REPORT

Financial Feasibility Assessment for Upscaling Nature-Based Solutions in the Mekong Basin

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1 Background and aim of the financial and economic feasibility analysis

The financial feasibility analysis aims to demonstrate to potential financiers the opportunities associated with Nature-based Solutions (NbS) investments in the Mekong Basin. This analysis identifies potential financial cash flows through a high-level assessment. However, focusing solely on financial feasibility proves too restrictive for the shortlisted measures, as they yield limited financial returns. Additionally, most of the stakeholders who were interviewed for this project, consider not only financial feasibility but also economic feasibility. Therefore, the financial feasibility analysis should encompass both financial and economic aspects. The difference between financial and economic feasibility is as follows:

- *Financial feasibility* = project feasibility from the perspective of the funder(s); includes only tangible cashflows (expenses and revenues) for those who fund the project (which can include funding for which no return is expected, such as donations), provides investment rationale or business case for stakeholders that fund the project.
- *Economic feasibility* = project feasibility from the perspective of society, can include tangible and intangible societal benefits from a broad range of stakeholders, provides investment rationale mainly for governments, international financial institutions and funders providing grants and donations.

An important aspect of financial and economic feasibility – and in the context of this project – is the scale at which NbS measures are considered. For many funders, projects need to have a certain scale to be viable, and this scale differs by type of funder. For instance, a private investor would only consider investing in projects between $3 to $20 million, while an international financial institution would be interested in financing projects or programmes with a value of over $100 million. On the other hand, individual stakeholders involved in the measures, such as farmers, look at the impact a project has on the income and expenditures of their households. In addition, the benefits of implementing measures at a regional or basin scale – in particular the environmental, climate adaptation and resilience benefits – are different when compared to individual project scales. Consequently, the costs, benefits, and resulting financial and economic viability differ when different scales are considered.

Hence, in this report, the financial and economic feasibility analysis aims to show potential funders (e.g., governments, international financing institutions, private investors, philanthropic organisations, etc.) the viability of NbS investments through a high-level cost-benefit analysis disaggregated by scale and type of stakeholder.

The outline of this report is as follows: Section 2 first explains the approach and methods used. Next, Sections 3, 4 and 5 discuss the economic and financial feasibility analysis for the three shortlisted NbS.

2 Approach and methods

In this study, the financial and economic feasibility analysis is high-level because the proposed shortlisted NbS projects are in an early stage of development and design and data availability is limited. High-level means that the steps of a standardised cost-benefit analysis (CBA) process are followed, but that identification of costs and benefits is mostly based on existing studies and information, and that quantification of identified costs and benefits is only indicative if secondary data is available. The results of a high-level feasibility analysis indicate the potential financial and economic viability of the NbS measures. By going through the CBA steps all costs and benefits of the NbS are systematically identified and evaluated, providing objective evidence for the financial and economic feasibility of the shortlisted NbS.

CBA is the main tool to help decision-making in financial and economic analysis. It is a systematic method to assess the effects, i.e., the costs and benefits, of a project on an organisation (financial CBA) or society (economic CBA). Financial and economic CBAs are largely similar, although they use some different terminology, and consider different effects and there are some differences in the monetisation of effects. An economic CBA is more comprehensive in the sense that it considers costs and benefits on society, including intangible costs and benefits, that would not be considered in a private investment decision.

The steps in Figure 2-1 show the CBA process. The analyses for the shortlisted NbS go through each of these steps, but quantification and monetisation of effects and risk and sensitivity analysis are only addressed to a limited extent due to the high-level nature of the analysis. In each of the steps, a distinction between local (a single project site) and basin level is made, and an overview is included of which benefits are enjoyed by which stakeholder. For reference, the local scale, or the scale of a single project is in the order of 500 ha, while the sum of projects on the basin scale would cover an area in the order of 30,000-50,000 ha.

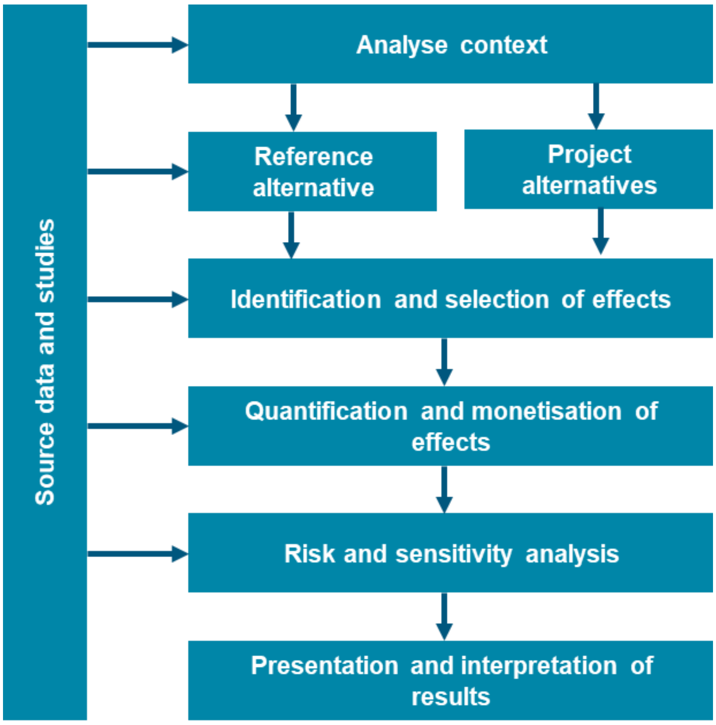

Figure 2-1 Steps in a cost-benefit analysis

In short, each of the steps consists of the following:

Step 1: Analyse context

The main purpose of this step is to get a thorough and complete understanding of the shortlisted NbS. This includes understanding the case study sites, key challenges, objectives and policy goals. The context will be considered at both the local (project) scale and basin scale. Understanding which stakeholders are involved is also part of this step. The contexts for the shortlisted NbS are mainly developed in the technical analysis; here only a very brief summary is provided and the potential stakeholders are identified.

Step 2: Reference alternative

The reference alternative is the case without the shortlisted NbS. The definition of the reference alternative is important, as it defines what the shortlisted NbS are compared to. Costs and benefits can only be determined incrementally; the effects of an NbS cannot be determined unless what would have happened without their implementation is determined, as far as possible. The reference alternatives will briefly describe the without-NbS situation.

Step 3: Project alternatives

The project alternatives are the three shortlisted NbS. Project alternatives should be clearly defined projects or policies so that their effects can be identified and quantified. At the local level, three case studies – one for each NbS – have been developed in the technical analysis. These case studies provide a sufficient level of detail for a high-level economic and financial assessment. As there are no concrete project or programme descriptions at the basin scale, assumptions have been made on the scale of NbS implementation for assessment in the CBA.

Step 4: Identification and selection of effects

Implementing the shortlisted NbS will have several effects that ultimately lead to costs and benefits for different stakeholders at different scales. Effects are wide-ranging and include, for instance, costs for sluices and gates, costs for training farmers, change in yields of rice crops leading to changing incomes for farmers, increased areas for spawning of fish leading to larger fish stock, higher incomes from fisheries and reduced flood damages. Identification of effects will follow the structure of an ecosystem services assessment[1], which links an action to benefits for people through an ecological production function.

Action → Processes → Ecosystem Services → Benefits for people

Figure 2-2 Ecosystem Services assessment

Effects experienced by different stakeholders and at different scales could be different, hence identified effects will be related to stakeholders and the scale (local or basin). Effects could be tangible (e.g., investment costs, increased revenues) and intangible (e.g., increased resilience). Intangible effects are difficult to quantify or measure. The selection of effects for quantification is based on their expected significance for the outcome, the ability to quantify them, and data availability. Effects that are not selected will be discussed qualitatively.

Step 5: Quantification and monetisation of effects

Quantification of effects will be based on the high-level designs and ideas for the three case studies and on the assumptions for upscaling the NbS. The quantification will be indicative and only for effects for which data is available. Monetisation for effects that can be quantified will be based on secondary data, and

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[1] *The ecosystem services assessment approach is presented in Boris van Zanten, Gonzalo Gutierrez Goizueta, Luke Brander, Borja Gonzalez Reguero, Robert Griffin, Kavita Kapur Macleod, Alida Alves, Amelia Midgley, Luis Diego Herrera, and Brenden Jongman. 2023. Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers. World Bank, Washington, DC.*

existing studies and reports. Selected effects that cannot be quantified will be discussed qualitatively. With the quantified and monetised effects, a simple present value calculation will be conducted to calculate an indicative economic net present value (NPV), benefit-cost ratio (BCR) and internal rate of return (IRR) for society.[2] The assumptions for these calculations are a social discount rate of 6%[3] and a project lifespan of 50 years. The base year and price level of the calculations is 2024.

Step 6: Risk and sensitivity analysis

Due to the preliminary nature of the analysis, it is not relevant to conduct a risk and sensitivity analysis. Yet, where relevant, sensitivities to assumptions will be discussed qualitatively.

Step 7: Presentation and interpretation of results

The final step is the presentation and interpretation of results, as reported in the chapters below.

Following the CBA, a qualitative financial analysis will be conducted in which the tangible cash flows from the projects are identified and an assessment is made of potential avenues for funding the projects.

[2] *Based on the available data and due to lack of tangible benefits it was not possible to calculate the financial NPV, BCR and IRR.*

[3] *While previously development banks used SDRs of 8-12%, increasingly lower discount rates are used, particularly for sustainability and climate-related projects (e.g., 6% for Vietnam, see World Bank (2022), Accelerating Clean, Green, and Climate-Resilient Growth in Vietnam: A Country Environmental Analysis, Supplementary Technical Note. World Bank.*

3 Financial Feasibility NbS1: Improving natural floodplain dynamics with flood-based agriculture

3.1 Context

The Upper Vietnamese Mekong Delta comprises an extensive river, floodplain and canal network with seasonal movement of water in the floodplain. The area has undergone rapid changes in river flow regimes due to various factors, including the conversion of natural landscapes into agricultural and aquaculture facilities, urbanization, upstream development of hydropower dams, and the influence of climate change. These changes have had significant impacts on the overall function of the floodplain and the responses of wetland ecosystems. As a result, the main problems faced are the deterioration of soil quality and texture and reduced elevation of floodplains, caused by the disconnection of floodplains in an agricultural region, because of the development of dike systems. NbS that could address these problems are to rehabilitate, restore, and enhance natural floodplain dynamics and to implement flood-based agriculture. River mainstreams can re-establish connections with the floodplain, which in turn revitalizes the floodplain's role. This helps improve soil quality by depositing essential fertile sediments, increases and maintains the elevation of the floodplain and, at the same time, reduces the risk of floods in the agricultural area and potentially downstream, by storing water in the flooding season and releasing it slowly. Flood-based adaptation of agriculture can provide a sustainable alternative to intensive farming, such as triple-crop rice. (From the report *“Shortlisted NbS with factsheets”.*)

The case study location for the proposed NbS is the area surrounding Lang Sen Wetland Reserve, see Figure 3-1. The total area is about 21,000 ha of which the Wetland Reserve covers 3,200 ha and the remaining area is mostly used for agriculture and aquaculture. Two villages are located in the area, and people live along the canals and levees. The case study area could be reconnected to main rivers through existing canals, and culverts can be installed in existing dikes to allow an area to periodically flood. As this is a large area, it could be redeveloped for flood-based agriculture in phases. For the financial analysis, it is assumed that initially, 500 ha will transition to flood-based agriculture.

On a larger scale, improving natural floodplain dynamics and flood-based agriculture could be established in areas that are suitable for the technical feasibility analysis. The highly feasible area for Group 2 (rice with fish stocking) in the Mekong Delta in Vietnam is 2,947.26 km^2 or 294,726 ha (see Table 3-1). For the financial analysis, it is assumed that 25% of this area will transition to flood-based agriculture. This would be a total of 73,681 ha. For Cambodia, 25% of the highly suitable area for Group 2 would be a total of 29,947 ha. Hence, the total area of a basin-wide project would be 103,628 ha. The other groups are not considered as they have lower revenues or because of lacking data.

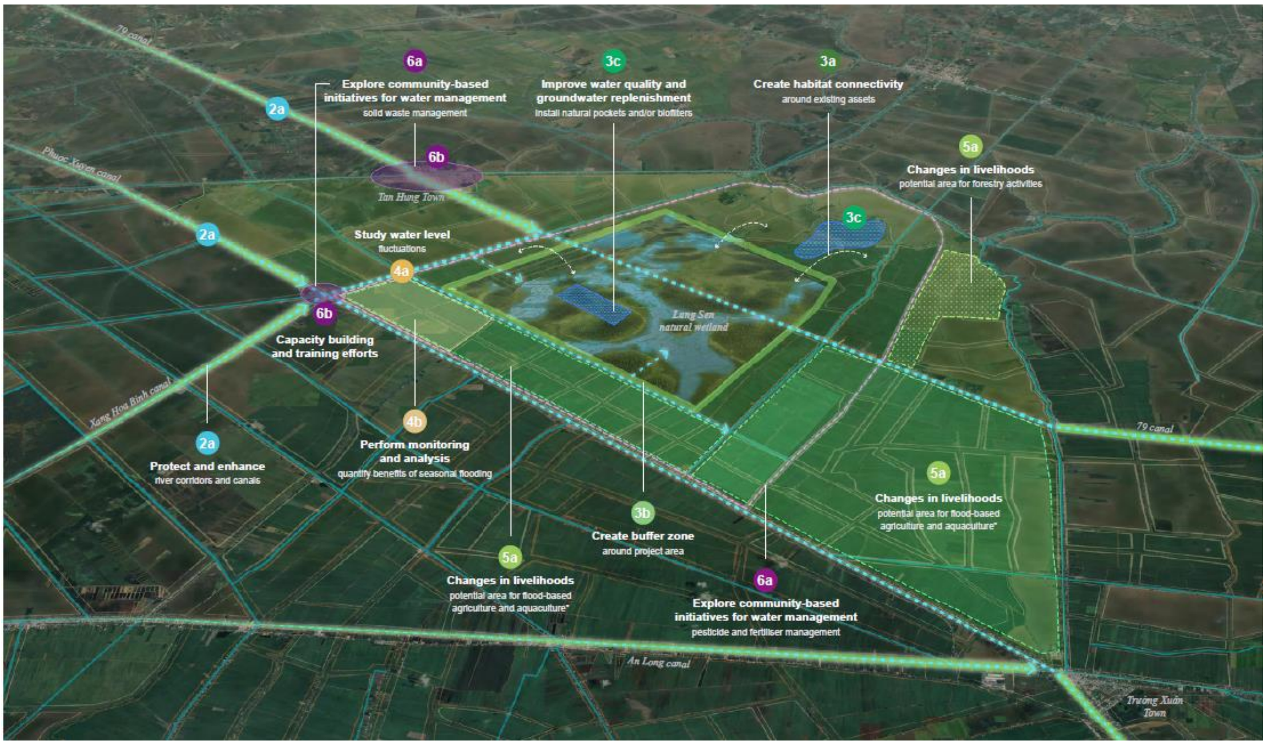

Figure 3-1 Location of the case study site and proposed measures.

