



Evaluation, Cost-Benefit and Cost-Effective- ness-Analysis of Ecosystem-based Adaptation measures in Viet Nam



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Evaluation, Cost-Benefit and Cost-Effectiveness-Analysis of Ecosystem-based Adaptation measures in Viet Nam

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DISCLAIMER

This study assesses options for continued implementation and upscaling of Ecosystem-based Adaptation (EbA) approaches, with focus on coastal protection forest plantations, in the North Central Coast of Viet Nam. For this, UNIQUE forestry and land use GmbH was contracted by the GIZ project 'Mainstreaming EbA in Viet Nam', which is supported by Germany's International Climate Initiative (ICI) with funding of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB). The information and views set out in this study are those of the authors and do not necessarily reflect the official opinion of GIZ. Neither GIZ nor any other person acting on their behalf may be held responsible for the use which may be made of the information contained therein.

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
BAU	Business As Usual
BTC	Belgium Technical Cooperation
CBA	Cost-Benefit Analysis
CEA	Cost-Effectiveness Analysis
CBO	Community-based organization
CCRAP	Climate Change Rapid Action Plan
CEA	Cost Effectiveness Analysis
CPC	Commune Peoples Committee
DARD	Department of Agriculture and Rural Development
DBH	Diameter at Breast Height
DoNRE	Department of Natural Resources and Environment
EbA	Ecosystem based Adaptation
EEA	European Environmental Agency
FCPF	Forest Carbon Partnership Facility
FFS	Farmer Field Schools
GIZ	Deutsche Gesellschaft für International Zusammenarbeit (GIZ) GmbH
ICMP	Integrated Coastal Management Programme
IFAD	International Fund for Agricultural Development
IRR	Internal Rate of Return
IUCN	International Union for the Conservation of Nature
MARD	Ministry of Agriculture and Rural Development
m.a.s.l.	Meters above sea level
MPI	Ministry of Planning and Investment
NCC-VN	Northern Central Coast Viet Nam
NGO	Non-Governmental Organization
NPV	Net Present Value
NTFP	Non-Timber forest Product
P2P	Peer-to-Peer
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United National Framework Convention on Climate Change
USD	United States Dollar
VND	Vietnam Dong
WP	Work Package

EXECUTIVE SUMMARY

Ecosystem-based adaptation (EbA) focuses on “*the conservation, sustainable management and restoration of ecosystems to help people to adapt to the impacts of climate change*” (IUCN 2017). The main purpose of EbA measures is to enhance the resilience against climate change; in addition, EbA measures has considerable potential to providing numerous additional benefits, including for biodiversity and the enhancement of ecosystem services (Scarano 2017). EbA approaches are developed out of the need to reduce the vulnerability of people and nature to climate change. In many instances, they represent low cost and site-specific alternatives to traditional ‘grey’ adaptation measures (i.e. infrastructure development). As people are at the core of EbA, it is crucial to engage affected communities in designing respective measures and activities, ensuring the suitability of select adaptation strategies (ELAN, 2015; Reid, 2016).

In Vietnam, and globally, the relevance of ensuring the provision of vital ecosystem services is increasingly acknowledged. While being a fairly new and still rather unknown approach in the Vietnamese context, EbA can enhance ecosystem services and the resilience and adaptive capacities of local communities against climate change and extreme weather events. This broadening awareness is leading to new synergies that be closely linked with EbA projects, which demonstrate the effectiveness of nature-based solutions. However, a challenge in scaling up investments in EbA is the need for proof-of-concept to demonstrate the effectiveness and competitiveness of EbA approaches over convention grey-adaptation measures.

From a technical view point, studies need to critically assess pilot measures and demonstrate the effectiveness and lessons learned from implemented measures. From an economic point of view, cost-effectiveness and cost-benefit analyses can compare EbA measures with alternate options (Baig et al. 2016) and help determining when and where which option is most appropriate. Detailed and comprehensive feasibility studies and supporting economic assessments should take into account site-specific conditions to support and inform decision makers at the national and provincial level.

The GIZ project ‘*Mainstreaming EbA in Viet Nam*’ has commissioned this study to further assess the current state of the GIZ project’s piloted EbA measures. Specifically, the assignment consists of three core work packages (WPs):

- **WP 1.** Technical analysis of an EbA pilot project in Hoa Binh Village, Quang Binh Province; including the development of recommendations related to planting techniques and the use of indigenous tree species
- **WP 2.** Provision of support for the development of a cost-effectiveness analysis for two ongoing EbA pilot activities in Ha Tinh and Quang Binh Province; and assessment of upscaling options/implementation support beyond the projects timeframe
- **WP 3.** Cost-benefit analysis of an EbA measure within the Integrated Coastal Management Program (ICMP).

Work Package 1

A field visit to Hoa Binh Village in Quang Hung Commune, Quang Binh Province, was undertaken to assess the current stage of implementation of the projects EbA measure for restoring coastal sand dune forests for coastal protection and supporting piloted livelihood models. In total, the

pilot aims to establish 10 ha of protection forests along the narrow strip of sand dunes along the coast of the village. For the pilot project, it was decided together with the village and other relevant stakeholders that acacia would be planted on 5 ha, while casuarina trees would be planted on the other 5 ha. The acacia plantation was already established in December 2016, while the site preparation and planting of the casuarina plantation is planned for September 2017. Three livelihood models were also piloted within the village to help reduce pressure on the coastal forests and create alternative livelihood opportunities, including: i) organic vegetable gardening, ii) cattle raising and fodder production, and iii) small scale aquaculture (fish-ponds). The evaluation of the acacia plantation demonstrated that so far the plot has a relatively high-survival rate (~90% of seedlings have survived so far). This was largely due to the right planting techniques applied, sustained commitment and ownership of the local community and government, where it was evident that maintenance measures had been adequately applied and that there had been no interference within the plantation (e.g. by adjacent land activities, such as firewood collection or cattle grazing). However, it was possible to see that there was some root damage of some dead seedlings that could lower the survival rate in the next year or two due to the inappropriate handling and treatment of seedlings, due to poor practices that are commonly applied in many nurseries around the country.

Based on the assessment it was possible to develop several key recommendations for the applied EbA measure:

- **Species selection:** Site-species matching for coastal protection forest plantations is of utmost importance to ensure adequate tree growth which later enables the forest stand to protect the hinterland from storms. There is limited knowledge available on native species in coastal dune forests, especially silvicultural knowledge about their growth conditions, markets, etc. Furthermore, nurseries often do not grow such species which can lead to higher costs and additional work. Due to past experiences piloting acacia and casuarina, as well as the fact that the knowledge base on both species is extensive it was more attractive to select such species for the pilot project. None the less, four native tree species (*Melaleuca cajuputi*, *Myrsine linearis*, *Lithocarpus concentricus*, *Syzygium corticosum*) were identified as being suitable for reforestation activities within coastal protection forests. It is recommended that within the next planting period in the remaining 5 ha that the project pilots a combination of casuarina and native species to create a diverse forest stand mimicking natural regeneration and enhancing biodiversity and other ecosystem services.
- **Enrichment of Acacia Plantations:** While the currently applied monoculture plantation model might serve its purpose for initial site preparation it is important to stepwise introduce suitable native tree species into coastal protection forests and the EbA model. Both acacia and casuarina can be seen as nurse crops that can improve the soil and general growing conditions for other plants, especially native species, and can help facilitate their establishment. Models for conducting such an enrichment planting have been promoted which mimic natural forest structures and natural canopy gaps to support assisted regeneration.
- **Planting design:** The approach implemented was based on the planting design of industrial acacia plantations, which is focused on maximizing timber production and economic return. However, the EbA measure focuses on planting in protection forests where the main objective is coastal protection and climate change adaptation, and as such the planting design should be adjusted to support the specific management objective of protection forests. Mimicking natural regeneration and natural stand structures is one to ensure more appropriate planting approaches in order to maximise the future protective capacity of plantations.

- **Improved seedling treatment:** As noted, there were signs of root damage and compaction in the acacia plantation. Bottomless containers with holes drilled in the sides could be used to help reduce such damage. Furthermore, additional trainings should be conducted in nurseries to ensure that employees conduct a quality control to ensure soft nutritious soils are used and to check for signs of soil compaction.

Livelihood modes were also discussed with villagers and project partners, however it was not possible to conduct a detailed analysis of the measures, as they have only recently been implemented. Households who have participated in organic vegetable production have noticed short-term returns and improved incomes, and in general are satisfied with the livelihood model. Households participating in the livestock and aquaculture livelihood models have yet to experience a return, due to the medium-term investments required by such models. As such, it is too early to conduct a detailed assessment of such models, although it is clear that a challenge will be to support villagers to cover initial liquidity gaps when both the livelihood model and coastal forest are not generating additional returns and benefits.

Work Package 2

The second work package focused on supporting the development of a cost-effectiveness analysis. Specifically, the WP package aimed to:

- Support the development of a cost-effectiveness analysis for EbA measures piloted in Quang Binh and Ha Tinh Provinces, specifically through the provision of methodological guidance for cost-effective assessments and the assessment of data availability and information gaps for CEA for the two pilot measures
- Assess the potential for scaling up EbA measures piloted in Quang Binh and Ha Tinh.
- Provide recommendations for ensuring the long-term sustainability of piloted EbA measures in Quang Binh and Ha Tinh Province.

The pilot project in Quang Binh was the project described above in WP1, while the EbA pilot project in Ha Tinh Province focused on EbA in a mountainous village (Village 1) in Son Tho Commune within Vu Quang District. Specifically the EbA measure focusses on natural forest protection and enrichment through applying different agroforestry approaches on different slope sections. This is to ensure provisioning ecosystem services while strengthening resilience and adaptive capacities of the local community towards negative climate change impacts.

Supporting the development of a cost-effectiveness analysis

Guidance for conducting a cost-effectiveness analysis was presented based on the approach developed by UNFCCC (2011) involving the following five core steps:

- i. Identification of the adaptation objective and potential adaptation options to compare
- ii. Establishment of a baseline
- iii. Quantification and aggregation of the costs for implementing select adaptation options
- iv. Determination of the effectiveness of the select adaptation options (whether it yields a desired result – i.e. climate change adaptation), and
- v. Comparison of the cost effectiveness of the different adaptation options.

Beyond describing key considerations for conducting such an analysis, an assessment of the information needs and gaps for two pilot projects in Quang Binh and Ha Tinh Province was conducted. This assessment found that while relevant data on the costs of EbA measures as well as

baseline and business as usual (BAU) data are available there is still a lack of information on potential benefits as well as alternative investments against which the EbA measure would be compared. While data needs and potential data sources were identified, additional research is required in order to carry out an informed cost effectiveness analysis based on the proposed approach.

Potential for scaling up piloted EbA measures in Quang Binh and Ha Tinh

In addition, upscaling potential of the piloted EbA measures in both Quang Binh and Ha Tinh province were assessed. While spatial locations for potential upscaling were identified through site suitability and political priorities it is important to consider that the EbA project ends late 2017. Hence ensuring the sustainability of currently applied pilots as well as their upscaling requires the provision of a proof of concept as well as a success story which then enables policy makers to push for the inclusion of these EbA measures in provincial policy making; most importantly into the coming 5-year socio economic development plans which would also allow for government budget support.

Recommendations for ensuring the longevity of piloted measures

To make sure that pilot measures will be supported beyond the project recommendations on how to ensure the endurance of the piloted measures were developed. These include direct recommendations on the development of local level measures to ensure peer to peer capacity building between communities. Furthermore active NGOs and international organizations were mapped regarding their capabilities to contribute to the pilot measures. In both cases the inclusion of pilot measures in district and provincial planning is recommended to ensure integration of models in policy making which in turn helps securing domestic funding as well as additional capacity building and implementation support.

Work Package 3

In the last WP, a brief Cost-Benefit Analysis (CBA) analysis of a coastal protection measure implemented through the Integrated Coastal Management Program (ICMP) was carried out. Specifically, bamboo T-fences¹ were selected and compared with hollow breakwaters². Since the effectiveness of bamboo T-fences for coastal protection was already proven over several years of implementation the CBA further found out that with a Net Present Value (NPV) of USD \$14,874 over 30 years and an Internal Rate of Return (IRR) of 22%. In conditions characterized

¹ Fences made out of [locally sourced] bamboo which form a 't-shape', which act as a natural barrier against strong waves yet allow water, sediments and aquatic animals to move independently, resulting in increased biodiversity and improved conditions for mangrove rehabilitation in fenced areas (GIZ 2012; Schmitt et al. 2013). Additional mangrove planting activities can be combined with the application of t-fences to assist mangrove rehabilitation which further strengthens the resilience of coastal ecosystems and communities.

² Hollow breakwaters are concrete based constructions, similar to a wall, located around 200m off shore. While there are different designs applied, breakwaters are generally identified as taller than average wave height in order to deflect waves. In some cases of along the Mekong Delta hollow breakwaters are filled with large stones in order to decrease sediment fluctuations and keep sediments caught within the breakwater allowing for the development of mudflats and mangrove regeneration.

by a relatively level terrain and low-erosion (low wave energy), T-fences combined with mangrove restoration represent a cost-effective option, especially when compared with hollow breakwaters which could be applied in a similar context. Being considered as hard infrastructural measures with much higher costs while achieving the similar end-results as T-fences, hollow breakwaters would however be able to withstand much higher wave energy.

CBA remains a powerful tool for comparing the efficiency of investments in climate change adaptation measures, including EbA. While this WP has provided an example of how to conduct a CBA for an EbA measure, it was based on a desk-study using existing literature and various assumptions. For adequately informing decision making processes a more detailed CBA should be conducted which reflects site- and investment-specific information, assesses in detail the technical feasibility based on robust and reliable data and consultations with diverse stakeholders.

Conclusion

EbA represents an important approach for supporting climate change adaptation in Viet Nam. While this study provides recommendations on the implementation of specific EbA measures, another main aspect is to assess the informational basis concerning the effectiveness of currently applied EbA solutions in the North Central Coast of Vietnam. An increased understanding of costs, benefits and the effectiveness of EbA measures provides important additional information to assist decision makers at provincial and national level to ensure future integration and for upscaling successful approaches. While challenges and uncertainties will remain, especially concerning data availability at the local level, well-designed evaluations and upscaling plans can strengthen the approach and encourage the mainstreaming of EbA. For effectively addressing these challenges and mainstreaming EbA across levels and sectors, further studies assessing in more detail the technical, economic and policy aspects are key to demonstrate “proof of concept” for specific EbA options and synergetic livelihood models.

1 INTRODUCTION

1.1 Climate Change and Ecosystem-based Adaptation in Viet Nam

Viet Nam is often exposed to extreme weather events, and climate change poses a major threat to the country (Kreft et al. 2015; ND-GAIN 2017): much of the country's population and agricultural activities are located in coastal lowlands, where rising sea levels and extreme storms can have detrimental impacts on both the economy and local livelihoods (WB-GFDRR 2011; ADB 2013; MPI 2015). It is estimated that impacts of climate change may result in economic losses of up to \$15 billion annually over the coming decades (Arndt et al., 2015). This is equivalent to approximately 5% of Viet Nam's current gross domestic product (World Bank 2017).

Livelihoods of local people are directly affected due to the vulnerability and exposure of coastal communities to extreme storms and rising sea levels. The lack of appropriate coastal protection measures can lead to salt water intrusion and salinization of drinking water and agricultural land (WB-GFDRR 2011). Changing climate conditions can also lead to changes in agricultural production systems, including changing agro-ecological zones, changes in precipitation, pests and diseases, among other impacts, which can have a long-lasting impact on the national economy and livelihoods (ICEM & MRC 2009). Especially in coastal protection the integration of biodiversity in EbA plays an important role as it is able to provide multiple benefits such as reduction of negative climate change impacts or improved livelihoods through provision of ecosystem services, among others (Perez et al 2010; CBD 2009).

There is evidence that maintaining the stability of functional coastal ecosystems can contribute to climate adaptation, ultimately reducing the vulnerability of coastal ecosystems and communities to climate risks and impacts (Schmitt et al. 2013; GIZ 2014ab; Spalding et al. 2014). Much of Viet Nam's coast is extremely vulnerable to climate change and extreme climate events due to human-induced land use changes, where mangrove forest and coastal dune forests have been largely cleared (Van Hue & Scott 2007; Schmitt et al. 2013). These ecosystems have important protective functions for safeguarding communities and land uses from extreme storms, rising sea levels, shoreline erosion and salt water intrusion (GIZ 2012; Schmitt et al. 2013; GIZ 2014ab; Spalding et al. 2014). Studies have shown that by restoring coastal ecosystems, the protective functions of these ecosystems can be restored which in turn increase the resilience of coastal communities and ecosystems, while providing diverse additional benefits (e.g. biodiversity conservation; Schmitt et al. 2013; GIZ 2014ab; Spalding et al. 2014).

