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REPORT

Best Practice Report on Ecosystem-based Adaptation (EbA)

Adaptation to Drought and El Niño effects in the Central Highlands of Vietnam (Drought-ADAPT)

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Abstract

The Central Highlands of Vietnam face significant climate risks, with drought events and rising temperatures being the primary hazards. With a thriving agricultural sector that caters to both domestic and international demands, the Central Highlands region is recognized as the world's second-largest producer and exporter of coffee, along with other important crops like rubber, pepper, cashew nuts, vegetables, and fruits. Given the region's heavy reliance on agriculture, it encounters significant challenges in water and forest management, as well as agricultural practices, due to the impacts of climate change which lead to recurring droughts, particularly towards the end of the dry season. El Niño conditions are aggravating these impacts, with severe droughts leading to agricultural losses. As climate change continues to intensify, there is a strong need for adapting existing practices to suit the evolving climatic conditions.

In response to these intensifying challenges, the concept of Ecosystem-Based Adaptation (EbA) emerges as a promising approach. EbA entails the implementation of strategies that integrate ecosystem services and biodiversity into the planning and management of natural resources, with the primary goal of enhancing the resilience of local communities in the face of a changing climate. This report serves as an orientation for EbA practices, shedding light on its various benefits and its practical application within the context of drought events in the Central Highlands. The domains of agriculture, forestry, and water management are thoroughly explored, encompassing in-depth descriptions and assessments of existing EbA initiatives in Vietnam. These are complemented by exemplary practices from around the globe, which offer viable and replicable solutions.

This report is part of the project “Drought-ADAPT: Adaptation to Drought and El Niño Effects in the Central Highlands of Vietnam”, financed by the German Federal Ministry of Education and Research (BMBF). The aim of Drought-ADAPT is to develop innovative solutions to support short, medium and long-term planning and adaptation measures to droughts and their effects in the Central Highlands of Vietnam.

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List of Abbreviations

ADB	Asian Development Bank
BCA	Biodiversity Conservation Agency
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
EbA	Ecosystem-based Adaptation
ENSO	El Niño Southern Oscillation
EPA	U.S. Environmental Protection Agency
FAO	Food and Agriculture Organisation
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSO	Government Statistics Office Vietnam
Ha	Hectare
ICO	International Coffee Organisation
IKI	Internationale Klimaschutzinitiative
IUCN	International Union for Conservation of Nature
MDRI	Mekong Development Research Institute
NWRM	Natural Water Retention Measures
UN	United Nations
UNEP	United Nations Environment Programme
USD	US Dollar
WH	Water harvesting

Introduction

This report focuses on the critical issue of drought adaptation in the Central Highlands of Vietnam, with a particular emphasis on the application of Ecosystem-based Adaptation (EbA). Vietnam ranks among the countries most affected by climate change, and the Central Highlands region is particularly sensitive to extreme weather events, such as those triggered by El Niño (Climate Risk Country Profile Vietnam 2021). These events, occurring every two to seven years, often result in severe droughts during the dry season, significantly impacting agricultural productivity, the environment, and the socio-economic sector. The combined effects of natural climate variability and anthropogenic climate change exacerbate the vulnerability of the region. The Central Highlands are renowned for their significant agricultural production, including coffee, rubber, pepper, cashew nuts, vegetables, and fruits, which are in high demand both domestically and for export (ADB 2022). However, as the region faces increasing challenges with climate change, the need for adaptation has become a priority (Parker et al. 2019; Ha et al. 2021).

The Drought-ADAPT project was initiated in response to these challenges, with the primary goal of developing innovative approaches and adaptation measures for managing drought situations within the context of climate change. Operating at multiple levels, the project aims to address the diverse needs of the region. This report explores existing measures and promising good-practice approaches on Ecosystem-based adaptation (EbA) that could improve the resilience of the Central Highlands and in particular of the agricultural sector to drought.

The first section of the report provides an overview of EbA, highlighting its four core elements and discussing the benefits and challenges associated with its implementation. EbA recognizes the interconnectedness of ecosystems and human well-being, emphasizing the conservation, restoration, and sustainable management of natural systems as a means to enhance adaptation capacities.

The subsequent section examines the specific areas of implementation for EbA in the context of drought adaptation. It explores the application of EbA practices in agriculture, such as agroforestry, crop diversification, crop rotation, organic farming, and other adaptive practices. Furthermore, it delves into the integration of EbA principles in forestry management and sustainable water management, recognizing the crucial role these sectors play in building resilience and mitigating the impacts of drought.

The report then shifts its focus to the Central Highlands of Vietnam, assessing the prevailing situation in the region. It discusses the observed climate change impacts, particularly the increasing frequency and intensity of drought events, and examines the implications for agriculture, forestry, and water management in the area. Additionally, it evaluates the effectiveness of existing EbA measures in the Central Highlands, identifying the gaps and opportunities for improvement.

Finally, the report presents a series of case studies that highlight successful EbA initiatives from different parts of the world in the appendix. These case studies serve as practical examples and sources of inspiration for stakeholders in the Central Highlands to develop and implement effective drought adaptation strategies.

By examining the specific challenges and opportunities in the Central Highlands of Vietnam and drawing on global experiences, this report aims to provide valuable insights and recommendations for policymakers, practitioners, and local communities. It underscores the importance of adopting nature-based approaches like EbA to build climate resilience in the region, thus sustaining the livelihoods and protecting the ecosystems that are vital for the well-being of inhabitants.

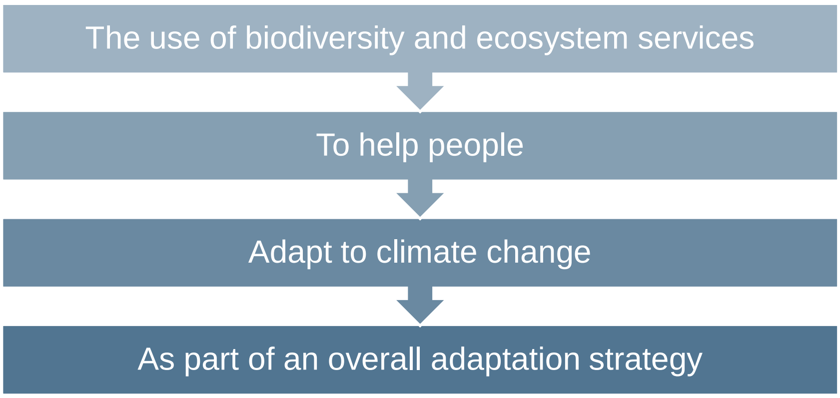
1 Overview on Ecosystem-based Adaptation

In the face of climate change and its far-reaching impacts, the utilization of biodiversity and ecosystem services has emerged as a vital tool in assisting communities to adapt to these changes. This approach, known as ecosystem-based adaptation (EbA), involves integrating biodiversity and ecosystem services into broader adaptation strategies to enhance resilience and mitigate the adverse effects of climate change. By harnessing the inherent capabilities of natural systems, EbA offers a holistic and sustainable approach to confront the challenges posed by a changing climate. This section provides a comprehensive exploration of the concept of EbA, delving into its core elements, as well as the associated benefits and challenges.

1.1 The Four Core Elements of EbA

EbA was defined within the environmental conservation context, driven by the efforts of the Convention on Biological Diversity (CBD) in 2009 (UN 2019). It is defined as a strategic approach that harnesses the inherent capacity of biodiversity and ecosystem services, integrating them into broader adaptation strategies (CBD, 2009). By doing so, EbA aims to assist communities in effectively responding and adapting to the adverse impacts of climate change. The four core elements of EbA are:

Figure 1: The 4 core elements of EbA



Source: CBD 2009; UN 2019

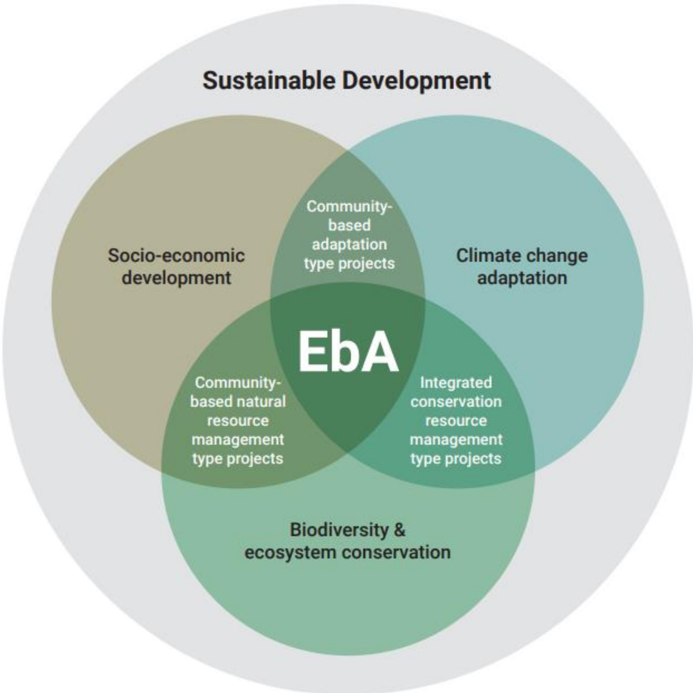
An Ecosystem-based Adaptation (EbA) approach combines three key components: socio-economic development, climate change adaptation, and biodiversity and ecosystem conservation. These components are interconnected and mutually reinforcing, forming the foundation for sustainable development and effective adaptation strategies (Figure 2).

Socio-economic development aspects ensure that adaptation measures are rooted in the needs and priorities of local communities. By engaging with communities and understanding their socio-economic contexts, EbA aims to support their livelihoods and enhance their resilience in the face of climate change impacts. This community-based approach recognizes the importance of local knowledge, values, and aspirations in shaping adaptation strategies that are both effective and sustainable.

