 jobs for the poor and lifted 488 households out of poverty. However, it is unclear whether climate change has been considered in the development of these models (Ha Tinh, PC 2016). The programme under Resolution 30a supports communities in Vu Quang and Huong Khe Districts.

Resolution 80/NQ-CP 2011 established the policy to accelerate poverty reduction in the poorest parts of the country, setting an annual poverty reduction target of 4% pa for 2011-2020, compared to the national target of 2%. The National Targeted Programme for Sustainable Poverty Reduction 2012-2015 (NTP-SPR) implements this policy to improve the well-being and livelihoods of the poor, particularly those in mountainous and ethnic minority areas.

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.

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 to certain impacts of climate change. Further studies are needed to understand the relationship between poverty alleviation and ecosystem-related climate change vulnerability at the provincial-scale.

2.1.4.2. Ethnic Minorities

The population of Ha Tinh is overwhelmingly of Kinh ethnicity; in 2015 only 0.16% of the total belonged to ethnic minority groups, amounting to 1972 individuals in 492 households. Table 2.5 presents all the population data available and shows the ethnic groups live in seven villages in seven communes in three districts: Huong Son, Huong Khe and Vu Quang, where they constitute 0.5%, 1.4% and 0.8% of their district populations respectively.

Table 2.5: Ethnic minority population of Ha Tinh, 2015

District	Commune	Village	Group[6]	Population			
				District	EM HH	EM Ind	% EM
Huong Son	Son Kim 1	Dai Kim	Dao		77	245	
	Son Kim 2	Thuong Kim	Dao		91	384	
				115,910	*168*	*629*	*0.5*
Huong Khe	Huong Trach	Soi Lim	Muong		125	476	
	Huong Lien	Rao Tre	Chut		34	137	
	Phu Gia	Phu Lam	Lao		61	256	
	Huong Vinh	Giang II	Chut		11	31	
				102,000	*231*		
Vu Quang	Huong Quang	Kim Quang	Lao	29,760	93	443	0.8
TOTAL	7	7	4		492	1972	

Source: Ethnic minority unit, Ha Tinh PPC, 2015.

In total there are 34 different minorities present in Ha Tinh, but only four of these "live in groups" and come to the attention of the Ethnic Minority Unit[7] of the PPC. The largest, the Muong, is a Vietic language speaking group closely related to and well-assimilated with the Kinh. They number over 1.2 million people nationally[8], but fewer than 500 Muong live in Ha Tinh, mostly in Huong Khe district. The Dao are a Hmong group, and have a substantial national population of over 700,000 people, but only 630 people in Ha Tinh, mostly in Huong Son district. The Lao belong to the Tai-Kadai language group; as the name suggests, their main population is in neighbouring Laos, but around 14,000 live in Vietnam. They represent the largest minority group in Ha Tinh, with some 700 people in Vu Quang and Huong Khe. All three of these groups are relatively well-assimilated with the Kinh, having good levels of education and higher engagement in commercial production and other enterprise (Ethnic Minority Unit, PPC, pers comm).

[6] Many minority groups are known by more than one name. The Dao, also known as the Yao or Mien, are called "Man" by the Kinh, and appear as such in some DOLISA reports.

[7] Ha Tinh PPC has only a small Ethnic Minority Unit, with three staff members, not the usual Sub-Committee for Ethnic Minority Affairs (SCEMA) that provinces with higher ethnic minority populations have.

[8] All these national population figures are taken from the 2009 census.

The fourth group, the Chut are also linguistically related to the Kinh, but nationally number only around 6,000 people and live more traditional ways of life, in relative isolation. About 170 people in 40 households live in two villages in Huong Khe district, close to the other main centre of Chut population in northern Quang Binh. About 40 years ago the Ha Tinh groups lived a semi-nomadic way of life in the mountain forests, practising shifting cultivation and forest product gathering, but have been resettled to permanent villages closer to commune centres and allocated land for cultivation. They still collect forest products, on request from buyers. They are the target of many different government programmes, including food subsidies. Despite these programmes, poverty amongst the Chut is said to remain at 100%. Subsidies are now being offered to Chut youth who marry with Kinh partners. This is seen as a way to break out of this poverty, but threatens the Chut's very identity.

2.1.4.3. Livelihoods 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, the family lacks alternatives to fall back on.

Specific studies on the relationship between livelihoods and poverty and thus vulnerability to climate change in Ha Tinh 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 Ha Tinh in the context of about 30 socio-ecological systems. The SES then provide the basis for assessing exposure, sensitivity and vulnerabilities across the province.

A comprehensive study of the labour market and employment in Ha Tinh is being conducted in 2016, but the data on employment and livelihoods available for the present study is limited (DOLISA pers comm). The workforce, defined as persons over 15 years of age[9], totalled 643,928 people or 52% of the population. Available information for 2009, breaks down the provincial workforce into three main areas. Obviously this obscures a lot of diversity important for understanding vulnerability to climate change. Over 56 % of the workforce was engaged in agriculture, forestry and fisheries, activities that are inherently vulnerable to climate events and change. The other main sectors are industry (including mining and processing and construction (13.8%) and 29% in "other fields". About 8% of the total workforce is employed in the state sector and all the rest in the private or household sectors, apart from 285 people employed in foreign companies. Over 60% of the workforce has no vocational training. Many of these will be in waged employment, and their livelihoods less vulnerable to climatic events and changes.

2.3. Conclusions

This chapter has assessed and mapped the key social data relating to climate change and ecosystem-based adaptation to it, at the provincial level Ha Tinh: population, vulnerable groups, poverty and livelihoods.

The densest populations in Ha Tinh are in the coastal lowlands. Here too are the largest numbers of poor people, who 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 Ha Tinh are the ethnic minorities living in the mountains. The poorest groups were resettled in the last few decades and remain in transition between their traditional livelihoods dependent on swidden cultivation and gathering forest products and more modern ways of life based on cash crops and commerce. 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. Their

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

populations are very small. While on one had this suggest they are not a high priority, on the other, not a lot of resources would be needed to address their particular climate change vulnerability.

The majority of the Ha Tinh workforce 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 local-level assessment and adaptation action would be the poor inshore fishing communities along the densely populated coast, rice farmers and the few ethnic minority villages. In the next chapter, this social perspective will be put together with the perspectives from ecology and economics to develop, describe and map Ha Tinh's socio-ecological systems and explore vulnerabilities in more detail.

2.4. References

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CHAPTER 3 ECOLOGICAL PROFILE OF HA TINH FOR VULNERABILITY ASSESSMENT AND EBA

3.1. Introduction

Report 1 in this series 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 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 the other ways they earn their livelihoods. 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.

Chapter 2 of this Ha Tinh Provincial Report focused the analysis on people, asking which groups are most vulnerable and why, based on an understanding of 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).

This Chapter 3 now focuses on the ecosystems of Ha Tinh, asking which types of ecosystem are present, how much of them is there, and what condition are they in. Which may be critical for supporting livelihoods and the economy in the face of climate change, and how are the ecosystems themselves vulnerable to climate change.

The present chapter examines the ecological dimensions of EbA in Ha Tinh, including the contextual information at the Provincial level that any provincial department should keep in mind in analysing and planning for CCA or EbA. It also examines the key parameters used in this study to develop and describe the Socio-Ecological Systems (SES). Chapter 2 (social factors); this chapter; and Chapter 4 (economic profile) are all brought together present a classification of the main SES for Ha Tinh in Chapter 5. As with Chapters 2 and 4, this ecological profile is based on existing data made available to the study by the different departments of the provincial government, as well as through more general literature review.

3.2. Overview of Key Ecological Factors for the Provincial -Scale Analysis in Ha Tinh

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 Ha Tinh. The macro-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 ecological factors for which sufficiently comprehensive data already exists at this level. Other factors will 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 local -levels of assessment

Macro-level assessment	Micro-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 Ha Tinh?
  - 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 reliance?
- How are the ecosystems themselves vulnerable to climate change?
- Conclusion: (based on contributions from ecological and social analysis) What should be focused on for the micro-level assessment.

3.3. Physical description: topography, climate and soils

Ha Tinh Province in North-central coastal Vietnam occupies a total area of just under 6,000km^2, situated between 17°53'50 -18°45'40 "North latitude, and 105°05'50" - 106°30'20 "east longitude. Ha Tinh borders Nghe An to the north and Quang Binh in the south, the People's Democratic Republic of Laos in the West and has a 137km coastline along the East Sea.

3.3.1. Topography

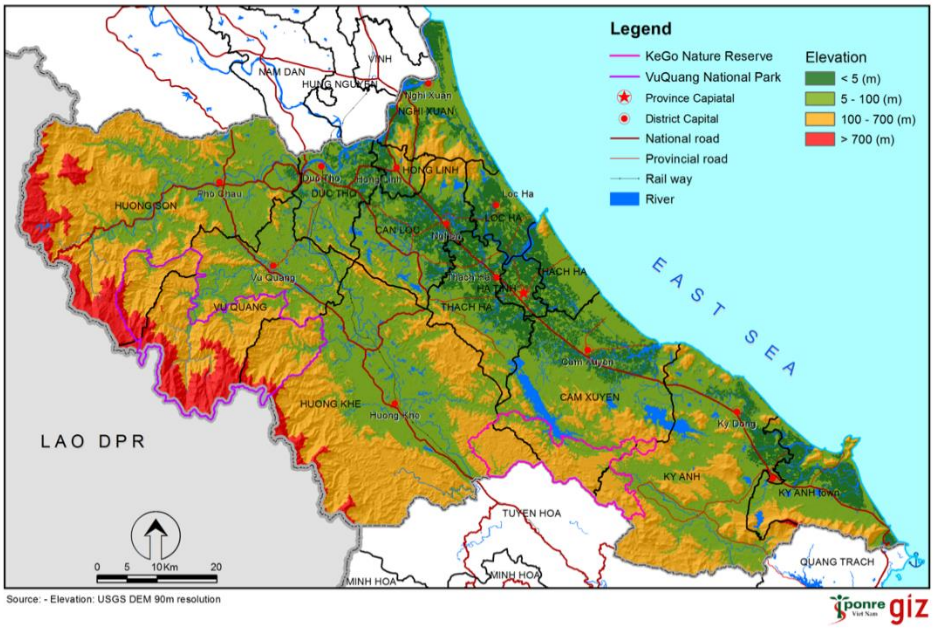
Based on a combination of geomorphology and ecological characteristics Ha Tinh can be divided into 4 altitudinal eco-zones or regions as follows:

- Mountain areas: Mountainous areas above 700m account for about 64% of the province, located mainly in the districts of Huong Son, Huong Khe and Vu Quang and west of Ky Anh district.
- Midland - hilly areas: These areas account for about 20% of the province. The lower foothills are surrounded by narrow carpet-like strips of flat land.
- Lowland Delta areas: Ha Tinh delta areas cover about 56,000ha, accounting for about 9% of land area of the province, including the districts and towns from Hong Linh town to Ky Anh district and part of Duc Tho district, and from Duc Tho town to Hong Linh town. Elevation is less than 5m with inclination gradually from west to east. The deltas are narrow narrow width, fertile soil. Consequently they have been largely been converted to paddy rice.

- Coastal areas: The total coastal area accounts for another 40,000ha or so (about 7% of the land area of the province, running from Nghi Xuan district to Ky Anh district. The terrain slopes from west to east, with altitudes less than 4m.

The Province also has some islands, including Hon Nom, Hon Lap, Hon En, Hon Booc, Hon Chim and Son Duong. All of these islands are within 2 - 5 km of the coastline.

Figure 3.1: Elevation map of Ha Tinh

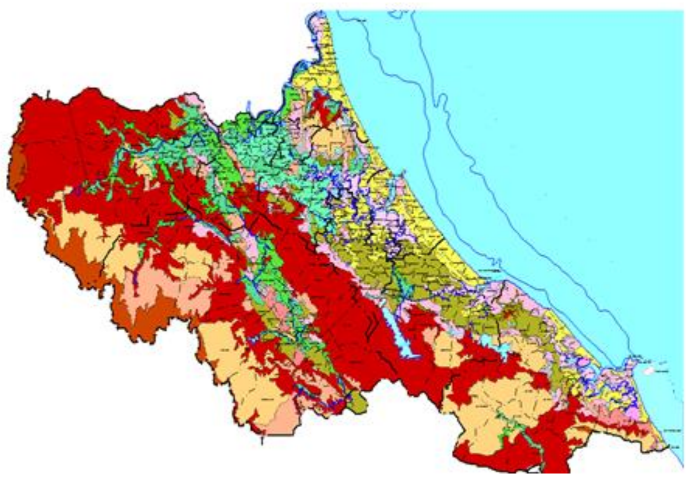


Source: original work of the consultant team

3.3.2. Soils

Soils in Ha Tinh are derived and distributed in paths that run in a Northwest-Southeast direction. They are very diverse with 8 soil groups, namely: sandy soils (Arrenosols), sulphate soils (salic Thionosols), alluvial soils (Fluvisols), degraded soils (Acrisols), ferralit soils (Ferrasols), mountainous alit soils (Alisols), accumulated soils, and eroded rocky soils. Overall, Ferrasols and Fluvisols dominate, covering 51.6% and 17.73%, respectively of the province's area. Ferrasols are derived from Schilst material, and are characterised by red-yellow color. This soil type has a soil thickness suitable for many plants, and would normally support well developed natural vegetation cover. Because these soils are also suitable for many crops, especially perennial crops, and have high productivity potential, then areas of natural ecosystems growing on the soils are also likely to be some of the first areas converted to agriculture.

Figure 3.2: Soil types in Ha Tinh province



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	ĐCs	Ferralic Acrisols - Dystric Cambisols	ĐCs
	Đồi xen đáy trũng hẹp	Macma axit	ĐHa	Arreni Acrisols - Dystric Fluvisols	ĐHa
		Phiến sét	ĐHs	Dystric Acrisols - Dystric Fluvisols	ĐHs
		Bazan	ĐHb	Haplic Ferralsols - Eutric Fluvisols	ĐHb
	Đồi xen đáy trũng rộng	Macma axit	ĐRa	Arreni Acrisols - Dystric Plinthosols - Dystric Fluvisols	ĐRa
		Phiến sét	ĐRs	Dystric Acrisols - Dystric Plinthosols - Dystric Fluvisols	ĐRs
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 - Thionic Fluvisols	ĐBs-t
		Cát	ĐBc	Ferralic Arenosols - Gleyic Arenosols	ĐBc
	Đồng bằng gió biển	Cồn, đụn cát	C	Haplic Arenosols	C

Source: Van Thang, 2016

3.3.3. Climate

The area is subject to a monsoon climate with very high rainfall particularly in summer and autumn. Annual rainfall in Ha Tinh Province varies in the range of 2,300 - 3,000mm. The highest rainfall is mostly concentrated in the coastal plains. The rainy season lasts from May to October, and the dry season lasts from November to April. Occasionally, the rainy season starts early in April; however, it is often interrupted in June and July due to dry, hot westerly wind effects. Average annual evaporation rate is within the range of 800 - 1,100mm. Evaporation does not exceed 100mm in most months, except June, July and August, the hottest months of the year (ISPONRE, 2009).

2.1.3.1. Temperature

According to the records from 1958 to 2007 at the Ha Tinh, Huong Son and Ky Anh stations, the average temperature in the period of 2001-2007 was 24.5°C. This was 0.5-0.8°C higher than that of 1961-1970, and 0.3-0.6°C higher than the average value in the period of 1981-1990 (Table 3.3). Summer became hotter on average by 0.3-1.6°C throughout the observed years. Winter is also becoming warmer. The average winter temperature during the years of 2001-2007 was 0.6-1.2°C higher than that of 1961-1970.

Table 3.2: Changes in temperature over time in Ha Tinh

Parameter	Station	1958 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - 2000	2001 - 2007
Average temperature (^{0}C)	Ha Tinh	-	23.8	23.8	23.9	24.3	24.5
	Huong Khe	-	23.5	23.5	23.9	24.2	24.3
	Ky Anh	-	24.0	24.2	24.3	24.5	24.6
Maximum temperature (^{0}C)	Ha Tinh	-	38.8	39.1	39.8	40.1	40
	Huong Khe	-	39.4	41.2	41.1	41.8	41
	Ky Anh	-	38.6	39.5	39.4	38.9	38.9
Minimum temperature (^{0}C)	Ha Tinh	-	8.1	7.9	7.9	7.8	9
	Huong Khe	-	4.4	4.6	5.8	4.5	8.5
	Ky Anh	-	8.9	7.9	8.2	8.8	10.4

Source: Institute of Meteorology, Hydrology and Environment and ISPONRE, 2009

2.1.3.2. Rainfall

In recent years, the total annual rainfall in Ha Tinh Province has been reduced when compared to the period of 1961-1990. The rainy season usually occurs later and ends earlier than before. The rainfall varies widely both in space and time. The rainfall period is not too long, but the intensity is relatively high and is concentrated in a small region that can cause floods and flashfloods.

According to the recorded data at the Ha Tinh station over the past 50 years, there have been 15 times that the daily rainfall has been over 30mm (Table 3.4). Whereas, at Huong Khe and Ky Anh stations, this was recorded 9 and 17 times, respectively. The highest daily rainfall observed during this period was 657.2mm at Ha Tinh station (October, 1992), 492.6mm at Huong Khe station (October, 1983) and 790.1mm at Ky Anh station (October, 1967). The highest monthly rainfall at these stations was all recorded in October 1983, which was 2,047.8mm at Ha Tinh, 1,614.6mm at Huong Khe and 2,218.4mm at Ky Anh. The highest annual rainfall is reported to be 4,391.3mm at Ha Tinh (1989), 3,784.4mm at Huong Khe (1989) and 4,386.1mm at Ky Anh (1978).

Table 3.3: Summary of climate information for Ha Tinh meteorological stations

Factors	Weather station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Average sunshine hours (hour)	Huong Son	65.4	50.8	73.5	132.9	202.1	17.3	199.8	149.1	140.1	119.0	82.9	75.1	1,463.0
	Ha Tinh	75.5	51.0	74.4	136.2	216.8	206.6	226.7	189.0	155.9	134.2	95.7	78.9	1,624.6
	Huong Khe	67.0	49.7	76.9	131.6	179.3	180.0	203.0	160.9	120.5	99.3	73.6	58.5	1,371.6
	Ky Anh	77.7	58.5	92.9	150.1	219.7	217.8	237.8	192.3	162.2	125.9	82.4	73.2	1,657.9
Average temparat ure (°C)	Huong Son	16.9	17.8	20.6	24.4	27.4	28.6	28.7	27.8	25.7	23.6	20.4	17.7	23.3
	Ha Tinh	17.7	18.4	20.8	24.5	27.8	29.5	29.7	28.7	26.8	24.4	21.5	18.7	24.1
	Huong Khe	18.0	19.0	21.6	25.1	27.6	28.9	29.1	28.0	26.1	24.0	21.2	18.8	24.0
	Ky Anh	17.9	18.7	21.0	24.7	28.0	29.7	29.9	28.9	26.9	21.7	21.7	18.8	23.5
Average rainfall (mm)	Huong Son	6.3	57.8	67.4	126.1	199.8	163.3	144.2	261.5	537.7	445.2	226.3	88.1	2,383.7
	Ha Tinh	98.5	66.1	59.5	72.4	150.8	133.6	127.6	228.9	503.4	693.9	341.4	164.1	2,634.4
	Huong Khe	41.9	47.5	62.9	94.4	213.5	162.3	144.1	294.6	491.4	549.1	190.5	71.8	2,358.5
	Ky Anh	109.4	73.3	59.2	57.8	155.4	128.9	98.8	234.9	563.8	749.0	417.0	205.9	2,842.1
Average evaporati on (mm)	Huong Son	32.2	27.6	41.4	71.0	133.3	178.1	218.7	150.7	68.1	46.6	34.3	34.5	1,036.5
	Ha Tinh	35.1	27.4	35.6	55.0	95.5	122.3	137.7	100.8	63.9	55.5	49.8	45.2	820.7
	Huong Khe	37.4	32.4	48.6	72.9	112.4	135.9	163.1	106.7	62.2	52.5	47.3	41.9	907.9
	Ky Anh	41.4	32.0	44.1	65.1	122.9	178.3	208.6	152.1	78.1	64.6	60.3	53.2	1,094.9
Average relatively humidity (%)	Huong Son	90	91	90	86	79	75	71	78	87	89	90	90	85
	Ha Tinh	91	92	92	88	81	77	74	80	87	89	89	88	86
	Huong Khe	91	91	90	86	80	78	74	81	87	88	88	89	85
	Ky Anh	90	92	91	87	89	74	70	76	82	88	88	88	84
Average wind speed (m/s)	Huong Son	1.9	1.0	1.1	1.3	1.9	2.7	3.2	2.2	1.1	0.8	0.7	0.7	1.5
	Ha Tinh	1.8	1.6	1.4	1.5	1.6	1.6	1.9	1.5	1.6	2.0	2.0	1.9	1.7
	Huong Khe	1.5	1.5	1.4	1.5	1.7	1.8	2.1	1.5	1.4	1.6	1.7	1.6	1.6
	Ky Anh	2.2	2.1	1.8	1.6	2.3	2.8	3.4	2.4	1.9	2.3	2.6	2.4	2.3

Source: Institute of Meteorology, Hydrology and Environment (Quoted in ISPONRE (2009)

Table 3.4: Frequency of heavy rain during period (1958 - 2007)

Value	Station		
	Ha Tinh	Huong Khe	Ky Anh
Over 300 mm daily	15	9	17
Over 1000 mm monthly	14	5	17
Over 1500 mm monthly	4	2	7
Over 2000 mm monthly	1	0	1
Over 3000 mm annual	13	4	20
Over 4000 mm annual	1	0	1

2.1.3.3. Humidity

The average relative humidity in the recent years (1991-2007) is 7-10% higher than the average of 1961-1990. The relative humidity reaches a maximum during the summer (May - July). According to the historical records, the average relative humidity during the summer of 1991-2007 was 11-14% higher than that of 1961-1990. The corresponding values during winter (November - January), spring (February - April) and autumn (August - October) are 6-12%, 6-10% and 6-8%, respectively.

2.1.3.4. Evaporation

Statistics from 1961 to 2007 (Table 3.5) showed that the average annual evaporation during 1991-2007 decreased by about 1-3 mm/year relative to the period of 1961-1990.

Table 3.5: Average values for evaporation and hot, dry days for every ten-year period at observed stations in Ha Tinh province

Parameter	Station	1961 - 1970	1971 - 1980	1981 - 1990	1991 - 2000	2001 - 2007
Evaporation (mm)	Ha Tinh	824	808	736	852	908
	Huong Khe	814	985	954	723	760
	Ky Anh	1199	1107	1084	1056	984
Number of hot and dry days	Ha Tinh	73	81	92	92	
	Huong Khe	98	95	111	102	

Source: Institute of Meteorology, Hydrology and Environment and ISPONRE, 2009

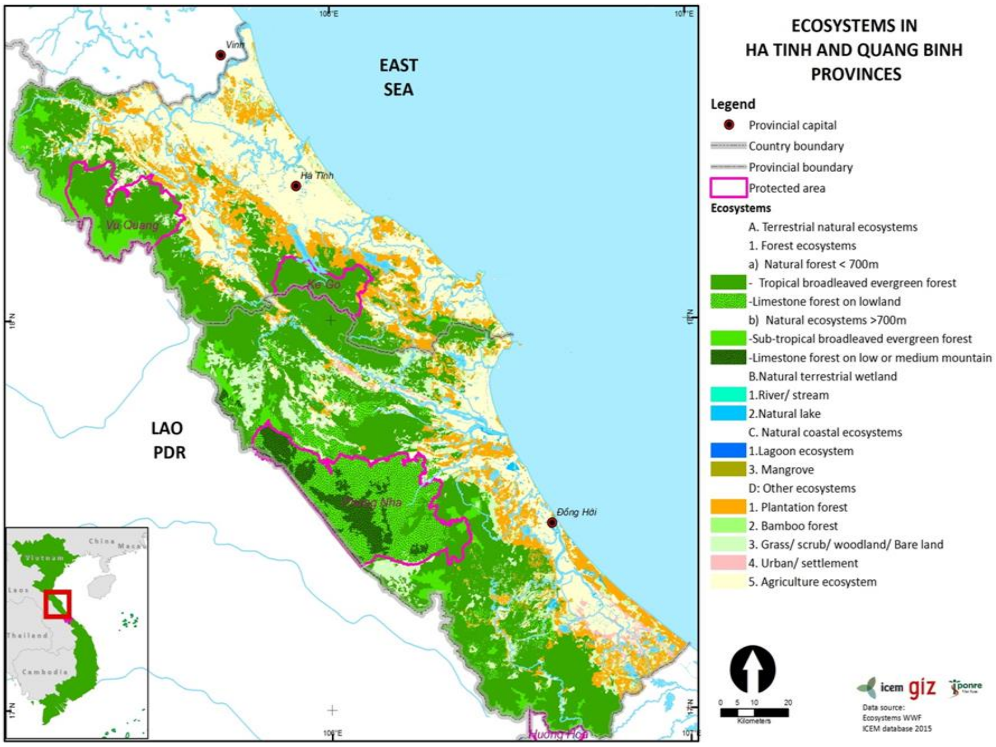
3.4. Natural ecosystems

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

On a low resolution mapping of global ecoregions conducted by WWF, all of Ha Tinh province falls within two ecoregions, namely the Northern Annamite Rainforest Ecoregion, and the Northern Vietnam Lowland Rainforest Ecoregion. 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 Ha Tinh. The mapping of terrestrial ecosystems is generally good, however considering coastal ecosystems, it does not identify sand areas 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 Ha Tinh. 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*. Ha Noi, 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.

Fiugre 3.3: Ecosystems of Ha Tinh and Quang Binh



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

3.4.1. *Terrestrial Ecosystems*

The main terrestrial ecosystems of Ha Tinh are:

- sub-tropical broadleaf moist evergreen forests above 700m altitude
- tropical moist evergreen broadleaf forest below 700m altitude

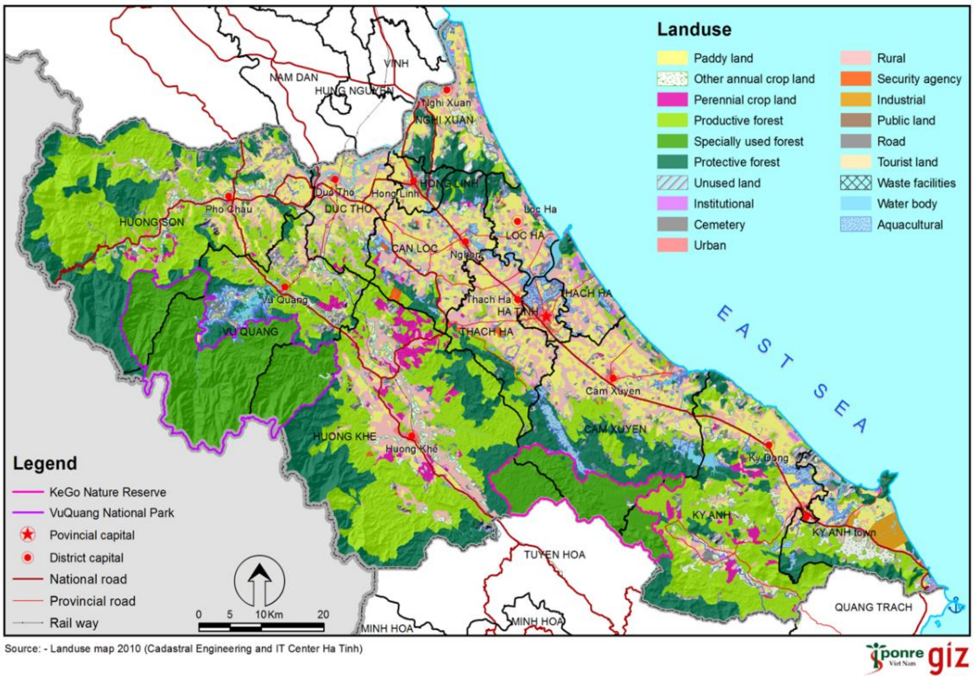
Around 351,000ha or over 58% of the land area of the province) is still identified as "forestry" land (see Table 3.6 and Figure 3.4). However, a land-use designation as forestry land apparently does not always mean that the land actually has forest cover. At the same time, land use statistics shown in Table 3.6 reveal that almost 22% of Ha Tinh's original land cover has been converted to some form of agriculture, and around a further 20% to other uses. Recent land-use patterns are shown in Figure 3.4.

Table 3.6: Land use in Ha Tinh

Use type of land	HT Statistical Yearbook 2013		MARD-FIPI 2012	DONRE 2015
	Ha	%	Ha	Ha
Total	**599, 782**	**100**		
Agricultural land	130,117	21.69		
Forestry	**351,891**	**58.69**	**351,891**	**350, 882.67**
• *Special use Forest*			*164,014*	*161,244.38*
• *Protection Forest*			*113,300*	*115,040.48*
• *Production Forest*			*74,577*	*74,597.81*
Aquaculture land	4,661	0.78		4,096.18
Salt production land	Not specified	Not specified		423.70
Resident/homestead land	9,695	1.62		
Special use/dedicated land	44,857	7.48		
Other Non-agriculture land	43,596	7.02		
Unused land	27,963	4.66		

Source: Ha Tinh statistical yearbook 2013, MARD-FIPI 2012, and DONRE Ha Tinh province, 2015

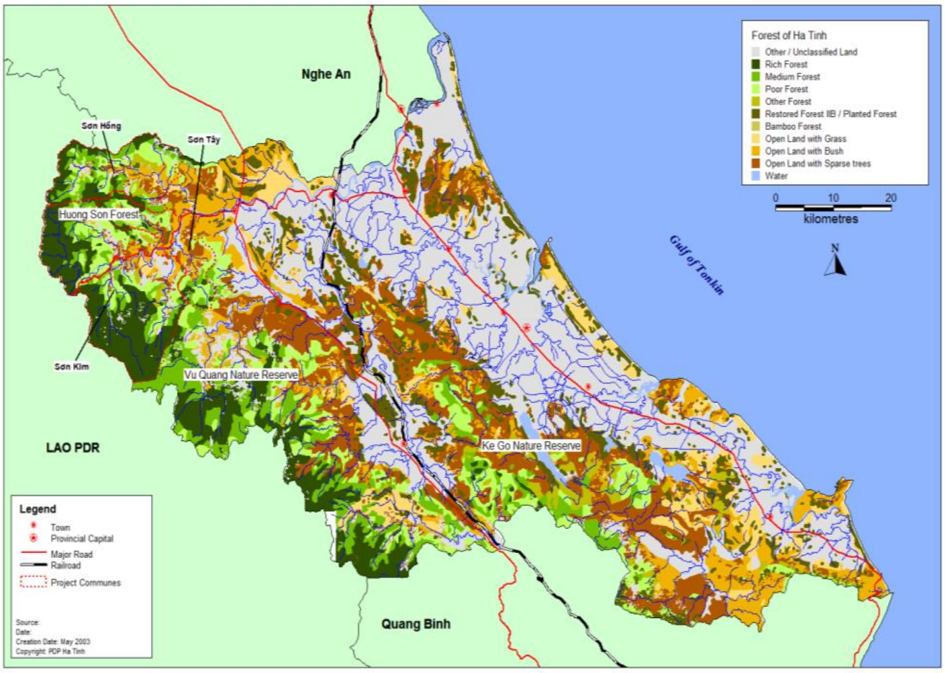
Figure 3.4: Land-use patterns in Ha Tinh



Source: Map produced by the consultant team

The forests of Ha Tinh are extremely diverse with over 1600 vascular plant species in 351 genera and 138 families (IEBR, 2001). Valuable timber species include: Lim (*Erythrophleum fordii*), Sến (*Madhuca pasquieri*), Gụ đỏ (*Sindora tonkinensis*), Vang Tam(*Manglietia fordiana*), Re huong (*Cinnamomum sp.*), Gioi (*Michelia gioi*), De (*Castanopsis spp*.). In addition, a large number of plant Non-Timber Forest Products (NTFPs) have been listed, including 554 species of medicinal plant, 98 species of ornamental plant, 83 species of essential oil and tannin, and 29 species of rattan. Animal life found in these forests is also diverse. Globally important species for conservation include the Saola (*Pseudoryx nghetinhensis*), and the Mang lon (*Muntiacus vuquangensis*). Formerly the area would have been important for large mammals such as tigers and elephants, but this is no longer the case. (Mackinnon and Van Dung, 1992; Van Dung et. al, 1994; Kuznetsov, 2001).

Figure 3.5: Forests of Ha Tinh province, 2003



Source: DARD Ha Tinh

MARD data for 2012 and HT DARD information for 2015 (see Table 3.7) suggests that actual forest cover is around 321,000 hectares (or about 50% of the land area of the province). Of this total amount of land with forest cover, about 70% is natural forest and about 30% is plantation forest, meaning that in total, natural forest covers about 35% of the province land area and plantation forest about 15%. About 40% of the remaining natural forest is contained within Vu Quang National Park and Kego Nature Reserve, which provide the best examples of Ha Tinh's native forests.

Information on changes in forest area in Ha Tinh from 1998 until the present, presents a picture that in some ways appears difficult to explain. Total forest area increased by 60,000ha between 1998 and 2012, and by a further 70,000ha between 2005 and 2012 - increasing at an average rate of almost 10,000ha/year during this period. Perhaps surprisingly, about 40,000ha of this increase in forest cover from 1998 to 2012 was identified as an increase in natural forest cover. In addition, HT DARD figures for 2015, suggest an additional 17,000ha increase in natural forest between 2012 and 2015.

Table 3.7: Change of forest area 1998-2005-2012-2015 in Ha Tinh province

	1998	2005	2012	2015
Forest tree area (ha)	190,923	250,529	321,377	320,381
Natural forest (ha)	*171,181*	*186,240*	*212,884*	*229,742*
Planted forest (ha)	*19,742*	*64,289*	*108,493*	*90,639*

Source: MARD Restructure of National Forestry, Hanoi-2014 for 1998, 2005 and 2012; and DARD HT for 2015

So where did this 57,000 hectares of additional natural forest come from in 17 years? There are two possible explanations for this increase in the area of natural forest - one is that the definition of what constitutes a natural forest and the criteria used to identify natural forest (e.g. percentage crown cover) have changed over time. The other explanation is that large areas of previously logged or otherwise severely degraded forest that previously did not meet the criteria for being identified as forest, have now recovered/regenerated to such an extent that they are now recognised and counted as forest (small trees have become big trees). Or it could somehow be a combination of both of these possibilities. Further work is required to clarify this.

The Forestry Management Boards, Forestry companies, Commune Peoples' Committees and Households are all major forest owners in Ha Tinh (see Table 3.8)

- National Parks and Nature Reserves manage the Special Use Forest which includes most of the richest forest with very high biodiversity including remaining areas of primary forest on the East flank of the North Truong Son mountain/border Vietnam-Lao PDR.
- Protection Forest Management Boards manage most protection forest and some production forest. They are responsible for large areas of natural forest, and some plantation forest.
- Forestry Companies manage most production forest including both natural and plantation forests. Combined they are managing a natural forest area that is bigger than Kego nature reserve and almost as big as Vu Quang National Park
- Forestry land allocated for households is mostly land for plantation forestry and ago-forestry practices. Very little natural forest has been transferred to households.

Table 3.8: Forest ownership and management responsibility in Ha Tinh province

Forest Owner			Area (ha)
I. Special Use Forest Management Board	Vu Quang NP	55,341	91,893 (N: 81,155; P: 10,738)
	Ke Go Nature Reserve	36,552	
II. Protection Forest Management Board (PFMB)	Ngan Pho river PFMB	25,019	83,207 (N: 66,030; P: 17,177)
	Ngan Sau river PFMB	16,860	
	Hong Linh PFMB	6,072	
	Tiem River PFMB	12,917	
	South Ha Tinh PFMB	20,567	
III. Forestry Company	Huong Son LLC	18,728	60,745 (N: 42,359; P: 18,386)
	Chuc A LLC	14,381	
	Ha Tinh Rubber Company	12,864	
	Huong Khe Rubber Company	14,666	
IV. Other Organization			5,540 (N: 3,989; P:1,551)
V. Commune PCs			31,717 (N: 14,932; P:16,785)
VI. Private Households			31,768 (N: 5,766; P:26,002)
VII. Not yet allocated			15,511 (N)
Total Forest area of Ha Tinh province			320,381 ha (N: 229,742ha; P: 90,639 ha)

Source: Ha Tinh DARD 2015

Vu Quang National Park and Ke Go Nature Reserve

Vu Quang National Park and Ke Go Nature Reserve together account for around 20% of the land area of the province. As such this represents a significant commitment to maintaining natural ecosystems in a protected state as Special Use Forest (SFU).

However, a large proportion of the natural forest estate of Ha Tinh (including in Vu Quang and Kego) is not however in its original natural condition. Much of it has been previously logged and is actually in various stages of regenerating secondary forest. Some areas of forest were also severely damaged by bombing in the American war. A seemingly very significant issue of smothering of trees by prolific invasive climbing plants was apparent in many patches of forest accessible by road. So far there has been no detailed study of overall forest condition in the province.

Vu Quang NP was established in 2002, in accordance with Decision No. 102/2002/QD-TTg of the Prime Minister of the Socialist Republic of Vietnam. It covers 55,029 ha lying between coordinates 18°09’ to 18 °26’ North Latitude and 105 °16’ to 105 °33’ East Longitude.

According to personal conversations with a number of leading conservation experts in Vietnam, the biodiversity importance of Vu Quang NP has declined over the last 2 decades and this is reflected in the fact that none of the major international conservation organisations have any ongoing or planned projects to support the area. If local communities were more actively involved in the management of Vu Quang NP, and if conservation agreements and benefit sharing arrangements were put in place, significant additional economic value and support for local livelihoods could be derived from sustainably managed collection of Non-Timber Forest Products (NTFPs) including rattan, resins, honey, mushrooms and medicinal herbs, etc. in Vu Quang NP. Under present management rules and structures this is unlikely to be the case, and the park is still struggling with illegal logging, poaching and harvesting of NTFPs. Tourism could also be potentially further developed.

Prior to 1990 the Ke Go area of gently undulating hills mostly under 300m elevation was under the management of Cam Ky Forest Enterprise which logged the area. In 1990 Cam Ky ceased logging operations and part of the area under its management was designated as Ke Go Reservoir Watershed Protection Forest (WPF). When Ke Go Nature Reserve was created in 1997 it combined 7,511ha previously under the management of Ha Dong Forest

Enterprise and 11.38ha previously under the management of Ke Go Reservoir WPF. The initial area was later expanded to a total area (including buffer zone) of over 40,000ha with the inclusion of additional protection forest areas into the Nature Reserve. A strictly protected core zone of 22,000ha accounts for just over half of the property and is recognized as Birdlife Important Bird Area (IBA) # VN019. The core zone and buffer zone together includes parts of 23 communes in 4 districts. The Kego Nature reserve protects large parts of the watershed of the Kego Reservoir as well as some of the last remaining tropical broadleaf moist evergreen forest of the Annamese region (although this is logged-over secondary forest). Professor Vo Quy, Vietnam's leading conservationist was a champion for the establishment of Kego Nature Reserve.

Professor Vo Quy, Vietnam's leading conservationist was a champion for the establishment of Kego Nature Reserve - particularly for the protection of pheasants, including the Vietnamese Pheasant (*Lophura hatinhensis*), discovered in 1964. Also known as Vo Quy's Pheasant, it is featured prominently as the logo for Kego Nature Reserve. More recently *L. hatinhensis* has been reclassified as a variety of Edward's Pheasant *L. edwardsi*, known originally from Ha Tinh, Quang Binh, Quang Tri and Thua Thien Hue. There have been no confirmed records of Edward's pheasant in the wild since 2000 - and it is not clear if any still survive in Kego. It is now classified as Critically Endangered by IUCN.

While there are no permanent settlements in the core area of Ke Go, there is significant human activity. Collection of any NTFPs that are not endangered species is allowed - the most important products being rattan and the palm leaves used for making traditional conical hats. However there is no information about the volume and value of these products collected; their relative importance as source of income for local people; or how many people are involved in their collection. In addition, there is no monitoring of the abundance and productivity of these species in the forest, and so no idea if their collection is sustainable or not. In addition, illegal activities including encroachment, illegal logging and poaching of wildlife as well as forest fires were identified as significant challenges faced by the nature reserve. A total staff of 77 includes 40 rangers stationed in 10 ranger stations around the property. Their main duty is patrolling for law enforcement.

Vu Quang NP and Ke Go NR both provide significant ecosystem services especially in terms of provision and regulation of water supply and quality for downstream communities, as well as carbon sequestration and climate regulation. To some extent the importance of these services is recognized simply in the decision to continue to maintain these areas as SFU areas - but the amount and value of the services has not been assessed. It is therefore difficult to try and understand if the level of investment of government budget in management of the area is appropriate or not when considering the value of services the area provides. It also makes it 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.

So far, the overall condition of the natural forest of Ha Tinh Province has not been evaluated in detail, and management measures appropriate to each type of forest and its specific context are not yet clearly understood. More detailed assessment of forest types, forest owners, the economic effectiveness and development performance of forests have to be made to evaluate more precisely how to manage, use and protect the forest estate more effectively and in a reasonable manner in the face of climate change.

3.4.2. Freshwater ecosystems

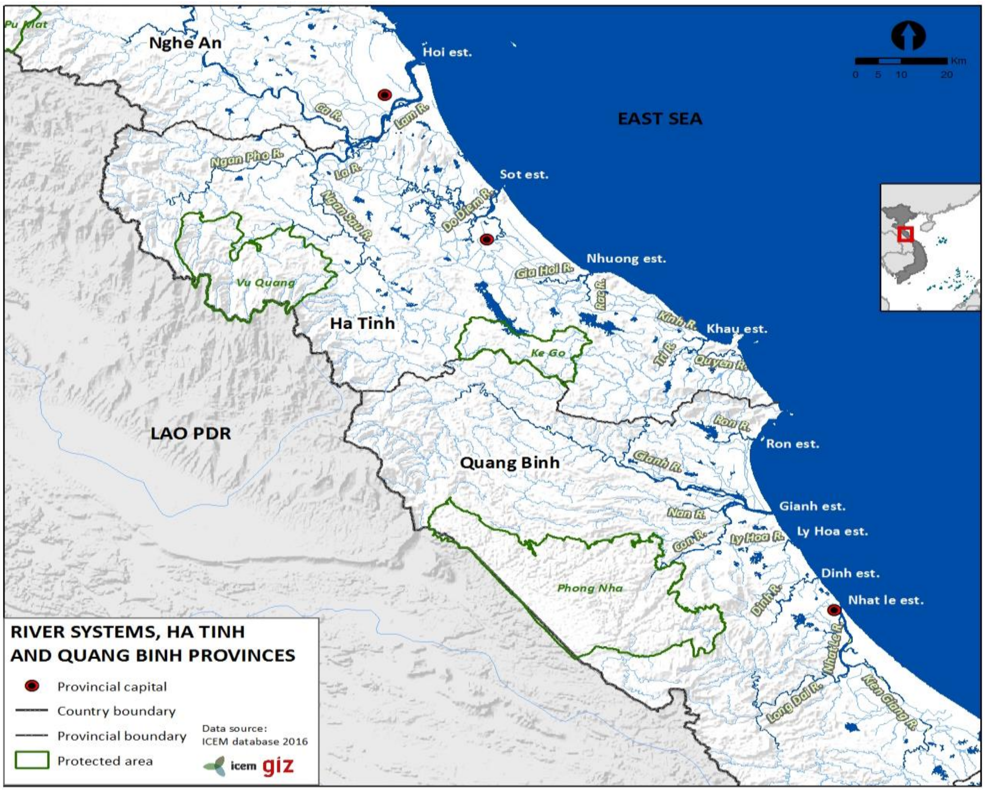
Freshwater ecosystems fall into the classes of riverine (rivers and streams) and lacustrine (open water bodies such as lakes and ponds)

3.4.2.1. Riverine Ecosystems

The abundant rainfall combined with the topography of the province and limited evaporation gives rise to more than 100 relatively short and steep rivers and streams with a total combined annual flow volume of 13 billion cubic metres (bcm). This includes 13 major river systems with a combined length of 400km. The longest river is the Ngan Sau, which is 131km long, and the shortest is the Cay River with a total length of only 9km. The largest river in the province in terms of channel size and volume is the La-Lam River, which forms the border between Ha Tinh and Nghe An Provinces. The La-Lam River system has its origins at Mt. Muong Khut and Muong Lap in Thanh Hoa (1,800 and 2,000m, respectively) and runs from the northwest to the southeast through the three Provinces of Thanh Hoa, Nghe An and Ha Tinh before flowing out into the East Sea via the Hoi river mouth. In the portion of the La-Lam Basin in Ha Tinh Province, we can distinguish two main sub-basin systems: (i) Ngan Pho river system, which has a total basin area of 2,061km^2 and consists of various small rivers, creeks and streams such as the Tiem, Rao Tro, Ngan Truoi; and (ii) Ngan Sau river system, which has a total area of 1,065 km^2. The Ngan Pho and Ngan Sau Rivers empty their water into the 12km long La River, which in turn flows into the 37km Lam River. In addition, the Do Diem and Rao Cai rivers have a basin area of 1,349 km^2, and the Gia Hoi and Rac rivers have a basin area of 356 km^2, while the Kinh, Tri and Quyen rivers have a combined basin area of 510 km^2 (Investment Promotion Center for North Vietnam, 2016).

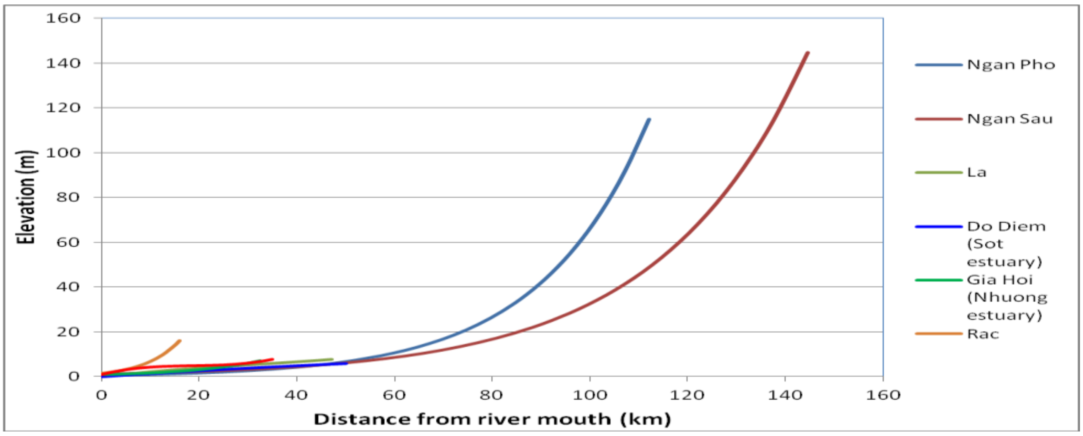
Figure 3.6 shows the major river systems of Ha Tinh and Quang Binh, while Figure 3.7 shows the longitudinal profile for some of the major rivers in Ha Tinh.

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



Source: original work of the consultants

Figure 3.7: Longitudinal profiles of major river in Ha Tinh province



Source: Original work of the consultants

Photo 3.1: Lac Giang River - most riversine vegeatation is removed and rice fields come right up to the river bank

No informaton was available on the ecological condition of the rivers. 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. However the middle and lower reaches of most rivers in the province 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 (see example in Photo 3.1).

The Rac River fluvial morphology is threatened by sand extraction. A number of local people illegally take sand out from the river through day and night (See Photos 3.3).

Photo 3.2: Lac Giang River, 31 km from Cua Nhuong river mouth River water at this location is still salty and cannot be used for irrigation

Photo 3.3: Sand extraction from the Rac River, and no evolution of sand flling-in between 2 consecutive groynes, becuae of the due to sand extraction

3.4.2.2. Lacustrine ecosystems

Lacustrine ecosystems include lakes, lagoons and ponds. Ha Tinh has about 340 recognised water bodies (including both natural and man-made lakes and reservoirs), with a combined storage capacity of over 700 million m^3. Without significant detailed survey effort across the province it is impossible to know how many of these are actually natural water bodies, what their specific ecology is like, and what condition they are in. On the other hand, some of the largest reservoirs are however well-known and immediately obvious, including Ke Go, Song Rac, Cua Tho (Cửa Thờ), Trai Tieu and Ngan Truoi - Cam Trang (which is still under construction).

Lagoons and lakes are not a very characteristic open water ecosystem in Ha Tinh province. Typically lakes and lagoons in North-central Vietnam are located on the sandy land of coastal areas. They contain fresh water when located in the inner sandy areas and brackish water in when closer to thesea. This wetland type plays an important role in biodiversity and local microclimate impacts.

Althought some coastal land in Ha Tinh is still identified as wetland areas but in fact local people have converted almost all of these wetlands to agricultural land, and only some smaller areas of open water remain. In the local language, Ha Tinh people call lakes and lagoons "đồng" the same word they use to identify other land use types such as paddy fields or crop fields. Hoi Thong lagoon is one of these area . This lagoon is called as "đồng thủy sản" meaning aquacultural production field".

Hoi Thong lagoon is located close to the Hoi estuary of Lam river and is managed for fish cultivation. More than 20% of local people, who live in Xuan Hoi commune get their daily income from Hoi Thong and some other smaller lagoons alongthe Lam river. Intensive fishing is for for the local market and for Vinh market. Both the diversity of native fish species and the abundance of fish, shrimp and other aquatic species have been dramatically reduced. Most of the native vegetation around the lagoon has also been destroyed and replaced with plantings of Acacia hybrid and *Casuarina equisetifolia*. Native tree species regernation is surpressed as any regrowth is cut down in weed control every year.

Photo 3.2: Hoi Thong lagoon, Xuan Hoi commune, Nghi Xuan district

Water infrastructure developed so far is significant, and includes 345 reservoirs, 57 weirs, 381 pumping stations, 318.5km of dykes and 19.2km of tier 2 river dykes. Current storage capacity is 745 million cubic metres, and Irrigation water is provided to 50,000ha. PPC of HT has approved a plan for an enhanced dyke system and are preparing dyke management planning.

3.4.2.3. Ngan Truoi-Cam Trang irrigation and hydropower project

According to information provided to the team in meetings with DARD staff, adn during visits to the site in December 2015, the Ngan Truoi reservoir is being developed by the Ministry of Agriculture and Rural Development, Vietnam starting in June 2009 with a total capital investment of approximately VND 6 trillion, raised mainly from the Vietnamese government bonds. The project was initially approved in 2006, and is considered to be one of the most critical development projects in Ha Tinh province. The project is being built on the Ngan Truoi River in Huong Dai commune in Vu Quang district. It is designed with a capacity of 775 million cubic meters (equal to the total existing capacity of all reservoirs in Ha Tinh). Upon completion, the reservoir will provide water to 35,400ha of farming land in seven districts of Ha Tinh, including Vu Quang, Huong Son, Duc Tho, Can Loc, Nghi Xuan, north Thach Ha and Hong Linh, with a capacity of 56.8m^3/s. It will supply water for domestic uses in the surrounding districts and for 12 industrial zones, especially the Thach Khe iron ore mining with a capacity of 6 m^3/s, and will also provide water for about 6,000ha of aquaculture, of which 3,500ha will be freshwater and 2,500ha brackish water. It is also claimed that the project will also help to reduce the damages caused by floods in the Ngan Sau and hence the La river, and at the same time will continue to contribute an environmental flow with a discharge of 4m^3/s for the lowland areas and estuaries. The work also includes a hydro-electric power system with a capacity of 16 MW.

The catchment area is 408km^2, located in Vu Quang NP, while the area of the reservoir itself will be 43km^2, including approximately 2,000ha of forest of VQNP. The project has so far relocated over 600 households with 2,977 inhabitants in 2 communes in Huong Quang and Huong Dien and some villages in Vu Quang district. Villages located inside Vu Quang National Park along the river valley that will be flooded by the reservoir, have been relocated to areas outside of the park. When the team visited in December 2015, main dam construction was nearing completion. It is expected to come into operation in 2017. The team also visited some of the total of 898 households who were resettled and provided with forest land in the buffer zone - which is being cut down and converted to agriculture.

This project involves the conversion of protected forest and a natural river to other development purposes. Essentially it implies a trade-off between irrigation/agricultural production on the one side and biodiversity conservation plus other ecosystems services that the forest and river supplied, on the other side. Between managed provision of water for downstream economic activities and livelihood development and the maintenance of a broad suite of services that can be considered as public goods.

3.4.3. Estuarine Ecosystems

Estuarine ecosystems include the estuaries themselves, together with associated mangroves and mud-flats. The Province has four major estuarine systems. From the most northerly to the most southerly these are the Hoi, Sot, Nhuong and Khau. The Hoi estuary is the outlet for the La-Lam River, the Sot estuary is the outlet for the Do Diem and Rao Cai rivers, and the Nhuong estuary is formed by the Gia Hoi and Rac rivers, while the Khau estuary river is the outlet of the Vinh, Tri and Quyen rivers.

Mangrove forest is found along banks of the four main river estuaries of Ha Tinh province and has been identified in Xuan Hoi, Xuan Truong of Nghi Xuan district, Thach My, Ho Do, Thach Chau and Thach Bang of Loc Ha district, Ky Ha and Ky Trinh of Ky Anh town. Ha Tinh PPC (2015) 302/QD-UBND-2014 and 1457/QD-UBND-2015 recorded a total area of only 510 ha of mangroves remaining in 2015 (a 33% decline from the 750 ha found in 2011).

Table 3.9: Mangrove forest in Ha Tinh province 2011

No	District	Total area (ha)	With mangrove	No mangrove	Aquacultural practice	Salt field
1	Ky Anh	568.0	360.5	207.5	0.0	0.0
2	Cam Xuyen	231.4	48.4	143.0	40.0	0.0
3	Ha Tinh city	74.2	66.4	7.8	0.0	0.0
4	Thach Ha	220.4	117.1	103.3	0.0	0.0
5	Loc Ha	265.1	113.6	19.4	118.2	14.0
6	Nghi Xuan	227.2	46.7	136.5	44.0	0.0
	TOTAL	1,586.3	752.6	617.6	202.2	14.0

Sources: Ha Tinh PPC, 2011. Report on Mangrove protection forest in Ha Tinh and action plan in 2014-2022

While the remaining area of mangroves is small, and *Rhizophora stylosa, Sonneratia caseolaris* and *Kandelia obovata* were recorded as dominant mangrove tree species, overal 27 species of 18 families were recorded in mangrove forests of Cua Sot. Six types of forest structure communities were found including *Avicennia lantana* community; Avicennia and Rhizophora community; Avicennia, Kandelia and Rhizophora community; Avicennia, Aegiceras, Kandelia and Rhizophora community; Avicennia, Aegiceras and Kandelia community; and , *Sonneratia casseolaris* community. In addition, more than 30 species of fish, shrimp, and clam species were caught daily by 25% of the local population Daily income from native fishing practices brings in more than 200,000 VND/day/person in the Cua Sot research area (Nguyen Thu Hien and Ho Dac Thai Hoang, 2015).

According to planning, the total area of mangrove forest in Ha Tinh is expected to increase from 752.6ha in 2015 to 1,162.1ha in 2022, as a result of new planting of 409.5 ha of mangroves in currently bare land. 36ha of this new planting will be in old shrimp ponds in Nghi Xuan District, while all the rest will be in tidal areas on the seaward side of existing mangroves (DARD, 2015). However it is worth noting that survival rates of recent mangrove planting schemes have been quite low. Some additional planting may be carried out in existing mangrove protection forests, and enrichment planting will be implemented in plots in poor condition with low densities of mangroves.

Table 3.10: Mangrove forest development planned for 2022 in Ha Tinh by district

Activities	Total	District					
		Ky Anh	Cam Xuyen	Ha Tinh city	Thach Ha	Loc Ha	Nghi Xuan
Existing mangrove area (ha)	752.6	360.5	48.4	66.4	117.1	113.6	46.7
New planting bare land (ha)	409.5	170.0	92.7	7.8	24.5	18.4	96.0
Total area by 2022 (ha)	1,162.1	530.5	141.1	74.2	141.6	132.0	142.7
Protection forest planting	499.2	192.5	38.4	54.4	115.1	60.1	38.7
Enrichment planting in poor and low density plots	253.4	168.0	10.0	12.0	2.0	53.5	8.0

Sources: DARD, 2015

Photo 3.3: New mangrove stand planted in January 2016, viewed from Cua Nhuong Bridge toward the river mouth

Photo 3.4: Newly planted mangroves in the Rac River

The area of the lac Giang River shown in Photo 3.7, used to have dense Sonneratia trees, but people cut most of them down them down. Those remaining in the picture are around the pond of Mr. Luu and Mrs. Huong who have lived here for over 20 years. According to Mr. Luu, his Sonneratia trees trees help to cool down the water temperature during the summer, so it's good for fish and shrimp.

Photo 3.5: Lac Giang River, Cam Quan commune, Cam Khe district

In addition to mangroves, there are some mud flat areas in the estuary of Cua Hoi - Song Lam in Nghi Xuan District; My Duong river estuary in Cuong Gian commune, Nghi Xuan District; the estuary of the Lac Giang River, Cam Nhoung Commune, Cam Xuyen District, and in Ky Ha commune of Ky Anh District. No detailed assessment of their status was available, but in general estuary and river mouth areas of all four main estuaries are highly developed and normal ecological functioning is disrupted.

Photo 3.6: Cua Nhuong Bridge - 1,390 m long, built 2010-2015, second longest bridge in Central Vietnam

Google Earth, August 2014

Normal ecological functioning of freshwater ecosystems upstream of the estuaries, and downstream coastal ecosystems, is also disturbed 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, making conditions too salty for many mangrove species to survive.

Photo 3.7: Do Diem saltwater barrier on the Nghen River (đập ngăn mặn Đò Điệm)

3.4.4. Coastal Ecosystems

The main coastal ecosystems of Ha Tinh are

- sandy beaches and sandy soil ecosystems (together with coastal forest formations at the landward edge of these systems)
- coral reefs
- sea-grass beds
- Deeper water (50m+) offshore marine ecosystems (not considered in this study)
- Island ecosystems (not considered in this study).

3.4.4.1. Coastal forests in sandy areas

Sandy areas in Ha Tinh province stretch along the sea shore about 100 km from the Lam river estuary, Nghi Xuan district to Con Bo river estuary in Ky Anh district. Sandy areas occupy about 12.7% of the total land area. According to DONRE (2015) Sandy areas include 2 main soil types, sandy soil and sand dunes (38,222 ha) and saline soils (22,405 ha). Main land uses in this sandy area are for protection forests, agriculture, aquaculture and residential land.

Similar to other coastal provinces in Central Vietnam, *Casuarina equisetifolia* is identified as the main tree species for plantation in sandy areas of Ha Tinh province. According to Van Thang, 2016 (quoting Ha Tinh PPC 2014, 2015) protection forest in sandy land areas of Ha Tinh province is 5,855.4 ha distributed in 33 coastal communes of 5 districts, Nghi Xuan, Loc Ha, Thach Ha, Cam Xuyen and Ky Anh. Of this, windbreak and environmental protection forest cover 885.9ha and 4,451.2 ha respectively.

Historically, sandy areas in Ha Tinh province were covered by more than 250 indigenous tree species. In most cases the original natural habitat has been highly degraded. With increasing population and expanding residential land, sandy natural forests were clear cut and replaced with *Casuarina equisetifolia* for fuel wood needs of local people. In addition to the main 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* (Van Thang, 2016, and personal observations of consultants).

Small remnant patches of Melaleuca forests are still found in some parts of Ha Tinh province such as in Cam Duong, Cam Hoa communes of Cam Xuyen District. But it is difficult to know their original extent (Van Thang, 2016).