Against this background, the Government of Viet Nam (GoV) has defined and agreed on ambitious objectives for climate change mitigation and adaptation, as well as for the protection and sustainable use of biodiversity at both the international and national level. Viet Nam is a Party to the United Nations Convention on Biological Diversity (CBD) as well as the United Nations Framework Convention on Climate Change (UNFCCC). The country ratified the UNFCCC Paris Agreement on November 3, 2016. At the national level, climate change mitigation and adaptation are prominent throughout the country's Green Growth Strategy, and are further reflected in national and provincial development and sectoral strategies, laws and decrees. Considering that Viet Nam boasts more than 3,000 km of coastline, coastal protection is among the country's key priorities with respect to increasing the country's resilience to climate change.

While the country has made substantial progress in developing and implementing supporting measures, ecosystem-based approaches to climate change adaptation have yet to be fully mainstreamed into national and regional policies (Nguyen et al. 2017). A study by Nguyen et al. (2017) noted that “... the lack of EbA in national policies is a key reason for its inadequate integration into related policies throughout all levels of government in Viet Nam”. The lack of an enabling environment and the integration of EbA measures into national and regional policies, including across diverse sectors, has prevented their large-scale implementation – despite the fact that they can represent cost-effective alternatives or complementary to so called *grey*-adaptation measures³³ (EEA 2013). EbA can increase the resilience of local communities and build their adaptive capacities, while providing additional benefits such as improved livelihood opportunities, enhanced food and water security, strengthened resilience to natural disasters and enhanced biodiversity conservation (EEA 2013; Schmitt et al. 2013; GIZ 2014b).

A major challenge for the implementation and scaling up of EbA measures is the need for additional information and evidence on the technical and financial effectiveness, in order to be able to compare these against a business as usual scenario or alternative interventions. There is a need to evaluate EbA pilot projects to assess their co-benefits, efficiency and also identify key lessons learned to refine and improve piloted EbA projects. In terms of economic assessments, there is a need for in-depth studies which quantify the associated effectiveness of EbA as an adaptation measure, as well as the monetary costs-and benefits. Such economic assessments of EbA measures can be useful in highlighting the effectiveness of EbA against alternative adaptation approaches (incl. grey-adaptation/engineering projects), especially when considering site-specific characteristics, development priorities, conservation targets and risk reduction aspects.

1.2 GIZ project on the “Strategic Mainstreaming of EbA in Viet Nam”

The GIZ project ‘*Strategic mainstreaming of ecosystem-based adaptation in Viet Nam*’ supports Viet Nam in meeting their national and international objectives to climate change, such as coastal protection through EbA. It develops systematic integration and implementation of innovative and effective methods, strategies and policy guidelines for EbA. In doing so, it aims to anchor ecosystem-based solutions systematically in policy and society through strengthening the capacity of stakeholders at national and subnational levels to support the mainstreaming of ecosystem-based solutions. It further intends to improve the national climate change adaptation policy framework, ensuring the scaling up and implementation of EbA measures such as the improvement of coastal protection and increasing the resilience of local communities in Quang Binh Province, among others. The project further assesses and pilots EbA measures in the provinces of Quang Binh and Ha Tinh in the North Central Coast of Viet Nam, including awareness raising and capacity building for implementers and policy makers. The pilot projects in Quang Binh province and rural mountainous communities in Ha Tinh province provide key lessons learned in relation to EbA and the development of sustainable livelihood models.

³³ According to the European Environment Agency (2013) “grey” adaptation measures are physical interventions, construction measures or the use of engineering services to make interventions essential for the social and economic well-being of society and more capable of withstanding extreme weather events. These approaches are focused on the direct impacts of climate change.

1.3 Objectives

The objective of this assignment is to support the GIZ's project on '*Strategic Mainstreaming of EbA in Viet Nam*', by conducting various assessments of piloted EbA solutions to address climate risks. Specifically, the assignment can be broken down into three distinct work packages (WP):

- **WP 1.** Technical analysis of an EbA pilot project in Hoa Binh Village, Quang Binh Province; including the development of recommendations related to planting techniques and the use of indigenous tree species (Chapter 2)
- **WP 2.** Provision of support for the development of a cost-effectiveness analysis for two on-going EbA pilot activities in Ha Tinh and Quang Binh Province; and assessment of upscaling options/implementation support beyond the projects timeframe (Chapter 3)
- **WP 3.** Cost-benefit analysis of an EbA measure within the ICMP (Chapter 4).

Each work package is presented in an independent chapter providing the relevant background information, methodological approach, findings and recommendations. At the end of the report a brief conclusion is provided which draws on the cross-cutting findings and main conclusions.

2 TECHNICAL ASSESSMENT OF EBA MEASURES APPLIED IN HOA BINH VILLAGE, QUANG BINH (WP 1)

2.1 Introduction and methodological approach

2.1.1 Introduction

Coastal sand dune forests can reduce coastal erosion (from water and wind), provide a protective storm-break against extreme weather events, provide alternative livelihood options and enhance biodiversity, among other benefits. The coastline along the NCC-VN was historically covered by sand dune forests consisting of native species, which played an important protective role for coastal communities and ecosystems. However, since 1975 extensive deforestation has occurred along the coastline of NCC-VN, with the removal of indigenous tree species from sandy dunes to help meet local communities' demand for fuelwood. As a result, large areas of coastal sandy dunes have become degraded and have lost their protective function, increasing the vulnerability of local communities and adjacent land use (e.g. villages, agricultural land, freshwater reservoirs, etc.) to the impacts from extreme weather events and climate change. While normally having a moderately-rich top soil level due to organic coverage, the natural exposure of sandy dunes in combination with the afore mentioned deforestation of coastal areas has led to severe degradation of soils in the coastal area. Hence, these soils areas are now either open and uncovered or, in other cases, covered by local low grass and small thorny shrubs.

Through the EbA project, the GIZ has implemented a pilot project in Hoa Binh Village in Quang Binh Province. The pilot project aims to implement EbA measures focusing on coastal restoration and increasing the resilience of coastal ecosystems and communities. Specifically, the project aims to reforest coastal sandy dunes using casuarina and acacia tree species on 10 ha of degraded land, classified as protection forests. Restoration activities have so far been implemented on 5 ha of land (50% of the pilot area) using acacia tree species, while the remaining site-preparation and planting activities (5ha of casuarina) are planned for September 2017, potentially even further expanding pilot trials for different coastal protection forest options depending on available finance.

The objective of this WP is to analyze the implementation of the GIZ pilot project in Hoa Binh Village (so far), and to provide technical recommendations related to the restoration approach applied. Providing a brief introduction and description of the approach, the chapter provides background information on the pilot village, past experiences with coastal restoration and a description of the current EbA activities being piloted in Hoa Binh Village. The findings from the technical analysis will then be discussed and final recommendations and conclusions presented.

2.1.2 Methodological Approach

The assessment of implemented EbA measures in Hoa Binh Village was based on two core activities: i) a field based technical assessment of the 5 ha pilot plantation site of coastal protection forest and the adjacent livelihood models implemented by the project; and ii) interviews with

key stakeholders who took part in the implementation and management of both the coastal protection forest plantation and the associated livelihood models.

The current state of the coastal sand-dune ecosystem was assessed together with a revision of the pilot projects proposed and currently implemented activities. Specifically, the consultants reviewed: the quality of seedlings, site selection, preparation and planting approaches (incl. spacing of seedlings), current growth performance, as well as maintenance and protection of the planting site, among other considerations. Furthermore, research was conducted on native plant species which are or were naturally occurring in this ecosystem, and recommendations were provided for a variety of native plant species suitable for rehabilitation and stabilization of coastal sand dunes based on site-species matching. A brief assessment of the projects livelihood models, implemented in areas adjacent to the pilot area, was also conducted to identify potential opportunities, challenges and key recommendations to help provide additional direct benefits to local communities.

Relevant supporting information was collected from a variety of sources, including literature, expert interviews, as well as stakeholder and village meetings. Interviews were conducted with technical experts (incl. project staff, project partners, external technical experts involved in the project, etc.) to provide detailed information and insight into current practices and key considerations for the application of EbA in coastal sand-dune forests of Quang Binh Province. Interviews and meetings with relevant stakeholders, such as the provincial Department of Natural Resources and Environment (DoNRE) and its sub-provincial line authorities, the provincial Department of Agriculture and Rural Development (DARD) as well as the Commune Peoples Committee (CPC) were conducted. During those meetings a pre-defined set of guiding questions was discussed and based on the context and information needs specific aspects relevant to each meeting were discussed in more detail. The approach was to ensure that diverse considerations and perspectives were taken into consideration and to provide key feedback based on each stakeholders specific experiences with the pilot project. Focus group meetings with villagers were also conducted to learn about their experiences with the pilot project so far, and to ensure that local knowledge and considerations were integrated into the recommendations, and to identify potential challenges or gaps in the approach. Finally, the consultants drew upon on existing literature and studies on coastal EbA and silviculture to ensure that best practices are applied which are appropriate and have been adapted to the site-specific context.

2.2 Description of pilot area and experiences with coastal protection

2.2.1 Hoa Binh Village in Quang Hung Commune

Hoa Binh Village is located within Quang Hung Commune, a coastal commune in the Northern part of Quang Binh Province. Quang Hung Commune has a total area of 210,000 ha and a population of 7,537 people (with a population density of approx. 359 people/km²) (Quang Trach DPC. 2014). Hoa Binh Village has approximately 710 households (key informant interview, June 2017) and is responsible for overseeing the management of 123ha of sandy areas along a 3km coastal stretch.

The climatic conditions of the area differ based on two main seasons: a dry season from March to August, characterized by hot and dry winds from the southwest monsoon, and a rainy season from September to February, characterized by cool and humid winds from the northeast monsoon. The annual mean temperature is around 24.5 °C and the annual rainfall is 2,200 mm, mainly occurring during October to December. The landscape is characterized by relatively bare sand dune areas with some natural shrubs and grasses, as well as two forested areas: a 25 year old well-established *Casuarina* plantation near the village, and a 7 year old poorly-managed plantation containing mostly acacia species. Common tree and shrub species found on sand dunes include *Launae samentosa* of Asteraceae, *Phyllanthus virgatus* of Euphorbiaceae, *Ipomoea pes-caprae* of Convolvulaceae, *Spinifex littoreus* of Poaceae; *Severinia monophylla* of Rutaceae. Soils of this area most importantly characterized through their moving sand surface.

Historically, coastal sand dunes in the commune were covered by various indigenous tree species that can still be found within many coastal communes in Quang Trach District (Quang Binh Province), including in Quang Xuan, Quang Dong and Quang Phu, among others. Species include *Melaleuca cajuputi*, *Myrsine linearis*, *Lithocarpus concentricus*, *Syzygium corticosum* among others. While historic information on indigenous tree species in the coastal dunes of Hoa Binh Village is not available, previous coastal protection forests were at least recognized by villagers as an important wind-break and protective barrier that helped protect the village from storms and coastal erosion in the past (key informant interview, June 2017). However, the coastline around Hoa Binh village experienced extensive deforestation and degradation due to the local community over-harvesting trees for firewood, making the community more vulnerable to climate-change and extreme weather impacts. Due to extensive clearing of coastal forests and the resulting degradation, natural regeneration has been limited as the soils have become increasingly degraded and do not provide the growth-conditions necessary for many native tree species to return.

In Quang Hung Commune, majority of livelihoods are sustained by agricultural activities, including the production of agricultural crops, paddy rice, home garden cultivation (for subsistence), animal raising and small fresh water fish ponds. Within Hoa Binh village, the main source of income primarily comes from paddy rice production, where inhabitants practice an irrigation-based rice cropping system with two harvests per year. While fishing with small boats was considered one of the main income activities until recently, massive fish deaths due to toxic spills of a further north located steel production plant in 2016 have forced many locals to work in factories or migrate to other areas in order to find labour. Hence, fishing activities are currently not considered a major economic activity within the village and commune. While coastal protection forests have the potential to provide alternative livelihood opportunities for local communities, the dunes in Hoa Binh Village are too degraded and in their current form and thus only have minimal benefits for the community. To a small extent, these areas are used for uncontrolled cattle grazing, however in general they are often unused lands. Hoa Binh village, in particular, was selected as pilot area as it has one of the lowest incomes of the province. In addition, Hoa Binh village is directly affected by negative climate change impacts such as: coastal erosion (estimated 150m of beach losses along a 2km coastal stretch over the last 10 years), typhoons and droughts.

2.2.2 Past experiences with coastal restoration in Hoa Binh Village and NCC-VN

Impacts resulting from the extensive degradation of coastal ecosystems have been evident for some time, and already in 1998 coastal plantations were identified as a priority⁴ for supporting forest protection and restoration in Quang Trach district (PM Decree 661). This priority was renewed under the Forest Plantation Program 327. However, despite political support for reforestation in coastal ecosystems, efforts to restore coastal forests in sandy dunes have had minimal success during the last twenty years. In general, two types of species have been promoted within NCC-VN: acacia and casuarina.

Casuarina

Casuarina equisetifolia is widely distributed throughout Australia and South East Asia. While regarded as native in NCC-VN it actually was introduced from Australia in the 16th century and since then spread along coastal areas due to its ability to withstand long periods (4-6 months) of drought and its ability to grow on coarse textured sandy soils (Orwa et al. 2009).

In Hoa Binh village, *Casuarina equisetifolia* was planted in 1989 by government owned cooperatives on commonly owned land characterized as coastal protection forests (see Figure 1 below). Over time, well maintained Casuarina plantations developed reasonably well and provided its main function as a windbreak along the sea shore of the commune. As such, Casuarina was generally regarded as a suitable tree species to reduce the impact of storms while at the same time providing income for local communities through firewood and litter production, the latter which could be used as fertilizer (Cat et al. 2009). Despite this progress, large areas of casuarina forests along the coast of NCC-VN continued to be logged due to local peoples demand for firewood and a lack of protection and law enforcement. Casuarina forests were further impacted by uncontrolled animal grazing, further increasing the degradation and destruction of young casuarina plantations, while the climatic conditions including poor sandy soils and strong storms in the rainy seasons further limited the reestablishment of coastal protection forests on sandy dunes.



Figure 1: Casuarina plantation (25 – 27 years old) in vicinity to Hoa Binh village

⁴ Prime Minister's Decision No. 6611QD-TTg of July 29,1998, on the targets, tasks, policies and organization of implementation of the country's 'Five Million Hectare Reforestation Program'

Other attempts at using casuarina in dune restoration in NCC-VN have been implemented with mixed results. Some restoration attempts found that stands developed poorly, and were often considered as shrubs instead of forest stands due to the limited growth in sandy and nutrient-poor soils and a lack of maintenance. These experiences may not necessarily be representative of the species, but instead reflect poor site-species matching, inappropriate planting design, poor seedling quality, or inappropriate monitoring, maintenance and protection practices. Other studies have found that it is a suitable species as it can grow quickly in the first years to help it become established and less vulnerable to waves and storms; it is a species that can tolerate strong winds, its root system has been characterized as wide and deep which can help reduce coastal erosion; it can be planted in a broad range of soils, improve the quality of degraded soils and withstand a range of climatic conditions (Cat et al. 2006; Tanaka et al. 2007; Midgley et al. 1997). While providing very positive results on reducing climate change impacts (mainly storms) over an initial timeframe of 20 years, research shows that the protective function of monoculture Casuarina stands further reduces over time due to breakage and uprooting (Wolanski, 2007; Gonsalves and Mohan, 2012). There is a need for additional piloting of casuarina plantations to demonstrate appropriate practices and generate key lessons learned to support EbA and coastal restoration in NCC-VN with this species.