Climate change adaptation is at the core of EbA. It involves understanding the specific risks and vulnerabilities posed by climate change and developing proactive measures to address them. EbA emphasizes the importance of anticipating and responding to climate-induced threats, such as extreme weather events, changing precipitation patterns, and rising temperatures. By integrating adaptation actions into development planning and decision-making processes, EbA seeks to enhance the adaptive capacity of communities and ecosystems.

Biodiversity and ecosystem conservation are essential components of EbA. Ecosystems provide a range of services, such as water regulation, soil fertility, and habitat provision, which are crucial for human well-being and resilience. EbA recognizes the intrinsic value of biodiversity and the role of healthy ecosystems in supporting adaptation efforts. By maintaining and enhancing ecosystem functions and services, EbA contributes to the long-term sustainability of both human and natural systems.

Figure 2. EbA definition



Source: UN 2019

The intersection of these three components is vital for successful EbA implementation. By adopting an integrated approach, EbA recognizes that sustainable development and effective adaptation strategies rely on the synergies between socio-economic development, climate change adaptation, and biodiversity conservation.

To assess the quality of an EbA measure, the International Union for Conservation of Nature (IUCN) has defined three key criteria or guiding questions as described in the following table (Glement & Bimson 2022).

Table 1: Three key criteria for EbA

1. Does the approach prioritize addressing climate-induced threats?
This criterion focuses on whether the approach is specifically designed to tackle threats arising from climate change impacts. This includes the extent to which the measure is tailored to address the specific vulnerabilities and challenges posed by climate change.

2.	**Does the proposed/implemented approach incorporate elements of ecosystem restoration, conservation, or management to maintain/enhance ecosystem services in response to climate threats?**
	The second criterion emphasizes the importance of incorporating ecosystem restoration, conservation, or management practices within the proposed or implemented solutions. It examines whether the measure recognizes and utilizes the potential of ecosystems to provide essential services and enhance their resilience in the face of climate-related risks.
3.	**Does the approach offer biodiversity benefits?**
	The third criterion assesses whether the EbA approach contributes to biodiversity conservation and examines whether the measure promotes the preservation and enhancement of biodiversity.

Source: Glement & Bimson 2022

By employing these three criteria, policymakers and practitioners can evaluate the effectiveness and suitability of EbA measures. These criteria help ensure that adaptation strategies consider climate-induced threats, incorporate ecosystem-based solutions, and generate biodiversity co-benefits. Ultimately, this approach facilitates the development of robust and sustainable adaptation measures that integrate the needs of both human communities and natural ecosystems.

1.2 Benefits and Challenges of EbA

Ecosystem-based Adaptation (EbA) is an alternative to conventional hard infrastructure or technology-based approaches, aiming to address climate change issues effectively. EbA approaches offer numerous advantages, including wide accessibility, cost-effectiveness compared to grey infrastructure solutions, and additional benefits such as food supply, increased income, and biodiversity conservation (Baig et al. 2016; Ollinaho & Kröger 2021). However, it is important to acknowledge that EbA approaches may take time to fully realize their impact.

Moreover, in the agricultural context, EbA practices like agroforestry and crop rotation encounter specific challenges. These practices still demand a certain amount of investments and careful implementation (D'Haeze 2022). Farmers need to possess knowledge of locally suitable plant species and acquire the necessary skills to manage each type effectively. Not meeting these requirements may lead to the failure of achieving the desired outcomes from these practices and falling short of expectations

Nevertheless, the long-lasting benefits of EbA lie in enhancing ecosystem resilience as well as recovery and thus, ensuring the sustained provision of vital ecosystem services such as food and water supply, flood regulation, drought mitigation, prevention of land degradation, among others (Munang 2013).

Having mentioned a few, Table 2 provides a comprehensive overview of the benefits and challenges associated with EbA.

Table 2: Benefits and Challenges of EbA

Benefits	Challenges
• Making use of ecosystem services for communities to withstand and recover from climate change impacts • EbA can be more cost-effective compared to traditional engineering approaches • Improves water quality and increases biodiversity • Promotes sustainable land and resource management practices, ensuring the long-term health and functionality of ecosystems • Provides opportunities to involve local communities in decision-making processes, fostering their ownership and empowering them to actively participate in adaptation efforts • Recognizes the dynamic nature of ecosystems and their ability to adapt to changing conditions, providing flexible and adaptable solutions for future uncertainties	• Lack of awareness and understanding of EbA among stakeholders, including policymakers • EbA requires specialized knowledge and capacity for ecosystem management, which is not available to all stakeholders • Integrating EbA into policy frameworks and development planning can be challenging, as it often requires cross-sectoral coordination and collaboration • Conflicts between different stakeholders or land uses when implementing EbA • Scaling up EbA initiatives and replicating successful practices across different ecosystems and regions can be complex and resource-intensive • Monitoring and evaluating the effectiveness of EbA measures can be challenging, requiring long-term data collection and assessment of ecological and socio-economic impacts

Sources: Baig et al. 2016; Sollen-Norrlin, Ghaley & Rintoul 2020; Munang 2013; D'Haeze 2022; CGIAR 2016; Ollinaho & Kröger 2021; Mosquera-Losada et al. 2023; Emerton 2017

2 Areas of Implementation

Ecosystem-based Adaptation (EbA) encompasses a range of interventions that promote sustainability in various sectors such as agriculture, water management, coastal and marine management, forest management, as well as urban development (Emerton 2017). These interventions harness the power of nature to diminish the vulnerability of local communities or specific vulnerable groups to climate change. This is achieved by prioritizing the conservation, restoration, and effective management of ecosystems. The scope of this report, however, revolves around addressing drought adaptation in the Central Highlands of Vietnam. Consequently, the focus lies on the implementation of EbA within the realms of agriculture, forestry, and sustainable water management, with the aim of fostering drought resilience. The following provides an overview on EbA in these three focal sectors, before diving into greater detail in the next section.

Agriculture
EbA in agriculture encompasses practices that embrace holistic, agroecological, and regenerative approaches, such as agroforestry and crop rotation (GIZ 2022b). These techniques are employed to enhance agricultural systems by integrating trees, diverse crops, and sustainable farming practices, promoting ecological balance and resilience in agricultural landscapes.
Forestry
EbA in forestry entails an approach to forest ecosystem management that is guided by natural models of development, encompassing trees, associated organisms, and ecological functions (UNEP 2022). It emphasizes the utilization of ecological principles and processes to enhance the resilience and sustainability of forest ecosystems. By drawing inspiration from nature's own mechanisms, EbA in forestry aims to promote the conservation and effective management of forest resources while preserving their inherent biodiversity and ecological integrity.
Sustainable Water Management
In the realm of water management, an EbA approach encompasses various interventions aimed at enhancing water availability and efficiency. These interventions include water harvesting, water budgeting, selecting appropriate crops, improving water use efficiency, and implementing participatory water governance (IKI 2021). By adopting such measures, EbA promotes sustainable water management practices that optimize water resources, mitigate water scarcity, and ensure the active involvement of stakeholders in decision-making processes related to water governance.

2.1 EbA in Agriculture

As one of the most vulnerable sectors to climate change (IPCC 2014), agriculture faces numerous climate-related hazards including temperature extremes, drought, flooding, soil erosion and land degradation (Chau et al. 2014). These climate impacts also affect water resource availability and seasonality, as well as pest and disease profiles.

As a result, it is crucial to implement sustainable approaches that enhance resilience and food security to adapt to drought as well as other climate impacts. Sustainable agriculture considers not only economic factors but also ecological and social aspects (GIZ 2022b). It encompasses various farming systems such as agroforestry, organic farming, agroecology, regenerative farming, and permaculture, described in the following figure:

Figure 3: Sustainable farming systems for adaptation to climate change.

Agroecology

Agroecological practices are local-specific methods that use, preserve and improve biological and ecological processes in agricultural production

Agroforestry

Woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals

Regenerative agriculture

Aiming to improve the regeneration of the topsoil, biodiversity and the water cycle without the use of pesticides and synthetic fertilizers

Organic farming

Three main principles:

- no synthetic fertilizers,
- no synthetic pesticides, and
- diversity as a fundamental component.

Permaculture

Permaculture (permanent agriculture) is the conscious design and maintenance of economical, agriculturally productive ecosystems that have the diversity, stability, and resilience of natural ecosystems

Source: Adapted from GIZ (2022a)

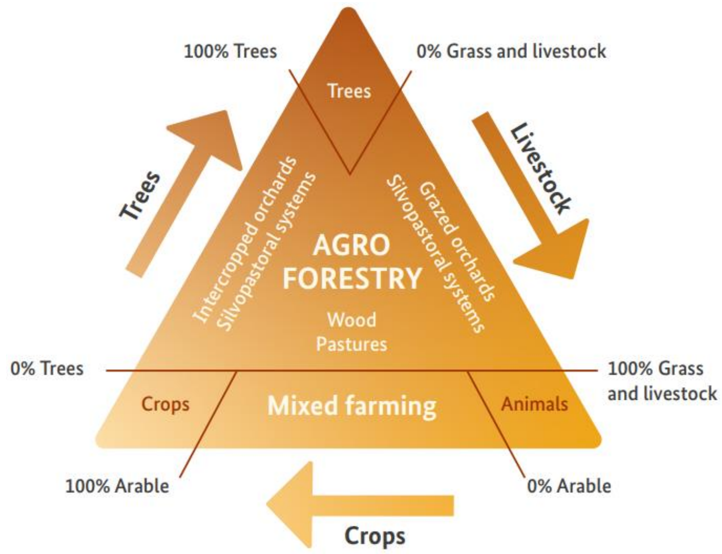
Customizing adaptation strategies for addressing climate change in agriculture is crucial. This involves considering specific climate conditions, farming potential, and the affordability of applied methods (Ivanchuk 2020). In the short term, farmers can adapt by changing seed varieties, adjusting irrigation and drainage practices, and modifying planting, harvesting, and soil/crop amendment schedules. In the long term, enhancing soil biodiversity and fertility through soil regeneration techniques (e.g. cover cropping, contour cultivation, terracing, organic matter increase) and protecting or replanting forests and natural vegetation in strategic locations near their land become essential EbA strategies for farmers to cope with climate impacts.