Table 3-1 Suitability statistics per group for Vietnam and Cambodia (km²)

Country	Group	Not suitable	High suitable	Moderate	Marginally
Vietnam	Group 1	8,590.11	2,998.69	3,853.26	5,295.85
Vietnam	Group 2	8,590.11	2,947.26	3,904.69	5,295.85
Vietnam	Group 3	5,712.91	3,679.03	3,459.34	7,886.63
Vietnam	Group 4	13,578.53	1,682.91	3,024.62	2,451.85
Cambodia	Group 1	35,131.24	408.51	7,655.49	1,754.93
Cambodia	Group 2	35,131.24	1,197.88	6,866.11	1,754.93
Cambodia	Group 3	33,360.13	528.08	4,825.27	6,236.68
Cambodia	Group 4	7,439.70	5,707.33	0.12	31,803.01

Note: Group 1 is rice + (giant) freshwater prawn, Group 2 is rice/ + fish stocking, Group 3 is rice + lotus or lotus with fish, Group 4 is Melaleuca timber plantations

Improving natural floodplain dynamics with flood-based agriculture would involve many stakeholders, including a large number of government agencies. These stakeholders can be categorised into the following main groups:

Table 3-2 Stakeholders for flood-base agriculture projects

Stakeholder group	Involvement
Farmers/households/ farming cooperatives	Direct beneficiaries of the project, are expected to change their farming model
Private sector companies	Potential beneficiaries of the project, adjusting to new or different business opportunities
Government organisations	Design, implementation and support of the projects
Funders	Provide loans, funds and other forms of financing for the project
Society	At a larger scale, social, economic and environmental co-benefits will affect society

In addition to these stakeholders, others can be identified, such as NGOs, knowledge institutions and contractors. However, these are not expected to be the main beneficiaries or responsible for the costs of the project and hence are not included in the financial and economic analysis. Note that there could be some overlap in stakeholder groups, e.g., government organisations could also be funders.

3.2 Reference alternative

The reference alternative is the scenario in which the NbS will not be implemented. Intensive agricultural practises, in which the land is kept free from flooding as much as possible through levees and grey infrastructure, and employing a model with three rice crops annually, are continued, both at the project level and at the basin level. The reference alternative assumes that no incremental investment costs are required to sustain the current systems, yet it is acknowledged that over time agricultural production is not sustainable and hence production may stall or decline, and costs of production increase substantially, mainly due to more fertiliser and pesticide use.[4] In the long run, a possible scenario is a severe decline in agricultural production of the Mekong Delta due to the sinking of soils below sea level and reducing soil fertility. However, this would be beyond the current project horizon.

3.3 Project alternative

The project consists of improving natural floodplain dynamics and conversion to a flood-based agriculture/aquaculture model. This requires some structural measures related to the water system to re-create a connection between the main river and the farmland and non-structural measures related to improving and/or restoring ecology and habitats. It also requires activities to support households and communities to transition to flood-based agriculture and aquaculture, such as outreach and training. Finally, it involves engaging other stakeholders, including those in the supply chain. For instance, for branding and promoting of farmer output and technical and organisational support. This will ultimately lead to a situation in which the benefits and co-benefits of flood-based agriculture are generated sustainably.

At the basin scale, it is assumed that the case study project would be replicated up to the point where 25% of the highly suitable land area has transitioned to flood-based agriculture. Implementing projects at the basin scale would likely lead to scale advantages in costs and benefits.

[4] *See Tran, D. D., van Halsema, G., Hellegers, P. J., Ludwig, F., & Wyatt, A. (2018). Questioning triple rice intensification on the Vietnamese mekong delta floodplains: An environmental and economic analysis of current land-use trends and alternatives. Journal of environmental management, 217, 429-441.*

In economic and financial analyses, the project period or project horizon is relevant as cash flows are discounted to a present value and different stakeholders have different time horizons. The project may be regarded as having an infinite lifetime as the switch to flood-based agriculture would be permanent. However, households and private sector stakeholders may have a horizon of one to a few years, as they would like to see relatively short-term returns on their efforts and investments. Public sector investments and societal benefits have much longer horizons as infrastructure generally has a lifespan of several decades and some effects may only materialise in the long run. Costs and benefits also need to be placed in a timeline, and for this, it is assumed that for the local scale project implementation takes 2 years and that at the basin scale, it takes 10 years to achieve the 25% conversion to flood-based agriculture. A project horizon of 50 years, from 2024 to 2073, is assumed.

3.4 Identification and selection of effects

The identification of effects is one of the most important steps and is done by comparing the project alternative with the reference alternative and identifying the incremental costs and benefits of the project alternative. Following the action-process-services-benefits approach, nine tangible benefits and one intangible benefit were identified, as shown in Figure 3-2. In addition, the project would result in a change in the agricultural model. Although this is not directly an ecosystem service, the change in agricultural production due to a change in the agricultural model is important to include in the analysis. Carbon credits and biodiversity credits are identified as potential financing mechanisms, though are not counted as benefits for people as they are considered financial transfers from one group of stakeholders to another group of stakeholders.

The effects are different at different scales and for different stakeholders. As ultimately everyone could benefit from each service through indirect effects, only the most directly affected stakeholder groups are considered. In Table 3-5, the column “Scale of benefits” indicates if benefits are predominantly present if a project is done locally or at a basin scale. Yet, through aggregation local benefits are also present at basin scale.

Table 3-3 Benefits by scale and stakeholder

No.	Benefits for people	Scale of benefits	Stakeholders	Comments
1	Change in fishing revenue	Basin, with benefits expected to increase with scale	Farmers/households & private sector companies	Private sector companies could benefit from new market opportunities (e.g., dried fish value chain). Note that aquaculture revenue is included under No. 6.
2	Change in tourism revenue	Local	Private sector companies & households	
3	Climate change mitigation	Basin, with benefits expected to increase with scale	Society	This is a global benefit and would ultimately also benefit the basin and local societies; carbon credits could benefit farmers/households.
4	Change in non-use values	Local & basin	All	All stakeholders have non-use values, also at the global scale, but the specific non-use values differ considerably among stakeholders.

5	Cost savings	Local	Farmers/households	This can be aggregated at the basin scale.
6	Change in quality/quantity of agricultural outputs	Local	Farmers/households & private sector companies	This can be aggregated at the basin scale.
7	Health benefits	Local	Farmers/households	
8	Reduction in flood protection cost / lower flood damage	Basin	Society	There might also be some local flood protection benefits
9	Increased drought resilience	Local	Farmers/households	Farmers are mostly affected by droughts, though impacts could be aggregated at the basin scale
10	Energy savings	Local	Farmers/households	This can be aggregated at the basin scale.

An effect that is not displayed in Figure 3-2 is the cost of the project. Implementation of the project comes with structural and non-structural costs for different stakeholders. Structural costs for the water system are generally borne by government organisations although they could be financed by other organisations, but ultimately are borne by society through taxes and fees. Non-structural costs are borne by government organisations, funders, farmers and households. Potential costs related to flood-based agriculture are related to:

1. Protection and enhancement of river corridors
2. Installation of culverts
3. Creating and maintaining habitat connectivity, e.g., through land zoning, regulations and planting of vegetation and installation or designation of buffer zones through land zoning and regulations
4. Installation or designation of buffer zones
5. Installation of natural pockets and/or biofilters
6. Studies, monitoring & analysis
7. Change of agricultural model
8. Initiating payment for ecosystem services to former and current landowners
9. Organised eco-tourism
10. Limiting activities/enforcement/community-based water management

In the first instance, all identified tangible and intangible effects are selected for inclusion in the CBA. However, only a limited number can be quantified and monetised.

Project related

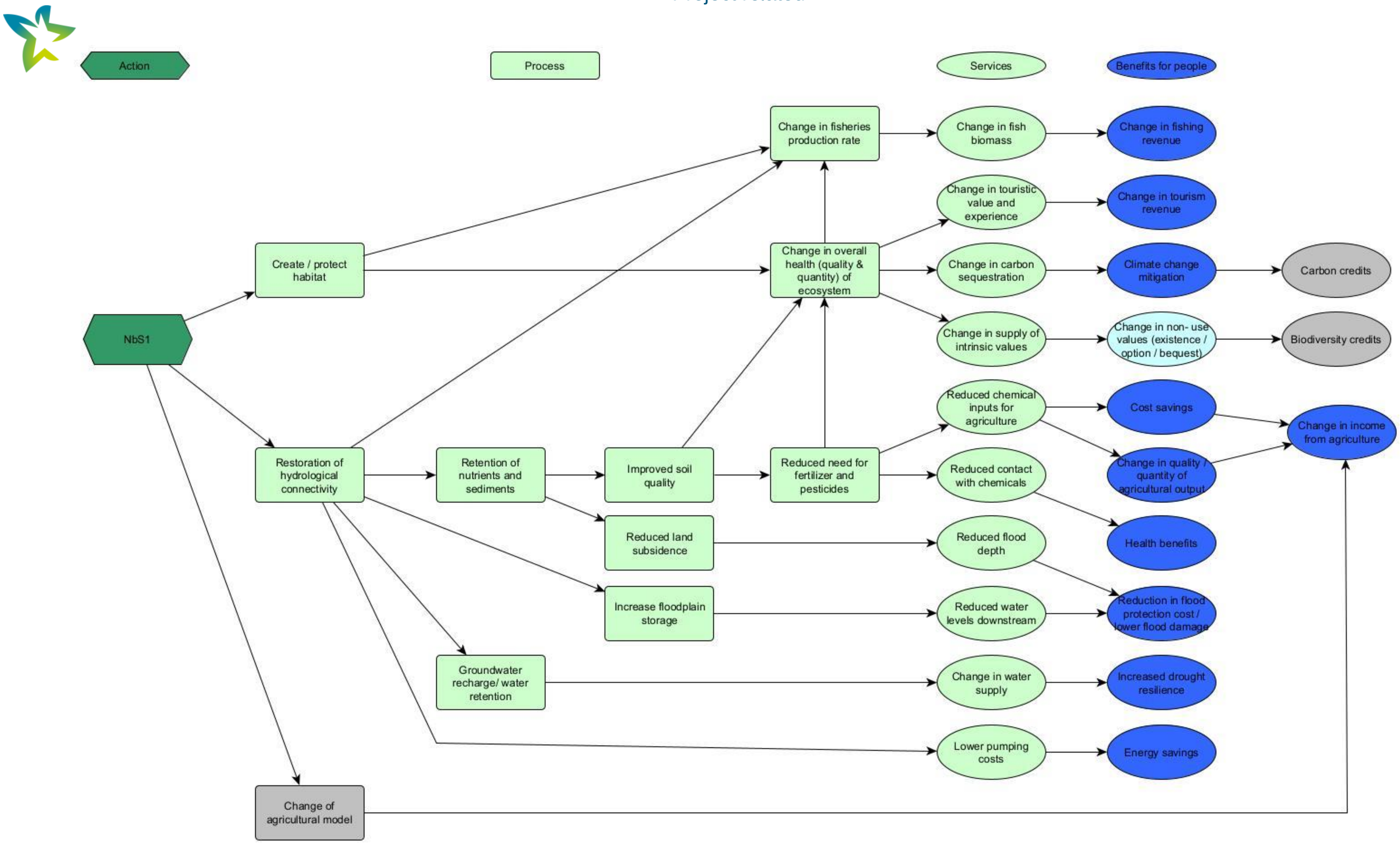

Figure 3-2 Effects of implementing flood-based agriculture and aquaculture

3.5 Quantification and monetisation of effects

3.5.1 Benefits

1. Change in fishing revenue

At the local scale, increases in fishing and aquaculture revenues are captured under the change in income from agriculture due to the change in the agricultural model.

At the basin level, recent estimates indicate that the economic value of the Mekong fishery dropped by more than a third between 2015 and 2020[5]. The estimated annual value of fish catches was estimated between USD 7.13 billion and USD 8.37 billion in 2019-2020.[6] While it is difficult to estimate the impact of flood-based agriculture on wild fisheries income in the basin in the absence of quantitative data, assuming that implementing the project in 25% of the highly suitable areas would only result in a 0.1% increase in fisheries, the revenues would generate about USD 7.75 million in annual benefits if the middle of the range of the 2019-2020 estimated annual value of fish catch (USD7.75 billion) is taken as a base.

2. Change in tourism revenue

At the local scale, the project could include components to attract tourists to the area. Tram Chim National Park received, pre-Covid, about 100,000 visitors per year, while the number of visitors in 2023 was about 60,000. Tram Chim is, however, a large well-known national park, while at Lang Sen Wetland Reserve there is no specific ecotourism component, although there are some simple visitor facilities. At this moment, Lang Sen is not open to the public, and only accessible to groups with academic- and/or research- purposes. However, it could be made suitable to open to the public in the future. If opened for tourism, it is assumed that the project would result in 10,000 additional visitors per year (10% of Tram Chim pre-Covid), who are assumed to generate an added value of USD 10 per visitor. Hence, the total annual benefit would be USD 100,000.