Acacia

Acacia is an introduced species, which gained substantial momentum in the country in the late 1980s/ early 1990s – with acacia plantations currently covering over 1.1 million ha (Nambiar et al. 2015). The three main Acacia species planted in Viet Nam are: *Acacia auriculiformis*, *Acacia mangium* and *Acacia crassicaarpa*. Acacia in general is often considered to be a suitable species to support forest restoration in coastal areas in NCC-VN in the short-and medium-term due to its fast growth rates, broad range of growing conditions (incl. coarse sandy soils) and ability to improve degraded soils through enhancing abiotic properties and biotic functions of soils (Doi and Ranamukhaarachchi 2007). In recent years, *Acacia auriculiformis* has been planted in sandy areas in NCC-VN, however their growth rates are generally considered low, with an average Diameter at Breast Height (DBH) between 6 -7 cm for seven year old trees.⁵ The following Figure shows the differences between the growth characteristics of a seven-year-old mixed *Acacia auriculiformis* and *Acacia mangium* inland plantation with a seven-year-old *Acacia auriculiformis* found around the pilot site.

⁵ Diameter at breast height, or DBH, is a commonly applied method of expressing the diameter of a standing trees trunk, normally measured at 1.3m above the ground (Mackie & Matthews, 2006). According to Sein & Mitlöhner (2011) the average DBH of 6-7 year old acacia stands is around 10cm while 6-7cm (as measured on site) normally represent 3 year old trees.



Figure 2: Comparison between a well-established inland Acacia plantation (left – photo credit: VAFS) and a coastal Acacia plantation (right - field observation)

However, in general acacia is not a suitable tree to support long-term sustainable coastal protection. With rapidly decreasing survival rates over time acacia is unable to create forest-like structures in the long-term, limiting the effectiveness of this measure over time. Furthermore, acacia has a rather poor timber quality and low-growth rates when grown in the marginal sandy soils typical of sand dunes in NCC-VN, which limits the potential for long-term livelihood opportunities for coastal communities. Nonetheless, in coastal sand dunes acacia plantations can play an important role in the restoration process of coastal ecosystems. They can be implemented as an initial step to create the necessary conditions for ecosystem restoration instead of a long-term solution for coastal protection. This approach is often seen with plantations, where exotic species can be grown in poor conditions and in turn improve and provide favorable conditions to later establish native tree species in secondary forest succession on degraded sites (Lamb et al. 2005; Padilla & Pugnaire 2006; Dong 2014; Dong et al. 2016; Forbes et al. 2016;). As in the case of casuarina, more experiences are required in piloting acacia for coastal protection and to support the reestablishment of native species to provide important lessons and demonstrate the effectiveness of the approach in supporting coastal protection and EbA.

2.2.3 Description of the EbA pilot project

Upon consultations and discussions with DoNRE in Quang Binh and other relevant stakeholders at the district, commune and village levels, EbA pilot measures were designed to carry out with a combined approach of rehabilitation and reforestation of coastal protection forest along with short-term livelihood support for local people in Hoa Binh village. It was planned that 10 ha of coastal protection forest of casuarina and acacia plantations would be planted along the 500m broad coastal strip between Hoa Binh village and the East Sea, while at the same time providing additional support through community forest management and developing business models to

enhance local livelihoods⁶. For the combination of sand dune plantations and livelihood models the following aspects were considered:

- low initial and ongoing cost
- effectiveness in reducing climate vulnerability
- fast and easy implementation
- co-benefits and limited disadvantages
- flexibility and reversibility
- optimization of local resources (i.e. labor force, ecosystem services and traditional knowledge)
- upscaling possibilities
- sustainability in terms of economic, social and environmental aspects.

Coastal Forest Rehabilitation and Reforestation

The development of a coastal protection forest was identified as suitable as it is expected that the implementation can help to strengthen several ecosystem services, such as: i) providing services (ensuring the maintenance of underground water for production and domestic use; providing fuelwood; providing food and income for local people from cattle raising (short-term) and acacia timber (long term); and ii) regulating services (increase underground water; reduce impact of storms & sea level rise on production area of local people; control erosion; regulate climate).

The pilot area is characterized by poor coastal sandy soils with a natural vegetation cover of approx. 20%, limited to various grass and shrub species. The site is located on top of a dune, where its average altitude is 12.5 meters above sea level (m.a.s.l.), with an average slope ranging from 2° to 7°. Based on the site-conditions and past experiences in piloting the reforestation of coastal dune forests, two 5 ha plots have been envisioned: one plot with *Acacia auriculiformis* (monoculture) and another plot containing casuarina (monoculture). Both species were chosen as there were no suitable native tree species based on the site conditions. Furthermore, experiences planting acacia and casuarina along coastal sandy areas in NCC-VN had demonstrated their ability to grow in such conditions, and act as a nurse crop to support the eventual integration of native species in coastal sand dune forests.

In total, 30 households were engaged in the pilot project, forming 10 community forest protection groups. Community forest protection groups are responsible for carrying out a joint forest mapping and planning exercise, and supported site preparation, planting, maintenance and monitoring. They were trained on various topics on planting techniques, the application of fertilizer, and forest protection and maintenance considerations. Through the project, periodical monitoring, advice and technical support is provided to participating households in combination with financial support for replanting and maintenance during the first two years of plantation establishment.

⁶ Three types of livelihood activities were identified during participatory consultations with 30 selected households: 1) vegetable gardening, 2) cow breeding and fodder production, and 3) fish farming

The establishment of the 5 ha acacia plantation took place in December 2016. The planting approach applied for the pilot acacia plantation is similar to the approach used for commercial inland acacia plantations in Viet Nam (cf. Figure 2) which is generally characterized through transect/line plantings and high densities of 5.000 or more seedlings per hectare. In the case of the EbA planting site, 5.000 seedlings/ha were planted in straight rows with a planting density of 2m x 1m. Seedlings were sourced from a commercial nursery, which normally provides seedlings for inland acacia plantations. The following Figure shows the current state of the planting site with sets of already established acacia trees in the back and a single seedling of the current planting site. The casuarina plantation has not yet been established, however site preparation and planting activities are planned for September 2017. The planting approach for the casuarina plantation currently plans to follow the same approach and planting design as for the 5 ha acacia pilot plantation. In addition casuarina will be used to re-plant dead seedlings of the initial 5ha acacia plantation, eventually resulting in a mixed acacia-casuarina plantation.



Figure 3: Pictures of current planting site (left) and a single seedling (right)

Livelihood Models

Livelihood models were developed and piloted to support the 30 participating households to help them to generate additional income and strengthen the ownership of the local community towards the EbA measure. After baseline surveys the 30 participating households were identified and three models were selected which were identified as having the potential to reduce the pressure on coastal forests, while also providing additional benefits to communities. As such the livelihood activities are directly linked to the coastal protection forest plantation, not only by reducing pressures but in addition also enhancing the adaptive capacity of local communities through diversification of agricultural products while increasing ownership for the coastal protection forest plantation as locals partaking in the livelihood models also have protection and maintenance responsibilities over the pilot plantations.

Vegetable gardening, fodder production and cattle raising as well as fish farming were identified and are expected to provide the below shown benefits over time:

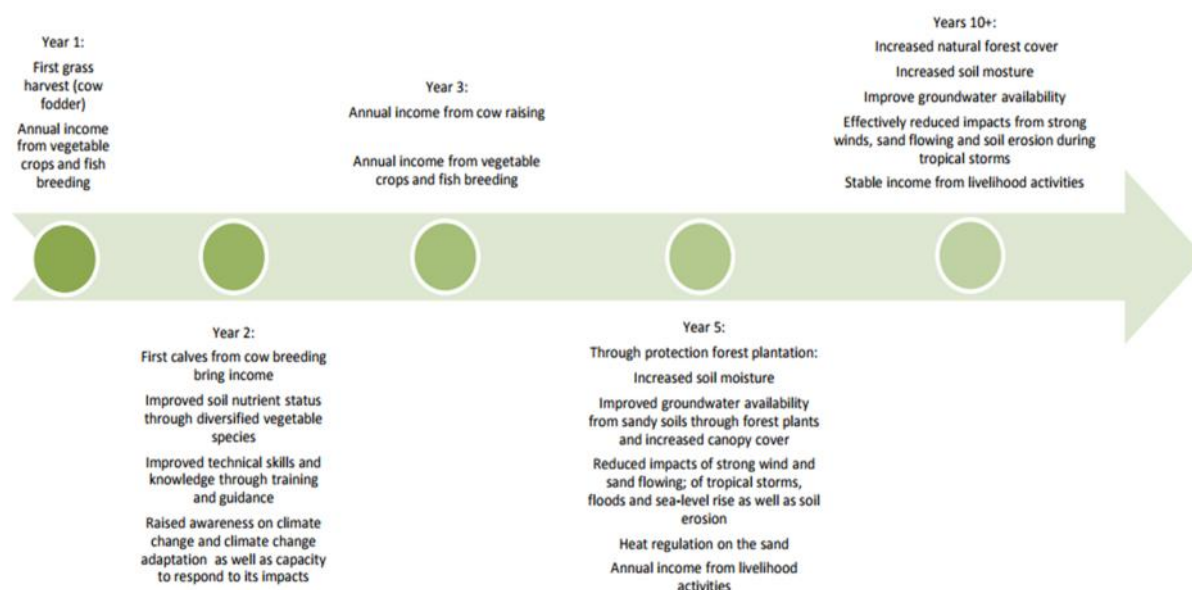


Figure 4: Timeline of benefits of proposed livelihood models (provided by GIZ)

The models were assigned to specific households based on their former livelihoods. Thus vegetable farmers were assigned to the vegetable gardening models while cattle and fish farmers took part in the respective pilots for their livelihood. Each of the participating households received capacity building and all required essentials (seedlings, tools, cattle, fish, etc.). They were not paid advancements or direct monetary payments.

Ultimately, the implementation of these models can further strengthen the local peoples' adaptive capacity through developing diversified income streams based on sustainable and climate-smart practices.

2.3 Assessment of implemented EbA measures

Since its establishment in December 2016, the plantation has maintained a relatively high seedling survival rate, equivalent to approximately 90%. The high seedling survival rate may be credited to proper management by local authorities and the application of good practices in the maintenance and protection of the plantation by the local community. This is especially visible as there was no evidence of interference from anthropogenic impacts (both direct and indirect impacts)⁷. While this is a positive observation, it should be noted that the plantation is still young and fluctuations in seedling mortality can still take place over the next years. During the field visit, it was evident that the roots of many seedlings were deformed and held back through a compacted block of hardened soil around the roots. In severe cases this can lead to premature death of the seedlings (as observed on site), as they are not able to receive enough nutrients to support the seedlings growth as seen in the Figure 5. Deformed roots can be found in acacia

⁷ E.g. Indirect impacts through, e.g., uncontrolled cattle grazing.

plantations throughout Viet Nam, and can be traced back to the handling and preparation of seedlings in nurseries.



Figure 5: Comparison of under developed roots of dead seedlings (left) and surviving seedlings (right)

In general, the inappropriate preparation and handling of seedlings harms the initial seedling development of the first years and in particular along the coast it can have negative impacts on the stand stability as trees with poor root development are likely to be uprooted during extreme weather events. Based on this observation, it is possible that during the next rainy season the seedling survival rate could further decline.

As previously stated, while acacia is considered a suitable tree species in many regions of the country, acacia in general is not able to create forest-like structures in the long-term due to decreasing survival rates. Acacia has a rather poor timber quality when grown in sand dunes (see Figure 2), which limits long-term livelihoods opportunities for coastal communities. While *Acacia auriculiformis* is considered inappropriate for the long-term, it is important to keep the initial state of the ecosystem in mind when identifying species to support rehabilitation and restoration efforts. *Acacia auriculiformis* plays a key role as a nurse crop that is able to provide a microclimate while also improving soil conditions, making the site more suitable for future forest stand development (Shono et al. 2007) while at the same time providing protective functions for wind inflicted erosion of sand dunes. Thus, considering the long-term restoration goal to support the reestablishment of native tree species in coastal sand dune forests, acacia plays an important role as a nurse crop which can help to establish the conditions for future restoration

activities using more appropriate native species, which would currently be limited by the marginal site conditions.

The local community's involvement in establishing, managing, protecting and maintaining the pilot site has been a valuable contribution to the pilot project. The community is aware of the ecosystem services provided by coastal forests and how the project can directly benefit their livelihoods. Storm protection, fuelwood, improved soil quality and protection of the local fresh-water reserves were identified by villagers during the field visit as some of the important services that coastal forests can provide. Based on the recognition of the key services provided by coastal forests, villagers are willing to carry out maintenance and protection tasks without receiving direct reimbursement. Their commitment to the plantation is an important success factor and has largely contributed to the positive results observed so far (incl. a high seedling survival rate).

Observations of pilot livelihood models

As mentioned above, three livelihood models were piloted based through a participatory approach with 10 households taking part in each: 1) vegetable gardening, 2) cattle breeding and fodder production, and 3) fish farming.

The vegetable gardening model pilot represents a model which is able to provide returns quickly based on short-term investments. As climate-smart agriculture model crop cultivation is rotating throughout the year, always cultivating certain crops based on specific seasons throughout the year. While there is no project support to marketing, business model development, market improvement or cooperative development the model is already providing farmers with a stable average monthly income of around \$300 (approximately 6 million VND per month) - nearly double the average monthly income of vegetable farmers in the Commune. This is partially due to the fact that participating farmers focus on organic production techniques and can acquire higher prices for their produce. As mentioned by the interviewees the demand for organic vegetables was very high so far, with the marketing so far only coming through word-of-mouth as the information on project involvement in organic production techniques has spread throughout the commune. In addition it was noted that inhabitants from Dong Hoi City (around 50km away) directly buy organic vegetables at farm gate from the respective farmers.

While receiving very positive feedback from interviewed households, it remains to be seen how effective the livelihood models related to fish aquaculture and cattle raising will be. A major challenge for both livelihood models is that they both require a longer initial investment period before receiving financial returns. Participating households who selected these livelihood models have had to cover liquidity gaps from other income sources, as the project only supplied the initial input for the livelihood model. Thus only vegetable farmers so far yield incomes from their livelihood models while the feasibility of other models is still to be shown. While there is no direct linkage between the livelihood models and the coastal protection plantation, both have generally received very positive feedback from the villagers allowing them to increase their adaptive capacities through both protection against climate events and improvement of growing conditions (coastal protection plantations) and diversification of income streams (livelihood models).

2.4 Recommendations for improving and refining EbA measures

2.4.1 Species selection

During the design of the EbA pilot project, only species with substantial experience and silvicultural knowledge were selected. Acacia and casuarina are both well-known species in Viet Nam which made their selection favourable due to the substantial knowledge base on their properties and growing conditions (incl. in sand dunes), as well as they are widely used in the country which ensured that seedlings could be sourced at a cost-effective rate. Limited information is available on native tree species in the sand dunes, and thus during the planning stage such tree species were not considered.

Nonetheless, for the establishment of coastal protection forest it is recommended that additional research and testing is conducted to strengthen the participation of native species within forest restoration and reforestation processes. Based on an inspection of the pilot site and traditional knowledge shared during the interviews, a number of potential native tree species have been pre-identified based on the site conditions for the pilot area in Hoa Binh village:

Table 1: Description of select native species that have been identified as having suitable characteristics for the EbA pilot site

Species	Description of species and growing characteristics
<i>Melaleuca cajuputi</i>	▪ small, hard leaved and light demanding evergreen wood species which serves as an intermediate between microclimate provision, wind erosion protection and party also to reduce strong winds ▪ grows to a max. height of 7m, and can reach an average DBH of up to 25cm ▪ naturally found in the sandy areas of Quang Dong Commune
<i>Myrsine linearis</i>	▪ small woody species frequently found in sandy areas, in a multi-layered stand it is considered a shrub that is able to create an appropriate microclimate for other here listed tree species ▪ Contributes mainly to microclimate generation and wind inflicted erosion, limited potential to protect from storms ▪ grows to a max. height of 5m with DBH of max. 15 cm ▪ native to Quang Xuan Commune, often found in communities with <i>Syzygium corticosum</i> and <i>Lithocarpus concentricus</i>
<i>Lithocarpus concentricus</i>	▪ small tree species that was previously a popular tree species in sandy areas due to its potential to produce both NTFPs (nuts) and firewood ▪ Once established, protects well against storms. ▪ grows to an average height within the range of 7 – 15 m and DBH between 15 – 25 cm ▪ distributed along the coastal areas of central Vietnam
<i>Syzygium corticosum</i>	▪ a species which was well received during interviews with local communities to its potential to contribute to the protection of sandy areas from wind-inflicted erosion, yet limited potential to protect from storms ▪ naturally found in Quang Xuan commune ▪ Average height of shrub 1-3 m

Source: Field observations and interviews

Since the project initially identified casuarina for the additional 5 ha it will be difficult to now completely change the approach, since it had been agreed upon together with the community and other relevant stakeholders. However, it is recommended to adjust the species composition to enhance the effectiveness of the measure. Since the casuarina planting approach has already been officially approved it will follow the same 2m x 1m planting approach as observed with the acacia plantation. In addition, it is recommended to overlay a mixed species planting approach consisting of 20% *Lithocarpus concentricus* and 80% of a variety of melaleuca, myrsine or synzgium native tree species resembling natural plant communities in the area is recommended. This overlaid grid is proposed with 10m x 10m planting distance between natural plant communities, with each plant community consisting of 5 trees (see Section 2.4.3 for more details). In this planting approach casuarina can function as a nurse species, providing a suitable microclimate and enhanced protection for the slower growing native tree species, while at the same time contributing to enhanced biodiversity in coastal forest stands. Eventually a multi layered stand will be created which is able to serve as a well-established bioshield against extreme climate change events, mainly storms.