In this section, we will give a brief overview of sustainable agricultural practices that play a crucial role in facilitating effective adaptation to drought conditions and can be considered as EbA (if implemented according to the EbA criteria).

2.1.1 Agroforestry

Agroforestry encompasses a range of land-use systems and practices that intentionally integrate woody perennials like trees, shrubs, and palms with agricultural crops and/or livestock within the same land-management units, either in a spatial arrangement or temporal sequence (FAO 2023). The following figure shows mixed agroforestry land-use systems depending on the use of crops, trees and livestock with different practices such as intercropped orchards and silvopastoral systems:

Figure 4: Characteristics of agroforestry systems



Sources: Plieninger et al. 2018, GIZ 2022a

The implementation of agroforestry practices brings forth numerous benefits for biodiversity conservation, carbon sequestration, and the provision of other valuable ecosystem services at both local and landscape scales. Particularly for smallholder farmers and rural communities, agroforestry plays a pivotal role in enhancing food security, income generation, and overall well-being (Ollinaho & Kröger, 2021). By increasing canopy cover and providing shade, agroforestry systems effectively mitigate soil drying during arid periods and protect plants from the adverse effects of sun and wind. Additionally, on sloping land, the strategic use of crop strips and contour planting reduces soil erosion and sedimentation. The extensive root systems of trees, particularly deep-rooted species, contribute to improved soil structure, enhanced infiltration, and efficient water retention (Mulia and Nguyen 2021).

2.1.2 Crop Diversification (Intercropping)

Crop diversification involves the cultivation of multiple plant species on a single piece of land, offering several advantages when compared to monoculture farming. This practice promotes efficient land and resource utilization while providing additional protection to the primary crops against adverse weather conditions such as winds, frosts, and droughts (Cherlinka 2023). Furthermore, crop diversification supports natural soil regeneration and facilitates natural plant succession. The interaction between different plant species across various strata, including herbaceous, shrub, and tree layers, improves the microclimatic conditions within the production system. The increased complexity of the production system enhances its resilience to stress situations that arise from factors such as rising temperatures, erratic rainfall, and drought. Numerous studies have demonstrated the positive impact of crop diversification on average agricultural yield and farm income (Armengot et al. 2016). Additionally, crop diversification provides a diversified source of food for household consumption and opportunities for income generation through the sale of by-products, such as firewood or timber.

2.1.3 Crop Rotation

Crop rotation is recognized as one of the most effective methods for preserving soil quality. By systematically alternating the types of crops grown on a specific field plot, soil degradation can be prevented, and pest cycles can be disrupted (Cherlinka 2023). This practice not only leads to a more efficient agricultural output but also contributes to increased yield. Moreover, crop rotation enhances plant resistance to abiotic stressors such as heat, floods, and droughts. By balancing nutrient levels, improving soil fertility, and increasing organic matter content, crop rotation promotes optimal productivity. It is crucial to prioritize the long-term implementation of crop rotation as the benefits, such as improved soil organic matter and the promotion of beneficial soil organisms, may take time to become evident. Support for the transition to crop-rotational diversity is urgently necessary to ensure the realization of these benefits (Bowles et al. 2020).

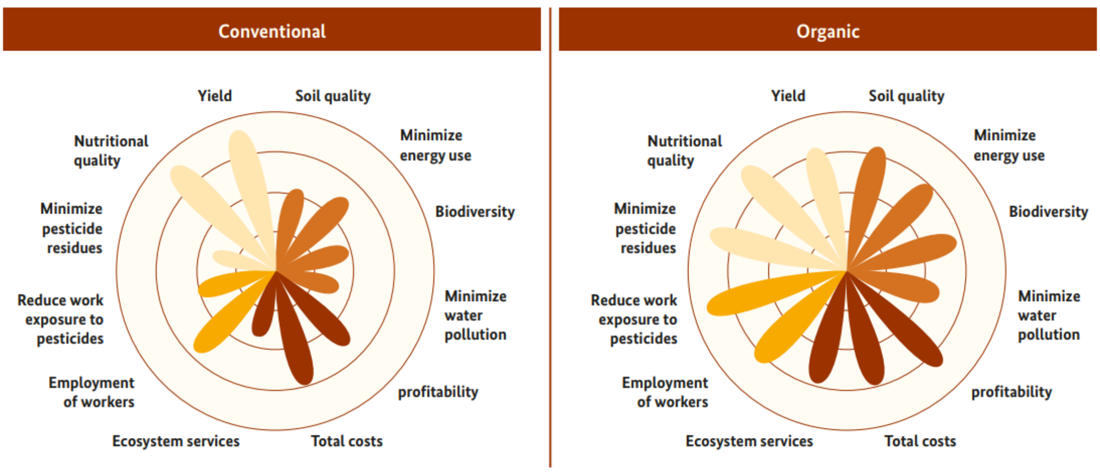
Furthermore, crop rotation plays a significant role in enhancing water use efficiency. By increasing the content of soil organic matter within the soil, both soil structure and water-holding capacity are improved. This method helps preserve moisture in the deeper soil layers, which plants can access during drought periods, reducing dependence on irrigation water (Cherlinka 2023).

2.1.4 Organic Farming

Organic farming distinguishes itself by its reliance on natural processes and avoidance of synthetic fertilizers and pesticides. A key aspect of organic farming is its emphasis on diversity. Comparative studies have consistently demonstrated the superiority of organic farming over conventional farming across various sustainability factors (Figure 5). One notable advantage is the enhanced water absorption and retention capacity of soils under organic farming, which can be twice as effective as conventionally managed soils. Additionally, organic farming promotes the accumulation of humus, contributing to improved soil structure, plant health, and resilience to changing weather conditions (GIZ 2022a).

Furthermore, it provides a systemic approach for reducing greenhouse gas emissions (GHGs) and increasing soil carbon sequestration, all while maintaining healthy soils and preserving biodiversity. By incorporating beneficial practices such as cover crops and crop rotations, organic farming contributes to the sequestration of soil organic carbon. This holistic approach not only reduces the environmental impact but also fosters long-term sustainability in agricultural systems.

Figure 5: Sustainability of conventional and organic agriculture



Source: Reganold & Watcher 2016

2.1.5 Further Practices: Cover Crops, Adaptive Crops, and Modifications

Another effective approach is the use of cover crops, which help prevent soil erosion, retain water, and fix nitrogen. These cover crops can also serve as organic manure or fodder for grazing cattle. Another strategy involves replacing traditional crops with adaptive species that are more tolerant to drought or heat, reducing the need for pesticides and fertilizers and enhancing resilience to flooding or droughts. Additionally, making small modifications to ongoing farming practices, such as adjusting planting and harvesting dates or applying soil and crop amendments, can yield significant benefits including improved pest control, enhanced microclimate conditions, increased yield, enhanced soil fertility, and improved water retention.

2.2 EbA and Forestry

Natural forest ecosystems play a vital role in sustaining life on Earth by providing numerous benefits to both humans and biodiversity. They serve as sources of clean air, water, food, timber, and medicinal products, while also acting as critical habitats for various plant and animal species (Swiss Federal Institute WSL 2021). These ecosystems also contribute to agricultural support, climate regulation, and the availability of water resources for rural and urban areas. Recognizing the importance of these ecosystems, an Ecosystem-based Adaptation (EbA) approach can be implemented for forest management to enhance climate resilience. This approach involves emulating natural models of development and preserving or restoring diverse fauna, flora, and ecological functions within the forest ecosystem (UNEP 2022).

EbA practices encompass a diverse range of strategies applicable to forestry operations, addressing environmental hazards, social concerns, and economic impacts resulting from climate change. These practices form a portfolio of approaches that synergistically foster resilience in forestry systems. They involve developing diversified production systems, cultivating strong relationships with forest communities, and promoting sustainable economic models (UNEP 2022). By combining these practices, EbA enhances the adaptability and thriving capacity of forests amidst changing environmental conditions, benefiting local communities and ensuring long-term sustainability.

To tackle environmental impacts such as water stress, drought, and higher temperatures, specific EbA practices can be implemented in forest management (UNEP 2022). These practices focus on improving water management and bolstering the resilience of forest ecosystems. Strategies include enhancing water infiltration and storage capacity through measures like increasing organic matter content and implementing retention systems such as storage lakes, infiltration ditches, contour planting, and rorak pits. Promoting diversity in tree ages, species, structure, and understory vegetation, particularly drought-resistant species, contributes to water conservation and ecosystem resilience. Safeguarding watersheds, headwaters, and implementing water harvesting techniques are crucial for water storage, flow regulation, and provisioning. Preserving forested hilltops facilitates humidity collection and water infiltration, while the strategic use of windbreaks helps prevent desiccation. These practices enable forest ecosystems to withstand and adapt to water-related environmental impacts, ensuring sustainable water management and the long-term health of the ecosystem.

While forest ecosystems support societies in building resilience they are at the same time facing climate risks. In order to avoid degradation and loss of forests, adaptive forest management practices need to be applied:

- **Slow onset changes** consider global temperature rise that can lead to unsuitable conditions for certain tree species, forest dieback, and economic losses for forest owners and communities whose livelihoods depend on forest products. Adaptation options can include restoring natural forest ecosystems with native tree species and considering predicted biome shifts.

- Another hazard is **heat waves** causing heat stress and increased mortality of trees, with adaptation options such as restoration and conservation of natural forests, sustainable forest management, and natural rejuvenation.
- The increased frequency and extent of **wildfires** can be addressed through improved prevention and management practices, transitioning from monoculture plantations to natural forests.
- **Droughts** result in reduced tree vitality, increased mortality, and limited growth, and adaptation options include enabling the growth of natural forests, prioritizing drought-resistant species, maintaining dead wood, reducing invasive species, and increasing water storage in and near forests. The mentioned impacts and adaptation measures are non-exhaustive and it is key to tailor them according to the local conditions, and where possible in cooperation with local communities.