At the basin level, ecotourism cannot be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that there would be 5 additional ecotourism sites throughout the basin, each would generate USD 100,000 per year, hence in total USD 600,000 per year.

3. Climate change mitigation

Through the creation and protection of habitat, the project could contribute to increased carbon sequestration. Increased carbon sequestration reduces greenhouse gases in the atmosphere, mitigating climate change, and hence benefiting people as a reduction in climate change and associated effects compared to a baseline without the project. This benefit can be valued through the amount of carbon sequestered by vegetation and a social price for carbon. However, rice production causes significant emissions of methane, nitrous oxide and carbon dioxide.[7] A change to flood-based agriculture likely impacts these emissions, but further research is required to determine exactly the changes in emissions. Hence, at this stage, it is not possible to assess the net impact of the project on greenhouse gases and the resulting benefit of climate change mitigation. As such, it cannot be quantified in the CBA.

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[5] *Cowx IG, Lai TQ and So N (2024). Fisheries Yield Assessment by Habitat Type at The Landscape Scale in The Lower Mekong River Basin 2020. Vientiane: Mekong River Commission Secretariat.*
[6] *Ibid*
[7] *https://blogs.worldbank.org/en/eastasiapacific/greening-rice-we-eat*

4. Change in non-use values

Non-use values are numerous and different for each person. Such values include bequest values (leaving something for the next generation), existence values (attaching value to knowing that something exists, for instance, expressed to donations to charity) and option values (not using it now, but maybe in the future). A monetary estimate of non-use values can generally only be obtained by asking people for their willingness to pay to conserve or enhance certain habitats, ecosystems or ecosystem services.

While there are some studies on non-use values of wetlands in the Lower Mekong Basin, the results cannot be easily translated for use in the CBA in this study, as they are site-specific and because of methodological issues in using values derived from site studies at a larger, basin, scale. An example is an estimation of the biodiversity values of Tram Chim National Park (Do and Bennett, 2007)[8] which found that the aggregated values for a wetland conservation program resulting in an increase in healthy vegetation, an increase in the number of Sarus cranes and an increase in the number of fish species are about USD 3.9 million. This gives a clear indication that there are significant non-use values that could support the decision to implement projects.

The change in non-use values could be linked to the potential value of biodiversity credits. Biodiversity credits are a verifiable, quantifiable and potentially tradeable financial instrument that rewards positive nature and biodiversity outcomes (e.g., species, ecosystems and natural habitats) through the creation and sale of either land, freshwater or ocean-based biodiversity units over a fixed period.[9] The market for biodiversity credits is, however, still at an early stage of development and the pricing of biodiversity credits is still largely unknown.

5 & 6. Change in agricultural income: cost savings and change in quality/quantity of agricultural outputs

A reduction in chemical and artificial inputs reduces the cost of agricultural production. The impact on agricultural production and resulting agricultural income is evaluated together with the change in quality and quantity of agricultural outputs, as they both ultimately lead to a change in agricultural income for households and potentially the private sector through supply chains.

The impact on income from agriculture and aquaculture is the result of many individual effects. Firstly, there are changes in inputs, including labour, fertiliser, pesticides, irrigation, rice seeds, and fish seedlings, that in the aggregate lead to cost savings. Secondly, there are changes in outputs including changes in the quality and quantity of the yield, new outputs such as fresh and dried fish, and products from water hyacinth. In total, this leads to a change in incomes for households and the private sector through supply chains. WWF conducted a pilot study under the Climate Resilient by Nature programme that can be used to gauge the impacts of the project on income from agriculture. Table 3-4 shows the financial results of flood-based agriculture for a full production cycle for 2022 and 2023 and intensive triple rice crops for 2022 as a comparison. The table shows that the production costs for flood-based agriculture are considerably lower than for intensive triple rice crops. However, revenues are also substantially lower, leading to a lower profit, or income from agriculture for households.

While in those two years, the financial benefit from the project was negative, these results need to be seen in the context of the pilot project. It is expected that soil health will increase over time as a result of flood-

[8] *Thang Nam Do and Jeff Bennett, Estimating Wetland Biodiversity Values: A choice modelling application in Vietnam's Mekong River Delta, Australian National University Economics and Environment Network Working Paper EEN0704, 2007.*
[9] *World Economic Forum: https://initiatives.weforum.org/financing-for-nature/home*

based agriculture, thereby increasing the productivity of conventional rice crops and floating rice crops over time. As supply chains for the products from fisheries and aquaculture have not been established yet, the production resulted in a local, temporary oversupply, resulting in low prices. The global price of rice also increased by about 3% in 2022 and 21% in 2023 due to geopolitical tensions (War in Ukraine) and adverse weather conditions (El Nino) making intensive triple rice crops relatively more attractive due to higher output. Hence, the results are very much determined by market conditions.

In the CBA it is conservatively assumed that the change in income from farming due to the project is zero. The following arguments support this. Firstly, as value chains become more established (e.g., good distribution channels for outputs), prices for fish and other aquaculture products would be more stable and higher. Secondly, rice from flood-based agriculture could command a premium price that might be sufficiently large to bridge part of the gap caused by the higher output from intensive triple rice crops. This will depend, however, on global market conditions and the right value chains and marketing/certification of flood-based rice. Thirdly, the required input from fertiliser would increase over time due to deteriorating soil conditions in the intensive triple rice cropping system, while productivity would decrease due to soil degradation and pesticide use. Fourthly, households in the pilot study also earned from harvesting water hyacinth and water hyacinth knitting and fish trap making, which also makes up part of the difference from conventional agriculture. Hence, over time it is expected that flood-based agriculture can compete with intensive triple rice cropping.

Table 3-4 Change in household income from different models (USD/ha/year).

	2 rice crops + floating rice integrated fish		2 rice crops + aquaculture		Intensive triple rice crops
	Results 2022	Results 2023	Results 2022	Results 2023	Results 2022
Production cost	1,887	1,846	1,591	2,049	3,050
Revenue	3,936	4,209	3,260	3,580	5,547
Profit	2,049	2,362	1,669	1,531	2,497

An intangible income-related benefit is that flood-based agriculture could provide a more stable household income as it is more climate and flood-resilient. Besides intangible social benefits from a more stable income, it could also support economic development. As the risk of loss of income or investments due to natural hazards decreases, households would be more inclined to invest their incomes, rather than saving for bad times. However, it is outside the scope of this study to estimate such benefits.

For private sector companies, upgrades in the value chain could lead to improved product quality and value, new sources of income, reduction of unit cost and increased scale of production and consumption.[10] This would lead to increased income and value-added from the private sector. The rice value chain in the Mekong Delta is, however, a large and complex system, linking thousands of small-scale rice farmers to large numbers of traders, processors, wholesalers, retailers, and exporters. Hence, it is difficult to quantify the

[10] *Source:* Report on solutions for upgrading the value chains of products from livelihood activities in the project area – Tan Hung district, Long An province, Vietnam.

change in revenues of the private sector due to the project. In line with the assumption for household income, it is assumed that there may be some shifts in revenues between products (e.g., less fertiliser sold, more fisheries revenues), but overall it is assumed that the net effect is zero.

7. Health benefits

If farmers and other people in the local community are less exposed to chemicals, this would lead to health benefits. Theoretically, health benefits could be quantified and monetised as reduced medical expenditures, avoided loss of working days due to illness, or an increase in expected healthy living years. However, as data on the impact of specific chemicals on health is not available, this benefit cannot be quantified in this study.

8. Reduction in flood protection cost / lower flood damage

The introduction of the NbS at the basin level would lead to flood risk reduction downstream, as the storage capacity for flood waters increases. In addition, increased inundation would result in the deposition of sediments, partly mitigating the effects of land subsidence and aiding in maintaining the elevation of the delta. Almost every year, floods cause damage to agriculture, infrastructure and buildings and lead to loss of lives, which might be reduced with greater water storage upstream to reduce peak flows. Reduced flood levels could result in lower required protection levels, and hence lower costs for flood protection infrastructure.

In terms of water storage, it is estimated that flood-based agriculture could store 740 million m^3 of flood waters in Vietnam and 300 million m^3 in Cambodia, leading to a flood depth reduction of 0.7 and 0.3 meters respectively in the Mekong River, see Appendix A. However, assessing the quantitative impact of implementing flood-based agriculture on resulting flood damage reduction and flood protection is complex.[11] and hence only a very rough indication of the benefits can be given. The average annual cost of floods in the Lower Mekong Basin ranges between USD 60 to 70 million.[12] Assume the project would contribute to a 1% reduction in damages this would be USD 600,000 to 700,000 annually.

9. Increased drought resilience

Closely related to the reduction of flooding, the NbS would also lead to increased resilience to drought through groundwater replenishment. There is, however, no data available to quantify this effect. Groundwater replenishment however is very important to mitigate further subsidence, and thereby also indirectly positively affects flood risk.

10. Energy savings

A flood-based agricultural model would reduce the dependency on pumping and hence reduce the pumping costs. It is assumed that the benefits of energy savings are included under the change in agricultural income as a reduction in the costs of inputs.

Summary of benefits

Table 3-5 provides a summary of the benefits.

[11] *See for instance Thanh, V. Q., Roelvink, D., Van Der Wegen, M., Reyns, J., Kernkamp, H., Van Vinh, G., & Linh, V. T. P. (2020). Flooding in the Mekong Delta: the impact of dyke systems on downstream hydrodynamics. Hydrology and Earth System Sciences, 24(1), 189-212 on the complexity of modelling and considerations to assess changes in the floodplain on flood levels.*

[12] *Mekong River Commission: https://www.mrcmekong.org/our-work/topics/flood-and-drought/*

Table 3-5 Benefit estimates NbS3

No.	Benefit item	Estimate project site (USD/year)	Estimate basin (USD/year)
1	Change in fishing revenue	-	7,750,000
2	Change in tourism revenue	100,000	600,000
3	Climate change mitigation	N/A	N/A
4	Change in non-use values	N/A	N/A
5	Cost savings	Included under 6	Included under 6
6	Change in quality/quantity of agricultural outputs	0	0
7	Health benefits	N/A	N/A
8	Reduction in flood damages and flood protection costs	0	650,000
9	Change in drought resilience	N/A	N/A
10	Energy savings	Included under 6	Included under 6
	Total annual benefits	100,000	9,000,000

3.5.2 Costs

Table 3-6 gives an overview of the cost estimates for the project site and basin. Note that these estimates are all very indicative and based on currently available data.

For the project, it is assumed that the investment costs are spread over two years at the beginning of the project period. Operational costs (items 1 and 10) are annual.

Table 3-6 Cost estimates and assumptions

No.	Cost item	Estimate project site	Estimate basin

1	Protection and enhancement of river corridors	USD 400 / year	USD 82,900 / year
2	Installation of culverts	USD 0	USD 82,902,400
3	Creating/maintaining habitat connectivity	No costs, part of overall planning and management costs, see 7	No costs, part of overall planning and management costs, see 7
4	Installation or designation of buffer zones	No costs, part of overall planning and management costs, see 7	No costs, part of overall planning and management costs, see 7
5	Installation of natural pockets and/or biofilters	USD 2,500	USD 518,140
6	Studies, monitoring & analysis	USD 50,000	USD 10,362,800
7	Change of agricultural model	USD 200,000	USD 33,160,900
8	Initiating payment for ecosystem services to (former) landowners	N/A	N/A
9	Organized eco-tourism	USD 25,000	USD 125,000
10	Limiting activities/enforcement / community-based water management	USD 3,000 / year	USD 621,768 / year
	Total Capital Expenditure	USD 277,500	USD 127,069,300
	Total Operational Expenditure	USD 3,400 / year	USD 704,670 / year

Notes for the calculation of costs:

- Item 1: Costs for protection and enhancement of river corridors and canals that lead to the designated areas. For the main canals, it is assumed maintenance costs are similar to in the reference alternative, though operation and maintenance practices may change. For the smaller connecting canals, enhancement and maintenance (e.g., clearing vegetation, dredging, stabilising canal banks with plantings) along 10% of the length is assumed. The length of smaller canals in the project area is assumed to be 2 km. Cost is assumed to be 2 USD per metre (this is based on the cost of dredging, which is 2 USD/m^3). Maintenance is an ongoing process, and it is assumed that it needs to be conducted annually. To arrive at a basin estimate, the costs on a local scale are multiplied by the increase in area (i.e., an area 10 times larger would cost 10 times more). In this case, the area for upscaling is about 200 times larger (103,628 ha) than the area assumed for the case study scale (500 ha).

- Item 2: Installation of culverts or other water control structures to let the water in periodically and lower or remove embankments. Existing water control structures may be sufficient to manage flooding in the case study area as it is sufficiently low-lying. If the project is upscaled to the basin, more investments in water control structures may be needed in areas with less favourable conditions. A sluice gate under a dike would cost about USD 800,000 and annual operating and maintenance costs would be around USD 8,000 (1% of investment costs). At basin scale, it is assumed that one culvert per 1,000 ha is required.
- Items 3 and 4: Creating habitat connectivity/corridors/buffers around existing assets. It is assumed that the acquisition of land is not needed. Planning and management of land use can achieve connectivity and corridors. This would involve planning, legislation (e.g., banning pesticide use), management costs (manpower), and costs to support farmers in implementing the measures. These costs are included as a one-time project cost under item 7.
- Item 5: Installation of natural pockets and/or biofilters to enhance and improve water quality and groundwater replenishment. This would require some earthworks. It is assumed that per 1,000 ha, 0.25 ha or 2,500 m^2 needs to be deepened for USD 5,000, based on 1 m depth and earth moving costs of USD 2 per m^3.
- Item 6: Studies and monitoring costs: flood-based agriculture and NbS would require studies on water level fluctuations to understand flooding duration and frequencies, and monitoring and analysis of the effects on agriculture, biodiversity and sedimentation. To some extent, these costs would replace other costs of water management in the Mekong basin and would decline over time as more experience is gained with flood-based agriculture. An amount of USD 50,000 per project area of 500 ha is included as costs, and costs are scaled to the basin scale based on the proportional increase in area.
- Item 7: The costs to transition to flood-based agriculture could include outreach and engagement costs to convince farmers to make the transition. Outreach and engagement costs can also aid in obtaining buy-in from suppliers and buyers in the value chain, training costs of farmers, and project management costs. These costs would entail additional manpower for governments, technical support costs, project management costs, project execution costs and training costs. Based on the project conducted by WWF, these costs are estimated to be USD 200,000 per project area of 500 ha. At the basin level, we assume that costs are 20% lower due to economies of scale.
- Item 8: Setting up a system for payments for ecosystem services (carbon credits, biodiversity credits or other) requires a certain scale to cover fixed costs. These costs are currently unknown.
- Item 9: The costs of building a simple visitor centre and developing an ecotourism strategy, brochures, etc. are estimated to be USD 25,000. Ecotourism could not be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that 5 sites could have ecotourism, with a budget of USD 125,000 in total.
- Item 10: It is assumed that enforcement costs would be USD 500 per month or USD 6,000 per year per 1,000 ha.