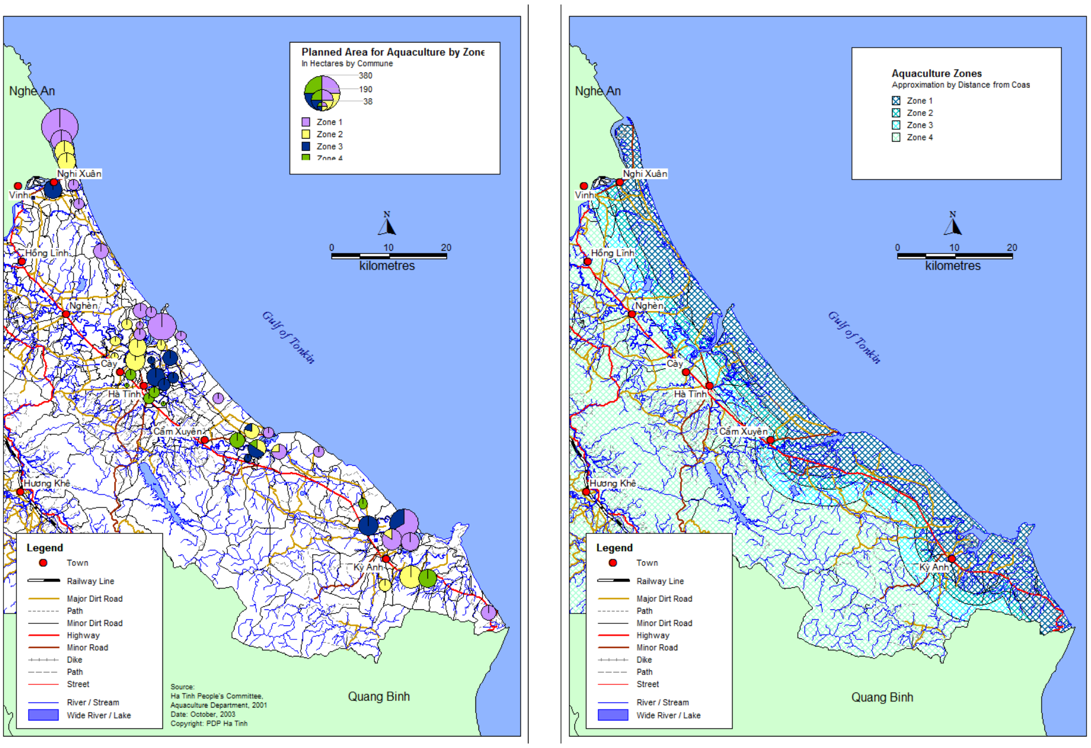
Photo 3.8: Land use in sandy areas - Cam Duong commune, Cam Xuyen District, Ha Tinh Province

Shrimp cultivation in Vietnam has experienced many periods of ups and downs. Nowadays, dry sandy areas have been identified as the best location to practice shrimp pond cultivation. Before 2013, most shrimp ponds in Ha

Tinh province cultivated giant tiger prawn but faced many problems of yield, market and also disease. In 2014 - 2015, the local goverment in Ha Tinh has started promoting new practices, raising white shrimp in sandy areas. Ha Tinh DARD (2015) recorded some 160ha of sandy land were converted to shrimp pond and were yielding 20 tons of shrimp per ha per rotation. It is anticipated that in coming years, with further development of the ASEAN Economic Community (AEC) both demand and price will increase. Consequently it is planned that large tracts of sandy areas will be converted to shrimp ponds for white shrimp cultivation. In addition to the transformation of sandy ecosystems, waste water drainage from shrimp ponds in Ha Tinh causes strong pollution to not only the sandy areas but also to nearby sea water and beaches.

Photo 3.9: Aquaculture in sandy areas of Xuan Pho Commune, Nghi Xuan District

Figure 3.8: Aquaculture zoning and planning in Ha Tinh



Source Ha Tinh PPC, 2003

Planting of sandy protection forest in Ha Tinh has been promoted to expand forest cover to face the challenges of disaster risk reduction and climate change. According to Ha Tinh PPC (2014, 2015) protection forests in sandy land areas of Ha Tinh province cover 5,855.4ha in 38 coastal communes of 6 districts (Nghi Xuan, Loc Ha, Thach Ha, Cam Xuyen and Ky Anh district and Ky Anh town), and are clasified into 3 main protection forest types: (i) mangrove forest along banks of rivers in estuaries; (ii) windbreak forest; and (iii) environmental protection forest. Windbreak and environmental protection forest cover 885.9ha and 4,451.2ha, respectively. Similar to other coastal provinces in Central Vietnam, *Casuarina equisetifolia* is the main tree species that has been widely planted in sandy areas of Ha Tinh province as protection forest. However in many large areas of Ha Tinh province with poor sandy soil *Casuarina equisetifolia* can not grow well as a tree form but is creeping on the ground.

Photo 3.10: Casuarina planting at the mouth of the Song Lac Giang River/Cua Nhuong Estuary

It is true that *Casuarina equisetifolia* plays an important role in fuel wood supply and also provides some benefit as a windbreak; in partiallty stabilising moving sand; regulating microclimate and protecting underground water in sandy areas. Nevertheless, at the end of the day it is still a monoculture tree plantation, poor in biodiversity, with very basic ecological funtions and greatly reduced ecosystem service values. While new casuarine planting is still going on, at the same time, clear-cutting of large areas of coastal protection forest for residential land and aquaculture has recently been recorded in all 6 coastal districts of Ha Tinh province.

3.4.4.2. 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 ha Tinh Province. From the coastal morphology and oceanic conditions, we might expect there to be some fringing reefs running parallel to the shore line.

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.

3.4.4.3. 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 Ha Tinh, no specific information could be found on sea-grass in Ha Tinh.

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 protection against 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, 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 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 3.11: Summary of key points of Quang Binh ecosystems for resilience and EbA

Ecosystem type	Amount	Status (condition) & main threats	Main climate vulnerability
Semi-tropical broadleaf moist evergreen forest >700m altitude	26,000 ha	Medium size area, good condition some in Vu Quang National Park SFU, and some in other high elevation Protection Forest areas	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
Tropical broadleaf moist evergreen forest <700m altitude	205,000 ha	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. A large proportion is in Vu Quang National Park and Ke Go Nature reserve, as well as a nuber of different protection forests	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
Rivers and streams	100+ short rivers with 400 km combined length, 13 billion cubic metres annual flow	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)	700 million m^3	Natural vegetation around open water bodies has been mostly replaced by casuarina and acacia, and the water bodies themselves have mostly be trained for agriculture. At least one lagoon is still managed for fisheries production.	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

Ecosystem type	Amount	Status (condition) & main threats	Main climate vulnerability
Mangroves	752 ha	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	N/A	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 /sandy area ecosystems	38,000 ha	Sandy areas account for a significant part of the coastal zone – but have mostly been heavily degraded by a combination of human settlement, tourism development, aquaculture, agriculture, titanium mining and development of a Special Economic Zone. 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

As identified in Chapter 2, the population in 2002, 2006, 2011 and 2015 was 1,277,878; 1,288,513; 1,237,809 and 1,261,288 people, respectively. Overall, about 16 % of the provincial population is urban, including the district headquarters, and 84% rural (Statistics Office, Ha Tinh, 2015). The mean population density is 211 persons/km^2 in 2015, but there are very distinct patterns in population distribution, which are reflected in land-use patterns and have implications for the extent, condition and resilience of ecological systems, as well as for climate change adaptation.

The majority of Ha Tinh's population (~ 80%) is concentrated in the lowland and coastal areas, broadly mirroring the distribution of paddy rice cultivation areas, the provincial capital of Ha Tinh and the route of the main national road 1A. 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. 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 have been impacted by tourism development, fishing village settlement and the development of aquaculture on sandy areas, as well as titanium mining and the development of the Vung Ang Special Economic Zone. 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. The people living in these areas are also most exposed to some of the most extreme climatic events - tropical storms, tidal surges, saline intrusion, while at the same time has the least remaining natural environment to support their resilience.

- 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.

The large number of small densely populated communes in the lowlands contrasts with the large sparsely populated districts in the upland areas, where large areas of uninhabited forests remain. In Huong Khe district, the average population density is less than 50 persons/km^2. At the same time Huong Khe has over 95,000 ha of forest and Huong Son over 80,000ha - together accounting for over half of the remaining forest land of the province (MARD-FIPI, 2012). As identified in Chapter 2, the poverty rate is also high in the mountainous districts. 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. Settlements in the mountainous areas are still quite concentrated in river valleys or other transport routes. People inhabiting the narrow inland valleys are subject to flash flooding and cold snaps, and on the mountain slopes to landslides, drought, high temperatures and hot winds from Laos.

A significant proportion of rthe remaining forest is protected in Vu Quang National Park and Ke Go nature reserve, as well as their adjacent buffer zones.

- 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

Reviewing the extent condition and trends of ecosystems in Ha Tinh, it seems that in the lowlands and coastal areas most original natural ecosystems have disappeared or been highly degraded. There is very little mangrove forest, and only small patches of melaleuca forest. Most coastal protection forest is single species casuarina plantation. Large sandy areas have been removed for the Formosa development or otherwise degraded or destroyed by titanium mining and aquaculture development. 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.

At the same time, as already identified in Chapter 2, the densest human populations in Ha Tinh are in the coastal lowlands. Here too are the largest numbers of poor people, who are on the front-line for many of the region's most severe climate events. 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.

- In this situation, these remaining lowland and coastal ecosystems are not in a good position to be able to offer 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. Any EbA intervention in the lowland and coastal areas of Ha Tinh would 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).

In the hilly and mountainous areas there is still significant forest cover. A large proportion of this is natural forest, of varying condition. As identified in Chapter 2, the poverty rate is high in the mountain districts. 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.

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, priority areas for further assessment at the local level, and development of EbA interventions could be formerly logged-over and partially degraded watershed forests, such as those of Ke Go. Improved management in general, together with a number of specific interventions could greatly enhance the resilience of these forests, and the ecosystem services they supply, in the face of climate change. Climate change mitigation, and biodiversity conservation co-benefits would also result from these interventions.

A micro-level assessment of Ke Go Nature Reserve could focus on:

- Getting a better understanding of the success of enrichment planting with indigenous species and assessing the effectiveness of this in reducing sensitivity to climate hazards, as well as identifying options and possibilities for further expansion of this approach
- Compiling information on temperature tolerances of different indigenous species and identifying the species that should be prioritized for planting based on their suitability for the expected future climate conditions
- Getting a better understanding of the level of illegal logging, poaching and encroachment (including through use of remote sensing and drones)
- Getting a better understanding of NTFP collection and its relative importance to local livelihoods
- Identifying a list of possible interventions that could improve management outcomes of the nature reserve, while also contributing to livelihood diversification and income generation for local people

Some initial ideas for EbA and related interventions might include:

3.6.1. Improved management of Ke Go nature reserve and Ke Go Reservoir

- Involving local communities in enrichment planting of NTFPs (rattan and other palms) while at the same time setting harvesting agreements and quotas for sustainable collection (this will create more good habitat for the pheasants as well it has been suggested that the pheasants eat rattan seeds and make their nests under the palms collected for conical hats)
- Establishing a captive breeding centre for Vo Quy Pheasant which could also generate income as a tourist attraction, and preparing for eventual reintroduction of the pheasants at a time when conservation agreements can be reached with communities to eliminate snaring
- Introduction of bamboo growing in degraded areas and development of bamboo products

3.6.2. Maintaining/restoring natural flows and rewilding rivers

- At least one of the main rivers in Ha Tinh 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.

3.6.3. 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 Vu Quang and Ke Go, as well as other forms of forest in the wider landscape.

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CHAPTER 4 ECONOMIC PROFILE OF HA TINH FOR VULNERABILITYASSESSMENT AND EBA

4.1. Introduction

The objective of the macro-level analysis economic scoping exercise for EbA Vulnerability Assessment is to identity the most important economic activities and assets at provincial level that need to be considered as part of the climate change vulnerability assessment. This economic profile complements the social profile and the ecological profile also prepared for Ha Tinh, and the three of them together are used to identify the Socio-Ecological Systems (SES) found in the province. These SES then form the basis for the climate change impact assessment.

4.2. Key economic factors for the macro-scale assessment of Ha Tinh

4.2.1. Overview of questions and data

This section presents information to answer key practical questions on economic issues for climate change vulnerability assessment and adaptation planning at the provincial level. It does not attempt to rehearse a full economic profile of Ha Tinh. The macro-level study is intended to use secondary data only and, while many interesting and relevant questions could be posed at provincial level, there is only a limited number of economic factors for which sufficiently comprehensive data already exists at this level or that need to be discussed.

The objective of the exercise is to identify the most important economic activities and assets at provincial level that need to be considered as part of the climate change vulnerability assessment. Thus, we attempt to answer a few simple questions:

- What is the current structure and status of Ha Tinh's economy?
  - Comparison GDP sector; GDP growth/trends; export, employment; land use etc.
  - Currently, what are the most important economic sectors?
  - Who is involved/most important (state, private, smallholder)
- What plans are there for future development?
- What are the key activities within those sectors?
- What are the key assets supporting economic activity and where are they located?
  - Transport (road, rail, ports, airports), electricity, water

The findings will then inform the identification and description of Ha Tinh's socio-ecological systems (SES), and the prioritisation of a small number of the SES for the micro-scale vulnerability assessment.

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 a concise overview of the economy, highlighting factors to consider in EbA planning.

4.2.2. Overview of the status and structure of the provincial economy

4.2.2.1. Provincial role/Position in national economy

The North-central Coast of Vietnam is still one of the economically less prosperous regions, compared with other parts of the country. In 2010, the poverty rate of the North-central and Central Coast region was 20.4%, just less than the North-west region and the Central Highlands. This high poverty rate may be explained both by distance from major economic centres and the harsh climatic conditions that this region suffers annually. Moreover, until recent times, much of the economic activity in the region has been related to agriculture, and the overall scale of production has been small and scattered. The government has recognized this challenge and has been taking actions to change this situation. In terms of GDP per capita, the North-central Coast ranked second from bottom, just above the North-western region. Of Vietnam's 63 provinces nationwide, Ha Tinh represents 1.8% of the total area, 1.5% of the population, and only 1.1% of the national GDP (Ha Tinh PC 2012).

The above notwithstanding, Ha Tinh does have some comparative advantages and opportunities for future development. The province is conveniently located for cooperation and trade with neighbouring countries. The major transport arteries include Highway 1A, the Ho Chi Minh road, the railway running north-south, as well as Highway 8A, and Highway 12A running east-west. In addition, Ha Tinh also has Cau Treo international border gate with Lao PDR, and the deep water port of Vung Ang - Son Duong which facilitates trade with countries in the region. The strengthening sub-regional development along the East-West Economic Corridor of the Greater Mekong Sub-region provides opportunities for Ha Tinh development and economic integration (Ha Tinh PC 2012).

4.2.2.2. GDP

In 2014, Ha Tinh had a GDP per capita equivalent to USD 1,674 (up from USD 690 in 2010) and a total GDP of slightly over US$2 billion, equivalent to 1.1% of national GDP. In 2014, only 26% of the budget came from the Provinces own funds, with 74% coming from central budget transfers and ODA (Ha Tinh Statistical Year Book, 2015).

4.2.2.3. Structure of the economy

4.2.2.3.1. Three sectors

In Vietnam, it is the convention to report the structure of the economy in terms of the GDP contributions of three main “sectors”: i) agriculture, forestry and fisheries (AFF) - the main land-using sectors; ii) industry andconstruction; and iii) other areas, including tourism. Given that AFF dependent livelihoods are generally more vulnerable to climate change than industrial or service-sector related livelihoods, then somewhat more detailed attention is given to AFF in this report. Trade and services currently accounts for 31% of GDP, industrial production and construction 38% agriculture forestry and fisheries 20% of GDP and product tax 11%.

4.2.2.3.2. GDP contributions: main sectors

Vietnam’s GDP in 2015 was 193.6 billion USD, up from 115.93 billion USD in 2010. Of this, in 2015, 18% was from AFF, 39% from industry and construction; 42% was from others (services and tax). The GDP share of all three sectors greatly increased since 2010, AFF is doubled, Industry and Construction is over fivefold and others are nearly triple (Statistic Publishing House, 2015).

Gross output (at 2014 current prices) is 90.4 trillion VND (equivalent to 67.8 trillion at 2010 constant prices) up from 32.2 trillion VND in 2010 - a very impressive rate of increase. Of 2014 gross output, 46.17% is from construction, 24.20% from services, 17.06% from agriculture, forestry and fisheries, and 12.75% from industry. Between 2010 and 2014, there has been a 9% decline in the share of agriculture; 8% decline in the share of services, and a 2.8% decline in the share of industry. At the same time the share of gross output provided by construction has risen by 20%.

In 2010, around 23% of economic activity was state controlled, around 68.5% was non-state, and less than1% was through foreign investment, the rest accounts for tax and subsidy. However, by 2015 the foreign investment sector had grown to account for 14.7% of gross output with state responsible for only 16.7% and non-state for 55% (of which collective =0.8%; private business =19.8%; and household =34.4%) (Statistic Publishing House, 2015). Only 2 FDI projects were active in the province in 2006. Between 2010 and 2014, a total of 44 Foreign Direct Investment (FDI) projects were licensed, with a total registered capital of 364 billion USDUSD 10 billion. Of these, three-quarters were for manufacturing activities, and coming from Taiwan, followed by a much smaller number of projects in accommodation and food service activities. In 2014, 6 new FDI projects in mining and quarrying were also approved (all from Taiwan) with a relatively modest combined registered capital of USD 17 million, and one new accommodation and food service FDI activity (from the Czech Republic) was approved with a registered capital of USD 25 million.

Within agriculture, forestry and fisheries the value per unit of cultivated area reached an average of 60 million VND/ha/year in 2015; of this, 48.81% is from animal husbandry in 2015. Food crop production reached 53.3 thousand tons; aquaculture production reached 44,119 tonnes; and meat output reached 86,976 tons, representing an overall increase of 10.7% compared with 2013. Restructuring of the agricultural sector in Ha Tinh is emphasising increasing the scale of production, and modernising and mechanising the sector with more production originating from larger enterprises, and increased private investment (Ha Tinh Statistical Year Book, 2015).

Within industry and construction, as mentioned above, construction is by far the largest component. Gross output of construction in 2014 was 41 trillion VND, of which foreign investment accounted for 23 trillion (56%).

Within industry per se, manufacturing accounts for about 5% of total GDP; production and distribution of electricity and gas for 1.6% of GDP; and mining and quarrying for 1% of GDP. In the mining sector, regulations on price calculation of royalties and payments associated with mining rights were passed under Decree 203/2013/ND-CP and applied to 129 mines, bringing in total revenue of 457.6 billion VND in 2014. “Handicraft” factory is a growing area. With gross output up 22.93% in 2014 compared with 2013.

Within services, wholesale and retail trade accounts for 11.6% of GDP; education and training 4.5%; transport and storage 3.8% accommodation and food services 2%. Activities of the Communist party, socio-political organisations, public administration, defence and compulsory security also account for 5% of GDP.

The remarkable economic growth in Ha Tinh over the last 5 years has largely been led by a boom in construction and a significant increase in foreign investment. The main thrust of Ha Tinh’s economic development strategy is to rebalance the provincial economy towards heavy industry and services, so that by 2020, the relative contributions of agriculture, industries and services are 13%, 55% and 32%, respectively. Overall, the economy is expected to grow at 18% pa and exports to increase 5-fold in value to USD 2,000 million by 2020.

A key focus of industrial development in the province is to ensure timely handling of any difficulties and challenges to accelerate implementation of industrial development and construction projects - including the acceleration of water supply projects to the Vung Ang special economic zone, speeding up the implementation of the Formosa facilities, etc. Saigon Brewery has increased its capacity for canned beer production.

4.2.2.4. Population

From 2006 to 2014, the population of Ha Tinh province slightly declined from 1.277 million to 1.261 million, with the annual average rate of population growth of -0.16%. As a result of this population trend, Ha Tinh province in 2010 accounted for only 1.41% of Vietnam's population. The decrease in the total population was derived from migration to other provinces in Vietnam or to other countries.

Nearly 85% of the Ha Tinh population still lives in rural areas. Of the 13 district units, so far only 3 are considered as urban centres - the city of Ha Tinh, towns of Ky Anh and Hong Linh. However as well as migration out of the province, there is a very clear trend of migration from rural to urban areas within the province. So while the overall population of Ha Tinh declined in the last decade, the rural population declined even more so, the urban population increased. During the periods 2001-2005, and 2006-2010, urbanisations growth rates were 9.1% and 8.3% in Ha Tinh city; and 3.8% and 13.3% in Hong Linh town, respectively, the Ky Anh town has been just established in 2015. In 2015 overall current urbanisation rate is 12% and by 2030 it is expected to be 48% (DOIC, 2015).

4.2.2.5. Employment

Wholesale and retail trade; manufacturing; construction; as well as accommodation and food services, are the biggest sources of employment in all types of enterprises. Overall employment is increasing with over 16,000 additional people employed in these four sectors alone, between 2010 and 2014.

Table 4.1: Employment in enterprises in main sectors in Ha Tinh in 2015

Sector	Employees (2011)	Employees (2015)
Construction	10,152	14,438
Manufacturing (mostly metal products and non-metallic mineral products)	25,759	20,333
Mining and quarrying	3,792	2,549
Wholesale and retail trade, and vehicle repair	42,110	50,941
Accommodation and food services	10,337	13,863
Transport and storage	4,795	5,365
Real estate	641	4,472
Other services	2,734	4,364

Source: Ha Tinh Statistical Year Book, 2015

(Note: only sectors employing more than 2,000 people have been listed)

4.2.2.6. Labour migration

More than 12,000 workers migrate out of Ha Tinh each year, with about half going to other provinces in Vietnam, and half going abroad. In the past 5 years, the proportion of people in the province migrating abroad has increased, mainly from the 5 coastal districts. Government policies also contributed to this. The Government of Vietnam has encouraged labour exports to achieve employment, increase income, and enhance the skills of the workforce. Anyone who wishes to, can join the labour export programme, they don't have to be poor. But poor households can get loan support and support with passports and visas and other administrative procedures (DOLISA, 2015).

In total more than 51,000 people from Ha Tinh are now working abroad in more than 25 countries including Japan, South Korea, Taiwan, Eastern Europe, and the Middle East. More than 35,000 went under the MOLISA international cooperation programme. Another 16,000 were spontaneous migrants/self-arranged mainly to Thailand and Lao PDR (there are more than 15,000 people from Ha Tinh working in Thailand). HaTinh DOLISA is now about to implement a review programme on spontaneous migrants to Thailand and Lao PDR as part of a MOLISA national review in preparation for AFTA and AEC. Data on returning migrants and job availability for them after returning is currently insufficient (DOLISA, 2015).

One of the main reasons for people to migrate is to seek better employment opportunities. Ha Tinh Province is considerably below the national average in creating new employment opportunities - while jobs in Vietnam have increased at a rate of 2.8% annually from 2000 to 2010, in Ha Tinh the figure is only 0.9%. Most migrants are working in the agricultural sector in Ha Tinh, where there is strong seasonal unemployment. Also, some people migrate in search of work and higher income in industries and services. These are jobs that are difficult to find in Ha Tinh. Others leave Ha Tinh to seek educational opportunities and more intensive training to improve their employment prospects. They rarely return to work in Ha Tinh, where there are fewer higher level jobs to suit their new skills and qualifications.

According to the Living Standards Survey of households, the average monthly per capita income in 2010 in Ho Chi Minh City was 2,737 million VND, compared to 2,013 million VND in Hanoi, 1.897 million VND in Danang and only 839,700 VND in Ha Tinh. Ha Tinh benefits however from remittances from its overseas workers. For example, in 2010 migrant workers sent 1,200 billion VND back to Ha Tinh, equivalent to a third of the province's export earnings (Ha Tinh PC 2012).

In addition to migration of Ha Tinh labour out of the province, there is also migration of Vietnamese and overseas labour into the province. The Vung Ang economic zone has 40,000 employees - nearly 8,000 are foreigners including Chinese, Taiwanese and others from a total of 25 countries from Asia, Europe, America and Africa. Of the other 32,000 Vietnamese nationals employed in Vung Ang, 50% are from Ha Tinh but the rest are from another 61 towns and provinces across Vietnam. Many of these are involved in the construction work. In another 2-3 years when the infrastructure is fully developed, this number will go down considerably.

Nationwide nearly 200,000 Graduate from university temporarily have no jobs. Many come back to their home towns because they cannot find jobs. Information on unemployed returning graduates in Ha Tinh was not available. DOLISA is the key agency implementing Decision # 156 - providing vocational training support for rural labour to help them shift from one job to another - to improve productivity and improve income. This includes short training courses for unemployed labour.

There are some social problems associated with high levels of migration. Firstly, in many villages the number of young working age adults is reduced, and young children of migrant workers are often left in the care of grandparents or other relatives. The Womens' Union established a "When mother is far from home club" to support children and adolescents. Secondly, in the Vung Ang Economic Zone, there are elevated levels of crime, sex workers, drug-related crime, etc. The local government is very concerned about this existing problem. Some groups are also trying to take advantage of situation to foment unrest between Chinese workers and Vietnamese people.

4.2.2.7. Land use

Land use patterns provide a different set of insights into an area's economy. Table 4.2 presents figures for Ha Tinh land use in 2015, while Table 4.3 presents a breakdown by districts, and Map 4.1 shows the distribution of the principal land uses. Reflecting the province's mountainous terrain and narrow coastal plain, the principal land use in the province is forestry, occupying 58% of the land, followed by paddy rice occupying around 11%.

Table 4.2: Land use pattern in Ha Tinh province (2015)

ID	LAND USE TYPES	Total (ha)	In which	
			Rural areas	*Urban areas*
	Total natural land	599717.66	40875.57	18968.18
1	Agricultural land (including Forestry)	476157.55	23093.15	11211.58
1.1	*Cultivation land*	120548.33	22288.03	6240.26
1.1.1	Annual crop	86709.61	2516.23	4483.46
1.1.1.1	Paddy rice	64691.09	1388.94	3725.56
1.1.1.2	Grassland for castle	438.32	35.10	4.40
1.1.1.3	Other annual crops	21580.20	1092.19	753.50
1.1.2	Perennial trees	33838.72	19771.80	1756.80
1.2	*Forestry land*	350882.67	642.68	4657.64
1.2.1	Production forest land	161244.38	455.16	1443.91
1.2.2	Protection forest land	115040.48	187.52	2509.83
1.2.3	Special use forest land	74597.81		703.90
1.3	*Aquacultural land*	4096.18	159.70	245.14
1.4	*Land for salt production*	423.70		10.12
1.5	*Other agricultural land*	206.67	2.74	58.42
2	Non-agricultural land	84961.15	17604.60	6360.12
2.1	*Residential land*	8654.29	7473.52	1154.04
2.1.1	Residential land in rural areas	7500.25	7473.52	
2.1.2	Residential land in urban areas	1154.04		1154.04
2.2	*Special use land*	42874.66	9427.49	2974.56
2.2.1	Land for government offices	293.09	157.21	98.00
2.2.2	Military land	1892.50	28.98	104.69
2.2.3	Security land	111.87	1.83	21.84
2.2.4	Business land	5508.52	226.25	365.73
2.2.5	Public land	35068.68	9013.22	2384.30
2.3	*Religional land*	337.01	252.53	35.31
2.4	*Graveyard land*	4783.45	86.41	267.47
2.5	*Water surface*	28273.85	363.29	1927.99
2.6	*Other non-agricultural land*	37.89	1.36	0.75
3	Unused land	38598.96	177.82	1396.48
3.1	*Unused flat land*	15049.89	135.62	1100.58
3.2	*Unused mountain and hill side land*	21358.41	42.20	295.31
3.3	*Rocky mountain without trees*	2190.66		0.59

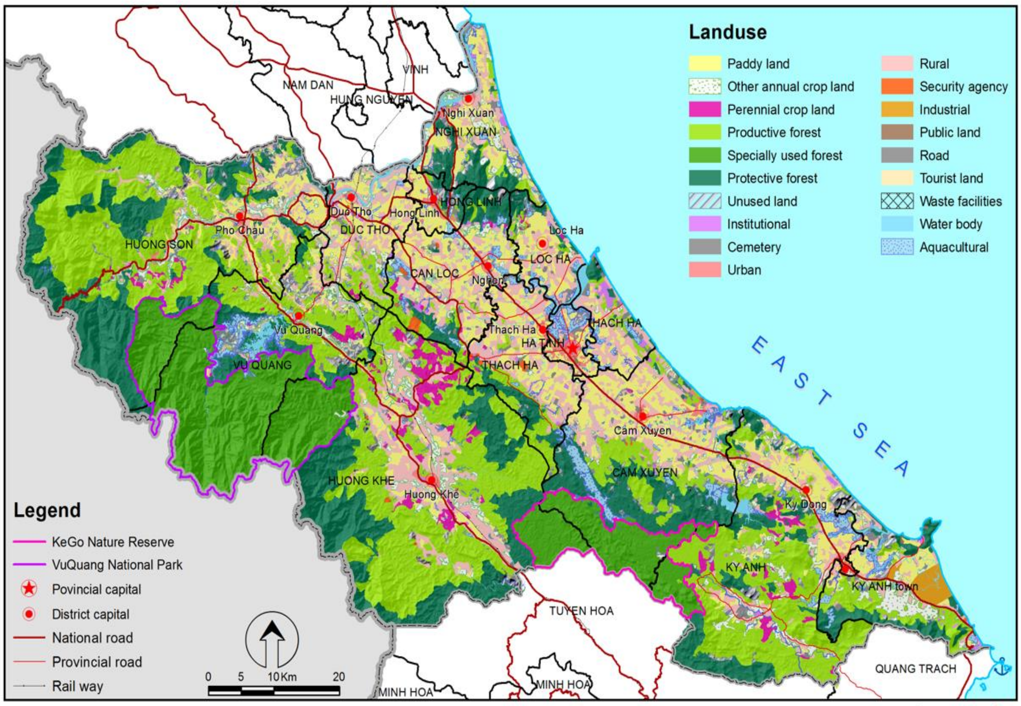
Source: DONRE Ha Tinh province, 2015

Table 4.3: Major land uses in Ha Tinh by district (as of 31 Dec. 2015)

Name of city/district[10]	Total area (ha)	Agricultural production land (ha)	Forest land (ha)	Special use land (ha)	Homestead land (ha)
Total	599,031	152.563	322.107	41.498	11.794
Ha Tinh city	5.655	2.475	72	1.297	808
Hong Linh	5,897	2.274	1.217	963	297
Huong Son	109.680	16.539	83.019	3.467	963
Duc Tho	20,349	11.219	3.161	2.384	947
Vu Quang	63,766	6.178	47.640	1.352	352
Nghi Xuan	22,246	8.345	4.724	2.090	717
Can Loc	30,213	15.109	5.736	3.653	1.139
Huong Khe	126,274	26.005	87.383	3.221	899
Thach Ha	35,391	15,057	7,448	5.057	1.672
Cam Xuyen	63,635	17.684	31.484	4,067	1.730
Ky Anh	75.960	18.760	40.003	5.973	939
Loc Ha	11,743	5.619	1.701	1.383	802
Ky Anh	28.222	7.299	8.519	6.591	529

Source: Ha Tinh Statistical Yearbook 2015

Figure 4.1: Land-use patterns in Ha Tinh



Source: - Landuse map 2010 (Cadastral Engineering and IT Center Ha Tinh)

[10] The Ky Anh town was just split-up from Ky Anh district in 2015

4.2.2.8. Economic Models

The Vung Ang industrial complex in southern Ha Tinh (see Photo 4.1) appears to be providing a model for provincial economic thinking. This new Taiwanese/Chinese owned investment will concentrate on steel production, planned to use the local iron ore deposits of Thach Khe , and the development includes two deep water ports, coal-fired electricity plants, new roads and bridges and integrated residential facilities for migrant workers. Construction of the complex levelled Ha Tinh's finest coastal sand dunes, and led to resettlement of many households. It is protected from extreme climatic events and sea level rise by a 10m high sea wall. It is unclear what impact this is having on adjacent coastal areas. Presently 24 different businesses and 94 contractors are working there. Income per capita is 5-10 million dong.

Photo 4.1: Vung Ang industrial economic zone

There are other effective economic effective models at much smaller scales, in fields such as animal husbandry, horticulture, aquaculture, forestry, processing, trade and services (Ha Tinh PC 2013). Many models of production and business efficiency are being replicated, and the number of cooperatives, cooperative groups and businesses in the agricultural sector has increased rapidly (Ha Tinh PC 2014). In 2015, restructuring of the agricultural sector achieved significant results, helping motivate development and leading to a production value growth rate of agriculture, forestry and fisheries of 7.96%. Some major agricultural products are starting to attract big business to invest, increasing the scale of production, upgrading quality and gradually integrating into higher value market chains. This is happening for example for high quality beef cattle, pigs and shrimp farming.

The Consultative Group on Social Policy Coordination established by the Provincial New Rural Development Office disseminates information to residents quickly and efficiently, helping people to easily access bank loans to invest in production development.

4.2.2.9. New Rural Development Criteria

In the New Rural Development Programme there are 19 criteria that communes need to follow. In Ha Tinh the national new rural development program focuses on improving transport, irrigation, electricity, telecommunications and housing in rural communities. Targets include providing 100 liters/person/day of potable water, and upgrading and expanding rural roads to reach the minimum width of 4m. The program also contributes to improving schools, cultural infrastructure, and the health care system in rural areas (Ha Tinh PC 2012). By the end of 2014, 26 communes had reached all 19 criteria; 8 communes achieved from 13-18 criteria; 135 communes achieved from 7-12 criteria and 65 communes achieved less than 7 criteria (Ha Tinh PC 2014). By late 2015, another 26 rural communes had achieved all new standards, bringing the total number to 52 communes (22.6%), and no commune had achieved less than 8 criteria (Ha Tinh PC 2016).

4.2.3. Economic development: performance and plans

While Ha Tinh is one of the poorest provinces of Vietnam, it is experiencing remarkably rapid growth and provincial government fully intends for this growth to continue. In identifying its development orientation to

2020, Ha Tinh provincial planning must be consistent with the strategic planning of sectors and products the country, including the zoning of the Central Coast 2020 which has been approved by the Prime Minister in Decision No. 61/2008/QĐ-TTg dated 9/5/2008. The key areas in this planning include:

a) Strengthening infrastructure

Central Coast Regional Infrastructure development should be consistent with the coastal area, including land and marine infrastructure. Ha Tinh will closely implement plans to build highways and important provincial roads, as well as upgrading the existing roads to expand capacity. Moreover, Ha Tinh will support the construction of a high-speed rail route, and will expand and upgrade the Vung Ang port and construction of infrastructure systems to support the provision of water, electricity and waste management more efficiently.

b) Development of the marine economy

With the potential of a large port cluster, Ha Tinh will have to build and develop the urban centers of the province to support maritime operations. Ha Tinh must also promote the development of Vung Ang economic zone by attracting more investment capital to the region.

c) Poverty alleviation and development of disadvantaged areas along the coastline of Vietnam:

Ha Tinh needs to improve both the health system and the education system to ensure that the physical facilities of schools and health facilities meet the new national standards. Specifically, the province needs to ensure that 100% of primary schools reach the national standards by 2015; and that 70% of high schools and 50% of junior high schools meet national standards in 2020. Ha Tinh also needs to focus on development of the social security system and the implementation of social policies to support the lives of poor populations.

d) Developing industry, services and agricultural activities:

The central coastal provinces should strengthen investments in technological innovation and product design in a list of selected industrial products including oil, petrochemical products, energy, metallurgy, electronics and shipbuilding. Ha Tinh will play an important role in industrial operations. Ha Tinh also needs to ensure agricultural and forestry activities in the province are unified, and consistent with agricultural and forestry activities of the entire central coastal area. To do this, the province will have to focus on the application of high technology to ensure the quality and safety of food and achieve higher yields. Ha Tinh also needs to pay continued attention to the protection and sustainable development of forest resources in the province.

e) Protecting the marine and coastal environment:

In the development plan, Ha Tinh will continue to implement initiatives to protect the environment, and conserve natural resources, while minimizing the impact of the development of the Vung Ang Economic zone.

f) Ensuring maritime security and defence:

Ha Tinh will train and develop individuals to participate in the security and defence forces. Moreover, Ha Tinh Province will support the security measures and defence for the central coastal region through development of industries such as shipbuilding, construction materials, textiles and communications. This economic activity will strengthen the capacity of coastal areas in the implementation of civil obligations (Ha Tinh PC 2012: 90).

DPI has overall responsibility for submitting Socio-economic Development Plans (SEDP) to PPC, based on guidelines from the Prime Minister and MPI. In principle planning starts from the commune level to the district and then to the provincial level where DPI develops the provincial plans and send them to the PPC. The plan sets development targets - for GDP growth and growth rate of different sectors, together with proposals including measures and tasks to implement the plans. These fall into two broad areas:

- measures and tasks for achievement of specific targets of specific sectors;
- development investment - with resources available what can we/should we do - where and how can we involve the participation of the business community.

Implementation of the SEDP in Ha Tinh mainly depends on central budget allocation - both budget transfer and ODA funding. In this context, decision # 60 of PM - on principles and cost norms for use of State Budgets is important in understanding which projects and which programme will be covered by the state budget and it means that investment decisions are very constrained by what is stated in this decision. Normally 80% of construction cost budgets are covered by budget transfer. Importantly for the consideration of Ecosystem-based adaptation, Ha Tinh DPI reported that in the past the province never got any budget allocation from the central budget for non-structural measures.

Ha Tinh DPI has also expressed that they would also like to make a change in the way the state budget is utilised. They have prioritised 3 areas of activities:

- Enhancement of sea-shore
- Reservoir safety - state budget and ODA funding especially DARD supported by ADB and WB
- Sustainable forest development (plantations)

DPI recognises the most important economic assets of HT province as:

1) Economic Zones
2) Livestock production
3) Aquaculture and capture fisheries
4) Processing industries
5) Service industries - Banking and Insurance services

DPI suggests that whatever else we do in Ha Tinh we will stick with agriculture - "it is key sector that should receive special support - it is the remedy to fix the poverty problem - 80% of the population is involved in agriculture - if we fail to pay sufficient attention people will starve".

Orientation for agricultural business development provided by DPI, suggests a focus on key products in different regions:

Coastal areas - promotion of shrimp production and other forms of aquaculture as well as vegetable growing in sandy areas

Lowland areas - paddy rice (cannot compete with the Mekong Delta for rice production)

Hilly areas - soil is not so fertile and weather is severe, land available is limited and fragmented - so it is difficult to improve yields - therefore focus on livestock production - expanding areas for pig and cattle production

Mountainous areas and hilly areas need to ensure forest protection and development.

There are also plans for more value-added products e.g. organic farming, food processing, etc. The province is calling for investment in rural development and agro-business processing, including rice processing, and other agricultural produce processing. There is already some small rice processing and export to China. Also some tea processing - tea is grown in Huong Son and Ky Anh Districts. It is high quality and exported to Europe. One company wants to invest in pomelo and ginger. There are also plans for meat processing factories - for export and for local use (but Vietnamese people don't yet have the habit of consuming frozen meat so it will probably be mostly for export). They are also encouraging and motivating companies to invest in prawn processing for export. One company is already doing fish and squid. Greater attention will also be paid to the maritime economy, particularly restructuring capture fisheries to better exploit the deeper water resources.

However, most emphasis will be put on industry and services. Regionally, Ha Tinh will exploit its location to provide logistic and transport services to its landlocked neighbour Laos, to north-eastern Thailand and even to eastern Myanmar. In all sectors, modern technologies and efficiencies will be pursued and infrastructure developed comprehensively to support it all.

DPI emphasises that Industrial development can bring good revenue from the economic development perspective but they are also very aware about the negative issues associated with industrial development - recognising that there are trade-offs and we have to pay the consequences - not only natural resources and environment suffer, but also industrial development takes land away from other uses, and we also have to find new employment for those whose land has been used for the industrial development.

Vung Anh Special Economic Zone is a springboard for economic development. It contributes 15 trillion dong annually - equivalent to 80% of the provincial budget revenue - from taxes, royalties, environmental fees, and import duties. They are very compliant to the tax regulations. In 10 years' time, it is expected that the special economic zone will also contribute a lot to the provincial and central budget through steel, metallurgy and harbour services. It will also create 15,000 new jobs in the future. Investors from South Korea, Singapore and Taiwan, are all seeking permission to invest there. In 5 years' time, Ky Anh town will become a more industrialized city. Many investors want to do harbour and logistics services. Vung Ang will have the biggest (coal-fired) thermal power plant. There will also be good revenue from this construction work. 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 vulnerability assessment.

4.2.4.1. Agriculture Forestry and Fisheries

4.2.4.1.1. Annual food crops

Rice: The total planted area of rice in the province is about 99,000ha. Yield has steadily increased from 4.75 tonnes/ha in 2011 to 5.04 tonnes/ha in 2014. The main rice growing season is the winter-spring season rice (lua dong xuan) starting from December with a total planted area of just over 55,000ha, followed by early summer-autumn season rice with a total area of over 41,000ha, starting from April. Summer-autumn rice is a very minor crop with an area of only just over 2,000ha planted in this season. This pattern of rice growing helps to avoid damage to crops caused by floods and storms in late summer (2013 figures- see Table 4.7 for more detail). Rice in Ha Tinh is mainly distributed in the lowland parts of the province along the coastal plain, with the largest areas in Cam Xuyen and Can Loc districts, followed by Thach Ha district, Ky Anh district and Duc Tho district.

Photo 4.2: Rice field in Phuc Loc communne, Can Loc district

Table 4.4: Rice production in Ha Tinh, by district, 2015

District	Total rice		Winter spring rice		Early summer rice		Summer rice	
	Area (ha)	Average Yield (tons/ha)	Area (ha)	Yield (tons/ha)	Area (ha)	Average Yield (tons/ha)	Area (ha)	Yield (tons/ha)
Ha Tinh	2,707	4,828	1,475	5,008	12,321,242	46,123,992	0	0
Hong Linh	2,484	4,913	1,374	5,458	11,101,075	42,403,141	0	0
Huong Son	6,786	4,793	4,583	5,485	22,032,816	33,552,458		
Duc Thọ	10,182	5,422	6,388	5,800	37,944,005	4,785,427	0	0
Vu Quang	1,561	5,557	1,243	5,890	318,335	42,553,093	0	0
Nghi Xuan	3,962	4,543	3,090	4,912	467,435	38,572,377	405,381	2,524
Can Loc	18,455	5,331	9,368	5,638	90,878,789	50,154,613	0	0
Huong Khe	5,541	4,587	3,428	5,437	13,101,516	33,012,505	803,676	3,057
Thach Ha	15,382	5,134	7,863	5,223	74,307,170	50,534,405	8,955	3,989
Cam Xuyen	18,462	5,504	9,529	5,503	89,338,430	55,044,611	0	0
Ky Anh dist.	9,324	4,886	5,110	5,071	42,144,097	46,624,033		
Loc Ha	5,161	4,717	2,961	5,362	16,501,348	46,104,254	55,0557	1,564
Ky Anh town	1,741	4,339	1,509	4,371	232	4,129		
TOTAL								

Source: Ha Tinh GSO (2015)

Table 4.5: Maize, sweet potato and cassava production in districts of Ha Tinh in 2015

District	Maize		Sweet potato		Cassava	
	Area (ha)	Yield (tons/ha)	Area (ha)	Yield (tons/ha)	Area (ha)	Yield (tons/ha)
Ha Tinh	7	1.714	50	4.42	0	0
Hong Linh	1	2	51	7.118	0	0
Huong Son	3,542	3.499	173		363	8.138
Duc Thọ	1,376	4.233	91	5.2545.989	24	7.042
Vu Quang	758	4.437	43	4.721	103	9.0
Nghi Xuan	148	2.155	1,383	7.034	379	12.124
Can Loc	260	3.354	678	6.389	271	9.734
Huong Khe	1,980	3.970	313	5.259	79	6.835
Thach Ha	135	2.015	501	6.174	44	6.977
Cam Xuyen	117	2.436	592	6.66	371	11.243
Ky Anh dist.	154	3.065	923	5.612	2,211	20.825
Loc Ha	240	2.029	559	5.472	37	8.892
Ky Anh town	6	2.5	220	5.877	207	12.483
TOTAL	8,724	3.688	5,577	6.189	4,089	15.959

Source: Ha Tinh GSO (2015)

Remark: rice yield in 2013 of whole country and north-central coastal region respectively are 5.58 and 5.37 tons/ha; spring rice are 6.44 and 5.66; early summer rice are 5.21 and 5.06; and summer rice are 4.73 and 4.25 tons/ha

Maize is the second most important annual food crop in Ha Tinh, and is grown especially in districts that have unfavourable conditions for rice production. These are typically the hilly and mountainous districts like Huong Son, Duc Tho and Huong Khe districts, which only have small areas for rice cultivation. Most of the maize is planted in the spring season and summer season - the wet season for rain-fed crops. Maize yield is still limited in Ha Tinh with an average yield of 3,688tons/ha. The highest yield is about 4tons/ha in Duc Tho and Vu Quang; and lowest yields are in Ha Tinh city and Hong Linh town, 1.2 and 2tons/ha, respectively (Ha Tinh GSO 2015)

Sweet potato is a traditional crop very highly suited to the light texture soil groups in Ky Anh and Nghi Xuan. It is grown in about 5,577ha, distributed mostly in sandy soils along the coastal area. The total production is about 34,515 tons/year (Ha Tinh GSO 2015).

Cassava is currently planted in about 4,089 ha in Ha Tinh Province, with a total production of 65,258 tons. It is used industrial purposes (ethanol production), animal feed production, and for human consumption. There is potential to expand production given the multiple sources of demand for the product, and the relative resilience of cassava to hot conditions and low rainfall in the dry season (Ha Tinh GSO 2015).

4.2.4.1.2. Annual Industrial Crops

Sugar cane in Ha Tinh is grown mostly in Huong Khe district with about 87 ha in 2015. Other districts have insignificant sugar cane areas (Ha Tinh GSO 2015).

Peanut is one of the strong industrial crops in Ha Tinh based on the highly suitable sandy soil and climate conditions. In 201 it was grown in a total area of 15,967 ha and was planted in most districts, but with the largest areas in Ky Anh, Huong Khe and Nghi Xuan. Peanut yield in Ha Tinh is about 2.3 tons/ha (Ha Tinh GSO 2015).

Sesame production is strong with a total area of 914ha, planted mostly in Ky Anh and Nghi Xuan districts (Ha Tinh GSO 2015).

Photo 4.3: Peanut field in Phuc Loc Commune, Can Loc District

Table 4.6: Some industrial crops in districts of Ha Tinh in 2015

District	Sugarcane (ha)	Peanut (ha)	Sesame (ha)
Ha Tinh	0	277	11
Hong Linh	0	38	1
Huong Son	16	1,769	1
Duc Tho	0	1,417	0
Vu Quang	24	678	0
Nghi Xuan	0	2,017	266
Can Loc	3	598	21
Huong Khe	87	2,205	3
Thach Ha	2	1,443	42
Cam Xuyen	4	1,167	150
Ky Anh dist.	0	2,345	197
Loc Ha	0	1,405	164
Ky Anh town	0	608	58
TOTAL	136	15,967	914

Source: Ha Tinh GSO (2015)

4.2.4.1.3. Perennial Crops

Over 24,000 ha of Ha Tinh are planted with perennial crops. Around one-third of this is planted with rubber, the single most important perennial crop (in terms of area). In addition, 9,800ha are planted with a variety of non-citrus fruit trees, and a further 2,538ha are planted with oranges and other citrus fruits, grown mainly in the higher elevation areas of Huong Son, Huong Khe, and Vu Quang Districts. Production of the famous Phuc Trach pomelo is still not enough to meet demand. Almost 3,000ha are planted with tea, and pepper is becoming increasingly important as a perennial crop.

Table 4.7: Some perennial crop areas in districts of Ha Tinh in 2015

District	Total Perennial crops (ha)	Tea (ha)	Fruit trees (ha)	Orange/other citrus (ha)
Ha Tinh	167	0	153	16
Hong Linh	110	10	92	11
Huong Son	3,692	678	2,324	772
Duc Tho	804	49	442	45
Vu Quang	3,028	149	1,754	950
Nghi Xuan	238	26	188	18
Can Loc	1,832	214	877	200
Huong Khe	10,483	450	2,854	958
Thach Ha	884	131	645	140
Cam Xuyen	1,469	128	1,271	143
Ky Anh dist.	1,955	617	664	105
Loc Ha	348	86	242	22
Ky Anh town	127	13	110	7
TOTAL	25,137	2,551	11,616	

Source: Ha Tinh GSO (2015)

4.2.4.1.4. Livestock

Although livestock numbers are not particularly high, the sector accounts for a large proportion of agricultural output. Disease prevention and control are increasingly of concern, with some serious outbreaks occurring in neighbouring provinces. DARD is developing vaccination programmes and planning responses to any epidemics that might happen in the future.

Strategies to improve livestock production include:

- promoting larger more commercial and more intensive animal production units
- Continued genetic improvement "Sindhilisation" of cattle herds through AI
- 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 and goats

Table 4.8: Livestock production in districts of Ha Tinh in 2015

District	Buffalo (head)	Cow (head)	Pig (head)	Poultry (1,000 head)	Deer (head)	Goat (head)
Ha Tinh	618	3,588	8,267	238	0	0
Hong Linh	886	1,818	5,166	155	17	333
Huong Son	9,397	27,327	47,930	581	36,627	6,975
Duc Tho	6,052	25,834	40,040	719	415	280
Vu Quang	3,837	9,518	25,372	244	660	257
Nghi Xuan	3,497	13,211	18,593	597	13	642
Can Loc	5,300	26,683	67,627	943	389	296
Huong Khe	17,356	13,406	54,506	643	1,758	374
Thach Ha	7,217	18,929	74,952	903	95	201
Cam Xuyen	8,744	21,796	91,737	1,161	91	223
Ky Anh dist.	11,757	14,482	22,397	636	64	1,200
Loc Ha	2,493	10,633	11,055	256	15	217
Ky Anh town	3,631	5,507	6,189	150	0	9
TOTAL	80,785	192,732	7,225	5,573	40,144	11,007

Source: Ha Tinh GSO (2015)

Overall, the total area of agriculture has remained relatively stable. Since 2007 the total area of rice planted has varied a little each year, between 99-101,000 ha, but summer rice has declined consistently from 7,475ha in 2007 to only 1,732 ha in 2014, while early summer and winter-spring rice planting have both increased. The areas planted with maize and cassava have remained relatively stable, while the area of sweet potato has declined consistently from 13,921ha in 2007 to 5,861ha in 2014. Peanut has remained relatively stable but both sesame and sugar cane (which are only planted in relatively small areas anyway) both declined in area by 40-50% between 2007 and 2014. The amount of tea has increased four-fold in the same period. Orange and lemon tree area has increased from 2,180 to 2,655ha, while the area planted with pomelo has remained about the same. The area planted with bananas has increased from 1,569 to 1,983ha, while the biggest rate of increase (but from a very low starting point) has been seen in mango cultivation which has grown from only 62ha in 2007 to 327ha in 2014 (a 500% increase). See Table 4.9 for more details.

PPC is also developing additional mechanisms to support farmers - for example supporting marketing for farmers' products, supporting provision of cooling trucks, using sludge and agricultural by-products to produce organic fertilizers, etc. The VN cooperation for minerals and mining, also has an animal feed factory.

Table 4.9: Changes in agricultural production in Ha Tinh over time

Total rice	Area planted (Ha)			Yield (tons)		
	2007	2010	2014	2007	2010	2014
	100,844	99,003	101,011	3,607	4,186	5,077
Winter-spring rice	54,514	53,569	56,619	4,342	5,014	5,608
Early summer rice	38,855	41,356	42,760	2,960	3,447	4,482
Summer rice	7,475	4,078	1,732	1,608	0.792	2,444
Other annual crops						
Maize	8,590	8,060	8,311	2,841	3,446	2,993
Sweet potato	13,921	9,427	5,861	6,076	6,244	6,120
Cassava	4,130	3,439	4,022	7,944	11,612	14,570
Beans	4,130	3,439	4,022	7,944	11,612	14,570
Vegetable			9,456			6,344
Jute	20	25	2	3.5	3.12	1.5
Rushes	100	100	100	6.5	6.5	6.5
Sugarcane	280	280	156	52,682	41,432	55,019
Peanut	20,450	19,414	17,376	1,805	2,110	2.,202
Sesame	1,567	14,67	885	0.267	0.339	0.47
Tobacco	6	4	1	0.5	0.5	0.5
Perennial crops	16,862	21,133	N/A	N/A	N/A	N/A
Tea Bud	811	895	2,548	N/A	N/A	N/A
Harvested tea	567	647	2,312	N/A	N/A	N/A
Orange, Lemon	2,180	2,568	2,655			
Pomelo	1,402	1,587	1,417			
Pineapple	296	411	197			
Bananas	1,569	1,951	1,983			
Loongan	145	193	215			
Litchi	111	188	218			
Mango	62	201	327			
Livestock						
Buffalos (1,000head)	109.8	94.7	79,592			
Cow	210.1	166.3	175,325			
Pig	422.4	356.0	434,167			
Horse	0.2	0.2	0.151			
Goats	23.9	11.1	8,588			
Poultry (1000 head)	4,379	4,956	6,492			
Chicken	3,425	3,837	4,952			
Duck, swan, Goose	954	1,025	1,349			

Total rice	Area planted (Ha)			Yield (tons)		
	2007	2010	2014	2007	2010	2014
	100,844	99,003	101,011	3,607	4,186	5,077
Aquaculture area	6,724	6,177				
Brackish water area	2,813	2,197				
Fish	71	99				
Shrimp	2,394	1,698				
Mixed	345	399				
Fresh water area	3,911	3,980				
Fish	3,832	3,955				
Shrimp	11	1				
Mixed	27	8				
Breeding	41	16				

4.2.4.1.5. Forestry

As described in Chapter 3, (the Ecological profile of Ha Tinh Province), around 351,000ha or over 58% of the land area of the province) is still identified as “forestry” land (see Table 4.2 and Map 4.1). However, a land-use designation as forestry land apparently does not always mean that the land actually has forest cover. MARD data for 2012 and HT DARD information for 2015 (see Table 4.10) suggests that actual forest cover is only around 321,000 hectares. Of this total amount of land with forest cover, about 70% is natural forest and about 30% is plantation forest, meaning that in total, natural forest covers about 35% of the province land area and plantation forest about 15%. About 40% of the remaining natural forest is contained within Vu Quang National Park and Kego Nature Reserve.

Table 4.10: Forest types in Ha Tinh

Use type of land	HT Statistical Yearbook 2015		MARD-FIPI 2012	DONRE 2015
	ha	%	ha	ha
Total land area	599, 031	100		
Agricultural land	152,563	25.47		
Forestry	322,107	53.77	351,891	350, 882.67
- *Special use Forest*			*164,014*	*161,244.38*
- *Protection Forest*			*113,300*	*115,040.48*
- *Production Forest*			*74,577*	*74,597.81*

The Forestry Management Boards, Forestry Companies, Commune Peoples’ Committees and Households are all major forest owners in Ha Tinh (see Table 4.11)

- National Parks and Nature Reserves manage the Special Use Forest which includes most of the richest forest with very high biodiversity including remaining areas of primary forest on the East flank of the North Truong Son mountain/border Vietnam-Lao PDR.
- Protection Forest Management Boards manage most protection forest and some production forest. They are responsible for large areas of natural forest, and some plantation forest.
- Forestry Companies manage most production forest including both natural and plantation forests. Combined they are managing a natural forest area that is bigger than Ke Go nature reserve and almost as big as Vu Quang National Park.
- Forestry land allocated for households is mostly land for plantation forestry and ago-forestry practices. Very little natural forest has been transferred to households.

Table 4.11: Forest ownership and management responsibility in Ha Tinh province

Forest Owner			Area (ha)
I. Special Use Forest Mangement Boad	Vu Quang NP	55,341	91,893 (N: 81,155; P: 10,738)
	Ke Go Nature Reserve	36,552	
II. Protection Forest Management Board (PFMB)	Ngan Pho river PFMB	25,019	83,207 (N: 66,030; P: 17,177)
	Ngan Sau river PFMB	16,860	
	Hong Linh PFMB	6,072	
	Tiem river PFMB	12,917	
	South Ha Tinh PFMB	20,567	
III. Forestry Company	Huong Son LLC	18,728	60,745 (N:42,359; P: 18,386)
	Chuc A LLC	14,381	
	Ha Tinh Rubber Company	12,864	
	Huong Khe Rubber Company	14,666	
IV. Other Organization			5,540 (N: 3,989; P: 1,551)
V. Commune PCs			31,717 (N: 14,932; P: 16,785)
VI. Private Households			31,768 (N: 5,766; P: 26,002)
VII. Not yet allocated			15,511 (N)
Total Forest area of Ha Tinh province			320,381ha (N: 229,742ha; P: 90,639ha)

Source: Ha Tinh DARD 2015

In 2014, the forest sector in Ha Tinh generated 1.16 trillion VND of which 957 billion (82.5%) came from timber harvesting, and the remainder came from from forest planting and care - 110 billion VND (9.7%); NTFPs, 52 billion VND (4.4%); and services 41 billion VND (3.4%). Over 50% of this value is generated from Ky Anh and Huong Son Districts, followed by Huong Khe, Vu Quang and Cam Xuyen which account for almost another 40% of the total. Around 260,000m^3 of timber was produced in 2014, of which about 93% was from plantations. Almost all of the plantation timber is used for pulp and chips, and the figures suggest 238,000m^3 of wood chips and pulp were produced. However, the biggest use of wood in the province appears to be for firewood - with a total volume used equal to almost double the total volume of timber, pulp and chips combined.

Table 4.12: Ha Tinh forest production in 2015

Item	Volume (m^3)
Timber (natural forest)	22,500
Timber (plantation)	247,149
Chips and pulp	243,319
Firewood (ster)	912,072
Bamboo (cane)	2,802
Rattan (tonne)	965

Source: Ha Tinh Statistical Year Book 2015

Wood processing in Ha Tinh

There are 5 types of wood processing in Ha Tinh, which are: sawmill, civil woodworking/ furniture, plywood, floor plywood, and wood chips (see Table 4.13). Ha Tinh has 509 timber processing units/factories with a combined annual capacity of almost 85,000m^3 of wood products and almost 300,000tons of wood chips. Only 195 of these factories have have operating licenses, the remaining 314 units (62%) operate without a license. Additional small-scale wood processing units at the household level are not registered and not managed. Indeed, local authorities do not have the capacity to manage them. Wood processing factories are often located near by the forest: wood resources are bought from the free local market, where the illegally harvested timber from natural forests is also unfortunately included in the supply chain. The statistics presented in Table 4.13 suggest around half of the raw material for production of sawn timber, plywood and furniture in Ha Tinh is imported (presumably mostly from Lao PDR), but on the other hand, all of the raw material for production of wood chips is sourced within the province, from the large areas of acacia plantations. This suggests there is an economic opportunity to shift somewhat away from production of chips and more towards production of higher value timber, as the market demand for this already exists.