Table 3 provides an overview on the above-mentioned climate hazards and potential adaptation options for forests.

Table 3: Hazard, climate impacts and adaptation options in forestry

Hazards	Climate Impacts	Adaptation Options
Slow onset changes: global temperature rise	• Local climatic conditions can become unsuitable for certain tree species • Forest can experience a massive dieback and a change in their location • High risk of economic losses for forest owners	• Restoring the natural forest ecosystem with native tree species • Consideration of predicted biome shifts and changes in climatic conditions in the selection of native tree species • Natural and passive rejuvenation/restoration with seeds from the area can be beneficial
Heat waves	Increase in heat stress and mortality rate of trees	• Restoration and conservation of natural forests with a mix of old stands • Sustainable forest management • Natural and passive rejuvenation/restoration
	Increase in the frequency and extent of wildfire events	• Improved wildfire prevention, surveillance and management practices • The transition from monoculture plantations to natural forests
Drought	Reduced tree vitality and increase in overall mortality • more vulnerable to disease and insect outbreaks • limited growth of trees, lower wood harvest • Root damage and higher number of windfalls	• Enable the growth of natural forests with multiple layers • Prioritising native drought and disease resistant species • Maintaining dead wood in the forest • Measures to reduce invasive species • Increase of water storage in and nearby forests

2.3 EbA Practices and Sustainable Water Management

An ecosystem-based approach to water management encompasses conservation and restoration efforts aimed at sustaining aquatic and non-aquatic ecosystems (IKI 2021). This approach involves implementing measures such as water harvesting, water budgeting, and selecting suitable crops. It also emphasizes measures to enhance water use efficiency and encourages participatory water governance. Notable examples of such activities include projects focused on river rejuvenation and river basin management, watershed development initiatives, water stewardship programs, and the establishment of provisions for environmental flows. By adopting this holistic approach, water resources can be effectively managed, ensuring the preservation of ecosystems and promoting sustainable water usage practices (IKI 2021). Communities can enhance their water resilience, reduce dependence on irrigation, conserve water resources, and mitigate the impacts of droughts.

Table 4: EbA Practices in water management

EbA	Description
Natural water retention ponds	• Water retention ponds are small-scale basins that store water and can be established by farmers/local communities to improve water availability in times of drought (NWRM, 2023).
Water harvesting and storage	• Water harvesting (WH) involves collecting rainfall runoff for subsequent beneficial use and has been practiced by farmers around the world for centuries to reduce erosion and enhance crop yields and production reliability (Maher et al. 2016). • WH and small-storage technologies supply water for domestic use, livestock, fodder, and tree production • WH can be used for fish and duck ponds
Agricultural water conservation practices	• Crop rotation involves planting different crops in sequence, which improves soil structure, organic matter content, and water-holding capacity. It helps retain moisture in deep soil layers, reducing the need for irrigation and conserving water resources (Cherlinka 2023). • Mulching, through the use of materials like straw or plastic cover, reduces evaporation and suppresses weed growth, thereby improving moisture retention in the soil (Prosdocimi, Tarolli & Cerdà, 2016). • Leaving crop residue on the field acts as natural mulch, preventing moisture loss. These practices contribute to water conservation and support plant growth, especially during dry periods.
Wetland and watershed Restoration and Conservation	• Protecting and restoring natural ecosystems, such as wetlands and watersheds, together with forests, is crucial for water management. These ecosystems regulate water flow, maintain groundwater recharge, and thus have the potential to mitigate the impacts of droughts. (EPA 2023).
Participatory Water Governance	• Involving local communities and stakeholders in decision-making processes related to water management promotes collective action, knowledge sharing, and equitable distribution of water resources (Megdal, Eden & Shamir, 2017). • Participatory water governance ensures sustainable water use during droughts through inclusive and transparent decision-making

3 Status quo in the Central Highlands

3.1 Agriculture

Vietnam, renowned as the second-largest coffee producer globally after Brazil (ICO 2011), takes the lead in Robusta coffee production, contributing to approximately 14.5% of the world's output and accounting for around 40% of global trade (Amarasinghe et al. 2015). The export value of coffee represents approximately 15% of the total agricultural export turnover in Vietnam and in recent years, the share of coffee in agricultural GDP has consistently exceeded 10% (VietnamCredit 2020).

With 95% of Vietnam's coffee production concentrated in the Central Highlands, this region has actually become the world's second-largest producer and exporter of coffee (idh 2023). The production of coffee is predominantly concentrated in the provinces of Dak Lak, Gia Lai, Kon Tum, and Lam Dong (Giovannucci et al. 2004). Among these provinces, Dak Lak holds a prominent position as the primary coffee-producing region in Vietnam, accounting for almost one-third of the country's total coffee production (GSO 2018).

However, the region's rapid growth in agricultural production has resulted in negative consequences. The Central Highlands now face challenges such as dwindling water supply, deforestation, and land degradation, stemming from the increased pressure on natural resources (VietnamCredit 2020).

In general, the productivity of coffee crops is affected by various factors, including weather conditions, the prevalence of pests (e.g., coffee berry borer), diseases (e.g., coffee rust), farmers' crop management skills, and the use of inputs such as fertilizers and pesticides.

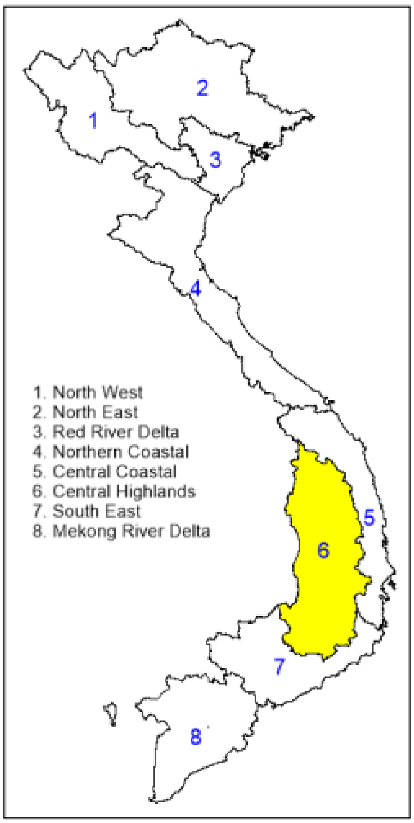


Figure 6: Location of the Central Highlands in Vietnam

Sources: BCA et al. 2013; CGIAR 2016

Previous studies have highlighted the significant influence of weather and climate on coffee (Dinh, Aires & Rahn, 2022). The combination of precipitation and temperature determines the viability of coffee as a profitable crop and affects its yearly yield and quality variations. Given the high sensitivity of coffee to changing precipitation patterns and rising temperatures, there are serious concerns about the future sustainability of coffee production in meeting the livelihoods of farmers and fulfilling the future demand for coffee, particularly in the context of climate change.

The adoption of agroforestry practices is one possible solution, which is already widespread in the Central Highlands. Their adoption in smallholder coffee areas is heavily influenced by factors such as plot location, ecological suitability, and market access (Nguyen et al. 2020).

3.2 Forestry

Forest cover in Vietnam has continuously increased since the 1990s from 28.8% in 1990 to 46.7% in 2020 (The World Bank 2023). However, the definition of forests in Vietnam differentiates between natural forests and plantation forests. The primary driver behind the increase in forest cover has been the expansion of plantation forests (Hoang et al. 2020).

As of 2019, Vietnam had a total of 10.3 million ha of natural forests and 4.3 million ha of plantation forests (Hoang 2021; GSO 2019). In the context of these statistics, a natural forest is described as one that occurs through natural processes or regeneration, encompassing both primary and secondary forests in accordance with the concept of "naturally regenerating forest" (Hoang 2021). A plantation forest refers to a forest that is under intensive management and fulfils specific criteria both during planting and when it reaches stand maturity. These criteria include having one or two species, a uniform age class, and trees spaced evenly.

Both definitions are part of the **Law on Forestry 2017**, which also governs alterations to the legal status of forestland and categorizes forestland based on their type of function in three classifications: special-use forest, protection forest, and production forest (MDRI 2022). According to the 2017 Law on Forestry, converting any type of natural forest to non-forest purposes is generally prohibited, except in cases of "important national projects", "projects for national defence and security purposes", or "other urgent projects approved by the Government" (MDRI 2022). These broadly defined exceptions are potentially leading to the practical implementation of numerous natural forest conversion projects.

Within the **plantation forests**, Acacia is the most prevalent tree species planted, covering over 1.1 million hectares, followed by Rubber occupying nearly 1 million hectares, and Eucalyptus spanning around 500,000 hectares (Harwood and Nambiar 2014). Other plantation trees such as Pine (Pinus), Manglietia conifera Dandy, and Melaleuca cajuputi occupy smaller areas (Hoang et al. 2020).

The main **natural forest** types consist of three distinct categories (Hoang et al. 2020). Firstly, there is the evergreen broadleaf forest, which holds significant dominance and wide distribution, covering more than 85% of the total natural forest area. Secondly, the deciduous forest, mainly comprising deciduous broadleaf trees, is prominently distributed in the Central Highlands and South Central Coast regions. Lastly, the coniferous forest, primarily consisting of evergreen coniferous trees, prevails mainly in the Central Highlands.