3.6 Discussion of results

Table 3-7 shows the results from the CBA. The results are indicative due to the assumptions being made, but some conclusions can be drawn from them. Firstly, both at the site level and at the basin level flood-based agriculture is economically viable. Over the lifetime of the project, the net present values (NPV) are positive, while the benefit-cost ratios (BCR) are above 1. The internal rates of return (IRR) of 30.2% and 8.7% show that there is a high return on investment.

Secondly, at the site level, it turns out that there is only one tangible benefit – ecotourism revenues. The change in the agricultural model does – under the present assumptions – not generate any tangible economic benefits at the site scale or basin scale, though there are intangible benefits, such as health benefits and non-use benefits. At the basin scale, the benefits of fisheries are about 86% of the total benefits. Without benefits for fisheries, the project would not be viable as the benefits from ecotourism and reduced flood risk would not be able to cover the costs of the project. However, considering the potential of a severe decline in agricultural productivity and output over the long run due to the lack of seasonal flooding, leading to soils sinking below sea levels and reducing fertility, even without the benefits of fisheries the project could be viable beyond the current project horizon.

Thirdly, the study of Do and Bennett (2007, see footnote 6) shows that there are considerable non-use values, which could already cover the costs of several projects. Non-use values are, however, intangible and would not contribute to the funding of the project.

Table 3-7 Results of the CBA for flood-based agri- and aqua-culture, Present USD values at a 6% discount rate over a 50-year project lifetime.

Indicator	Value for Site	Value for Basin
Total lifetime costs	USD 0.32 million	USD 105.41 million
Total lifetime benefits	USD 1.48 million	USD 132.88 million
NPV	USD 1.16 million	USD 27.47 million
BCR	4.62	1.26
IRR	30.2%	8.7%

3.7 Financial analysis

To make (parts of) projects financially viable, they need to generate tangible revenue streams that can be captured by a stakeholder. However, aside from revenues from ecotourism, there are no tangible revenue streams resulting from the projects. Ecotourism may contribute to funding the project at some of the wetlands linked to flood-based agriculture projects, though it is unlikely that it could fund a substantial part of the project. Revenues from ecotourism will go directly to the households and private sector companies as they sell their services, and only for instance an entrance fee or license fee paid by households and private sector companies could provide funding for the projects.

Biodiversity credits and carbon credits are a form of Payment for Ecosystem Services (PES). PES might provide a viable avenue for funding flood-based agriculture, though there are many challenges in setting up such schemes.[13] One of the challenges is financial viability: financial viability requires sufficient, stable, and sustained payments for project investment and operational costs and acceptable rates of return for project investors (including public financers seeking societal benefits). While biodiversity credits could contribute to the overall funding of the projects, this is still a largely undeveloped market. Other ecosystem services, including the most important one – an increase in fisheries – are difficult to capture under a (privately funded)

[13] *See Canning, A. D., Jarvis, D., Costanza, R., Hasan, S., Smart, J. C., Finisdore, J., ... & Waltham, N. J. (2021). Financial incentives for large-scale wetland restoration: Beyond markets to common asset trusts. One Earth, 4(7), 937-950.*

PES scheme. Certification of some form of rice and other products from flood-based agriculture may provide a more viable way to increase revenues and convince farmers to adopt it.

Hence, public funding would need to cover the majority of the expenses.

4 Financial Feasibility NbS2: Improving the flooded forest ecosystem

4.1 Context

Flooded forest is a specific type of ecosystem characterized by the regular inundation of water due to the natural flooding of the Mekong River, the area surrounding the Tonle Sap Lake, and the connecting river between the lake and the Mekong River. Within this region, the flooded forests are adapted to the seasonal rise and fall of water levels, creating a dynamic environment that supports diverse flora and fauna. These areas are vital for the Mekong River's ecology, providing habitat for various animal and plant species and contributing to the overall health of the river ecosystem. But to remain, a flooded forest needs 6-8 months of inundation each year (not more, and not less). Ongoing developments in the Mekong Basin have brought about changes in river flows and flood patterns, particularly the construction of hydropower dams and the incision of the main river due to concentrated flows of water in the main channel, trapping of sediment behind dams and sediment mining. The alteration in the flow of the Mekong River results in higher water levels during the dry season and lower water levels during the wet season because dams are being filled in the wet season and water is released during the dry season to generate electricity. Thereby, the dams reduce ecosystem productivity because they disrupt fish migratory patterns and affect the habitat itself (including spawning areas) by for example vegetation patterns that adapt to the changing flooding regime. The proposed NbS to address this problem is restoring flooded forest areas, and assessing how the local population uses the flooded forest and whether that contributes to its degradation. This might require a change in livelihoods. (From the report *“Shortlisted NbS with factsheets”.*)

The case study area for NbS2 is located in Kampong Chhnang province covering flooded forests along the Tonle Sap River, which connects the Mekong River with the Tonle Sap Lake (Figure 4-1). In this area, several villages rely on aquaculture and agriculture for their livelihoods. Uncontrolled encroachment into the flooded forest has led to declines in fish populations and reduced income from fisheries. The conversion of flooded forests to agricultural land has destroyed vital breeding grounds and nursery habitats for fish. Subsequently, fertilizers and pollutants are used on the converted lands, which leads to a further deterioration of water quality and further threatens the fish population. Secondary causes for local decline in flooded forests and fish populations are forest fires and illegal fishing. The impact of low flows on rice and reduced income from fisheries has further worsened the situation because to increase or maintain income, additional land is being converted for agricultural use. About 10% of the flooded forest has disappeared since 2018. Fish catches have been estimated to have declined by 10-30% over the same period. On the wider Mekong scale, the loss of forest is even larger, and fish catches have been estimated to have declined by almost 90% in 20 years or so[14].

Through land acquisition, reconnecting low-lying areas, connecting habitats, protecting and restoring river corridors, and providing alternative livelihoods for farmers, the area could be restored and protected. Socio-economic actions are especially challenging in this complex social environment where people are poor, and governance and enforcement of laws and regulations are often weak. A field visit was conducted in three communes (Kampong Hav, Peam Chhkaok, and Koah Tkov) to understand the situation in the study area,

[14] *Hughes, K (2024) The Mekong’s Forgotten Fishes and the Emergency Recovery Plan to save them. WWF, Gland, Switzerland*

focusing on household information, income, flooded forest use, flooding, and land ownership. Data collected from this visit was used in this CBA.

At the basin level, flooded forests can be found along the Mekong River in Stung Treng and Kratie and the Tonle Sap Lake area. Following the technical feasibility study, 197,200 ha was found to be highly suitable for flooded forests in Cambodia, see Table 4-1. For the financial analysis, it is assumed that from the area with high suitability, 25% will be restored to flooded forests.

Table 4-1 Suitable area NbS 2

Country	Suitability category	Suitable area (ha)
Cambodia	Marginal suitability	253,600
	Moderate suitability	259,300
	High suitability	197,200

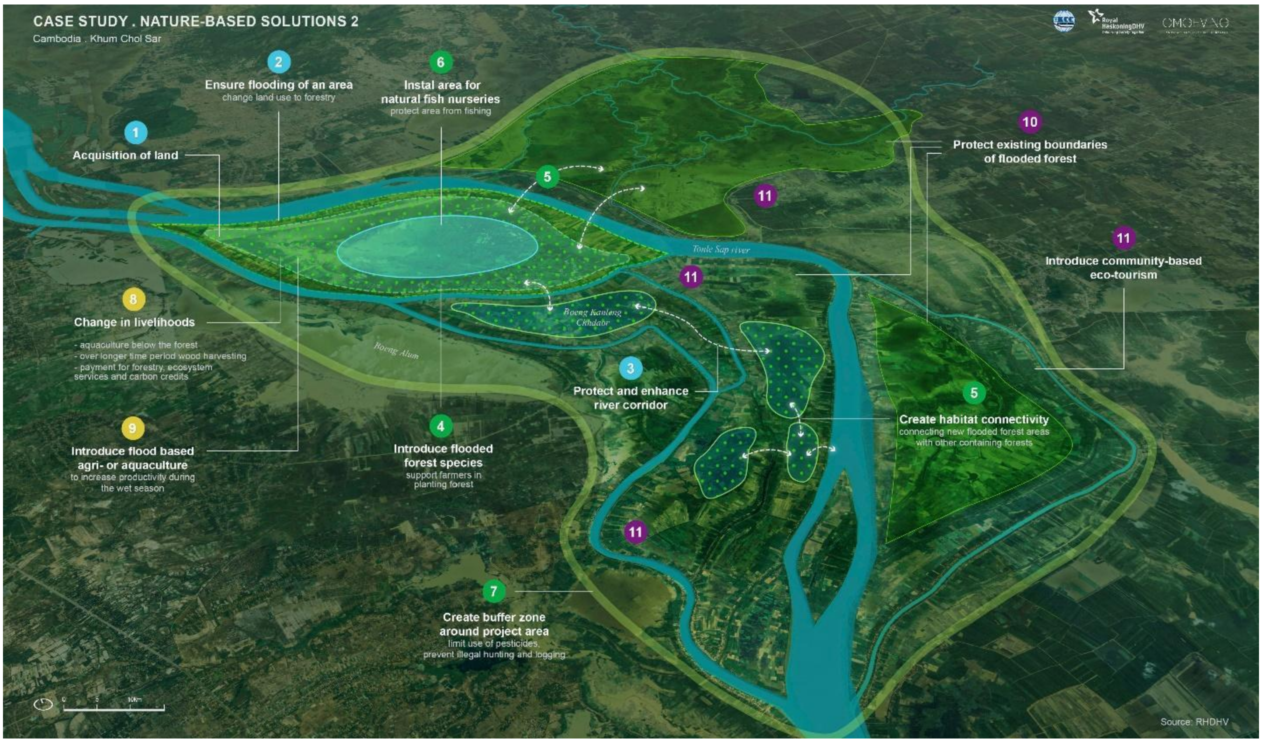

Figure 4-1 Case study for improving the flooded forest ecosystem.

Improving natural floodplain dynamics with flooded forests would involve many stakeholders, including several government agencies. These stakeholders can be categorised into the following main groups:

Table 4-2 Stakeholders for flooded forest projects

Stakeholder group	Involvement
Households	Direct beneficiaries of the project, are expected to shift their sources of income

Private sector companies	Potential beneficiaries of the project, adjusting to new or different business opportunities
Government organisations	Design, implementation and support of the projects
Funders	Provide loans, funds and other forms of financing for the project
Society	At a larger scale, social, economic and environmental co-benefits will affect society

In addition to these stakeholders, others can be identified, such as NGOs, knowledge institutions and contractors. However, these are not expected to be the main beneficiaries or responsible for the costs of the project and hence are not included in the financial and economic analysis. Note that there could be some overlap in stakeholder groups, e.g., government organisations could fund part of the projects.

4.2 Reference alternative

The reference alternative is the scenario in which the NbS will not be implemented at the case study site or in any of the suitable areas. In this scenario, the flooded forests will continue to deteriorate due to further encroachment, changes in flooding patterns, climate change, and contamination of the flooded forests with solid waste and agricultural chemicals. The reference alternative assumes that no incremental costs are required to sustain the current systems, yet it is acknowledged that over time fish catch would decline due to loss of habitat for fish.

4.3 Project alternative

The project consists of restoring or creating flooded forest areas. This requires the acquisition of land and in some cases, structural measures related to the water system to create or recreate a connection between the main river and the flooded forests and non-structural measures related to improving and restoring ecology and habitats. It also requires activities, such as outreach and training, to support households and communities to change their livelihoods to more sustainable sources of income. Finally, it involves engaging other stakeholders, such as the private sector to set up eco-tourism in the area. This will ultimately lead to a situation in which the flooded forest sustainably provides its ecosystem services and works together with other livelihoods supporting a sustainable and complimentary income such as agriculture, aquaculture and tourism.

At the basin scale, it is assumed that the case study project would be replicated up to the point where it would be implemented in 25% of the highly suitable land area, which amounts to 49,300 ha. Doing the projects at the basin scale would likely lead to scale advantages in costs and benefits. An ecosystem of significant scale is required to provide ecosystem benefits.

In economic and financial analysis, the project period or project horizon is relevant as cash flows are discounted to a present value and different stakeholders have different time horizons. The project has an infinite lifetime as the restoration of flooded forests should be permanent. However, households and private sector stakeholders may have a horizon of one to a few years, as they would like to see relatively short-term returns on their efforts and investments. Public sector investments and societal benefits have much longer horizons as infrastructure generally has a lifespan of several decades and some effects may only materialise in the long run. Costs and benefits also need to be placed in a timeline, and for this, it is assumed that for the local scale project implementation takes 2 years and that at the basin scale, it takes 10 years to achieve the 25% restoration of flooded forests. A project horizon of 50 years, from 2024 to 2073, is assumed.

4.4 Identification and selection of effects

The identification of effects is one of the most important steps and is done by comparing the project alternative with the reference alternative and identifying the incremental costs and benefits of the project alternative. Following the action-process-services-benefits approach, five tangible and one intangible benefits were identified, as shown in Figure 4-2. In addition, the project would result in a conversion of agricultural land to flooded forest. Although this is not directly an ecosystem service, the change in agricultural production due to a change in land use is an important effect of the project. Carbon credits and biodiversity credits can be identified as financing mechanisms, though are not counted as benefits for people as they are financial transfers from one group of stakeholders to another group of stakeholders to sustain or enjoy a benefit.