To operationalize this recommendation, the timely identification of suitable seed/ *mother trees*⁸ will be important to ensure that there is enough time to develop seedlings before the planned planting, season which is starting in September 2017. Given that this will imply a change in the plan to plant 100% casuarina in the remaining 5 ha, the local community and key stakeholders should be consulted to discuss the change and to further discuss the suitability of the aforementioned native species. Factors which might decide the final species selection could be: ecosystem services provided by chosen species, Non-Timber Forest Products (NTFPs) associated with chosen species, maintenance and protection requirements as well as potential growth limitations or external factors such as diseases or pests. Once the desired native species is selected, potential mother trees will need to be identified as soon as possible at sites similar to the project's planting site to identify mother trees with attractive growth characteristics (e.g. disease-free, good growth characteristics, etc.; Adams et al. 1994).

2.4.2 Enrichment of Acacia plantation

As described above, acacia plantations in coastal sand dunes in NCC-VN are important nurse crops, which can create the conditions to support indigenous secondary forest succession in degraded or marginal site-conditions (Dong 2014; Dong et al. 2016). Once the 5 ha Acacia stand is established and stable (after approx. 3-5 years considering slower than normal growth rates under sandy conditions), the next step will be to introduce native tree species into the acacia stand. Such an enrichment process should preferably be carried out by mimicking natural regeneration in artificially created gaps (see Figure 6 below)⁹.

⁸ Seed/mother trees are to supply seedlings for natural regeneration in the seed-which out to be used for replanting the same species. As such, selected seed trees should be the best phenotypes, generally healthy, of good growth form and provide large amounts of seedlings (Adams et al. 1994).

⁹ In both Quang Dong and Quang Xuan commune it was observed that native tree species regenerated under a canopy of initially monoculture Acacia and Casuarina plantations. Displaying good growth characteristics it is assumed that the native tree species were enabled through a beneficial macroclimate provided by Acacia and Casuarina.

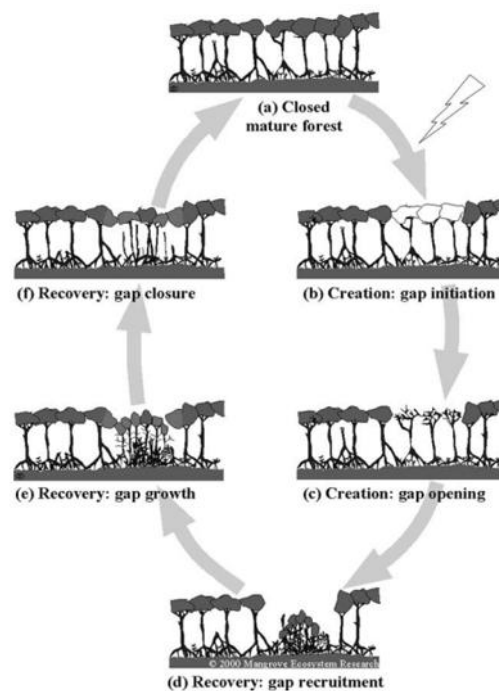


Figure 6: The process of gap creation and introduction of natural regeneration (Schmitt, 2013 and Duke, 2001)

In doing so, greater ecosystem resilience can be achieved while establishing a close-to-nature stand structure based on a more balanced forest composition. Since this is a small-scale approach, the creation of large gaps in the forest must be avoided in order to maintaining the protective function of the coastal forest. However, in order to support the establishment of native species, it will be necessary to clear small plots of several trees within the plantation to create an artificial canopy gap (e.g. Dong 2014; Forbes et al. 2016; Dong et al. 2016). This canopy gap will provide the growth conditions necessary for the establishment of native species (e.g. sunlight) and help mirror natural regeneration patterns.

2.4.3 Planting design

As previously mentioned, the applied planting design for the first 5 ha was based on the planting design for industrial acacia tree plantations with a focus on timber production purposes. Such industrial plantations are usually located in mountainous areas and have completely different site characteristics than sand dunes. In particular, commercial acacia plantations are established in areas with more nutrient rich soils that enable trees to achieve high growth rates. Furthermore, the management objectives between industrial acacia plantations and acacia in coastal protection forests are extremely different. In industrial plantations, the planting design has been designed for such conditions to maximize timber production and the economic benefits per hectare. On the other hand, in coastal protection forests commercial logging is forbidden, and instead management goals focus on maintaining the forests' protective functions. As such, a planting design focused on maximizing the economic benefit from timber harvesting is not relevant

for EbA and coastal restoration in coastal protection forests. Instead, the planting design should rather mimic natural stand structures and natural regeneration.

Yet, since the planting design for casuarina was already officially approved by government authorities and consented by the local community, it will follow a similar approach. While this is not optimal, there are still measures which allow to generate a more natural stand structure over time. In order to mimic such a natural stand structure and natural regeneration patterns, it is recommended that the in-between the 2m x 1m spaced acacia and casuarina plantings a 10m x 10m planting grid with native tree species is added. Each plot should consist of 20% *Lithocarpus concentricus* casuarina and 80% of a variety of melaleuca, myrsine or synzgium native tree species resembling natural plant communities. The proposed seedling spacing is adjusted for the reforestation of acacia and casuarina pilot plantation areas, mimicking tree structures of 5 trees observed along other sand dune ecosystems in NCC-VN (Figure 7)¹⁰.

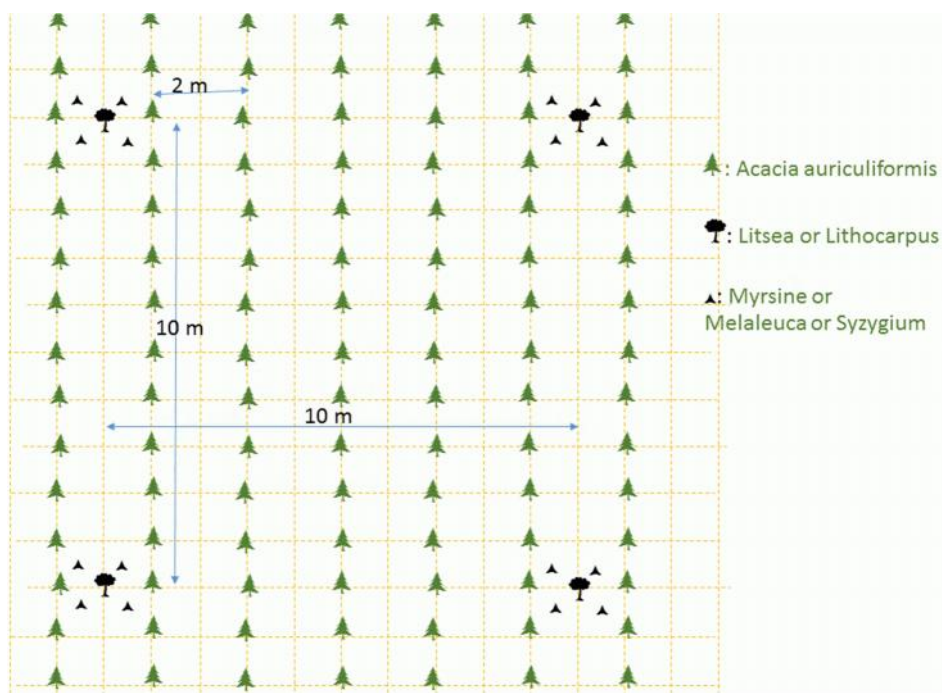


Figure 7: Proposed planting design of native tree species within acacia/casuarina plantations

2.4.4 Improved seedling treatment

As previously mentioned, the seedling treatment applied to seedlings utilized in the establishment of the first 5ha of the pilot project severely hindered the root development of seedlings. This has a negative impact on seedling survival, growth rates and the future overall stability of the stand. Improved seedling treatments should be adopted to encourage healthy root development in seedlings. It is recommended that differently sized seedling containers are used dur-

¹⁰ The recommendations on the planting design are based on field observations. Observations in neighboring communes and similar ecosystems along NCC-VN showed groups of mixed native tree species growing in a distance of around 10m to each other, with each group consisting of 5-9 trees.

ing different stages of nursing and seedling preparation in tree nurseries. In addition, these seedling containers should be open at the bottom, to make sure that there are no physical restrictions that limit root development. Special attention should be given to assessing the quality and characteristics of the soils used when placing the seedlings in containers, ensuring that soft nutrient-rich soils are utilized to support root growth. Soil compaction must be avoided when placing the seedling in containers. When using different sized seedling containers, one option to allow for adequate root development is the so-called '*bareroot*' nursery practice. Riley and Steinfeld (2005) mention that bareroot practices allow nurseries to "... *maximize root development and growth*". Bareroot nurseries do not rely on seedling containers at all, but instead raise seedlings bare rooted after an initial period in ground expecting to maximize root development and growth while at the same time requiring more maintenance (Riley & Steinfeld 2005). While a promising technique, it represents a relatively uncommon practice to Viet Nam and pose adaptation or management challenges as nursery providers are not used to this practice.

As an alternative option in the short and medium-term, seedling containers could be punctured with holes on the sides and in open bottom containers to stipulate air pruning (Riley & Steinfeld 2005)¹¹. While there are MARD-issued and PPC/DARD-implemented guidelines for seedling production in specifically certified seedling companies it might be challenging to implement the above recommendation. In this case direct contact with a certified nursery is recommended in order to discuss about the potential of treating seedlings based on above recommendations; or to develop community nurseries with own standards.

In the specific case of native tree species, as described above, is important to identify mother trees which show positive growth characteristics in similar environments. Once these trees are identified, it will be necessary to collect seedlings from such trees, and prepare them in a community nursery before planting them. The preparation of the seedlings in a community nursery allows for the application of the proposed adjustments to improve seedling treatment, as conventional nurseries are required to follow specific government regulations on seedling treatment and it is unlikely that they would be able to implement such adjustments. Since planting season for the remaining 5 ha is expected to start in September 2017, the identification of mother trees, as well as the collection and preparation of seedlings should preferably be carried out as soon as possible (ideally July 2017).

¹¹ In air pruning, roots which are exposed to air outside of their seedling container are automatically pruned (Riley & Steinfeld 2005). Pruned roots then branch out to develop secondary and tertiary root growth, resulting in a well-developed root system which is able to establish itself effectively and quickly once planted.

3 SUPPORT FOR THE DEVELOPMENT OF A CEA FOR TWO ONGOING EBA PILOT ACTIVITIES IN QUANG BINH AND HA TINH PROVINCES (WP 2)

3.1 Introduction and methodological approach

3.1.1 Introduction

EbA focuses on “... *the conservation, sustainable management and restoration of ecosystems to help people to adapt to the impacts of climate change...*” (IUCN 2017). A challenge in attracting investors is the lack of in-depth studies which provide evidence for the cost-effectiveness of EbA measures. There is a clear need to develop concise and robust studies which demonstrate the cost-effectiveness of EbA approaches which have already been piloted to demonstrate the clear proof-of-concept, and ultimately the competitiveness of EbA as a technically and financially effective approach to climate change adaptation.

To support the mainstreaming of EbA it will be necessary to demonstrate the technical feasibility and the financial effectiveness of EbA measures. Furthermore, EbA measures should be assessed on their suitability for scaling-up taking into account technical, institutional, financial and site-specific considerations.

WP 2 has the following main objectives:

1. Support the development of a cost-effectiveness analysis for EbA measures piloted in Quang Binh and Ha Tinh Provinces, specifically through the provision of methodological guidance for cost-effective assessments and the assessment of data availability and information gaps for CEA for the two pilot measures
2. Assessment of the potential for scaling up EbA measures piloted in Quang Binh and Ha Tinh Provinces.
3. Provision of recommendations for ensuring the long-term sustainability of piloted EbA measures in Quang Binh and Ha Tinh Province.

After describing the approach (Section 3.1.2), relevant background information, including a description of the piloted measures and pilot areas, is briefly presented Section 3.2. Section 3.3 provides guidance to support the eventual implementation of an analysis of the cost-effectiveness of the piloted EbA measures, and further provides the results from an initial analysis of data availability and information gaps for conducting such an analysis. Section 3.4 then presents the results from the assessment of the upscaling potential of the piloted EbA measures. Finally, Section 3.5 outlines the recommendations developed to support the longevity and effectiveness of the piloted EbA measures.

3.1.2 Methodological approach

Cost-effectiveness assessments are utilized to support the identification of “... *the most cost effective option for achieving a set of predefined objectives*” (UNDP 2013). In the case of climate change adaptation, it focuses on assessing the cost-effectiveness for maximizing the adaptation benefit. It is an important tool which especially allows for the comparison of diverse projects that share the same objectives, e.g. EbA measures and grey-engineering measures for climate change adaptation.

Since the EbA measures for both pilot projects have only been implemented in the last 6-12 months there was not sufficient information available at the current state to ensure a robust and well-founded CEA. Thus, together with the client it was decided to focus on supporting the eventual development of a CEA by supporting the following key tasks:

- i. Provision of guidance for conducting a CEA
- ii. Assessment of data availability and gaps for CEA
- iii. Assessment of the potential for scaling up piloted EbA measures
- iv. Recommendations on ensuring the long-term sustainability of implemented EbA measures

To support data collection and information gathering for the following tasks, a field visit was conducted in Quang Binh Province from June 7-10, 2017, where the pilot site was inspected and interviews were conducted with villagers, project staff, and government authorities at the commune, district and provincial level. In Ha Tinh Province it was not possible to conduct a field visit; thus, interviews were conducted with project technical staff, as well as commune, district and provincial government authorities via telephone. Additional project specific resources were provided by the client to further support the completion of this WP.

Provision of guidance for conducting a CEA

Guidance for conducting a CEA was provided by the consultants as requested by the client. Such guidance was developed based on the consultant's own experience in conducting economic analyses, as well as the guidance document for conducting CEAs developed by UNFCCC (2011). Additional insight was provided through the revision of other relevant literature (e.g. Lenvin 1995; Balana et al. 2011; GIZ 2013).

Assessment of data availability and information gaps for CEA

Having presented guidance on how to potentially approach a CEA in the case of the two EbA pilot projects in Quang Binh and Ha Tinh Province, the consultants developed a set of data needs for developing a CEA. This included finding relevant data for input costs as well as other indicators to assess the quantitative and qualitative benefits of implemented EbA measures. Based on the approach described in the guidance, the assessment of existing and required information was based on a revision of existing literature and discussions with relevant stakeholders and actors (e.g. local communities government authorities potentially involved in project implementation and/or NGOs and international organizations active in comparable fields) to confirm the availability of data or identify data gaps.

Assessment of the potential for scaling up EbA measures

In order to assess the potential to scale up EbA measures piloted in Quang Binh and Ha Tinh Provinces, an assessment of the institutional and technical suitability was carried out. Initially socio-ecological systems were assessed. Provided through the project and Provincial DoNREs, these maps were initially developed by the International Centre for Environmental Management (ICEM) and include compiled information on forest type, land use, geology and soils. This was then followed by an institutional assessment which focused on assessing provincial policies in each Province to determine in how far pilot activities would fit in existing plans and in how far these could finance the pilot activities. Key policies and plans assessed include: socio-economic development plans (SEDPs), climate change adaptation plans and climate change action plans. In addition to revising key policies and plans, interviews with provincial authorities were conducted during the field mission or via telephone to help determine if specific areas in each province had already been prioritized for further EbA interventions.

In assessing the technical suitability of EbA measures, it was key to assess the suitability of EbA measures together with the specific site conditions and requirements. This included assessing potential areas where there were similar soil, land use and ecosystem types in both provinces. Based on the results from the institutional and technical assessments, a set of recommendations were developed for each province that identify suitable areas for scaling up EbA measures.