In the **Central Highlands** the area of natural forest has been gradually shrinking (MDRI 2022), and forest resources have been seriously degraded in recent decades (Van Trieu 2021). Back in 1975, 70% (3.8 million ha) of the whole region was covered with natural forest (Tran 2023). Until 2005, the total forest area was reduced to 2.97 million ha, accounting for 23.53% of Vietnam's total forest area. From 2006 to 2020, the forest cover rate in the Central Highlands has further declined from 54.4% to 45.9% while the area of natural forest has seen a reduction from 2.83 million ha to 2.18 million ha (Van Trieu 2021). By 2023, the natural forest area further decreased to 2.1 million hectares, losing about 25,000 hectares each year even after the Forest Law 2017 (Tran 2023) was enacted. Regarding the classification type of function of the total forest area in the Central Highlands, 60% (1.7 million hectares) was classified as productive forest, 22% (0,62 million hectares) was protection forest and 17% (0.49 million hectare) was special use forest in 2013 (CGIAR 2016).

The forest loss has been driven by various factors, including: forest fires, illegal logging, and the expansion of productive activities by local communities (MDRI 2022). It is estimated that approximately 78% of the forest loss is attributed to the conversion of land for different purposes, while illegal deforestation constitutes only 6% of the total (Tran 2023). The exploitation of plantations accounts for 4% of the loss, forest fires contribute to 1%, and the remaining 11% is caused by various other factors. The primary factors responsible for deforestation in the Central Highlands of Vietnam have been identified as the conversion of forests into agricultural lands, with rubber, coffee, and pepper being the main plantation crops in this region (Hoang 2021).

By interviewing agricultural departments in the Central Highlands and international organizations, further aspects regarding the forest management have been highlighted. The district department of agriculture in Krong No, for instance, receives yearly afforestation goals from the government. Each district is assigned an annual goal that must be achieved. The They strive to better protect forests by improving their guarding systems and stopping further explorations of forests. According to their own assessment, the awareness of local people to protect the forest is now very high and the policies for forest protection are significantly more effective now than some decades ago. Moreover, there is a proposal to revise the Law on Forests 2017. This proposal was published in April 2023 and builds on feedback from five provinces in the Central Highlands.

3.3 Water management

Vietnam is endowed with vast water resources, including nearly 3,500 rivers and an annual rainfall of around 2,000 millimeters (The World Bank 2019). However, the distribution of these resources is uneven, and two-thirds of the water is transboundary, posing challenges for direct management. The country is highly **vulnerable to water-related natural disasters**, with over 70% of the population at risk. Despite a high per capita renewable freshwater availability of about 10,200 cubic meters, there are emerging water stress issues in certain regions and seasons, driven by rapid economic growth and increasing demands from various sectors. If these challenges are not addressed, water stress is expected to affect 11 out of 16 river basins in Vietnam by 2030 (The World Bank 2019). The country has invested heavily in irrigation infrastructure, but challenges in operation and maintenance have led to declining water services and productivity levels. Addressing these issues is crucial to ensure sustainable water management and security in Vietnam.

Agriculture plays an especially crucial role in Vietnam's overall water usage, accounting for more than 70 percent of the country's total water consumption (Kong 2022). The Central Highlands, in particular, are currently facing intensifying drought conditions, water scarcity, and water pollution, which pose significant threats to both agricultural production and the availability of clean water for human consumption. Groundwater supplies serve as the primary source of irrigation throughout the Central Highlands (Pavelic et al. 2022). The rapid expansion of well irrigation has resulted in the depletion of groundwater resources, posing a significant challenge to water availability (Pavelic et al. 2022; Amarasinghe et al. 2015).

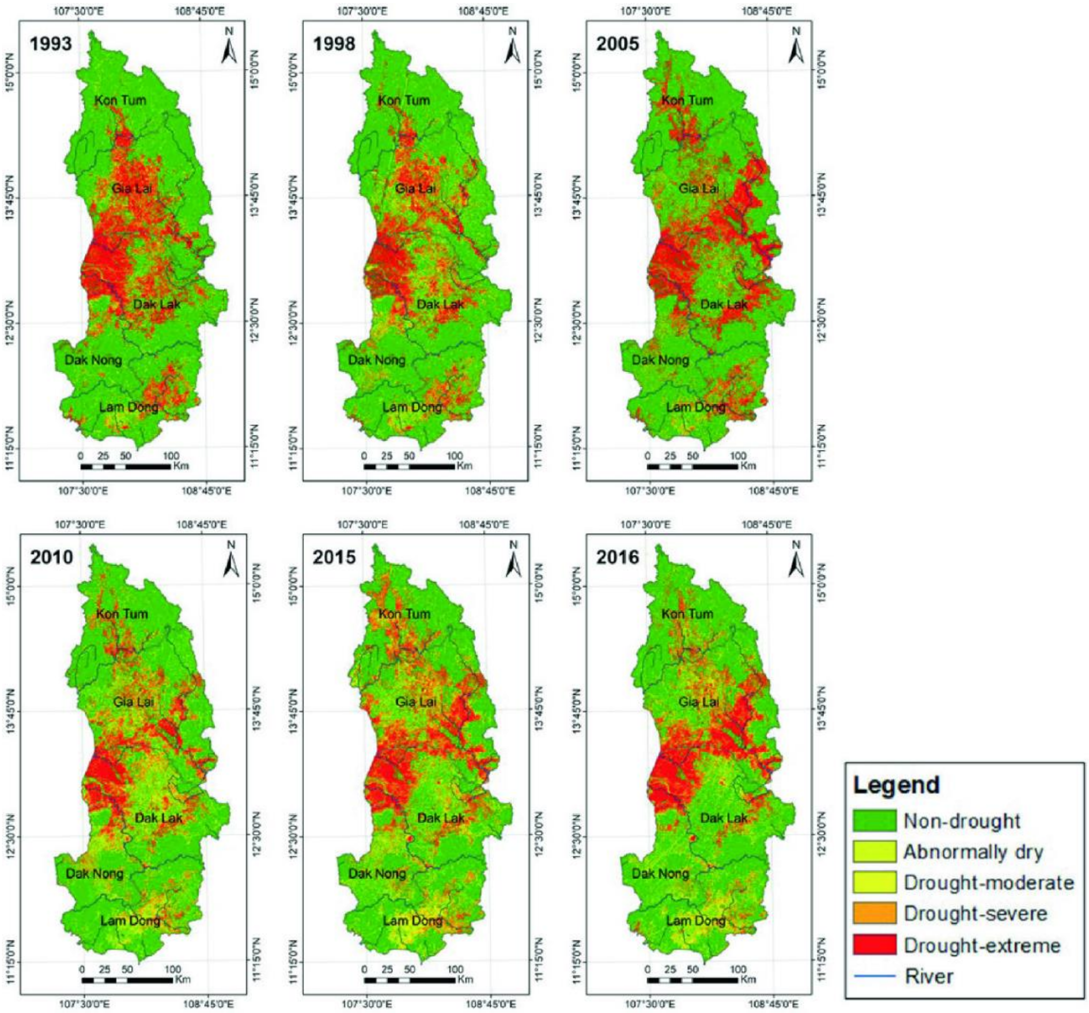
However, the abundant monsoonal rainfall creates opportunities to increase groundwater storage by managing local surface runoff through a process called managed aquifer recharge (MAR) (Pavelic et al. 2022). The region's intense land use and limited availability of unused land make subsurface water storage an appealing option. Lately, there has been growing interest in exploring the potential of MAR as a means to address water supply and demand discrepancies.

Further challenges in water management are the **shortage of irrigation water** due to competition with hydropower plants, the **shortage of clean water** due to pollution, and the **shortage of fresh water** due to climate-induced droughts and saline intrusion (VD-Office 2023).

3.4 Climate change impacts

The Central Highlands provinces have experienced drought episodes since at least 1993, with Dak Lak and Gia Lai being most affected, especially the western part of Dak Lak and the eastern part of Gia Lai as indicated in the following figure (Ha et al. 2021).

Figure 7: Drought in the Central Highlands of Vietnam in March for several years



Source: Ha et al. 2021.

The drought events occur primarily towards the end of the dry season (March) and are influenced by the **El Niño Southern Oscillation (ENSO) phenomenon and a changing climate** (Climate Risk Country Profile Vietnam 2021). These droughts have had negative impacts on the environment, agriculture, and the livelihoods of the local population (CGIAR 2016, Quyen et al. 2016). For instance, in the dry season of 2015, the largest drought-impacted area so far was reported, corresponding to 46% of the highland's total area (Ha et al. 2016).

As a response, the Vietnamese Government has provided more than 5.000 tons of food and allocated 45 million USD worth of relief and disaster support services for people in the drought affected regions in the Central Highlands (CGIAR 2016).

Drought risk records indicate that even mild droughts can cause a 20-30% reduction in crop yields, while severe droughts can lead to a 50% reduction, and extremely severe droughts can result in a complete loss of yield (Quyen et al. 2016). Coffee and rice are particularly sensitive crops in the region (CGIAR, 2016). For instance, in Ninh Thuan province, crop yields were reduced by 85% between 2015-2016 (Nam & Trang 2019). Moreover, the impact of drought extends beyond smallholder farmers and low-income groups, also affecting industrial agriculture.

Looking into the future impacts, the climate risk and vulnerability assessment conducted by Parker et al. (2019) suggests that the Central Highlands of Vietnam are highly vulnerable to climate change, particularly under a high emission scenario (RCP 8.5). This vulnerability is determined based on factors such as exposure to natural hazards (e.g., drought, land degradation, flooding), sensitivity of key crops (maize, rice, coffee) to climate change, and the adaptive capacity of the population, considering indicators such as education, poverty, health care, and organizational capacity.

These findings highlight the urgent need for adaptation and resilience-building measures in the Central Highlands to address the challenges posed by drought and climate change, ensuring the sustainability of agriculture and the well-being of the local communities.

3.5 Effectiveness of Existing EbA in the Central Highlands

Ecosystem-based Adaptation (EbA) initiatives in Vietnam's Central Highlands region are gaining recognition for their crucial role in addressing the challenges posed by climate change. The Central Highlands, known for its rich biodiversity and unique ecosystems, is vulnerable to the adverse impacts of climate change, such as increased temperature, altered rainfall patterns, and prolonged droughts. EbA projects in this region aim to enhance the resilience of natural systems while simultaneously benefiting local communities. These initiatives involve a range of activities, including reforestation, forest restoration, watershed management, and sustainable land management practices. By integrating EbA measures into climate change adaptation strategies, initiatives in the Central Highlands are not only helping to protect and restore ecosystems but also providing valuable ecosystem services, such as water regulation and carbon sequestration, which contribute to the overall well-being and livelihoods of the local population.