The effects are different at different scales and for different stakeholders. As ultimately everyone could benefit from each service through indirect effects, only the most directly affected stakeholder groups are considered. In Table 4-2, the column “Scale of benefits” indicates if benefits are predominantly present if a project is done locally or at a basin scale. Yet, through aggregation, local benefits are also present at the basin scale and in some cases (e.g., change in fishing revenue) benefits are present at both local and basin scales through slightly different processes (e.g., fish in local habitat versus migrating fish).

Table 4-3 Benefits by scale and stakeholder

No.	Benefits for people	Scale of benefits	Stakeholders	Comments
1	Change in fishing revenue	Local & Basin, with benefits expected to increase with scale	Households & private sector companies	Private sector companies would benefit from supply chain opportunities.
2	Change in income from non-forest timber products	Local	Households	
3	Change in tourism revenue	Local	Private sector companies & households	
4	Climate change mitigation	Basin, with benefits expected to increase with scale	Society	This is a global benefit and would ultimately also benefit the basin and local societies; carbon credits could benefit farmers/households.

5	Reduction in flood damages and flood protection costs	Basin	Society	
6	Change in non-use values	Local & basin	All	All stakeholders have non-use values, also at the global scale, but the specific non-use values differ considerably among stakeholders.
7	Change in agricultural revenue	Local	Households & private sector companies	This is a disbenefit, though can be partly mitigated by optimising land use and changes in agricultural practices

An effect that is not displayed in Figure 4-2 is the cost of the project. Implementation of the project comes with structural and non-structural costs for different stakeholders. Structural costs are generally paid by government organisations although they could be financed by other organisations, but ultimately are borne by society through taxes and fees. Non-structural costs are borne by government organisations, funders and farmers/households. Potential costs involved in restoring and creating flooded forests are:

1. Acquisition of land
2. Reconnecting low-lying areas with the main river, e.g., through digging canals or removing levees
3. Protect and enhance river corridors, e.g., through land zoning, regulations and planting of vegetation
4. Creating/maintaining habitat connectivity, e.g., through land zoning, regulations and planting of vegetation
5. Install or designate buffer zones through land zoning and regulations
6. Plant / introduce flooded forest species
7. Install zones designated for natural fish nurseries
8. Develop a strategy for ecotourism development, e.g., through building a visitor centre and building resting huts in flooded forests, as well as promotion, engaging tour operators, etc.
9. Initiate payment for ecosystem services to (former) landowners
10. Limiting activities that could harm the flooded forest and enforcement of regulations.

In the first instance, all identified tangible and intangible effects are selected for inclusion in the CBA. However, only a limited number can be quantified and monetised.

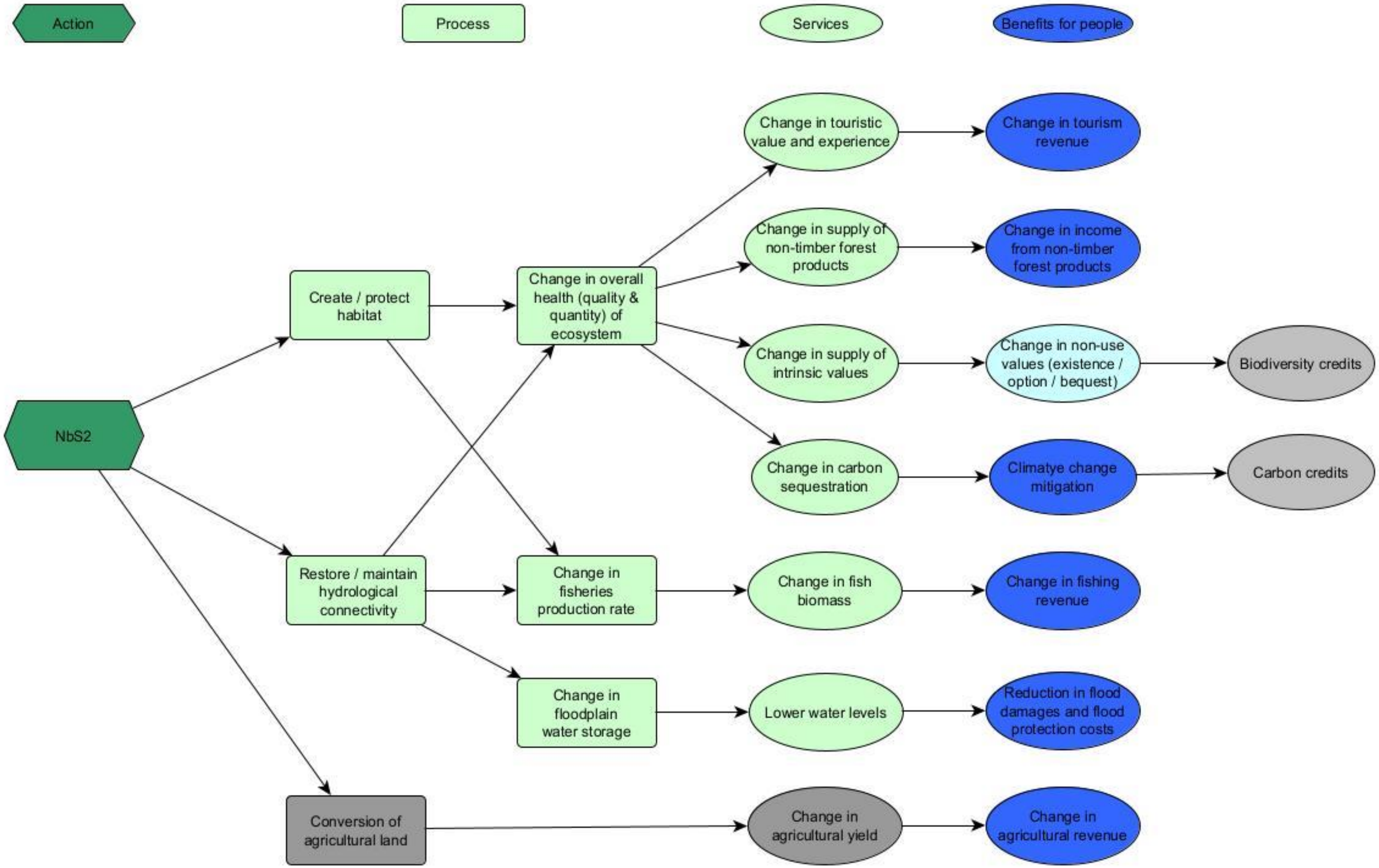

Figure 4-2 Effects of improving the flooded forest ecosystem

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4.5 Quantification and monetisation of effects

4.5.1 Benefits

1. Change in fishing revenue

At the project site, fish catches have reportedly decreased by 30-40% since 2018. The income from fishing in the wet season is between USD 250 to 1000 per household, while there are about 1,700 households in three communes where interviews were conducted and whose primary source of income is fishing. Research in Tonle Sap Lake found that fish populations fell by 88% between 2003 and 2019[15] and recent estimates indicate that the economic value of Mekong fishery dropped by more than a third between 2015 and 2020[16]. The estimated annual value of fish catch was estimated between USD 7.13 billion and USD 8.37 billion in 2019-2020.[17]

These figures show the large economic importance of fisheries. For the CBA it is, however, not possible to quantify and monetise the impact of the project as it is not known how much the project would change the fisheries production rates, increase the fish biomass and hence change the fishing revenue.

As a very rough estimate, it could be assumed that at the local level, the project would partly reverse the decline since 2018 – e.g., assume 15% – as other factors, such as dam construction, climate change and impacts from outside the project site also affect fish catch within the site. Hence, taking the average income from fisheries per household (USD 625 during the wet season) as reported during the field visit, and 1,700 households, the benefits would amount to about USD 160,000 per year (note that there are more households than in the three villages that would benefit from more fish and there are also households whose main source of income is rice or crops that would benefit, so this is likely an underestimate).

At the basin level, it is more difficult to estimate the impact of larger areas of flooded forests on fisheries income. But taking a strongly conservative estimate, if implementing it in 25% of the highly suitable areas resulted only in a 1% increase in fisheries, the revenues would generate about USD 77.5 million in annual benefits if the middle of the range of the 2019-2020 estimated annual value of fish catch (USD7.75 billion) is taken as a base.

2. Change in income from non-timber forest products

At the project site, there is no known harvesting of non-timber forest products, or at least it was not reported during the field visit. Yet, studies show that products such as resin, bamboo, rattan, wild honey and fuelwood are collected from forests in Cambodia.[18,19] However, data on the amounts and values of these products is limited. A study by Sophanna et al. (2022) conducted a survey in 22 villages in the Tonle Sap Lake area that are located within 500 metres of a flooded forest to assess ecosystem services. They found the following annual economic benefits per person per year from flooded forests: fuelwood – USD 12; wild food – USD

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[15] *Chevalier M, Ngor PB, Pin K, Touch B et al., (2023) Long-term data show alarming decline of majority of fish species in a Lower Mekong basin fishery. Science of The Total Environment, Volume 891.*

[16] *Cowx IG, Lai TQ and So N (2024). Fisheries Yield Assessment by Habitat Type at The Landscape Scale in The Lower Mekong River Basin 2020. Vientiane: Mekong River Commission Secretariat.*

[17] *Ibid*

[18] *Chou, P. (2017) The importance of Non-timber Forest Products in Rural Livelihoods and Ecosystem Services at Phnom Princh Wildlife Sanctuary, Cambodia. International Journal of Environmental and Rural Development, 8-1.*

[19] *Sophanna et al. (2022). Flooded Forests. in: C. Yoshimura et al. (eds.), Water and Life in Tonle Sap Lake, Chapter 32. Springer Nature Singapore.*

8; traditional medicine – USD 1; honey – USD 1, hence in total USD 22 per person per year.[20] This is USD 121 per household per year at an average household size of 5.5 (as reported in the same study). It is, however, not known how many households at the site and in the basin are located within 500 metres of flooded forests and how restoration of flooded forests would affect this benefit. To still reflect these benefits, it is conservatively assumed that 10% of the households at the site (493 households) live within 500 meters of the flooded forest and that by restoring the flooded forest 25% of the annual value of non-timber forest products (USD 30) can be regained. Hence, the benefit at the site is USD 14,790 annually. At the basin level, the amount from the site will be scaled based on the area to be purchased, i.e., 50 times USD 14,790 is USD 739,500.

3. Change in tourism revenue

In the case study area, there is no tourism at this moment. Based on other ecotourism sites, the assumption was made that the project site could attract 1000 to 5000 (average 3,000) tourists per year, of which half would stay overnight. Tourists would spend (added value, excluding costs of the tourism offering) on average USD 10 per person, while tourists that stay overnight would spend an additional USD 20. Hence, the total annual benefits would be USD 60,000.

At the basin level, ecotourism cannot be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that there would be 5 additional ecotourism sites throughout the basin, each would generate USD 60,000 per year, hence in total USD 360,000 per year.

4. Climate change mitigation

Through the creation and protection of habitat, the project could contribute to increased carbon sequestration. Increased carbon sequestration reduces greenhouse gases in the atmosphere, mitigating climate change, and hence benefiting people as a reduction in climate change and associated effects compared to a baseline without the project. This benefit can be valued through the amount of carbon sequestered by vegetation and a social price for carbon. Measuring this would require an estimate of carbon sequestration in the project area without and with the project. For this, newly established vegetation, restored degraded forest and avoided deforestation could be considered. Calculating the amount of carbon sequestered is complex and falls outside the scope of this study. Yet, using a ballpark calculation, an indication of the benefit could be obtained. Assuming carbon sequestration is 5.5 $tCO_2\ ha^{-1}yr^{-1}$ [21] and the value of a tonne of CO_2 is USD 5 [22], benefits would be USD 27.50 per ha per year, or USD 6,875 per year for the 250 ha planted area.

At the basin level, the planted area (assumed 12,325 ha, see below) would generate USD 338,938 as a ballpark figure.

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[20] *They also find an economic value for fisheries of USD 5021 per household per year, which is considerably higher than in the case study area.*

[21] *Based on Sasaki et al (2016). Forest reference emission level and carbon sequestration in Cambodia. Global Ecology and Conservation, Volume 7, July 2016, Pages 82-96*

[22] *The value of one tCO_2 varies widely: the recent social costs of carbon are estimated at USD 225 per tCO_2, the price of carbon under the EU ETS varied from about EUR 100 in February 2023 to EUR 50 in March 2024, and the value of REDD+ carbon credits under the voluntary market (most relevant in this context) were on average USD 4.7 per tCO_2, in 2021 and USD 1.46 at the time of writing this report.*

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5. Reduction in flood damages and flood protection costs

By restoring the flooded forests, the floodplain water storage capacity will increase. This could potentially lead to lower peak flood water levels and a reduction in flood damages and flood protection costs (e.g., lower requirements for levees). Moreover, there would be more water available in the dry season.

In terms of water storage, it is estimated that flooded forests could store 490 million m^3 of flood waters, leading to a flood depth reduction of 0.5 meters in the Mekong River, see Appendix A. However, assessing the quantitative impact of restoring hydrological connectivity on flood damage and flood protection is complex,[23] hence only a very rough indication of the benefits can be given. The average annual cost of floods in the Lower Mekong Basin ranges between USD 60 to 70 million.[24] Assuming the project would contribute to a 1% reduction in damages this would be USD 600,000 to 700,000 annually.

6. Change in non-use values

Non-use values are numerous and different for each person. Such values include bequest values (leaving something for the next generation), existence values (attaching value to knowing that something exists, for instance, expressed to donations to charity) and option values (not using it now, but maybe in the future). A monetary estimate of non-use values can generally only be obtained by asking people for their willingness to pay to conserve or enhance certain habitats, ecosystems or ecosystem services.

The non-use values are not included in the CBA as no good studies are available for flooded forests in Cambodia.