Table 4.13: Wood processing in Ha Tinh

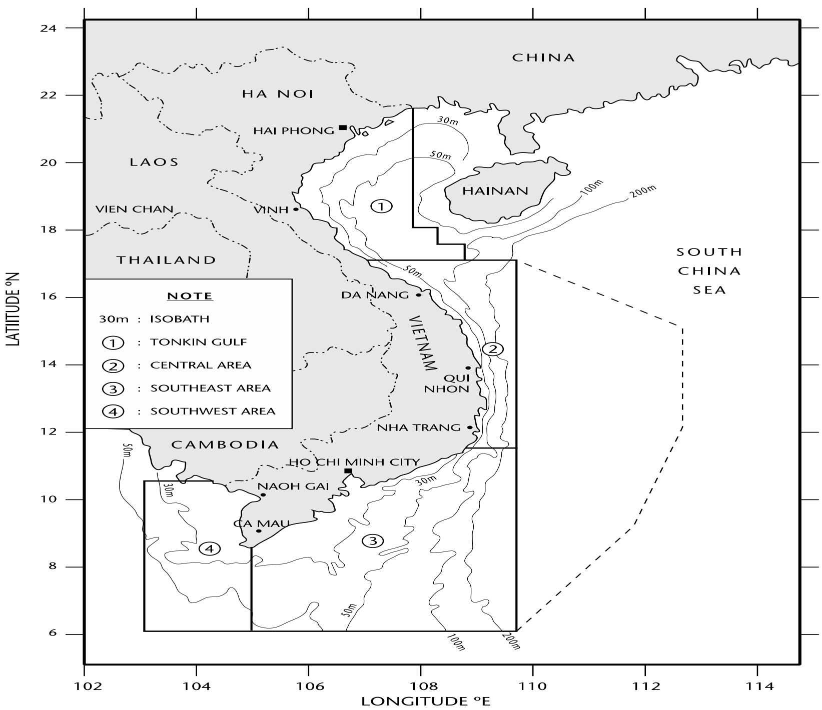
Activity	No. of factories	Yearly capacity	Source of wood (%)			District
			Natural forest	Plantation forest	Import	
Sawmill	385	47,145m³/year	36.87	8.86	47.45	Huong Son, Huong Khe, Vu Quang, Ky Anh
Civil woodworking and furniture	109	25,557m³/year	29.40	8.22	59.20	Duc Tho, Huong Son, Huong Khe, Vu Quang, Ky Anh
Plywood	5	5,076m³/year	29.56	66.29		Duc Tho, Hong Linh, Nghi Xuan
Flooring plywood	5	6,409m³/year	28.04	15.74	48.15	Duc Tho, Nghi Xuan, Huong Son, Huong Khe
Wood chips	5	298,191ton/year		100		Nghi Xuan, Huong Khe, Ky Anh

Source: Unpublished document provided to consultant by Ha Tinh DARD, 2012

4.2.4.1.6. Capture Fisheries

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 Map 4.2). The Gulf of Tonkin spans an area of 140 000 km^2 and is shared by Vietnam and China. The Gulf is relatively shallow, mostly less than 50m depth and has a relatively flat bottom with muddy to sandy substrate. Ha Tinh is located in the southern part of the Gulf of Tonkin (see Map 4.2).

Figure 4.2: Fisheries regions of Vietnam



The fisheries sector of Vietnam plays an important role in the social and economic development of the country, accounting 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.

Nationally, marine capture fisheries production increased steadily from 1981 to 1999, posting a nearly three-fold increase from 419,740t in 1981 to 1,212,800t 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 453,871 Horse-power (HP) in 1981 to 2,518,493 HP in 1999. CPUE declines were observed in specific fishing grounds (Vinh et al. 2001). In in the Gulf of Tonkin (between 1985 - 97); the decline ass from 1.06 to 0.66 t/HP year. 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 increase in HP of the fishing fleet continued to grow twice as fast as the increase in production during this period.

There are evident signs that the past growth of the country's marine capture fisheries is non-sustainable. 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. 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.

Small scale fisheries are defined as those that use non-powered boats or motorized boats with an engine of less than 90 HP. Over 100,000 small fishing boats are operating in near shore areas of Vietnam (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). 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. Common small scale fishing gear include beach seines, gillnets, lift nets, push nets, trawls, cast nets, traps, hooks, lines, set nets and trammel nets. 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.

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 overcapacity and destructive fishing practices is taking a heavy toll on biodiversity, the quality of resources, and the viability of livelihoods of many coastal communities. At the same time, Climate Change is creating additional threats as 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.

Since 1998 the Vietnamese government has a policy to give preferential loans 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 operations.

Effective Co-management systems could 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.

The capture fishery in Ha Tinh exploits over 100 species, including fish, shellfish, shrimp, and squid, using a diverse array of equipment and technologies, including gillnets, seines, trawls. The structure of the capture fishery, shown in Table 4.14, is based on engine size, reflecting the distance from shore of the waters exploited.

Table 4.14: Structure of Ha Tinh's capture fishery

Engine size (horsepower)	No. of boats	Fishing Area
>90 HP	31	Offshore to Distant waters
50-90 HP	56	Off-shore
20-50 HP	692	Off-shore
<20 HP	3,010	Near shore
TOTAL	3,789	

Source: World Bank (2012)

Currently there are over 3,000 small often woven bamboo-hulled boats (<20 HP), operated from beaches by groups of 6-10 men and fishing on-shore (within 6 nautical miles of shore). Routine catches are landed and sold on the beach near the largely poor villages where the fishermen live. There are two fish processing factories in Ha Tinh for export, but most of the fisheries produce is sold on the domestic market.

While no specific in-depth studies have been carried out in Ha Tinh Province, there is no reason to assume that the situation here is any different from the pattern across the rest of the country. It is safe to say that near-shore coastal fisheries in Ha Tinh are already under severe stress. Indeed, discussions with DARD Fisheries Division confirmed that near shore-resources are already exhausted - suggesting that what is remaining now is really just for subsistence use.

The future of capture fisheries in Ha Tinh is seen restructuring the fishery from many small-scale inshore boats, to a smaller fleet of larger off-shore boats exploiting the (perceived to be) still abundant resources of deeper waters and protecting national sovereignty towards sea areas and islands. For these reasons, and in line with national policy in the fisheries sector, the Ha Tinh provincial 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. HT province Decision # 90 HT is to reduce the number of small scale fishing boats and provide incentives for bigger vessels through provision of low interest loans from the social policy bank. Loans from commercial banks are also necessary to invest in the biggest boats. To invest in boats of 90-150HP, fishers can get 200 million VND of soft loans; for 250 to <400 HP they can get 300 million support; and for 400+ HP they get 600 million VND soft loan support. DARD Fisheries Division also expressed hope that in about 10 years-time near-shore resources will recover, after the number of near-shore fishers has been significantly reduced.

The World Bank Project "Coastal Resources for Sustainable Development (CRSD) Project - P118979 (2012-2018) development objective is to improve the sustainable management of coastal fisheries in Project Provinces with four components:

A. Institutional capacity strengthening for sustainable fisheries management (Cost $5.30 M)
B. Good practices for sustainable aquaculture (Cost $48.10 M)
C. Sustainable management of near-shore capture fisheries (Cost $52.20 M)
D. Project management, Monitoring and Evaluation (M&E) (Cost $12.30 M)

This project is assisting with coastal spatioal planning in ha Tinh. Cam Xuyen is the pilot istrict, after which activities will be replicated in other coastal districts. In addition, there is a GEF project - $5 million for 8 provinces that is supporting a fisheries resource conservation site on the Ha Tinh coast. These two projects may help to address some of the issues plaguing near-shore fisheries in Ha Tinh.

In December 2015 and March 2016, DARD Fisheries Division in Ha Tinh also expressed concern about the impact of pollution for example from the Formosa development and sea port at Vung Ang - including incoming and outgoing vessels, oil leakages, and other forms of pollution are damaging near shore resources. A massive fish die-off that severely impacted fisheries in 4 provinces that some say was caused by a massive release of carbolic acid an industrial cleaning agent) used to clean pipes in Formosa, occurred in April 2016, showing that their concerns were well founded.

4.2.4.1.7. Aquaculture

The shrimp industry in Vietnam has experienced many periods of ups and downs. Before 2013, most shrimp ponds in Ha Tinh cultivated giant tiger prawn; however they faced many difficulties including issues of disease, poor yield and market access. In 2012 Ha Tinh PPC passed a decision to support shrimp aquaculture on sandy areas (mainly using white shrimp). Ha Tinh DARD (2015) recorded that some 180ha of sandy land were subsequently converted to shrimp ponds and were yielding about 20tons/ha/rotation. Our informant has been doing shrimp farming himself on sandy soil for 2-3 years, with about 5 hectares of ponds, 20km from city centre. He produced good size shrimps - 70-80 shrimps/kg and reported that there is no need to worry about market.

Furthermore, PPC aquaculture development policy is to support producers to improve production from extensive to intensive production by providing 50 million VND subsidy per person. The province is also preparing for industrialized models. There are two processing factories - they buy at lower prices and export to China - but they are calling for more investors. One of the 5 components of the World Bank “Coastal resources for Sustainable Development” $8 million project for Ha Tinh will support diversification of aquaculture and application of Viet GAP and Biosafety standards as well as some infrastructure development.

Overall there are now about 6,000ha used for aquaculture production in Ha Tinh with a total of about 6,000 tons production of which 1,600tons is coming from production on only 180ha on sand.

Shrimp production on sandy areas requires a salinity level of about 23 ppt, and the sea water is around 33ppt, so the salinity has to be diluted somewhat by mixing with freshwater. Freshwater supply for aquaculture production on sandy areas is challenging however - it is competing with other users such as agriculture, as well as domestic use of coastal fishing communities. Shrimp farmers therefore have to rely on groundwater.

Waste water discharge from shrimp production is an issue - if there is no investment in waste water treatment, this will be a growing problem in the future. Most shrimp ponds on sandy areas simply release waste water into the surrounding environment (note the “tail” from the ponds to the seashore in Photo 4.4).

Photo 4.4: Aquaculture in sandy areas of Xuan Pho Commune, Nghi Xuan District

Other issues in prawn aquaculture include:

- Diseases - EMS - acute
- Climate change temperature increase increases growth rate - but when temperature gets very hot (37 degrees+) it is actually bad for the prawns, which stop feeding

- Typhoons and floods can damage and sweep away facilities - e.g. 2010 severe floods had a big impact

It is assumed by DARD Ha Tinh, that in coming years, demand within ASEAN will increase, spurred by the AEC, and shrimp price will increase. Consequently, it is planned that large tracts of sandy areas will be converted to shrimp ponds for white shrimp cultivation.

Table 4.15: Aquaculture in Ha Tinh

Classified aquaculture are	Year				
	2011	2012	2013	2014	2015
By types of products					
Shrimp	1,656	1,653	1,659	1,930	2,146
Fish	3,906	3,837	3,943	4,107	4,076
other aquatic	399	482	522	461	504
By farming methods					
Intensive aquaculture	373	147	276	604	602
Semi intensive aquaculture	3,638	3,823	3,989	4,086	857
Extensive and improved extensive aquaculture	1,950	2,002	1,859	1,808	5,267
By types of water					
Freshwater	3,841	3,756	3,824	4,004	3,958
Brackish water	1,748	1,782	1,805	2,091	2,353
Salty water	372	434	495	403.	412

Source: Ha Tinh GSO (2015)

Table 4.16: Aquaculture production in districts of Ha Tinh (ha)

District	Area (ha)	Gross output per ha (mil.VND)
Ha Tinh	355	166.03
Hong Linh	69	118.52
Huong Son	402	39.64
Duc Tho	568	98.90
Vu Quang	139	28.51
Nghi Xuan	761	233.24
Can Loc	607	55.58
Huong Khe	289	48.47
Thach Ha	1,186	214.49
Cam Xuyen	694	144.40
Ky Anh dist.	464	112.65
Loc Ha	736	147.67
Ky Anh town	456	112.65
TOTAL	6,726	

Source: Ha Tinh GSO (2015)

Future development of the Agriculture Cluster (including agro-processing)

In Ha Tinh, agriculture, livestock, fisheries and forestry, still provides a significant share of provincial GDP and provides a very significant source of employment. This will continue to be a pillar for prosperity in the next 10 years. Ha Tinh will make initiatives such as product diversification, improving productivity, food processing and enhancing the participation of the private sector to enhance the value of this sector. In addition to increasing economic value for farmers, these initiatives will also help to improve the resilience of the agricultural sector.

4.2.4.2. Industry

Throughout Vietnam, and much of E and SE Asia besides, special economic zones are highly favoured by governments as means of stimulating economic development. Ha Tinh currently has two special economic zones with preferential investment and tax treatments - Vung Ang, on the coast, where Formosa steel works is located, together with a coal fired power station, a port for coal import and a container port; and the Cau Treo Border Gate Economic Zone on the main route to Lao PDR. In HT a single Provincial Economic Zone Management Board (merged from 2 previous boards) oversees both of the SEZs.

"Clustering" of activities is also a preferred strategy. By 2020 it is planned that there will be 25 industrial clusters. Also 29 craft villages of which 4 will recognised/certified - engaged in wood processing, furniture making, and steel moulding. Overall industrial value in 2010 was 13 trillion dong by 2020, this is expected to reach 230 trillion.

4.2.4.2.1. Iron and Steel

Iron ore reserves of around 550 million tons in the province provide the basis for a strong mining sector. It is expected that activities in this cluster (beginning with the Thach Khe iron mine) will not only make a great contribution to provincial GDP, but also create more than 7,000 jobs by 2020. Steel production will play a very important role in Ha Tinh development. Not only through the large steel mills themselves, but also through other associated raw material suppliers (coke) and future manufacturing plants that will use the steel for various value-added products for both the domestic market and the surrounding region. Formosa produces 21 million tons of steel. However, while one large iron ore mine is fully operational, in a second large mine site, 11 million tons of cover soil were excavated and then work stopped because of a sharp decline in the iron ore price, and lack of financing. In fact, the GDP share of the mining industry in Ha Tinh in 2014 was only 1.09%, down from 2.36% in 2010. Smaller iron mines are distributed in mountains areas of other districts.

4.2.4.2.2. Titanium

Three licenses have been provided by MONRE for Heavy Sands surface (open cast) Titanium mining in two districts of the province. Titanium ore in Ha Tinh used to be the biggest in Vietnam in the early 1990s. Now it has been almost exhausted, and there is a ban on export of raw material (it should be processed to add value). Exhausted titanium mining sites are now being converted to vegetable growing areas for pumpkin and for shrimp production, and maybe also be used for a solar power development area, (but the solar farm requires 500 hectares so there might not be enough land in the former titaniunm mining site) instead of just planting with acacia.

4.2.4.2.3. Quarrying

Limestone and other rocks are also quarried for construction materials

4.2.4.2.4. Textile and Garment Cluster

Ha Tinh has the opportunity to take advantage of qualified workforce and investment in infrastructure, including ports and power, and water supply, to build industry clusters for textiles and garments. Ha Tinh can take advantage of Vietnam's strong position general on the international market of this sector.

4.2.4.3. Construction Cluster

The ongoing development of the Vung Ang zone, including the construction of new coal-fired power plants, together with the rapid expansion of urban infrastructure in Ha Tinh City, construction at the Cau Treo special economic zone, and the planned construction of new roads and railways, will ensure that construction will still be a major sector of the economy in the coming years. Boat building could also be expanded in the future.

4.2.4.4. Services

4.2.4.4.1. Commercial Sector, Trade, and Transport and Logistics Cluster

Besides its role as auxiliary to the main pillars mentioned above, this sector helps the efficient transport of raw materials and finished products. Logistics will also contribute to forming a key phase for the development of Ha Tinh province. By building roads Laos and North-eastern Thailand can be connected to the sea in Vietnam, and Ha Tinh will have the opportunity of building more commercial activities around the port area of the province and the Cau Treo border gate.

Cau Treo economic zone near the Lao border has a total area of 56,000 hectares (but only 12,000 will be developed as the rest is mountainous) It will be the location for an industry cluster and a trading facility. Some of the supporting infrastructure - roads and electricity facilities has already been constructed, but nobody has invested yet. Provincial Decree #64 allocated some of the land in this area to people as forest land.

4.2.4.4.2. Telecommunications

Ha Tinh where many young qualified people are based requires reliable telecommunications infrastructure - this is one solid area for development industry business service contracts. This sector creates new jobs, contributes to GDP Not just to create jobs, facilitate the development of high tech and information-based industry in the medium to longer term.

4.2.4.4.3. Education

In education the focus is on upgrading secondary education, vocational training and promotion of higher education to develop a talented workforce for the future of Ha Tinh.

4.2.5. Key assets supporting economic sectors

4.2.5.1. Transport

Ha Tinh has a dense network of transport including roads, railways and waterways. The total length of the inland roads is about 16,600km. The corresponding length of the internal waterways and railways is about 200km and 150km, respectively. Ha Tinh has several seaports, of which the Vung Ang deep water sea port is the most important one which contributes to 80% of the province's GDP in 2014 - 2015, according to a DPI report. Since the province has no airport, the transport development is focused on roadways, railways and waterways[11]. According to the present planning of the provincial transportation sector, by 2020 the total annual shipping will be 32.9-35 million tons of goods and 22.8 to 24 million passengers.

4.2.5.1.1. Roadways

Ha Tinh has 5 national routes with 383km total length crossing the province, comprising national road No. 1A, the Ho Chi Minh road, and the railway; as well as national road No. 8 connecting Hong Linh Town with Laos and through Laos to Thailand at the Cau Treo border gate, and national road No. 12A connecting Vung Ang economic zone with Laos and subsequently northeast Thailand through the Chalo border gate, as well as national Road # 15. National road No. 1A, which runs through the province from Ben Thuy bridge through Nghi Xuan district and Hong Linh town and on through the other districts of Can Loc, Cam Xuyen, Thach Ha, Ha Tinh and Ky Anh with a total length of 126 km. Road No. 12A is the shortest route that links Ha Tinh and Quang Binh to the Vietnam - Lao borderline. Ha Tinh can be considered as a big gateway of the East-West Economic Corridor.

In addition, according to information provided to the consultants in meetings with Ha Tinh Transport Department in December 2015, Ha Tinh has 28 provincial level roads with total length of about 390 km; 46 inter-district roads with a total length of 1,646km and an inter-commune road system that is accessible by car with a total length of 3,623km, according to 2014 statistics. If village roads and farm roads are included, the total length of roads in the province is 16,000km. Ha Tinh is one of leading provinces in the country, in terms of developing rural roads and often receives government awards. Most rural roads are concrete. Government and local people contribute together. Government supports cement and design, while labour is provided by the community. 1,000km of new/upgraded rural roads are developed each year in Ha Tinh. Rural roads are of a good standard, not only in the lowlands but also in hilly areas. Building new rural roads is part of the new rural development

[11] Transportation planning of Ha Tinh Province toward 2020.

programme. For roads to farm fields for agriculture activities - especially for access of agricultural machinery to the fields, the government will also support cement, but development is still limited compared with rural road development overall.

During floods, a part of the No. 1A road from Nghi Xuan district to Hong Linh town is often inundated. Many parts of the No. 8 road are dangerous during the rainy season due to the impact of flashflood hazard events. The HCM road and highway #15 provide a safe refuge area during floods as the roads are at much higher elevation than the surrounding areas. Highway #8 still has some problems with landslides in some high mountainous areas with steep slopes. There are also two places in highway #15 with some landslides, but not really a big problem. Ky Anh District road also has a little bit of a problem. In addition, some of the main roads in the province including the road No. 1A and Ho Chi Minh road are also badly damaged by overweight trucks requiring significant spending on repairs and maintenance every year.

A planned new coastal road will connect all four river mouths along the coast and will connect to neighbouring provinces to the north and south. A plan has also been approved for a new highway parallel to highway #1. National highway #8 to Laos will be upgraded. A second border crossing is being planned in Huong Khe district. Ky Anh Distric will also have an Asean highway to Quang Binh and also to the border with Laos.

4.2.5.1.2. Waterways

The main navigation route in the province is from Ngan Sau to Cua Hoi via the La and Lam rivers with a transport length of about 60km. However, big ships cannot travel far inland during the dry season (November to early May) due to the shallow water depth. The inland waterway in this season is largely dependent on the tidal regime. Cua Hoi and Cua Sot, which are the two largest river mouths, are often closed due to the sedimentation that creates difficulties for ships.

Ha Tinh is endowed with the Vung Ang port, which will be able to receive 50,000 tonnage vessels (when the second phase of development is completed) and Xuan Hai port (near the Cua Hoi river mouth) for ships of 3,000tons. The Government of Vietnam has proposed a master plan for building up the Vung Ang seaport system in order to serve steel making, ship building and repairing, petrochemical industries and especially turning the port into the main location to help Lao PDR to import and export of goods and open its trade to the world.

The wharf No. 1 in Vung Ang deep seaport has a design capacity capable of receiving 460,000 tons/year of goods. It now is able to receive vessels of 30,000 tons and some special vessels of 45,000 tons. The second phase of the seaport is now in progress; it will increase the capacity and the comprehensive conditions of the port for receiving vessels of up to 50,000tons capacity.

4.2.5.1.3. Railways

The North - South national railroad passes through 2 districts, namely Huong Khe and Duc Tho with two stations: Yen Trung and Huong Pho. Another railroad named Vung Ang - Thakhaek is expected to be built that connects the Lao capital of Vientiane with Vung Ang seaport. The total length of this railway will be 550 km, of which the section in Vietnam is reported to be about 119km long. Currently, a feasibility study for this railway is being conducted, which will take about two years to complete, scheduled from December 2015 to December 2017. The study is funded with a US$3 million grant from Korea International Cooperation Agency (KOICA), with the aim of preparing a master plan and providing capacity building to the railway sectors of the two countries.

4.2.5.1.4. Air transport

Ha Tinh has no airport. The closest airport is in Vinh City (Nghe An Province), which is about 50km and 100km away from Ha Tinh and Vung Ang Economic Park, respectively. Another nearby airport is in Dong Hoi, Quang Binh Province, which is about 150km from Ha Tinh City. However, the province is al so planning new airport in the sandy area of the coastline in the former titanium mining area (in Cam Duong and Cam Hoa communes, Cam Xuyen district).

4.2.5.2. Power supply

4.2.5.2.1. Coal-fired thermal power

The province has 110 kV, 220 kV, and 500 kV power lines. A cluster of thermal (coal-fired) power plants with a combined capacity of 4,800 MW has been planned in the Vung Ang Economic Zone. The 1,200MW Vung Ang 1 Thermal Power Plant, financed by the Vietnam Oil and Gas Group, came into operation in September 2015, while the Vung Ang 2 Thermal Power Plant is now under construction and Vung Ang 3 is planned. All of this is in line with the national power sector plan #7.

4.2.5.2.2. Hydropower

In addition, there are 3 small scale hydropower plants already in operation, and one under construction:

- Huong Son (33MW)
- Hoho (14MW
- Kego (3MW)
- The Ngan Truoi-Cam Trang Reservoir in Vu Quang will also produce 10MW power although the project is mainly for irrigation (see more details below in water supply section)

4.2.5.2.3. Other renewable energy and energy conservation

A South Korean company has asked for permission to do a scoping and feasibility study for a 300MW solar PV farm. There has been no planning for wind power. For biogas and biomass energy - some households and some pig farms use biogas, but it is very small scale. Some pig farms have received EU project support to develop biogas, and many others work with the CP company in a co-investment scheme.

The Centre for Energy Efficiency and Conservation is implementing a national programme - which started in 2013. They provide training for the business community and households and energy managers at businesses and they also implement “Earth Hour” each year, and have competitions for youth. They support LED lighting in rural areas. They also develop and regularly update a list of the big energy consumers in the province and report to MOIT so that MOIT can proceed with organising energy audits (done from national level).

4.2.5.3. Water supply

Water resources management in Ha Tinh is problematic due to climate extremes and climate change. Ha Tinh suffered serious floods in 2002, 2007, 2013, as well as 2010, when following a prolonged period of rain, the whole region flooded. The mountainous Huong Son, Huong Khe and Vu Quang Districts appear to be most affected by flooding and it is unclear to what extent management of the watershed, is contributing to the problem.

According to information provided by H a Tinh DARD to the consultants in December 2015, Ha Tinh has 347 reservoirs 57 weirs and 381 pumping stations with a total 785 million cubic metres capacity providing irrigation for 50,00ha of farmland and water for aquaculture, as well as for industrial and domestic uses. Vung Ang economic zone receives about 162 million cubic metres of water each year, and iron ore processing requires about 345 mililon cubic metres. Ke Go reservoir with a reservoir catchment of 223sq km capacity of 345 million cubic meters, provides the water supply for Ha Tinh City.

Reservoirs need to be operated under reservoir safety regulations. In addition, where there are multiple reservoirs in the same basin national level inter-reservoir operation procedures will be introduced. According to the plan to 2020, and vision to 2030, the province is striving to ensure adequate water supply for the province’s development needs, even in In the long-lasting drought periods that can be expect to be more intense with climate change (they are basing their planning on IMHEN/MONRE 2009 climate change scenarios).

According to information provided by DARD Ha Tinh, and by the management Committee of Vu Quang National Park, as well as through site inspection and review of remote sensing images, In Vu Quang they are now building the Ngan Truoi-Cam Trang irrigation scheme where the main reservoir capacity will be 778 million cubic metres (i.e. this one reservoir will contain as much water as the total of the 347 already existing reservoirs in the province). It will supply irrigation water for an additional 32,000ha, and also water for aquaculture and industrial use (see Photo 4.5).

Ha Tinh has 318.5 km of dykes, including 19.2km teir 2 river dykes. Ha Tinh PPC has approved a plan for an enhanced dyke system and are preparing dyke management planning. A World Bank Project will finance two big sluices as part of this plan.

Photo 4.5: Ngan Truoi River Valley in the Vu Quang National Park will be flooded by construction of a new irrigation dam

In Ha Tinh there is very limited use of ground water for industry. Baseline data in 1980s shows groundwater is generally rather limited. Ground water from wells is however used for mixing with sea water to dilute the salinity for prawn farms on sandy areas. The underground water is also likely to be high pH and high iron content - treatment to remove iron would be very costly. There are regulations on groundwater extraction to prevent subsidence. While it is thought that the total volume of groundwater extraction is not so significant, no proper studies have been conducted.

At the same time, there is considerable saline intrusion up the rivers which is exacerbated by the reduced flows in the river due to water extraction for irrigation, meaning the river has less ability to flush the saline water out. Several anecdotal comments from local people suggest they have witnessed salinity intrusion for 30 it has become much more severe in the last 10 years. Reportedly composition of the fish species caught is also becoming more dominated by saline species.

Two barrages have already been constructed to prevent this intrusion - one over 10km upstream, the Do Diem barrage on the Nghen river near Ha Tinh city; and another 50km, Ky Ha barrage on the Quyen River near the Vung Ang Economic Zone. Photo 4.6 shows the Do Diem barrage and freshwater backing up on the upstream side. On the downstream side, the lack of freshwater is damaging the mangroves. The mangroves were established in the 1980s under an Oxfam sponsored project, to promote livelihoods and support the fisheries. The trees were well-established, but growth has now checked, and die-back is spreading. It is unclear how water flow through the barrage is being managed and what is happening to the dip and fixed bag-net fishery in the estuary.

Photo 4.6: Saline intrusion barrage, Do Diem, on the Nghen River, near Ha Tinh City

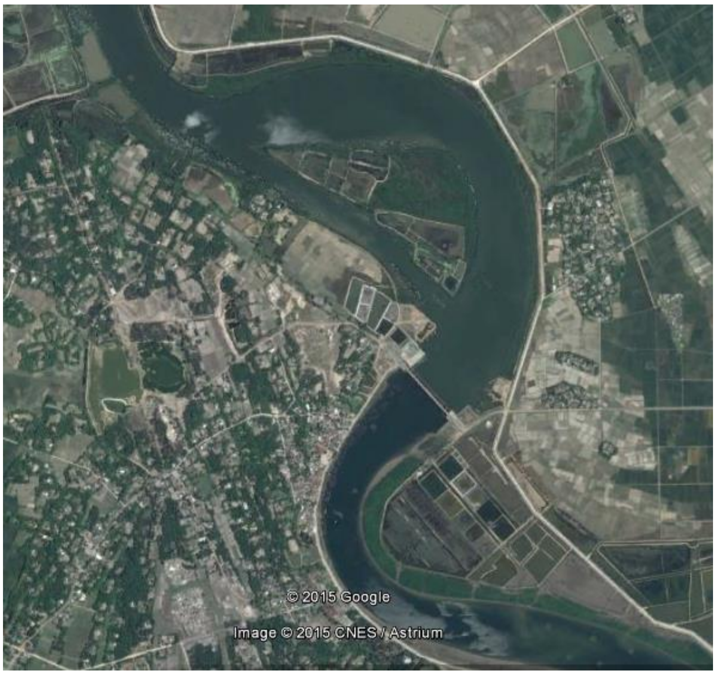


Photo 4.7 shows an area near the Nghèn River, Phuc Loc commune, Can Loc district. In the past, this area was in the brackish water zone, now since the construction of the Do Diem barrier it has become a freshwater aquaculture area.

A more holistic approach to water resources management, based on the principle of maintaining "environmental flows", decreasing demand and decreasing loss through the system could be explored.

Photo 4.7: Freshwater aquaculture ponds upstream of Do Diem barrier

4.3. Conclusions

From a low starting point as part of one of the poorer regions of Vietnam, Ha Tinh has developed economically very rapidly in the last decade. In the last 5 years much of this growth has been driven by the construction sector and FDI. Much of the recent construction to date has been related directly or indirectly to the development of the Vung Ang industrial zone and deep sea port, which provides the model for a future industry-led economy of Ha Tinh.

Nevertheless, in terms of its contribution to GDP, the proportion of land area used and employment provided (especially for poorer people), as well as its dependence on natural resources and higher vulnerability to climate factors the “agriculture, forestry and fisheries” sector (AFF) still remains the most important one for the identification and implementation of Ecosystem-based adaptation measures.

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CHAPTER 5 SOCIO-ECOLOGICAL SYSTEMS (SES) OF HA TINH

5.1. Introduction

This chapter presents the methods and outcomes of the work on Socio-Ecological System (SES) carried out under the provincial-level assessment for Ecosystems-based Adaption in Ha Tinh 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 two chapters present the climate-related information for Ha Tinh, and finally Chapter 9 completes the provincial-level study by presenting the findings of the provincial vulnerability assessment, and identifying provincial level EbA interventions for 10 priority SESs.

5.2. Identification of Socio-Ecological Systems (SES)

The purpose of the provincial-scale vulnerability assessment is to help a 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 most number of people, or the most poor people, or because they affect a strategic "asset" in the provincial economy.

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

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; Rockstrom 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 Ha Tinh province - requiring all SESs present in the province to be identified. For the micro-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 to 4 three sets of components ecological, social and economic - and their constituent variables relevant to Ha Tinh, were identified. These are shown in Table 5.1.

Table 5.1: Ecological, social and economic components and variables for SES identification

Topographical/Ecological	Social	Economic
Mountains > 700 m	Ethnic minority smallholders	Paddy rice (irrigated or not)
Hill Areas < 700 > 10 m	Kinh smallholders	Upland rice
Lowland Coastal < 10 m	Kinh SME commercial	Field crops (gnuts, cassava, maize etc)
Limestone forests	Kinh large scale enterprise	Forest product gathering
Sub-tropical forests	Government Agency	Fast-growing tree plantations
Tropical moist broadleaf forest	State-owned enterprises	Rubber
Floodplains	Foreign-owned enterprise	Fruit crops
Coastal sandy areas		Fish cultivation
River systems and lakes		Shrimp cultivation
Mud flat estuary		Capture fishery
Mangrove forest		Livestock rearing
Brackish lagoons		Vegetable production
Inshore marine areas		Salt production
Off-shore marine areas		"Key Assets" – infrastructures, special economic zones, etc.

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.

An example of how one of the SESs was defined is provided below, together with a photograph illustrating a representative area of this type of SES (Photo 5.1).

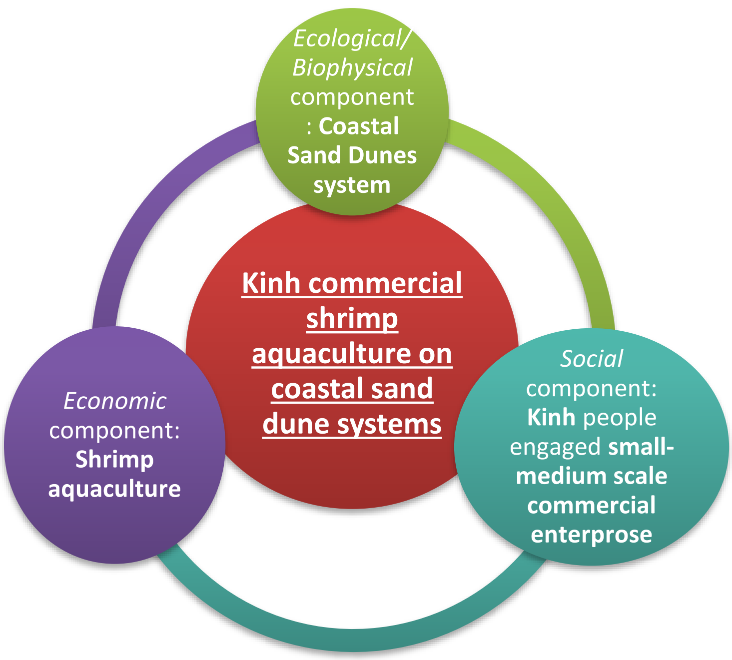


Photo 5.1: Commercial aquaculture on coastal sand dune systems in Ha Tinh

In all, 32 different SESs were identified for Ha Tinh, including eight "key assets" (without a coherent ecological basis). The full list, including an estimate of the area covered, is provided in Table 5.2.

Table 5.2: List of 32 socio-ecological systems in Ha Tinh

SES Code	Full name of SES	Area	
		Ha	%
1 PA1	SUBTROPICAL FOREST >700 M State PA Management (Vu Quang)	13,522	2.27
FPMB1	FPMB on upland forest	18,813	3.15
2 PA2	MOIST TROPICAL FOREST < 700M State PA Management (Vu Quang, Ke Go)	66,999	11.23
FPMB2	FPMB on lowland forest	83,733	14.03
2b	Kin/Ethnic minority smallholder field + tree crops	38,846	6.51
2c	Kinh commercial forestry (or SFE) on hill forest (Huong Son and Chuc A LLC)	Part of FPMB2	
2d	Kinh smallholder inland valley paddy cultivation + tree crops (pine acacia, citrus, rubber, tea)	91,246	15.29
2e	EM smallholder inland paddy + field crops + forest product collection	0	0
2f	Kinh commercial rubber plantations (Ha Tinh; Huong Khe)	26,710	4.48
2g	Kinh commercial livestock raising enterprises	0	0
3 3a	COASTAL FLOODPLAIN Kinh smallholder lowland coastal floodplain paddy rice cultivation	43,230	7.25
3b	Kinh smallholder floodplain-hills transition: paddy rice + mixed farming, tree crops	58,326	9.78
4	INLAND FRESHWATER	24,026	4.03

SES Code	Full name of SES	Area	
		Ha	%
4a	Kinh smallholder/commercial mixed freshwater aquaculture		
4b	Kinh small holder freshwater capture fishery	0	0
5 5a	ESTUARY Kinh commercial brackish water fish / shrimp cages and ponds	2,051	0.34
5b	Kinh artisanal shell fish collecting	0	0
5c	Kinh smallholder salt production	274	0.05
6 6a	COASTAL SAND DUNE Kinh small holder vegetable gardening (oft combined with 7b)	973	0.16
6b	Kinh smallholder livestock (cattle) raising	0	0
6c	Kinh smallholder freshwater fish ponds	196	0.03
6d	Kinh commercial brackish water shrimp aquaculture	778	0.13
6e	Kinh commercial and small enterprise beach tourism	472	0.08
7 7a	MARINE Kinh artisanal and commercial offshore fishing (> 6 nm from coast.	0	0
7b	Kinh artisanal inshore fishing (< 6 nm from coast)	70,191	11.76
8 8a	KEY ASSETS Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)	?	?
8b	commercial mining - quartz, clay, sand, titanium	470	0.08
8c	state transport and associated infrastructure	0	0
8d	commercial thermal energy production facilities and distribution infrastructure	0	0
8e	state managed special economic and industrial zones (coastal)	1,841	0.31
8f	state managed special economic and industrial zones (montane)	18,427	3.0
8g	State port and river transportation infrastructure	1,436	0.24
8h	urban and rural settlement, industry, services	7,356	1.23
TOTAL		596,629	100

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 households 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 see Ha Tinh's SESs differently. Such debate is 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

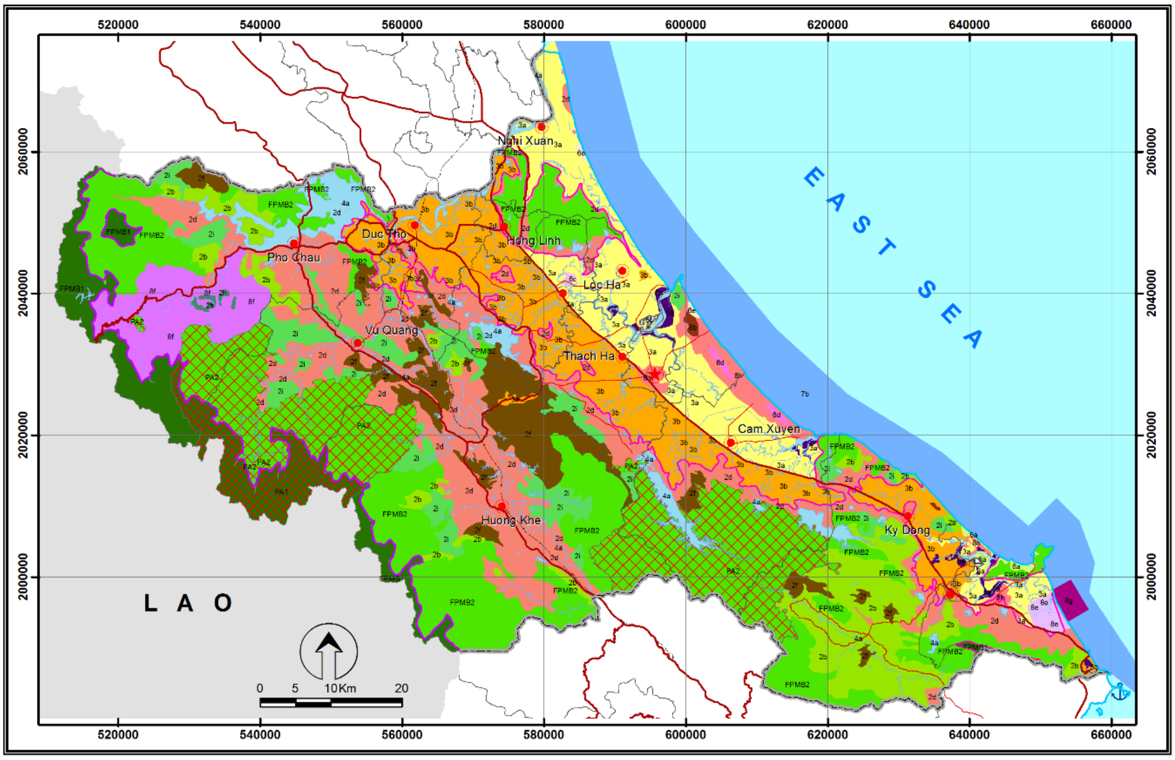
Spatial variation can arise for a number of reasons. Both biophysical and socioeconomic conditions may vary across a province, and different drivers of change may be more or less pronounced in different locations (Baumann et al. 2011). Spatial mapping can therefore help to elicit spatial variation and can highlight trade-offs and synergies among different system properties such as ecosystem services (Raudsepp-Hearne et al. 2010, Qiu and Turner 2013) and anticipate impacts of climate change and extreme climatic events. Spatially explicit mapping is therefore a key part of studying socio-ecological systems. Mapping all of the SESs across the entire Ha Tinh Province was therefore a very critical part of the SES assessment process, and the results are presented in Map 5.1, below. The SES map was compiled from a variety of sources. The WWF ecosystems and forest type maps for VN 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, but given the discussed above, Google Earth was used intensively to understand Ha Tinh's landscapes and identify SES units and boundaries. A limited amount of ground-truthing was carried out, focusing on particular sites and landscapes where uncertainty existed.

5.4. Prioritisation of the Socio-Ecological Systems

It was beyond the scope of this assessment to investigate and describe all the identified SESs in detail. A ranking exercise was therefore conducted to identify the most important SES, and the top 10 were then described, and subject to provincial-level assessment of ecosystem services and climate change vulnerability.

The ranking was based on 12 criteria, encompassing ecological, social, economic, climatic and environmental factors identified in the profiles developed in the first phase of the project (see Chapters 2 to 4) and the professional judgement of the consultant team. Due to the lack of the up-to-date and reliable quantitative data on many relevant parameters, the scoring of the criteria was largely qualitative. The SES map provided an estimate of the area of land used by each SES. The results of the ranking of the full set of SES are provided in Annex 5.I. The top 10 SES, shown in Table 5.3, represent over 70% of the land area of the province and all of the near-shore waters.

Figure 5.1: Socio-ecological systems of Ha Tinh



Legend

Province capital
District capital
District border
National road
Provincial road
Rail way

Elevation

100m
700m

1. SUBTROPICAL FOREST >700m

PA1. State PA Management (Vu Quang)
FPMB1. FPMB on upland forest

2. MOIST TROPICAL FOREST < 700m and >10m

PA2. State PA Management (Vu Quang, Ke Go)
FPMB2. FPMB on lowland forest
2b. Kinh/Ethnic minority smallholder field + tree crops + forestry
2d. Kinh smallholder inland valley paddy cultivation + tree crops (acacia, citrus, rubber, tea)
2f. Kinh commercial rubber production
2f. Kinh commercial tea production
2i. Community forest management

3. COASTAL FLOODPLAIN

3a. Kinh smallholder lowland coastal floodplain paddy rice cultivation
3b. Kinh smallholder floodplain-hills transition: paddy rice + mixed farming, tree crops

4. INLAND FRESHWATER

4a. Kinh smallholder/commercial mixed freshwater aquaculture

5. ESTUARY

5a. Kinh commercial brackish water fish / shrimp cages and ponds
5c. Kinh smallholder salt production

6. COASTAL SAND DUNE

6a. Kinh small holder vegetable gardening
6c. Kinh smallholder freshwater fish ponds
6d. Kinh commercial brackish water shrimp aquaculture
6e. Kinh commercial and small enterprise beach tourism

7. MARINE

7a. Kinh artisanal and commercial offshore fishing
7b. Kinh artisanal inshore fishing

8. KEY ASSETS

8b. Commercial mining - quartz, clay, sand, titanium
8e. State managed special economic and industrial zones (coastal)
8f. State managed special economic and industrial zones (montane)
8g. State port and river transportation infrastructure
8h. Urban and rural settlement, industry, services

Table 5.3: Top 10 priority SESs in Ha Tinh

Rank	SES Code	Name of SES	% area
1	8a	Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)	n/a
2	8h	Urban and rural settlement, industry, services	1.2
3	PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)	13.5
4	3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation	7.25
5	3b	Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops	9.78
6	FPMB 1+2	Forest Protection Management boards on subtropical forest > 700m and moist tropical < 700 m	17.18
7	8e	State-managed Special Economic and Industrial Areas (coastal)	0.31
8	2b	Kinh and ethnic minority smallholder field and tree crops	6.51
9	2d	Kinh smallholder inland valley addy cultivation + tree crops	15.29
10	6d	Kinh commercial shrimp aquaculture on sand	0.13
TOTAL AREA			**71.15**

5.5. Profiling the Socio-Ecological Systems

To assist readers in understanding the SES, 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 illustrative 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 the next chapters. The profiles can be found in Annex 5.2.

5.6. Conclusion

The provincial-level identification of all SES 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 31 SES for Ha Tinh presented here represents a preliminary analysis, based on incomplete data, and limited ground-truthing. The methodology is still evolving and the results here should be considered provisional.

ANNEX 5.I: PRIORITY RANKIG OF HATINH SES

Code No.	SES Name	Ecological		Social			Economic					Climate/ Environment		Rank
		Provid-er of ES	Depend on ES	Popu-lation	Pov-erty	Other Vulnerable Group	direct GDP	Future emphasis (SEDP)	Land use % *<5%; ***>15%	Labour used	Base for Value Addi-tion	Climate damage trends	Neg Environ Impact	
1+2 PA1 PA2	SUBTROPICAL FOREST >700 M, MOIST TROPICAL FOREST < 700M State SUF Management (Vu Quang) State SUF Management (Vu Quang, Ke Go)	xxx	xx	x	x	-	x	x	xx 13.5	x	xxx	x	-	3
FPMB1 FPMB2	FPMB on subtropical forest >700m FPMB on moist trop forest< 700m	xxx	x	x	x	x	x	x	xxx 17.4	x	xxx	x	-	7
2 2b	MOIST TROPICAL FOREST < 700M Kin/Ethnic minority smallholder field + tree crops	x	xx	xx	xx	x	xx	xx	xx 6.5	xx	x	xx	x	8
2c	Kinh commercial forestry on hill forest (Huong Son and Chuc A LLC)	xx	xx	x	x	-	x	xx	xx 5.5	x	xx	xx	xx	13
2d	Kinh smallholder inland valley paddy cultivation + tree crops (pine acacia, citrus, rubber, tea)	xx	xx	xx	x	-	xx	xx	xxx 15.3	xx	xx	xx	xx	9
2e	EM smallholder inland paddy + field crops + forest product collection	xx	xxx	x	x	x	x	x	x 0.0	x	xx	xx	xx	29
2f	Kinh commercial rubber plantations (Ha Tinh; Huong Khe)	x	x	x	x	-	x	xx	x 4.5	x	x	xx	xx	14
2g	Kinh commercial livestock raising enterprises	x	xx	x	-	-	xx	xx	x 0.0	x		xx	xx	15
3 3a	COASTAL FLOODPLAIN Kinh smallholder lowland irrigated floodplain paddy rice cultivation	x	xxx	xxx	x	-	x	x	xx 7.2	xx	xx	xx	x	4
3b	Kinh smallholder floodplain-hills transition: paddy rice + mixed farming, tree crops	x	xx	xx	x	-	x	x	xx 9.8	x	xx			5
4 4a	INLAND FRESHWATER Kinh smallholder/commercial mixed freshwater aquaculture	x	xx	x	x	-	x	x	x 4.0	x	x	x	x	22
4b	Kinh small holder freshwater capture fishery	x	xxx	x	x	-	x	x	x 0.0	x	x	x	x	23

5 5a	ESTUARY Kinh commercial brackish water fish / shrimp cages and ponds	x	xx	x	-	-	x	xx	x 0.1	x	x	x	xx	20
5b	Kinh artisanal shell fish collecting	x	xx	x	x	-	x	x	x 0.0	x		x	x	28
5c	Kinh smallholder salt production	-	xx	x	x		x	x	x 0.0	x		xx	xx	24
6 6a	COASTAL SAND DUNE Kinh small holder vegetable gardening (oft combined with 7b)	x	xxx	x	x	-	x	x	x 0.1	x		xx	x	25
6b	Kinh smallholder livestock (cattle) raising	x	xx	x	x	-	x	x	x 0.1	x		x	xx	27
6c	Kinh smallholder freshwater fish ponds	x	xxx	x	x	-	x	x	x 0.1	x		xx	x	26
6d	Kinh commercial shrimp aquaculture	x	xx	x	-	-	xx	xxx	x 0.1	x	x	xx	xx	10
6e	Kinh commercial and small enterprise beach tourism	x	xx	x	x	-	x	x	x 0.0	x	xx	xx	xx	21
7 7a	MARINE Kinh artisanal and commercial offshore fishing (> 6 nm from coast.	xx	xxx	x	x	-	xx	xxx	x 0.0	x	xx	x	x	12
7b	Kinh artisanal inshore fishing (< 6 nm from coast)	xx	xxx	xx	xx	-	x	x	xx (11.8)	xx	xx	xx	xx	11
8 8a	KEY ASSETS Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)	xxx	xxx	xx	x	-	x	xxx	xx ??	xx	xxx	xx	xx	1
8b	commercial mining - iron ore ,quartz, clay, sand, titanium	x	x	x	-	-	x	xx	x 0.8	xx	xx	x	xx	19
8c	state transport and associated infrastructure	x	xx	xxx	x	x	xx*	xx	x ??	xx	xxx	xx	xx	9
8d	commercial coal-fired energy production facilities and distribution infrastructure	-	x	xxx	x	x	xx*	xx	x 0.0	xx	xxx	x	xx	17
8e	state managed special economic and industrial zones (coastal)	-	x	xx	-	-	xxx	xxx	x 0.3	xx	xxx	x	xxx	7
8f	state managed special economic and industrial zones (montane)	x	xx	xx	-	x	x	xx	x 3.0	x	xx	x	x	16
8g	State port and river transportation infrastructure	-	x	x	-	x	xx	xxx	x 0.0	x	xx	xx	x	18
8h	Urban and rural settlement, industry, services	x	xx	xxx	x	x	xxx	xx	x 1.2	x	x	x	xx	2

ANNEX 5.II: PROFILES OF SELECTED PRIORITY 10 SOCIO-ECOLOGICAL SYSTEMS OF HA TINH

Rank	SES Code	Name of SES
1	8a	Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)
2	8h	urban and rural settlement, industry, services
3	PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)
4	3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation
5	3b	Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops
6	FPMB 1+2	Forest Protection Management boards on subtropical forest > 700m and moist tropical forest < 700 m
7	8e	State managed Special Economic and Industrial Areas (coastal)
8	2b	Kinh and ethnic minority smallholder field and tree crops
9	2d	Kinh smallholder inland valley paddy cultivation + tree crops
10	6d	Kinh commercial shrimp aquaculture on sand

Proposed formats for ECOSYSTEM SERVICES and VULNERABLE ASSESSMENT

ECOSYSTEM SERVICES

No	Main Services	Description	Source of ecosystem service	Rank (1=least/worst; 5=most/best)		Justification for ranking
				Importance	Condition	
Direct Provisioning						
P1	food					

VULNERABILITY ASSESSMENT

CLIMATE CHANGE RISKS	Exposure		Sensitivity		Impact Score	Adaptive Capacity		Final Vulnerability Score
	Score	Explanation	Score	Explanation		Score	Explanation	
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 eventually die in prolonged heat, particularly when heat is combined with drought and the desiccating Laos wind.	5	3	*Remote from extension services and markets.* *Lack of livelihood alternatives, resources, knowledge, organisation for adaptation.* *BUT the diversity of traditional rice varieties helps cope with drought* *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

1. SES 8a: Commercial and state water management infrastructure

Example: Ngan Truoi reservoir, Vu Quang district, Ha Tinh

Key Descriptors:

Social: Kinh people, paddy rice cultivation, freshwater aquaculture community

Ecological: Water bodies, rivers and streams

Economic: Agricultural irrigation, Water supply for industrial zones and Thach Khe ore mining and also domestic uses, Brackish and freshwater fish aquaculture, Hydropower generation, Flood protection, Tourism.

Trends: Decreasing poverty; conversion of pine forest and field crop land to citrus

Climate Change Threats: Drought; excessive cold or heat; floods; hot winds.

Description:

The Ngan Truoi reservoir is being developed by the Ministry of Agriculture and Rural Development, Vietnam in June 2009 with a total capital investment of approximately VND 6,000 billion, raised mainly from the Vietnamese government bonds. The project, initially approved by the Vietnam Government Office in 2006, is considered to be the most critical project within the Ha Tinh province. The project is being built on the Ngan Truoi River in Huong Dai commune in Vu Quang district. It is designed to contain 775 million cubic meters. Upon completion, the reservoir will provide water to 35,400 hectares of farming land in seven districts of Ha Tinh, including Vu Quang, Huong Son, Duc Tho, Can Loc, Nghi Xuan, north Thach Ha and Hong Linh, with a capacity of 56.8 m3/s. It will supply water for domestic uses in the surrounding districts and for 12 industrial zones, especially the Thach Khe ore mining with a capacity of 6 m3/s, and about 6,000 ha of aquatic farming, of which 3,500 ha freshwater and 2,500 ha brackish. The project will also help to reduce the damages caused by flood in the Ngan Sau and hence the La river, contribute an environmental flow with a discharge of 4 m3/s for the low land areas and estuaries. The work includes a hydro-electric power system with a capacity of 16 MW, supplementing the national electric grid, providing electricity for production and daily life of locals.

The reservoir is connected to Truong Son primitive forest, Nuoc Sot eco-tourist area, Huong Son hydro-electric power plant and other historical and cultural relics, Vu Quang revolutionary base, Phan Dinh Phung worshiping temple, Tran Phu tomb area, Am Pagoda, Le Huu Trac tomb area, creating a tourist route fascinating both domestic and foreign tourists, particularly those from the expanded Mekong sub-region.

However, the project has migrated over 600 households with 2,977 inhabitants in 2 communes Huong Quang and Huong Dien and some villages in Vu Quang district.

Figure 5.2 Overview of Ngan Truoi reservoir and Cam Trang hydropower dam

Source: VNCOLD

According to the CCWR - Consulting Center for Water Resources, Vietnam, and the construction of the Cam Trang hydropower dam will induce inundation to about 590 ha of cultivation land in Huong Khe, Vu Quang and Duc Tho districts. This inundation will upset the lives of thousands of residents, relocate more 857 households; the cost of the resettlement compensation may up to VND 1,318 billion.

In addition, due to the rapid and extreme flood flow in the Ngan Sau river, for safety the reservoir should open all gates to release about 20 million m3 of water. This will cause serious problems to the downstream areas, such as river bank erosion, flash flood, land slide, destroying roads, bridges, and other infrastructures as well as natural environments. With the existence of the Ngan Truoi reservoir, the river flow in the downstream of the Ngan Sau and La rivers will be depleted, which will in turn induce problems to the wetland areas such as salinity intrusion and river morphology.

Ecosystem services:

Table 5.4: Ecosystem services important to Kinh people have food production, livestock and aquaculture

No.	Main services	Rank	Description
Direct Provisioning			
P1	food	High	The reservoir can provide much food to local people such as fish and shrimp. It also supplies water for crop and vegetable production.
P2	water	High	It keeps the water during the rainy season for uses in the dry season. Besides, it also increases problems due to water use conflict among socio-economic sectors such as hydropower generation and irrigation, navigation, water supply requirement for industry and agriculture, etc.
P3	Medicines		NA
P4	Fibres	Mod.	Reservoir does not directly provide fibres to local people, but residents can collect wood near the dam and sluice gates as the streams and rivers carry all materials to these places
P5	building materials	High	With the existence of the dam, the sand is gradually transported to the reservoir and then the gates. Bank erosion is a major source for the sand, which can be used as a building material.
P6	Water energy	High	This is especially important, once a reservoir is built, there is a significant difference in water head between upstream and downstream of the dam, which potentially generates much energy for hydropower plant construction. Ngan Truoi hydropower plant is a good example.
P7	Biomass energy		NA
P8	transport	Mod. high	The reservoir can improve navigation systems, especially in the upstream reservoir. However, it may result in low water level in the rivers downstream during the dry season.
Regulating			
R1	carbon fixation/storage	Mod. high	Reservoir helps to regulate the temperature and humidity, and hence the carbon fixation
R2	water quality maintenance	High	It captures the sediment and dissolved materials in the reservoir. River water downstream tends to be clean and fresh.
R3	air quality maintenance	High	Reservoir helps to improve the air quality
R4	climate buffering	High	It reduces temperature in the surroundings, protect the area from Laos wind
R5	pest and disease control	Mod. high	It increases humidity. High humidity also creates good conditions for the viruses, bacteria and moulds, leading to an increase of respiratory infections (pharyngitis, acute rhinitis bronchitis, pneumonia).
R6	waste recycling / detoxification	Mod.	Each reservoir has its own water cleaning mechanism.
R7	physical protection	High	Reservoirs play a vital role that protects the surrounding areas from hot winds.
R8	control of water flows	High	It strongly affects the hydrological flow regime in the downstream of the Ngan Sau and La rivers.
R9	control of sediment flows	High	It stops the sediment flow in the river downstream almost

No.	Main services	Rank	Description
			throughout the year.
Supporting (basic ecosystem functions)			
S1	carbon cycling	High	Reservoir affects climate at the regional scale through the exchange of heat and water with the atmosphere. Also, it plays a substantial role in the regional carbon cycle. It controls the sediments and emissions to the atmosphere as well as alters the transport to the sea.
S2	photosynthesis, primary production		unclear
S3	nutrient cycling	Low	A reservoir can be considered as a closed system. There are two dominant factors in nutrient availability in a reservoir, i.e. water and pH. Most chemical forms of nutrients available to trees are in a soluble state. As water moves through and across soils, it carries valuable nutrients. As a landscape captures water, it will capture many of the nutrients dissolved in the water. This is the critical connection between the hydrologic cycle and nutrient cycles. A reservoir dam will stop the natural hydrological flow and nutrient cycle. Additionally, reservoirs in granitic basins tend to have lower pH values, lower biological productivity, and are much more vulnerable to drops in pH with the addition of acid inputs. Lowered pH in these sensitive lakes can have negative consequences on the biota.
S4	soil formation	High	A soil type is defined by characteristics such as soil structure, moisture, soil genesis, particle size and texture. Different soils are capable of producing certain levels of biological productivity. Reservoirs accelerate the soil formation both in upstream and downstream zones.
S5	water cycling	High	It affects the regional and global water cycling
S6	pollination		NA
S7	seed dispersal		NA
Cultural-spiritual			
C1	religious-spiritual	High	Ngan Truoi reservoir connects to Vu Quang revolutionary base, Phan Dinh Phung worshiping temple, Tran Phu tomb area, Am Pagoda, Le Huu Trac tomb area, creating a tourist route fascinating both domestic and foreign tourists.
C2	recreation, sports, ecotourism	High	Same as C1.
C3	science, education	High	Many lessons learned we might have in the future.
C4	historical / nation building	High	Same as C1.
C5	relaxation/mental health	High	It creates a good scene and good environment.
C6	aesthetics /artistic inspiration		unclear

Climate and Climate Change

Table 5.5: Exposure and sensitivity of the reservoir

Climate Change Variables and Phenomena	Degree Exposure	Nature of sensitivity (describe)	Degree Sensitivity
TEMPERATURE			
Hot season is hotter and longer	High	Increase in water evaporation. Lake level will be decreased. Much less water storage in reservoirs during summer months	
by 2-3 deg C in 2050			
# hot days >35^{o}C increasing	High	Increase in water consumption for drinking, irrigation, hydro-electric generation and industrial uses.	
Shift in timing of seasons	Moderate high	May increase the problems to water supply if the dry season lasts too long.	
Temperature rises more in May and June		Caused drought for summer season	
PRECIPITATION			
Wet season is getting wetter	High	May cause the dam break if rainfall intensity is extremely high and lasts for over 24 hours, causing flash flood and inundation in the downstream areas.	
5% more rain in summer by 2050			
Dry season is getting drier	High	Less water in reservoir affecting the water supply.	
5% less rain in spring by 2050			
More frequent drought	High	Not enough water for domestic use, irrigation and hydro-electric generation	
WIND AND STORMS			
Wind speeds higher	High	Will cause bank erosion, move sand will be transported into reservoir, changes in bed form, and reduce the storage volume.	
Storms frequency less predictable	High	Storms come with high rainfall intensity. A reservoir likes a water bomb. Storm prediction is significantly important for the reservoir operation.	
Storm season coming later	Moderate high	Storm comes at time reservoirs are almost full, after the main rainy season. It is good for reservoirs to have more water, in constrast; it will cause serious damages if the water inflow is much over the storage capacity of the reservoir.	
SEA-LEVEL RISE			
Average 3mm/year, for last 20 years	Moderate	Introduce the saline intrusion problem.	
1m rise by 2100	High	Require much more water from reservoirs to flush out the salinity or to improve the water environment.	

Extent and relative importance of the SES

The Ngan Truoi reservoir is the largest one in the Ha Tinh province. It provides water for industrial, agricultural and aquacultural productions as well as drinking water, eco-environment improvement and natural disaster reduction for Vu Quang, Huong Son, Duc Tho, Hong Linh Town, Nghi Xuan, Can Loc, Loc Ha, and northern communes of Thach Ha District. It also includes a hydro-electric power system with a capacity of 15 MW, supplementing the national electric grid, providing electricity for production and daily life of locals.