Recommendations on ensuring the long-term sustainability of implemented EbA measures

Developing recommendations to ensure the long-term sustainability of the projects' EbA interventions is of crucial importance since the project will already come to an end in March 2018. Since the EbA measures have just been initially implemented in late 2016, there are still additional inputs required beyond the scope of the project, including the monitoring of intervention success, regular technical support (e.g. capacity building and maintenance of implemented measures), as well as awareness raising in pilot communities. Currently, the projects are beginning to search for potential synergies with NGOs or other development projects that could either support the maintenance of implemented measures to ensure the longevity of the applied approaches, or to support the upscaling of EbA activities in the future (see the following component of WP2). The consultants assessed the two pilot projects and developed recommendations to support the long-term sustainability and maintenance of implemented EbA measures. Recommendations were developed based on a literature review and research on similar approaches, a field mission to Quang Binh Province and stakeholder interviews (in person and via telephone).

3.2 Description of pilot projects

3.2.1 EbA Pilot Project Ha Tinh

The GIZ is implementing an EbA pilot project in Son Tho Commune within Vu Quang District in Ha Tinh Province in NCC-VN. Son Tho commune is about 70 km from the Provincial capital in the mountainous Northwest of the Province. The commune covers 4,591 ha, which consists of 3,465 ha forested land (75.5% of the total area), 668 ha agricultural land (14.5% of the total area), and

290 ha that are classified as ‘other’ land use (6.3%). Approximately 2,715 residents (756 households) live in the commune within 10 villages (Lien et al. 2017). The pilot village, Village 1, is located in the northernmost part of Son Tho Commune. The village owns 413 ha of land, where 180 ha correspond to native secondary forest and 160 ha are used for monoculture acacia plantations. There are 114 households in the village with an estimated population of maximum 500 inhabitants.

Extreme droughts with hot spells and dry winds make up most of the communes weather conditions from March to September, with temperatures peaking up to 41°C. Followed by heavy rains and storms in October and November which are regularly causing flooding, flash flood, and landslides. Cold and rainy periods dominate from December to February.

Ecosystems in the commune include mostly native forests and acacia monoculture plantations. Besides Acacia plantations the main income source comes from agricultural production such as paddy rice, cassava, sugar cane and maize cultivation as well as, perennial tree crops and home gardens. Based on this the socio ecological system was defined as “...*moist tropical forest, mainly utilized through Kinh smallholder inland valley paddy rice cultivation and tree crops (acacia, citrus, rubber, tea)*” which is considered one of the most relevant socio-ecological systems in Ha Tinh province (ISPONRE et al. 2016).

Unplanned conversion, illegal logging and unsustainable land use have led to forest loss of 13,536 ha and forest degradation of 36,685 ha in Ha Tinh Province during the time period of 2000 – 2010 (MARD and FCPF, 2016). Deforestation due to unsustainable land management practices as a result has led to an increased vulnerability of the local community and ecosystems to extreme climate events and natural disasters including landslides, flashfloods and storms.

Hence, Village 1 was identified as priority intervention area for the project pilot with the objective to improve resilience to and reduce impacts from extreme climate change events, while also enhancing the provisioning ecosystem services and improving/diversifying livelihoods for rural communities. The overall EbA pilot activity implemented is considered as a form of natural forest protection and enrichment to improve soil quality and to protect from soil erosion, flash floods and storm impacts. A forest area owned by ten households comprising 40 ha was divided through a four slope approach¹² which is expected to ensure: 1) provisioning services such as improved surface water regulation and food security, 2) regulating services including ground water and soil improvements, and 3) supporting services such as habitat for native tree species and improved pollination for cultivated crops (Lien et al. 2017). The following Table provides a brief overview on the proposed four slope approach.

¹² The four slope approach is characterized by dividing a certain (slope) area in 4 sections based on topography. Each slope section would then be managed and used based on the initial state of the slope sections ecosystem and its suitability to contribute to water provision, reduced soil erosion and macroclimate regulation.

Table 1: Overview of 4 slope system applied in Ha Tinh Province

Slope section	Intervention “technology”	Component	Anticipated impacts
Upper section	Forest enrichment in natural forest	- Native tree species should be considered for planting: <i>Castanea sativa</i>, <i>Calophyllum soulattri</i>, <i>Michelia mediocris</i>, <i>Erythrophloeum fordii</i>, <i>Manglietia conifera</i> - NTFPs (e.g. nuts, herbs, mushrooms)	Short-term: - Seedling and tree survival rates - NTFP-based incomes - Reduced soil erosion Long-term: - Reduced soil erosion, flood prevention - Reduce impacts of storms – wind breaks - Micro climate regulation
Upper middle section	Permanent plantation with selective cutting, stands with mixed age/species	- Maintain planted acacia in allocated natural forest; - Introduction of native trees in recently harvested plots, e.g. <i>Morinda officinalis</i>; <i>Arachis pintoi</i> - Installation of bee-hives	Short-term: - NTFP income generation - Reduced soil erosion - Reduced storm damage, - Pollination Long-term: - Reduced landslides, in-situ soil moisture recharge
Lower middle section	Agroforestry with hedgerows along contour lines for fodder and green manure	- Fruit trees and annual crops under <i>Morinda officinalis</i> as shade tree with - Beehives - Multipurpose hedgerow e.g. <i>Leucaena leucophala</i>	Short-term: - fodder grass, honey - Reduced soil erosion - Increase income sources from fruits and nursery - Pollination, biological pest control - Reduced soil degradation Long-term: - Microclimate regulation; reduced water stress
Plains (low-land)	Intercropping based on seasonal weather forecasts Soil improvement with compost, bio-char, biological pest control	- Two rice harvests/year - Short-duration crops (e.g., maize, peanut, beans) - Cassava with legumes for poor soils - Sugarcane	Short-term: - Reduced exposure of crops to extreme weather events - Yield/income increase - Improved soil carbon and nutrient status Long-term: - Stabilized water regulation

Source: Adapted from Lien et al. 2017

3.2.2 EbA Pilot Project Quang Binh

The EbA measures implemented in the pilot project in Quang Binh Province involve the restoration of 10 ha of coastal forests (using acacia and casuarina as nurse crops) on exposed and degraded sand dunes along the coast of Hoa Binh Village. This pilot project is described in detail in Section 2.2.

3.3 Key considerations for CEA development

3.3.1 Methodological guidance

Cost-effective analyses consist of five main steps (UNFCCC 2011):

- vi. Identification of the adaptation objective and potential adaptation options to compare
- vii. Establishment of a baseline
- viii. Quantification and aggregation of the costs for implementing select adaptation options
- ix. Determination of the effectiveness of the select adaptation options (whether it yields a desired result – i.e. climate change adaptation), and
- x. Comparison of the cost effectiveness of the different adaptation options.

The following sub-sections will present these steps in greater detail, and discuss their relevance and key considerations within the context of the two EbA pilot projects.

Identification of the objective and potential adaptation options to compare

An initial step in conducting a cost-effectiveness analysis is to identify the objective and scope of the analysis (UNFCCC 2011). In this case, the overall goal would be to assess the cost-effectiveness of EbA measures to support climate change adaptation. The specific objective which is to be compared will need to be further defined as it needs to be a clear, realistic and measurable objective. For instance, this could focus on reducing vulnerability, strengthening adaptive capacities or resilience, or enhancing the provision of certain ecosystem services (UNFCCC 2011). Other measurable benefits could include ecosystem health, e.g. through productivity and diversity of the ecosystem, or the provision of economic benefits, e.g. through increased net income or access to natural resources (Espinosa-Romero 2011).

The more detailed the study, the better the evaluation of the overall cost-effectiveness of such an approach. Selected options for comparison within a cost-effective analysis should cover diverse intervention options, which are “...*wide-ranging and creative*” (Lenvin 1995, p. 382). In this context, it will be necessary to identify the specific adaptation options which should be compared. This can include comparing an EbA approach with a do-nothing scenario, with other EbA approaches, and/or with grey-adaptation measures.

For the pilot project in Quang Binh options could include, for instance:

- Coastal protection measures involving reforestation on exposed degraded sandy dunes in protection forests (further differentiation could be made on the types of species utilized)
- Grey-adaptation measures (e.g. surge barriers, seawalls, dykes, etc.)

In the case of Ha Tinh options could include, for instance:

- Development of earth dykes with tree planting on the dyke banks against both floods and strong winds
- Monoculture Acacia plantations to reduce potential storm impacts
- Concrete walling of steep areas prone to soil erosion
- Concrete river dykes to prevent floods

In general, the selected options for the analysis should lead to similar outputs and hazard reduction (UNEP 2017). This would imply the comparison of adaptation measures, which have similar results in supporting climate change adaptation.

Baseline development

Once the specific objective of the cost-effectiveness analysis has been determined and the options to compare are selected, the next step is to describe the baseline for the assessment (UNFCCC 2011). The baseline is considered as the '*business as usual*' (BAU) scenario, which reflects the conditions in the project area without the adoption of any projects (i.e. the current and unchanging situation). The baseline should take into account diverse characteristics including climatic conditions¹³, socio-economic indicators (incl. livelihood information), land use practices, and any past developments (Lenvin 1995). Past and planned (unrelated) developments should also be considered to help develop a future scenario without project interventions. This information allows a well-informed comparison of the expected impacts from assessed interventions (e.g. EbA measures, grey adaptation measures, etc.).

The baseline should also take into account existing projects and efforts that are supporting communities in the project area to adapt to climate change. Since communities themselves adapt to climate change autonomously over time it is important to separate results attributed to autonomous adaptation efforts to prevent the misinterpretation of derived cost-effectiveness ratios. As such it will be necessary to note relevant adaptation-related activities that have already been implemented by the communities themselves, as well as other related projects (planned or undergoing implementation) related to climate change adaptation and sustainable land use in the project area (GIZ 2013).

Quantification and aggregation of the costs

Quantifying and aggregating costs for implementing the selected adaptation measures is the next step once the baseline has been clearly established (UNFCCC 2011). Three main costs should be taken into consideration for the assessed adaptation measures (UNEP 2017):

- implementation costs,
- potential opportunity costs, and
- potential environmental costs.

¹³ A description of both past and potential future climate change events which could be derived from official sources and publicly available climate models (e.g. Christensen et al. 2007 or van Oldenbourg et al. 2013). Past and potential future climate should be described through a change of temperature, site specific factors (such as precipitation for mountainous areas or sea level rise for coastal areas) as well as the type and severity of extreme weather events (GIZ 2013).

Implementation costs refer to costs that are directly related to the implementation of the measure (e.g. costs for staff, materials, maintenance, monitoring, etc.). Opportunity costs describe the difference in economic and non-economic (e.g. ecosystem service) gains from one option over another. UNEP (2017) highlights two key questions to support the identification of opportunity costs: i) whether there is a more attractive but equally resilient alternative adaptation measure, and ii) whether or not there are additional or enhanced ecosystem services provided by the alternative adaptation measure. Environmental costs are based on the potential environmental degradation, which could occur due to the implementation of the adaptation measures (i.e. the loss of monetary value of ecosystem services; UNEP 2017).

Estimating the effectiveness of assessed adaptation options

Once the costs have been identified, it will be necessary to estimate the effectiveness of the selected adaptation measures in meeting the pre-defined objective (e.g. increased resilience, adaptive capacity, reduced vulnerability etc.; UNFCCC 2011; UNEP 2017). Each measure will be assessed, based on the baseline, to determine the effectiveness of the adaptation options in supporting the select objective related to climate change adaptation. For example, a case study in Brazil studied the cost-effectiveness of Dengue control strategies, where the effectiveness focused on the measures' ability to reduce the average number of disability-adjusted life years (UNFCCC 2011). Another study conducted a cost-effectiveness analysis in the Pacific Islands, where the effectiveness of the study focused on the ability of adaptation measures for securing freshwater resources, where the effectiveness of the measures focused primarily on the water harvesting potential per adaptation option assessed in liters per person (UNFCCC 2011). Thus, the selection of an appropriate measurable objective for the assessment is key (step 1), along with the establishment of a detailed and realistic baseline which provides a strong basis from which future impacts can be estimated (step 2).

Comparison of the cost-effectiveness of assessed adaptation options

Finally, after the implementation of the four previous steps, the cost-effectiveness of the assessed options can be compared (UNFCCC 2011). According to UNFCCC (2011) there are two main ways to present cost effectiveness results:

- i. *Incremental cost-effectiveness ratio*: the cost/unit of effectiveness for the comparison of two options. It is the most relevant way to approach to assess different adaptation options when numerous approaches will be adopted at the same time (i.e. in combination). It can be calculated using the following calculation:

$$\text{Incremental Cost-Effectiveness} = \frac{\text{Cost of Option A} - \text{Cost of Option B}}{\text{Effectiveness of Option A}^* - \text{Effectiveness of Option B}}$$

**where Option A is the most effective option assessed*

- ii. *Overall cost-effectiveness ratio (per measure)*: displays the effectiveness as the cost per unit of effectiveness (based on the measureable objective identified in step 1 and measured in step 4). It is the most relevant approach when only one measure will be implemented, and thus allows for the individual assessment of cost-effectiveness ratios. It can be calculated using the following calculation:

$$\text{Overall Cost-Effectiveness} = \frac{\text{Cost of Option A}}{\text{Effectiveness of Option A}}$$

Based on this assessment, the measure with the lowest cost-effectiveness ratio represents the most cost-effective measure.

3.3.2 Data availability and gaps for CEA in Ha Tinh and Quang Binh

Based on the approach described in Section 3.3.1, the data required to conduct a CEA for the two pilot projects in Ha Tinh and Quang Binh Province were identified and their availability assessed. The following section provides an overview on data availability in each province for the identification of a baseline scenario, intervention alternatives and potential costs and effectiveness indicators.

While the project intervention itself was clearly identified for both provinces, alternative interventions were not. Interviews left the impression that ‘do nothing’ is a currently applied option. Yet this does not allow for comparability as the overall target should reduce vulnerability, strengthen adaptive capacities or resilience, or enhancing the provision of ecosystem services (UNFCCC 2011). As such potential intervention options could be found in literature (see Table 2 below) or additional in-depth consultation with government authorities would be required.

Table 2: Overview on data availability and sources for project intervention and potential alternatives

Data	Availability QB Province	Availability HT Province	(potential) source
Project intervention	yes	yes	Project document
Alternative interventions	no	no	- other projects - consultations - literature (Cat et al. 2009; Mai et al. 2009; Thao et al. 2014)

It was found that adequate information and data to generate a baseline was available for both provinces. Part of this information is directly based on the project document while other has been identified through available literature or is available at provincial authorities, mainly DPI, DoNRE and DARD. While government owned data was not available to the consultants it is known that this data is available and could potentially be obtained by the project. In order to add another level of detail it is recommended to carry out consultations and community interview, which allow to improve the informational bases on past and current land use practices and potential autonomous interventions. A summary of these data needs and sources can be seen in Table 3 below:

Table 3: Overview on baseline data needs and availability

Data	Availability QB Province?	Availability HT Province?	(potential) source
Project Area	yes	yes	Project document
Project lifetime (yrs)	30	30	Assumption
Past and current climate impacts	partly	partly	- official documents / public records - Scientific journals (e.g. Thao et al. 2012; Nguyen-Thi et al. 2012; Thuy et al. 2017; Cat et al. 2006; etc.)
Other active projects	yes	yes	- DPIs - Other projects
Currently practiced land uses	yes	yes	- Consultation and community interviews - Land Use Plans
Autonomous adaptation measures	yes	yes	Consultations and community interviews

As outlined in Section 3.3.1 an assessment of cost is required to be able to compare the proposed intervention with its potential alternatives. While detailed implementation costs are available for the project intervention, opportunity and environmental costs were not available. In addition costs for potential alternative interventions could not be identified as this requires the initial identification of alternative intervention options. Sources could be found in literature, government documents or cost norms or through additional consultations (see Table 4).

Table 4: Overview of intervention costs and potential sources

Data	Availability QB Province	Availability HT Province	(potential) source
Implementation costs project intervention	Yes	yes	Project document
Implementation costs alternative interventions	No	no	- Gov't cost norms - other projects - consultations - literature (Hillen et al. 2010)
Opportunity costs of project compared to alternative interventions	No	No	- Gov't documents - other projects - consultations - literature
Environmental costs of project intervention	No	no	- Assumptions - Literature (Dicks et al. 2014, Munro et al. 2012, etc.)
Environmental costs of alternative interventions	No	no	- Assumptions - literature (Dicks et al. 2014, Munro et al. 2012, etc.)