The change in non-use values could be linked to the potential value of biodiversity credits. Biodiversity credits are a verifiable, quantifiable and tradeable financial instrument that rewards positive nature and biodiversity outcomes (e.g., species, ecosystems and natural habitats) through the creation and sale of either land or ocean-based biodiversity units over a fixed period.[25] The market for biodiversity credits is, however, still at an early stage of development and the pricing of biodiversity credits is still largely unknown.

7. Change in agricultural revenues

Clearing of flooded forests in the study area partly happened because fish catches were reducing over time while growing rice provides a higher income of about USD 1,500 per ha per year. The purchase of land for flooded forest restoration would reduce the agricultural land available for rice cultivation and hence should be included as a disbenefit (cost). For the 500 ha to be purchased in the case study area this would amount to an annual disbenefit of USD 750,000. At the basin level, this would amount to almost USD 37 million annually.

It should be noted that the purchase of land (listed under costs) incorporates compensation for the loss of income. Hence, including both the cost and the disbenefit in the CBA would lead to double-counting. The cost of land is equivalent to about 12 years of income from growing rice (at a 6% discount rate of future revenues). In the CBA only the costs of the purchase of land are included, as the data on costs of land are better, and loss of agricultural revenue could partly be compensated by changing agricultural practices, such as implementing flood-based agriculture in the wet season.

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[23] *See for instance Thanh, V. Q., Roelvink, D., Van Der Wegen, M., Reyns, J., Kernkamp, H., Van Vinh, G., & Linh, V. T. P. (2020). Flooding in the Mekong Delta: the impact of dyke systems on downstream hydrodynamics. Hydrology and Earth System Sciences, 24(1), 189-212 on the complexity of modelling and considerations to assess changes in the floodplain on flood levels.*

[24] *Mekong River Commission: https://www.mrcmekong.org/our-work/topics/flood-and-drought/*

[25] *World Economic Forum: https://initiatives.weforum.org/financing-for-nature/home*

Summary of benefits

Table 4-4 provides a summary of the benefits.

Table 4-4 Benefit estimates NbS2

No.	Benefit item	Estimate project site (USD/year)	Estimate basin (USD/year)
1	Change in fishing revenue	160,000	77,500,000
2	Change in income from non-timber forest products	14,790	739,500
3	Change in tourism revenue	60,000	360,000
4	Climate change mitigation	6,875	338,938
5	Reduction in flood damages and flood protection costs	0	650,000
6	Change in non-use values	N/A	N/A
7	Change in agricultural values (excluded in the benefits calculation)	-750,000	-36,975,000
	Total annual benefits	241,665	79,588,438

4.5.2 Costs

Table 4-4 gives an overview of the cost estimates for the project site and basin. Note that these estimates are all very indicative and based on currently available data.

For the project, it is assumed that the investment costs are spread over two years at the beginning of the project period. Operational costs (item 10) are annual.

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Table 4-5 Cost estimates and assumptions

No.	Cost item	Estimate project site	Estimate basin
1	Acquisition of land	500 ha at USD 13,000/ha Total USD 6,500,000	Assume 50% of highly suitable land needs to be purchased, the remaining 50% is already owned by the government.[26] 24,640 ha at USD 13,000/ha Total USD 320,450,000
2	Reconnecting low-lying areas with the main river	Not required at the site as it is already flooding	At basin level, some sites may require some groundwork. Assume per 1000 ha, a canal of 2-meter width, 1-meter depth and 1,000-meter length needs to be created at USD 2/m^3. Total USD 197,200
3	Protect and enhance river corridors	No costs, part of overall planning and management costs, see 5	No costs, part of overall planning and management costs, see 5
4	Creating/maintaining habitat connectivity	No costs, part of overall planning and management costs, see 5	No costs, part of overall planning and management costs, see 5
5	Install or designate buffer zones	Planning, management, training, and engagement costs are assumed to be USD 200,000 for the site Total USD 200,000	Planning, management, and training costs are assumed to be USD 200,000 per project area of 1000 ha Total USD 9,860,000
6	Plant / introduce flooded forest species	Plant in 50% of the acquired land (250 ha). A tree costs USD 1; per ha 2,500 trees are required and people can plant about 75	Same assumptions as for the project site Total USD 36,975,000

[26] *Even if land would not need to be purchased (e.g., due to unclear or missing land ownership documents), still households would need to be provided with alternative livelihoods if they were to lose their agricultural land.*

		trees per day for USD 10/day. Total USD 707,500	
7	Install zones designated for natural fish nurseries	No costs, part of overall planning and management costs, see 5	No costs, part of overall planning and management costs, see 5
8	Strategy for ecotourism development	The costs of building a simple visitor centre and developing an ecotourism strategy, brochures, etc. are estimated to be USD 30,000	Ecotourism could not be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that there would be 5 additional ecotourism sites. Total USD 150,000
9	Training and support to help households move to more sustainable livelihoods	Training, support, and engagement costs for households are assumed to be USD 200,000 for the site Total USD 200,000	Training, support, and engagement costs for households are assumed to be USD 200,000 per project area of 1000 ha Total USD 9,860,000
10	Initiate payment for ecosystem services to (former) landowners	Setting up a system for payments for ecosystem services (carbon credits, biodiversity credits or others) requires a certain scale to cover fixed costs. These costs are currently unknown. Payment for Ecosystem Services could be initiated for water storage, groundwater replenishment and fish spawning functions	Setting up a system for payments for ecosystem services (carbon credits, biodiversity credits or others) requires a certain scale to cover fixed costs. These costs are currently unknown. Payment for Ecosystem Services could be initiated for water storage, groundwater replenishment and fish spawning functions
11	Limiting activities/enforcement	Enforcement costs are estimated at USD 700 /	For the basin, it is assumed the project

		month / 6 communes or about USD 1,400 / year/commune; the project site has 7 communes, so a total of USD 9,800	would cover 100 villages Total USD 140,000
	Total Capital Expenditure	USD 7,637,500	USD 377,492,200
	Total Operational Expenditure	USD 9,800 / year	USD 140,000 / year

4.6 Discussion of results

Table 4-6 shows the results from the CBA. The results are indicative due to the assumptions being made, but some conclusions can be drawn from them. Firstly, from the perspective of a single site, NbS2 does not seem economically viable, as the net present value (NPV) is negative, and the benefit-cost ratio (BCR) is below 1.0. However, on the basin scale, it is a very viable intervention. These results are mainly dependent on the assumption made for the value of the benefits for fisheries. As mentioned above, at the site level the benefits from fisheries are likely underestimated as not all communes are included. If the change in revenue from fisheries would be about 3 times as large as currently estimated, the project would break even. The change in revenue from fisheries at the basin level is a guestimate, however, even if the project would only increase the revenue from fisheries by 0.25% the project would already be able to break even.

Secondly, the price of carbon credits is volatile and in the analysis USD 5 per tCO_2 is being used. This price cannot cover the costs of planting flooded forests on cleared land (see also financial analysis below). The price of carbon would need to increase to at least USD 31 per tCO_2 to cover the costs of planting alone at the project level, which is excluding the costs of land, over 50 years (assuming this is the period over which the newly planted forest would sequester on average 5.5 $tCO_2\,ha^{-1}yr^{-1}$ – this period may be shorter). Thirdly, the non-use values have not been quantified, and there might be additional benefits that have not been identified, such as benefits related to restoring the floodplain hydrology. Taking into account that not all benefits are included, while most of the costs are, the results in Table 4-6 are expected to be conservative.

Table 4-6 Results of the CBA for restoration of the flooded forest, Present USD values at a 6% discount rate over a 50-year project lifetime.

Indicator	Value for Site	Value for Basin
Total lifetime costs	USD 7.57 million	USD 295.75 million
Total lifetime benefits	USD 3.57 million	USD 1,175.06 million
NPV	USD -4.00 million	USD 879.30 million
BCR	0.47	3.97
IRR	1.6%	46.8%

4.7 Financial analysis

To make parts of projects financially viable, they need to generate tangible revenue streams that can be captured by a stakeholder. However, aside from carbon credits and potentially biodiversity credits or Payment for Ecosystem Services (PES), there are no tangible revenue streams. Carbon credits and biodiversity credits could contribute to the overall funding of the projects, though will not be able to fully fund the projects. PES could be initiated for water storage, groundwater replenishment and fish spawning functions. As discussed in the CBA, revenues from carbon credits are small – only around 1% of the total project cost in present value - and the value of biodiversity credits is at this moment unknown. The price of a tonne of carbon in the nature-based offset market is currently, however, very low; end-2021 the price was peaking above USD 20 / tonne and it can be expected that prices will increase in the coming years. Ecotourism may contribute to funding the project at some of the wetlands, though it is unlikely that it could fund a substantial part of the project. Revenues from ecotourism will go directly to the households and private sector companies as they sell their services, and only for instance an entrance fee or license fee paid by households and private sector companies could provide funding for the projects.

Biodiversity credits and carbon credits are a form of Payment for Ecosystem Services (PES). PES could provide a viable avenue for large-scale flooded forest restoration and conservation, though there are many challenges in setting up such schemes.[27] One of the challenges is financial viability: financial viability requires sufficient, stable, and sustained payments for project investment and operational costs and acceptable rates of return for project investors (including public financers seeking societal benefits). Carbon credits alone are not sufficient, and while biodiversity credits could contribute to the overall funding of the projects, this is still a largely undeveloped market. Other ecosystem services, including the most important one – an increase in fisheries – are difficult to capture under a (privately funded) PES scheme.

Hence, public funding would need to cover the majority of the expenses.

[27] *See Canning, A. D., Jarvis, D., Costanza, R., Hasan, S., Smart, J. C., Finisdore, J., ... & Waltham, N. J. (2021). Financial incentives for large-scale wetland restoration: Beyond markets to common asset trusts. One Earth, 4(7), 937-950.*

5 Financial Feasibility NbS3: Improving riverine wetland ecosystems and increasing the lateral and longitudinal connectivity with the main river

5.1 Context

Maintaining habitat connectivity is essential for species movements, resource flow, and ecological processes across landscapes. In aquatic environments, connectivity involves the continuous flow of water and linkage between water patches, crucial for enabling aquatic species to thrive and navigate the landscape. The Mekong River basin is home to diverse wetland habitats that play a crucial role in supporting biodiversity, providing habitat for various aquatic vertebrates, including the critically endangered Siamese crocodile, Irrawaddy dolphin, resident and migratory fish species, and several frog and turtle species. The ability of aquatic animals to move freely between feeding, breeding, and resting areas along sheltered waterways is crucial. The loss of both lateral and longitudinal connectivity stands out as a primary threat to the fish community in the Mekong River. Connectivity plays a pivotal role in sustaining viable fish populations, and preventing localized extinction in freshwater habitats is of utmost importance. The proposed NbS to address this problem aims at increasing connectivity through re-opening wetlands by removing dense patches of vegetation (native/invasive) that hinder fish movements and impede the free flow of water during the dry season, removing invasive plant species, such as water hyacinth, which can diminish dissolved oxygen levels in the water, often leading to fish kills and maintaining water quality to prevent chemical barriers, such as low dissolved oxygen and acid sulphate. (From the report *“Shortlisted NbS with factsheets”.*)

The case study area for NbS3 is the Goot Ting Marsh, which lies along the Mekong River in Nong Khai Province, Thailand, see Figure 5-1. The site has high biodiversity yet faces a threat from hydropower dam development upstream. This development disrupts the natural river flow, exacerbating the drying of the marsh even after the rainy season. This alteration in the natural flood-drought cycle and sediment transport adversely impacts the ecosystem, posing a serious threat to fisheries productivity – a vital component of the livelihood for the surrounding communities. Approximately 23,000 villagers across 40 communities depend on the Goot Ting Marsh for their primary livelihood. By connecting the wetlands with the main river and establishing interconnectivity within the wetland area, protecting and enhancing river corridors, creating and maintaining habitat corridors, removing invasive species, improving water quality and introducing sustainable practices for the use of ecosystem services, the area could be restored and protected. Some data for the case study was provided by the WWF country office.

At the basin level, the area that is highly suitable for NbS3 is 880 km^2. For the financial analysis, it is assumed that from the area with high suitability 25% will be part of the project area where riverine wetland ecosystems will be improved. This 25% is equivalent to 220 km^2 or 23 wetland sites.