Conclusion

This SES is very important to the provincial development, and it is good if we can carry out micro-level assessment for this SES unit, the Ngan Truoi reservoir.

2. SES PA1 and PA2: State managed special use forest (protected area) in upland (>700m) and lowland (<700m) forest

Example: Vu Quang National Park

Key descriptors:

Social: Managed as a National Park under the control of the PPC. Kinh communities formerly living inside VQNP have been relocated from a valley that will be flooded by a new reservoir.

Ecological: Moist evergreen broad leaf forest of both tropical and sub-tropical types covering a range of elevations from 100 -1900m

Economic: VQNP provides a major water supply to downstream areas, the economic value of which has not been calculated. Budget for management of VQNP is provided by the PPC. Tourism in the park generates relatively minor income.

Trends: Decreasing poverty; conversion of pine forest and field crop land to citrus

Climate change threats: Drought; excessive cold or heat; floods; hot winds.

Description:

Vu Quang National Park was established in 2002, in accordance with Decision No. 102/2002/QD-TTg of the Prime Minister of Socialist Republic of Vietnam

Location:
The East borders with Hoa Hai commune (Huong Khe district)

The West borders with Son Kim commune (Huong Son district)

The South borders with the Laotian and Vietnamese border

The North borders with Son Tay commune (Huong Son district) and Huong Dai commune, Huong Minh commune (Vu Quang District)

Geographical coordinates:
From 18°09’ to 18°26’ North Latitude

From 105°16’ to 105°33’ East Longitude

Total area of Vu Quang National Park: 55,029 ha, include:

- Strict Protection Sub-area: 38,800 ha
- Ecological Restoration Sub-area: 16,185 ha
- Administration and Service Sub-area: 44 ha

Flora of Vu Quang National Park: Available information for Vu Quang National Park shows 1600 species in 351 genera and 138 families of vascular plants (IEBR, 2001*).* Valuable timber species include: Lim *(Erythrophleum fordii),* Sên *(Madhuca pasquieri),* Gụ đo *(Sindora tonkinensis),* Vang Tam *(Manglietia fordiana),* Re huong *(Cinnamomum sp.),* Gioi *(Michelia gioi),* De *(Castanopsis spp.),* In addition a large number of plant NTFPs have been listed, including 554 species of medicinal plant, 98 species of ornamental plant, 83 species of essential oil and tannin, and 29 species of rattan *(*Le Thanh Huong, 2015*)*

Fauna of Vu Quang National Park: Available information shows that Vu Quang National Park has 94 mammals, 315 birds, 310 butterflies, 65 reptile and 25 amphibian, 88 fishes *(* IEBR, 2009*).* In addition, 28 ant species belonging to 43 genera were listed in Vu Quang and Huong Son districts *(*Bui T. V., 2011)

Globally important species for conservation include the Saola (*Pseudoryx nghetinhensis*), Mang lon (*Muntiacus vuquangensis*). Formerly the area would have been important for large mammals such and tigers and elephants, but this is no longer the case.

Climate and hydrology:

The area is subject to a monsoon climate with vey high rainfall particularly in summer and autumn. VQNP is the the watershed of the Ngàn Trươi-Cam Trang river system.

Table 5.6: Summary of climate information for Ha Tinh meterologial station

Climatic description	Unit	Value
Annual mean temperature	^{o}C	23.9
Lowest temperature	^{o}C	6.8
Highest temperature	^{o}C	40.2
Annual mean rainfall	mm	2690
No. of days per year with rain	days	159
Highest rainfall per day	Mm/day	657
No. of drizzle days per year	days	16
Av. Air humidity	%	85.7
Av. Wind speed	m/s	1.5
Sunshine hours	h/year	1664
No. of foggy days	days	15
Cloudy days	days	8

Source: Ministry of Construction, Natural data information for construction

Economic activities

Ngan Truoi-Cam Trang irrigation and hydropower project:

- Construction started at June, 2009. When the team visited in December 2015, it was nearing completion of the main dam and auxiliary dam. It is expected to come into operation in 2017
- The catchment area is 408 km^2, located in Vu Quang NP
- The area of the reservoir is 43 km^2
- Capacity of reservoir is 752 million m^3 of water, equal to the total combined capacity of all current reservoirs in Ha Tinh Province. It is expected to supply water to 20,000 ha of agricultural land in the districts of Huong Khe, Duc Tho, Can Loc, Thach Ha and to serve the Thach Khe iron mine.
- It will also generate 15MW of hydropower electricity.
- In total the project occupies about 4,000 ha of land, including approximately 2,000 ha of forest of VQNP
- 898 households in the project area were resettled and provided with forest land in the buffer zone which is being cut down and converted to agriculture

This project involves the conversion of protected forest to other development purposes. Essentially it implies a trade-off between irrigation/agricultural production on the one side and and biodiversity conservation plus other ecosystems services that the forest supplied, on the other side. Between managed provision of water for downstream economic activities and livelihood development and the maintenance of a broad suite of services (see table 2 below) that can be considered as public goods.

Illegal exploitation and trade in forest products: timber, NTFPs, animal species

As VQNP is legally a protected area, the main economic benefits derived from any direct consumptive use of timber, wild plant NTFPs and wild animals come in the form of illegal exploitation. Illegal logging and wildlife poaching continue to be major problems for the national park. The scale of these activities and their economic value is largely unknown and difficult to measure.

Tourism

From discussion with the parks staff, tourism activities in VQNP seem to be very limited, and tourism is considered as a relatively minor economic activity – completely dwarfed by comparison with e.g. tourism in Phong Na Ke Bang in neighbouring Quang Binh Province.

Ecosystem services:

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 of Vu Quang National Park

No	Main services	Rank	Description
Direct Provisioning			
P1	Food		Wild food (including fish) was undoubtedly previously important to communities living inside VQNP, but this is no longer the case. It is likely that illegal harvesting is still carried out in the park by people living outside the boundaries
P2	Water supply		VQNP is the watershed of major rives supplying downstream areas. This is a very significant ecosystem service
P3	Medicines		A large number of medicinal herbs may have previously been important to communities living inside VQNP, but this is no longer the case. It is likely that illegal harvesting continues
P4	Fibers		
P5	building materials		Timber for house construction was previously important for people living inside VQNP – nowadays illegal logging of high value timber species continues
P6	Water energy		The reservoir under construction largely for irrigation purposes will also generate 14MW of hydropower
P7	Biomass energy		
P8	Transport		
Regulating			
R1	Carbon fixation/storage		The carbon sink value of VQNP is huge – it has not been calculated, and is not necessarily appreciated and taken into account by decision makers
R2	Water quality maintenance		VQNP plays a major role in regulating water quality of the downstream water supply. Vegetation cover on the sloping areas prevents soil erosion and prevents excessive sediment loading of the water. Vegetation cover and infiltration into the soil provides filtration of water before it subsequently joins the in-stream flow
R3	Air quality maintenance		
R4	Climate buffering		The large tree-covered area of VQNP exerts a significant cooling effect on local temperatures. VQNP also buffers the extremely hot and dry west wind (Lao wind) that is prevalent during April-June
R5	Pest and disease control		VQNP provides significant pest control services to the surrounding areas – including predatory insects that provide biological pest control for agricultural lands and bats that consume large numbers of mosquitos and other pests on a nightly basis
R6	Waste recycling / detoxification		
R7	Physical protection		Vegetation cover in VQNP provides protection from erosion, landslides and some storm impacts
R8	Control of water flows		Interception of rainfall by multi-layered forest canopies reduces velocity of rainfall; vegetation cover reduces speed of run-off and increases opportunity for infiltration of water into the soil as well as groundwater recharge. Together these processes control the amount of flow, timing of flow and speed of flow of water as it moves downstream through the landscape. The

No	Main services	Rank	Description
			large size of VQNP means that this function is happening on a significant scale
R9	Control of sediment flows		Vegetation cover reduces erosion and thereby controls sediment flowing into the streams and rivers. Similar to water flows, the large area of VQNP exerts significant influence on sediment flows as well. This has never been calculated or valued economically (e.g. for its role in extending the working life of downstream reservoirs by preventing them from being filled-in by sediment
Supporting (basic ecosystem functions)			
S1	Carbon cycling		This is happening throughout VQNP
S2	Photosynthesis, primary production		This is happening throughout VQNP
S3	Nutrient cycling		This is happening throughout VQNP
S4	Soil formation		This is happening throughout VQNP
S5	Water cycling		In addition to what has already been described under regulating water flow, the large vegetation covered area of VQNP is also a major source of transpiration that returns water vapour back to the atmosphere. The cooling effect of the vegetation cover combined with the turbulence to air movements caused by tree covered hills may have some impacts on rainfall patterns
S6	Pollination		Birds bats bees and other insects in VQNP provide natural pollination services for surrounding farmland especially for fruit trees, pumpkin, squash and beans
S7	Seed dispersal		Seed dispersal for wild trees is carried out by birds, bats, squirrels, primates etc. in the natural ecosystem (in addition many species are wind dispersed) but seed dispersal services for crops in adjacent farmland are not considered as a major service because most agricultural crops are grown from seed collected or bought by the farmer
Cultural-spiritual			
C1	Religious-spiritual		Not known
C2	Recreation, sports, ecotourism		Associated with a famous game of buffalo fighting
C3	Science, education		VQNP provides significant opportunities for scientific research and education, but it appears that very little of this is actually happening at the present time
C4	Historical / nation building		VQNP provided a significant source of food and other materials for soldiers fighting in the American war
C5	Relaxation/mental health		There is a growing body of scientific research demonstrating the links between time spent in nature and mental and physical health. VQNP could undoubtedly provide significant services in this regard but this is hardly being utilized at the present time
C6	Aesthetics /artistic inspiration		Again the potential is high but is largely underutilized

Climate change related hazards:

Table 5.8: Exposure and sensitivity of the Kinh people have food production, livestock and aquaculture 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	HIGH	Some species of wild plants may not be able to tolerate long hot dry periods and may start to disappear from the ecosystem Reproductive behaviour of some species may be affected	Depends on each individual species and requires in depth study of each species
by 2-3 deg C in 2050			
Hot days >35ºC increasing	HIGH HIGH	Similar to above. Productivity and survival of many species declines above 35 degrees. Some animals may suffer heat stress and reproductive behavior may be affected. The risk of forest fire may be increased	AS ABOVE HIGH
Shift in timing of seasons	MODERATE	Plant phenology – timing of emergence of new leaves, of flowering and of fruiting may change – which could also affect food supply for some animal species at critical times in their life-cycles	AS ABOVE
Temperature rises more in May and June		Caused drought for summer season	
PRECIPITATION			
Wet season is getting wetter	HIGH	May cause waterlogging of the soil which many species cannot tolerate. May increase the occurrence of flash floods and landslides within VQNP	MODERATE
5% more rain in summer by 2050			
Dry season is getting drier	HIGH	Combine with hotter temperatures, the risk of forest fire is increased	HIGH
5% less rain in spring by 2050			
More frequent drought	MODERATE	Meteorological drought may translate into physiological water shortage for some species far from water sources	MODERATE
WIND AND STORMS			
Wind speeds higher	MODERATE	Wind-throw – some trees in the forest can be blown over by strong winds in storms	MODERATE
Storms frequency less predictable	MODERATE	Less frequency but less predictable and higher intensity with stronger damages	LOW
Storm season coming later	MODERATE	Damage autumn and winter crops/vegetable, economic loss	LOW
SEA-LEVEL RISE			
Average 3mm/year, for last 20 years	N/A		N/A

Extent and relative importance of the SES:

VQNP covers a significant portion of HT province, and together with Ke Go Nature Reserve which is similarly managed as a protected area, accounts for around 20% of the land area of the province. A s such it represents a significant commitment to maintaining natural ecosystems in a protected state (although some of VQNP and almost all of KGNR had been selectively logged by State Forest Enterprises before their designation as protected areas).

VQNP provides significant ecosystem services especially in terms of provision and regulation of water supply and quality for downstream communities, as well as carbon sequestration and climate regulation. 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 try and understand if the level of investment of government budget in management of the area is appropriate or not when considering the value of services the area provides. It also makes it 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.

According to personal conversations with a number of leading conservation experts in Viet Nam, the biodiversity importance of VQNP has declined over the last 2 decades and this is reflected in the fact that none of the major international conservation organisations have any ongoing or planned projects to support the area.

If local communities were more actively involved in the management of VQNP, and if conservation agreements and benefit sharing arrangements were put in place, significant additional economic value and support for local livelihoods could be derived from sustainably managed collection of NTFPs in VQNP. Under present management rules and structures this is unlikely to be the case, and the park is still struggling with illegal logging, poaching and harvesting of NTFPs. Tourism could also be potentially further developed.

Conclusion and consideration as a possible micro-level assessment site

To really approach this from the perspective of an Socio-Ecological System, the focus should not be so much on the park itself, but rather be on the communities in the buffer zone, and how they relate to and interact with VQNP - looking at how they benefit from and the extent that they depend on, the ecosystem services of the area, etc. One or more communities in the buffer zone could therefore be considered as a potential site for a micro-level assessment. This would have to be compared with similar possibilities for conducting a micro-assessment in the buffer zone of Ke Go Nature Reserve or in the buffer zone of Phong Na Ke Bang in Quang Binh, as we would not select to do more than one pilot micro-assessment in these kind of similar areas. Another closely related alternative may be to consider doing a micro-level assessment of the reservoir and irrigation system (although this may be difficult when it has not yet been completed) or to do an assessment of the Ngàn Trươi-Cam Trang river basin including its headwaters in VQNP, the irrigation scheme and other aspects further downstream in its lower reaches.

3. SES 3a: Kinh irrigated floodplain rice (and vegetable cultivation)

Example: Phuc Loc commune, Can Loc district, Ha Tinh

Key descriptors:

Social: Kinh, smallholder vegetable cultivation, not poor, community

Ecological: Agricultural Flood Plain; less than 10 m above sea level

Economic: Upland crops, maize, peanut, vegetable in winter season

Trends: Decreasing poverty

Climate Change Threats: Drought; excessive cold and heat, floods.

Description:

Phuc Loc commune is located in flood plain near the shoreline in Can Loc district at elevations of less than 10m. The basin is derived on alluvial soil from Ngan Sau water shed.

This flood plain commune is inhibited by a population of about 7800 people on total area of 970 ha including 480 ha agricultural land, most belong to Kinh group live here very long time ago.

Topography, this area is very flat, pedology is belong to alluvial bad to for alluvial soil from Nghen river basin. Alluvial process forms this soil type at high (cao, vàn cao) elevation and sandy soil texture. Soil characteristics characterized by light soil texture (sandy loam soil). This delta has formed long time ago with crop production is the most agricultural activities, original is potato and some upland crop as sesame but some changes in crop type (for example a lot of sweet potato, long duration rice varieties and summer rice in the past).

Economic: key crops, economic activities

Dominated crop in this area are upland crops, mainly peanut in spring season, many upland crops during the year and vegetable in winter season. The main crop rotations in the area are spring peanut, onion, maize, potato, beans, green bean.

Plantation also varies associated with land elevation changes. Basically this area was planted very simple upland crops such as sweet potato and peanut, but farmer now introduced a lot of high very crops such as onion, baby onion with very high income. Especially, Ha Tinh population is growing very fast due to urbanization and industrialization causing of very high consumption of food and vegetable. So that vegetable is planted not only in the suitable sandy loam, but also widespread in sand and sand dune near the shore line.

Economically, most farmer in the commune have vegetable, rice production and livestock together as household livestock production with limited 1-2 cows or buffalo, 1-2 pigs or sows.

Farmer incomes are from rice, upland crop products (such as peanut, maize, vegetable…), livestock and may be from aquaculture.

Ecosystem services:

Key ecosystem services communities obtain from the landscape, and their current status are shown in Table 5.9. 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 5.9: Ecosystem services

No	Main Services	Rank	Description
Direct Provisioning			
P1	Food (not agriculture)		Very long time in the past, people fishing for their food but now very little and people change to raise fish. The system provide grass for farmer's cattle
P2	Water		Water is the most important resources for human and agriculture activities (as Vietnamese said most water, second fertilizer, third hard working, and fourth variety). Water also the most important for practicing aquaculture
P3	Medicines		
P4	Fibres		
P5	Building materials		Houses were previously built by earth and now constructed by brick, also made from earth
P6	Water energy		
P7	Biomass energy		
P8	Transport		This also very important to have a good transportation system that can help growing economic development quickly for traders to assess production area (for example water-melon, onion) and also one of the criteria for new rural development
Regulating			
R1	Carbon fixation/storage		Not perceived
R2	Water quality maintenance		Vegetable need fresh irrigation water, but vegetable itself easily to deteriod water quality because of high in put of fertilizer and pesticide
R3	Air quality maintenance		Vegetable fields makes air quality more fresh, but it can deteriod air quality if pesticide overused
R4	Climate buffering		Reduce temperature from urban area and from west wind (Lao win), reduced methane emission when replacing rice field by vegetable
R5	Pest and disease control		Some time increase pest and disease, but reduce pest and disease if we have good rotational of rice - vegetable
R6	Waste recycling / detoxification		Deteriod by over use of fertilizer and presticides
R7	Physical protection		A large vegetable fields provide protection from hot winds in certain locations
R8	Control of water flows		
R9	Control of sediment flows		
Supporting (basic ecosystem functions)			
S1	Carbon cycling		
S2	Photosynthesis, primary production		This is the most important process make good production of food and food staff production in this area
S3	Nutrient cycling		Good nutrient cycling with contributes of soil nutrient, plant uptake, fertilization and crop residue decomposition
S4	Soil formation		This is a long process of soil formattion to make a typical soil type with dominated soil process of leteratic (accumulation of iron,

No	Main Services	Rank	Description
			alliminum but leaching of Canxium, magnesium, potassium) and make soil more acid
S5	Water cycling		
S6	Pollination		Important for crops production, especially fruit trees, pumpkin, squash and beans
S7	Seed dispersal		Good for many beans
Cultural-spiritual			
C1	Religious-spiritual		Related to weather rules, disasters management of human
C2	Recreation, sports, ecotourism		Associated with a famous game of bufalo fighting
C3	Science, education		A lot of researches and education about crop production
C4	Historical / nation building		The main sources for feeding solders, who fight for country
C5	Relaxation/mental health		Some products can be very good for facial (like cucumbers)
C6	Aesthetics /artistic inspiration		unclear

Climate and Climate Change

Rainfall is from1800-2000 mm/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 Ha Tinh is provided in Table 5.10.

Table 5.10: Summary of climate Information for Ha Tinh meteorological station

Climatic description	Unit	Value
Annual mean temperature	°C	23.9
Lowest temperature	°C	6.8
Highest temperature	°C	40.2
Annual mean rainfall	mm	2690
No. of rain days per year	mm	158.5
Highest rainfall per day	mm/day	657
No. of drizzle days per year	15.6	
Average air humidity	%	85.7
Av. winspeed	m/s	1.5
Sunshine hour	h/year	1664
No. of foggy days	day	15
Cloundy day	day	7.6

Table 5.11: Exposure and sensitivity of the Kinh people have food production, livestock and aquaculture 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	HIGH	Drought /heat affects vegetable, reduce vegetable yield, especially to rolling of cabbage, biomass of salad or beans	
By 2-3 degree C in 2050			
Hot days >35°C increasing	HIGH	As above; heat increases pig, chicken, cattle disease; reduces labour efficiency, especially for rice flowering period attached by Lao win (late May)	
Shift in timing of seasons		Extreme cold cause dieing of young vegetable or vegeteble seed can not emerge	
Temperature rises more in May and June		Caused drought for summer season	
PRECIPITATION			
Wet season is getting wetter		Concentrate heavy rainfall damage onion	
5% more rain in summer by 2050			
Dry season is getting drier		Consump mor irrigation water for vegetable and increase cost	
5% less rain in spring by 2050			
More frequent drought		Drought affects vegetable because vegetable need to irrigate many, especially cabbage and salad	
WIND AND STORMS			
Wind speeds higher	MODERATE	Can be easily damage soft vegetable stem such as onion, pumkin and squash frame	
Storms frequency less predictable		Less frequency but less predictable and higher intensity with stronger damages	
Storm season coming later		Damage autumn and winter crops/vegetable, lost of economic	
SEA-LEVEL RISE			
Average 3mm/year, for last 20 years		Salt intrusion deeper into the mainland (20-30km from river mouth), increase salinity, salty irigation water cause drought for paddy	
1m rise by 2100			

Source: Ministry of Construction, Natural data information for construction

In Table 5.11, the impact of predicted changes in the climate (exposure and sensitivity) on this SES is explored.

Extent and relative importance of the SES:

When Ha Tinh has a large soil of of highly suitable to vegetable and other upland crop. There are simple vegetable planted in the past with not higher than rice income, but nowadays, extension workers and farmer themslf introduced a lot of new crops and varieties with high yield, better quality and high value, especially in condition of increasing industrilization, urbanization and services. The income and benefits from vegetable and other upland crops increasing high than growing traditional rice and other crop. Especially in very large sandy soil, loams soil. Because of that this SES should be studied and invested more to market oriented to improve farmer benefits. In practice, some new project already invested to have intensive vegetable on sandy soil and sand dune using high technology to optimaize solar, nutrient and water irrigation, that savety vegetable can stand very good for high requirement from society

Conclusion

This SES will be one of the good SES to stipulate high production to improve farmer benefit but sustain the ecology.

Figure 5.3: Google Earth image

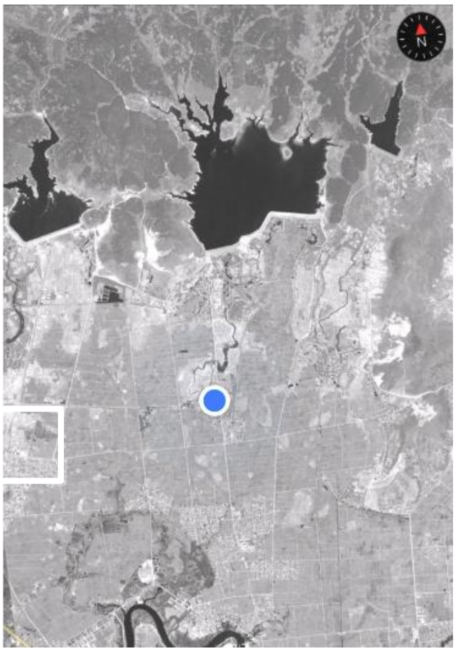


Photo: Peanut field at Nha Giam field, Phuc Loc commune

4. SES 2d: Inland valleys in tropical moist hill forest (< 700m > 10m), Kinh smallholder paddy rice and tree crops

Example: Son Truong commune, Huong Son district

Key descriptors

Social: Kinh, small holders, not poor, willing to innovate.

Ecological: Inland river valleys; complex terrain: small low altitude (< 50 m) flood plain areas, dry fields, part-forested hills to 150 m; many small reservoirs.

Ecosystem services: Water (irrigation and domestic); soil nutrients

Economic: Diversified; Paddy rice; semi-technical irrigation, field crops; tree crops, livestock, good market access

Trends: Decreasing poverty; conversion of pine forest and field crop land to citrus

Climate Change Threats: Drought; excessive cold or heat; floods; hot winds.

Description

Son Truong commune straddles the Ho Chi Minh Highway in Huong Son District, north-central Ha Tinh. The topography of the commune is a complex mosaic of small valleys of recent (Holocene) sediments at 15-30 m amsl elevation and low hills under 150 m amsl, derived from Triassic sandstones. There are iron deposits nearby, making the area high risk for lightning strikes. The area drains both to the Ngan Pho River to the north and the Ngan Sau River to the south. The original vegetation would have been lowland tropical rainforest, but the entire landscape has been converted to other uses and very little, if any, of this remains.

Settlements are located in the valleys along roads and watercourses. From land allocation programmes, households typically have access to both flat arable land in the valleys and the hills for tree crops. Many small reservoirs have been constructed in the hills, providing irrigation for some areas of paddy rice. Beyond the reach of these schemes, valley land is planted to field crops, primarily peanuts, but also maize and cassava.

Parts of the commune previously belonged to a state forest enterprise, and in late 1990s, hilly land was allocated to households and planted to pine, under an ODA afforestation programme. Over the last 10 years, through New Rural Development and other government programmes, villagers have been encouraged to replace the pine and plant up any bare areas with higher earning citrus, and now 80% of households grow them. Citrus species are particularly suitable here, as they are tolerant of poor soils and drought although they do need some irrigation to supplement rainfall. Trees yield up to 125 kg/yr when mature, and fruits sell at 40-100,000 VND/kg. They are estimated to earn up to 1 billion VND/ha/yr 10-20 times more than other crops. Two varieties are planted Chanh and Bu; Chanh fruits first, but Bu (Cam Huong Son But the certified variety of Ha Tinh) is higher value and more disease resistant. Pomelo was tried here and failed. Some pine and acacia remain on hill tops.

Some farmers also produce livestock traditionally cattle and deer, and more recently, rabbits. Most animals are stall fed, and fodder is planted on the hills. Cattle manure is used to fertilise the citrus plantations.

Ecosystem services

The natural tropical rainforest ecosystem has been almost entirely converted to other uses. Table 5.12 below discusses the ecosystem services currently available.

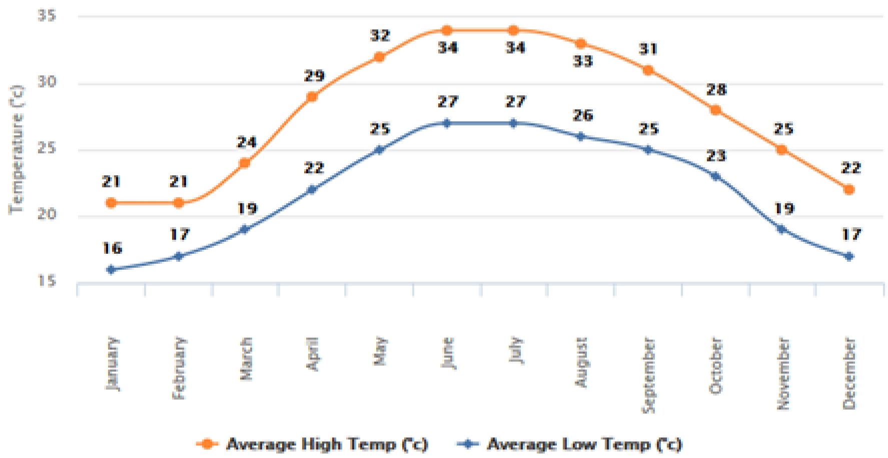
Table 5.12: Ecosystem services important to people in inland valleys

No	Main services	Rank	Description /Status
Direct Provisioning			
P1	Food	Low	Heavily degraded; some fish capture still occurs
P2	Water	High	Watersheds provide water for trees and cattle; levels of rivers and reservoirs have declined in last few years
P3	Medicines	Low	Heavily degraded; some plants still available in secondary growth
P5	Building materials	Moderate	Local materials now little used for houses; bamboo used for fencing and animal shelters.
P7	Biomass energy		Plantations and some agricultural residues provide fuel rather than natural ecosystems.
Regulating			
R1	Carbon fixation/storage		Not perceived
R2	Water quality maintenance		
R3	Air quality maintenance		n/a
R4	Climate buffering		Forests can provide favourable microclimates for adjoining fields, but this service is diminished by the degraded nature of forest
R5	Pest and disease control		Pest and disease situation not known
R6	Waste recycling / detoxification		
R7	Physical protection		Forests provide protection from hot winds in certain locations
R8	Control of water flows		River levels have declined in the last few years
R9	Control of sediment flows		Absence of forest cover increases soil erosion
Supporting (basic ecosystem functions)			
S1	Carbon cycling		Primarily from planted crops
S2	Photosynthesis, primary production		Primarily from planted crops
S3	Nutrient cycling		Degraded through loss of biomass and relevant organisms, tho Vital for crop production
S4	Soil formation	High	Degraded through loss of biomass and relevant organisms; tho vital for maintaining soil fertility
S5	Water cycling		Degraded by loss of vegetation structure leading to increased runoff; tho vital for
S6	Pollination	High	Bee pollination of citrus crops
S7	Seed dispersal		Not important for crops currently cultivated and wild foods used
Cultural-spiritual			
C1	Religious-spiritual		Unclear
C2	Recreation, sports, tourism		unlikely
C3	Science, education		Unlikely
C4	Historical / nation building		unlikely
C5	Rlaxation/mental health		Unlikely
C6	Aesthetics /artistic inspiration		unclear

Climate and Climate Change

Ha Tinh has a tropical monsoon climate, influenced by the south-west monsoon in summer and the north-east monsoon in winter. Annual rainfall is from 2000 mm to as much as 4000 mm in the high mountains. The rainy season is from April/May to November/December, but with frequent interruptions in June and July, when the south-west monsoon brings hot dry winds from Laos. Most rain falls from August-September, when storms occur and frequently cause floods. The summer average temperature is around 22°C , with maxima over 40°C. The dry season is in winter, with particularly cold months from December to February, but there is still frequent drizzly rain. The north-east monsoon can bring cold air down from China, taking temperatures to 7 °C or lower several times a month.

Figure 5.4: Avearage tempearture graph for Ha Tinh



In recent years, drought and heat have become more serious. Maximum temperatures in summer now reach 43°C, and last longer. Rice is killed, and farmers forced to plant again. Fruit trees grow slowly and productivity declines. There are shortages of drinking water.

Cold snaps have also become more serious, with temperatures as low as 5°C. The cold can also kill rice; cold delays the flowering of citrus; in March, trees usually have small fruits, but this year they are just flowering.

Flash floods have become more frequent and powerful, damaging rice and peanut crops, and causing loss of agricultural land from erosion.

In Table 5.13, the impacts of predicted changes in the climate (exposure and sensitivity) on this SES are explored.

Table 5.13: Exposure 12 and sensitivity 13 of the inland valley 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	HIGH		
By 2-3 deg C in 2050			
# Hot days >35C increasing	HIGH		
# Cold days/nights <5C increasing		Paddy rice can be killed; citrus flowering delayed	
Shift in timing of seasons			
Temperature rises more rapidly earlier in spring			
PRECIPITATION			
Wet season is getting wetter		Landslides, erosion increase(?), sedimentation in small reservoirs;	
5% more rain in summer by 2050		Ngan Sau valley is prone to flooding	
Dry season is getting drier			
5% less rain in spring by 2050			
More frequent drought	HIGH	Main crops require some irrigation	MOD
WIND AND STORMS			
Wind speeds higher	MOD	Citrus vulnerable to wind damage	
Storms frequency less predictable			
Storm season coming later			

Extent and relative importance of the SES

This SES is extensive - including large parts of four upland districts and three main river systems: Huong Son (Ngan Pho River), Vu Quang and Huong Trach (Ngan Sau River) and Ky Anh (Dao Cai River). The greater part of the population of the three inland districts - some 250,000[14]people make their livelihoods in this SES.

The Ngan Pho River flows from the mountains, almost perpendicularly, to the coast, becoming the La River below the confluence with the Ngan Sau River. Until about 10 km from the Lao border, the valley bottom is still only 50 m amsl. Where it enters the flood plain, the valley is 4 km wide.

The Ngan Sau River, the main tributary of the La River, forms a long valley running broadly north-northwest to south-southeast about 35 km inland, beyond and to some extent protected by the first range of 200-300 m hills that lie west of the main coastal plain. It comprises three valley systems. The upper valley near the border with Quang Binh, runs south south-east from 125 - 80 m amsl until entering a gorge, now flooded by the Ho Ho Dam. Below the dam, at an elevation of around 50 m amsl, the river turns 180 degrees to flow back north-northwest in the main Ngan Sau Valley. At its widest point, near Huong Khe town, the valley is about 14 km wide, but only 25 m amsl. Paddy fields are extensive, and well-irrigated. Field crop lands and home gardens are being converted to pomelo. There are experiments with sustainable rice intensification (SRI) in Huong Trach Commune. The Ngan Sau enters a second gorge at about 15 m amsl, before turning north and entering the flood plain of the La River at about 5 m amsl. The gorges represent bottlenecks for air-masses, trapping cold air in the two upper valleys.

[12] Exposure: Duration (length of time); Frequency; Location (Area); Magnitude (size, volume) ; Intensity (power/energy involved); Aspect (topography)

[13] Sensitivity: infrastructure: design, materials, siting, maintenance; crops: tolerances (to duration, magnitude, intensity, etc)

[14] Total pop of 3 districts – includes the district towns, and some for the people above the valley.

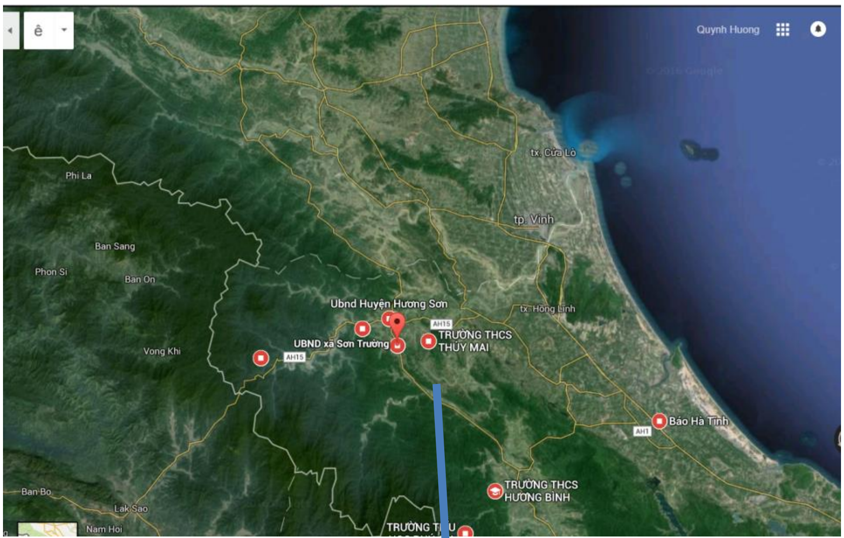
This broad topographic band combines these large low elevation inland valleys, with deep alluvial soils and their minor shorter tributaries, with their adjacent hills, and enables the basic livelihood combination of paddy rice, citrus and/or forest trees, depending on soil type and water availability.

The Dao Cai River in the uplands of Ky Anh roughly parallels the Ngan Sau valley, before turning south to flow into the Gianh River in Quang Binh. The valley system has a broad, but dissected upper part at 50-80 m amsl on its northern tributary, and a narrow lower part at around 40-60 m amsl on its southern tributary, with a short gorge – now dammed - in between. Paddy land is limited to the immediate river margins; acacia plantations more abundant.

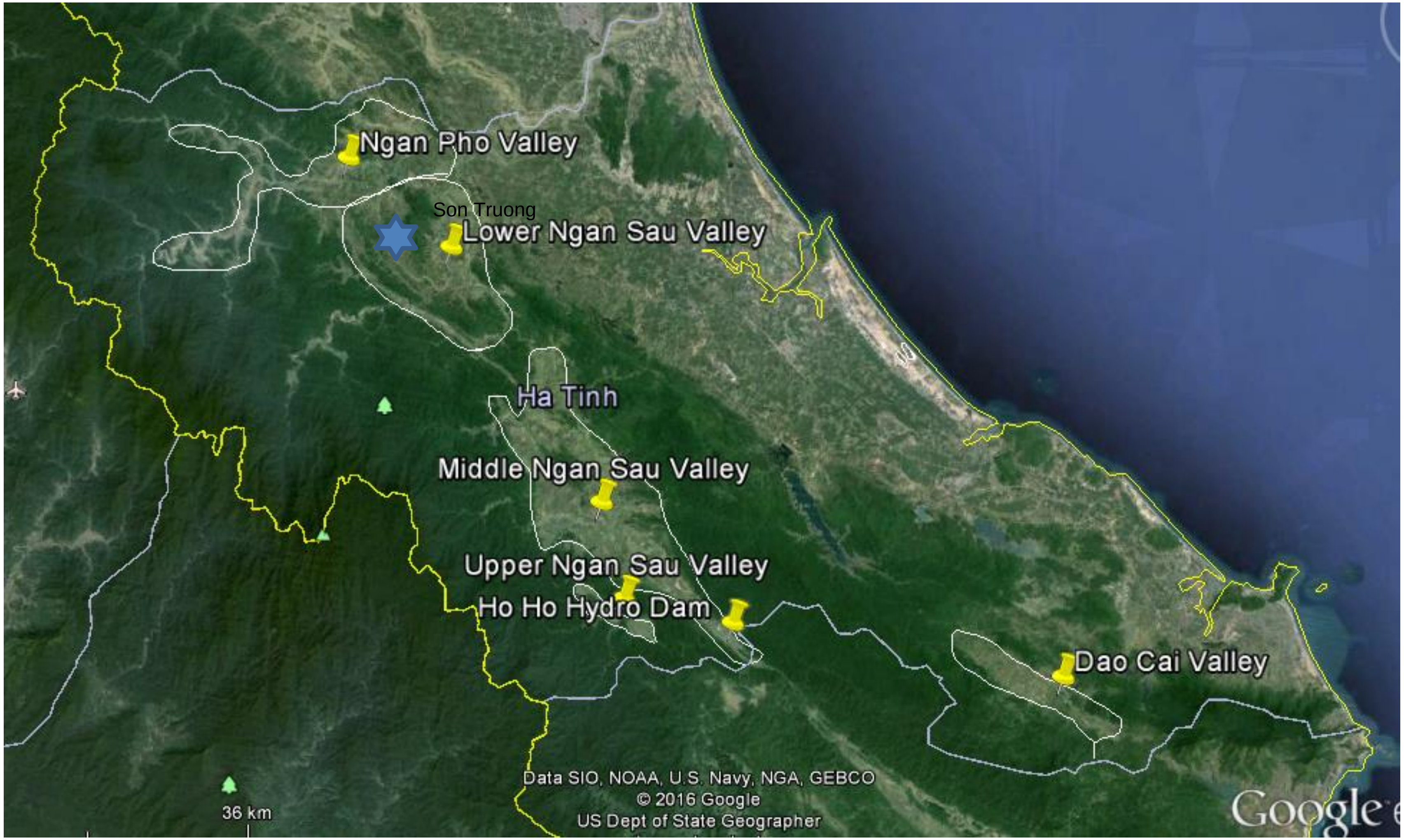
Conclusion

This SES is extensive and well-populated and contributes some important crops, such as citrus, to the provincial economy, and plans are for this production to increase in the next 10 years. The system is vulnerable to certain climate change impacts – particularly drought, and in some places flooding and erosion. Almost none of the natural vegetation remains – so environmental services are highly degraded. However, the majority Kinh people are relatively prosperous, with diversified livelihoods including paddy rice, field crops and tree crops. It is an important, but perhaps not a priority system for study at the micro-level now.

Figure 5.5: Google Earth images of Son Truong commune, Huong Khe district, Ha Tinh



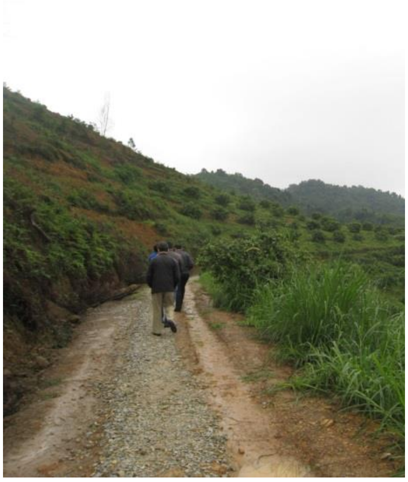
Son Truong commune, Huong Khe District, Ha Tinh



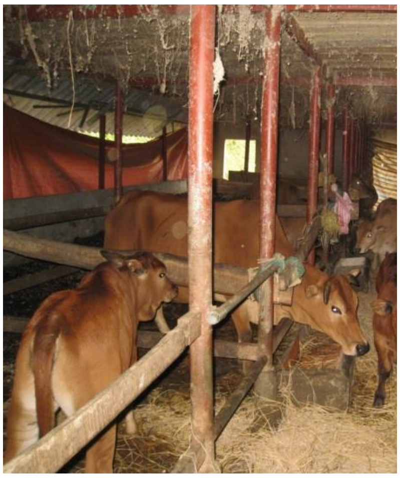
Location of the main areas of the SES: Inland valley tropical moist forest Kinh smallholder paddy rice and tree crops

Photos

The house of household that grows oranges and raises cattle



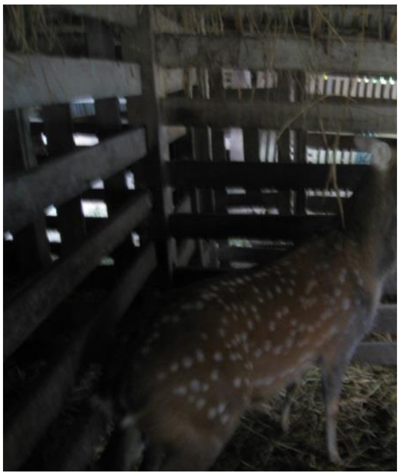
Mixed Chanh and Bu oranges and grass



Cattle raising also produces manure for oranges

Water supply for orange cultivation. Water would be pumped up to the hills

Mix of Chanh and Bu oranges, site preparation



Deer, kept for antlers and meat, are stall fed

5. SES 6d: Kinh commercial shrimp cultivation on coastal sand dunes

Example: Cam Duong commune, Cam Xuyen district, Ha Tinh

Key descriptors:

Social: Kinh people, middle farmer class

Ecological: Coastal sandy areas about 4-6 m amsl.; bare land of inner sandy areas or coastal sandy areas, Shrub trees of *Melaleuca cajuputi* mix with *Baeckea frutescens*.

White Shrimp (Lipopenaeus vannamei)

Economic: Commercial - High value business of high input and also high output

Trends: Decreasing poverty

Climate change threats: Drought; excessive cold or heat; floods; hot winds.

Description:

Cam Xuyen district is located in the South East of Ha TInh province where can found all types of topography types, mountain, hill, river, plain land and also sandy. Total natural land areas is about 63.554 ha in which agricultural land is about 12.985 ha, distributed in 25 communes and 2 towns. Total population in 2015 is about 153.518 people in 38.455 household. The mean density is 239 person/km^2 but 91% of total population live in the rural areas.

Seven coastal communes of Cam Xuyen district occupied 7.698 ha with high population density, about 841 person/km^2. Main incomes of local people in coastal communes came from agricultural cultivation, salt production, aquaculture... Average income per person in 7 coastal communes are about 18.2 mil. VND/person/year (2015), lower than mean income figure of Cam Xuyen district (23 mil/person/year (2015)).

Cam Xuyen district has 18 km coastal areas with long and narrow sandy areas immediately inland.

Table 5.11. Coastal communes in Ha Tinh province

Commune	Total natural land areas (ha)	Population (person)	Density (person/km^2)	Main income
Cam Hoa	1429.76	4595	321	Crop, rice and aquaculture
Cam Duong	1441.16	6128	425	Crop, rice and aquaculture
Thien Cam	1401.34	4,863	347	Crop, rice and tourist
Cam Nhuong	278.32	9286	3336	Aquaculture
Cam Linh	1745.39	5476	314	Crop, rice, salt, fishing
Cam Phuc	779.98	3,650	468	Crop, rice, salt, fishing
Cam Loc	622.77	4,495	678	Crop, rice and aquaculture
Total	7.698.72	38222	841	

Tidal and intertidal zones of Cam Xuyen district are large. This is habitats of aquatic biomes where live of many species of fish (49 species) and crustacean (19 species). Actually, some good aquatic products in Cam Xuyen are *Clupanodon thrissa*, *Konosirus punctatus*, *Lates calcarifer*, *Epinephelus awoara*, *Epinephelus malabaricus*; *Acetes japonicus*, *Charybdis cruciata*, *Charybdis feriatus*, *Penaeus merguiensis*, *Anadara antiquata*, *Anomia cytaeum*, *Loligo beka*, *Meretrix meretrix*.

Forest in Cam Xuyen district is recorded as 13.241 ha (2010) occupied 278 % of total agricultural land of the district. Two forest types in Cam Xuyen district is production forest and coastal protection forest with main tree species area *Casuarina equisetifolia* and *Acacia* spp. In 2015, according to Decision 1475/QĐ-UB (23/04/2015) of Ha Tinh PPC, 7 coastal communes of Cam Xuyen district own 1.402 ha forest areas in which coastal protection forest 907.8 ha (65%) and production forest 493.8 ha (35%).

Economic:

Ha Tinh PPC released Decision 1742/QĐ-UB (20/6/2014) approved planning vegetable zone in coastal sandy areas of Ha Tinh province from 2015-2020). In coming years, Ha Tinh people will reclaim sandy areas include sandy shrub and bare sandy land for intensive vegetable production in new rural program. It estimates of contributing about 12.000 labor works with average income 5-7 mil VNF/month. To 2020, intensive vegetable farms in Ha Tinh will be about 684,1ha and may produce 23.000 ton of high value vegetable with estimates cost of 230 bil. VND/year for domestic and export market.

Ha Tinh province also enhanced their own capacity in aquaculture practices in salt, brackish and frest water cultivation. Five main shrimp production in Cam Xuyen district were identified. Cam Hoa commune (288.5 ha) and Cam Duong commune (42.63 ha) and change land use type from paddy rice to shrimp pond production some about 150 ha in Cam Loc, Cam Hung and Cam Phuc commune.

Main income of local people in sandy areas of Cam Duong commune in 2015 came from fishing from tidal and intertidal zones, shrimp production and crop productions.

Ecosystem services: Key ecosystem services communities obtain from secondary sources and field visits.

Table 5.12. Ecosystem services in the coastal sandy areas

No	Main services	Rank	Description
Direct Provisioning			
P1	Food		Coastal sandy areas in Ha Tinh province is not direct provide food to local people but local people practice crop and vegetable production in dry land areas. Many lower sandy land in side of sea dykes, large sandy land areas were irrigated and practice paddy rice in Winter – Spring crop and maybe Summer-Autumn crop Cattle graze freely in coastal protection forest
P2	Water		Sand dune and shrubs, forest in sandy play main role of water resources in sandy areas. Main fresh water underground resource was use for paddy rice, crop, daily use and other aquacultural productions
P3	Medicines		*Melaleuca cajuputi* and *Baeckea frutescens* can extract to essential oil for herb (expensive)
P4	Fibres		*Agave cantala* is identified as traditional fibres of local fishermen for fishing net
P5	Building materials		Sand was mined for construction and road building
P6	Water energy		No
P7	Biomass energy		For along time, shrubs and plantation forest in sandy areas contribute firewood to local people
P8	Transport		N/A
Regulating			
R1	Carbon fixation/storage		Not perceived
R2	Water quality maintenance		YES but N/A
R3	Air quality maintenance		n/a YES
R4	Climate buffering		Sandy area contributes main fresh water for crops and paddy rice Winbreak

No	Main services	Rank	Description
			Mitigated typhoon
R5	Pest and disease control		N/A only
R6	Waste recycling / detoxification		Poor waste recycling
R7	Physical protection		Winbreak from typhoons
R8	Control of water flows		Ungerground water from coastal sandy areas is reducing by time in dry season
R9	Control of sediment flows		Moving sand
Supporting (basic ecosystem functions)			
S1	Carbon cycling		Protection plantation forest (casuarina) is monoculture and poor protection, Natural sandy areas were interfered for land use change
S2	Photosynthesis, primary production		N/A
S3	Nutrient cycling		N/A
S4	Soil formation		Sandy
S5	Water cycling		
S6	Pollination		N/A
S7	Seed dispersal		*Mimosa pigra* propagated to sandy areas
Cultural-spiritual			
C1	Religious-spiritual		Chris and other
C2	Recreation, sports, ecotourism		Good practice in clubs of communes
C3	Science, education		Good education with national education system
C4	Historical / nation building		Good
C5	Relaxation/mental health		Commune health stations but poor capacity
C6	Aesthetics /artistic inspiration		Traditional

Climate and Climate Change

Tropical typhoons, coastal erosion, dough and salinity in summer are 4 main climate problems in Cam Duong commune, Cam Xuyen district

Table 5.13: 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	HIGH	Drought /heat affects paddy rice and change land use of paddy rice in summer-autumn to vegetable crops. Some large areas change from 1 crops agriculture to shrimp production	
by 2-3 deg C in 2050			
# hot days >35C increasing	HIGH	As above; heat increases pig, chicken, cattle disease; reduces labour efficiency	
PRECIPITATION			
Wet season is getting wetter	MOD	Coastal erosion (no floods)	
5% more rain in summer by 2050			
Dry season is getting drier	HIGH	Drought affects shrimp cultivation and paddy rice cultivation	
5% less rain in spring by 2050			
More frequent drought	HIGH	Drought affects all crop and aquatic practices	
WIND AND STORMS			
Wind speeds higher	MOD	Reducing rice yield, shrimp production	
Storms frequency less predictable			
Storm season coming later			
SEA-LEVEL RISE			
average 3mm/year, for last 20 years		n/a	
1m rise by 2100			

Conclusion

It needs further micro-level assessment in natural protection sandy forests, underground water regime of the sand dune and effect of shrimp production in sandy areas. In recent year, intensive vegetable production is also conducted in sandy areas without any environmental research. It needs some further study in this area.

Photos

Construction of the Cam Trang dam and spillway

Upstream view from the Ngan Truoi bridge

Downstream view from the Ngan Truoi bridge

CHAPTER 6 CLIMATE AND CLIMATE - RELATED DISASTER PROFILE OF HA TINH

6.1. Introduction

This Chapter provides background climatic data for Ha Tinh, as a prelude to the climate change scenarios and vulnerability assessments in the following chapters. The account begins with an overview of Ha Tinh's climate data, followed by a description of the province's present climatic conditions and an account of the province's history of climate-related disasters and their economic costs.

The account draws on four key documents:

- ISPONRE (2009) *Ha Tinh Assessment Report on Climate Change*.
- Ha Tinh Provincial People's Committee (2011) *Climate Change Response Action Plan for Ha Tinh (2011-2015) and orientation to 2020*.
- DONRE (2012) *Climate Change Response Action Plan for Ha Tinh.*
- Ha Tinh Provincial People's Committee (2014) *REPORT: Disaster situation over the last ten years and the impacts on agriculture and rural development*.

6.2. Identification of Socio-Ecological Systems (SES)

Ha Tinh has six climate stations, managed by IHMEN, four which have been functioning since 1982, long enough to contribute to climate change data: Ha Tinh and Ky Anh on the coast, and Huong Son and Huong Khe inland. Map 6.1 shows their location and approximate elevation.

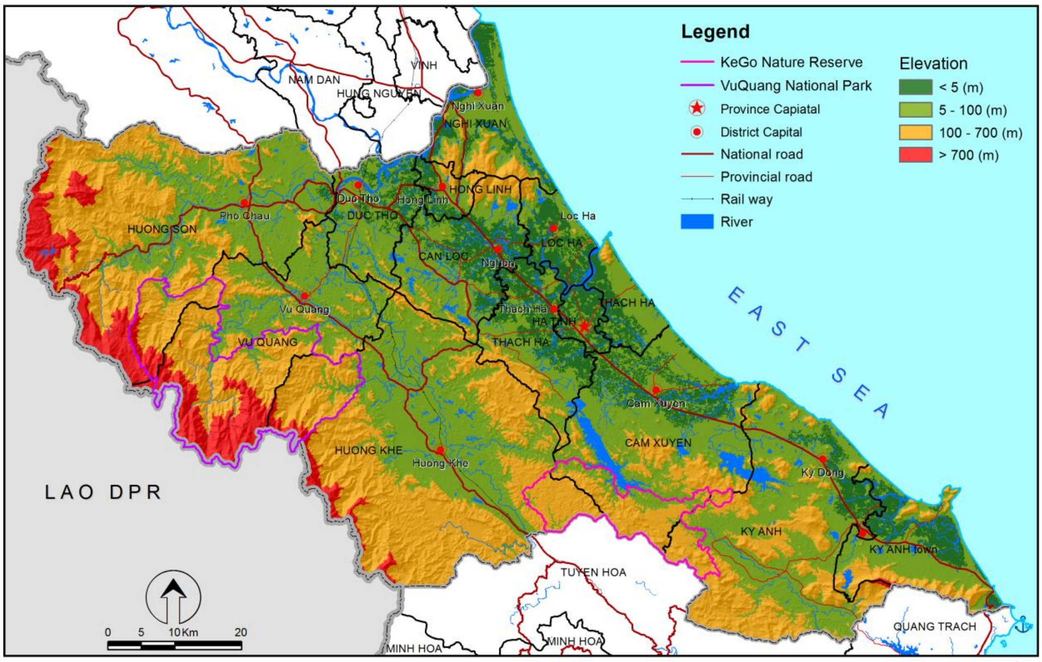
A detailed analysis of the economic and social impacts of extreme climatic events has not been conducted for Ha Tinh. Anecdotal information is available in the sources listed above.

6.3. Existing climatic conditions

6.3.1. Overview

Ha Tinh Province is located within the tropical monsoon belt, and the overall climatic pattern is governed by the seasonal shifts of winds and pressure between north and south. The cold, drier north-east monsoon dominates from November to May, and south-west monsoon from June to October. In this transition zone, the province experiences both the tropical heat of the South, and the near freezing winters of the North. Superimposed on this, local climatic patterns within the province are strongly influenced by topography, and differ substantially from place to place.

Figure 6.1: Location and elevation of Ha Tinh's main meteorological stations



Source: - Elevation: USGS DEM 90m resolution

Table 6.1: Average values for climate parameters at four meteorology stations in Ha Tinh, 1982-2011

Parameter	Ha Tinh	Huong Son	Ky Anh	Huong Khe
Average annual temperature (°C)	24.8	24.7	24.9	25.0
Lowest temperature (date obs.)	4.4 (02/95)	2.3 (12/99)	7.4 (03/96)	3.7 (12/99)
Highest temperature (yr. obs.)	40.2(05/94)	40.5(05/92)	40.4(06/06)	42.6(05/92)
Average annual rainfall (mm)	2680	2085	2816	2444
Highest daily precipitation	657 (08/92)	519 (10/83)	573 (08/07)	493 (10/83)

Source: DONRE2012

6.3.2. Temperature

Average annual temperatures in the plains and low mountains of Ha Tinh are 24.7 to 25°C, while in the higher peaks they are significantly cooler at 14 – 15°C. Hot weather coincides with the rainy season, from May to July, when the monthly average temperature is between 24.7°C and 30.1°C. The highest temperature ever recorded was 42.6°C, in 1992.

The cooler dry season lasts from November to March, when the average monthly temperature ranges from 17.9°C - 22°C. Under the influence of the East Asia Monsoon, two to four times during this period, particularly in January and February, cold air masses move in, and temperatures decrease to below 7°C. Temperatures as low as 2°C have been recorded.

Table 6.2: Monthly average temperature in Ha Tinh City in 2014 (°C)

Month												
1	2	3	4	5	6	7	8	9	10	11	12	Mean
17.6	18.3	20.5	26.0	30.2	31.1	30.4	29.7	28.4	25.6	23.7	18.0	25.0

Source: DONRE 2015; Ha Tinh Hydro-meteorology Station

Maps 6.2 show the temperature baseline for Ha Tinh across four seasons. The maps illustrate the relationship between latitude and topography, and seasonal average maximum temperatures. In restricted areas along the coast especially near Ha Tinh City, summer temperatures of up to 36°C are the norm, with slightly lower temperatures in a lens in the northern coastal lowlands of the province and lower temperatures still in the montane areas near the Lao border. In winter, the central and southern coastal areas of the province remain warmer than elsewhere, with the lowest average maximum winter temperatures in mountainous areas in the northwest of the province.

A "very hot day" is defined as one with temperature exceeding >35°C and relatively humidity of less than 65%. Huong Son and Vu Quang districts typically experience over 40 hot days per year, while Ha Tinh City and Ky Anh get less than 30 days. Table 6.3 presents the incidence of hot dry days at the province's four climate stations and Map 2b shows the geographic and seasonal variation.

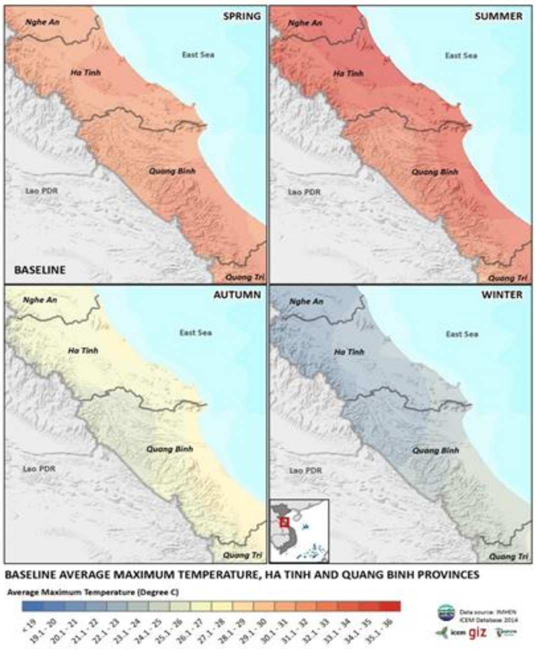
The Lao wind, responsible for many of the heat waves, occurs between February and September, with a peak April-August. It plays a major role in the incidence of drought and water shortages, and can disrupt the normal convective activity and associated rainfall of the summer season for up to 3 months.

Table 6.3: Incidence of hot dry days in February-September, at four climate stations in Ha Tinh

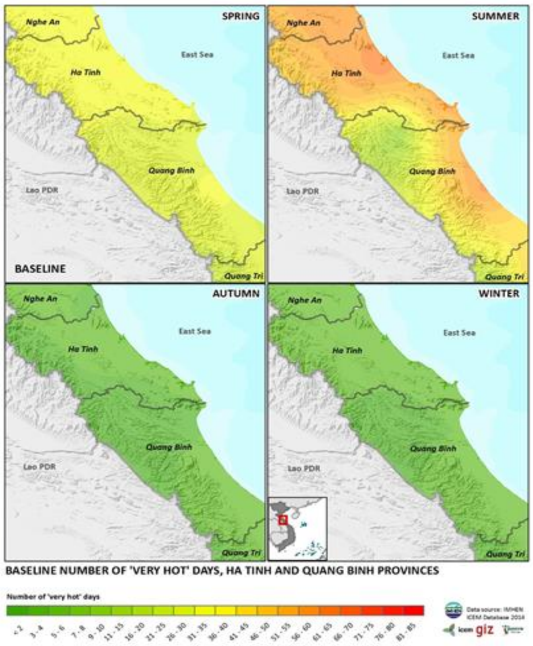
Station	Feb	Mar	Apr	May	June	July	Aug	Sept	Avg
Huong Son	0.0	0.6	3.4	4.0	8.4	9.6	2.2	0.6	28.8
Ha Tinh	0.0	0.8	1.8	3.8	11.0	10.2	1.8	0.4	29.8
Huong Khe	0.4	1.4	5.4	8.8	14.4	14.4	3.4	0.8	49.0
Ky Anh	0.0	1.0	3.0	6.0	9.0	9.2	2.6	0.0	30.8

Source: ISPONRE 2009

Figure 6.2: Baseline for four seasons



Baseline Four Season Average for Maximum Temperature (ºC) in Ha Tinh



Baseline for Four Season incidence of very hot days (> 35 °C)

6.3.3. Precipitation, humidity and evaporation

Ha Tinh experiences high levels of rainfall, averaging over 2,000mm/year, with some places such as the upper Ngan Pho River, Ngan Sau, Rao Tro, Heng Son area, Loc Ha-Ky Anh receiving up to 3,500mm/year. Rainfall is distributed unevenly throughout the year. In winter-spring, 20-25% of annual precipitation falls, mostly as drizzle associated with the northeast monsoon. The heaviest rain is concentrated in summer and autumn (May until November), when 75-80% of annual rainfall occurs, with the maxima occurring in late autumn. In many places rain is interrupted in October (or July) by the hot dry westerly "Lao" wind (see above).