Eventually effectiveness indicators were assessed (see Table 5 below). While the project document includes effectiveness indicators on general project implementation, these were too general to apply to comparing project intervention with potential alternatives. In general, effectiveness indicators should be based on information needs of decision makers, which would require in depth consultation with provincial level authorities.

Table 5: Overview on effectiveness indicators and their potential sources

Data	Availability QB Province	Availability HT Province	(potential) source
Effectiveness indicators of project intervention	No	no	▪ Assumptions ▪ Literature ▪ Consultations/stakeholder expectations
Effectiveness indicators of project intervention	no	No	▪ Assumptions ▪ Literature (UNFCCC, 2011; Espinosa-Romero, 2011; etc.) ▪ consultations/stakeholder expectations

With the exception of the implementation costs associated with the two EbA pilot projects, the availability of other relevant data for a cost-effectiveness assessment is very limited in both provinces. In terms of the EbA measures, they are both in the early implementation stages during which they are still too new to present measurable benefits. It will be possible to immediately assess benefits from the implemented livelihood models after first yields have been quantified. Yet benefits from planted forest stands in order to reduce negative climate impacts such as storms will not be apparent in the first years after planting. Initial benefits are assumed around the age of 5-7 years, reaching their potential peak protection performance between 10 and 20 years of stand age (Forbes and Boradhead, 2007). In order to be able to assess effects of the proposed EbA measures immediately it is recommended to investigate neighbouring communes with similar ecosystems, which might have representative examples available (in the case of Quang Binh native tree species stands have been reported by communes neighbouring to Quang Hung commune).

A challenge in conducting this assessment was the lack of available information about preferred alternative measures for coastal protection and climate change in NCC-VN. As such, it was not clear what would be the main approaches to compare with EbA for coastal protection and climate change adaptation. Government planning documents do not specify potential alternative interventions, and grey adaptation measures for coastal protection are relatively scarce in NCC-VN. Further discussions are required with government officials to determine what would be the preferred grey adaptation measures to compare with the EbA findings within a cost-effectiveness analysis. This also allows to better understand the willingness to invest into such measures, while assessing potential bottlenecks such as limited budget or lack of awareness of potential hazards. To identify potential measures a more detailed review of grey-adaptation investments in neighbouring provinces would be required. Nonetheless, cost information for the implementation costs for certain grey-adaptation measures, such as dykes and surge barriers, exist for

some provinces, especially in the South of Viet Nam. These, or literature sources from other countries, could be used to develop rough cost estimates for grey-adaptation alternatives (e.g. Hillen et al. 2010, Hudson et al. 2015, government cost norms and project experiences from infrastructure interventions in the Mekong Delta). Once it is clear what alternative investments could be it is important to use conservative estimates in order to neither overestimate costs nor potential benefits.

While data for natural disasters and extreme events on national level are available through public institutions and research, data gathering proved challenging at the province, district and commune level. The lack of such local level data prevents accurate results and makes comparability with other solutions applied domestically more challenging. A potential source for improved local level data sources could be the international disaster database (<http://www.emdat.be/>). Identification and collection of local data should be of high priority in order to ensure accurate results for the Cost-Effectiveness Analysis.

While a Cost-Effectiveness Analysis helps to determine the most effective solution for the least cost it fails to take potential monetary benefits into account. To inform decision makers such information might be of high relevance and as such should also be considered in the analysis. In order to quantify potential benefits the below Table 6 provides initial guidance on which benefit categories ought to be considered and where potential sources of information could lie.

Table 6: Overview of potentially quantifiable benefits

Data	Availability QB Province	Availability HT Province	(potential) source
Avoided damages	partly	partly	- Assumptions - field observations - literature
Income generation	partly	partly	- Assumptions - field observations
Co-Benefits	partly	partly	- Assumptions - field observations
Improved Ecosystem services	partly	partly	- Assumptions - field observations - literature (Cat et al. 2006; Van Hue & Scott, 2008; CRES, 2004; potential additional Vietnamese literature)

3.4 The potential for scaling up EbA measures piloted in Ha Tinh and Quang Binh

3.4.1 Ha Tinh Province

In order to upscale the project approach of Ha Tinh Province it is recommended to liaise with organizations and local governments which have the technical capacity to carry out trainings for local communities on participatory farming and sustainable landscape management. Such capacity building measures should be preferably jointly implemented by both DARD and DoNRE to be able to maximize the effects of EbA interventions through the use of available synergies and resources (e.g. extension services are provided by line agencies of DARD that are operational at the local level, whereas DoNRE operates only at the provincial and district level without field level implementation staff). Capacity building should always consider sustainability, hence Training of Trainers (ToT) would allow to continue capacity development even after the project ends. Such ToTs could, in addition to the above mentioned technical trainings, further cover awareness raising on EbA/ and climate change issues as well as trainings for policy makers on sustainable development planning.

Interviews with key stakeholders identified that there is a set of NGOs, research and/or development organizations which can potentially support upscaling processes or enhance the longevity of the pilot measures. Such organizations include the Farmers' Union, the Consultative Group for International Agricultural Research (CGIAR), Belgian Technical Cooperation (BTC), Centre for Environment and Community Assets Development (CECAD), Scottish Rural Development Programme (SRDP) and the International Fund for Agricultural Development (IFAD), among others. Each of the above mentioned organizations offers potential synergies and shared goals. While some organizations may be better equipped to support technical implementation, others may be able to finance the replication or expansion of piloted EbA measures. To tap synergies early on, it is important to directly contact these organizations to jointly discuss on potential synergies for scaling up the projects EbA pilot activities.

Based on the analysis of socio-ecological systems in Ha Tinh Province (Figure 8) and the revision national/provincial policy documents (ISPONRE, 2009; the Climate Change Rapid Action Plan of Ha Tinh Province, 2016) Huong Son, Huong Khe and Duc Tho districts were identified as the most suitable areas for scaling up the projects piloted EbA measures.

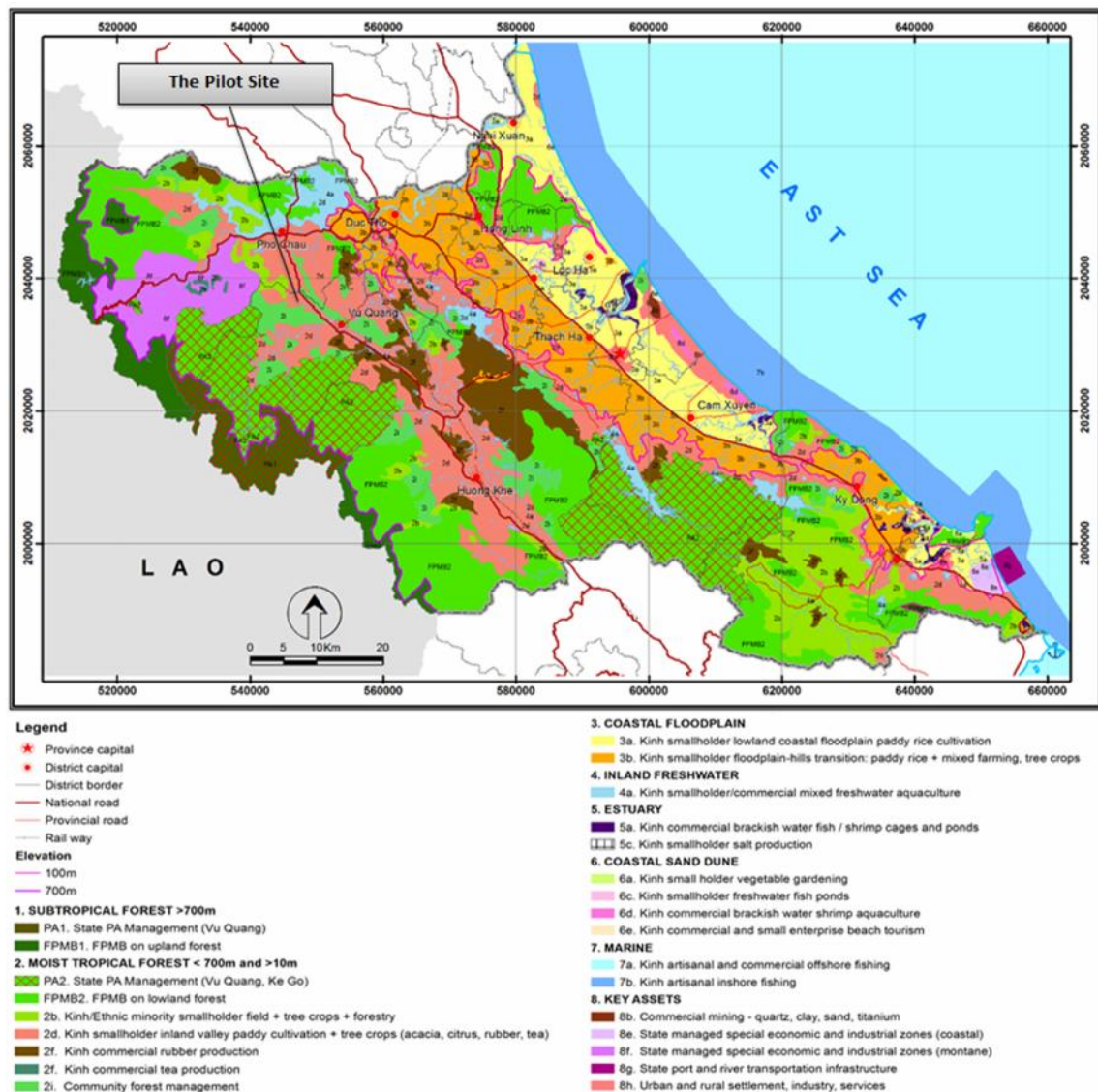


Figure 8: Overview on Socio Ecological systems of Ha Tinh Province

Source: Map provided by GIZ (ISPONRE et al. 2016))

For a more site specific upscaling approach a prioritization of communes should be carried out within the mentioned districts which are regularly affected by floods and storm events (ISPONRE, 2009), and are considered high priority intervention areas for EbA measures. According to the Climate Change Adaptation Plan of Ha Tinh Province (2011), the protection of local livelihoods was identified as one of the priorities for the aforementioned mountainous districts which share similar socio-ecological systems¹⁴, allowing for the replication of the piloted EbA measures. Consultations or focus group discussions with commune staff of each district (leader representatives, officer in charge of cadastral, agriculture, environment) as well as a detailed assessment of district-level reports on climate change impacts should be carried out.

¹⁴ The socio-ecological system of Son Tho Commune and Vu Quang District is defined as 'Kinh smallholder inland paddy cultivation with tree crops' (classified as light red number 2d in Figure 5)

3.4.2 Quang Binh Province

According to stakeholder interviews and based on a socio-ecological analysis, three coastal communes in the direct vicinity of the current EbA pilot were identified as suitable /priority areas for upscaling. According to provincial and commune representatives, Quang Xuan, Quang Tho and Quang Long commune have been identified as highly vulnerable to potential climate change impacts, and as such are considered to be priority areas for scaling up EbA and adaptation measures. The most relevant socio-ecological systems in Quang Trach Districts are characterized as “...forest protection management boards on sand” and “...Kinh¹⁵ small scale vegetable growing on sand dunes” (categories 9a and 9b respectively) as depicted in the following map of Quang Binh Province (Figure 6, ISPONRE et al. 2016)). The coastal area of Quang Trach district is generally considered as priority since other large coastal stretches in the center of the province are currently focusing on supporting the development of tourism and aquaculture activities. Other suitable areas could include the two southernmost districts of the province, namely Le Thuy and Quang Ninh.

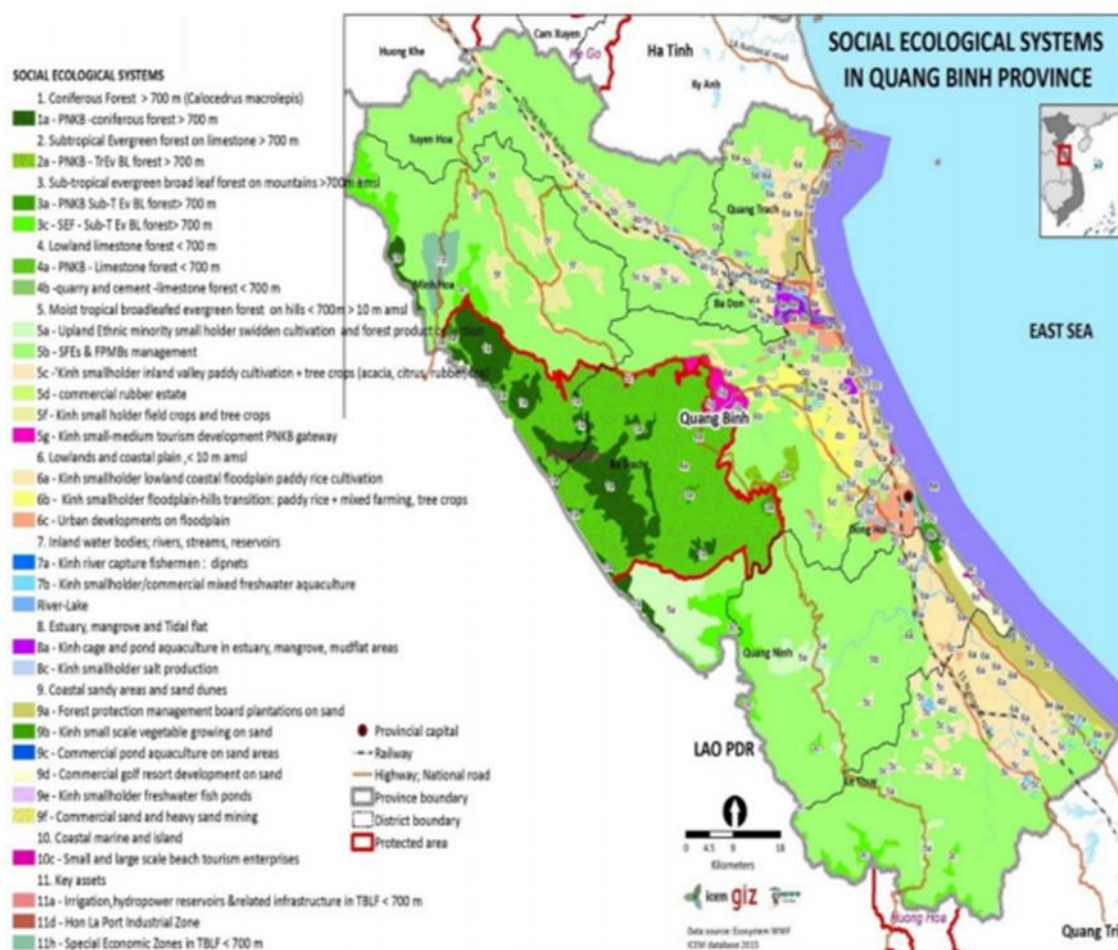


Figure 9: Overview on Socio Ecological Systems of Quang Binh Province

Source: Map provided by GIZ (ISPONRE et al. 2016)

¹⁵ Kinh is the ethnicity of Vietnamese people

Again, a further prioritization of proposed upscaling areas within each commune should be carried out based on consultations or focus group discussions with commune and village representatives in order to find the most suitable implementation areas.

In the meantime a large potential for financing the scaling up of EbA measures, especially for coastal protection forests, could come from other organization and projects, such as the upcoming World Bank funded Vietnam Forest Sector Development and Coastal Resilience Enhancement Project, which, according to province level sources, intends to fund coastal protection activities with a budget of \$18 million in Quang Binh Province. In general a more detailed feasibility study would be required which can specifically assess domestic, international and local funding, support and upscaling sources. This would need to identify and quantify where potential funding sources are, how these could be accessed in detail and to what specifically they could contribute.