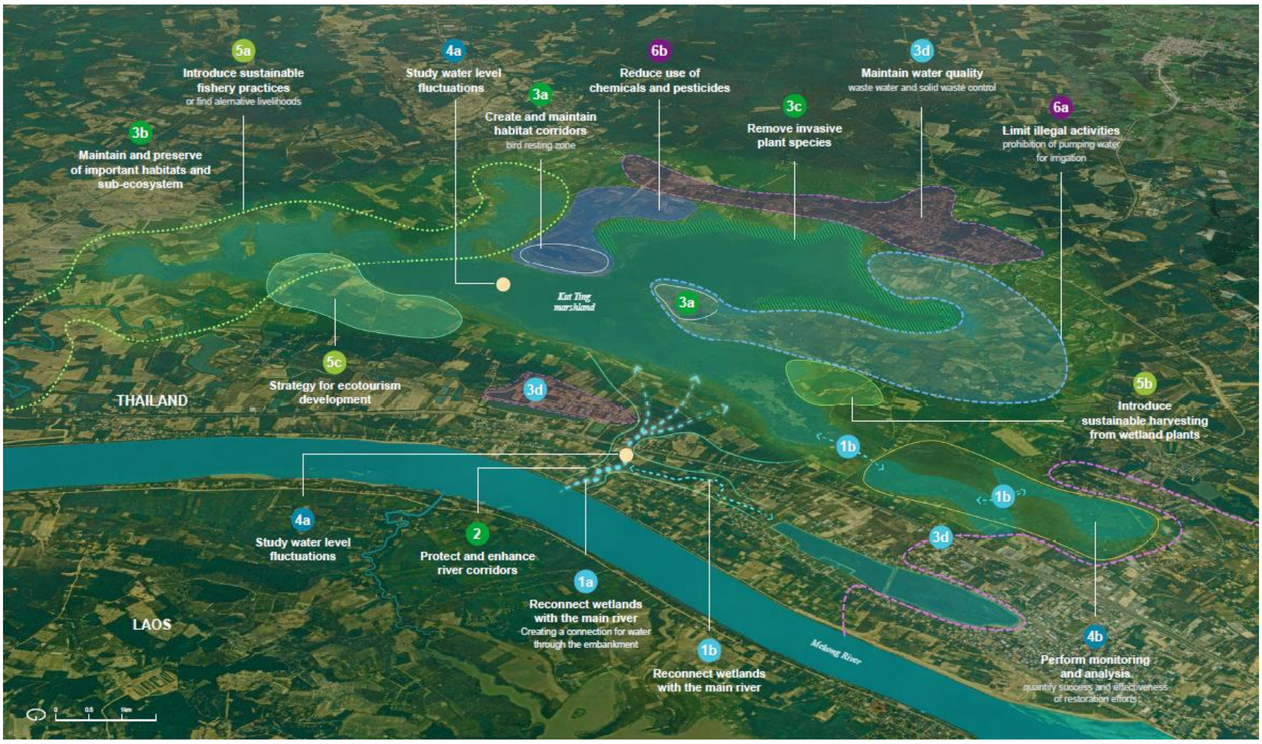

Figure 5-1 Case study area for improving riverine wetland ecosystems

Improving riverine wetland ecosystems and increasing the lateral and longitudinal connectivity with the main river would involve many stakeholders, including several government agencies. These stakeholders can be categorised into the following main groups:

Table 5-1 Stakeholders for flooded forest projects

Stakeholder group	Involvement
Households	Directly affected by the project; beneficiaries of the project are expected to diversify and shift their sources of income to more sustainable resource use
Private sector companies	Potential beneficiaries of the project, adjusting to new or different business opportunities
Government organisations	Design, implementation and support of the projects
Funders	Provide loans, funds and other forms of financing for the project
Society	At a larger scale, social, economic and environmental co-benefits will affect society

In addition to these stakeholders, others can be identified, such as NGOs, knowledge institutions and contractors. However, these are not expected to be the main beneficiaries or responsible for the costs of the project and hence are not included in the financial and economic analysis. Note that there could be some overlap in stakeholder groups, e.g., government organisations could fund part of the projects.

5.2 Reference alternative

The reference alternative is the scenario in which the NbS will not be implemented in the case study area or any of the suitable areas. In this scenario, the riverine wetland ecosystems will continue to deteriorate due to further disconnection, encroachment, changes in flooding patterns, climate change, and contamination with agricultural chemicals. The reference alternative assumes that no incremental costs are required to sustain the current systems, yet it is acknowledged that over time ecosystem services of the wetlands, such as fish catch, would decline further.

5.3 Project alternative

The project consists of improving riverine wetland ecosystems and increasing connectivity with the main river. This requires structural measures related to the water system to create or recreate a connection between the main river and the wetlands and non-structural measures related to improving/restoring ecology and habitats. It also requires activities, such as outreach and training, to support households and communities to change their livelihoods that are aligned with sustainable use of the ecosystem services of the wetlands. Finally, it involves engaging other stakeholders, such as the private sector to set up eco-tourism in the area. This will ultimately lead to a situation in which the wetland sustainably provides its ecosystem services and works together with other livelihoods supporting a sustainable and complimentary income (such as agriculture, aquaculture and tourism).

At the basin scale, it is assumed that the case study project would be replicated up to the point where it would be implemented in 25% of the highly suitable land area for riverine wetlands, which amounts to 22,000 ha. Doing the projects at the basin scale would likely lead to scale advantages in costs and benefits. After all, an ecosystem of significant scale is required to provide ecosystem benefits.

In economic and financial analysis, the project period or project horizon is relevant as cashflows are discounted to a present value and different stakeholders have different time horizons. The project has an infinite lifetime as the improvement of riverine wetlands should be permanent. However, households and private sector stakeholders may have a horizon of one to a few years, as they would like to see relatively short-term returns on their efforts and investments. Public sector investments and societal benefits have much longer horizons as infrastructure generally has a lifespan of several decades and some effects may only materialise in the long run. Costs and benefits also need to be placed in a timeline, and for this, it is assumed that for the local scale project implementation takes 2 years and that at the basin scale, it takes 10 years to achieve the improvement of 25% of riverine wetlands. A project horizon of 50 years, from 2024 to 2073, is assumed.

5.4 Identification and selection of effects

The identification of effects is one of the most important steps and is done by comparing the project alternative with the reference alternative and identifying the incremental costs and benefits of the project alternative. Following the action-process-services-benefits approach, five tangible and one intangible benefits were identified, as shown in Figure 5-2. In addition, the project may result in a conversion of agricultural land to create channels, buffer zones or enlarged wetland areas. Although this is not directly an ecosystem service, the change in agricultural production due to a change in land use is an important effect of the project. Moreover, carbon credits and biodiversity credits can be identified as financing mechanisms, though are not counted as benefits for people (as they are financial transfers from one group of stakeholders to another group of stakeholders to sustain or enjoy a benefit).

The effects are different at different scales and for different stakeholders. As ultimately everyone could benefit from each service through indirect effects, only the most directly affected stakeholder groups are considered. In Table 5-2, the column “Scale of benefits” indicates if benefits are predominantly present if a project is done locally or at a basin scale. Yet, through aggregation local benefits are also present at the basin scale and in some cases (e.g., change in fishing revenue) benefits are present at both local and basin scales through slightly different processes (e.g., fish in local habitat versus migrating fish).

Table 5-2 Benefits by scale and stakeholder

No.	Benefits for people	Scale of benefits	Stakeholders	Comments
1	Change in fishing revenue	Local & Basin, with benefits expected to increase with scale	Households & private sector companies	Private sector companies may benefit from supply chain opportunities.
2	Change in income from compost sales and cost savings from chemicals	Local	Households	
3	Change in tourism revenue	Local	Private sector companies & households	
4	Climate change mitigation	Basin, with benefits expected to increase with scale	Society	This is a basin-scale and global benefit and would ultimately also benefit the basin and local societies; carbon credits could benefit farmers/households.
5	Reduction in flood damages and flood protection costs	Basin	Society	
6	Change in non-use values	Local & basin	All	All stakeholders have non-use values, also at the global scale, but the specific non-use values differ considerably

				among stakeholders.
7	Change in agricultural revenue	Local	Households & private sector companies	This is a disbenefit, though can be partly mitigated by optimising land use and changes in agricultural practices.

An effect that is not displayed in Table 5-2 is the costs of the project. Implementation of the project comes with structural and non-structural costs for different stakeholders. Structural costs are generally paid by government organisations (though could be financed by other organisations) but ultimately are borne by society through taxes and fees. Non-structural costs are borne by government organisations, funders and farmers/households. Potential costs involved in restoring and creating flooded forests are related to:

1. Acquisition of land
2. Reconnecting wetlands with the main river, e.g., through digging canals, removing levees or creating a sluice or culvert to let the water in.
3. Removal of dense patches of vegetation and invasive plant species.
4. Protecting and enhancing river corridors, e.g., through land zoning, regulations and planting of vegetation
5. Creating/maintaining habitat connectivity, e.g., through land zoning, regulations and planting of vegetation and installing or designating buffer zones through land zoning and regulations
6. Installing zones designated for natural fish nurseries
7. Implementing and enforcing regulations to maintain water quality.
8. Developing a strategy for ecotourism development, e.g., through building a visitor centre and building resting huts in flooded forests, as well as promotion, engaging tour operators, etc.
9. Training and support to help households move to more sustainable livelihoods
10. Initiating payment for ecosystem services
11. Limiting activities that could harm the wetland and enforcement of regulations.

In the first instance, all identified tangible and intangible effects are selected for inclusion in the CBA. However, only a limited number can be quantified and monetised.

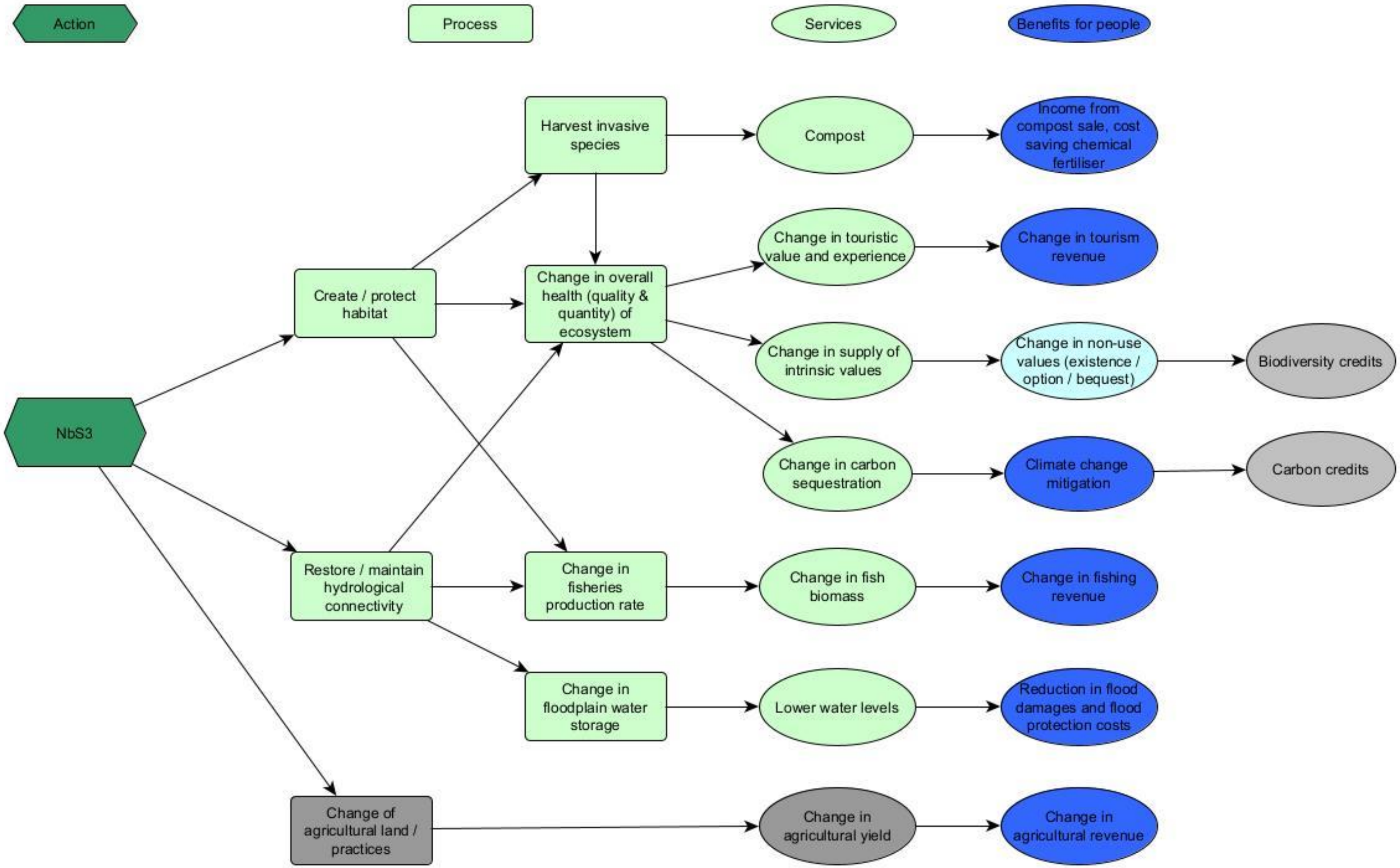

Figure 5-2 Effects of improving the connection between the wetlands and the main river

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5.5 Quantification and monetisation of effects

5.5.1 Benefits

1. Change in fishing revenue

At the project site, fish catches have reportedly declined because of invasive plants and water level declines. The average income from fishing is about USD 12 per household per day for 4 kg per day. The catch in Goot Ting wetland is around 24,000 kg per year, hence the revenue is about USD 72,000 per year. On a local scale, implementation of the project might increase fish catches by 5% to 10%, which would mean a 5% to 10% increase in revenues from fisheries assuming prices remain the same. Taking the middle of the range, the benefits of the project would be USD 5,400 per year.

At the basin level, recent estimates indicate that the economic value of the Mekong fishery dropped by more than a third between 2015 and 2020[28]. The estimated annual value of fish catch was estimated between USD 7.13 billion and USD 8.37 billion in 2019-2020.[29] While it is difficult to estimate the impact of larger areas of flooded forests on fisheries income in the basin in the absence of quantitative data on the impact of wetland areas of fisheries, a rough indication is that if implementing the project in 25% of the highly suitable areas would only result in a 1% increase in fisheries, the revenues would already generate about USD 77.5 million in annual benefits if the middle of the range of the 2019-2020 estimated annual value of fish catch (7.75 billion) is taken as a base.

2. Change in income from compost sale and cost savings from chemicals

Invasive species can be used to make compost. Households can sell the compost or use it in their fields, which would reduce their production costs. As this would reduce the use of chemical fertilisers, it would also help to improve water quality.

Unfortunately, there is no quantitative information on the amount of compost produced by invasive species at the Goot Ting wetland or the basin scale, nor on the prices of such compost. Hence, it is not possible to include this in the calculation of the benefits. It is, however, expected that these benefits are relatively small.

3. Change in tourism revenue

Tourism at the Goot Ting wetland is currently limited to about 50 persons per year who come for bird watching. They stay on average two nights and spend about USD 30 per person. An ecotourism strategy, including building a simple visitor centre and developing information and promotion materials, could increase the number of visitors. Based on other ecotourism sites, the assumption was made that the project site could attract 1000 to 5000 (average 3,000) tourists per year, of which one-third would stay one night, one-third would stay two nights and one-third would just visit for the day. With wider accommodation and restaurant offerings, as well as boat rental and tours, it is assumed that a tourist staying one night would spend USD 20 (added value, excluding costs of the tourism offering), a tourist staying two nights would spend USD 40 and a day visitor would spend USD 15. Hence, the total annual benefits would be USD 75,000.