Table 6.4: Monthly average rainfall in Ha Tinh city in 2012 (mm)

Month												
1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
11.2	27.3	31.8	59.3	36.2	227.4	39.4	168.5	164.0	563.9	208.9	167.7	1705.6

Source: ISPONRE 2009

The highest daily rainfall averages 240-290 mm, while the actual highest daily rainfall varies from 492mm in Huong Khe (1983) to 790 mm in Ky Anh (1967). In the 50 years to 2009, daily rainfall exceeding 300mm occurred on 17 occasions in Ky Anh, 15 in Ha Tinh City and 9 in Huong Khe. Highest monthly rainfall recorded was 2,218 mm in Ky Anh (1983). Table 6.5 provides more details, for three climate stations.

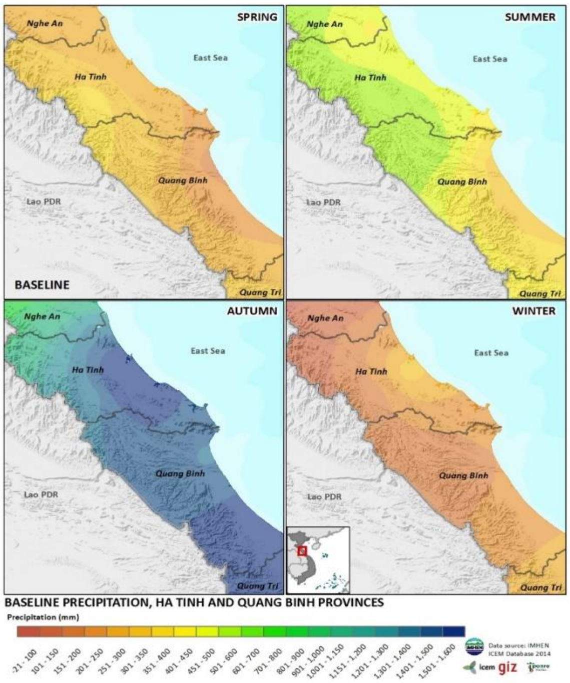
Table 6.5: Frequency of high rainfall events, 1958 – 2007

Value	Station		
	Ha Tinh	Huong Khe	Ky Anh
Over 300 mm daily	15	9	17
Over 1000 mm monthly	14	5	17
Over 1500 mm monthly	4	2	7
Over 2000 mm monthly	1	0	1
Over 3000 mm annual	13	4	20
Over 4000 mm annual	1	0	1

Source: Institute of Meteorology, Hydrology and Environment and ISPONRE, 2009

Map 6.3 presents the baseline scenario for precipitation across four seasons, based on IHMEN data, and shows the spatial and temporal variability of rainfall across the province. In autumn and winter, rain in Ha Tinh falls mainly on the coastal plain, with volumes decreasing into the mountains. However, in spring and summer - the main agricultural season - the pattern is reversed, with higher rainfall recorded in the mountains.

Figure 6.3: Four season baseline scenarios for precipitation in Ha Tinh



6.3.4. Storms and wind

In Ha Tinh, the storm season usually begins in August and storms are most frequent between September and November. Most are associated with tropical cyclones, originating in the Pacific Northwest or the East Sea, but other factors include activity in the inter-tropical convergence zone, cold air-mass incursions and combinations of these (ISPONRE 2009).

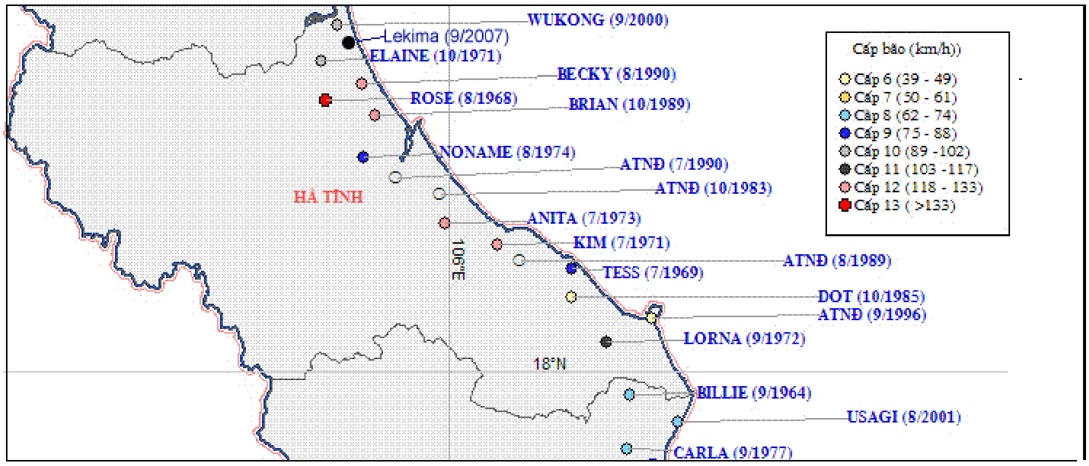
Between 1961 and 2004, Ha Tinh experienced 12 hurricanes and five tropical depressions. Their paths and landfalls are shown on Map 6.4. While this represents an average of 0.90 storms per year, some years there have been as many as four storms, and more than half of the years have had no storms at all.

The strongest recorded storm was Rose, a level 13 storm, which made landfall in August 1968 There have been four level 12 storms: with Kim (7/1971), Anita (7/1973), Brian (10/1989) and Becky (8/1990). Map 6.4 shows the landfall and wind speeds of all these storms.

At the Ky Anh meteorological station, the annual average wind speed is 2.3m/s (8.3km/hr; 4.5 knots), level 2 or a “light breeze” on the Beaufort Scale. The highest wind speed recorded was 54 m/s (194 km/hr; 105 knots) - a level 16 “super typhoon”.

In the summer, southwest winds prevail about 35-40% of the time. Northeast winds also occur in the summer but with an incidence of only 5-6%; for the remainder of the time south or southeasterly winds dominate. In autumn and winter, northeasterly and northerly winds dominate. In the transition periods, there is virtually no prevailing wind direction.

Figure 6.4: Landfall location of major storms affecting Ha Tinh, 1961-2004



Source: Ha Tinh PPC (2011)

6.4. Climate hazards and the economic costs of disasters

Ha Tinh suffers regularly and heavily from extreme events associated with the climatic patterns described above, including heatwaves and droughts, cold snaps, storms, floods, whirlwinds and storm surges and salt water intrusion, and interactions amongst these. In 2010, damage from extreme climatic events was estimated to cost 6.4 billion VND, including 2.5 billion VND (or 40% of the total) damage to agriculture and rural development (Ha Tinh PPC, 2014). Further details of the occurrence of these different hazards and, where available, their economic and social costs are provided below, and some locations referred to in the text are shown on Figure 6.5.

6.4.1. Heat waves and drought

Heat waves are defined as periods of more than 2 days experiencing temperatures over 35°C and relative humidity under 65%. Each year, there are 15-22 heat waves in Ha Tinh. Most last from two to five days, but they can last up to 14 days. Huong Son and Vu Quang districts typically experience over 40 hot days per year. Much of this is a result of the Lao wind which occurs between February and September, with a peak April - August. The hot wind accelerates the evaporation rate and reduces both humidity and soil moisture, adding to the severity of any drought and water shortage. Coastal areas, including Ha Tinh City and Ky Anh get less than 30 days.

Table 6.6 presents the monthly and annual drought index for four climate stations in Ha Tinh. The annual drought index ranges from 0.30-0.44[15], which is lower (less severe) than other North Central provinces. Droughts are mainly summer droughts - but can appear any time from February to August. These droughts cause serious set-backs to crop production - both directly from water stress and indirectly from salinisaton penetrating deeply inland along the main rivers (see below). Serious droughts have occurred four years in each of the last decades. Drought-affected areas have increased to thousands of hectares (12,680 in 2003, and 3,360 in 2005).

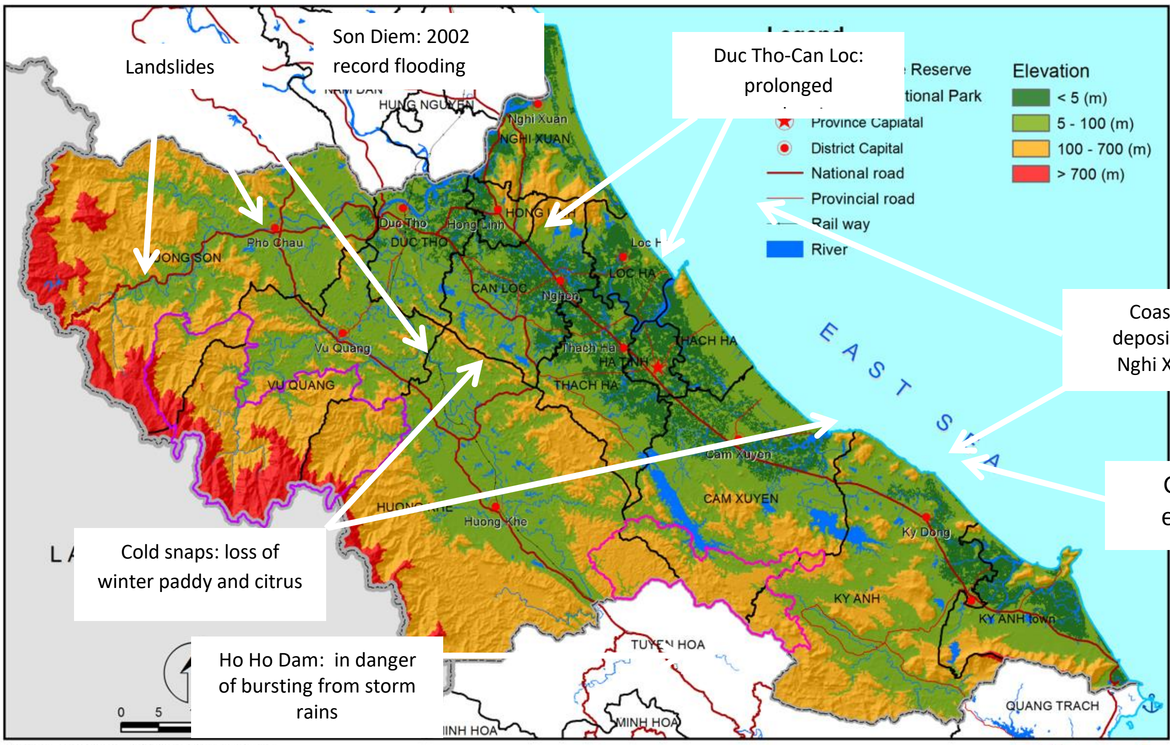
Table 6.6: Monthly and annual drought index for four climate stations in Ha Tinh

Weather Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Huong Son	0.48	0.45	0.67	0.57	0.58	1.18	1.27	0.59	0.16	0.09	0.18	0.36	0.44
Ha Tinh	0.35	0.41	0.65	0.70	0.65	0.81	1.22	0.45	0.12	0.07	0.15	0.27	0.30
Huong Khe	0.87	0.72	0.80	0.80	0.55	0.79	1.14	0.43	0.13	0.10	0.24	0.61	0.39
Ky Anh	0.39	0.44	0.78	1.06	0.88	1.37	2.15	0.71	0.14	0.08	0.14	0.26	0.38

Source: ISPONRE 2009

[15] The drought index is a product of drought severity and drought frequency and expresses drought probability (ISPONRE 2009).

Figure 6.5: Location of some extreme climatic events and disasters in Ha Tinh



Source: - Elevation: USGS DEM 90m resolution

Serious losses to agriculture in Ha Tinh caused by drought occurred in the summer season of 2010. In Huong Son District, 2,450ha rice failed due to poor germination and slow growth. In some areas such as Son An, Son Bang, Son Trung and Son Quang, Son Tra, lack of water was exacerbated by unstable power supply, so pumped irrigation water was not available. Duc Tho District, considered the province's granary, lost more than 2,000ha for the same reasons.

High temperatures and drought also increase the risk of forest fires. Ha Tinh has 365,000 ha of forests and forest lands, and dozens of hectares of forest burn every year as a result of drought. The years 2005 and 2006 were particularly bad.

6.4.2. Cold snaps

As described above, the coldest weather in Ha Tinh typically occurs between December and February, and cold snaps with temperatures below 5°C lasting several days can occur several times during the season. Cold snaps are most common in constricted mountain valleys, but in 2008, the entire province was affected. These prolonged and extreme cold weather events can kill rice seedlings, cause the abortion of citrus crops and even kill livestock. Farmers on the coastal plain south of Ha Tinh reported losing 25% of their winter paddy to cold, but detailed figures for economic losses from cold snaps in Ha Tinh are not available.

6.4.3. Storms and floods

Storms bring heavy rains and high winds. In estuaries and coastal areas storms cause floods, and areas inside dikes, such as Duc Tho - Can Loc, often suffer prolonged waterlogging. Storm surges associated with cyclones typically leave many displaced households. Province-wide 8,615 households (31,946 people) had to be relocated, with the largest number in Ky Anh district (2,920 households and 8,893 people). Downstream of large reservoirs like Ke Song, debris carried by flood water causes loss of lives and property. High winds cause damage to infrastructure including the loss of roofs or total collapse of houses and other buildings, falling transmission poles and breaking of transmission wires. They also cause considerable damage to agriculture - including lodging of field crops, and wind throw of tree crops, and loss of fruits from fruit trees.

In Ha Tinh, floods often occur simultaneously on all 4 major rivers - Ca, La, Ngan Sau, and Ngan Pho. Flooding also occurs on a smaller, local scale, such as in Ngan Sau (1960), La (1978) and Ngan Pho (2002). While on many rivers, floods peak for short periods, usually 6 - 8 hours, on the Ngan Pho River, they often last 8 - 12 hours and may take 8-10 days to recede fully. Flash floods, peaking for 2-3 hours and receding again after 2-3 hours are common in the Huong Son and Huong Khe, where rivers flow through narrow mountain valleys. Between 1959 and 2006, 21 major floods reached a Level 3 alarm. The largest floods and flash floods occurred in 1960, 1962, 1964, 1978, 1983, 1989 and 2002. A few of these events are described below, and available data on the economic and social impacts of individual storms over the last 10 years are provided in Table 6.7.

In September 2002, a tropical depression hit Ha Tinh, causing heavy rains across the whole province, particularly on the Ngan Sau and Ngan Pho River basins. Son Diem experienced 753mm of rain, the highest daily total in 50 years, and the water level of the Ngan Pho River there rose to 15.8 m, reaching a Level 3 alarm. In flood, this river typically flows at over 2m/second and carries huge amounts of mud, as well as trees and debris from damaged houses. This flood left mud deposits up to 80 cm thick. Flash floods in Huong Son, Huong Khe, Vu Quang and Duc Tho associated with the same storm killed 53 people and injured 111 more.

Typhoon No.2, in August 2007 brought four days of heavy rain, with 1,153mm falling in Huong Khe. The accompanying flood peaked at a record 16.13m. Water quickly flooded the Ngan Sau and Ngan Truoi rivers, affecting 22 communes in Huong Khe, nine in Vu Quang and four in Duc Tho. Huong Son district was completely isolated from the rest of the province. The storm caused loss of life and infrastructure damage, with 29 people killed, and 44 injured and total damage estimated at 667 billion VND.

Table 6.7: Summary of economic and social damage from selected storms in Ha Tinh, 2002-2013

Year	Dates	Deaths	Injuries	Damage (Billion VND)
2002	18-22 Sep	56	111	824
2007	06-08 Aug	29	44	667
2010	14-19 Oct	51	175	6,400
2013	15-16 Oct	5	23	1037
TOTAL		141	353	8,928

Source: Ha Tinh PC 2014

In October 2010, the various climate phenomena combined to produce six days of heavy rainfall: Chu Le received 1,032mm; Son Diem 672mm and Ha Tinh City 1,126mm, producing another historical peak flood at Chu Le of 16.6m and flows of 582m^3/s. Floods inundated 182 of the province's 262 communes causing severe damage to people, property and technical infrastructure: 51 people died, 175 were injured and damage estimated at 6.4 trillion VND was caused. The floods nearly caused the Ho Ho Dam to fail, when heavy rains filled the reservoir to capacity. Emergency discharges caused serious damage to villages and agricultural land downstream in the Ngan Sau Valley and to the railway line.

Typhoon No.11 in 2013 also struck in October, with level 7-8 winds and up to 19 hours of rain, bringing 400-500 mm rain and peak floods of 14.4m and Level 3 flood alerts. There was severe flooding and heavy damage to 66 communes in 4 districts Huong Son, Huong Khe, Vu Quang and Duc Tho. In Ha Tinh city many streets were flooded from 0.5 to 1.0m deep. The flood killed 5 people, and injured 23, with a total estimated damage of 1,037 billion VND.

Heavy rains associated with storms cause soil erosion and landslides. Erosion is exacerbated by unsustainable land use, which leaves soil surfaces bare or poorly covered. In the lowlands, surface erosion removes topsoil leaving gravel and stone. Gully erosion is common in the upland districts of Huong Son, Vu Quang, Huong Khe, leading to sedimentation of reservoirs and reducing irrigation and electricity generation capacity. The rate of erosion in Ha Tinh is estimated at over 20 tons/ha/year, and eroded areas are estimated to extend over 100,000 ha. In Ha Tinh, the most damaging landslides occur mostly along Highway 8, between Hong Linh to the Cau Treo border gate; Provincial Road 5 in Vu Quang, the Vung Ang to Dong Le (Quang Binh) road[16]. Landslides are also common on steep slopes in forested areas, particularly where short-rotation tree crops have been planted.

These storms caused significant loss of life and economic damage in Ha Tinh. As shown in Table 4, between 2002 and 2013, cyclones killed 141 people, injured a further 353, and caused economic losses of 8,900 billion VND.

6.4.4. Whirlwinds and blowing sand

Whirlwinds often occur during the transition period between dry and wet season (March-April). For example in April 2013, two days of heavy rain were accompanied by whirlwinds that killed a two-year old boy, swept the roofs off more than 1,000 houses and flattened 100 ha of crops in Huong Khe District. Total damages in Ha Tinh are estimated at 2 billion VND. Wind erosion is very common in coastal areas of Ha Tinh. Under the effect of sea breezes, sand from the coastal dunes blows onto fields, especially in the dry season.

6.4.5. 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. In 10 years to 2014, in Cam Xuyen District, high tides exceeded the previous high water mark by 10-15cm. Other districts such as Nghi Xuan, Thach Ha, and Loc Ha are also experiencing the initial impacts of sea level rise, salt water intrusion in rivers and flooding in some coastal areas. Sea level rise also exacerbates storm surges during cyclones.

The coastline of Ha Tinh is relatively straight, and erosion and sedimentation processes occur to different degrees seasonally and in different places, reflecting the underlying geology. Overall, depositional process dominate, for example from Xuan Dan to Xuan Truong and Xuan Hoi, the coast road at Thien Cam beach and certain sections of the coast in Ky Phu and Ky Xuan Communes. However, 11 sections of the coast are eroding. The average rate of erosion is 8.8m/yr, but in certain sections rates are much higher: Xuan Hoi - Nghi Xuân (19.4m/yr), Cam Hoa (18.6m/yr), Cam Nhuong (30m/yr), Cam Xuyen and Ky Nam (12.2m/yr) and Ky Phuong (15m/yr) (Ha Tinh PPC, 2011)[17].

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 Ha Tinh's coastal plains is already a problem and several seawater intrusion barriers have been constructed.

6.5. Summary and conclusions

The climate of Ha Tinh is characterized by a cool relatively dry winter, November - March and hot wet summer April - October. Its position in the tropical monsoon transition zone brings much variability. Early in the summer season, hot dry Lao winds frequently interrupt the rains, bringing drought. Most years, late in the summer season tropical cyclones hit the province, bringing heavy rains and strong winds. The province's topography of a narrow coastal plain backed by high mountains, drained by steep rivers, intensifies the impacts. Thus the people and economy of the province Ha Tinh have long experienced a range of climate challenges and impacts, including storms, droughts, dry hot westerly winds, heavy rains and floods.

Overall, storms have had the greatest impact, economically and socially. Storms take place towards the end of the main growing season for the most important crops, and typically affect a wide area, bringing both high winds and heavy rains, causing flooding and landslides inland, storm surges at the coast, and wind damage everywhere. The area at the confluence of the Ngan Pho and the Ngan Sau rivers is particularly susceptible to floods. Heat waves and drought, caused by the rainfall regime and the dry Lao wind, and cold snaps caused by movement of continental air-masses, also tend to have widespread effects, though costs incurred from neither have been quantified. Other climatic events are more localized. Salinization affects coastal areas and lower river systems. Depending on local geology, on some parts of the coast are depositing, others eroding.

As will be seen in the next chapter, climate change is set to make most of these impacts worse.

[16] Landslides also occur as a result of earthquakes associated with the activity along the Ca River fault zone.
[17] These figures seem too high, and should be checked.

CHAPTER 7 CLIMATE CHANGE SCENARIOS FOR HA TINH AND THEIR EXPECTED IMPACTS

7.1. Introduction

The previous chapter examined Ha Tinh's present climate and history of climate-related disasters and this chapter now looks ahead at the climate change scenarios for the province and their expected impacts. The discussion begins with a review of current trends in key climate factors. The sub-set of climate change parameters used in scenario development for ecosystem-based adaptation vulnerability assessments and the rationale for their selection are then provided. An overview of the three scenarios developed for Vietnam is provided before presenting the B (2) Scenario in detail. Detailed maps and data tables are provided in Annexes 7.1 and 7.2.

The analysis is the original work of the EbA Vulnerability Assessment climate specialist, and also draws on same four key publications used in Chapter 6[18].

7.2. Recent Trends in Key Climate Factors

Recent trends in climate change provide initial indications regarding likely future changes. To assess recent trends in climate change in Ha Tinh, ISPONRE (2009) analysed eight key climatic factors from three climate stations (Huong Khe, Ha Tinh and Ky Anh), in 5 year periods from 1956-1960 to 2001-2005. The results are shown in Table 7.1, and more graphically in Table 7.2. The only statistically significant trends were in annual average temperature and frequency of heat waves, both showing increases. Maximum temperatures also showed an increasing trend for stations at Ha Tinh City and inland at Huong Khe.

[18] ISPONRE (2009) Ha Tinh Assessment Report on Climate Change.

- DONRE (2012) Climate Change Response Action Plan for Ha Tinh.
- Ha Tinh Provincial People's Committee (2014) REPORT: Disaster situation over the last ten years and the impacts on agriculture and rural development

Table 7.1: Trends in climate factors at three stations in Ha Tinh

Factor	Station	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
Sunshine hours (hour)	Ha Tinh	-	1,674	1,574	1,620	1,654	1,674	1,784	1,622	1,560	1,482
	Huong Khe	-	-	-	-	-	-	-	-	-	-
	Ky Anh	-	-	-	1,650	1,678	1,822	1,860	1,786	1,770	1,460
Average temparature (°C)	Ha Tinh	-	23.8	23.7	23.7	13.8	23.7	24.1	24.1	24.4	24.5
	Huong Khe	-	23.5	23.4	23.4	23.6	23.7	24.1	24.1	24.2	24.3
	Ky Anh	-	23.9	24.1	24.0	24.3	24.0	24.6	24.4	24.5	24.5
Maximum temparature (°C)	Ha Tinh	-	38.1	39.5	38.5	39.7	39.3	39.9	40.2	39.9	40.0
	Huong Khe	-	39.5	39.3	41.1	41.2	40.5	40.3	42.6	41.0	41.0
	Ky Anh	-	38.3	38.8	38.6	40.4	39.3	39.5	39.4	38.3	38.8
Minimum temparature (°C)	Ha Tinh	-	7.6	8.6	7.6	8.2	7.3	8.2	8.1	7.5	9.0
	Huong Khe	-	2.8	5.9	2.6	6.5	5.5	6.5	5.4	3.6	8.5
	Ky Anh	-	8.3	9.4	6.9	8.9	7.5	7.8	9.2	8.4	10.4
Annual Rainfall (mm)	Ha Tinh	-	2,128	2,438	2,974	2,541	2,572	2,938	3,020	2,188	2,680
	Huong Khe	-	2,552	2,114	2,336	2,182	2,462	2,816	2,280	2,256	1,862
	Ky Anh	-	2,676	2,912	2,972	2,736	3,190	2,828	2,446	2,866	2,614
Highest daily Rainfall (mm)	Ha Tinh	-	244.7	308.3	456.1	502.4	434.9	546.0	657.2	266.1	401.6
	Huong Khe	-	274.6	290.3	411.2	313.2	492.6	347.0	294.4	357.3	302.6
	Ky Anh	-	206.3	790.1	377.7	475.8	519.1	367.8	484.2	480.1	359.0
Evaporation (mm)	Ha Tinh	320.1	768	8.8	832	784	730	74.2	820	884	908
	Huong Khe	-	722	906	946	1,024	1,068	840	672	774	760
	Ky Anh	316.6	1,070	1,328	1,128	1,086	1,034	1,033	1,040	1,072	984
No. of hot and dry days	Ha Tinh		62	77	68	72	89	93	79	103	81
	Huong Khe		94	99	96	96	94	116	115	103	100
No. of storms including those in coastal line of Nghe An-Ha Tinh-Quang Binh	-	8	6	4	7	4	4	2	2	2	2
Average No. of heat waves	Ha Tinh	-	912.4	15.4	13.6	14.4	17.8	18.6	15.8	20.6	16.2
	Huong Khe	-	18.8	19.8	19.2	19.2	18.8	23.2	23.0	20.6	20.0

Source: Institute of Meteorology, Hydrology and Environment

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

The impacts of these climate changes shown in Table 7.3 and their likely implications are discussed in the following sections.

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

7.3. Selection of Climate Change parameters for the Vulnerability Assessment

As discussed in Chapter 6, there are a lot of different factors and parameters that can be used to measure climate variability and climate change. For this EbA vulnerability assessment, it was necessary to focus on a limited number of parameters, relevant to our objectives, for which reliable data exists, and for which likely consequences of those changes could be interpreted. These are presented in Table 7.2. The following factors were considered in making this selection.

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 climatic 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 climatic conditions that are most appropriate for 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 do not lead to any real understanding of how living things will be affected.

Changes in extremes and the duration that 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 affected. 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, the growth of rice and other crops is widely thought to be stimulated by higher levels of atmospheric carbon dioxide, through the stimulation of more efficient photosynthesis. However, theoretical, experimental and on-farm research have shown that increased carbon dioxide concentration, combined with increased temperature actually reduces rice yield[19].

Table 7.4: Important climate change parameters and their impacts

Parameter	Specific 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.
	More days > 35°C	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 eb exceeded with a danger of dam failure
	More days with high rainfall events (>50mm rain)	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

[19] Simulated yield potential in the major rice-growing regions of Asia with present atmospheric CO_2 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 researches shown that the strongest correlation is between increasing night time temperature during the growing season, and reduced rice grain yield. It appears that while plants are producing more in the day time as photosynthesis is indeed increased, they are also burning up more energy at night time as respiration is also increased with higher temperature, with the net result of lower yield (Peng et.al 2004).

The selected parameters combine those that are highly relevant to existing climate-related disasters in Ha Tinh - particularly storms and rainfall changes (relating to both floods and droughts) - with sea-level rise that is likely to become of increasing concern in the future.

The next section examines the different climate change scenarios and expected impacts for these key parameters.

7.4. Main climate change scenarios and their expected impacts

7.4.1. *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 for initial assessment of the impact of climate change and sea level rise and to design action plans to respond to climate change. These scenarios were updated and elaborated for each province in 2012 (MONRE, 2012). The general scenarios for Ha Tinh for temperature and rainfall changes as well as sea level riseare all taken from MONRE (2012). Then, for the present provincial-level assessment in Ha Tinh, additional analysis and maps showing key temperature and precipitation change parameters have been prepared presenting the baseline situation, and predicted changes for 2030, 2050 and 2100, again reflecting the medium emissions (B2) scenario.

7.4.1.1. Scenarios for changes in temperature

The three scenarios predicted for annual average temperature change in Ha Tinh are:

- *Low emission scenario (B1):* By 2100, annual mean temperature in most of areas of Vietnam north of Hua Thien-Hue (Including Ha Tinh) will have increased by 1.6 to 2.2ºC relative to the baseline period (1980-1999).
- *Medium emission scenarios (B2)*: by 2050, annual mean temperature in areas from Ha Tinh to Quang Tri will have increased by 1.6 to 1.8ºC. By 2100, it is forecast to increase by 3.1 to 3.3ºC.
- *High emission scenario (A2):* by 2100, annual mean temperature in most of the country will have increased by between 2.5 to more than 3.7ºC.

However, as discussed above, for adaptation considerations, the more important parameters than average annual temperature are the extremes: average maximum temperature and the number of hot days.

Four season changes for average maximum temperature (Tmax) in 2100 over baseline under the B2 scenario are shown in Map 7.1. The variation in the magnitude of change broadly reflects local latitude and altitude, greatest in the southeast and least in the northwest. The baseline level of Tmax is already quite high, between 31.2 and 32.9 in spring and between 33.6 and 35.6 in summer. Predictions are for this to increase by 2100 to between 3.3-4.2^{o}C in spring, and in summer by between 3.3 and 3.8 ^{o}C.

Four season changes in the number of hot days (maximum temperature above 35ºC) over the baseline are shown in Map 7.2. The baseline level is also quite high. Depending on location, hot days currently occur from 60 - 90 days (~ 33-50% of the time) over the six spring and summer months. They are predicted to increase by between 15 and 30 days over this baseline by 2100. The total number of very hot days (>35 degrees C) may increase by up to 35 days in 2030, up to 38 days by 2050, and up to 54 days by 2100.

Although not modelled by MONRE or this report, the number of cold snaps is expected to decrease, as general temperatures rise.

The full sets of the maps (baseline, 2030, 2050 and 2100) and the commune level data sets are provided in Annex 7.1.

Figure 7.1: Four season change in average maximum temperature; 2100 over baseline (B2)

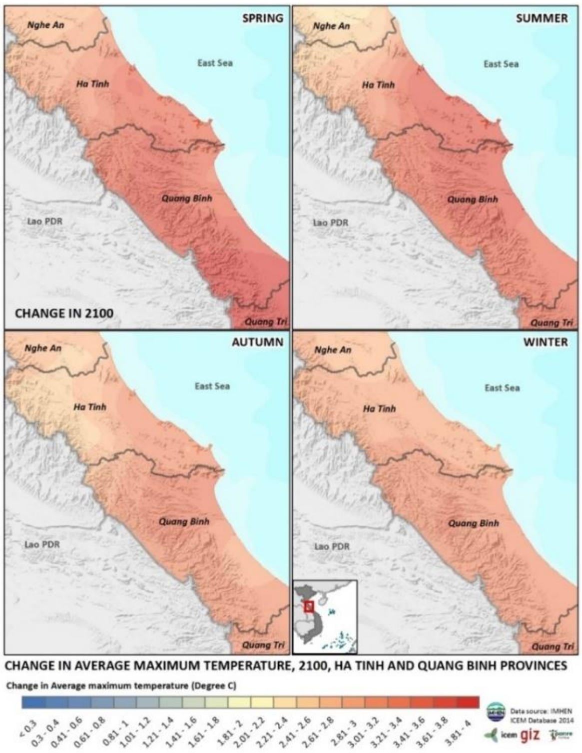


Figure 7.2: Change in the number of very hot days (>35°C) for Ha Tinh, 2050 over baseline (1980- 1999)

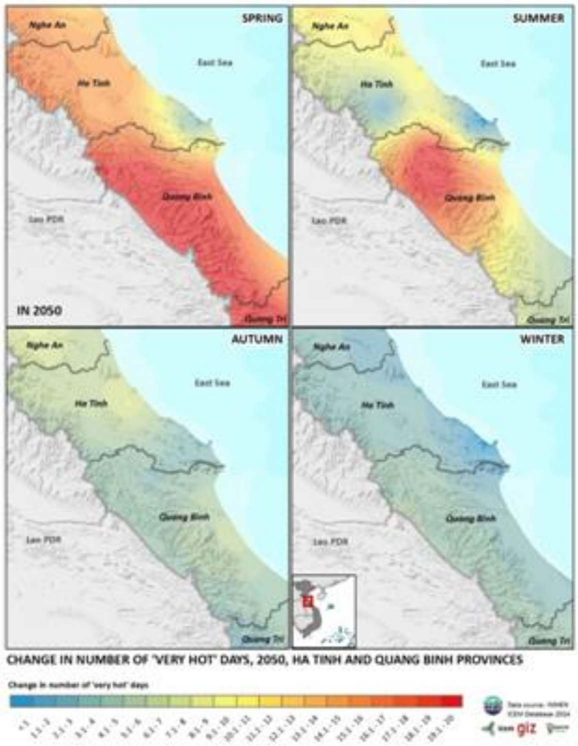
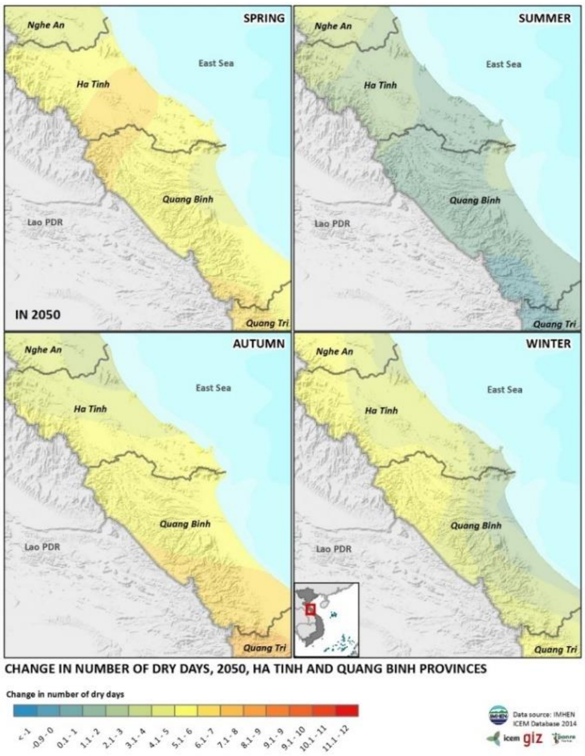


Figure 7.3: Seasonal change in precipitation by 2100, over baseline (%)

Figure 7.4: Seasonal change in number of dry days by 2050, over baseline



7.4.1.2. Scenarios for changes in precipitation

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 2100, annual rainfall will have increased in most of Vietnam by about 6% relatively to the reference period 1980-1999.
- Medium emission scenarios (B2): By 2100, annual rainfall will have increased 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 will increase in the North Central zones (including Ha Tinh). Extraordinary daily rainfall may occur anywhere, with rainfall about two times higher than present maximum daily rainfall.
- High emission scenario (A2): By 2100, annual rainfall will have increased by between 2 and 10 % over most of the country.

Map 7.3 shows the percentage change in seasonal precipitation between baseline and 2100 for Ha Tinh. Depending on locality, spring a critical season for agriculture is predicted to become drier by from 4.3 to 9.9 %. All other seasons will become wetter, particularly the summer, when rainfall will increase 5.3-11.4%. Maps and data sets of the seasonal baseline for precipitation and the predicted changes for 2030, 2050 and 2100 are provided in Annex 7.2.

The number of dry days is also set to increase by up to 10%, from the baseline of 165 / yr to 181 /yr in 2050. Map 7.4 shows the four season changes over baseline by 2050. The summer season (June-Aug) has the highest baseline number of dry days (65), and is least affected, but dry days in the spring and autumn seasons increase by around 10% by 2050. All the maps and the data set are provided in Annex 7.2.

7.4.1.3. Scenarios for Sea Level Rise

Sea level rise, over the 1980-1999 baselines, in most of the coastal zones of Vietnam, for the different emissions scenarios, by 2100 is as follows:

- *Low emission scenario (B1):* Between 49 and 64 cm.
- *Medium emission scenarios (B2):* Between 60 and 71 cm.
- *High emission scenario (A2):* Over 100 cm

Table 7.5: Expected sea level rise in Vietnam under three emissions scenarios

Scenario	Specific value	Sea Level Rise (cm)			
		2020	2050	2070	2100
Very high (A1F1)	Upper boundary	11.8	33.4	57.1	101.7
	Middle boundary	6.5	18.5	31	52.9
	Lower boundary	2.6	7.6	12.6	20.3
High (A2)	Upper boundary	11.8	30.8	48.9	85.9
	Middle boundary	6.6	16.8	26.1	44.5
	Lower boundary	2.7	6.6	10.2	16.8
Medium (B2)	Upper boundary	11.7	30.1	45.8	73.7
	Middle boundary	6.6	16.2	23.9	37
	Lower boundary	2.6	6.1	8.7	12.9

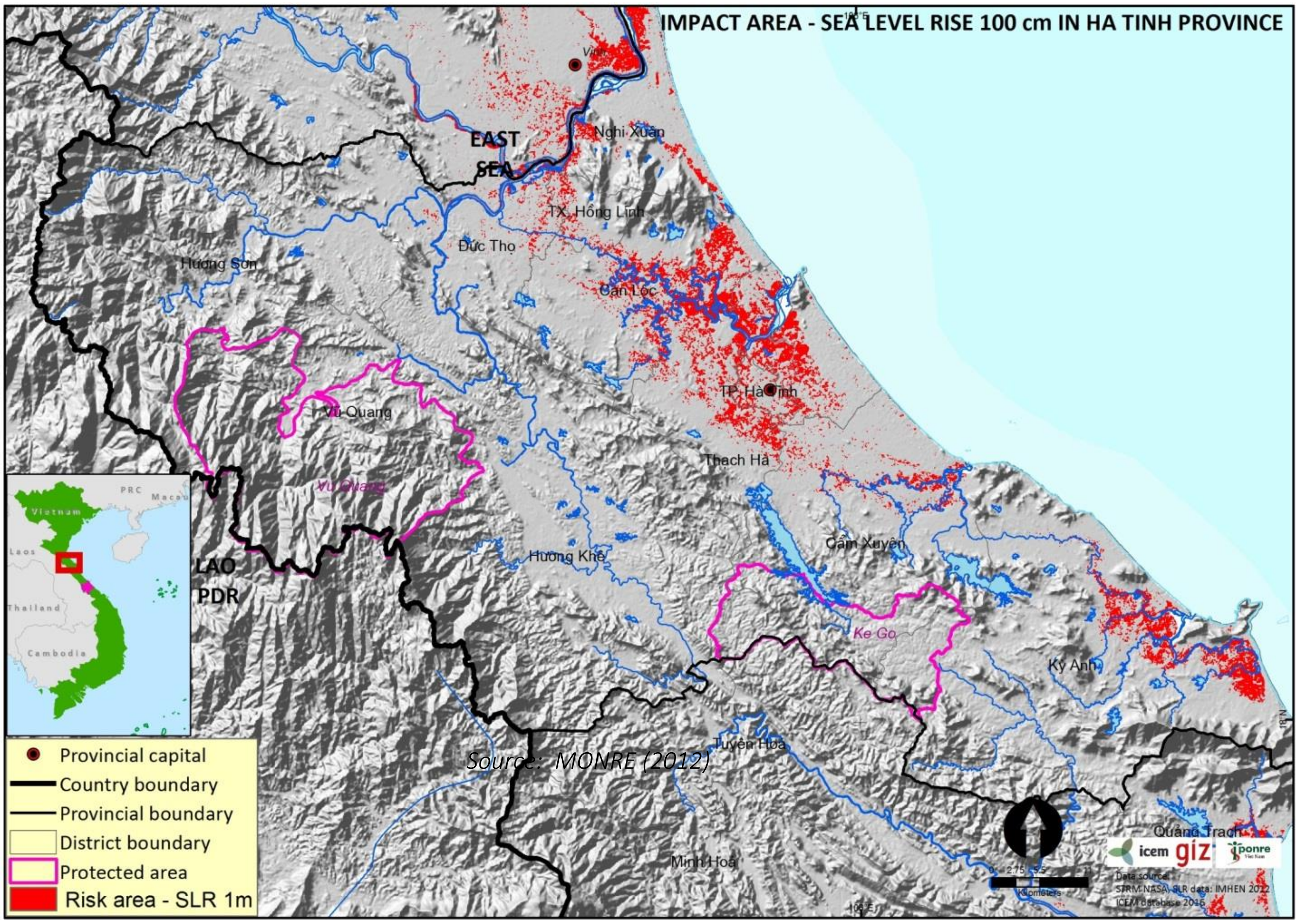
Source: IMHEN (2012)

Map 7.5 shows the areas of Ha Tinh that would be affected by a one metre rise in sea level[20]. Other national level studies modelling the impacts of sea level rise have estimated that 24.3 km^2 of Ha Tinh would be

[20] Mapping is only possible at the 1 m contour interval - the map is intended for illustration only, the actual area affected under the B(2) scenario would be less than that shown.

submerged by a 1 m SLR, representing 0.41% of the provincial land area, 0.01% of the national land area and 0.17% of the national inunduated area (Carew Reid 2007)[21].

Figure 7.5: Areas of Ha Tinh that would flood under 1 m[22] rise in sea level (highlighted in red)



Source: MONRE (2012)

7.4.1.4. *Scenarios for storms*

Changes in the frequency and intensity of storms have not been formally modelled. However, it is expected that the changes in temperature and rainfall will translate into:

(i) increasing wind speeds associated with storms;

(ii) increased unpredictability of the timing of storms.

7.4.2. *Expected impacts of climate change In Ha Tinh*

This section reviews the expected changes in key parameters and some general impacts anticipated on natural ecosystems, agriculture forestry and fisheries and settlements and infrastructure. Interactions between the parameters are highlighted. It must be noted, however, that it is beyond the scope of this study to provide a detailed review of the literature on the impacts of climate change on all the relevant ecosystems, natural resource based activites, and urban environments/infrastructure. The local-level vulnerability assessments will examine impacts in more detail.

7.4.2.1. *Impacts of rising temperatures and increasing number of very hot days*

As discussed above, the average temperature in Ha Tinh is set to increase by 3.1 to 3.3 ^{o}C by 2100 - far above the IPCC target (global) ceiling of a 1.5^{o}C change. Additionally, average daily maximum temperature during June-

[21] NB The top five most affected provinces have 40-50% of their land area inundated.

[22] Best possible resolution, though maximum SLR expected by 2100 under B(2) scenario is 73.7 cm.

August may increase by 2 ^{o}C by 2050, and by over 4 ^{o}C by 2100. The number of very hot days (>35 ^{o}C) may increase from a baseline of 76 days, by up to 38 days (50%) by 2050, and by up to 54 days (71%) by 2100.

7.4.2.1.1. Impacts on Natural Ecosystems

Forests

Relatively undisturbed natural forest areas of Ha Tinh are concentrated in two main areas: the Lao border area stretching from Huong Son LLC, through Vu Quang National Park across to Huong Khe district - and the watershed of the Ke Go reservoir. The plant and animal species composition in the three main forest types, tropical and sub-tropical moist evergreen broadleaf forests, and very limited areas of lowland limestone forest, is determined by the range of preferred conditions (comfort zones) of each of the individual species. Theoretically, the response of species to increasing average maximum temperatures will be a distributional shift either by altitude or latitude to a place where the climate conditions are still within their comfort zone. In general, for every centigrade degree of temperature change, a 100-200m increase in altitude (depending on moisture conditions) or a 35 km increase in latitude (move of towards the pole) is required to find a place with the same original temperature. In practice, given the complexity of forest ecosystems, it is extremely difficult to predict any specific changes. For trees, with long life spans, distributional changes will be effected by their abilitiy to regenerate successfully, but depending on species, this may also be affected by the presence of pollinators and seed dispersers. Most animal species are mobile, but their flexibility to move in response to temperature change may be limited by the distribution of their food species and other habitat factors. The increasing number of very hot days up to 54 in 2100, may exceed temperature tolerances of some species and lead to mortality and local extinction.

7.4.2.1.2. Impacts on Agriculture, Forestry and Fisheries

a. Agriculture

Agriculture in Ha Tinh is dominated by the cultivation of cereals, particularly rice and maize. Peanuts are also widely grown. Sweet potato and cassava are locally important. Amongst tree crops, rubber and citrus, are most important.

Temperature is a primary factor affecting the rate of development of all species and warmer temperatures and more frequent extreme temperature events will have an impact on plant productivity. Pollination is particularly sensitive to temperature extremes and few adaptation strategies are available to cope with this, other than to select for species and varieties that shed pollen during the cooler periods of the day or are indeterminate so flowering occurs over a longer period of the growing season. In controlled environment studies, warm temperatures increased the speed of phenological development, but there was no effect on vegetative biomass compared to normal temperatures. Reproduction was most affected by warmer temperatures and in all cases grain yield in maize was significantly reduced by as much as 80−90% from a normal temperature regime. Furthermore, temperature effects are exacerbated by water deficits or excess soil water (Hatfield and Preuger, 2015).

According to the 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 1C, maize productivity will decrease 5 - 20% and it could drop by as much as 60% if temperature rises by 4C. If the temperature increases by 3C, 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 (see below) is likely to make rice growing less and less successful for Ha Tinh’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.

At the same time, the general increase in temperature will be accompanied by a decrease in the frequency and duration of cold snaps - that will benefit both rice cultivation (reduction in replanting) and citrus production (reduction in fruit abortion).

Optimal conditions for rubber (latex) production include:

- Maximum temperatures of 29°C - 34°C and minimum of about 20°C or more with a monthly mean of 25 to 28°C;
- Rainfall of 2000 - 3000 mm evenly distributed without any marked dry season and with 125 to 150 rainy days per annum;
- Absence of strong winds[23]

By this reckoning, Ha Tinh is already a borderline area for rubber production in terms of prevailing temperature, dry season and high winds, and the predicted changes are likely to reduce productivity.

Citrus crops have complex environmental and climatic requirements for optimal fruit production. Impacts of increased temperatures include: less flower bud induction; Higher fruit drop; faster volume growth of fruit; earlier maturation; poorer fruit color; earlier loss of juice; faster decline in acidity. Prolonged cool temperatures are required to induce flowering (Albrigo 2016).

For many different crops, increasing temperatures increase the incidence, severity and range of pest and disease attacks.

b. Forestry

Ha Tinh's forestry sector focuses primarily on plantation species such as acacia, eucalyptus and pine. As mean temperatures increases over time the area suitable for pine will shrink and shift altitudinally towards areas of higher elevation where temperatures are still within its comfort zone.

The main plantation species in Ha Tinh is a clonal *Acacia* hybrid (*Acacia mangium* × *Acacia auriculiformis*), and it has wide average climatic tolerances: temperatures from 12 to 35°C, annual precipitation from 1200 to 1850 mm, and elevation is 50–350 m (Vozzo 2002). Thus, in Ha Tinh it is grown well within its comfort zone. Climate change induced temperature increases and increases in the number of hot days may enhance growth rates and productivity. However increased temperatures may increase the frequency of pest outbreaks, which are are difficult to control, especially in the remote and mountainous areas on the Lao border.

Increased average and maximum temperatures and increased frequency of hot days in combination with drought factors (lower spring rain and more dry days) increases the risk and incidence of forest fires.

c. Aquaculture

The pond and cage aquaculture sector is an important and growing sector in the economy of Ha Tinh. Both fish and shrimp are extremely sensitive to water temperature. Oxygen levels in water decline as water temperature increases, and at the same time respiration rates increase. Higher temperatures also increase evaporation, raising salinity, changing the pH and encouraging algal growth and disease. So, as average and maximum air temperatures rise with climate change, it will become more expensive and in some cases impossible to maintain suitable conditions in pond, rivers and estuaries.

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.

d. Capture fishery

In general, rapid or dramatic increases in temperature above normal maximum temperatures are expected to have significant negative effects on overall viability of some natural fish populations (Munday et al., 2008). Fish are particularly sensitive to temperature changes early in their 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 1-3C could shorten the incubation period of eggs for pelagic spawning (Munday et al., 2007), enhancing survival.

The Indo-Pacific Mackerel (*Rastrelliger brachysoma*) is one of the most important species for income and food security in the capture fishery of Ha Tinh. It is a shallow pelagic species that spawns offshore, but after eggs

[23] http://rubberboard.org.in/ManageCultivation.asp?Id=33

hatch, the 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 studies such as those by Pradhan and Reddy (1962) carried out nearly 50 years ago, show that mackerel may well be highly vulnerable to changes in temperature. As seas warm, mackerel and other species may be expected to shift their distribution northwards into cooler water to stay within their temperature comfort zone.

Squid, on the other hand, is likely to thrive in warmer seas. Increased growth rates, accelerated life histories and rapid turnover in populations will potentially lead to population expansion at the expense of slower-growing teleost competitors (Jackson, 2004). However, under continued temperature increases there will likely come a point where growth rates start to decrease as metabolic costs continue to rise and growth potential is subsequently reduced (Pecl and Jackson, 2008).

7.4.2.1.3. Impacts on urban and rural settlements and infrastructure

It is well-known that urban centres are heat islands, with temperatures 2-3 ^{o}C higher than surrounding areas. Increased temperature and increased number of hot days resulting from climate change may push temperatures in Ha Tinh City, the Vung Anh Industrial area 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.

Increased temperatures will increase evaporation from reservoirs, affecting domestic and industrial water supplies and irrigation. Very hot days affect transport infrastructure by melting the tarmac, causing increased damage to road surfaces.

7.4.2.2. Impacts of increased and more intense rainfall in the rainy season

Climate change will lead to increased rainfall, in summer, winter and particularly the autumn. The rainy season (September to November) will be shorter, and the number of heavy rainfall days will increase, and storms will be more severe (see below). By 2050 there is expected to be 4.4 - 8% more rain in the autumn, and by 2100 this change could rise to 5.3 - 11.4%. This will increase the severity of the flooding already experienced in the province.

7.4.2.2.1. Impacts on natural ecosystems

The natural terrestrial forests of Ha Tinh are moist evergreen formations. Additional heavy rainfall in the rainy season is not likely to have a major impact on intact forest. 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.

Increased and more concentrated rainfall will increase water flows and leading to flooding in all four major river basis - the La, Cua Sot, Cua Nhuong and Cua Khau. Annual flow is likely to rise by 3-4% by 2050 and by 6-7% by 2100. Flood flows are likely to increase 6-7% and 10-12% in the same periods. However, dry season flows (see 4.2.3 below) are likely to reduce by 5-7% by 2050 and 12-13% by 2100. These decreased flows will increase salinity by an estimated 1 part per million in the Cua Sot, Cua Nhuong and Cua Khau rivers, and saline intrusion will extend further inland (ISPONRE 2009).

Mangrove species are sensitive to water salinity so both extensive floods and reduced river flows leading to saline intrusion are likely to stress them, particularly if regularly repeated. Prolonged submersion can also cause the death of some mangrove trees. The remaining mangrove areas in Ha Tinh are very small, so repeated stress could lead to a local extinction.

Heavy rainfall causes increased inflow of freshwater into estuaries changing the salinity profile which could affect the distribution and abundance of brackish water species. But this will most likely only be a temporary change each time a heavy rainfall event occurs.

7.4.2.2.2. Impacts on Agriculture, Forestry and Fisheries

It is unlikely that the overall increase in annual rainfall in itself will significantly stress any Ha Tinh's agricultural, forestry or fishery species, however, the increase in rainfall during the late summer may affect the harvest of certain crops, particularly rice, and require increased seasonal drainage.

Sudden heavy rainfall after a period drought can cause physical damage due to the rapid erosion of dry soils, resulting in the loss of soil fertility and the soil itself. Some crops, notably cassava and maize, if drought-stressed and then suddenly exposed to large amounts of rain, can accumulate hydrogen cyanide (or prussic acid), and become poisonous. Cases of people dying after consuming cassava with high levels of prussic acid have been reported from Kenya and the Philippines (UNEP 2016). Such climatic patterns are already a commonly experienced in Ha Tinh, particularly when an El Nino period is rapidly followed by a La Nina period, and may happen more frequently and more intensely under climate change.

Higher temperatures and humidity also increase the threat from insect pests and diseases. 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).

As described in Chapter 6, floods in Ha Tinh regularly cause substantial damage to agriculture and infrastructure, and changing rainfall and storm patterns are likely to increase flooding. Losses are incurred from the erosion of agricultural land close to the river banks, prolonged inundation of fields and deposition of mud.

The 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.

Short term harvesting cycles for acacia production forest, conversion of forest to agriculture, and illegal logging, all add up to more rapid run-off and greater erosion, causing flooding to happen even more rapidly, and landslides to become even worse as watershed forests will not have enough trees to retain soil and slow down run-off. In the 2010 floods, huge volumes of soil and dirt were swept away, much of it ending up in reservoirs. Without changes to forest management practices, we could see even larger amounts being swept away by heavier rains in the future.

7.4.2.2.3. Impact on rural and urban settlements and infrastructure

The topography of Ha Tinh 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 increase with the heavier rains resulting from climate change. Many settlement areas will be affected, with inundation periods varying from hours to days, depending on locality. As sea level rises and natural drainage is reduced, inundation will be exacerbated.

The changes in precipitation patterns will lead to increased erosion and landslides, causing more damage roads and railways and increasing sedimentation in reservoirs and irrigation canals.

Ha Tinh has over 300 reservoirs of various sizes. With precipitation increasingly concentrated in the rainy season, and increasing sedimentation reducing their capacity, many may not be able to store the full volume of water flowing into them and may be at risk of failure, as threatened Ho Ho Dam in 2010. This would pose significant threats to areas downstream of these reservoirs.

7.4.2.3. Impacts of longer and drier dry seasons

While total precipitation in Ha Tinh is expected to rise, the rainfall in spring (March-May) is expected to decline by 2.3 to 5 % by 2050, and by 4.3 to 9.9% by by 2100 (Map 3 and Annex 7.2).

The number of dry days per year is predicted to increase by around 10%, from the baseline of 142 days/ yr, to 159 days/yr in 2050, and 160 days in 2100, particularly in the spring, when the increase over baseline will be about 30% (Map 4 and Annex 7.2).

The hot, dry Lao wind is expected to start earlier in the year, end later and episodes are expected to last longer.

7.4.2.3.1. Impacts on natural ecosystems

Longer and drier dry season will affect forest ecosystems in a similar way as increasing temperatures, described in the previous section, taking some species out of their "comfort zones" and ultimately changing population distribution and size, or killing them outright.

The more intense dry season will reduce water flows in rivers, aggravating the already serious problems caused by excessive offtakes for irrigation and domestic water supply and affecting many biophysical aspects of natural ecosystems in ways that are hard to predict.

As discussed above, mangroves are sensitive to changes in salinity. The recent dieback of 10,000 ha of mangrove in northeastern Australia has been attributed to drought and high temperatures brought by climate change24.

The combination of high temperatures and drought dramatically increases the risk of forest fire. In 2016, Ha Tinh reached the maximum Level V risk and Temperature the impacts described for increased temperature and with will increase risk of forest fire. The majority of these fires take place in plantation forests where the canopy is more open and resinous species such as eucalyptus and pine are found in dense concentrations.

Despite this, forest fires are not presently considered as a major problem in Ha Tinh, 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.

7.4.2.3.2. Impacts on agriculture, forestry and fisheries

The interaction between droughts, rising temperatures and sea level rise will exacerbate the problem of salinization of surface and ground water already being widely experienced across the province.

Salinization results in further freshwater shortages for agricultural production. High levels of evaporation (960 to 1,200 mm 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 30,000 m3 freshwater every year. The main water sources for sand- based shrimp farming come from local ground water. Although quite rich, ground water sources in Ha Tinh 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.

7.4.2.3.3. 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 Ha Tinh are not able to supply sufficient water for agricultural production in severe droughts.

Reduced rainfall in upland areas, together with increased temperatures, and increased evaporation, result 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.

[24] http://www.abc.net.au/news/2016-07-10/unprecedented-10000-hectares-of-mangroves-die/7552968

7.4.2.4. Impacts of sea level rise

Under the medium emissions scenario (B2), the inundated/salinised area of Ha Tinh would be 287 km 2 or less 5 % of the total area of the province. The majority of the inundated areas will occur in rice cultivation land, urban land and residential areas, as well as in aquaculture land and coastal fishing villages in Ky Anh, Nghi Xuan and Loc Ha.

7.4.2.4.1. Impacts on natural ecosystems

In estuarine and coastal areas, the high sea level rise would alter the dynamic balance between river and ocean, which in turn will change the sediment accumulating process in the river estuary and river bank area, requiring increasingly expensive maintenance.

As mentioned above, mangroves are sensitive to salinity changes, and in the estuaries may be killed or, where not confined by saline intrusion barriers, will retreat further inland.

7.4.2.4.2. Impacts on agriculture, forestry and fisheries

In the interim period, saline intrusions caused by sea level rise, and exacerbated by reductions in environmental flows in the river systems (due to drought and temperature increases) cause agricultural productivity to drop significantly, especially for the Winter-Spring crops.

Coastal forests, particularly mangroves, but also planted casuarina and acacia will be at risk. Casuarinas and the native Melaleuca species are tolerant of both salt and inundation.

7.4.2.4.3. Impacts on urban and rural settlements and infrastructure

As Map 5 indicates, much urban and residential land and key transport corridors (National Highway 1A) would be submerged under a 1 m rise in sea level, unless coastal and estuary defensive dikes were raised and maintained.

Sea level rise and saline intrusion are likely to cause contamination of near-coastal aquifers and surface waters, affecting water supply for domestic, agricultural and industrial users.

7.4.2.5. Impacts of storms and strong winds

Related to the changing patterns of rainfall discussed above, the intensity and frequency of storms is expected to increase, and their timing to become more erratic and unpredictable. In Ha Tinh, storms occur from August to October on almost an annual basis (see Chapter 6). In addition to the floods, discussed above, storms bring high winds, lightening and, in coastal areas, storm surges. With increased storm frequency, intensity and unpredictability caused by climate change, these phenomena are all likely to increase.

7.4.2.5.1. Impacts on natural ecosystems

Natural forests tend to be more resilient to storm winds than plantation forest, due to their mixed species and age structures. However, storm damage to natural forests in north-central Vietnam is relatively common and includes windthrow as well as broken branches.

Mangroves typically provide protection to areas backing estuaries, but these are now seriously reduced in extent, leaving such areas more exposed. Mangroves themselves suffer from physical damage from wind and waves, and erosional and depositional processes associated with storms.

7.4.2.5.2. Impacts on agriculture, forestry and fisheries

As mentioned above, storm winds cause considerable damage to agriculture – including lodging of field crops, and wind throw of tree crops including acacia and rubber, and loss of fruits from fruit trees. These are only likely to increase in the future. Inland valley SES may be more protected by topography than the coastal areas.

The inshore fishery is already seriously affected by storms, with many boats and much gear being damaged each year. Although larger boats, based in the main estuaries can now take refuge in storm shelters, smaller boats, drawn up on the beaches remain at risk.

In coastal areas, increasing storms and strong winds will cause sand blows to occur more frequently and more severely than elsewhere. Although there are extensive dune systems in these areas, their natural vegetation cover has been removed. The sparse coverage of casuarina in 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.

7.4.2.5.3. Impacts on Urban and rural settlements and infrastructure

Storms already cause considerable damage to buildings and infrastructure in Ha Tinh (see above), and increased intensity and frequency of storms due to climate change will only exacerbate these problems in the future.

On sandy shorelines, coastal dunes represent the last line of defense against storms, as well as limiting erosion, the landward intrusion of waves and salt spray. Dunes act as a barrier to oceanic inundation and they provide for an important morphological and ecological transition from marine to terrestrial environments.

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.

Where dunes are unstable, villages, infrastructure and facilities near the back of the beach may be subject to inundation from the ocean, to structural damage from wave attack, undermining by foreshore erosion, or to sand drift.