The forthcoming section will highlight a selection of successful EbA initiatives already implemented within the region, showcasing established and effective practices. Subsequently, the report will broaden its scope by incorporating additional noteworthy examples from various parts of the world in the appendix.

While monoculture continues to dominate agricultural practices in the Central Highlands, agroforestry stands out as a well-known EbA approach in the region. However, its widespread adoption remains constrained (Mulia and Nguyen 2021). Local farmers in the area frequently employ a combination of coffee cultivation alongside other crops, including Rubber, Black Pepper, and fruit trees like Durian. Moreover, certain production systems integrate intercropping methods involving vegetables like Maize, Green Beans, and Cassava, as illustrated in Table 5. Despite these positive examples, the broader implementation of agroforestry techniques in the Central Highlands is yet to be fully realized.

Table 5: Agroforestry systems in the Central Highlands

Province	Agroforestry system	Area (ha)	Productivity (ton/ha)
Dak Nong	Coffee-Cashew-Durian	9,295	Coffee: 2.5 Cashew: 2.5 Durian:11
Kon Tum	Coffee-Litsea glutinosa	5,206	Coffee: 1.7

	Rubber- Cassava	1,268	
Gia Lai	Litsea glutinosa-Cassava	1,037	Litsea: 14-19 Cassava: 12-18
Lam Dong	Coffee-Macadamia-Black Pepper-fruit trees	202,022	Coffee: 4.1 Black pepper: 1.4 Durian: 4 Avocado: 5.2 Macadamia: 0.5-0.8
	Coffee-Macadamia	19,976	Coffee: 3 Macadamia: 3-5
Dak Lak	Coffee-Black Pepper-Durian-fruits-maize-green bean	260,000	Coffee: 2

Sources: Based on Mulia and Nguyen (2021) and CGIAR (2016)

Lam Dong province stands out with the largest area dedicated to agroforestry, covering 202,022 hectares and incorporating diverse crops like Coffee, Macadamia, Black Pepper, Durian, and Avocado. The productivity of Coffee in Lam Dong is notably high at 4.1 tons per hectare. In Dak Lak province, agroforestry occupies 260,000 hectares, showcasing its extensive implementation. The Coffee-Cashew-Durian system in Dak Nong province demonstrates significant productivity, particularly for Durian, yielding 11 tons per hectare. Additionally, Litsea glutinosa plays a significant role in agroforestry systems in both Kon Tum and Gia Lai provinces, boasting productivities ranging from 14 to 19 tons per hectare. These facts collectively demonstrate the scale and productivity of agroforestry practices in the Central Highlands.

Figure 8. Transition from monocrop farming (left) to intercropping (right)

A comprehensive assessment conducted by D'haeze (2022) has examined the benefits and challenges associated with transitioning from monocrop farming to intercropping in the Central Highlands. This transformation seeks to improve productivity, sustainability, and profitability within the agricultural sector. The advantages of intercropping include increased coffee production, substantial potential for intercrop cultivation, augmented revenues, water conservation, carbon sequestration benefits, environmental sustainability, and long-term profitability for farmers. However, the process of transformation also poses certain obstacles, including initial losses, market absorption considerations, resource demands, investment expenses, market uncertainties, exposure to early losses, and the necessity for awareness-raising initiatives (see Table 6). Understanding these benefits and challenges is crucial for making informed decisions regarding the adoption of intercropping practices.

Table 6: Benefits and challenges associated with transitioning from monocrop farming to intercropping

Benefits	Challenges
• Increased coffee production • Potential for significant production in intercrops • Higher gross revenues at the farm level • Water savings through optimized irrigation practices • Carbon sequestration gains for climate change mitigation • Environmental sustainability through reduced water consumption and carbon capture • Long-term profitability and net benefits for farmers	• Initial losses during the transition • Market absorption of intercrops • Time and resource requirements • Investment costs for training and nurseries • Market uncertainty and competition • Exposure to losses in the initial years • Need for awareness-raising efforts

Source: D'haeze 2022

Regarding **water management in the Central Highlands**, interviews with local authorities indicated a very limited number of EbA projects in the region. The emphasis in water management predominantly leans towards grey infrastructure, such as dams, with a greater focus on technological solutions like new irrigation systems rather than the integration of EbA practices. However, there are several noteworthy good practice examples across Vietnam showcasing the application of EbA principles:

Sa Nghia commune, Central Highlands

In Sa Nghia commune, a farmer invested his own funds to create a fish pond. This innovative approach enabled him to share water with neighbouring coffee farms during the dry season, demonstrating the successful implementation of EbA principles (CGIAR 2016).

Bắc Giang Province, north-eastern Vietnam

In Bắc Giang Province, rice fields have been transformed into suitable habitats for fish and other aquatic species. This is achieved by widening the distances between plants and creating furrows, effectively integrating EbA practices (GIZ 2022b).

Bắc Giang Province, northeastern Vietnam

Through the implementation of rice-duck-fish plots, there has been a remarkable increase of 35% in fish, ducks, and other natural enemies of rice pests. This efficient pest control approach has allowed farmers to reduce pesticide usage by up to 100%, emphasizing the effectiveness of EbA (GIZ 2022b).

These examples highlight the successful utilization of EbA strategies in different regions of Vietnam, promoting sustainable water management and showcasing the potential for replicating and scaling up such practices across the country. In the Annex (section 6), international case studies of EbA are presented to provide further examples and insights on EbA in the context of drought adaptation in the agricultural sector.

4 Conclusion

This report examined the critical issue of drought adaptation in the Central Highlands of Vietnam, with a special focus on the application of Ecosystem-based Adaptation (EbA). The Central Highlands region, renowned for its agricultural production, is confronted with increasing crop damages, limited water availability and drought events in the face of climate change. As climate change intensifies, the region's vulnerability is exacerbated, particularly due to extreme weather events triggered by El Niño. These events, occurring every two to seven years, often result in severe droughts during the dry season, imposing significant impacts on agriculture, forestry and water availability. Given the increasing drought risks, the Central Highlands need effective drought adaptation measures.

In **agriculture**, there is a need to transform existing monocropping practices into more sustainable approaches such as intercropping. By diversifying crops and implementing adaptive practices like agroforestry, crop rotation, and organic farming, the region can enhance its resilience to drought and climate change. These agricultural adaptation measures, guided by EbA principles, will contribute to sustaining agricultural productivity and reducing vulnerability to water scarcity.

Forestry plays a crucial role in drought adaptation, and the report underscores the significance of preserving and restoring natural forests in the Central Highlands. Afforestation efforts and enhanced protection measures can promote water retention, mitigate the adverse effects of drought, and support ecosystem resilience. By prioritizing the conservation and sustainable management of natural forests, alongside with the transition from monoculture plantations, the region can safeguard its biodiversity, enhance water availability, and contribute to an overall adaptation strategy.

Sustainable water management is essential in mitigating the impacts of drought in the region. The report emphasizes the underutilization of EbA principles in current water management practices and highlights the need to incorporate nature-based approaches. Measures such as increasing water storage in and nearby farmland and forests can enhance water availability, improve water quality, and strengthen the region's resilience to drought. Collaboration among stakeholders is crucial to implement effective water management strategies that integrate EbA principles, thereby ensuring the sustainable supply of water for agriculture, ecosystems, and human consumption.

It is worth noting that the Vietnam, including the Central Highlands, already boasts successful examples of EbA measures that have been implemented with positive outcomes. These existing EbA initiatives in the region serve as valuable models for guiding future efforts. Furthermore, the report presents international case studies in the Annex that showcase successful EbA projects from Vietnam and other parts of the world. These case studies not only offer practical examples but also serve as a source of inspiration and orientation for stakeholders in the Central Highlands to develop and implement effective EbA strategies tailored to the region's specific needs. By leveraging the existing successful EbA practices and drawing insights from international experiences, the region can make informed decisions and build upon the knowledge gained to ensure the effectiveness and success of future EbA projects.

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6 ANNEX: EbA Case Studies

EBA-CASE STUDY
FARMER MANAGED NATURAL REGENERATION

NR. 1

NR.1 | AGROFORESTRY | SOURCE: SDGS.UN.ORG

OVERVIEW

Farmer-Managed Natural Regeneration (FMNR) is a practice that focuses on regrowing and managing trees and shrubs from stumps, roots, or seeds. By integrating these regrown trees and shrubs into crops and grazing pastures, FMNR restores soil structure and fertility while curbing erosion and soil moisture evaporation. Additionally, it aids in rehabilitating springs and the water table, contributing to improved water availability and increased biodiversity in the area. Some tree species also enrich the soil by imparting essential nutrients like nitrogen.

The advantages of FMNR are far-reaching. It has the potential to double crop yields, ensuring enhanced food production and bolstering local economies. Moreover, FMNR provides valuable resources like building timber and firewood, and it offers fodder and shade for livestock. The presence of wild foods adds nutritional diversity and medicinal options for communities. Through its sustainable approach, FMNR not only benefits the environment but also leads to increased incomes and improved living standards for farming families and their communities.