At the basin level, ecotourism cannot be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that there would

[28] *Cowx IG, Lai TQ and So N (2024). Fisheries Yield Assessment by Habitat Type at The Landscape Scale in The Lower Mekong River Basin 2020. Vientiane: Mekong River Commission Secretariat.*
[29] *Ibid*

be 5 additional ecotourism sites throughout the basin, which each would generate USD 75,000 per year, hence in total USD 450,000 per year.

4. Climate change mitigation

Through the creation and protection of habitat, the project could contribute to increased carbon sequestration. Increased carbon sequestration reduces greenhouse gases in the atmosphere, mitigating climate change, and hence benefiting people as a reduction in climate change and associated effects compared to a baseline without the project. This benefit can be valued through the amount of carbon sequestered by vegetation and a social price for carbon. Measuring this would require an estimate of carbon sequestration in the project area without and with the project. While wetlands sequester carbon, and the project potentially could increase carbon sequestration through sustainable wetland management practices, it is difficult to calculate the increase in carbon sequestration due to the project. Moreover, there are no established or accredited methods to assess carbon sequestration for floodplain wetlands, hence they are generally not considered for carbon credits. Compared to reforestation of flooded forests (NbS2), the climate change effects for wetland restoration are likely much smaller. As such, the reduction in climate change will not be quantified in the CBA.

5. Reduction in flood damages and flood protection costs

By restoring hydrological connectivity between the rivers and wetlands at the basin level, the floodplain water storage capacity will increase. This could potentially lead to lower peak flood water levels and a reduction in flood damages and flood protection costs (e.g., lower requirements for levees). Moreover, there would be more water available in the dry season.

In terms of water storage, it is estimated that flood-based agriculture could store 220 million m^3 of flood waters, leading to a flood depth reduction of 0.2 meters in the Mekong River, see Appendix A. However, assessing the quantitative impact of restoring hydrological connectivity on flood damage and flood protection is complex,[30] hence only a very rough indication of the benefits can be given. The average annual cost of floods in the Lower Mekong Basin ranges between USD 60 to 70 million.[31] Assuming the project would contribute to a 1% reduction in damages this would be USD 600,000 to 700,000 annually.

6. Change in non-use values

Non-use values are numerous and different for each person. Such values include bequest values (leaving something for the next generation), existence values (attaching value to knowing that something exists, for instance, expressed to donations to charity) and option values (not using it now, but maybe in the future). A monetary estimate of non-use values can generally only be obtained by asking people for their willingness to pay to conserve or enhance certain habitats, ecosystems or ecosystem services.

While there are some studies on the non-use values of wetlands in the Lower Mekong Basin, the results cannot be easily translated for use in the CBA in this study. For instance, Rakthai (2018) estimated the willingness to pay for biological diversity conservation in the Lower Mekong River Basin by households located along the Mekong River and found a value of USD 3.99 per household per year or a total value of USD 153,471 per year based on the population sample.[32] This is, however, not specifically for wetlands and

[30] *See for instance Thanh, V. Q., Roelvink, D., Van Der Wegen, M., Reyns, J., Kernkamp, H., Van Vinh, G., & Linh, V. T. P. (2020). Flooding in the Mekong Delta: the impact of dyke systems on downstream hydrodynamics. Hydrology and Earth System Sciences, 24(1), 189-212 on the complexity of modelling and considerations to assess changes in the floodplain on flood levels.*

[31] *Mekong River Commission: https://www.mrcmekong.org/our-work/topics/flood-and-drought/*

[32] *Rakthai, S. (2018). Willingness to pay for biological diversity conservation of the Lower Mekong River Basin in Thailand: A contingent valuation study. Songklanakarin Journal of Science and Technology, 40(3), 570-576.*

respondents gave their total value for biological diversity conservation, which may also include use values for some respondents. Hence, the non-use value cannot be quantified in the CBA.

The change in non-use values could be linked to the potential value of biodiversity credits. Biodiversity credits are a verifiable, quantifiable and tradeable financial instrument that rewards positive nature and biodiversity outcomes (e.g., species, ecosystems and natural habitats) through the creation and sale of either land or ocean-based biodiversity units over a fixed period.[33] The market for biodiversity credits is, however, still at an early stage of development and the pricing of biodiversity credits is still largely unknown.

7. Change in agricultural revenue

Surrounding the Goot Ting wetland, farmers grow rice, rubber trees and cassava and hold cattle. Farmers will need to shift to more sustainable agricultural practices – reducing the input of fertilisers and chemicals, stopping encroachment and limiting water pumping for irrigation – to conserve and restore the wetland. This may impact agricultural revenues. However, with proper outreach and training, the shift to more sustainable agricultural practices would not need to imply a reduction in agricultural revenues and could even increase agricultural revenues.

There is, however, not sufficient information to assess the impact of the project on agricultural revenue at the local or basin level. Hence, it is assumed that there is no impact on agricultural revenues (zero benefits / zero costs).

Summary of benefits

Table 5-3 provides a summary of the benefits.

Table 5-3 Benefit estimates NbS3

No.	Benefit item	Estimate project site (USD/year)	Estimate basin (USD/year)
1	Change in fishing revenue	5,400	77,500,000
2	Change in income from compost sales and cost savings from chemicals	N/A	N/A
3	Change in tourism revenue	75,000	450,000
4	Climate change mitigation	N/A	N/A
5	Reduction in flood damages and flood protection costs	0	650,000

[33] *World Economic Forum: https://initiatives.weforum.org/financing-for-nature/home*

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6	Change in non-use values	N/A	N/A
7	Change in agricultural values	0	0
	Total annual benefits	80,400	78,600,000

5.5.2 Costs

Table 5-4 gives an overview of the cost estimates for the project site and basin. Note that these estimates are all very indicative and based on currently available data.

For the project, it is assumed that the investment costs are spread over two years at the beginning of the project period. Operational costs (item 10) are annual.

Table 5-4 Cost estimates and assumptions

No.	Cost item	Estimate project site	Estimate basin
1	Acquisition of land (to reconnect wetlands with the main river)	1 ha at USD 150,000/ha Total USD 150,000	Based on 23 wetlands, their average distance to the main river and a canal width of 20 m, a total of 759 ha would be required at USD 150,000/ha. Total: USD 113,850,000
2	Reconnecting low-lying areas with the main river (digging of canals)	The groundwork required would be 500 m length by 20 m width by 2 m depth is 20,000 m^3 for a cost of USD 3/m^3 Total USD 60,000 In addition, two sluice gates (one at the inlet and one at the outlet) would be required to manage water levels for about USD 800,000 each Total USD 1,600,000	At the basin level, groundwork would be required for 759 ha or 759,000 m^2 with a 2 m depth at USD 3/m^3 Total USD 45,540,000 In addition, each wetland would require two sluice gates or culverts (one at the inlet and one at the outlet) for about USD 800,000 each Total USD 36,800,000
3	Removal of dense patches of vegetation	Assume 5 ha of dense vegetation would need	Assume 5 ha of dense vegetation would need

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		to be cleared for USD 650/ha Total USD 3,250	to be cleared for 23 sites for USD 650/ha Total USD 74,750
4	Protect and enhance river corridors	No costs, part of overall planning and management costs, see 6	No costs, part of overall planning and management costs, see 6
5	Creating/maintaining habitat connectivity	No costs, part of overall planning and management costs, see 6	No costs, part of overall planning and management costs, see 6
6	Implementing regulations to maintain water quality	Planning, management, training, and engagement costs are assumed to be USD 200,000 for the site Total USD 200,000	Planning, management, training, and engagement costs are assumed to be USD 200,000 per site for 23 sites Total USD 4,600,000
7	Installation of zones designated for natural fish nurseries	Estimated at USD 3,500 for one Fish Conservation Zone set up Total USD 3,500	Estimated at USD 3,500 for one Fish Conservation Zone set up, assume one FCZ at each of the 23 sites. Total USD 80,500
8	Strategy for ecotourism development	The costs of building a simple visitor centre and developing an ecotourism strategy, brochures, etc. are estimated to be USD 25,000. Total USD 25,000	Ecotourism could not be implemented at all sites, as the total market demand for ecotourism is limited and not all sites are suitable, e.g., in terms of accessibility. In total, it is assumed that out of 23 sites, 5 could have ecotourism. Total USD 125,000
9	Training and support to help households move to more sustainable livelihoods	Training, support, and engagement costs for households are assumed to be USD 200,000 for the site Total USD 200,000	Training, support, and engagement costs for households are assumed to be USD 200,000 per site Total USD 4,600,000

10	Initiate payment for ecosystem services	Setting up a system for payments for ecosystem services (carbon credits, biodiversity credits or others) requires a certain scale to cover fixed costs. These costs are currently unknown.	Setting up a system for payments for ecosystem services (carbon credits, biodiversity credits or others) requires a certain scale to cover fixed costs. These costs are currently unknown.
11	Limiting activities/enforcement	The community is reportedly supportive of wetland conservation, hence there would be no enforcement costs	It is assumed that enforcement costs would be USD 500 per month or USD 6,000 per year per wetland Total USD 138,000
	Total Capital Expenditure	USD 2,241,750	USD 210,930,250
	Total Operational Expenditure	-	USD 138,000 / year

5.6 Discussion of results

Table 5-5 shows the results from the CBA. The results are indicative due to the assumptions being made, but some conclusions can be drawn from them. From the perspective of a single site, restoring the connection of wetlands with the main river does not seem economically viable, as the net present value (NPV) is negative, and the benefit-cost ratio (BCR) is below 1.0. However, on the basin scale, it is a very viable intervention. These results are mainly dependent on the assumption made for the value of the benefits for fisheries. At the site level, the benefits from the revenues in fisheries due to the project are rather modest, as it is assumed that the catch will increase by 5% to 10%. The present total benefits for the site are about USD 80,000 / year. If this would be around USD 160,000, the project would break even at the site level. Taking into account that several of the benefits cannot be quantified, such as revenues from composting, cost savings from reduction in chemical use, and non-use values, USD 160,000 may be achievable.

At the basin level, the benefits from fisheries are more than 98% of the benefits, with the remainder the benefits from tourism and flood impact reduction. Hence, for a more accurate CBA, it would be important to properly quantify the impact of restoring 25% of the wetlands on the fish caught in the basin.

Table 5-5 Results of the CBA for reconnecting wetlands, Present USD values at a 6% discount rate over a 50-year project lifetime.

Indicator	Value for Site	Value for Basin
Total lifetime costs	USD 2.18 million	USD 165.79 million
Total lifetime benefits	USD 1.19 million	USD 1,160.46 million

NPV	USD -0.99 million	USD 994.67 million
BCR	0.54	7.00
IRR	2.4%	93.2%

5.7 Financial analysis

To make parts of projects financially viable, they need to generate tangible revenue streams that can be captured by a stakeholder. However, aside from potential biodiversity credits, there are no tangible revenue streams resulting from the projects. Ecotourism may contribute to funding the project at some of the wetlands, though it is unlikely that it could fund a substantial part of the project. Revenues from ecotourism will go directly to the households and private sector companies as they sell their services, and only for instance an entrance fee or license fee paid by households and private sector companies could provide funding for the projects.

Biodiversity credits and carbon credits are a form of Payment for Ecosystem Services (PES). PES could provide a viable avenue for large-scale wetland restoration and conservation, though there are many challenges in setting up such schemes.[34] One of the challenges is financial viability: financial viability requires sufficient, stable, and sustained payments for project investment and operational costs and acceptable rates of return for project investors (including public financers seeking societal benefits). Reconnecting wetlands is unlikely to generate a large volume of carbon credits and while biodiversity credits could contribute to the overall funding of the projects, this is still a largely undeveloped market. Other ecosystem services, including the most important one – an increase in fisheries – are difficult to capture under a (privately funded) PES scheme.

Hence, public funding would need to cover the majority of the expenses.

Regarding the financial costs of projects, it should be noted that some sites would likely have lower project costs than others, for instance, if gates would not be required, as these make-up more than half of the project costs, or if they are located close to the main river with a smaller distance to connect. From a financial perspective, it would make sense to start with these less expensive projects.

[34] *See Canning, A. D., Jarvis, D., Costanza, R., Hasan, S., Smart, J. C., Finisdore, J., ... & Waltham, N. J. (2021). Financial incentives for large-scale wetland restoration: Beyond markets to common asset trusts. One Earth, 4(7), 937-950.*

Appendix A: Calculation of potential reduction in flood water levels in the Mekong Basin due to the NbS

	1. area (m^2)	2. Inundation depth (m)	3. Storage volume (m^3)	4. Potential discharge reduction (m3/s)	5. Width Mekong (m)[1]	6. Depth Mekong	7. CSA (m^2)	8. Flood discharge (m^3/s) [2 & 3]	9. Flow velocity (m/s)
	25% of the highly suitable category		1 * 2	Assume the peak is 7 days, then 3 / 24*7 h, so divide by 604,800			0.888888889		
NbS 1 Vietnam	740,000,000	1	740,000,000		1200	14.9	17867	26,800	1.5
				-1224	1200	**-0.7**	-816		1.5
NbS 1 Cambodia	300,000,000	1	300,000,000		1200	22.2	26667	40,000	1.5
				-496	1200	**-0.3**	-331		1.5
NbS 2	490,000,000	1	490,000,000		1200	13.9	16667	25,000	1.5
				-810	1200	**-0.5**	-540		1.5
NbS 3	220,000,000	1	220,000,000		1200	13.9	16667	25,000	1.5
				-364	1200	**-0.2**	-243		1.5

[1] It varies a bit from place to place, but 1200m width seems a reasonable order of magnitude.
[2] Discharge at Kratie on Average is 13200, peak can be up to 40000. From Phnom Penh to the Cambodian–Vietnamese (CV) border, the Mekong River flows mainly through the Mekong branch, reaching up to 26 800 m3 s−1 during flood peaks (Fujii et al., 2003). https://hess.copernicus.org/articles/24/189/2020/
[3] Discharge at Vientiane (https://www.sciencedirect.com/science/article/pii/S2405844023068986)