7.5. Conclusions

The most important and analysable parameters for the EbA vulnerability assessment relate to temperature, precipitation, storms and sea level rise. The values for the parameters selected for the vulnerability assessment are shown in Table 7.6.

Table 7.6: Values for climate parameters used in the vulnerability assessment

Parameter	Specific Change	Values
Temperature	Hot season hotter and longer; Tmax will increase	+ 2 - 2.5 ° C in 2050, + 3.6 ° C in 2100
	More days > 35°C	+ 34 - 48 days in 2050 + 41 - 63 days in 2100
	Temperature increasing faster and earlier in Spring	n/a
Precipitation	Less rainfall in dry season	- 5% in 2050 -8-10% in 2100
	More dry days	+ 17-20 days in 2050 + 14-19 days in 2100 Over baseline of 188 dry days
	More rainfall in rainy season	+ 3-5% in 2050 + 7-9% in 2100
	More high rainfall event days (>50mm rain)	n/a
Storms	Storms with increasing speed(intensity)/stronger winds	n/a
	Storms more unpredictable and happening at different times	n/a
Sea Level Rise	3mm/year in last 20 years,	+ 1m rise by 2100

Chapter 9 presents the vulnerability assessment for Ha Tinh assessing the exposure and of the ten priority SES, against these parameters and values.

Even before the formal vulnerability assessment, it is clear that without significant, concerted and continuous investments and efforts to address key issues, overall climate change is likely to slow down economic growth and negatively affect quality of life in Ha Tinh. 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.

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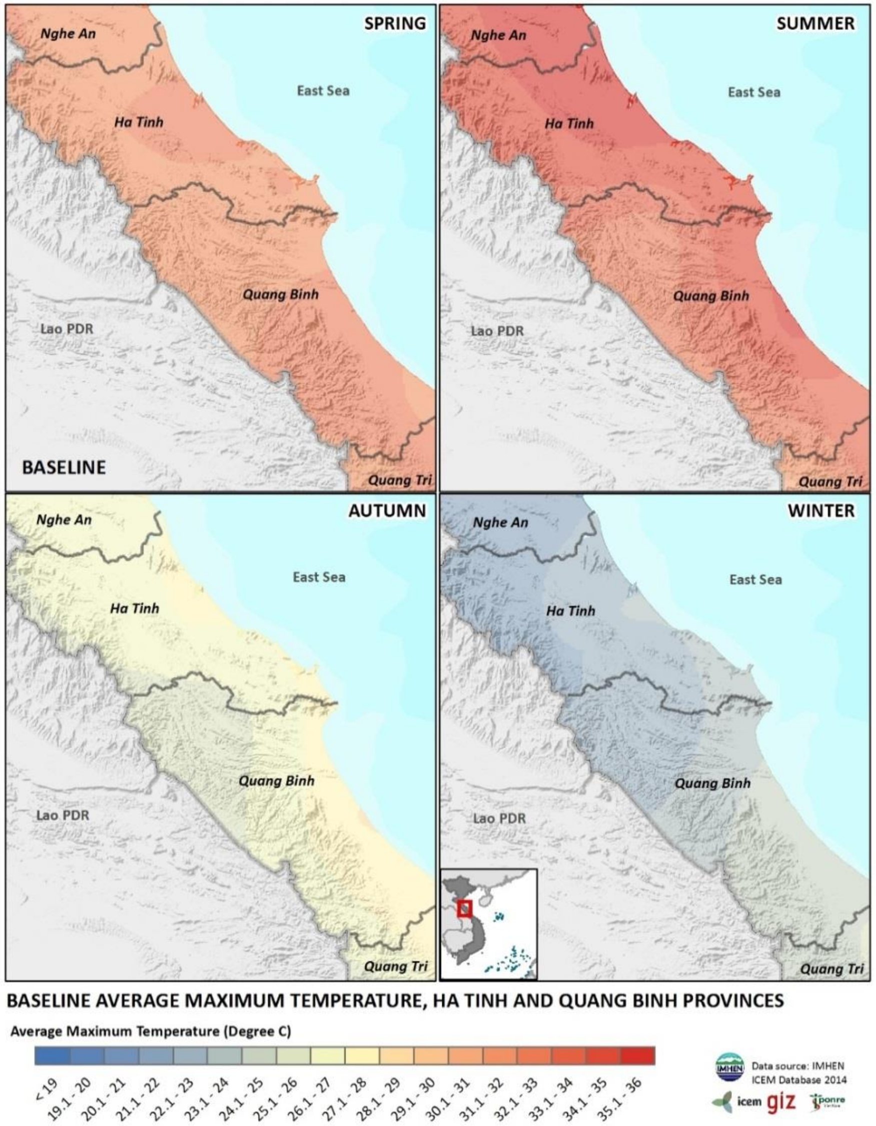
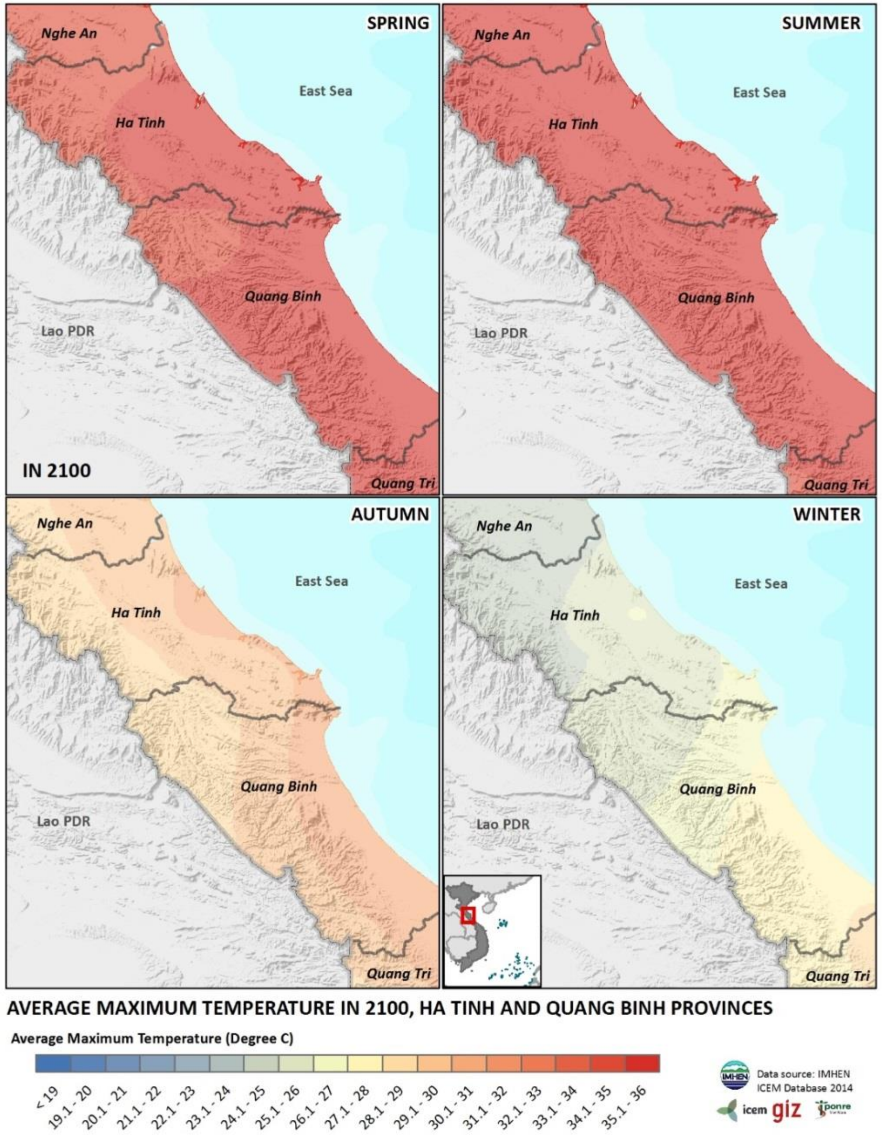
ANNEX 7.I: TEMPERATURE CHANGE SCENARIOS (B2): MAPS AND DATA

1a: Four Season Average Maximum Temperature (TMax): (i) Baseline and (ii) 2100

(i) Baseline

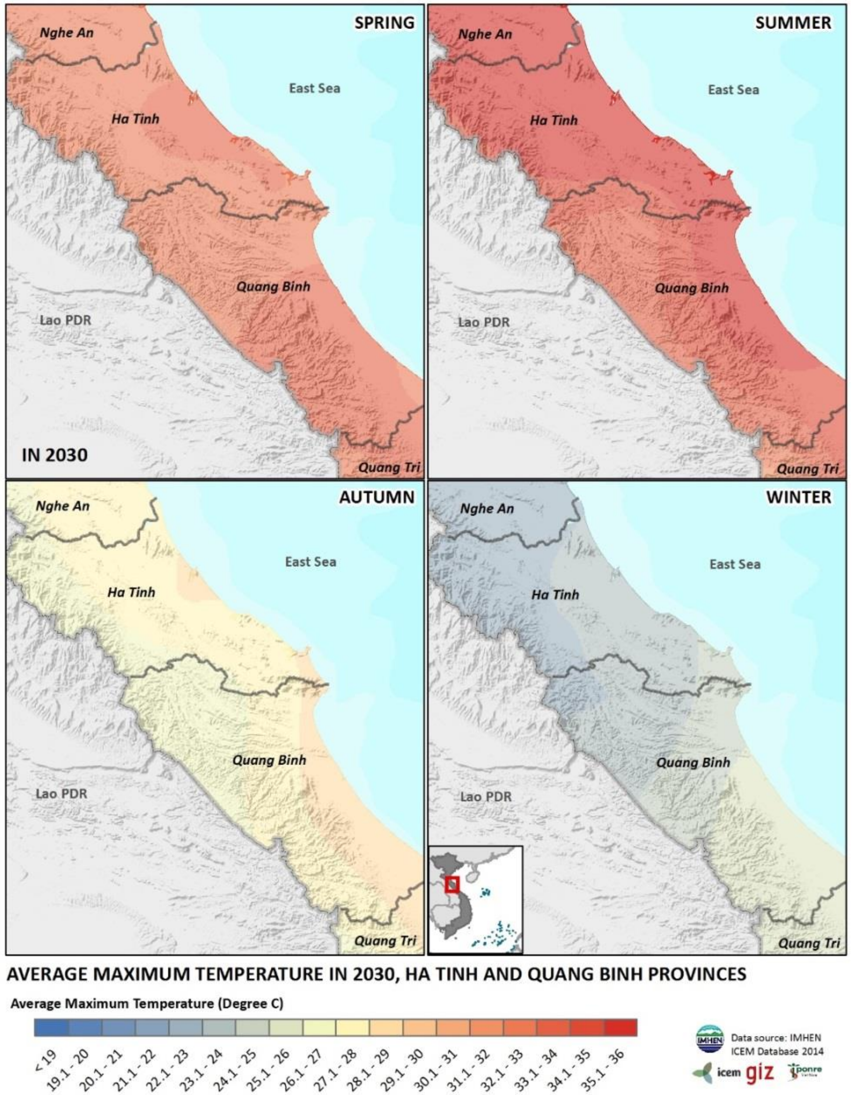


(ii) 2100

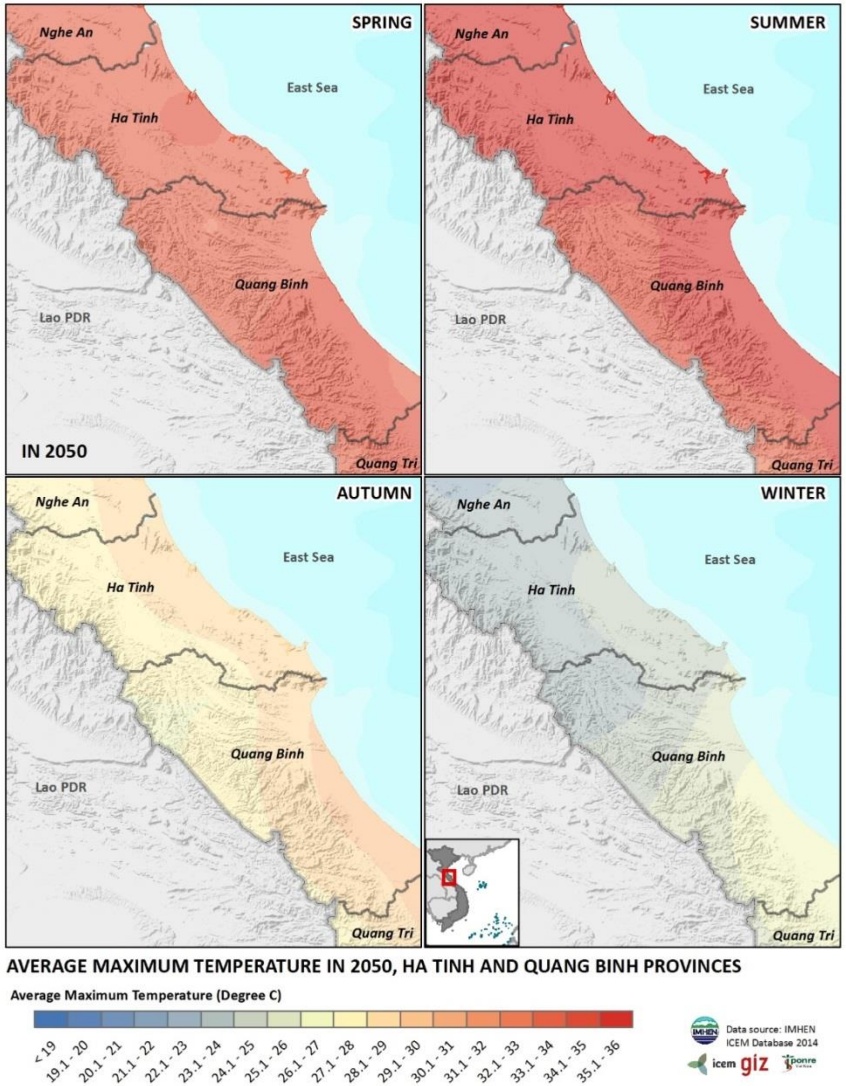


1b: Four Season Maximum Temperature: (i) 2030 and (ii) 2050

(i) 2030



(ii) 2050



1 c: Data for four season change in average TMax, Baseline, 2030, 2050 and 2100

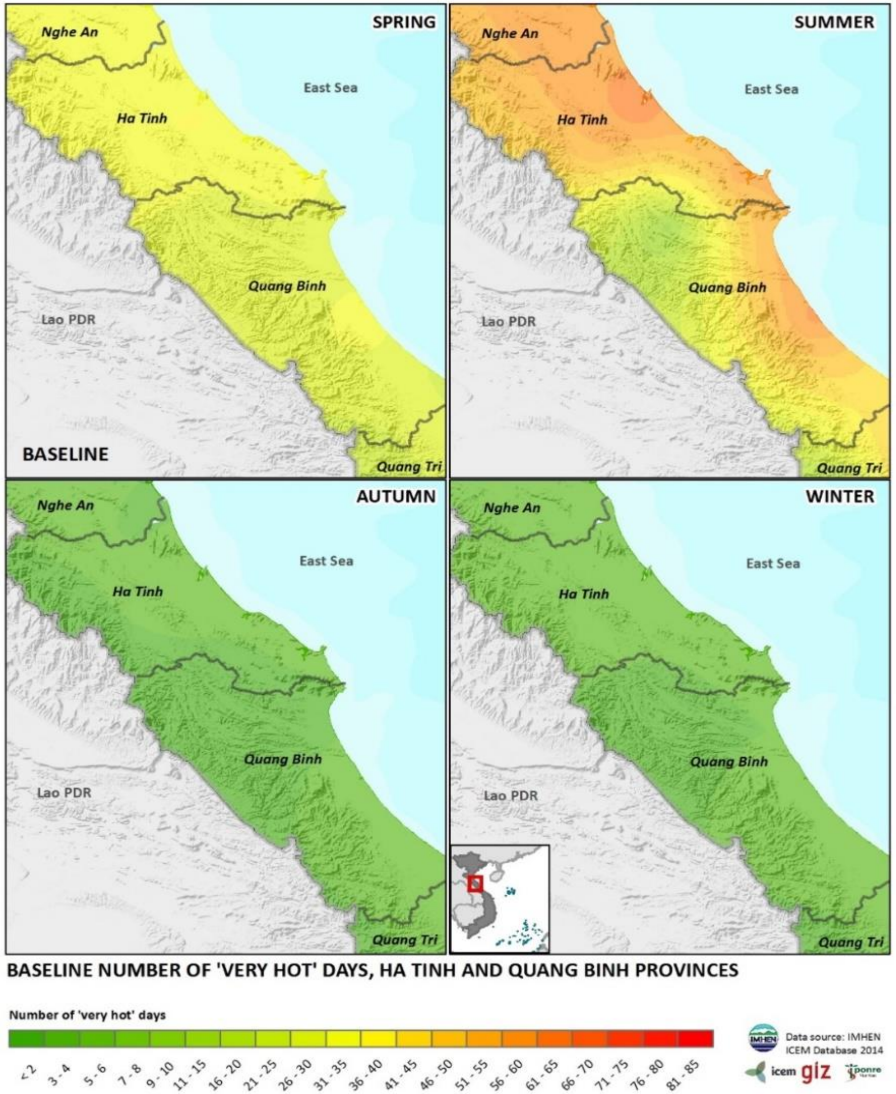
	Baseline Average Maximum Temperature				Change in Average Max Temperature, 2030				Change in Average Max Temperature, 2050				Change in Average Max Temperature, 2100			
	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May
	Degree C				Degree C				Degree C				Degree C			
AVG	23.0	26.9	34.7	32.0	0.9	0.9	1.0	1.0	1.5	1.5	1.8	1.8	3.0	3.0	3.4	3.4
MAX	24.9	28.1	35.6	33.0	0.92	0.97	1.09	1.82	1.7	1.8	2.0	2.6	3.2	3.4	3.8	4.4
MIN	21.7	25.3	32.3	31.0	0.79	0.73	0.72	-0.16	1.4	1.3	1.3	0.5	2.7	2.5	2.5	1.9

1 d: Data for four season change in the number of "very hot" days, Baseline, 2030, 2050 and 2100

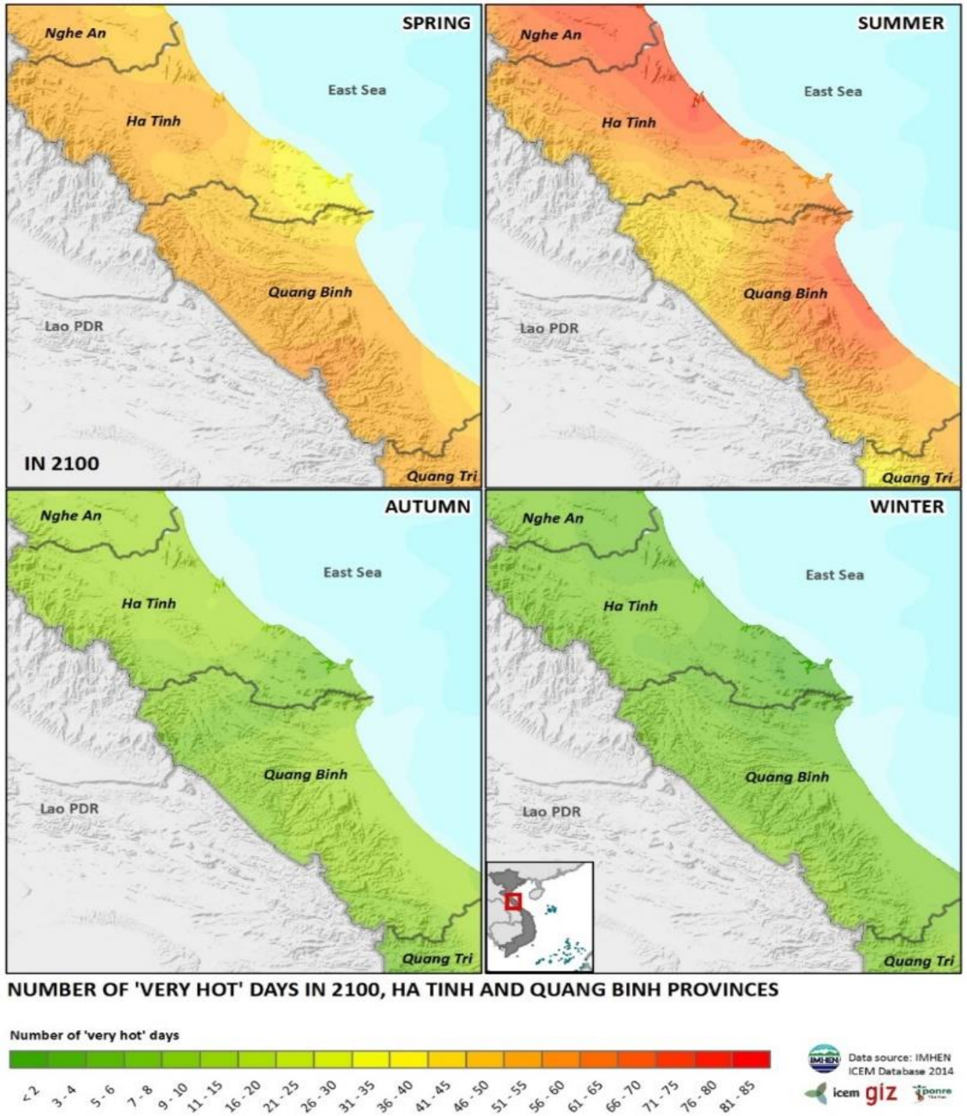
	Baseline Number of 'very hot' days				Change in Number of 'very hot' days in 2030				Change in Number of 'very hot' days in 2050				Change in Number of 'very hot' days in 2100			
	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb
	Days				Days				Days				Days			
AVG	33	56	2	3	12	9	3	0	13	8	6	3	15	10	10	3
MAX	35	62	3	3	15	13	3	1	16	14	8	4	19	19	12	4
MIN	29	32	1	2	11	6	1	0	4	0	3	1	-1	-2	3	-2

2 a: Seasonal change in very hot days (>35 oC), (i) Baseline and (ii) 2100

(i) Baseline



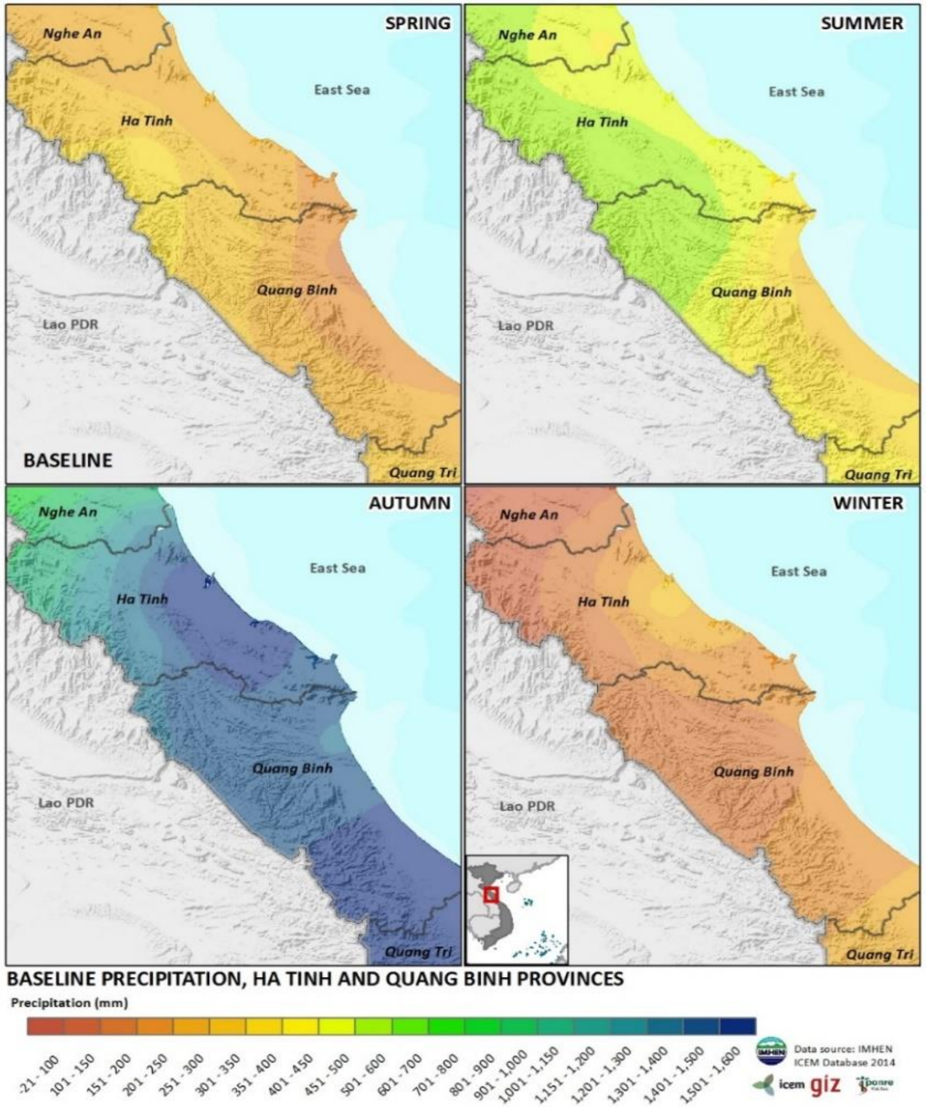
(ii) 2100



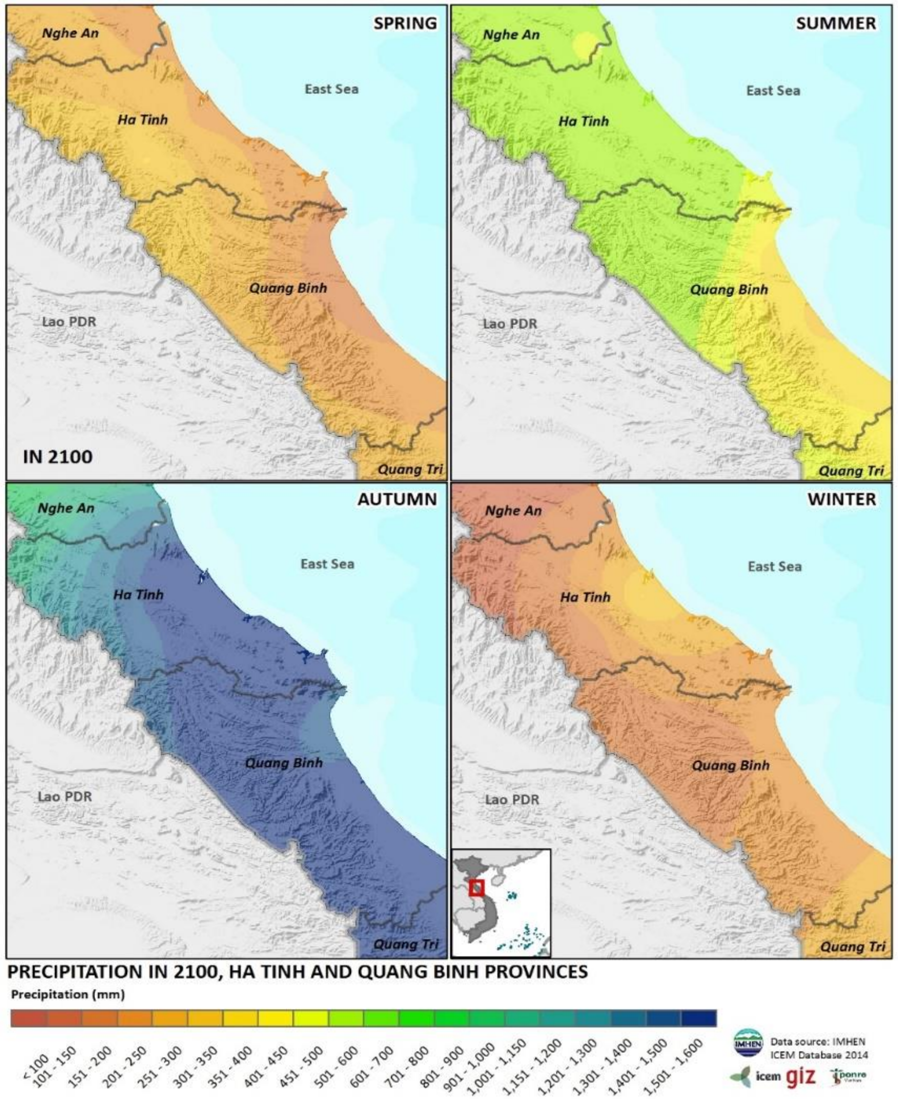
ANNEX 7.II: PRECIPITATION CHANGE SCENARIOS (B2): MAPS AND DATA

7.2.1a: Seasonal average precipitation in Ha Tinh and Quang Binh, (i) Baseline (1980-1999) and (ii) 2100

(i) Baseline (1980 - 1999)

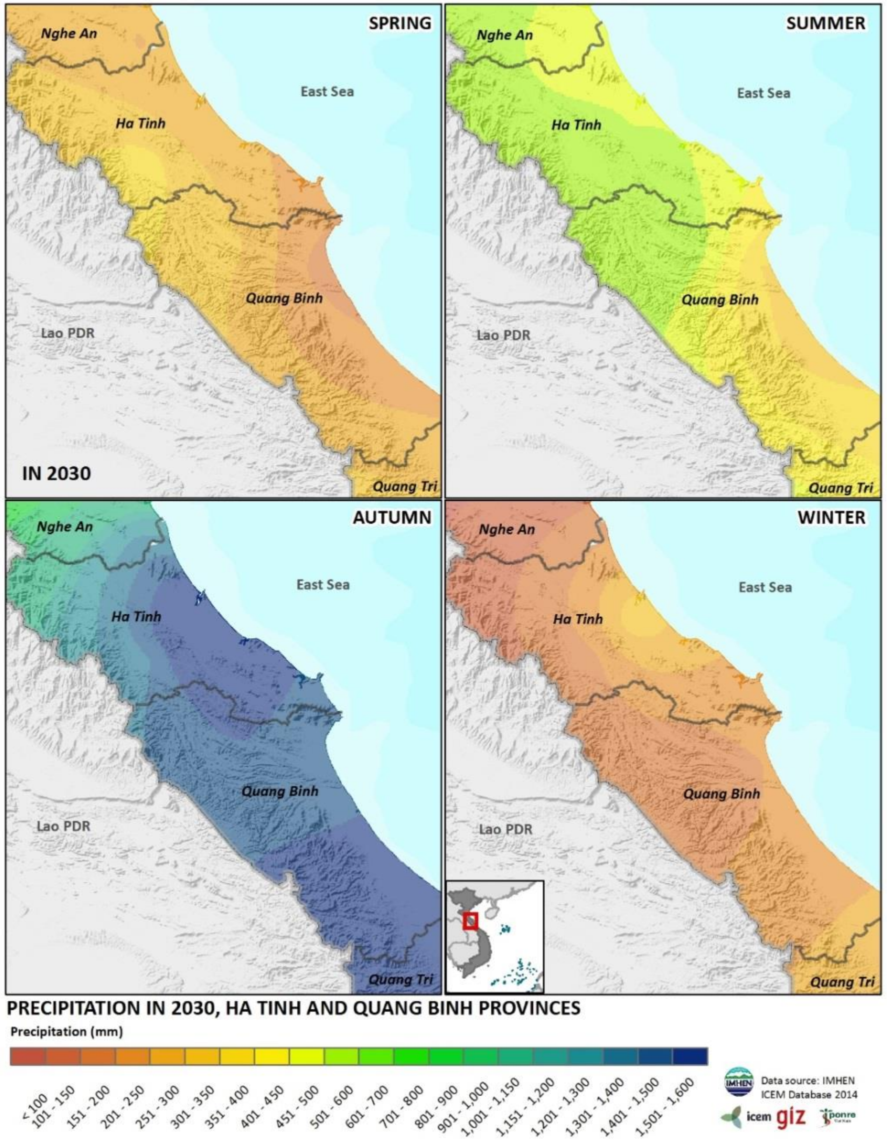


(ii) 2100

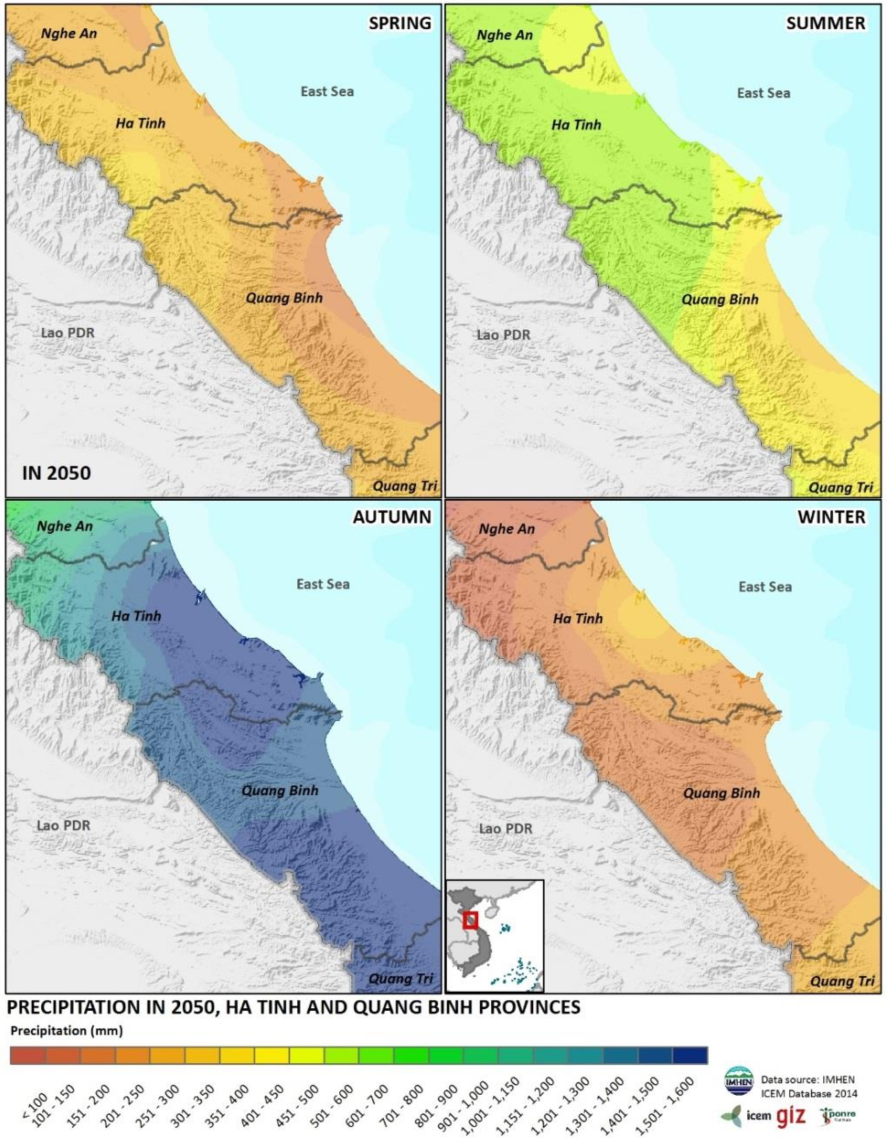


7.2.1b: Seasonal average precipitation in Ha Tinh and Quang Binh, (i) 2030 and (ii) 2050

(i) 2030



(ii) 2050



7.2.1c: Data for four season change in precipitation, baseline, 2030, 2050 and 2100

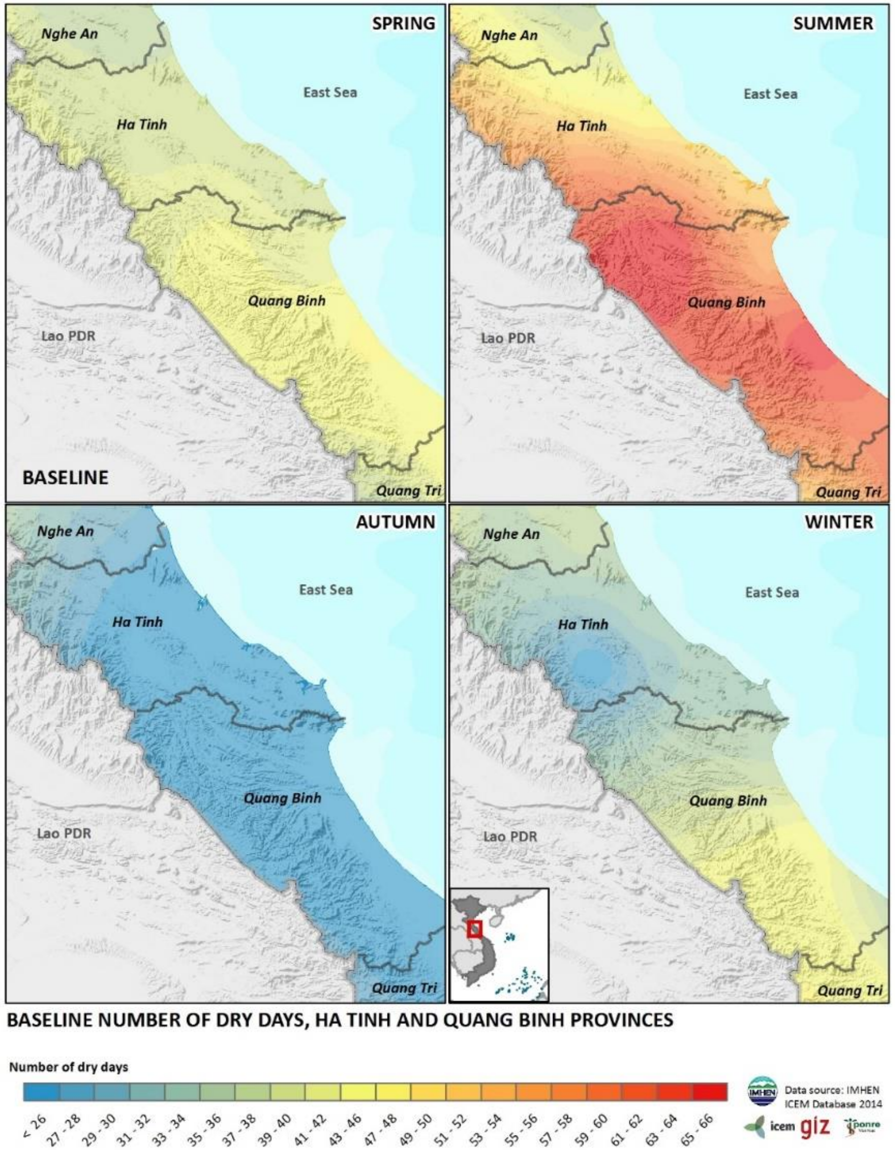
	Baseline Precipitation				Change in Precipitation, 2030				Change in Precipitation, 2050				Change in Precipitation, 2100			
	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May	Dec - Feb	Sep - Nov	Jun - Aug	Mar - May
	mm				%				%				%			
AVG	220	1462	453	271	1.3	1.6	2.6	-2.3	2.5	2.9	4.8	-4.2	4.7	5.6	9.2	-8.1
MAX	327	1725	560	382	1.9	2.2	3.4	-1.2	3.5	3.9	6.3	-2.3	6.7	7.5	12.0	-4.3
MIN	120	1025	312	186	0.1	1.3	1.5	-3.1	0.2	2.3	2.8	-5.6	0.4	4.4	5.3	-10.7

7.2.1d: Data for four season change in daily maximum precipitation, baseline, 2030, 2050 and 2100

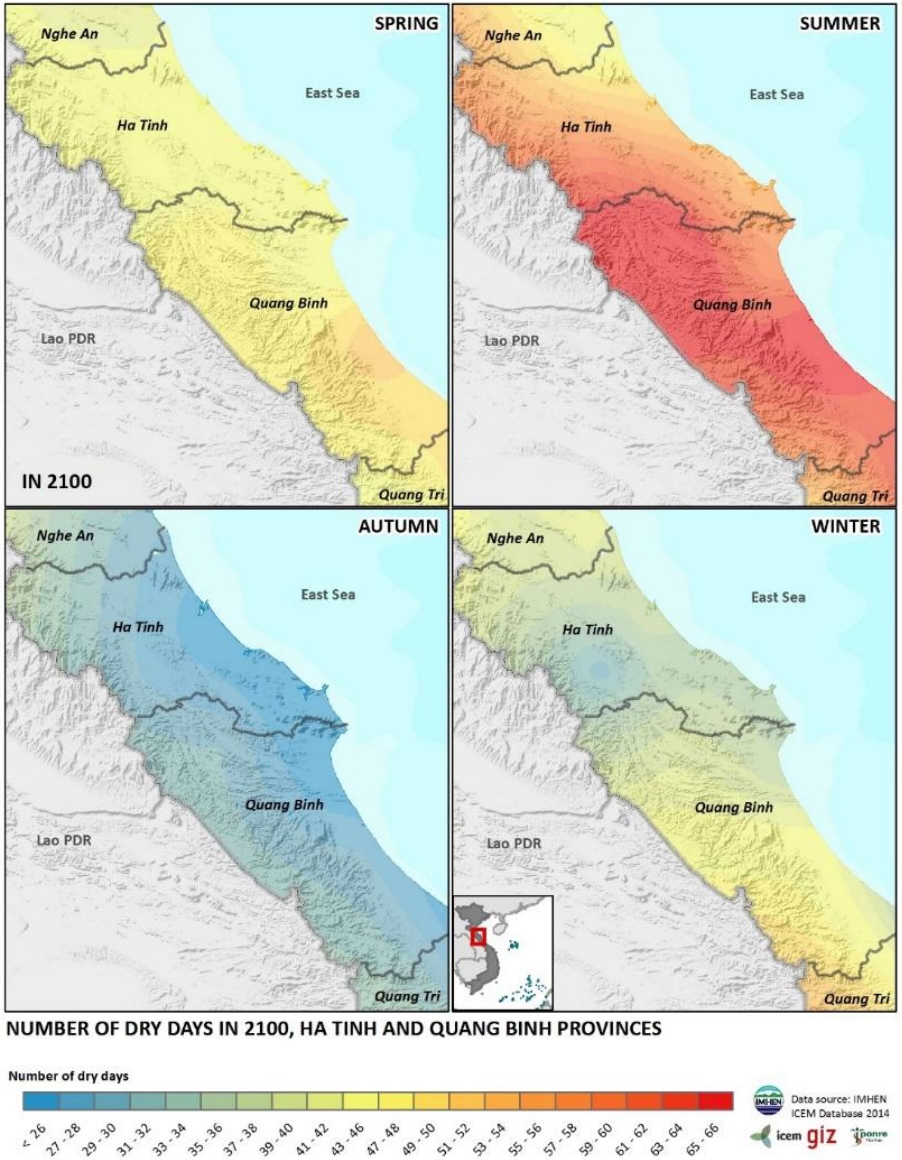
	Baseline Daily maximum precipitation				Change in Daily maximum precipitation in 2030				Change in Daily maximum precipitation in 2050				Change in Daily maximum precipitation in 2100			
	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb
	mm/day				%				%				%			
VG	63	98	214	32	-3	0	2	-11	-31	-13	-20	26	-22	-55	9	46
MAX	69	109	262	44	6	25	23	14	-17	-3	0	38	0	-46	19	59
MIN	58	85	169	21	-12	-5	-13	-29	-41	-18	-29	21	-28	-61	-6	25

7.2.2a: Seasonal number of dry days, (i) Baseline (ii) 2100

(i) Baseline

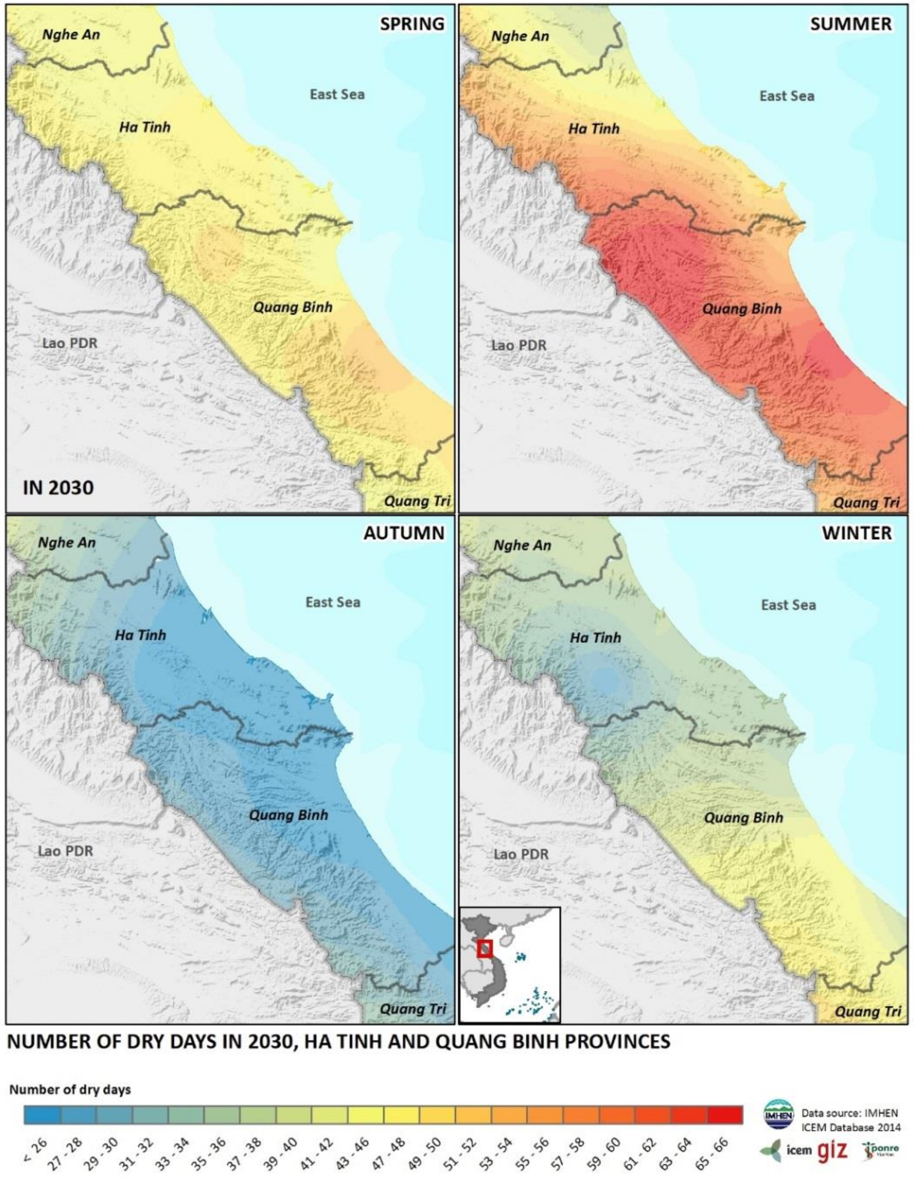


(ii) 2100

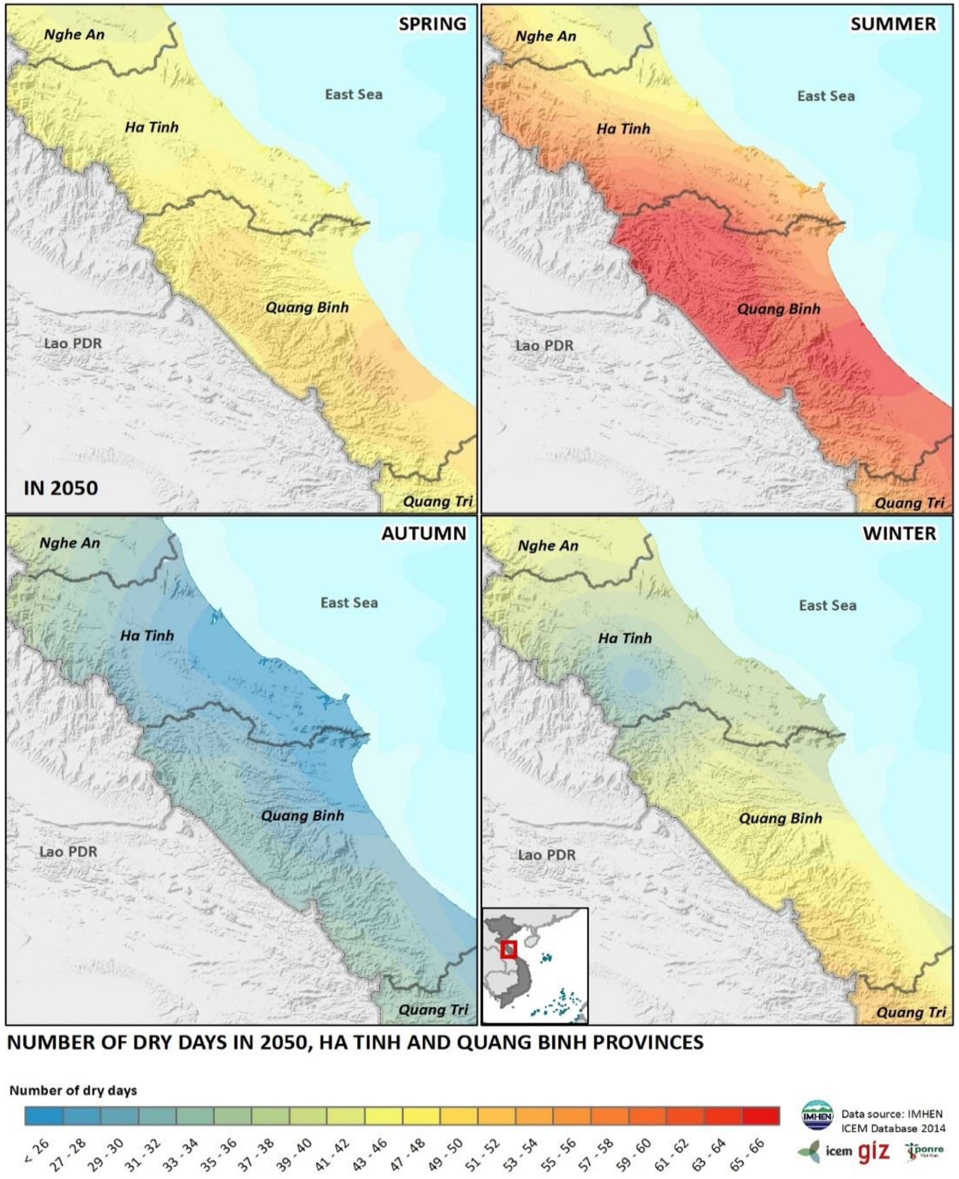


7.2.2b: Seasonal number of dry days, (i) 2030 (ii) 2050

(i) 2030



(i) 2050



7.2.2c: Data for four season change in number of dry days, Baseline, 2030, 2050 and 2100

	Baseline Number of dry days				Change in Number of dry days in 2030				Change in Number of dry days in 2050				Change in Number of dry days in 2100			
	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb	Mar - May	Jun - Aug	Sep - Nov	Dec - Feb
	Days				Days				Days				Days			
AVG	39	48	23	32	7	0	3	2	6	2	4	4	5	5	4	4
MAX	41	61	31	37	8	1	4	3	6	3	6	6	5	6	6	5
MIN	38	39	17	24	5	-1	2	1	5	2	3	2	4	3	2	1

CHAPTER 8 ADAPTIVE CAPACITY IN CLIMATE CHANGE VULNERABILITY ASSESSMENTS: HA TINH

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 Ha Tinh. 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 Ha Tinh. 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 is considered in the village level assessments.

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:

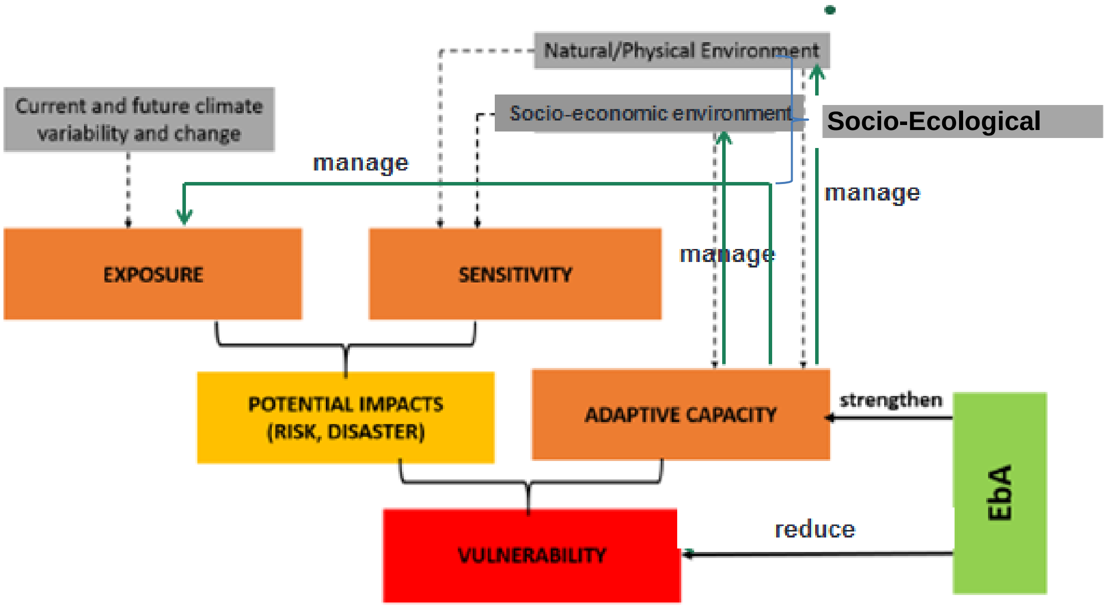
"The potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects or impacts" (from Smit et al., 1999).[25]

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 and their activities front

[25] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=650

and centre in the analysis, in the context of the ecosystem in which they are living and conducting those activities, and the ecosystem services on which they depend. 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 addressing it.

Figure 0.1: Adaptive Capacity in Climate Change Vulnerability Assessment for EbA



Source: Adapted from GIZ, Adelphi and EURAC 2013, based on IPCC 2007

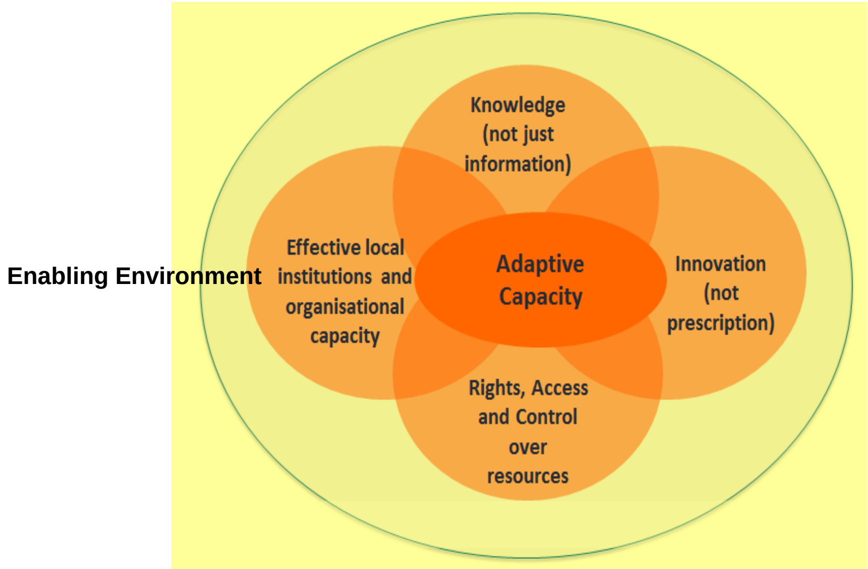
Adaptive Capacity of Species and Ecosystems

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 for the most part, 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 maintaining ecosystem patches of as large size as possible; ensuring connectivity of patches across the landscape (both horizontally and vertically) 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 0.2: 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 adaptive capacity 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[26]. 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

[26] 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.

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. Developing Adaptive Capacity

The interlinked global challenges of climate change; environmental degradation; and the recent worldwide financial and economic crises, have resulted in complex new development needs, and have increased the demand for specialized advice and capacity support on a wider range of issues and problems. Capacity is a critical aspect of development, which is reflected throughout the Paris/Accra Aid Effectiveness Agenda. In international development, capacity is seen as "the ability of people, organizations and society as a whole to manage their affairs successfully" (OECD/DAC), ultimately leading to attainment of the Sustainable Development Goals. It follows then that in the context of Climate Change, Adaptive Capacity can be seen as "the ability of people, organizations and society as a whole to manage the challenges and opportunities posed by climate change, successfully.

The general trend in the international development community is to replace the term "capacity building" with "capacity development". The shift in terminology reflects an evolution from an original concept of an essentially externally-driven process in which there were no pre-existing capacities, to a new concept that places strong emphasis on national ownership and on endogenous change processes. Capacity Development (CD) is the "process whereby people, organizations and society as a whole unleash, strengthen, create, adapt and maintain capacity over time" (OECD/DAC). Again, in the context of climate change we can therefore understand Adaptive Capacity Development as "the process whereby people, organisations and society as a while unleash, strengthen, create, adapt and maintain capacity to address climate change over time" CD has traditionally been associated with knowledge transfer and training of individuals, yet it is a complex, non-linear and long-term change process in which no single factor (e.g. information, education and training, technical assistance, policy advice etc.) can by itself be an explanation for the development of capacity.

More effective CD is based on an integrated approach whereby capacities of individuals, organizations and the enabling environment are considered, (with attention to both Technical and Functional capacities), and CD interventions are tailored to address specific needs across the three interlinked individual, organizational, and enabling environment dimensions. This applies to development of Climate Change Adaptation Capacity as much as it does to any other area of capacity development.

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 developing 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.

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 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 Ha Tinh is strongly shaped by institutions and policies at the national level. Figure 8.6 shows how Vietnam's response to climate issues is structured, and Figure 8.7 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[27]. 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

[27] MARD, MONRE and National Defence, public security, Information and communication, Transport , Industry and Trade, Planning and investment, Finance, Education and Training, Health, MOLISA

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:

(i) Assessing the impacts of climate change

(ii) Identifying appropriate responses

(iii) Developing a scientific-technical programme

(iv) Strengthening capacity and the policy framework in the relevant organisations and institutions

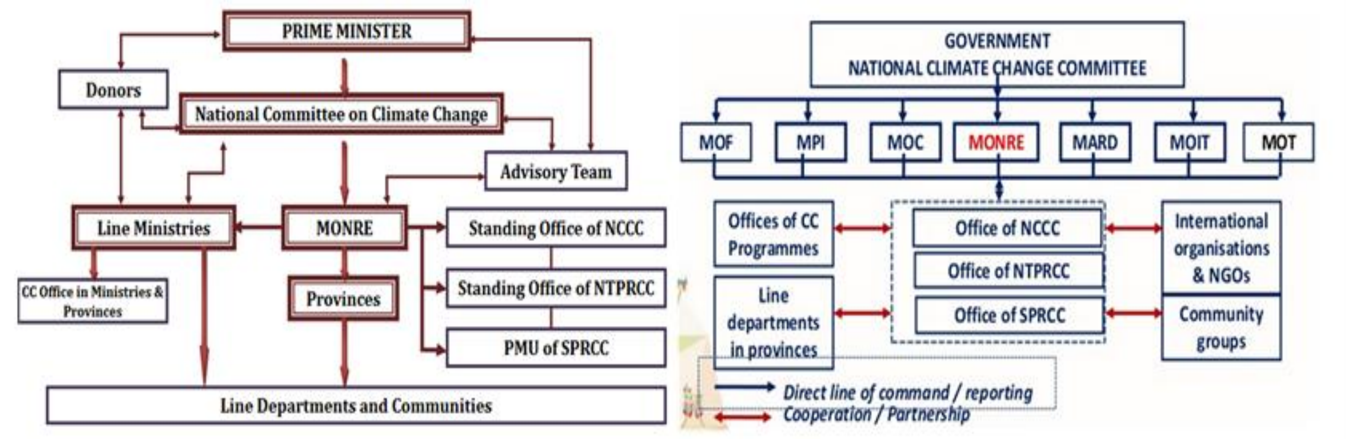
(v) Raising awareness across the country

(vi) Enhancing international cooperation

(vii) Mainstreaming the NTP across all sectors

(viii) Developing Specific action plans to respond to climate change (all ministries, sectors, localities).