3.5 Recommendations to ensure the long-term sustainability of piloted EbA measures in Ha Tinh and Quang Binh

While the EbA project activities end in December 2017, the implemented EbA measures will still require ongoing support in terms of capacity building, upscaling and monitoring in order to ensure the sustained effective implementation of the pilot projects. Such support can be ensured through the coordination and cooperation with local NGO's and other development organizations/projects to follow up with specific measure of the pilot sites. The following Table provides an overview of NGOs and development organizations that are active in one or both provinces:

Table 7: Overview of development projects and NGOs in HT and QB Provinces

NGO/Organization/Project	Province	Focus/Funding/Additional
CGIAR	Ha Tinh	- Research programme on climate change, agriculture and food security. - Technical advice to farmer unions
Belgian Technical Cooperation	Ha Tinh	Integrated Water Management
Centre for Environment and Community Assets Development	Ha Tinh / Quang Binh	Agricultural development and diversification
Scottish Rural Development Programme	Ha Tinh / Quang Binh	Agricultural and rural development
International Fund for Agricultural Development	Ha Tinh / Quang Binh	- Improvement of income in upland areas - Reduction of vulnerability of rural households
World Bank	Ha Tinh / Quang Binh	- Plantation of coastal protection forests - Financial & capacity support for forest owners
GIZ – follow up to current EbA project	Ha Tinh / Quang Binh	- Follow up on current EbA Project - Deriving lessons learnt for policy makers
Japan International Cooperation Agency	Ha Tinh / Quang Binh	Financial and technical support to Protection Forest Management Board

For further public sector support through DoNRE/DARD or the CPC, it is important that the current stand-alone pilot projects are referenced within provincial and district planning documents, which then allows for government budgeting support (and potentially also scaling up) for the interventions. While the current 5 year SEDP is still running until the end of 2019, this timeframe allows the pilot projects to produce visible results, which can then be incorporated into the following five year plan (2020-2025). Such a proof-of-concept as a visible ‘success story’ is required to prove to provincial law makers that the pilot measures are worth maintaining and upscaling.

A set of EbA measures at the local level could also help to ensure both long-term sustainability and scaling up. Therefore, it is recommended to develop Farmer Field School (FFS) or Peer to Peer (P2P) learning approaches so that local communities can exchange knowledge and build capacities within themselves. This helps to share and improve knowledge and management practices applied. It is recommended that such FFS or P2P approaches are facilitated by district and commune authorities in order to ensure adequate capacity building and development of local communities.

For Quang Binh, it is recommended to develop specific business models for the coastal protection forests in order to create direct benefits for local communities, which then also help to ensure longevity through potential financial independence. Being categorized as protection coastal protection forests active logging of trees is not allowed, yet the use of NTFPs or other products is permitted. Therefore, it is recommended to develop a business model for the soon to be planted native tree species order to make them more appealing to local communities through providing a direct economic incentive. Such business models, based on specific native tree species, could include using *Melaleuca cajuputi* leaves for medicinal purposes (essential oils) as practiced in Thua Thien Hue Province or *Lithocarpus concentricus* nuts for food.

In order to produce essential oils the leaves of *M. cajuaputi* will be collected, boiled and pressed, extracting the oil eventually. It is commonly used in Northern Central Vietnam to generate soothing scents which are said to relax body and mind. While no detailed information on market size and demand is available, the use of these oils is commonly observed in both rural and urban areas. The economic returns per ha are estimated conservatively at \$1,500/year, which is similar to the nuts of *L. concentircus*, which are estimated at \$ 2,000 per household/year. These nuts are roasted or boiled and sold for food roadside throughout Vietnam.

Table 8: Output overview on potential business models from native tree species

Business model	Potential harvest/ha/year	Potential financial benefits
Essential oils from <i>M. cajuputi</i>	20l/ha/year	\$ 1,500 household/year
Nuts from <i>L. concentricus</i>	60kg/ha	\$2,000 household/year

4 WP 3: CBA OF AN EbA MEASURE WITHIN THE ICMP

4.1.1 Introduction

The GIZ's Integrated Coastal Management Program (ICMP) aims to “...support the Vietnamese authorities in preparing the coastal area for a changing environment and to lay the foundations for sustainable growth” (GIZ 2016, p.1). With ongoing erosion throughout the coastline of the Mekong Delta, part of the program has focused on supporting the development of a set of effective site-specific interventions for coastal protection. Both grey-adaptation and EbA adaptation measures were considered and have been thoroughly assessed in the region. Schmitt et al. (2013) highlight the importance of having an integrated approach containing “...a diverse suite of adaptation strategies” (p. 553), to strengthen adaptive capacities to climate change and to take into account the diverse site-specific conditions along Viet Nam's coastline. In this sense, neither grey adaptation measures, nor EbA measures represent a *one-size-fits-all* solution. In some areas grey adaptation measures may be necessary while in other areas diverse ecosystem-based approaches may be more appropriate.

It is important that detailed feasibility assessments are conducted to identify the suitability of proposed measures based on environmental, political, technical, and socio-economic considerations. One economic tool which can be useful in assessing the suitability of such measures, is cost-benefit analysis (CBA). CBA is useful to assess the efficiency of investments (in this case the financial investment spent per monetized adaptation benefit), and can assess diverse alternate investments that have different impacts (UNFCCC 2011). For instance, it is possible through this tool to evaluate different scenarios, such as doing nothing, implementing EbA and implementing different grey adaptation approaches, to identify which adaptation measure represent the most efficient approach based on monetized costs and benefits¹⁶.

The objective of this WP is to conduct a sample CBA to demonstrate how such an analysis can be conducted and its relevance for EbA studies. The CBA focused on the following two measures for coastal protection and climate change adaptation:

- The application of bamboo T-fences to support mangrove restoration (an EbA measure): fences made out of [locally sourced] bamboo which form a 't-shape', which act as a natural barrier against strong waves yet allow water, sediments and aquatic animals to move independently, resulting in increased biodiversity and improved conditions for mangrove rehabilitation in fenced areas (GIZ 2012; Schmitt et al. 2013). Additional mangrove planting activities can be combined with the application of t-fences to assist mangrove rehabilitation which further strengthens the resilience of coastal ecosystems and communities.
- The construction of hollow breakwaters (a grey-adaptation measure):

¹⁶ While a useful tool for comparing alternatives for climate change adaptation, it should be noted that the approach is only able to use monetized benefits and may exclude other benefits, which may be difficult to express in monetary terms (UNFCCC 2011). As such, CBA should be conducted in cooperation with other assessment approaches, including stakeholder consultations, which also focus on qualitative and non-monetized benefits that may not be considered within CBA.

Hollow breakwaters are concrete based constructions, similar to a wall, located around 200m off shore. While there are different designs applied, breakwaters are generally identified as taller than average wave height in order to reflect waves. In some cases of along the Mekong Delta hollow breakwaters are filled with large stones in order to decrease sediment fluctuations and keep sediments caught within the breakwater allowing for the development of mudflats and mangrove regeneration.

This comparison is based on actual implementation scenarios where GIZ ICMP implemented T-Fences combined with mangrove rehabilitation in Soc Trang and Bac Lieu Provinces while government investments in Ca Mau Province focused on different infrastructure investments (in this case hollow foreshore breakwaters)

Data to support this assessment were provided by the ICMP. It should be noted that this analysis is a rough desk-based CBA, which aims to demonstrate the main steps and considerations for conducting a CBA. For decision-making purposes a more detailed assessment should be conducted, which further involves the triangulation of information and additional fieldwork to strengthen the robustness of the assessment.

4.1.2 Methodological approach

The methodological approach applied for this WP is based on that of UNFCCC (2011), and includes the following main steps¹⁷:

- i. Agreement on the adaptation objective and identification of potential adaptation options
- ii. Quantification and aggregation of the costs
- iii. Quantification and aggregation of the benefits
- iv. Comparison of the aggregated costs and benefits

Agreement on the adaptation objective and identification of potential adaptation options

The adaptation objective was defined to be coastal protection focusing on avoided losses from natural hazards and the provision of other ecosystem services. Together with the client, it was decided that the analysis would focus on conducting a CBA for bamboo T-fences applied in the Mekong Delta (EbA measure). To demonstrate the comparative power of CBA, it was then decided to compare bamboo T-fences combined with mangrove rehabilitation with the construction of hollow foreshore breakwaters (a grey-adaptation approach).

¹⁷ For a more detailed description of the CBA methodology refer to the publication by UNFCCC (2011)

Establishment of a baseline

The establishment of the baseline followed the guidance provided in Section 3.3.1. Information to support this step was provided by the client and ICMP staff, as well as in secondary literature and government documents.

Quantification and aggregation of the costs

The identification of costs followed the guideline presented in Section 3.3.1, focusing on the identification of implementation costs, potential opportunity costs, and potential environmental costs. Specific data for identifying the direct and indirect costs (such as maintenance, harvesting of mangrove for firewood or co-management cost) were provided by ICMP staff, as well as government literature (e.g. government cost norms) and other key publications (e.g. Salem & Mercer, 2012).

The main cost variables utilized for this assignment can be found in the following table. T-fence costs focused on the initial construction costs, and then the maintenance costs for a period of 5 years (assuming these costs would be equivalent to 10% of the construction costs per year). Based on actual construction cost one km of breakwater installation is assumed at \$90,000 with an estimated 3% of the initial investment as maintenance cost for the first 3 years.

Table 9: Overview of key cost variables for used for the CBA

Description of Cost Variable	Unit	Value
EbA Measure – Bamboo T-fences and mangrove restoration		
Cost T-Fence construction	USD/m	55.00
T-Fence Maintenance (10% annually for 3 years)	USD/m	5.50
Cost mangrove planting	USD/ha	2,000.00
Co-management and maintenance over 3 years	USD/ha	133.30
Co-management year 4 onwards	USD/ha	50.00
Average harvesting costs	USD/m ³	13.60
Grey-Adaptation Measure – Hollow breakwaters		
Cost breakwater construction	USD/m	900.00
Maintenance of breakwaters (3% of investment, 3 years)	USD/m	30.00

Sources: GIZ ICMP, government cost norms for mangrove planting and management

Quantification and aggregation of the benefits

Variables used to quantify the potential benefits of the assessed measures can be found in the following table 10. For the quantification of costs and benefits a period of 30 years, while assuming a 10 percent discount rate, was applied. The assumption of 30 years allows to consider long term impacts of potential investments, which are relevant when considering forest stand development as well as expected long term benefits of specific interventions. In addition, a discount rate of 10% is considered rather conservative while ensuring not to undervalue potential benefits with even lower discount rates.

Table 10: Potential benefits of both proposed interventions

Description of Benefit Variable	Unit	Value
Avoided losses due to extreme climate change events	USD/ha/year	80.00
Average price per m ³ of firewood	USD/m ³ /year	36.00
Average timber harvesting levels	m ³ /ha/year	7.00
Ecosystem service value for maintaining mangrove forest in healthy status	USD/ha/year	3,847.00

Sources: GIZ ICMP; Salem & Mercer, 2012

It was assumed that both measures would be equally effective at avoiding losses from extreme climate change events, especially considering damages to infrastructure and the loss of agricultural yields. Additional benefits were attributed to the EbA measure assessed due to the provision of additional ecosystem services, mainly through the restoration of mangroves that enhance the provision ecosystem services (e.g. in providing key habitat for aquatic life; Hogarth 2015). It is assumed that the mangrove forest can be planted two years after T-fence installation, and that a 5-year-old stand is able to fully provide the above mentioned ecosystem services. Additional data or research would especially be required for the area of avoided losses. While initial information on avoided losses from agricultural yields was available, it was not clear in how wide-ranging the effects of coastal protection measures are for the hinterland. In addition, there was no direct value to quantify protected land, which would otherwise have been lost to erosion.

Comparison of the aggregated costs and benefits

Once the costs and benefits are identified and aggregated, it is possible to present the results of the CBA. Three different indicators can be used to present the results of the CBA (UNFCCC 2011):

- Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. NPV is applied to analyze the profitability of a projected investment. While a positive NPV (above 0) indicates that the projected earnings generated through said investment exceed the expected costs, a negative NPV predicts potential losses through the investment
- Benefit-Cost-Ration (BCR) is the ration of benefits to costs based on the NPV. It helps to identify the relationship between the cost and benefits of a proposed investment, allowing to compare whether the NPV of an investments benefits outweighs the NPV of the potential costs.
- Internal rate of return (IRR): *"...the discount rate that makes the NPV equal to zero"* (UNFCCC 2011, p.13). As such the IRR allows to compare investments against each other. A high IRR indicates that an investment is more appropriate than using the same funds for other alternatives.

For this assessment it was decided it would be the most relevant to calculate the NPV and IRR. For the quantification of costs and benefits a period of 30 years, while assuming a 10 percent discount rate, was applied to account for both time value of money (now and in 30 years) and uncertainty of future cash flows. In addition, a sensitivity analysis was carried out to assess the economic viability due to potentially changing assumptions on the total project costs and benefits. In a final step, the two proposed investments were then compared for their financial viability.

4.2 CBA results

The total initial investment costs for the T-fences and mangrove rehabilitation was approximately \$7,500 per hectare, whereas the costs for breakwater construction was approximately \$90,000 per hectare (a difference of \$82,500 per hectare).

The overall economic IRR for **T-fences** was calculated over a period of 30 years and amounted to **22%** with a NPV of **\$14,874/ha** (using a 10% discount rate). Based on this calculation, T-fences are considered a beneficial investment that can support local communities in reducing erosion, providing ecosystem services and protecting from extreme climate change events. In comparison, the IRR of the breakwaters over the same time period is estimated at **1%** and a NPV (10%) of **-\$59,486/ha** showing that the costs of **breakwater installation** do not outweigh its potential benefits which are similar (both in quantity and quality) to the benefits of T-Fences. This is visualized in a summary of the sensitivity analysis in Figure 10 below showing comparison of both sensitivity analyses as depicted in the following Tables 11 and 12:

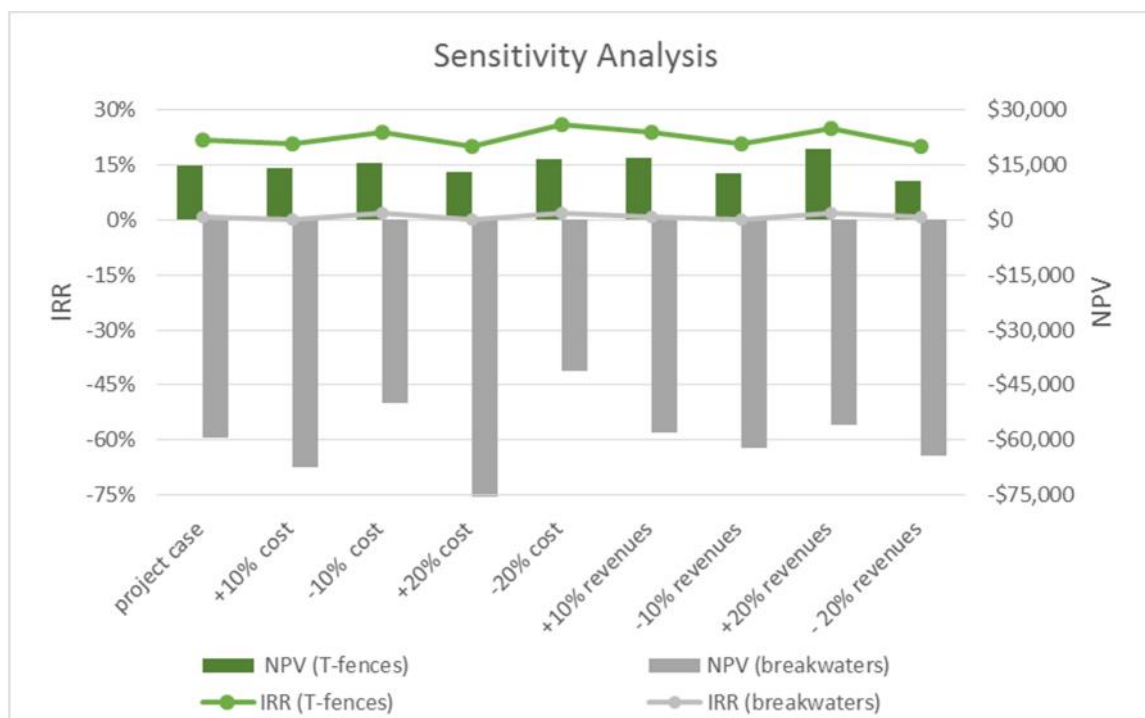


Figure 10: Diagram visualizing IRR (left) and NPV (right) of Eba intervention (T-fences - green) and infra-structural intervention (breakwaters - grey)

A sensitivity analysis was conducted, and concentrated on the impacts on IRR and NPV from changes in overall project costs and revenue price fluctuations. The IRR is sensitive to revenues and costs in the range of 10% – 20%. Table 11 and 12 below present the sensitivity analyses.