OBJECTIVES

- The increase of tree cover on a landscape and the FMNR method lead to improvements in soil quality, microclimate, and water quality and availability
- Improving food security and transforming food systems through agroforestry and silvopastoral systems
- Improving household livelihoods and resilience by increasing availability of wood and forests products as well as quality and quantity of crop yields
- Strengthening gender equality by improving access to resources and creating income generating opportunities for women

EBA-TYPE
Agroforestry Landscape Restoration

REGION
Africa (24 countries)

ORGANIZATION
World Vision

PERIOD
2000-2025

COST
$40-$50/hectare

REPLICABILITY
●●●●○

TACKLED CHALLENGES
Desertification, Drought, Erratic rainfall, Extreme heat, Floods, Increasing temperatures, Land and Forest degradation, Loss of Biodiversity, Erosion, Ecosystem loss, Unsustainable harvesting, Lack of access to long-term funding, Lack of alternative income opportunities, Lack of food security

IMPLEMENTATION

(1) Organize participatory FMNR sensitization meetings involving traditional and government leaders, forestry and agriculture department staff, other NGOs/CBOs, and community members. These meetings serve to educate them about FMNR and its relevance to their livelihoods

(2) Conduct FMNR training sessions for project and government extension agents.

(3) Empower communities to select FMNR champions who will actively teach and lead by example.

(4) Train farmer champions through extension agents and ensure ongoing follow-up and monitoring. Offer encouragement and assistance with problem-solving.

(5) Facilitate exchange visits from neighboring districts after the adoption of FMNR. Peer-to-peer experiences play a crucial role in encouraging adoption among farmers.

(6) Develop tree product value chains and integrate FMNR with other livelihood options. This approach enables impoverished communities to allow trees to grow while having diversified income sources to meet their immediate needs.

"FMNR is an easy, low-cost way for farmers to increase the number of trees in the fields." – *UN Department of Economic and Social Affairs*

ENABLING FACTORS

- Implementation of enabling policies that grant tree ownership and/or user rights. These policies should be locally generated and supported by effective by-laws and enforcement mechanisms.
- Encouragement of membership in FMNR practitioner groups, fostering collaboration and knowledge-sharing among stakeholders.
- Ensuring legal market access for selling tree products, enabling communities to benefit economically from their efforts in FMNR.
- Five essential conditions for spontaneous adoption of agroforestry enterprises by resource poor households:
  1. Ease of access to markets for the forestry products,
  2. Benefits (economic and other) from agroforestry are higher than from alternatives,
  3. A viable forestry production technology is available and known to farmers,
  4. Farmer access to sufficient areas of land and security of tenure to that land and farmer confidence in being able to control risk, such as fire, pests, theft.

CHALLENGES

- Constraints in FMNR implementation involve free-range grazing, bushfires, continuous woody biomass removal (including theft), and extensive border-to-border cultivation.
- The typical project cost ranges from $40 to $50 per hectare, with major expenses linked to complementary activities such as water harvesting, promoting horticultural crops, introducing fuel-efficient stoves, and improving livestock breeds.
- Social challenges arise due to false beliefs, negative attitudes, and destructive practices against trees, posing obstacles to successful implementation.
- Policy challenges include certain countries restricting farmers from taking responsibility for tree care or legally benefiting from trees, leading to increased tree destruction.
- Tree theft significantly discourages adoption in some contexts.

https://sdgs.un.org/partnerships/farmer-managed-natural-regeneration-fmnr-technique-effectively-combat-poverty-and

EBA-CASE STUDY

IMPROVING BIODIVERSITY IN COFFEE LANDSCAPES IN VIETNAM

NR. 2

NR.2 | AGROFORESTRY | SOURCE: WWW.4C-SERVICES.ORG

OVERVIEW

The Biodiversity Performance Tool (BPT) developed by the EU LIFE Initiative "Food & Biodiversity" has been adapted to the Vietnamese context and successfully applied, evaluating biodiversity situations and implementing biodiversity action plans accordingly. The BPT is a practical instrument designed to assess and improve biodiversity on farms, addressing the need for a baseline evaluation of biodiversity on the farm, identifying strengths and weaknesses using a classification system, and creating a Biodiversity Action Plan based on the evaluation.

It focuses on two main areas of action: (1) creating potential for biodiversity and reducing negative impacts on biodiversity, (2) empowering farmers and farm group managers to make informed decisions on implementing measures to enhance biodiversity while facilitating transparent communication about the progress made in improving biodiversity on the ground.

OBJECTIVES

The project's main objective is to enhance biodiversity in coffee production through landscape-level biodiversity action plans. It further includes:

- Farmers benefit from training and support for developing biodiversity action plans.
- Enhanced coffee farming practices lead to increased biodiversity conservation and improved productivity and profitability for farmers.
- Coffee regions become more biodiverse as biodiversity-friendly practices are implemented on various farms.
- Awareness about the benefits of biodiversity conservation within coffee plantations increases at local, regional, and national levels.
- Improved market connections between coffee farmers producing biodiversity-friendly coffee and responsible European markets.

EBA-TYPE
Agroforestry

REGION
Vietnam

ORGANIZATION
4C Services GmbH

PERIOD
2021- 2022

COST
N/A

REPLICABILITY
●●●●○

TACKLED CHALLENGES
Desertification, Drought, Loss of Biodiversity, Erosion, Ecosystem loss

IMPLEMENTATION

Phase 1: Adaptation and Testing

- BPT adapted to the Vietnamese context and tested for implementation.
- Conducted farm visits in January 2021 to evaluate biodiversity and identify potential improvements.

Phase 2: Upscaling Biodiversity Action Plans (BAP)

- Biodiversity Action Plans developed and implemented on a landscape level.

Phase 3: Support for Market Access

- Efforts to facilitate market access for biodiversity-friendly coffee producers.

Phase 4: Dissemination and Anchoring

- Results of the project disseminated to raise awareness.
- BPT further adjusted for use on a landscape level in Vietnam's coffee cultivation.

"We have learned about the value of biodiversity and how to enhance it. Our soil is now looser and more fertile, coffee plants are more resilient, and beneficial insects such as ladybugs, bees, worms and crickets have appeared." - *Farmer*

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BENEFITS

Implementation of good management/farming practices:

- Breaking monoculture systems through intercropping.
- Promoting soil health through increased vegetative layers.
- Maintaining and planting flowers/shrubs to protect beneficial insects, pollinators, and enhance the aesthetic value of coffee farms.
- Shade tree maintenance and expansion of shade tree planting, providing a conducive environment for coffee cultivation.
- Protection not only for coffee farms but also for the surrounding area, promoting ecological sustainability.

Awareness raising and capacity building:

- Integrated Pest Management and Weed Management, reducing reliance on harmful chemicals and fostering a balanced ecosystem.
- Promotion of shade trees and intercropping strategies, enhancing coffee farm resilience and biodiversity.

CHALLENGES

- Projects and approaches often focus on singular topics, such as pesticide use or shade trees, lacking a holistic approach to biodiversity.
- The need for a pragmatic approach that demonstrates progress efficiently and can be transparently communicated along the supply chain.

EBA-CASE STUDY

STRENGTHENING THE RESILIENCE OF SMALLHOLDER AGRICULTURE

NR. 3

NR.3 | AGROFORESTRY AND WATER MANAGEMENT | SOURCE: WWW.GREENCLIMATE.FUND

OVERVIEW

The project's primary goal is to empower vulnerable smallholders in five provinces of Vietnam's Central Highlands and South-Central Coast regions. This includes economically disadvantaged households, ethnic minorities, women-dependent households, and those facing poverty. The project aims to enhance their ability to manage climate risks in agriculture by ensuring water availability, adopting climate-resilient farming methods, and providing access to agro-climate information, credit, and markets.

To achieve this, the project follows a two-pronged approach:

1. Supply-side intervention: The project focuses on providing water-efficient irrigation infrastructure and increasing water storage capacity to mitigate the risk of water scarcity.
2. Demand-side intervention: Climate-resilient crop diversification, land treatment, and agronomic practices are introduced to reduce water input requirements for food and agricultural production.

OBJECTIVES

- Empowering vulnerable smallholders in the Central Highlands and South-Central Coast regions of Vietnam, especially women and ethnic minority farmers, to manage climate risks in agricultural production effectively.
- Securing water availability, adopt climate-resilient agricultural practices, and strengthening access to actionable agro-climate information, credit, and markets for small-scale farmers.
- Promoting a paradigm shift towards more integrated, multi-stakeholder coordination of investments to sustain smallholder agricultural production through climate-risk informed water and agricultural management.
- Addressing the threat posed to vulnerable smallholder agricultural production by the impacts of climate-change induced rainfall variability and drought.

EBA-TYPE

Agroforestry, Water Management

REGION

Vietnam

ORGANIZATION

UNDP

PERIOD

2022- 2026

COST

124.26 million USD

REPLICABILITY

●●●○○

TACKLED CHALLENGES

Desertification, Drought, Water Scarcity, Lack of food security

IMPLEMENTATION

Enhanced water security for smallholder farmers facing climate-induced rainfall variability and drought through:

- Establishing last-mile connections between irrigation infrastructure and poor/near-poor farmer lands.
- Enhancing supplementary irrigation for rainfed smallholders.
- Increasing smallholder capacities in water-efficient practices to cope with rainfall variability and drought.

Increased resilience of smallholder farmer livelihoods through climate-resilient agriculture and improved access to climate information, finance, and markets:

- Scaling up climate-resilient cropping systems and practices through Farmer Field Schools.
- Providing technical assistance for enhanced market access and credit for sustainable climate-resilient agricultural investments.
- Developing and utilizing localized agro-climate advisories to enhance climate-resilient agricultural production.

"Overall, the project will benefit over 139,416 households as direct and indirect beneficiaries in climate-vulnerable areas of Dak Lak, Dak Nong, Ninh Thuan, Binh Thuan and Khanh Hoa provinces of Central Vietnam or 10.1% of the total population of the five provinces." - *UNDP*

ENABLING FACTORS

- Connecting poor and near-poor farms to large-scale irrigation infrastructure and increasing farmer capacities for water-efficient technology use can be replicated in other areas in Vietnam with similar conditions, potentially covering one million hectares.
- Knowledge generated through project experience will be disseminated through standard training and information channels for potential policy discussions.
- Rehabilitating, upgrading, or constructing climate-proofed water storage facilities can be easily replicated in rural Vietnam, ensuring the resilience of critical production components like household and communal ponds.
- The project's training programs for facilitators and lead farmers have a replication potential to reach additional poor and near-poor households in the target provinces and nationwide when mainstreamed.
- Climate, weather, and agricultural advisories produced by the project can be replicated in other districts through various media channels, covering the entire farm population in the target provinces.