Figure 0.3: Vietnam's institutional structures relating to Climate Change



Source: Nhat 2015 *Source: Nhat 2016*

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).

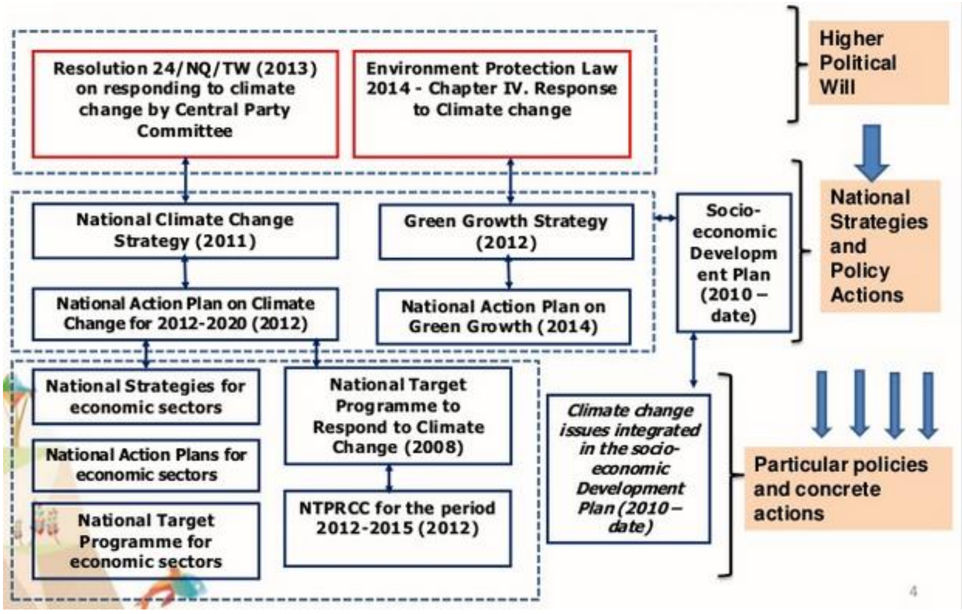
Between 2010 and 2013 all 63 provinces and centrally-run cities issued their own climate change response action plans (CCRAP). Ha Tinh prepared its CCRAP in 2011 and it was being renewed in 2015-16.

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 Defence and other agencies and approved by the PM in 2007. It broadly responds to requirements under the UNFCCC, Kyoto Protocol, Hyogo Framework for Action[28] 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 0.4: Vietnam's National Policy Framework responding to Climate Change



Source: Nhat (2015)

8.2.2. Adaptive Capacity at provincial level in Ha Tinh

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.

[28] 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 agreed in 2015.

8.2.2.1.1. Department of Natural Resources and the Environment (DONRE)

In Ha Tinh, DONRE is the Standing Agency for the implementation of the NTP-RCC in the province, and the province does has a Provincial Steering Committee for Climate Change related to the NTP[29]

DONRE's primary role is to prepare and manage the Provincial Climate Change Response 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 (November 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 a large number of 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 weather stations and several hydrological stations on the main rivers. DONRE also collects some information on water salinity and saline intrusion but this is not regular and frequent enough, or carried out at enough places, to provide clear monitoring of changes in saline intrusion related to sea level rise and other changes.

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. 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. 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 subsidized 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.

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[29] There are very many different steering committees overseen by the Ha Tinh PPC. So – a Steering Committee does not necessarily produce real focus on critical issues.

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.

There is also a Provincial Committee on Flood Control and Rescue. Many departments are involved in this, e.g. the Transport Department is in sub-team in charge of providing means of transportation.

Finally, an element of coordination and the "enabling environment for adaptation" that remains weak in Ha Tinh, 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.

8.2.2.1.4. Knowledge and Understanding Of Climate Change and Adaptation Issues

Ha Tinh'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 sectoral and even sub-sectoral in nature, 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 small climate change unit. 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 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.

8.2.2.1.5. 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. 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 Ha Tinh was initially proceeding without reference to EbA. A special consultant had to be recruited to provide the needed integration. Ha Tinh's SEDP 2011-2015 made little reference to climate change and no reference to EbA. The updated SEDP is not yet available for review in English.

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

8.2.2.2. 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. Many other 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 Ha Tinh's climate change adaptation actions to date. Further collaboration with provincial departments is required to complete this analysis.

8.2.2.2.1. 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.

For crop production, DARD has 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. In the near future there are plans to apply drip irrigation (Israel style) and greenhouse planting for more controlled environment. There will also be studies on finding drought and cold tolerant species. Will develop agriculture plan to reduce CC impacts because many activities such as fertilizer use, paddy rice, etc. contribute to GHG emissions.

Role of forest is crucial - not only in provisioning, but for environmental protection. DARD provides direct support to forest management. Big programmes in forestry include 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.

Aquaculture is a severely impacted sector. Some solutions have been considered as follows: 1) policy - restructuring aquaculture sector including CCA Options; 2) production plan by ecosystems – e.g. freshwater fish; shrimp on sandy areas; sustainable brackish water fish; 3) some pilot activities to enhance ecosystem services - fish and rice model working really well 4) in areas showing some environmental degradation, shift from intensive shrimp to one shrimp and one fish crop. Or one shrimp and algae for gelatine (agar) production

Outputs of the he restructuring programme to include CCA are not yet as clear as expected, because the programme was only developed recently. There is a focus on engineering works like dykes and irrigation reservoirs. There are targets to repair or upgrade many reservoirs for irrigation purposes but budget is very limited. Also there is a goal to put monitoring equipment in all reservoirs for flood forecast and prevention. There is no separate funding support for CCA, it is all integrated to other programmes. There is no provincial budget allocated to DARD for CCA. All specific CCA work is supported by other donors.

8.2.2.2.2. 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.

Some concerns expressed about emissions from coal-fired thermal power plant - some other renewable energy options are being looked at e.g. -wind power potential - joint venture with South Korea.

Project appraisal is a key area in which CCA (and especially EbA) could be strengthened. For projects using central budget - different departments within their expertise will do the appraisal. For projects proposed by companies DPI will first look at some of the key information - how much land will be used what technologies will be used, what will you produce, what impacts it will it have (this part is non-monetary) the investors have to do EIA and DONRE will step in to monitor it. For other social impacts such as loss of land and shift of labour the investors and local government will have to take care of this.

Every year there is a budget available for reservoir safety. A combination of state budget local budget and ODA is used for reservoir safety and investments in evacuation routes and rescue facilities. Programmes for 78 reservoirs spent 1,274 billion dong. Ha Tinh people are very familiar with and very proactive in responding to floods. Decentralised reservoir management (but with a standardised approach) is very important. Some small reservoirs can be managed and maintained at the commune level.

MARD guidelines anticipate higher frequency and intensity of flooding so there is a need to design reservoir capacity appropriately. DPI is the focal point for overall appraisal - looking at the intended social and economic impact of the project, and the appropriate scale of the project in consideration with the budget available (cost-benefit analysis). For specific reservoir technical specifications, DARD is responsible, and for the EIAs DONRE is responsible. When forest is flooded for reservoir construction (as is happening in VQNP) DPI suggests that new forest should be replanted to compensate for this, using high value indigenous species. (It is not clear if this is just an idea, a guideline, or something that must be implemented and is enforced).

So far, farmers do not pay for irrigation water, it is paid from the local budget. The irrigation companies do not have to pay PES fees - but water supply and industrial uses have to pay. Studies in other parts of Vietnam have shown that when farmers get water for free they do not use it efficiently and there is a lot of water wasted. This issue should be considered seriously in relation to adaptive capacity.

Provincial and district level land-use planning processes are now working on adjustments for 2016-2020, to be approved at the provincial level. 13 districts and townships have already submitted adjusted planning to the province level, in which they include consideration of climate change.

Mineral planning to 2025 and environmental protection planning were approved in 2014. Water resources management planning will be adjusted in 2016. For Biodiversity Conservation planning an outline for the period until 2020 and orientation to 2030 are being developed.

8.2.2.2.3. Department of Transport

Impact of CC on the Transport sector is complicated and the Central Region is most severely affected. Ha Tinh has an annual work plan 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 them to local context. Sometimes initiatives and innovation come from the local level.

The Department of Transport is responsible for management of the whole of the road traffic system of 16,600km of roads - including national highways provincial district and commune roads and local roads in villages and farmers' roads, except Highway #1 and the HCM trail. They also manage the waterway transport system. On behalf of PPC manage all traffic construction in the province including planning and appraisal and quality management of construction work.

In the context of climate change impacts, some road systems need to be upgraded. Two options to deal with increasing flood water flows - (i) expand the width of bridges; (ii) increase number of culverts. Highway # 8 and 15 often flooded in the past but now upgraded both so fewer problems. The third option is to reinforce embankments on either side of roads. In 2013 a big flood on highway #8 broke the road - upgraded by making "dry" bridges to allow water flow under the road when necessary in times of flood. Landslides occur most frequently near the Lao border in Huong Son District; on highway #8 (very high mountains steep slopes) and two places on highway #15 but not really a big problem. Ky Anh District road also a little bit of problem. It is not clear to what extent bioengineering approaches are being used in erosion management. This could be an area for further innovation and application.

HCM trail and highway#15 provide a safe refuge area during floods as the roads are much higher than the surrounding areas. The whole coastline of HT doesn't normally flood, but it may happen with superstorms - nevertheless people still have alternative roads to travel on. If sea level rises, the first option will be highway #1, second option HCM trail. Some places in northern Duc Tho are completely isolated in floods.

8.2.2.2.4. 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.

8.2.2.2.5. 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.

DOIT works on industrial environmental safety - particularly safety in mining, in trading of petroleum and NPGs and electricity. Titanium mining in the province is almost finished - but after the land has already been handed over, it appears that acacia plantation and crop production is very difficult. Mostly the former titanium mining areas have been converted to aquaculture on sandy soils and 200 hectares of old mines have been converted to vegetable production. If there is no strict control and management so restoration of the environment will not be achieved.

8.2.2.2.6. Department of Construction

Climate Change is very important for construction sector. However the Construction Law does not integrate climate change considerations. Climate change adaptation is therefore applied through project related actions only.

Construction/architecture should pay attention to important technical specifications, especially for water supply and drainage. Inundation and flooding occurs very quickly but luckily the drainage also happens very quickly. Short distance from mountains to the sea - average 60km. Main river systems also support very quick drainage - flooding and inundation only occurs during high spring tides when rivers also in flood.

Provincial planning has green space targets - areas with remaining green space will be preserved. From Vung Ang economic zone to the city. However, it also depends on the project owners and the managers of the economic zones to be responsible for maintaining the green space (i.e. there is no enforcement!). The 137km of coastline already has coastal casuarinas protection forest line. Urban development planning also has targets for maintaining green space - especially along the river banks.

Targets (for green space and for drainage) are set based on technical regulations of VN and VN standards (these are set at national level and may not yet incorporate climate change projections). In the coastal zone DoC considers we should have a 150m belt of trees but in reality much of the coastline is very crowded with fish ponds, housing and other structures. The World Bank project is helping with coastal spatial planning.

The department provides guidelines and training for districts and clusters of districts to disseminate laws and decrees, as well as training on safety and technical standards and regulations. They conduct spot-checks on projects (but do not do overall routine supervision of projects). The department is involved in zoning for the entire province - commenting on green space targets, riparian set-back safety zones, and evacuation plan for neighbourhoods prone to flooding.

Ha Tinh is one pilot province of a project working in 7 provinces to look at housing that is more adapted to flooding, and strengthening houses to be resistant to typhoons. In 2011 they introduced 3 options for flood adapted housing - with support from DWF (French Agency) with MOC e.g. pillars 3.6m high to ensure floor is not flooded, and designed for easy access for rescue boat to approach the house.

For typhoon resistant housing, guy ropes pegged to the ground - government.

Programme 167 housing support for the poor - covers all of HT province- poor people can get grants or loan credit to strengthen their houses - the support package includes 10 million from the government, and 10 million from the social policy bank - about 1,200 houses already adapted to floods and 1,100 to typhoons. Many people are copying the designs.

In the second phase of housing support for the poor programme - about 1,200 hh will benefit.

8.2.2.3. Resources

Ha Tinh is a budget deficit province which receives most of its funds 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 Ha Tinh CCRAP 2011-15 requested a budget of over USD 200 million but apparently none of the projects implemented. The updated CCRAP 2016-2020 has a similar size of budget, 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- especially EbA and thus on provincial “adaptive capacity”.

8.2.2.4. Gaps in Adaptive Capacity in some key areas

The examples provided below are taken from just one sub-sector - forestry. These are provided just to illustrate some of the areas that need to be looked at in much more detail, if a serious climate change adaptation capacity development plan were to be seriously developed. In every other sector there will also be similar challenges in the areas of basic competencies, staffing numbers equipment and budget; as well as law enforcement.

Ha Tinh has a large amount of forest cover. SUF Forest includes Vu Quang National Park (VQNP) and Ke Go Nature Reserve (KGNR). When capacity to manage these areas as effectively as needed is already lacking, then it is difficult to see how there would be capacity to adapt to the additional stresses brought about by climate change.

<u>Ke Go Nature Reserve and Adaptive Capacity</u>

In Ke Go, collection of any NTFPs that are not endangered species is allowed - the most important products being rattan and the palm leaves used for making traditional conical hats. However, there is no information about the volume and value of these products collected; their relative importance as source of income for local people; or how many people are involved in their collection. In addition, there is no monitoring of the abundance and productivity of these species in the forest, and so no idea if their collection is sustainable or not. So it can be concluded that the resource is not being managed effectively under present conditions - never mind considering the changing conditions caused be climate change.

In addition, illegal activities including encroachment, illegal logging and poaching of wildlife as well as forest fires were identified as significant challenges faced by the nature reserve. A total staff of 77 includes 40 rangers stationed in 10 ranger stations around the property. Their main duty is patrolling for law enforcement. The 4 rangers we visited after a cold and wet one-hour boat ride to Station #1 explained that are responsible for protection of a 6,000 ha part of the nature reserve, and they get to go back to town twice per month. Although their facilities and living conditions were fairly basic, they did have an electricity supply provided by solar power, which enabled them to charge mobile phones, watch a small TV, etc.

In Ke Go, the 327 plantation programme planted acacia around the reservoir area and then under the 661 reforestation project some acacia was also planted but was subsequently harvested and then replanted with indigenous species. Enrichment planting of 800ha has been carried out with indigenous species propagated in nurseries from seed collected from the forest.

A JICA project (2008-2018) working in 11 provinces also supported enrichment planting with indigenous species. There may be a UN REDD Biogas project, but details were unclear. Previously there have been already completed agricultural extension projects, as well as an Oxfam GB project to support bamboo cultivation. There may have been SNV and FFI projects as well. The successes and benefits of these projects have not been clearly identified and understood by the management of the nature reserve.

It was also reported to the consultants by Ke Go personnel that planting of a specific type of Melaleuca imported from Australia has helped stabilize soil erosion on some parts of the banks of the reservoir. Because this species can survive being partially underwater for up to 6 months, then it can be planted right down to the reservoir's edge and has helped prevent siltation and improve water quality.

Currently within Ke Go NR there is a 1 ha plantation for bamboo shoots, and the Chair of the Management Board suggested a particular part of the reserve that might be suitable for production of medicinal herbs. He also objected to a proposed 1,000 ha cattle project which was not approved.

Undoubtedly, improved management of Ke Go including reduced encroachment, illegal logging and poaching would increase the overall resilience of the forest to climate change by reducing or removing other non-climate stressors. A better managed forest with more diverse species composition that recreates a more natural multi-storied forest structure would enhance soil protection, reduce run-off, erosion and landslides, all contributing to improved watershed service function - that will be important with the predicted increase in heavy rainfall in the rainy season in future. Such a forest would be more robust to the battering by expected more severe storms, and would be less sensitive to the increased forest fire risk with extended periods of increasingly hotter days expected in the future. A more diverse forest would support more wildlife and would increase its attractiveness as a tourism destination.

Competence Standards for Protected Area Jobs

Both KGNR and VQNP are forms of internationally recognized protected areas. Through a collaborative process between ASEAN member countries and the ASEAN regional Centre for Biodiversity Conservation, attempts have been made to identify the typical types of jobs that are necessary within all forms of protected areas, and further to develop competency standards for each of these jobs. Appleton (2003) provides recommendations for the skills and knowledge ideally required for 24 key protected areas jobs, divided into 17 technical categories and five seniority levels. The report contains details of all the standards and guidance as to how to use them.

The standards were developed to assist protected area management authorities, training and educational organisations and conservation projects to improve human resource development, staff performance and training. They have been developed through a review of best practice in the region and are intended to be adapted as required by those using them to meet specific national requirements and training and development contexts. A key recommendation of the Third Southeast Asia Regional Meeting of the IUCN World Commission on Protected Areas (held in Manila in April 2003) was the adaptation and adoption of these standards in the region.

Based on single day rapid assessment visits to both VQNP and KGNR, the impression is that these standards have not been effectively applied in these two protected areas. In addition, the standards as developed in 2003 do not adequately address competencies in relation to climate change, and competencies of protected area personnel need to be updated in this regard.

Forest Fire Management

With longer drier and hotter springs and early summers, forest fire will be an increasing problem in Ha Tinh. Because the province has a very large forest area, this issue should be taken seriously. While no specific assessment of forest fire management was conducted in Ha Tinh as part of the VA, we can consider some general concerns about forest fire management capacity from national studies in Vietnam.

According to Kauffman et. al. 2007, forest fire management in Vietnam remains inefficient. The main reasons provided are as follows.

A strict management system for wildfire prevention and suppression is lacking at all levels. Guidance for fire prevention and suppression programs is inadequate due to the absence of precise and current information, transport means and other facilities and accessories. The Central and Provincial Forest Protection Departments perform their functions to provide fire-danger forecasting, warning and detecting. However, they have insufficient financial support, inadequate monitoring equipment and facilities and a lack of focused education and training. In addition, the data collected to calculate the fire-danger rating does not adequately represent the full diversity of locality specific areas and sub-areas throughout the country. Furthermore, the scientific methodologies lack the rigor needed to calculate more site specific fire-danger ratings. At present, the system is capable of predicting only large-scale fire hazards. Technology to locate wildfires through satellite imagery "hot spots" for early detection and suppression is not yet available.

Although the fire prevention and suppression law is enforced, professional fire crews have not yet been established. The forest protection force is responsible for wildfire prevention and suppression, yet their forces are small and fragmented with few qualifications or expertise. The provincial Forest Protection Departments have not yet received any investment capital to develop highly professional fire crews.

Coordination is inconsistent and inefficient among fire crews and overall guidance is inadequate. People have not yet distinguished between the executive mechanism and the coordinative one. Although the forest protection force has a large number of staff they have little expertise and their functional performance to combat wildfires is ineffective.

Management of Wood Processing in Ha Tinh

Ha Tinh has 509 timber processing units/factories but only 195 have operating licenses, the remaining 314 units (62%) operate without a license. Further, small-scale wood processing units at household level are non-registered and not managed. Wood processing factories are often located near by the forest: wood resources are bought from the free local market, where the illegally harvested timber from natural forests may also enter the supply chain.

Based on these numbers it seems the government capacity to manage wood processing is presently limited. With increasing pressures on the forest from climate change, the need to enforce better protection, to ensure legality of timber entering the supply chain, and to monitor that the amount of wood of native timber species processed is in line with known legal harvests, will all become increasingly important.

8.3.

8.4. 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 Ha Tinh'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 Ha Tinh, climate change (and more specifically EbA responses to climate change, are 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 Ha Tinh 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. 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.

The SES - 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.

Taking a different example form a mixed system in a hilly area, SES 5d e.g. Huong Trach commune in Huong Khe district, has about 2,000 households with almost 8,000 people with just over 10,000 ha of forest and agricultural land. Of this 5,871ha is SUF of KGNR; 2,888ha is protection forest and 1,066ha is production forest. About 460 ha of maize peanuts and sweet potato are grown and 150ha of rice fields produce two crops/year. In addition, 280ha of pomelo and 100ha of oranges are grown. Fruit tree orchards appear to be the most profitable form of agriculture in this area, and the commune development plan has the aim of increasing the area of oranges and pomelo. However, in recent years, drought is becoming more and more serious, impacting not only fruit trees but also rice and drinking water supply. At the same time, in the rainy season flash floods are getting more severe and cold snaps in the cool season are also apparently getting worse. So when considering adaptive capacity, we have to ask whether or not the commune development plan and the advice provided by DARD extension services, has fully considered the implications of more intense future droughts, floods and cold spells on fruit trees; and whether or not they have identified the tree species and varieties that will be most suitable in the future climate conditions - or is this just a short-term decision based on the thinking that fruit trees provide better income?

For rice growing in this area, the Netherlands Development Agency SNV has supported an SRI rice model in 3.3ha of rice where 25 households have available water. Chemical fertilizer use has been reduced, and animal manure increased. Also seedlings of local native timber species have been provided for plantations, including 4200 trees of lim (Fabaceae), giổi (Magnoliaceae), vang tâm (Manglietia fordiana), and 1,200 medical plants mộc hoa trắng (Holarrhrena antidysenteria).

8.5. Conclusions and recommendations

The provincial government of Ha Tinh has the foundations of “adaptive capacity” for dealing with climate change, but adaptive capacity still needs to be further developed. Some key conditions that increase chances of successful development of adaptive capacity are as follows:

- Use of frameworks derived from international initiatives (e.g. UNFCCC)
- Commitment of national actors to policy implementation and performance improvements
- Identification of local champions to catalyse change
- Undertaking of targeted needs assessment
- Attention to all three dimensions of capacity (individual-organisation-enabling environment)
- Attention to both technical and functional capacities
- Combination of modalities of intervention
- Application of sound training methodologies with appropriate pedagogy
- Adoption of medium- to long-term approaches
- Creation of networks for knowledge and experience sharing
- Internalization of changes by national actors into their priorities, systems and processes
- Ongoing strategic budget allocations
- Incremental approaches building on feedback from previous phases
- Monitoring and evaluation of outcomes and impact

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 Ha Tinh.

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 Ha Tinh - 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 a wide range of provincial officials. As part of this process, conduct a KAP (Knowledge, Attitudes, Perceptions) study/capacity needs assessment 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 implementation.

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 Brief 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 Ha Tinh.

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ANNEX 8.I: BACKGROUND CONCEPTS OF ADAPTATION 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.

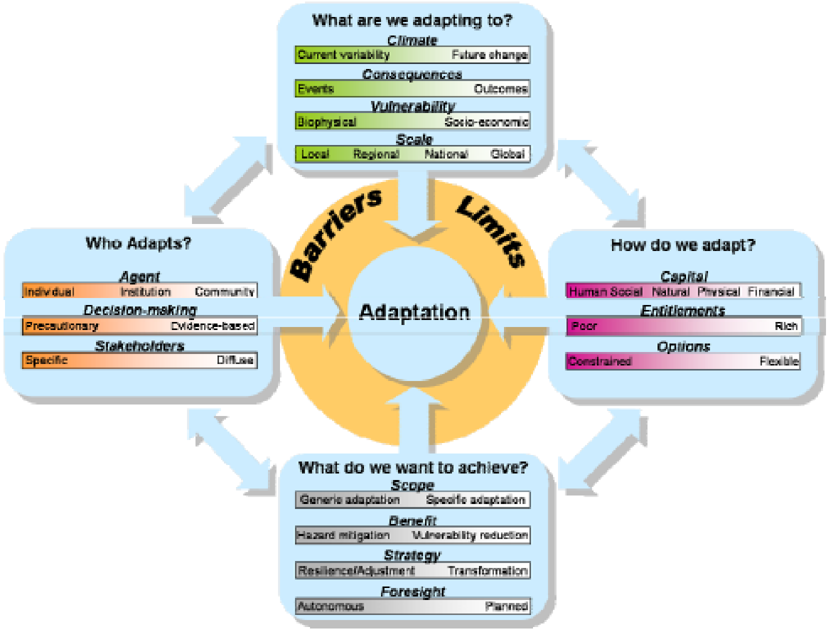
Adaptation is often conflated with "resilience", but whereas adaptation is a process of change, resilience is a characteristic or condition of a system. Resilience implies the ability to better withstand impacts and to more quickly re-establish an original state after a disturbance. Resilience is determined 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 8.5). 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 0.5: 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.

2. 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".

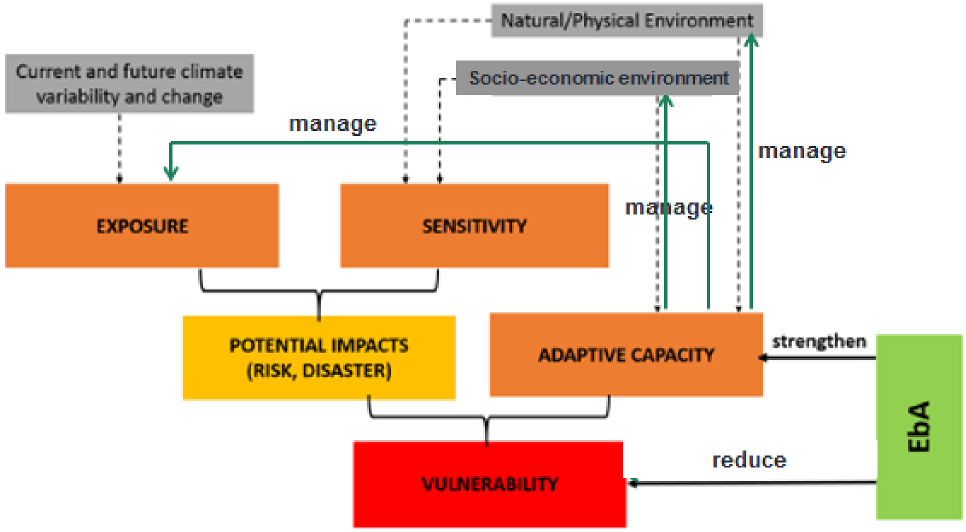
In the context of climate change, it has been defined as:

"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)[30].

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.

[30] http://www.ipcc.ch/ipccreports/tar/wg2/index.php?idp=650

Figure 0.6: 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 Report 1, exposure is defined as the extent to which an entity (eg 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)[31]. 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"

[31] 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"*.

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 the greater the likelihood the species will survive. However, in terms of the analytical framework presented in Figure 8.2, 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, then 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.

For the purposes of this study, adaptive capacity is essentially:

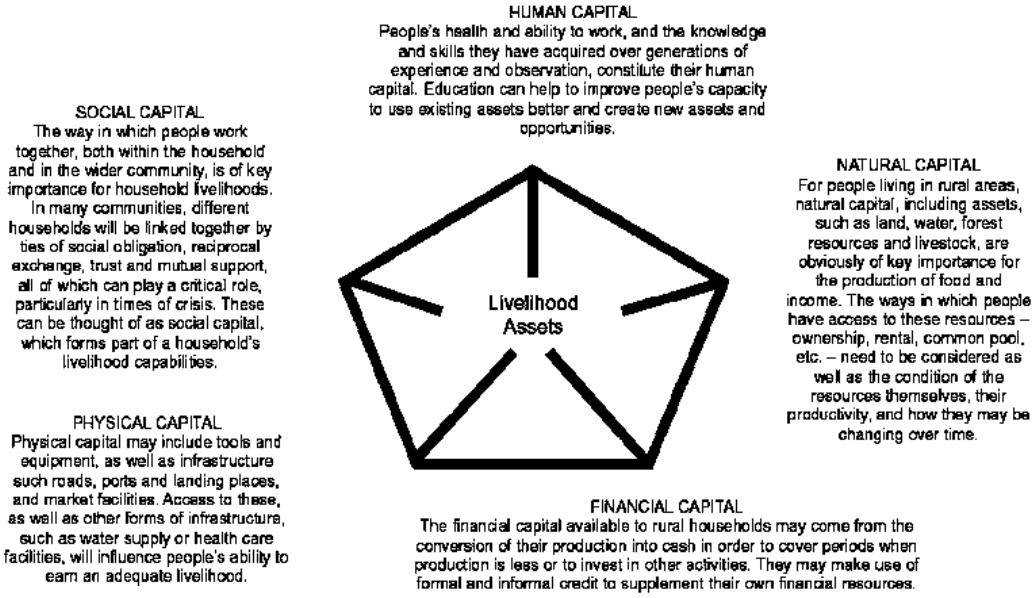
"the broad set of enabling traits, possessed by people, to manage the exposure and sensitivity of their socio-ecological system, either for the increased resilience of the system to changing climatic circumstances, or for its transformation to a new regime that is better suited to new climatic circumstances."

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[32]. 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.

[32] See DFID Sustainable Livelihoods Guidance Sheets for more details on livelihood assets.
http://www.eldis.org/vfile/upload/1/document/0901/section2.pdf

Figure 0.7: 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 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.

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).

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.
- 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 ASSESSMENT AND EBA RECOMMENDATIONS FOR THE PRIORITY SOCIO-ECOLOGICAL SYSTEMS OF HA TINH

9.1 Introduction

In this chapter, we present the final results of the provincial-level vulnerability assessment for ecosystem-based adaptation to climate change for Ha Tinh. The top 10 of the 33 SESs in Ha Tinh have been subjected to further detailed analysis of their generic ecosystem services and climate change vulnerability at the provincial-level. These are listed in Table 9.1. The methods for this assessment are described, and the results discussed, with full details of the analyses provided in Annexes.

The assessment builds particularly on the information provided in Chapter 5, in which the SES of Ha Tinh were identified, mapped, prioritised and described, Chapter 6 and 7 examining the climate change context of Ha Tinh and Chapter 8 on Ha Tinh's provincial level adaptive capacity.

Table 9.1: Ten priority Socio-ecological Systems for Ha Tinh

Rank	SES Code	Name of Socio-Ecological System
1	8a	Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)
2	8h	Urban and rural settlement, industry, services
2	PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)
3	3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation
4	3b	Kinh smallholder floodplain-hills transition,paddy rice + mixed farming and tree crops
5	FPMB 1+2	Forest Protection Management boards on subtropical forest > 700m and moist tropical < 700 m
6	8e	State managed Special Economic and Industrial Areas (coastal)
7	2b	Kinh and ethnic minority smallholder field and tree crops
8	2d	Kinh smallholder inland valley paddy cultivation + tree crops
9	6d	Kinh commercial shrimp aquaculture on sand
10	7b	Kinh artisanal inshore capture fishery up to 6 nm offshore

9.2 Ecosystem Service and Vulnerability Assessments towards EbA Recommendations for 10 priority Socio-Ecological Systems

9.2.1 Ecosystem service assessments

The purpose of the ecosystem service assessment is to identify the key services in each SES, understand the status or condition of this service and ultimately see the extent to which these services might be restored, to help the stakeholders of that or adjacent SES adapt to climate change. Clearly the nature and importance of ecosystem services is very site specific. Thus, at this provincial-level, the assessment can only be generic and qualitative, based on a general understanding of the SES. It is based primarily on the professional judgement of the consultant team and literature review, and is intended to inform and help guide the site-specific more detailed local-level assessment.

The analysis was structured around a modified version of the Common International Classification for Ecosystem Services (CICES) developed through the European Environment Agency. The assessment attempted to answer following questions for each SES:

- On which ecosystem services does this SES depend?
- Where is this service generated?
- How important is it (to what and why), on a scale of 1 (least important) and 5 (most important)?
- In what condition is this ecosystem service on a scale of 1-5 (compared with a hypothetical intact ecosystem)?
- Which ecosystem services does this SES provide to other SES?

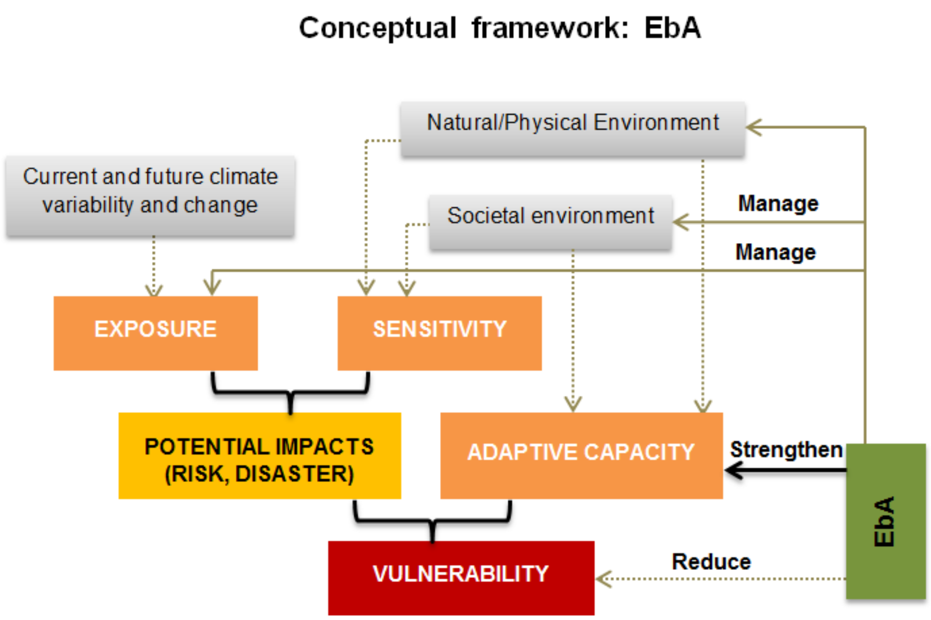
Overall, Special Use Forest SESs were found to be the single biggest area of healthy natural ecosystems, and the single biggest provider of ecosystem services. They play a major role in the provision and regulation of the water supply on which many downstream people and activities are dependent. Forest Companies and Forest Protection Management Boards are also managing large areas of natural forest (as well as plantations) that provide 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 - 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 Ha Tinh 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 natural ecosystems nevertheless provide some of the same services as the original natural forests they replaced such as carbon storage and physical protection, albeit often with more limited effectiveness. At the same time, these fragments of natural ecosystem are themselves are less resilient and ultimately more vulnerable to climate change than intact ecosystems within the same landscape. Detailed ecosystem service assessments of the ten most important SESs are provided in Annex 9.1.

9.2.2 Climate Change Vulnerability Assessments

Chapter 7 examined climate change scenarios and their likely impacts for Ha Tinh, and identified seven specific climate change parameters under four broad areas of change on which to assess vulnerability: precipitation (annual, number of dry days, number of high rainfall events, and), temperature (maximum temperature and number of hot days), storms and sea level rise. The main focus of this study is to assess each SES in terms of these seven parameters.

The overall conceptual framework for this assessment is shown in Figure 9.1.

Figure 9.1: Analytical framework for identifying EbA actions for Socio-ecological Systems



Source: adapted from GIZ, Adelphi and EURAC 2013, based on IPCC, 2007

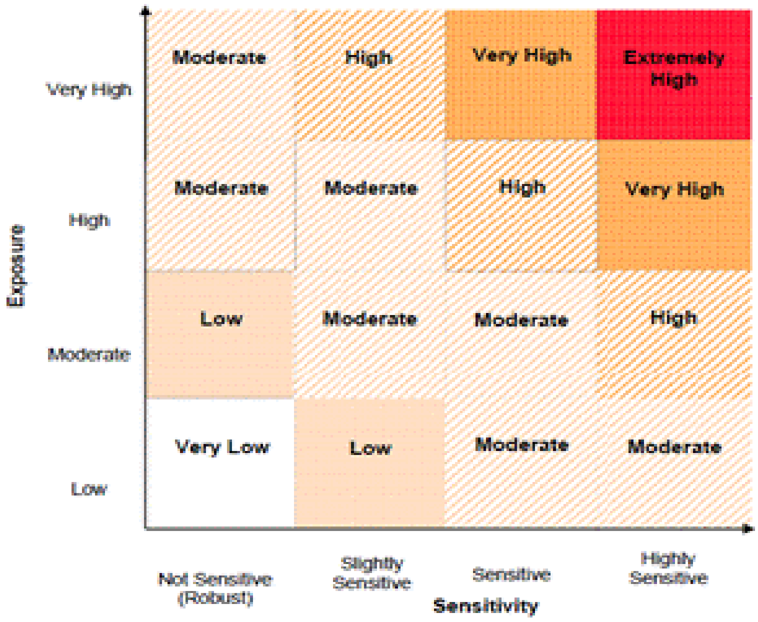
The process for scoring vulnerability is two-stage:

IMPACT = Exposure x sensitivity

VULNERABILITY = IMPACT x Adaptive Capacity

First, IMPACT is assessed (Figure 9.2). Impact is a product of the exposure of the SES to a change parameter and its sensitivity to that parameter. Each is scored from from 1 to 5 (high)[33], using best available secondary information and the expert judgment of the team members. Exposure is then plotted against sensitivity to give an overall score for the impact of that parameter on the SES. Then, VULNERABILITY is assessed (Figure 9.3). Impact is plotted against provincial-level capacity to adapt to it, to give an overall score for vulnerability for that parameter. The overall vulnerability of the SES to climate change is understood as the mean of these seven vulnerability scores. The overall vulnerability scores for the top 10 SESs are provided in Table 9.2, and the component scores for each SES against the seven parameters are provided in Annex 9.3. The full vulnerability analysis for each of the 10 priority SESs is provided in Annex 9.2.

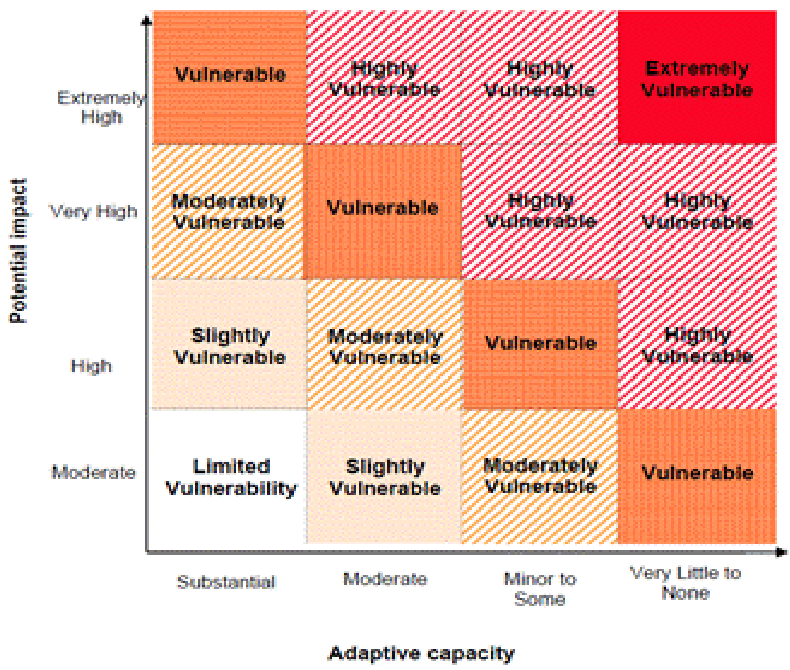
Figure 9.2: Potential impact matrix



Corresponding values used in Tables:

0.0 - 0.99 = Low
1.0 - 1.99 = Moderate
2.0 - 2.99 = High
3.0 - 3.99 = Very High

Figure 9.3: Vulnerability matrix



Corresponding values used in tables:

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

[33] 1 being least exposed or sensitive, 5 being most

Table 9.2: Summary of the Vulnerability Assessment of the top 10 Socio-ecological Systems

SES Importance Rank	SES Code	Name and Code of SES	Main Justification for Importance Ranking	Mean vulnerability score for 7 climate factors	Vulnerability Rank
1	8a	Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)	Hugely important for supporting water supply for agriculture, industry and domestic use	3.3	2
2	8h	Urban and rural settlement, industry, services	Ha Tinh is rapidly urbanizing; services and construction are main contributors to GDP	3.3	2
3	PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)	Covers significant land area and provides important ecosystem services to a variety of downstream SESs	2.7	8
4	3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation	Rice growing is a major agricultural activity in the lowland plains, provides significant employment, support food security and contributes to GDP	3.4	1
5	3b	Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops	Employment, food security and GDP	3.3	2
6	FPMB 1+2	Forest Protection Management boards on subtropical forest > 700m and moist tropical < 700 m	Covers significant land area and provides important ecosystem services	2.7	8
7	8e	State managed Special Economic and Industrial Areas (coastal)	A key model for driving future economic development, Foreign Direct Investment	2.6	10
8	2b	Kinh and ethnic minority smallholder field and tree crops	Land area, employment, food security and income generation	3.3	2
9	2d	Kinh smallholder inland valley paddy cultivation + tree crops	Land area, employment food security and income generation	3.3	2
10	6d	Kinh commercial shrimp aquaculture on sand	Employment, food security and income generation	3.1	7

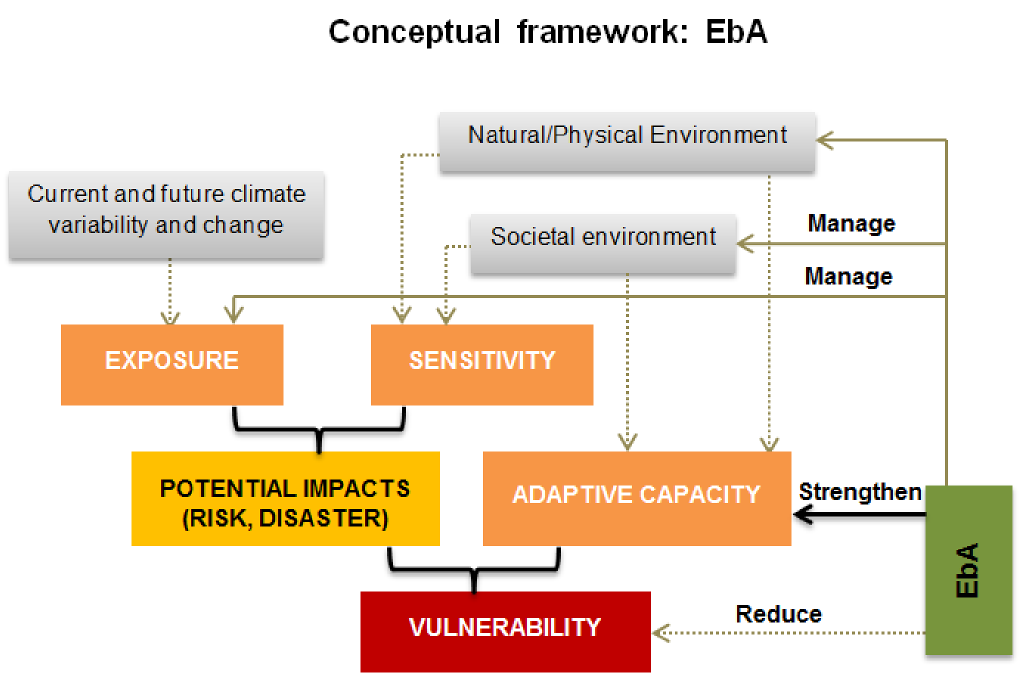
9.2.3 Recommendations for Ecosystem-Based Adaptations

At this concluding point in the provincial-level study, when appropriate EbA actions are identified, it is useful to review the analytical framework for EbA, first presented in Chapter 1. This is shown again in Figure 9.4. Without the blue arrows, Figure 9.4 represents the understanding of the components of vulnerability that was used above, and that has been popular since the IPCC first presented the idea that vulnerability is a function of (Exposure X Sensitivity)/Adaptive capacity. Since EbA actions are intended to reduce vulnerability, they do this by reducing exposure to a climate change parameter, reducing the sensitivity of the entity in question to that parameter, and by strengthening adaptive capacity. The addition of the blue arrows to Figure 9.4 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 and exposure in SESs. Thus, management of exposure, and management of sensitivity, made possible through increased adaptive capacity, combine to reduce overall vulnerability.

Each EbA recommendation presented below is justified by evidence presented in the preceding chapters, highlighting why it is necessary and important, and indicating the benefits it will provide. A tentative timetable for the implementation of each intervention is also given.

The proposed EbA measures fall into several distinct types. Some address climate shocks, and some address stresses, caused by, or exacerbated by climate change. Thus, they do not relate only to disasters caused by extreme climate events, but also to the cumulative stresses on systems that develop through gradual directional change (in temperature, rainfall patterns, sea level rise, and storm patterns) that will modify or in some cases transform these systems.

Figure 9.4: Analytical framework for identifying EbA actions for Socio-ecological Systems



Source: adapted from GIZ, Adelphi and EURAC 2013, based on IPCC, 2007

Some care has been taken only to label an intervention as EbA if it clearly meets this definition. To include other interventions would create (or add to existing) confusion about EbA approaches. Nevertheless, we have attempted to be pragmatic and good adaptation interventions do not have to be 100% pure EbA. In this context:

- Some recommendations relate to "Climate Smart" agriculture (including crop production and livestock-raising), plantation forestry, and aquaculture. 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 "renaturation" process (to help bring back nature) so that additional future ecosystem service benefits can be obtained.

9.3 Key findings and recommendations for each Socio-Ecological System

For each of the ten priority SES, the following sections present summaries of the findings of the ecosystem services assessment and of the main climate change vulnerabilities identified in the vulnerability assessment. Based on these, potential "generic" EbA and other CCA interventions are identified.

9.3.1 SES 8a: Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)

9.3.1.1. Ecosystem Services

Reservoirs transmit what is probably the most important ecosystem service for the province of Ha Tinh: water - for agriculture, for power, for domestic and industrial needs, and for natural "environmental flows" that sustain the province's freshwater biodiversity. All reservoirs depend on the inflow of water from the watersheds of forested SESs (PA 1+2, FPMB 1+2) upstream of their location. Thus intact forested ecosystems and the provisioning (water), regulating (water quality, control of water flow, control of sedimentation) and supporting ecosystem services they provide are vital to the sustainable functioning of reservoirs. The reservoirs are then used to regulate the flow of water to other downstream SESs, through irrigation canals, pipelines, as well as through the water they release into the natural river channels below the reservoirs.

9.3.1.2. Main Climate Vulnerabilities

Drought > lack of water: the predicted reduction in rainfall in winter and spring will reduce the water inflow to reservoirs and water availability to downstream users.

Heavy Rains > dam failure: The predicted increase in prolonged periods of intense rainfall in the rainy season can quickly fill reservoirs to their safe limits, and raise the risk of dam failures.

Heavy rains > erosion: Intense rainfall in many degraded watershed areas is also likely to increase erosion, and the resulting sedimentation of the reservoirs decreases their capacity and working life.

Storms > dam damage: Reservoir facilities may also be vulnerable to physical damage from strong winds and storms.

9.3.1.3. Potential EbA Interventions

- Increase working life of reservoirs by reducing sediment inflow through improved watershed management, particularly using longer rotations in forest plantations, and stopping any further conversion of natural forest to other uses.
- Establish populations of floating pond weed to reduce evaporation
- Install large areas floating solar panels on reservoir surfaces to generate electricity and reduce evaporation losses
- Protect reservoir infrastructure from physical damage from storms through planting of wind-breaks

9.3.1.4. Other Adaptation-related Interventions

- Integrated provincial water management plan, encompassing problems related to many different SES.
- Conduct scenario planning exercises for future water demand in the areas supplied by each reservoir
- Multi-stakeholder water conservation campaigns and demand management

9.3.2 SES PA1+2: State special use forest (National Park, Nature Reserve) management (Vu Quang, Ke Go)

9.3.2.1. Ecosystem services

Vu Quang National Park and Ke Go Nature Reserves together represent the biggest areas of healthy natural ecosystems, and the biggest provider of ecosystem services in Ha Tinh. In addition to the primary role of conserving biodiversity, as discussed above, these protected forests play major roles in the provision and regulation of water supply on which many downstream activities depend. As yet, these SUF do not contribute significantly to tourism in the province either domestic or international as travellers to the region are more likely to visit the renowned World Heritage site of Phong Nha-Ke Bang, in neighbouring Quang Binh.

These forests play a very significant role in carbon sequestration and storage, which may in future have a monetary value, and in local level micro-climate regulation. They also provide pest control and pollination services to adjacent agricultural areas forest, depending on the particular crops being grown, but equally, these protected areas are often a source of vertebrate and insect pests which cause damage in adjacent SES. In times of food shortage, forest adjacent villages may also find a source of wild foods here to help them cope until domestic food supply is restored. Although it is illegal to do so, many people gather building materials, fibres, etc. from these forests, for sale or household use.

9.3.2.2. Main climate vulnerabilities

Rising temperatures > changes in species distribution and abundance: The large area of forest in these special use forests, their rich biodiversity, and connectivity within the landscape, all help reduce their vulnerability to climate change. Their elevation and distance from the coastline reduce the impacts of storms and put them out of reach of the direct effects of sea level rise. However, there are some specific aspects of vulnerability related to temperature and precipitation changes that should be considered.

As discussed in the previous chapter, all species have biophysical tolerances or ecological "comfort zones", so if climate change results in temperatures rising above a species' threshold, an animal species might migrate to stay within their comfort zone; plants might respond in a longer term, resulting in changes of distribution. Typically, each one centigrade degree of temperature increase, results in a shift of 35 km in latitude, or 100-2000 m in altitude (or some combination of the two). For species presently suited to conditions at the highest elevations in Vu Quang, this would leave them nowhere to go, as temperatures rise. For species that will need to migrate further northwards outside the present northern boundary of Vu Quang, the land-use pattern of that area will determine whether there is an opportunity for them to move successfully or not. For these reasons, biodiversity conservation planners try to maintain "connectivity" amongst different protected areas.

Hot dry weather > Fire: 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.

9.3.2.3. Possible EbA interventions

- Improved, ecologically based PA management: Vulnerability is reduced by removing or reducing non-climate stressors thereby increasing the resilience of these protected areas to withstand climate change. The main threats to protected forests include conversion to other uses, illegal logging and forest product gathering and wildlife poaching, and these threats can only be reduced by improved management, including EbA and other interventions. This must include strengthening the relationship between protected area management and local communities, through participatory management, access rights and benefit sharing.
- Restoration of degraded areas within the protected forests, using native species;
- Spatial planning and land management to ensure connectivity of Vu Quang and Ke Go to other forests in the larger landscape (including Phong Nha-Ke Bang National Park in Quang Binh) 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. In Ha Tinh, it is essential that the Cao Tre Border Industrial Zone has a strong environmental planning component, so Vu Quang does not become

isolated. Collaboration with Lao PDR should be continued and strengthened, to develop effective management of the trans-boundary landscapes.

9.3.2.4. Other Adaptation-related Interventions

- Ensure effective enforcement of laws against illegal logging, forest conversion and wildlife poaching.
- Raise awareness in downstream SES of the importance of protected forests.
- Clarify and enforce land use planning regulations to prevent "legal" forest conversion.
- Improving forest fire prevention and if fires do occur, ensure proper rehabilitation of burnt sites with native species.

9.3.3 SES 3a: Kinh smallholder lowland floodplain irrigated paddy rice cultivation

9.3.3.1. Ecosystem services

This SES is most dependent on environmental service of upstream forest ecosystems for the supply of irrigation water for rice growing, although this is now provided through a system of reservoirs and irrigation canals. The soils of rice paddies take years to reach their optimum structure and composition and are practically ecosystems in their own right, depending on the maintenance of diverse factors to sustain their fertility. In some places, paddy fields still supply some natural foods in the form of wild fish, crabs and frogs etc. that can live in the rice fields (although heavy use of chemicals in rice-growing will reduce this wild food supply).

9.3.3.2. Main climate vulnerabilities

Drought > paddy failure: Paddy rice is vulnerable to drought and frequently in Ha Tinh, irrigation water is not sufficient to meet all needs.

Drought > salinization of paddy fields: In Ha Tinh rice paddies in coastal floodplains are at risk of increasing salinization as salt water penetrates further upstream from estuaries, and seeps under dykes into agricultural fields. Irrigation, while providing water for rice crops, reduces river volumes and regimes, which aggravates saline intrusion.

Storms, floods > paddy failure: These coastal rice growing areas take the full force of tropical storms, unprotected except by low dunes in some place. Paddy rice is vulnerable to storm damage and flooding when the crop is ripe and about to be harvested. It is also vulnerable to cold: if a cold snap occurs soon after seedlings are transplanted, the entire crop can be killed. Cold snaps are, however, predicted to decrease in intensity and duration with climate change.

Rising temperature > declining rice yields: Rice productivity also declines as temperatures increase. Night-time temperatures are critical. As they increase, plant respiration increases, reducing growth rates.

Sea Level Rise > permanent inundation, more extreme storm surges. Unless, addressed, sea level rise (estimated at between 13 and 74 cm (B2)), will permanently inundate some 25 km^2 of Ha Tinh's lowland flood plain paddy growing area and its urban areas.

9.3.3.3. Possible EbA interventions

The main lesson from EbA for the lowland floodplains is that their problems of drought, flooding and saline intrusion cannot be seen or planned for, in isolation. They need to be considered as part of a broader integrated water resource management plan which should consider:

- the "renaturation" or "rewilding" 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, accommodate sea level rise and purify water supply, for the benefit of all downstream SESs.
- On rivers where saline intrusion barriers already exist, gates need to be opened and closed in a strategic fashion to deliver multiple benefits; reduction of upstream saline intrusion; downstream sediment transport, migration of fish and other species, and the continued survival of estuary mangroves. This is poorly understood, and research is needed. Then, community-based committees with representative from both upstream and downstream of the barriers should be established to manage their operation.

- Further research on alternative livelihood activities such as the use of more saline-tolerant rice varieties or transition out of rice-growing into brackish-water aquaculture.
- Improved reservoir management to restore environmental flows in rivers and help to reduce saline intrusion and salinization of rice fields.

A number of "climate-smart agriculture" initiatives are already being promoted in the province that should be continued and expanded. These include:

- Promotion/adoption of the "System of Rice Intensification" (SRI), which can significantly reduce water use, as well as the use of fertilisers and pesticides, while increasing yields. 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) so crops ripen before the storm and floods of late summer.
- Expand the use of ratoon rice allowing the harvested rice plants to re-sprout and produce a second crop. This reduces the rotation time to as little as 45 days, and while productivity may only be around 65% of the original harvest, all labour and input costs 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.
- Where salinization is already advanced and reducing rice yields, continue the practice of changing crops to more salt tolerant varieties (eg. sunflowers), or changing activities altogether for instance to aquaculture.

9.3.3.4. Other adaptation-related interventions

- Ecosystem based adaptation cannot address all climate change challenges. Areas critical to the economy and social well-being of Ha Tinh can continue to be physically protected by raising the level of existing dikes and sea walls and constructing others, where necessary.
- Encourage households to diversify their livelihoods and include activities not based on risky renewable natural resources, to reduce dependence on a few sources of income, and enhance resilience by spreading risk and lower risks inherent in depending on few sources of income.
- Ensure land use planning protects the highly productive lowland paddy fields from further urban settlement/expansion.

9.3.4 SES 3b: Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops

9.3.4.1. Ecosystem services

Located at the topographic transition between the plains and the hills, this widespread SES is dependent on a broad range of ecosystem services. In many places, small watersheds and reservoirs provide water for irrigation and domestic use, but natural forests on these watersheds are largely converted to plantations, other land uses or degraded, and water supplies can be limited. As mentioned above, the rice fields themselves may still supply some natural foods in the form of wild fish, crabs, frogs etc. that are often found in paddy fields, but uplands less so. Soils are more exposed, both through cultivation of annual field crops, and by the planting of tree monocultures, although acacias do fix nitrogen. Some physical protection is still provided, as well as pollination and pest control services of varying importance (depending on crops and distance from the forest).

9.3.4.2. Main climate vulnerabilities

Drought > Crop failure: Rice and other field crops are 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.

High rainfall > erosion, landslides and water shortages: Intense rainfall in many deforested and watershed areas and agricultural lands will increase erosion affecting soil fertility and crop production and causing landslides in some places. Increased surface runoff will also reduce infiltration and potentially decrease ground water supplies, leading to water shortages.

Short rotation tree monocultures leave soils exposed for long periods, and intensifying seasonal droughts, followed by heavy rains will increase erosion, particularly on slopes, and ultimately reduce site fertility.

Drought, rising temperatures > Fire: Plantations of acacia, eucalypts and pines are generally tolerant of high temperatures and drought, but the risk of forest fire will increase, as well as the risk of crop and tree diseases.

Storms > crop damage: Tree crops are damaged by high winds. Fruit trees can lose their crops; rubber is subject to wind throw and storms.

9.3.4.3. Possible EbA interventions

In the short andmedium term:

- Employ SRI paddy cultivation systems where appropriate.
- Apply soil and water conservation practices to the cultivation of upland crops and citrus trees, especially on steep slopes, using contour planting, alley cropping, mulching, etc to reduce erosion and encourage infiltration of rain water
- Promote the use of nitrogen fixing (soil) cover crops to protect soils and enhance their fertility.
- Diversify the tree crops within plantation landscapes to increase the structural (and economic) complexity of the stands, and enhance their resilience to climate stress.
- When preparing land for plantation, or harvesting tree crops, leave strips of trees along the edges of rivers and streams (this will improve the water supply and water quality services)
- Change crop varieties 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 rotation length for acacia, eucalyptus and pine, to protect the upland soils and control erosion, particularly around small reservoirs and other areas vulnerable to erosion.
- Where irrigation water is in short supply, switch crops from paddy rice, to less water demanding crops such as cassava and maize.

9.3.4.4. Other adaptation interventions

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

9.3.5 SES FPMB 1+2: Protection Forest Management Boards on subtropical forest > 700m and moist tropical < 700 m

9.3.5.1. Ecosystem services

Protection Forest Management Boards are responsible for managing approximately 83,000 ha (25%) of Ha Tinh's 320,300 ha forest estate. There are five Boards managing natural forest (80%) as well as plantations (20%), for both protection and some production (See Chapter 3). Watershed forest areas provide significant ecosystem services to downstream areas, similar to those described above for Special Use Forests, most notably the provision of water for irrigation, power, and domestic and industrial uses. The production (plantation) forests to a limited extent provide fibres, building materials and biomass to broader provincial society. The natural forests protect biodiversity the provinces "natural capital".

9.3.5.2. Main climate vulnerabilities

The vulnerabilities of the PFMB forests are also similar to those described for SUF above (Section 3.2).

Temperature change and drought > changes in species abundance and distribution. In the longer term, there will be shifts in in the abundance and geographic distribution of both animal and plant species, and some species may become locally extinct.

Heavy rainfall > erosion: Where forest management includes plantations harvested on short rotations for pulp, the combination of exposed soils and heavy rainfall will lead to increased erosion and declining site productivity and cascading downstream impacts such as sedimentation of reservoirs and reduced water supplies to consumers.

Rising temperature, drought >Fire: Fire hazards are greater, because much of the area is planted to monocultures of acacia or the more flammable eucalypts and pines and the stands are more open. Most fires are started accidentally by forest workers and illegal forest harvesters (rattan, timber) who camp for up to several weeks, but some are started intentionally, to justify later conversion to other uses.

Over-riding threats: The greatest threat to these forests and the services they provide however is not from climate change, but from their legal and illegal conversion to other uses. In Ha Tinh, a large area of forest in Vu Quang National Park is being submerged in the reservoir of the Ngan Toui Dam project.

9.3.5.3. Possible EbA interventions

The overall recommendation is to manage production forest in Ha Tinh more effectively and appropriately for a combination of both economic and ecosystem service benefits (not just economic benefits alone), with a focus on measures to control fires and erosion and improve water management, while maintaining diversity and connectivity.