Table 11: Sensitivity analysis for T-fences

Financing scenarios	IRR - 30 years	NPV (USD) - 30 years
IRR/NPV project case	22%	14,874
IRR/NPV @ +10% cost	21%	14,013
IRR/NPV @ -10% cost	24%	15,734
IRR/NPV @ +20% cost	20%	13,153
IRR/NPV @ -20% cost	26%	16,595
IRR/NPV @ +10% revenues	24%	16,897
IRR/NPV @ -10% revenues	21%	12,851
IRR/NPV @ +20% revenues	25%	19,400
IRR/NPV @ - 20% revenues	20%	10,828

Table 12: Sensitivity analysis for breakwaters

Financing scenarios	IRR - 30 years	NPV (USD) - 30 years
IRR/NPV project case	1%	-59,486
IRR/NPV @ +10% cost	0%	-67,431
IRR/NPV @ -10% cost	2%	-49,978
IRR/NPV @ +20% cost	0%	-76,158
IRR/NPV @ -20% cost	2%	-41,251
IRR/NPV @ +10% revenues	1%	-57,993
IRR/NPV @ -10% revenues	0%	-62,137
IRR/NPV @ +20% revenues	2%	-55,920
IRR/NPV @ - 20% revenues	1%	-64,210

4.3 Discussion

This example CBA demonstrated the power of CBA to assess two options for coastal protection and climate change adaptation. The calculations demonstrated that in the instance where the benefits are similar (in terms of resilience and the provision of additional ecosystem services), that T-fences and mangrove restoration is a very attractive option for coastal protection. In both cases erosion rates will be stopped and sedimentation rates increased, allowing mangrove forests to be restored, which in return provide valuable ecosystem services to local communities. Yet in the case of breakwater installation, the invested costs heavily outgrow the potential benefits. As a result, when looking at costs and benefits the EbA based solution including T-Fences and mangrove rehabilitation was in this example found to be far more financially beneficial than the installation of breakwaters. This is based on the assumption that the measures are implemented in an area with low-erosion, where the measures will be equally effective at supporting coastal protection and reducing potential losses. In addition a single installation of T-Fences is

assumed, while in reality re-installation of additional T-Fences further outward in order to establish more mudflats could be applied. In terms of sensitivity the values assume for provisioning services of mangrove ecosystems if of high importance as this currently represents the majority of quantified benefits. According to a meta-analysis about studies on economic valuation of Mangroves by Salem & Mercer (2012) those values range between \$ 2,772 and \$ 80,000/ha. The here applied value is the median derive from these Salem & Mercer (2012) and as such considered very conservative and might strongly influence the feasibility of coastal investments, depending on which rate is applied.

However, it is important to note that this assessment was based on a literature review, and that in practice such assessments need to take into account more detailed site-specific characteristics and a more profound and robust data collection process. The implementation cost of T-fences very much depends on the coastal profiles and the used materials, thus costs may vary between different sites. Furthermore, contrary to breakwaters T-fences are not appropriate for high erosion sites as they cannot withstand very strong waves. In these scenarios, breakwaters and/or other grey-adaptation measures may be more effective to protect coastal communities, livelihoods and ecosystems. Otherwise sedimentation rates within breakwaters are less predictable than within T-Fences, potentially having negative effects on mangrove development (e.g. high sedimentation rates might cover seedlings completely).

When using CBA for decision making processes, it is critical that the analysis takes into account the site-specific conditions to strengthen the reliability of data for the identification of costs and benefits. For instance, if conducting a CBA for an area characterized by high wave energy it will be necessary to take into account the reduced effectiveness of bamboo T-fences and mangrove restoration, which would be reflected in both higher costs and reduced benefits for the EbA measure whereas the benefits for grey-adaptation measures may be more attractive. Furthermore integrated coastal management and protection might not necessarily limit itself to only one solution only but can, depending on site conditions, utilize a set of mixed interventions in order to achieve the expected coastal protection target.

In summary, the CBA conducted in this chapter is a simplified calculation that in practice needs to be fine-tuned to reflect a mixture of interventions and approaches. The applied calculation was based on 1ha models, yet the protection of, for instance, a 100m wide coastal stretch will require more detailed modeling and more detailed assessments of the costs, benefits and technical suitability of a range of approaches for supporting integrated coastal protection and climate change adaptation. While this WP has provided an example of how to conduct a CBA for EbA, it is based on existing literature and various assumptions. In reality, to support decision-making processes a more detailed CBA should be conducted based on site-specific information, involving detailed technical feasibility assessments, the collection of robust and reliable data and consultations with diverse stakeholders. CBA remains a potential tool for comparing the efficiency of investments in climate change adaptation measures, including EbA.

5 CONCLUSION AND OUTLOOK

EbA is considered to be an effective approach to adapt to climate change. It can help increase the resilience of local communities and ecosystems through improving local livelihoods and enhancing the provision of ecosystem services (Colls et al., 2009). The GIZ's project on 'Mainstreaming EbA' supports the integration of EbA into planning and decision making processes.

This assignment aimed to support the aforementioned GIZ program by strengthening piloted EbA approaches through the provision of technical recommendations, and by supporting economic assessments on the efficiency and effectiveness of piloted EbA measures. The findings of this study demonstrate the ability of EbA to provide not only benefits to increasing the resilience of ecosystems and communities, but also providing numerous additional benefits while remaining competitive with other adaptation approaches in terms of effectiveness, efficiency and costs.

It was observed that technical approach applied in the Quang Binh pilot project (WP1) has made important progress in piloting the restoration of coastal forests in sand dunes along the coastline. Such progress is important to support the development of a proof-of-concept, and demonstrate to decision makers the strengths of applied measures and lessons learned. Based on these lessons learned the approach can be modified and strengthened, increasing the effectiveness of the EbA measure applied. A main success factor observed in the Quang Binh pilot project was that the sustained commitment by the local community in terms of supporting site preparation, planting and maintenance strongly influenced the high survival rate of the plantation. Consultation and close planning with communities is thus a cornerstone of applying EbA in NCC-VN to promote the longevity of piloted approaches.

However, there are also key lessons and recommendations which have been elaborated for further pilots. For instance, applied practices can be improved by adjusting the planting approach to reflect the management goals of coastal protection forests, i.e. focusing on coastal protection as a main goal instead of timber production. To further support this management goal and to enhance biodiversity, it was further recommended to also pilot planting native tree species in order to create a mixed species forest stand. Piloting native species should be discussed with the local community so that the most appropriate species can be selected. In general, this WP demonstrated the importance of conducting technical assessments and regular monitoring. In NCC-VN, EbA measures need to be adapted based on the site-specific context and a range of options and alternatives need to be taken into context. Pilot projects provide a key opportunity to generate early experiences and lessons learned, strengthening the EbA approaches applied and provide a foundation of knowledge, which helps future decision makers and practitioners to design adaptation approaches that are well-suited and tailored to unique sites.

The cost-effectiveness and cost-benefit related WPs demonstrated the opportunities as well as the challenges in applying such assessments to EbA in NCC-VN. The identification of alternative options was challenging, as limited grey-adaptation measures and coastal protection initiatives have been implemented in the region. Within WP2, another challenge was that both pilot projects are still in the process of being implemented, and that there is not sufficient information to conduct a cost-effectiveness analysis. It is important that the effectiveness of piloted approaches can be represented by a measurable indicator, however in both cases the pilot projects are still in an early stage where benefits are not yet visible. Both projects are forest-based, which implies that stands need to be established in order for the measures' protective functions to

take effect. Nonetheless, key information sources were identified which will in future be useful for conducting such a study, together with future studies on the effectiveness and benefits of the piloted approaches.

The efficiency of EbA measures was demonstrated in the sample CBA (WP3). An example from the ICMP was utilized to demonstrate the power of CBA for supporting decision-making and the assessment of alternative adaptation approaches. ICMP has been active since 2011, and thus there is a strong foundation of information related to coastal protection and a wide-range of measures, including both EbA and grey-adaptation measures. The assessment showed the power of EbA under suitable conditions (in this case in areas with low erosion and suitable terrain), where it can be more efficient than alternate grey-adaptation approaches (i.e. hollow breakwaters). Results from CBA studies can support efforts to mainstream and scale up EbA solutions demonstrating not only their technical effectiveness but also their cost-efficiency (Baig et al. 2016). However, the assessment further demonstrated the sensitivity of such assessments, and the need for conducting detailed technical feasibility studies based on the site-specific context to ensure that robust and reliable data for the costs and benefits of such measures are taken into context.

Such economic tools and technical assessments are important to support the scaling up of EbA measures, to demonstrate the effectiveness and efficiency of EbA measures. This is important as already in WP2 it was evident that within Quang Binh and Ha Tinh alone that there are substantial areas which are suitable for scaling up the applied EbA activities. However, technical and economic assessments alone are not sufficient to determine the success of EbA measures. Regular consultation and participation of diverse stakeholders is a cornerstone of EbA to further understand both the direct and indirect benefits and needs of local communities. Some EbA options might not be able to immediately generate short-term visible benefits, which can make it difficult to convince decision makers and local communities for the need of such measures. Hence an applied combination of EbA measures and supporting direct livelihood development models, as observed in Quang Binh, can be applied to help generate direct benefits for local communities and in return increase ownership and buy-in for ensuring the longevity of the piloted approaches and upscaling EbA. Ultimately, such an approach increases the chances of the successful implementation of EbA measures, which in return helps to develop a proof of concept for the piloted measures. Such proof of concept, both in terms of implementation success as well as in terms of cost-effectiveness and efficiency, is required if the applied EbA measures are to be scaled up in the future.

In summary, EbA represents an important approach for supporting climate change adaptation in Viet Nam. EbA measures should be applied within a holistic and integrated approach to coastal management, based on the site-specific conditions and requirements. Such an approach not only helps to improve local people's resilience to climate change but at the same time can also contribute to provincial or national development targets (Kumar et al. 2010; Rizvi et al. 2015;). A good understanding of the costs, benefits and the effectiveness of applied EbA approaches is of high relevance to assist decision makers and promote the adoption and mainstreaming of EbA. While data gaps still remain (especially on benefits and the effectiveness of approaches), it is important to provide a proof of concept to inform policy makers about the importance of investing in EbA solutions. Finally, it is important to keep in mind that making the case for EbA

does not only require technical, economic and institutional evaluations, but should also demonstrate direct and indirect benefits for local communities and their livelihoods taking their preferences into account. Diverse stakeholder engagement is a core element of EbA to ensure the integrated management of ecosystems to support climate change adaptation objectives that can increase the resilience and adaptive capacities of local communities.

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ANNEX

Annex I: Mission Schedule

Date & Time	Location	Participants	Main topics
07.06 Am	Travel from Hue to Quang Binh	Maximilian Roth Dr. Ho Dac Thai Hoang	-
07.06 Pm	GIZ project office Quang Binh	Consultant team GIZ Team	Project overview Introduction to pilot activities Mission coordination
08.06 All day	Hoa Binh Village Villag meeting (2h) and site visit (2h) <i>Optional: meeting with additional village which was not included in pilot</i>	Consultant team GIZ team Village representatives	Focus group discussion 'On-site Workshop' in the field (discussion with village representatives): Implementation experiences Direct benefits so far Effects on livelihoods Positive/Negative experiences Potential improvements
09.06 am	DoNRE Quang Trach District (1h) CPC Quang Hung Commune (1h)	Consultant team GIZ Team Staff of relevant authorities	Revision of findings from field visit Implementation experiences Management experiences Upscaling potential Connection to provincial policies Gov't monitoring approaches Positive/Negative experiences Potential improvements
09.06 pm	DoNRE Quang Binh (1-2h) DARD Quang Binh (1h)		Revision of finding from field visit Implementation experiences Management experiences Upscaling potential Connection to provincial policies Gov't monitoring approaches Positive/Negative experiences Potential improvements
10.06 am	GIZ project office Quang Binh (1h)	Consultant team GIZ team	Wrap up

Annex II: Guiding questions

Technical Questions:

- From your point of view, what are the objectives and targets of the pilot activity?
- How are available capacities concerning the successful implementation of the pilot activity? Can you provide a prioritization of capacity building needs?
- What are the investments/resources required to enhance the effectiveness and/or scale of the pilot activities?
- Which of the pilot activities have the highest impacts on local communities' livelihoods?

Aims of the discussion:

- According to your opinion: could the plantings be implemented in a 'better' way?
- Did all the implementation go according to their expectations? If yes: OK. If no: explain what you would have expected in a different way.
- In your opinion on whether they think this model makes sense. Would you upscale it to other areas? If so, which areas?
- For upscaling, what would you need? (Money, trainings etc.) and what are the crucial points to make upscaling successful?

Financial Questions:

- What is the financial/economic impact of this intervention? (costs & benefits)

Aims of the discussion:

- Besides what GIZ pays, how much would it cost the government to implement this model?
- Is finance to implement the models independently available? Is there willingness to implement the models independently?
- If finance is available, how much (commune/district/provincial level)?
- If you were to implement it themselves. What activities would you prioritize/adapt?

Implementation-related Questions:

- Who are the target groups/ main actors involved in implementation and management?
- How are the pilot activities being implemented (institutional structures, capacities, etc.)?
- What are your key lessons learned so far?
 - What are the main institutional barriers and risks for pilot activity?
- How would you describe the degree of engagement with the local population? What are their impressions of the project?
- May you please discuss some of the opportunities, achievements and challenges with the project?
- Are there synergies with other projects or initiatives (e.g. from the government, private companies, donor organizations, etc.)?
 - Who is/would be responsible to implement those activities?

- What kind of policies and measures would be required to ensure/guide implementation?
 - And what are the main policies and measures which the current activities are implemented?

Aims of the discussion:

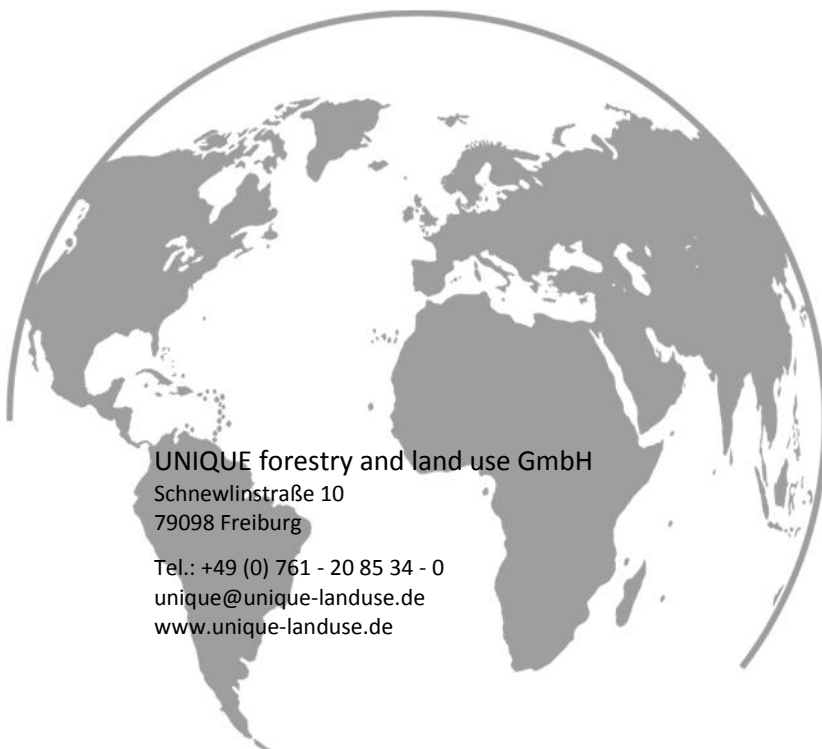
- Do you think the model as applied by GIZ makes sense/is useful? If yes: OK, if no: why?
- What is your contribution to the pilot? Do you regularly support it? How?
- Which parts of the activities were the easiest for you, which one the most difficult?
- What went well so far, what didn't? How could this be improved in your opinion?
- What will you do after GIZ leaves? Will you keep supporting it by yourself? How?
- How this model could be integrated in policies and implementation for the VN government. What needs to be done/needs to happen that this will actually be done?

Social and environmental benefits related questions:

- What are potential opportunities/barriers to enhance engagement with local communities?
- What are the social benefits? What are the additional environmental benefits of this proposed intervention option? What are the potential negative social impacts / risks?
- From your point of view, what are the environmental benefits? What are the potential negative impacts or risks?

Aims of the discussion:

- In how far were you working with local communities? What went well? What didn't? Why?
- Do you see any visible positive benefits of the pilot activities? Of yes, what kind?



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