CHALLENGES

- Limited financial capacity of smallholder farmers and the government to invest in additional water sources to adapt to climate change-induced rainfall variability and drought.
- Lack of awareness among smallholders and weak technical capacities in extension support, hindering the scaling up of climate-resilient agriculture practices.
- Limited technical capacities of institutions to generate and disseminate timely, integrated, and actionable agro-climatic information for on-farm climate risk-informed water management and agricultural planning.
- Limited access to credit and market information, posing barriers to sustaining investments in resilient water and agricultural systems in response to evolving climate risks.

https://www.greenclimate.fund/sites/default/files/document/funding-proposal-fp125.pdf

EBA-CASE STUDY

SUCCESSIONAL AGROFORESTRY BETWEEN THE ANDES AND THE AMAZON

NR. 4

NR.4 | AGROFORESTRY AND WATER MANAGEMENT | SOURCE: PANORAMA.SOLUTIONS/EN

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OVERVIEW

Successional agroforestry has proven to be a viable approach in restoring depleted soils and crisis-ridden plantations, like cacao and coffee, without relying on external inputs. The project has emphasized the importance of respecting natural succession and biodiversity as fundamental rules of life for long-term human-nature interactions.

By increasing the turnover of organic matter and diversifying production systems, they have successfully adapted management practices to meet the specific requirements of crops and ecosystems. This has led to a notable decline in pest and disease issues, resulting in visible short-term outcomes. Additionally, the project has demonstrated how successional agroforestry positively impacts food security for farmers and their families.

OBJECTIVES

The project is designed into two Building Blocks. Farmer field schools and the upscaling of implementation of Dynamic Agroforestry Systems. Within those two blocks, the following objectives should be achieved:

- Create diverse agroforestry systems with natural regeneration trees and a variety of crops.
- Utilize natural succession dynamics to optimize density and diversity by grouping crops and trees based on their life cycle.
- Establish a composition that starts with fast-growing crops to provide shade for slower-growing primary forest species, while transitioning to timber as a long-term investment with cacao in full production.
- Provide environmental benefits such as soil regeneration, organic matter accumulation, improved microclimate, and pest control through the high diversity of the system. Encourage knowledge-intensive management practices for successful implementation.

EBA-TYPE

Agroforestry

REGION

Bolivia, Ecuador, Ghana, Ivory Coast

ORGANIZATION

ECOTOP Consult

PERIOD

N/A (around 2017)

COST

N/A

REPLICABILITY

●●●●○

TACKLED CHALLENGES

Drought, Extreme heat, Land and Forest degradation, Loss of Biodiversity, Unsustainable harvesting incl. Overfishing, Conflicting uses / cumulative impacts, Pollution (incl. eutrophication and litter), Ecosystem loss, Lack of technical capacity, Lack of public and decision maker's awareness.

IMPLEMENTATION

The training concept for successional agroforestry is designed to embrace the uniqueness of each farm, recognizing that there is no universal recipe but underlying principles. Local "lighthouse" families' experience and vision are utilized through field courses and farmer-to-farmer exchanges. The training consists of a 12-month modular program with eight one-week modules. Five modules focus on theory and practice of dynamic agroforestry, held in centralized locations. In between these modules, participants implement a dynamic agroforestry plantation on their own farms, under the supervision of ECOTOP trainers. Each participant records their progress, challenges, and successes.

The training concludes with a "final test" module, during which each participant presents their experiences and lessons learned from their own farm. A notable aspect of the concept is the recognition of local innovative farmers as agricultural technicians, granting them a university title. This not only generates prestige within communities but also enhances their ability to interact with policymakers. Many of these "peritos" have become local leaders and advocates, actively promoting successional agroforestry within their regions.

Lead farmers play a crucial role by sharing their practical knowledge and documenting experiences during the installation period. This approach facilitates practical implementation within the context of rural family production.

"At least 3 on-farm field visits of each farmer with practical instructions is required during the first year. Follow up should be guaranteed during 3 to 5 years" – *ECOTOP*

ENABLING FACTORS

Farmer field schools:

- Reward local leaders educated in the program with a university degree, who promote the vision in local public and private entities.
- Thorough selection of committed and open-minded participants, contributing to the project's success.

Upscaling of implementation of Dynamic Agroforestry Systems:

- Long-term program development (at least 5 years).
- Participatory institutional framework.
- Committed and open-minded staff.
- Adequate budget for training, follow-up, equipment, and monitoring.
- Careful selection of local trainers and lead farmers.
- Experienced and skilled senior trainers.
- Access to markets for cash crops.
- Short-term benefits for farmers (annual crops, reduced labor, no external input expenses).

CHALLENGES

- Institutional restrictions and limited understanding of natural dynamics, necessitating a long-term learning process.
- Extractivist logic promoted during colonization of regions like the Yungas and other tropical areas, viewing nature and biodiversity as threats rather than virtues.

EBA-CASE STUDY

LARGE-SCALE ECOSYSTEM-BASED ADAPTATION IN THE GAMBIA

NR. 5

NR.5 | FORESTRY AND WATER MANAGEMENT | SOURCE: WEDOCS.UNEP.ORG


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EBA-TYPE
Forestry, Water Management

REGION
Gambia

ORGANIZATION
UNEP

PERIOD
2017 - 2023

COST
25 Million USD

REPLICABILITY
●●●●○

TACKLED CHALLENGES
Drought, Extreme heat, Land and Forest degradation, Loss of Biodiversity, Unsustainable harvesting, Conflicting uses / cumulative impacts, Ecosystem loss, Lack of technical capacity, Lack of public and decision maker's awareness, Poverty

OVERVIEW

The project focuses on promoting climate-resilient sustainable development through large-scale Ecosystem-based Adaptation. It involves restoring degraded forests and agricultural landscapes with climate-resilient plant species that offer valuable goods.

Additionally, the project facilitates the establishment of natural resource-based businesses through participatory processes and management committees for sustainable management. Strategic recommendations and technical support are provided to integrate EbA into existing policies. Local communities are engaged in planning and design, ensuring alignment with national and subnational priorities. The extensive restoration activities use multipurpose plant species to strengthen adaptation and reduce soil degradation.

OBJECTIVES

UN Environment and the government of Gambia have launched the country's largest adaptation project, which aims to develop a sustainable natural resource-based economy. The main objective within this project are:

- Developing a sustainable natural resource-based economy in the Gambia.
- Restoring degraded forests and farmland to enhance ecosystem health and resilience.
- Establishing ecologically sustainable businesses to stimulate economic activities.
- Creating 'home-gardens' to diversify food and income sources for local communities.
- Integrating adaptation measures to address climate change and rising seas, improving the resilience of the Gambian population.

IMPLEMENTATION

The project focuses on extensive reforestation using multi-purpose plant species selected for their provisioning value and climate resilience. **Enrichment planting** is employed in both farms and natural ecosystems, enhancing adaptation by reducing soil erosion and improving groundwater supplies. **Rainwater harvesting** devices are constructed for tree nurseries, and green protection belts are established to minimize evaporation losses. **Fire breaks** are created around restored landscapes to prevent bushfires in the dry season. **Land-use plans** are being developed to support transhumance corridors and prevent human-wildlife conflicts.

The project establishes 166 natural resource-based businesses, stimulating economic activities for poor communities and generating investments in ecosystem services. Demonstrations are provided to local communities on creating 'home-gardens' of diverse plant species, ensuring continuous agricultural productivity regardless of extreme weather events.

Additionally, the project aims to integrate adaptation actions into four sectoral policies (transhumance, migration, agriculture, energy) with explicit budget and monitoring structures for effective implementation. Over 20 years, a total of $11.3 million will be raised for the National Forest Fund from taxes and licensing fees.

"The main approaches of the project are to restore degraded forests and farmland; establish ecologically sustainable businesses; develop 'home-gardens' to diversify food and income sources; and integrate adaptation actions into four sectoral policies." – UNEP


©Annie Spratt – unsplash.com

RECOMMENDATIONS

- Implementation of rainwater harvesting schemes to support restoration efforts.
- Enhancing groundwater recharge and reducing evaporation through vegetation around reservoirs.
- Conducting baseline studies to determine climatic risks and adapting measures accordingly.
- Establishment of fire belts to prevent bushfires around key trees.
- Adoption of the Zai Pits method for tree growing.
- Organizing a national policy discourse around the recommended minimum tree cover in farms and other public spaces, which outlines a number of actionable resolutions in all managed landscapes.
- Integration of livestock management and transhumance movement into farming practices.
- Limiting the impacts of charcoal and firewood usage by establishing woodlots (about 100 hectares of mixed species) as a medium- to a long-term solution and alternative to biomass clearing for cooking fuel.

CHALLENGES

- Low availability of adequate and viable seedlings:

The team encountered its initial challenge with the insufficient availability of suitable and viable seedlings that aligned with the project's objectives. The absence of existing seed banks to store viable seeds and the underestimation of tree nursery requirements in the project design added to the issue. Additionally, crucial nursery attendants were lacking, further complicating the situation.

- Low survival rate of seedlings:

During the first year of implementation, the seedling survival rate was 10% in community forests and approximately 48% in degraded agricultural lands. Identified causes include the need for better preparation to grow robust and viable seedlings, ensuring they can endure harsh field conditions. Additionally, the restoration teams faced challenges due to the use of seedlings with unknown genetic bases, affecting their viability.

Moreover, human activities posed a significant threat to seedling survival, with bushfires and illegal logging proving to be stronger drivers of ecosystem degradation than initially anticipated.

https://wedocs.unep.org/bitstream/handle/20.500.11822/37784/Gambia_Adaptation.pdf