In the natural protection forests:

- Enhance the resilience of the forested ecosystems through restoration and improvement of degraded areas (and enrichment planting where selective logging has already taken place), using only native high value timber species that are selected for their suitability to the future climate conditions

In the acacia and eucalyptus plantations in the production forest estate, revise management strategy, including:

- Use of longer (15 yr) rotations for higher value sawn timber, taking pulp wood from routine thinning and branch wood
- Harvest from 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.
- Leave strips of trees approximately every 50 to 100 m on steep slopes and as riparian buffers along water courses.

9.3.5.4. Other Adaptation-related Interventions

In the medium to longer term:

- Improved prevention measures againstforest fire, including planning and effective use of fire-breaks, education of people going into the forest for other purposes such as approved rattan collectors.
- 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

9.3.6 SES 8e: State managed special economic and industrial areas (coastal, Vung Ang)

9.3.6.1. Ecosystem services

These developments are amongst the most transformed SES in the province, dominated by infrastructure works and commercial supply chains to replace natural ecosystem services – such as drainage, control of erosion and pollution, provision of raw materials, maintenance of micro-climates and protection of the built environment. These areas still rely on upland watersheds and reservoirs for water supply.

9.3.6.2. Main climate vulnerabilities

Storms, high winds, high rainfall, storm surges > flooding, wind damage. Located right on the coast, these sites are in the front line for tropical cyclones, bringing high winds, heavy rain and storm surges, potentially causing wind and wave damage and localized flooding.

Rising temperatures > heat stress: Lowland coastal sites will suffer amongst the greatest impacts from rising temperatures. Urban areas are typically heat islands, and these industrial areas, with great expanses of concrete, will function as such, and will constitute seasonal health hazards for resident populations.

Sea Level Rise > inundation, increase storm surge damage: The Vung Ang industrial and port area is amongst the areas of Ha Tinh most threatened by sea level rise (see Map 5 In Chapter 7).

9.3.6.3. Potential EbA interventions

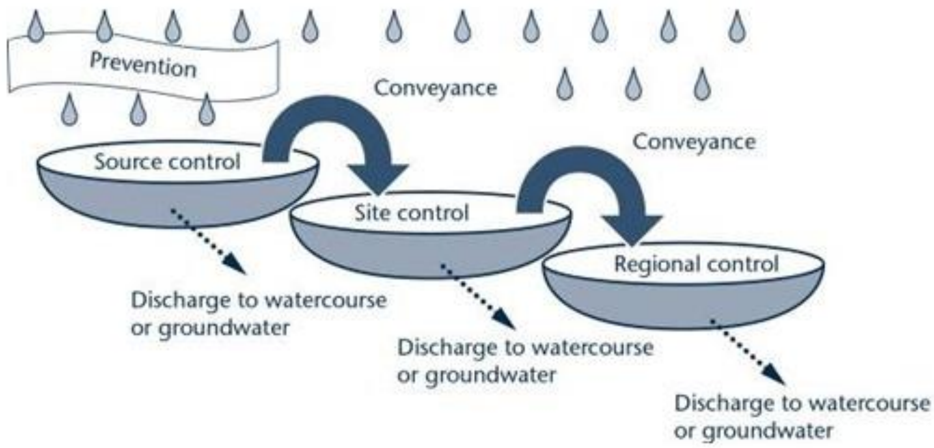
Sustainable Urban Drainage Systems (SUDS) prevent pollution and flooding in urban areas, controlling rain water and providing opportunities to discharge to water courses or ground water: i) at source ; ii) on site; and iii) regionally, as shown in Figure 9.5.

i) Source controls (at or near where rain lands):
   - Green roofs with a layer of vegetation or patches of vegetation as part of the roof cover that can:
     - reduce or eliminate run-off from roof areas
     - cool building during the summer by evaporation and reduce overall “heat island” effects
     - provide sound insulation
     - provide a habitat for wildlife.
   - Permeable or porous surfaces

ii) Site controls
   - Infiltration trenches filter drains and filter strips
   - Swales - shallow drainage channels

iii) Regional controls
   - Detention basins, purpose built ponds and wetlands
   - Green architecture and urban planning: buildings and developments designed with energy efficiency and climate change in mind, including mechanisms to reduce the heat island effect:
     - green walls: building walls designed to accommodate vegetation, which provides natural shading to the buidling
     - abundant open and green spaces within an urban development.

Figure 9.5: Sustainable urban drainage systems discharge flood waters at source, site and regional levels



Source: http://www.netregs.org.uk/environmental-topics/water/sustainable-urban-drainage-systems-suds/

9.3.6.4. Other Adaptation-related Interventions

To adapt to sea level rise, probably only conventional physical infrastructure.

9.3.7 SES 2b: Kinh and ethnic minority upland small holder field crops and forestry (< 700m)

9.3.7.1. Ecosystem services

Located primarily in upland areas, away from main valleys, the people in this SES depend on their local landscape and surrounding natural ecosystems for a range of services, most importantly provisioning of water for domestic and agricultural purposes, but also regulating services of physical protection from extreme weather events, water quality maintenance, pest and disease control and climate buffering, supporting services of nutrient cycling and soil formation, control of water and sediment flows. Some wild foods may also be available, along with moderate quantities of timber and NTFPs, collected primarily by ethnic minorities. Most of these natural services have been replaced by largely less effective, more expensive artificial inputs and materials.

9.3.7.2. Main climate vulnerabilities

Storms, high rainfall > Flash floods: Increasingly intense high rainfall events will add to the already frequent flash floods experienced along watercourses of upland valleys.

High rainfall > erosion, landslides and water shortages: Intense rainfall in upland watersheds, many of which are deforested, and on agricultural lands will increase erosion affecting soil fertility and crop production and causing landslides in some places. Increased surface runoff will also reduce infiltration and potentially decrease ground water supplies, drying up water courses and leading to water shortages.

Hot Lao winds, Drought > crop decline or failure: Field crops in unirrigated upland areas are killed by drought, which is often intensified by the hot lao winds, that will become more intense with climate change. Tea is also sensitive to drought, suffering reductions in quality and production.

Hot Lao winds, Drought >Fires: Fire hazards particularly occur where monocultures of timber crops are planted - acacia or the more flammable eucalypts and pines but also occur in natural forests, often started by local people gathering forest products. .

Drought/domestic water shortage: When drought is prolonged, communities living higher up watersheds, reliant on small streams for domestic water supply can quickly run out water for livestock and domestic purposes.

9.3.7.3. Potential EbA interventions

- Land use planning and watershed management Critically important to ensure that land use plans include protection of all remaining watersheds and that the plans are strictly enforced.
- Soil and water conservation measures: Apply soil and water conservation practices to the cultivation of upland crops, especially on steep slopes, using contour planting, alley cropping, nitrogen fixing cover crops, mulching, etc to reduce erosion and encourage infiltration of rain water.
- Crop selection and management to adapt to drought conditions, while protecting the soils.
- Sustainable harvesting of timber and NTFPs, to protect watersheds and diversitfy and enhance incomes.

9.3.7.4. Other Adaptation-related Interventions

- Hard Terracing where erosion is serious and hard to control, and situation is suitable, invest in hard terracing
- Experiment with tea agroforests to reduce drought effects (Verschot et al 2007)
- Community based forest fire control

9.3.8 SES 2d: Kinh smallholder inland valley paddy cultivation and tree crops

9.3.8.1. Ecosystem services

This SES has essentially combines characteristics and services of the flood plain paddy SES (3b) and the upland field and tree crops and forestry (2b), most importantly provisioning of water for domestic and agricultural purposes, but also regulating services of physical protection from extreme weather events, water quality maintenance, pest and disease control and climate buffering, supporting services of nutrient cycling and soil formation, control of water and sediment flows. Most of these natural services have been replaced by largely less effective, more expensive artificial inputs and infrastructure.

9.3.8.2. Main climate vulnerabilities

Livelihoods in this SES exploit the range of habitat types inland valley floodplains, hills and upland slopes and so tend to be more diversified, which gives households greater resilience to climate change. Additionally, the hills enclosing the inland valleys provide a measure of natural protection from high winds associated with tropical storms.

Storms, high rainfall > Flash floods: Increasingly intense high rainfall events will add to the already frequent flash floods experienced along watercourses of narrow inland valleys, particularly where there are bottle-necks (.

Hot Lao winds, drought > crop decline or failure: Paddy fields are typically irrigated by small reservoirs, vulnerable to running out of water. Field crops in unirrigated upland areas are killed by drought, which is often intensified by the hot lao winds, that will become more intense with climate change. Citrus is also sensitive to drought, suffering reductions in quality and production.

Hot Lao wind, drought > Fire: Fire hazards particularly occur where monocultures of timber crops are planted - acacia or the more flammable eucalypts and pines but also occur.

9.3.8.3. Potential EbA interventions

These interventions essentially combine some of those suggested for SES 3b (lowland paddy hills transition) with some from SES 2b (upland field and tree crops)

- Employ SRI paddy cultivation systems where appropriate.
- Where irrigation water is in very short supply, switch crops from paddy rice, to less water demanding crops such as cassava and maize.
- Apply soil and water conservation practices to the cultivation of upland crops and citrus trees, especially on steep slopes, using contour planting, alley cropping, mulching, etc to reduce erosion and encourage infiltration of rain water
- Promote the use of nitrogen fixing (soil) cover crops to protect soils and enhance their fertility.
- Diversify the tree crops within plantation landscapes to increase the structural (and economic) complexity of the stands, and enhance their resilience to climate stress.
- When preparing land for plantation, or harvesting tree crops, leave strips of trees along the edges of rivers and streams (this will improve the water supply and water quality services)
- Change crop varieties, cropping pattern and adapt cropping calendar to suit changing conditions
- Increase the rotation length for acacia, eucalyptus and pine, to protect the upland soils and control erosion, particularly around small reservoirs and other areas vulnerable to erosion.
- Protect all remaining watershed forests from unsustainable use and conversion to other uses, through revision of land use plans and their strict enforcement.
- Sustainable harvesting of timber and NTFPs.

9.3.9 Other adaptation-related interventions

- Hard Terracing where erosion is serious and hard to control, and situation is suitable, invest in hard terracing
- Community based forest fire control

9.3.10 SES 6d: Kinh commercial and small-holder shrimp and fish aquaculture on sand

9.3.9.1. Ecosystem Services

This coastal SES is critically dependent on the supply of abundant, good quality freshwater to manage water quality and salinity in the brackish ponds and this comes from either nearby rivers or from ground water. Small scale freshwater fish aquaculture (especially snakehead) relies directly on ground water and ponds are dug down to breach the water table. Snakehead aquaculture uses "trash fish" from the capture fishery SESs for feed. Commercial shrimp feed also uses about 25% fish meal[34]. The dense natural stands of melaleuca and other species that once covered the dunes provided natural protection from storms, winds, high temperatures. These have now largely disappeared and been replaced by plantation forest of casuarina and acacia. This is much sparser, but still provides some physical protection. Disposal of waste water from aquaculture ponds is a problem. In some places, freshwater swamp vegetation behind the dunes provides a natural pollution treatment facility but more often, waste water is released untreated directly onto the beaches or into the sea.

9.3.9.2. Main Climate Vulnerabilities

Shrimp and fish ponds are complex biochemical environments requiring careful control of factors such as temperature, salinity, dissolved oxygen, pH, and waste products.

Since this is a heavily managed commercially based SES, the implication of these vulnerabilities is less about catastrophic failure, and more about ever-increasing management costs and impacts on other users.

Drought > lack of freshwater for ponds: Commercial ponds, with pumping equipment, are likely to fair better and at the expense of households who rely on natural ground water levels to fill their fishponds.

Storms > salinity changes, blowing sand: Storms bring sudden influxes of freshwater which upset the salinity in brackish ponds and potentially kill the crop. High winds associated with storms blow sand which fills the ponds, requiring expensive maintenance, but wind also helps raise oxygen content of water.

[34] It is not clear whether commercial feed production takes place in Ha Tinh.

Rising temperatures > heat stress in ponds: Higher temperatures reduce the dissolved oxygen content of water and change pH and salinity. This will demand more attention to water quality management.

9.3.9.3. *Potential EbA Interventions*

- Investigate the t impacts of drought and multiple water users on ground water supply and assess future demand (from aquaculture, vegetable growing and tourism development) to develop appropriate management.
- Reduce physical damage from storms and reduce impacts of high temperatures by restoring natural beach vegetation around ponds to provide physical protection and shade. This is more practical around the small freshwater ponds dug down into the sand. Trees should not be planted too close, as they can reduce the oxygen content of the water.
- Improve management of waste water discharges to reduce pollution of ground water and adjacent marine environments and impacts on fisheries, by directing the discharge through specially created wetlands to precipitate and filter out toxins.

9.4 Conclusions and recommended sites for local-level assessment

9.4.1. *Conclusions*

Ha Tinh has a long history of climate disasters that climate change is now exacerbating; future impacts will only become more challenging. Although the Province has done much to respond to past extreme events and adapt to future problems, there is now a tendency to keep responding to climate change in conventional ways and with each sector responding independently of the others. Droughts and water shortage demand more reservoirs and water supply projects. Floods demand more dikes and bigger dikes. Saline intrusion demands barrages. Riverbank erosion demands more revetments. These interrupt natural processes or replace natural ecosystem services. It appears as an attempt to reinforce a status quo, to conduct "business as usual", when the time has come to consider other approaches. Often, the solutions for one problem exacerbate a different problem. For instance constructing new dams to help address water supply for irrigation and domestic purposes, without considering the downstream effects of disrupting natural river flows and retaining more water upstream - salinization.

This provincial level study had three purposes:

i) demonstrate the methodologies for vulnerability assessment for EbA as a basis for mainstreaming the approach throughout the province.
ii) conduct vulnerability assessments based on secondary data to identify the main climate change challenges and practical EbA solutions at the macro-level to address them;
iii) identify sites within the province to conduct local-level or micro-scale assessment

This pilot study provides a strong justification for a more integrated and holistic approach to adaptation and demonstrates the usefulness of the Socio-ecological system concept and the ecosystem-based adaptation framework. These promote resilience simultaneously in both ecosystems and societies, and are multi-sectoral and multi-stakeholder approaches, predicated on effective participation of those stakeholders. The explicit spatial dimension of this study has shown the different geographical scales at which impacts occur and so adaptation must operate and the importance of linkages between them (upstream, downstream, etc). It also clearly shows the need for the most recent quantitative data, qualitative analysis and mapping resources the province has to come up with an appropriate strategy.

At the provincial level, the analysis above shows the paramount importance of water and soil management issues, as climate changes intensifies both the wet and dry seasons and brings very high temperatures (>35 oC). Table 9.3 summarises the key vulnerabilities of the SES in Ha Tinh, and shows how all of the top 10 SES have existing or emerging problems with irrigation; domestic and industrial water supply and water quality; and with flooding and erosion, that are having impacts on crop viability and yields, human health, livelihoods, and security. All EbA interventions are site specific and must be planned in a participatory manner with relevant stakeholders, so these recommendations are for action areas, rather than for specific actions, combining the use of biodiversity and the promotion and/or restoration of ecosystem services. These action areas are:

i) Land Use Planning: Revision of provincial land-use planning strategy, based on integrated provincial water management

For each of Ha Tinh's four main watersheds, review:

- Sustainable and strategic management of the watershed forests, to restore/optimize the water cycling service of intact forests
- Seasonal water use regimes of users at all parts of river system, from source to mouth to understand extent of natural flows
- Inventory of reservoirs, characteristics, sedimentation
- Inventory of water users and demand and practical conservation measures
- Inventory of existing adaptation infrastructure and barrages, dikes, etc. what can be used, what can be enhanced, what should be replaced
- Inventory of flood and salinization risk areas for potential "renaturation".

ii) Conservation agriculture, with a primary focus on controlling soil erosion and landslides and enhancing soil fertility
   - Identification of hotspots
   - Continue programme of SRI
   - Promotion of cover crops

iii) Payment for environmental services - compensating farmers and local government for income foregone.

Immediate practical actions:

i) Across all PFMBs and Forest companies increase rotation lengths in all production plantations from 7 to 15 years
ii) Strict Moratorium on any further clearance or conversion of natural forest.
iii) Climate focused EIAs on all development projects

At a higher level, Ha Tinh's approach to mainstreaming EbA requires a basis in:

i) Enforcement of land use planning, mobilising government at all levels to ensure it is done, and using satellite imagery for monitoring
ii) Using EbA and CCA to frame the entire Socio-Economic Development Plan (SEDP), with particular attention to cross-sectoral integration, so one sector does not undo the good done in another, and using Strategic Environmental Assessments
iii) Strategic Environmental Assessments (SEA) which incorporate climate change considerations are conducted on the SEDP as a whole as well as all major sector development plans.

9.4.2 Short-list of proposed EbA local level-assessment sites

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) contributes 20% to GDP, but uses 80% of provincial land and employs a lot of people in Ha Tinh.

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 30% of households in Ha Tinh are categorised as poor and near poor.

State agencies and State-controlled Companies directly manage large areas of the province, and are directly responsible for significant economic activity in priority SESs. 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 8a (Commercial and state water management infrastructure), PA1+2 (State Managed Special Use Forests (National Parks and Nature Reserves) and SES PFMB 1+2 (Protection Forest Management Boards in upland and lowland forest).

A discussion on site selection for the local-level assessment was held with provincial level stakeholders at a provincial workshop in August 2016, following on from a presentation of the findings of the provincial level Vulnerability. On the basis of this discussion it was agreed to focus on Son Hong village (results presented in Report 5).

Table 9.3: Key vulnerabilities and impacts from predicted changes in selected climate parameters in the top 10 SES of Ha Tinh

SES Code	Socio-scological system	Temperature			Rainfall		Storms	SLR
		Longer, hotter summer Higher Tmax	Hotter spring	More hot days >35°C	Wetter season More high rainfall events > 50 mm	Drier season> More dry days	Storms , winds	Sea level rise
8a	Commercial and state water management infrastructure	Higher evaporation from reservoirs and canals	Higher water demand when less water available	Higher evaporation from reservoirs and canals	Increased erosion, reservoir sediment; risk dam failure	Low water levels in reservoirs in spring	Risk of Dam Failure;	Dams Retaining water increase problems downstream
8h	Urban and rural settlement, industry, services							
PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)	Long-term species distribution / abundance	Long-term species distribution / abundance	Long-term species distribution / abundance; fire	Long-term species distribution / abundance	Long-term species distribution / abundance; fire	Stand Damage	n/a
3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation	High evaporation; crop yield declines	Rice establishment harder; more pest diseases	Higher risk of irrigation failure.	Crop yield increase, but flood/storm damage at harvest; more sediment carried in floods	Saline intrusion > declining yields, domestic water shortage	More damage from storm surges, near coast	Saline intrusion then permanent inundation
3b	Kinh smallholder floodplain-hills transition: paddy rice + mixed farming and tree crops	Some species tolerances exceeded	Declining crop yields if water also insufficient	Irrigation failure, heat stress on crops ; fire risk	Soil Erosion	Irrigation and crop failures Soil degradation; fire risk	Wind throw in tree crops; lodging in paddy field	n/a

SES Code	Socio-scological system	Temperature			Rainfall		Storms	SLR
		Longer, hotter summer Higher Tmax	Hotter spring	More hot days >35°C	Wetter season More high rainfall events > 50 mm	Drier season> More dry days	Storms , winds	Sea level rise
						domestic water shortage		
PFMB 1+2	Protection Forest Management boards on subtropical forest > 700m; moist tropical < 700 m	Increased Fire Risk; decreased growth	Increased Fire Risk;	Increased Fire Risk; decreased growth	Erosion in managed areas; more pest /disease	Increased Fire Risk	Wind throw in plantations	Coastal plantations inundated
8e	State managed Special Economic and Industrial Areas (coastal)	Heat stress on humans; High cooling costs	Heat stress on humans; High cooling costs	Heat stress on humans; High cooling costs	Localized flooding	Risk of water shortage from reservoirs; higher pollution	Flooding, storm damage	Flooding
2b	Kinh and ethnic minority smallholder field and tree crops	Some species tolerances exceeded	Declining crop yields if water also insufficient	Irrigation failure, heat stress on crops ; fire risk	Flash floods, erosion	Field crop failure, fire risk; domestic water shortage	Wind throw of tree crops Flash floods, landslides	n/a
2d	Kinh smallholder inland valley paddy cultivation + tree crops	Some species tolerances exceeded	Declining crop yields if water also insufficient	Irrigation failure, heat stress on crops ; fire risk	Flash floods, erosion	Irrigation and crop failure domestic water shortage	Flash floods, landslides	n/a
6d	Kinh commercial shrimp aquaculture on sand	Heat stress in ponds ; lower O_2, higher salinity and pH; disease; increase costs, or lower productivity			Fluctuating salinity levels; seasonal shortage of fresh water		Sand into ponds	Salinization of freshwater supply; inundation of ponds

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ANNEX 9.I: ECOSYSTEM SERVICES ASSESSMENT FOR THE TOP SOCIO-ECOLOGICAL SYSTEM OF HA TINH

9.1.a: SES 8a: Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)

No	Main Services	Description	Source of ecosystem service	Importance (1=least 5=most)	Justification for ranking
Direct Provisioning					
P1	Food	Some freshwater fish (but mostly managed), shrimp, molluscs, etc in reservoir	SES	2	
P2	Water		Surrounding watersheds	5	Vital service on which most other SES depend
P3	Medicines			1	Negligible
P4	Fibres			1	
P5	Building materials			1	
P6	Water energy			2	Very few reservoirs combine irrigation with hydro, tho scope exists. Ngan Truoi and Ho Ho
P7	Biomass energy			1	
P8	Transport	Boating		2	Scope at least for local use of reservoir s
Regulating Services					
R1	Carbon fixation/ storage				
R2	Water quality maintenance				
R3	Air quality maintenance				
R4	Climate buffering				
R5	Pest and disease control				
R6	Waste recycling /				

No	Main Services	Description	Source of ecosystem service	Importance (1=least 5=most)	Justification for ranking
	detoxification				
R7	Physical protection				
R8	Control of water flows				
R9	Control of sediment flows				
Supporting Services					
S1	Carbon cycling				
S2	Photosynthesis/ primary production				
S3	Nutrient cycling				
S4	Soil formation				
S5	Water cycling				
S6	Pollination				
S7	Seed dispersal				
Cultural-spiritual					
C1	Religious-spiritual				
C2	Recreation, sports, ecotourism				
C3	Science, education				
C4	Historical / nation building				
C5	Relaxation/mental health				
C6	Aesthetics /artistic inspiration				

9.1b: SES PA1+2: State managed special use forest (National Park, Nature Reserve) management (Vu Quang, Ke Go)

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 CO2 in the atmosphere. This is a global environmental service
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

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
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 production	PNKB forest is a major source of primary productivity	The SES itself	4	
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	

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
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	

9.1c: SES 3a: Kinh smallholder lowland floodplain irrigated paddy rice cultivation

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	Importance* 1=low 5=high	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	

No	Main Services	Description	Source of ecosystem service	Importance* 1=low 5=high	Justification for ranking
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	
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	Unlikely/Unimportant		0	

No	Main Services	Description	Source of ecosystem service	Importance* 1=low 5=high	Justification for ranking
	production				
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	

9.1d: SES 3b: Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
Provisioning Services					
P1	Food	Some wild foods may be gathered from forests and streams in and around SES, esp in by ethnic minority groups in periods of food shortage	SES itself and adjacent SES	2	Mostly very occasional use only, for coping.
P2	Water	Most of water for people's daily life and production activities in this SES is provided by rivers from uphill forests and ground water	SES itself and watershed natural forests in adjacent SESs	5	Rain can provide some but rivers are still the main source of water for people and agricultural production activities in this SES
P3	Medicines	Medicinal herbs still used to some extent	SES	1	
P4	Fibres	Limited	SES	0	
P5	Building materials	Pole wood probably still obtained from degraded natural vegetation	SES	1	
P6	Water energy	Some use of household level micro-hydro is likely or possible.	SES	1	
P7	Biomass energy	Some fuelwood likely gathered from degraded natural vegetation within SES.	SES itself	1	Most fuelwood obtained from homegardens and plantations. Natural ecosystem is secondary source.
P8	Transport	none		0	
Regulating Services					
R1	Carbon fixation/storage	Limited permanent forest cover; Fruit trees have limited biomass; Acacia etc plantations managed on short rotations	SES	1	This service is unlikely to be valued by local population, as rewards for carbon storage not yet available.
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter	Watershed	2	The service is limited because of degradation of watershed

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
		pollutants and improve water quality	natural forests in adjacent SESs		natural forests
R3	Air quality maintenance	Unclear		0	
R4	Climate buffering	Remnant natural vegetation will ameliorate micro-climates (temperature, wind) in settlement areas to some extent, as will tree crops within the SES	SES itself Natural forests in adjacent SESs	2	There are not really any significantly large areas of natural forest close to most lowland paddy areas
R5	Pest and disease control	Likely that natural control agents still live in the SES and surroundings.	Natural forests in and around SES	1	Chemical agents widely used and may interfere with the natural ones.
R6	Waste recycling / detoxification	Unclear		0	
R7	Physical protection	Forests provide protection against storm winds, Lao wind, landslide to downhill fields and farms.	Natural forests in and around SES	2	Extreme climatic events occur regularly -
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	2	Extent of natural vegetation providing this service is limited
R9	Control of sediment flows	Forest trees and other natural vegetation provide cover for soils and roots help hold soils, - reduce soil erosion, thus control sediment flows in streams and springs	Watershed natural forests in other SESs	2	Extent of natural vegetation providing this service is limited
Supporting services					
S1	Carbon cycling	See below			
S2	Photosynthesis, primary production	Natural primary production			
S3	Nutrient cycling			2	Vital basis for all production, but natural cycles now

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
					disrupted by application of inputs.
S4	Soil formation	Natural input of inorganic and particularly organic matter, and activities of soil organisms		2	Vital basis for all production, but disrupted by unsound agricultural practices
S5	Water cycling				
S6	Pollination	Most crops are wind pollinated, but some fruit trees rely on insect pollination, still provided by natural environment, though bee-keeping is increasing	Vegetation in and around SES	3	Vital for certain crops – eg citrus.
S7	Seed dispersal	Limited		1	Most crops are intentionally planted.
Cultural services					
C1	Religious-spiritual	A number of traditions/ ceremonies, particularly of ethnic minorities, are linked to the annual hill rice planting and harvesting calendar and spirits found in the wider environment;	SES itself and adjacent SES	2	Specific groups and localities only.
C2	Recreation, sports, ecotourism	Very limited		0	Not part of local culture
C3	Science, education	n/a		0	More focused in protected areas
C4	Historical /nation building	n/a		0	Very loal
C5	Relaxation /mental health	Unclear		0	People more focused on economic development
C6	Aesthetics /artistic inspiration	Unclear		0	People more focused on economic development

1=low, 5 = high

9.1e: SES FPMB 1+2: Protection Forest Management boards; subtropical forest > 700m and moist tropical < 700 m

Ha Tinh's FPMBs are primarily in

Possible EbA interventions include: Increasing diversity protection forest planting by including a large number of different native species. This may require the establishment of special tree nurseries for these species, and the provision of training in nursery and planting techniques.

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	

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
R2	Water quality maintenance	Protection plantations help to maintain water quality but this is not important to the SES as a whole	The SES itself	1	
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					

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
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	

9.1f: SES 2b: Kinh and ethnic minority small-holder field crops and tree crops

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
Provisioning Services					
P1	Food	Some wild foods may be gathered from forests and streams in and around SES, esp in by ethnic minority groups in periods of food shortage	SES itself and adjacent SES	2	Mostly very occasional use only, for coping.
P2	Water	Most of water for people's daily life and production activities in this SES is provided by rivers from uphill forests and ground water	SES itself and watershed natural forests in adjacent SESs	5	Rain can provide some but rivers are still the main source of water for people and agricultural production activities in this SES
P3	Medicines	Medicinal herbs still used to some extent	SES	1	
P4	Fibres	Limited	SES	0	
P5	Building materials	Pole wood probably still obtained from degraded natural vegetation	SES	1	
P6	Water energy	Some use of household level micro-hydro is likely or possible.	SES	1	
P7	Biomass energy	Some fuelwood likely gathered from degraded natural vegetation within SES.	SES itself	1	Most fuelwood obtained from homegardens and plantations. Natural ecosystem is secondary source.
P8	Transport	none		0	
Regulating Services					
R1	Carbon fixation/storage	Limited permanent forest cover; Fruit trees have limited biomass; Acacia etc plantations managed on short rotations	SES	1	This service is unlikely to be valued by local population, as rewards for carbon storage not yet available.
R2	Water quality maintenance	Forests reduce amount of sediment in water flows, filter pollutants and improve water quality	Watershed natural forests in adjacent SESs	2	The service is limited because of degradation of watershed natural forests
R3	Air quality maintenance	Unclear		0	

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
R4	Climate buffering	Remnant natural vegetation will ameliorate micro-climates (temperature, wind) in settlement areas to some extent, as will tree crops within the SES	SES itself Natural forests in adjacent SESs	2	There are not really any significantly large areas of natural forest close to most lowland paddy areas
R5	Pest and disease control	Likely that natural control agents still live in the SES and surroundings.	Natural forests in and around SES	1	Chemical agents widely used and may interfere with the natural ones.
R6	Waste recycling / detoxification	Unclear		0	
R7	Physical protection	Forests provide protection against storm winds, Lao wind, landslide to downhill fields and farms.	Natural forests in and around SES	2	Extreme climatic events occur regularly -
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	2	Extent of natural vegetation providing this service is limited
R9	Control of sediment flows	Forest trees and other natural vegetation provide cover for soils and roots help hold soils, - reduce soil erosion, thus control sediment flows in streams and springs	Watershed natural forests in other SESs	2	Extent of natural vegetation providing this service is limited
Supporting services					
S1	Carbon cycling	See below			
S2	Photosynthesis, primary production	Natural primary production			
S3	Nutrient cycling			2	Vital basis for all production, but natural cycles now disrupted by application of inputs.
S4	Soil formation	Natural input of inorganic and particularly organic matter, and activities of soil organisms		2	Vital basis for all production, but disrupted by unsound agricultural practices
S5	Water cycling				
S6	Pollination	Most crops are wind pollinated, but some fruit	Vegetation in and	3	Vital for certain crops – eg citrus.

No	Main Services	Description	Source of ecosystem service	Importance	Justification for ranking
		trees rely on insect pollination, still provided by natural environment, though bee-keeping is increasing	around SES		
S7	Seed dispersal	Limited		1	Most crops are intentionally planted.
Cultural services					
C1	Religious-spiritual	A number of traditions/ ceremonies, particularly of ethnic minorities, are linked to the annual hill rice planting and harvesting calendar and spirits found in the wider environment;	SES itself and adjacent SES	2	Specific groups and localities only.
C2	Recreation, sports, ecotourism	Very limited		0	Not part of local culture
C3	Science, education	n/a		0	More focused in protected areas
C4	Historical /nation building	n/a		0	Very loal
C5	Relaxation /mental health	Unclear		0	People more focused on economic development
C6	Aesthetics /artistic inspiration	Unclear		0	People more focused on economic development

9.1g: SES 2d: Kinh smallholder inland valley paddy cultivation and tree crops

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	SES itself	0	

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
		human and economic activities of 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	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	Unlikely/Unimportant		0	

No	Main Services	Description	Source of ecosystem service	Rank	Justification for ranking
	production				
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
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	

9.1h: SES 6d: Kinh commercial shrimp aquaculture on sand

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	The SES itself	1	With low density and poor quality, coastal protection forests only have limited capacity of

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
		but this is not important at all for commercial shrimp production			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 passes through 30 m of sand dunes	The SES itself	5	Water quality affect directly on shrimp productivity and local people's health
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	

No	Main Services	Description	Sources of Ecosystem service	Rank	Justification for ranking
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 practice		1	There are not much evidences for this kind of service provided by the SES
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	

ANNEX 9.II: VULNERABILITY ASSESSMENT FOR THE TOP SOCIO-ECOLOGICAL SYSTEM IN HA TINH

9.2.a: SES 8a: Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)

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 1.9 degree C in 2050, 3.6 degree C in 2100	3	Higher water requirement Higher evaporation	3	Water demand will be increaesed Less water will come into the reservoirs	3	3	Budgets for maintenances, improvement are limited; No ideas or plans to reduce evaporation	3
Number of Dry days increase 15 - 16 days in 2050, 12 - 13 days in 2100, Number of hot days > 35oC 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	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5% in 2050; 9% in 2100;	4	Inflow into reservoir will be increased upstream erosion will increase sedimentation of the	4	Risk of overflow and flooding, Risk of dam safety reduced capacity of the dam as it fills in with	4	3	Budgets for maintenances, improvement are limited	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
		reservoir		sediment				
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	Inflow into reservoir will be reduced	4	Water held in reservoir in the dry season may be insufficient to meet needs	4	3	Budgets for maintenances, improvement are limited	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	High risk of overflow Dam safety Risk of storm damage to dam	4	3	Budgets for maintenances, improvement are limited Storm warning system Storm forecast is not highly accurate	4
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	No exposure	1	No sensitivity	1	5	N/A	1
	3.3		3.0		3.3	3.3		3.3

9.2.b: Urban and rural settlements, industry and services

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	*Urban and built-up areas ae heat traps/heat islands with large areas of concrete surfaces absorbing the heat*	4	*Prolonged high temperatures can cause heat stress especially in very young, old and sick people, and poor people*	4	2	*Better planning is needed to increase green space, increase shading, use less heat absorbant materials,etc*	4
Number of Dry days increase 19 days in 2050, 18 days in 2100, Number of hot days > 35oC also increase 43 - 46 days in 2050, 55 - 59 days in 2100	1	*Exposure to this risk is very limited for this SES*	1	*There is no real direct sensitivity of settlements to increased dry days, as long as reservoirs have sufficient water supply*	1	3		2
Temperature will increase faster and earlier in Spring	1	*Exposure to this risk is very limited for this SES*	1	*There is no sensitivity of urban and rural settlements industry and services to this*	1	3		2
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4% in 2050; 8% in 2100;	4	*Urban and rural Settlements in lowland areas will be exposed directly to the rainfall and also to downstream flooding caused by upstream rainfall. Upland settlements*	4	*Floods can cause significant damage to property, loss of life, and economic losses*	4	2	*The province has significant experience and preparedness for flood disaster response, and is introducing flood adapted housing in some places, but settlement and land-use planning needs to be improved to be adapted to living with floods*	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
		will be exposed to flash floods						
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 9% in 2100	1	*Exposure to this risk is very limited for this SES*	1	*There is no real direct sensitivity of settlements to increased dry days, as long as reservoirs have sufficient water supply*	1	3	.	2
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	*Larger settlements are located in the coastal plain and near to the the coastline, so they are more directly exposed to these risks*	4	*Storms can cause significant damage to property, loss of life, and economic losses*	4	3	*The province has significant experience in preparing or storms and responding to the damage they cause. There may be some need for building design standards to be more strictly enforced to reduce future storm damage*	4
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	4	*Larger settlements are located in the coastal plain and near to the the coastline, so they are more directly exposed to these risks*	4	*Se-level rise will inundate coastal settlements causing increased coastal flooding and coastal erosion. Eventually some areas will become permanently submerged*	4	2	*Protection of all coastal settlements against sea level rise would require an impossibly large budget. On the other hand there is no clear planning for a gradual retreat of settlements away from the current shoreline over time*	5
	2.7		2.8		2.7	2.6		3.3

9.2 c: SES PA1+2: State Managed Special Use Forest (National Park, Nature Reserve) Management (Vu Quang, Ke Go)

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	Both VQNP and KGNR will be exposed to these changes	3	Species close to the limit of their temperature tolerance will be most at risk, especially those already only found at higher elevations	3	3	The PAs have management in place, but there has been no planning for long-term survival of species impacted by temperature increases	3
Number of Dry days increase 17 days in 2050, 15 days in 2100, Number of hot days > 35oC also increase 23 - 24 days in 2050, 34 - 35 days in 2100	3	Both VQNP and KGNR will be exposed to these changes	3	Increased number of dry days and very hot days will increase risk of forest fire	3	3	The PAs have management in place, but more resources will be needed for forest fire management in the future	3
Temperature will increase faster and earlier in Spring	3	Both VQNP and KGNR will be exposed to these changes	3	This may affect phenology of plant species, emergence of insects, and reproductive behavior of many species	3	3	The PAs have management in place, but there is little understanding of what kind of changes might happen and how to respond to them	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5% in 2050, 9	3	Both VQNP and KGNR will be exposed to these	2	This might result in increased erosion and landslides in some parts of the protected areas.	3	3	There is not much that can be done beyond normal management of	3

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
- 10% in 2100; FLOOD RISK		changes		Extended waterlogging of the soil may also be a problem for some plant and tree species			the area	
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100 - DROUGHT RISK	3	Both VQNP and KGNR will be exposed to these changes	3	This will also add to the forest fire risk, together with the increase in dry days and very hot days (above)	3	3	The PAs have management in place, but more resources will be needed for forest fire management in the future	3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	2	Being located further inland from the cost VQNP will be less exposed to storm impacts, KGNR is a bit closer to the coast and is therefore a bit more exposed	2	Some tree species may be damaged by storms	2	3	There is not much that can be done about this beyond normal management of the area	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	Both VQNP and KGNR are sufficiently inland and sufficiently elevated to not be at risk from sea level rise	1	High elevation Far from the sea	1	5	There is no need to take any adaptive action on this issue	1
	2.9		2.4		2.9	4.1		2.7

9.2.d: SES 3a: Kinh smallholder lowland floodplain irrigated paddy rice cultivation

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 1.9 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 > 35oC 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	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

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
				flowering period				
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	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)								0
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 crop (harvest). Winter-spring (planting)	2	Crop grow better More rainfall during flowering time may rotten pollen of some vegetables More rainfall during rainy season may cause nutrient leaching	2	5	Use high yield and quality crop varieties to optimal crop production in higher rainfall condition	2
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	2	July -November (storm)	4	Later storm season may impact	3	3	• Need to setup optimal crop calendar to avoid risk from typhoon	3

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later		Crop harvest (Apr & July) 1/2 frequency direct storm but high frequency if indirect storm& low tropical pressure		on summer rice at mature period High risk due to high uncertainty forecast Strong typhoon associated with heavy rainfall cause flooding and loosing harvest			• Need to have smart action on harvesting to rescue rice from falling	
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

9.2.e: SES 3b: Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	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	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	4	More evaporation and transpiration, means crops will require more water;, temperature strongly impacts many aspects of plant metabolism- rice terraces and hilly land planted with tree crops will be affected - rice yield may decline 7-15% for every one degree rise in temperature; crop diseases may become more prevalent, or new diseases not previously occurring in this area may arrive.	4	3	Varieties tolerant to higher temperature are available Farmers can use nets to protect pomelo and oranges	4
Number of Dry days increase 16 - 17 days in 2050, 14 - 15 days in 2100, Number of hot days > 35oC also increase 33 - 40 days in 2050, 47 -51 days in 2100	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	5	Crops will be more sensitive to drought risk soil moisture may decrease below wilting point for some plants; Some crops will be not suitable in these condition; crop yield will be reduced when drought period coincides with flowering period; small reservoirs in the lower hilly areas will be more rapidly exhausted	4	2	It is hard to adapt this condition, but use of ratoon rice is one option Need to have better water resource management Need to have more drought tolerant varieties	4
Temperature will increase faster and earlier in Spring	4	Spring crops will be most highly exposed to this change	3	Flowering and fruiting of some tree crops will start earlier Life-cycles of tree crops and their natural pollinators may be disrupted so they are no longer synchronised	4	2	Also hard to adapt this condition because it changes crop growing pattern Need a lot of	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnera -bility
				Some tree crops will not suitable in these conditions Some vegetable and temperature crops will not be suitable. Rice yields are usually lower in warm springs			experience and knowledge to adjust crop growing calendar appropriately	
PRECIPITATION (RAINFALL)								0
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 9 - 12% in 2100;	4	Summer crops will be highly exposed to these changes	3	Many crops will grow better with additional rainfall; however excessive rainfall during the flowering time may cause rotting of the pollen; more rainfall during rainy season may cause nutrient leaching and erosion on hilly slopes, resulting in a lack of nutrients at the end of the season, and a lower quality citrus crop Inland valley paddy fields may be damaged by flash floods	4	5	Farmers can use high yield and quality crop varieties to optimize crop production in higher rainfall condition	3
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	4	Soil will be degraded, with lower productivity; May cause some delays in during very low soil moisture content periods; Drier dry season has a strong impact to tree crop because tree crops grow very slowly; Drier dry season may lead to longer	4	2	Need to have more reservoirs for water resources management Need to change to higher drought tolerable Need to irrigation, improve irrigation method to save	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnera -bility
				drier period, associated with soil moisture content dropping below wilting point, and some crops will die			water, need increase more fertilizer because drought lower fertilizer use efficiency suitable and farmer have to change crop and crop calendar	
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	Late summer season crops will be more exposed to storms, but because the areas are far inland, they are somewhat protected from the worst exposure to storms	3	Later storm season may impact on the maturation periods of citrus and tea Later storm season is associated with later rainfall, which can be good for tea and fruit trees • Small storms (level <7) may not impact tree • Strong typhoons may break tree (i.e. extreme typhoon in 2013)	3	2	Need to find more options for avoiding negative impacts of strong winds breaking tree crops, especially rubber and citrus Need to have better field design with wind break lines	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	1	N/A	1	N/A	1	5	N/A	1
	3.4		3.3		3.4	3.0		3.3

9.2.f: SES FPMB 1+2: Forest Protection Management boards; subtropical forest > 700m and moist tropical < 700 m

CLIMATE CHANGE RISKS	Exposure		Sensitivity		Impact	Adaptive Capacity		Vulner-ability
	Score	Explanation (E)	Score	Explanation (S)		Score	Explanation (AC)	
TEMPERATURE								
Hot season will be hotter and longer; will increase 2 - 2.5 degree C in 2050, 3.6 degree in 2100	4	Higher temperature, high evaporation,	3	Risk of forest-fire Influence to forest growing	4	4	Well-management by FPMB Existing of Ranger stations Forest patrol regularly,	3
Number of Dry days increase, Number of hot days > 35oC also increase	4	Evaporation increases, soil moisture decreases, resulting in growth indicators & vitality of forest trees can be reduced	3	Risk of forest-fire Influence to forest growing	4	4	Well-management by FPMB Existing of Ranger stations Forest patrol regularly,	3
Temperature will increase faster and ealier in Spring	3	Heat and drought level rise	3	Risk of forest-fire Increase the risk of insect development, destructive plant diseases	3	4	Well-management by FPMB Existing of Ranger stations Forest patrol regularly,	3
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 5 - 10% in 2050; No. heavy rains (>50mm) increase	3	High elevation, so water can be withdrew fast	2	High elevation, so water can be withdrew fast Forest is not so sensitive with high rainfall	3	4	Well-management by FPMB Existing of Ranger stations Forest patrol regularly,	3
Dry season will be drier, Rainfall of Spring will decrease 4 - 9% in 2050	3	Low humidity Lack of water	3	Forest can be slow growth	3	4		3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	2	The wind speeds reduced Far from coast and so storm í weaker	4	Broadleaved forest or mixed forest High sensitivity with the strong wind	3	4	Storms can be forecast	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	1
	2.86		2.71			4.14		2.71

9.2.g: SES 8e: State managed special economic and industrial areas (coastal, Vung Ang)

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure		Sensitivity		Impact	Adaptive Capacity		Vulner-ability
	Score	Explanation	Score	Explanation		Score	Explanation	
TEMPERATURE								
Hot season hotter and longer; Summer average maximum temperature will increase 1.8 degree C in 2050, 3.4 degree C in 2100	4	The built-up factory and workers housing areas ae heat traps/heat islands with large areas of concrete surfaces absorbing the heat	4	Prolonged high temperatures can cause heat stress especially in very young, old and sick people, and poor people	4	2	Better planning is needed to increase green space, increase shading, use less heat absorbant materials,etc	4
Number of Dry days increase 19 days in 2050, 18 days in 2100, Number of hot days > 35oC also increase 43 - 46 days in 2050, 55 - 59 days in 2100	1	Exposure to this risk is limited for this SES	1	There is no real direct sensitivity of the SEZ to increased dry days, as long as reservoirs have sufficient water supply to meet the needs	1	3		2
Temperature will increase faster and earlier in Spring	1	Exposure to this risk is very limited for this SES	1	There is no sensitivity of the factories, workers housing and other facilities to this	1	3		2
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4% in 2050; 8% in 2100;	4	The SES will be exposed directly to the rainfall and also to downstream flooding caused by upstream rainfall.	4	Floods can cause significant damage to factories, workers housing and other facilities loss of life, and economic losses	4	3	The province has significant experience and preparedness for flood disaster response. Large overseas investors have sufficient resources to install effective storm water management systems to reduce flooding	3

CLIMATE CHANGE RISKS	Exposure		Sensitivity		Impact	Adaptive Capacity		Vulner-
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 9% in 2100	1	Exposure to this risk is very limited for this SES	1	There is no real direct sensitivity of the SEX to increased dry days, as long as reservoirs have sufficient water supply	1	3		2
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	4	The SES is located on the coastline, so it is directly exposed to these risks	4	Storms can cause significant damage to factories, workers housing loss of life, and economic losses	4	3	The province has significant experience in preparing or storms and responding to the damage they cause. It is assumed that large foreign investors in Vung Ang will build their facilities to appropriate standards	3
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	4	The SES is located on the coastline, so they are more directly exposed to these risks	4	Without protection, sea-level rise would inundate and eventually submerge the SEZ	4	4	The SEZ is protected by a high sea wall	2
	2.7		2.7		2.7	3.0		2.6

9.2.h: SES 2b: Kinh and ethnic minority small-holder field crops and forestry

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 1.9 - 2 degree C in 2050, 3.6 - 3.7 degree C in 2100	4	Late Spring and Early Summer season crops will be highly exposed to these changes	4	- Temperature affects plant metabolism, causing reduced yields of many field crops, esp maize; - existing crop diseases more prevalent; new diseases arrive - More evaporation/ will increase crop water demand,	3	3	Varieties tolerant to higher temperature are already available	4
Number of Dry days increase 16 - 17 days in 2050, 14 - 15 days in 2100, Number of hot days > 35oC also increase 33 - 40 days in 2050, 47 - 51 days in 2100	4	Late Spring and Early Summer crops will be highly exposed to these changes	5	Crops will be more sensitive to drought risk soil moisture may decrease below wilting point for some plants; Some crops will be not suitable in these conditions; crop yield will be reduced when drought period coincides with flowering period	4	2	Need to have better water resource management and water conservation practices in the fields Need to have more drought tolerant varieties	4
Temperature will increase faster and earlier in Spring	4	Spring crops will be most highly exposed to this change	3	Flowering and fruiting of some tree crops will start earlier Life-cycles of tree crops and their natural pollinators may be disrupted so they are no longer synchronised Some tree crops will not suitable in these conditions Some vegetable and temperate crops will no longer be suitable	4	2	Also hard to adapt this condition because it changes crop growing pattern Need a lot of experience and knowledge to adjust crop growing calendar appropriately	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 9 - 12% in 2100;	4	*Summer crops will be highly exposed to these changes*	*3*	*Many crops will grow better with additional rainfall; however excessive rainfall during the flowering time may cause rotting of the pollen; more rainfall during rainy season may cause nutrient leaching and erosion in citrus growing land, resulting in a lack of nutrients at the end of the season, and a lower quality citrus crop* *Crops may also be damaged by flash floods and topsoil may be eroded and washed away, reducing fertility*	4	4	*Farmers can use high yield and quality crop varieties to optimize crop production in higher rainfall conditions*	3
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	*Late Spring and Early Summer season crops will be highly exposed to these changes*	*4*	*Soil will be degraded, with lower productivity;* *May cause some delays in during very low soil moisture content periods;* *Drier dry season has a strong impact to tree crop because tree crops grow very slowly;* *Drier dry season may lead to longer drier period, associated with soil moisture content dropping below wilting point, and some crops*	4	3	*It is difficult to provide irrigation in these areas* *Need to change to more drought tolerant crop varieties or shift to more tolerant species such as cassava*	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
				will die				
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	*Late summer season crops will be more exposed to storms, but because the areas are far inland, they are somewhat protected from the worst exposure to storms*	*3*	*Later storm season may impact on the maturation periods of citrus and tea* *Later storm season is associated with later rainfall, which can be good for tea and fruit trees* *Small storms (level <7) may not impact tree* *Strong typhoons may break tree (i.e. extreme typhoon in 2013)*	3	3	*Need to find more options for avoiding negative impacts of strong winds breaking tree crops, especially rubber and citrus* *Need to have better field design with wind break lines*	3
SEA LEVEL RISE Increased 3mm/year in last 20 years May increase to 75 cm by 2100	1	*N/A*	1	*N/A*	1	5	*N/A*	1
	3.4		3.3		3.3	3.1		3.3

9.2.i: SES 2d: Kinh smallholder inland valley paddy cultivation and tree crops

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 1.9 - 2 degree C in 2050, 3.6 - 3.7 degree C in 2100	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	*4*	More evaporation and transpiration, means crops will require more water;, temperature strongly impacts many aspects of plant metabolism- rice yield may decline 7-15% for every one degree rise in temperature; crop diseases may become more prevalent, or new diseases not previously occurring in this area may arrive	4	3	Varieties tolerant to higher temperature are available Farmers can use nets to protect pomelo and oranges	4
Number of Dry days increase 16 - 17 days in 2050, 14 - 15 days in 2100, Number of hot days > 35oC also increase 33 - 40 days in 2050, 47 -51 days in 2100	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	*5*	Crops will be more sensitive to drought risk soil moisture may decrease below wilting point for some plants; Some crops will be not suitable in these condition; crop yield will be reduced when drought period coincides with flowering period	4	2	It is hard to adapt this condition, but use of ratoon rice is one option Need to have better water resource management Need to have more drought tolerant varieties	4
Temperature will increase faster and earlier in Spring	4	Spring crops will be most highly exposed to this change	*3*	Flowering and fruiting of some tree crops will start earlier Life-cycles of tree crops and their natural pollinators may be disrupted so they are no longer synchronised Some tree crops will not suitable in	4	2	Also hard to adapt this condition because it changes crop growing pattern Need a lot of experience and	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
				these conditions Some vegetable and temperature crops will not be suitable			knowledge to adjust crop growing calendar appropriately	
PRECIPITATION (RAINFALL)								0
Higher rainfall in rainy season; Rainfall in Summer will increase 4-6% in 2050; 9 - 12% in 2100;	4	Summer crops will be highly exposed to these changes	*3*	Many crops will grow better with additional rainfall; however excessive rainfall during the flowering time may cause rotting of the pollen; more rainfall during rainy season may cause nutrient leaching and erosion in citrus growing land, resulting in a lack of nutrients at the end of the season, and a lower quality citrus crop Inland valley paddy fields may be damaged by flash floods	4	5	Farmers can use high yield and quality crop varieties to optimize crop production in higher rainfall condition	3
Dry season will be drier, Rainfall of Spring will decrease 5% in 2050, 10% in 2100	4	Late Spring and Early Summer season rice and other crops will be highly exposed to these changes	*4*	Soil will be degraded, with lower productivity; May cause some delays in during very low soil moisture content periods; Drier dry season has a strong impact to tree crop because tree crops grow very slowly; Drier dry season may lead to longer drier period, associated with	4	2	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	4

CLIMATE CHANGE RISKS (2050 & 2100)	Exposure	Explanation (E)	Sensitivity	Explanation (S)	Impact	Adaptive Capacity	Explanation (AC)	Vulnerability
				soil moisture content dropping below wilting point, and some crops will die			more fertilizer because drought lower fertilizer use efficiency suitable and farmer have to change crop and crop calendar	
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	3	Late summer season crops will be more exposed to storms, but because the areas are far inland, they are somewhat protected from the worst exposure to storms	*3*	Later storm season may impact on the maturation periods of citrus and tea Later storm season is associated with later rainfall, which can be good for tea and fruit trees Small storms (level <7) may not impact tree Strong typhoons may break tree (i.e. extreme typhoon in 2013)	3	2	Need to find more options for avoiding negative impacts of strong winds breaking tree crops, especially rubber and citrus Need to have better field design with wind break lines	3
SEA LEVEL RISE Increased 3mm/year in last 20 years May increase to 75 cm by 2100	1	N/A	1	N/A	1	5	N/A	1
	3.9		3.3		3.4	3.0		3.3

9.2.j: SES 6d: Kinh commercial shrimp aquaculture on sand

CLIMATE CHANGE RISKS (2050 & 2100)	Expo-sure	Explanation (E)	Sensitivity	Explanation (S)	Impa-ct	Adaptive Capacit-y	Explanation (AC)	Vulnerabil-ity
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	The ponds will be directly exposed to the hotter and longer summer temperatures, resulting in increased water temperature in the pond, and increased evaporation from the pond which will concentrate the salinity of the water in the pond	3	Shrimp may grow faster and bigger in warmer water, until an (uncertain) threshold is reached When it is too hot, shrimp may not eat their food, and stop growing altogether Salinity that is too high also reduces productivity of the shrimp	3	3	Partial shading of the ponds with vegetation can easily reduce the impact	3
Number of Dry days increase 14 - 17 days in 2050, 10 - 15 days in 2100, Number of hot days > 35oC also increase 19 - 41 days in 2050, 22 - 54 days in 2100	4	The ponds will be directly exposed to the increased number of very hot days, resulting in increased water temperature in the pond, , and increased evaporation from the pond which will concentrate the salinity of the water in the pond	3	Shrimp may grow faster and bigger in warmer water, until an (uncertain) threshold is reached When it is too hot, shrimp may not eat their food, and stop growing altogether Salinity that is too high also reduces productivity of the shrimp	3	3	Low adaptive capacity (required high investment, and technology)	3
Temperature will increase faster and earlier in Spring	2	The ponds will be directly exposed to this more rapid temperature increase earlier in spring, leading to water temperature warming up earlier in the year	2	Shrimp season starting depends on when the temperature is high enough, so this could be a good thing, allowing the season to start earlier	2	4	Shrimp farmers can easily take advantage of the early start to the season	2
PRECIPITATION (RAINFALL)								
Higher rainfall in rainy season; Rainfall in Summer will increase 4	4	The surface of the ponds will be directly exposed to the	3	Shrimp are very sensitive to sudden changes in salinity and pH	3	3	Farmers will need to pump some extra sea water into	3

CLIMATE CHANGE RISKS (2050 & 2100)	Expo-sure	Explanation (E)	Sensitivity	Explanation (S)	Impa-ct	Adaptive Capacit-y	Explanation (AC)	Vulnerabil-ity
- 6% in 2050, 9 - 11% in 2100;		increased rainfall – this can dilute the salinity of the water in the pond, and also change the pH		which can shock and kill them- this will only happen in the heaviest rainfall events with very significant dilution of the pond water shrimp can tolerate very different pH and salinity levels if the changes are more gradual			the ponds to maintain the optimum salinity and pH levels	
Dry season will be drier, Rainfall of Spring will decrease 5 - 6% in 2050, 10 - 11% in 2100	3	The surface of the ponds will be directly exposed to the reduced rainfall. This can increase the salinity of the water in the pond, and also change the pH	2	While shrimp are sensity to changes in salinity and pH, the changes caused by a lack of rainfall will be more gradual, accumulating on a daily basis and the shrimp will be much better able to cope with these changes	2	3	Farmers will need to pump some extra fresh water into the ponds to maintain the optimum salinity and pH levels	3
STORM/ WIND/ TYPHOON Higher speed (intensity)/ stronger Difficult to forecast the storm frequency Storm season will come later	5	The ponds are very close to the shoreline and will be directly exposed to the full effect of these changes	4	Physical damage from storms may kill shrimp directly, and may damage the shrimp pond infrastructure and facilities	5	3	The construction standards are not always good enough to withstand storms, and rehabilitation after damage requires high investment	5
SEA LEVEL RISE Increased 3mm/year in last 20 years Would be increase 1m in 2100	3	The ponds are very close to the shoreline and will be directly exposed to the full effect of these changes	3	Some prawn farm areas will be damaged by erosion as the sea rises, and some areas will eventually become completely submerged. At the same time however, new areas that were previously further from the shore and not suitable for prawn farming will become available	3	2	Physical protection against sea level rise is prohibitively expensive (and would cause other problems anyway), but as yet there is no clear planning for a managed gradual retreat as sea level rises	3
	3.6		2.6		3.0	3.0		3.1

ANNEX 9.III: SUMMARY OF THE VULNERABILITY ASSESSMENT SCORE FOR THE TOP 10 SOCIO-ECOLOGICAL SYSTEMS OF HA TINH

Importance ranking			Temperature			Precipitation		Storms	SLR*	Vulnerability	
			Hot season will be hotter and longer	More dry days; More hot days > 35ºC	Increase faster and earlier in Spring	Higher in rainy (summer) season No. heavy rains (>50mm) increase -	Dry season (spring) will be drier, Drought risk	Higher speed /stronger winds Storm season will come later	Increased 3mm/year in last 20 years	Total score	Rank
RANK	No.	SES									
1	8a	Commercial and state water management infrastructure (dams, weirs, saline intrusion barrages, irrigation canals)	3	4	3	4	4	4	1	3.3	2
2	8h	Urban and rural settlement, industry, services	4	2	2	4	2	4	5	3.3	2
3	PA1+2	State SUF (National Park, Nature Reserve) Management (Vu Quang, Ke Go)	3	3	3	3	3	3	1	2.7	8
4	3a	Kinh smallholder lowland floodplain irrigated paddy rice cultivation	4	4	4	2	4	3	3	3.4	1
5	3b	Kinh smallholder floodplain-hills transition, paddy rice + mixed farming and tree crops	4	4	4	3	4	3	1	3.3	2
6	FPMB 1+2	Forest Protection Management Boards on subtropical forest > 700m and moist tropical < 700 m	3	3	3	3	3	3	1	2.7	8
7	8e	State managed Special Economic and Industrial Areas (coastal)	4	2	2	3	2	3	2	2.6	10
8	2b	Kinh and ethnic minority smallholder field and tree crops	4	4	4	3	4	3	1	3.3	2
9	2d	Kinh smallholder inland valley paddy cultivation + tree crops	4	4	4	3	4	3	1	3.3	2
10	6d	Kinh commercial shrimp aquaculture on sand	3	3	2	3	3	5	3	3.1	7

*SLR = Sea level rise

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 Ha Tinh.

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 Ha Tinh, 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 32 different SESs were identified and mapped. Using 12 criteria, the top 10 highest ranking SESs were identified for further work on vulnerability assessment.

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 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 Ha Tinh. 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.

10.3. Mainstreaming recommendations

In addition to identifying the 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 some priority SESs as well as KEAs 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 some of these SESs.

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 incorporate 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, Ha Tinh 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, Ha Tinh 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 in Ha Tinh.

- 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 Ha Tinh has been discussed in detail in Chapter 8, and 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 (outsourced 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.

10.4. Budget for implementation of EbA interventions

Presently, hard infrastructure projects account for over 95% 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, coastal zone management from WB, and agriculture from SNV, etc.

In addition, DONRE should work closely with DPI through support from MONRE and MPI to attract additional international funding for EbA projects in Ha Tinh. The PPC, 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.

Other major new sources of climate change related funding such as the GCF, are just starting to come on line in Vietnam. Ha Tinh 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 Ha Tinh.

10.5. 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) contributes about 30% to Ha Tinh's annual GDP, uses about 80% of provincial land and employs a large number of people in Ha Tinh (84% of the population is rural, most of which would likely be employed in AFF).

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. Approximately 30% of the population of Ha Tinh 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).

Based on discussions about the vulnerability ranking in a provincial workshop in August 2016, a number of recommended sites were considered for micro-assessments. Finally, village 1, Song Hong Commune, Huong Son District was selected for implementation of the community-level vulnerability assessment. The results of that assessment are presented in a separate report

10.6. Monitoring, evaluation and learning from EbA implementation

The EbA and other adaptation measures eventually selected for implementation in Ha Tinh 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.