Valuation of ecosystem services in LuangPrabang City

February 2025

Valuation of ecosystem services in Luang Prabang City

February 2025

Table of Contents

Acronyms and Abbreviations

DAFO District Agriculture and Forestry Office
DICT Department of Information, Culture and Tourism
DLSW Department of Labour and Social Welfare
DONRE Department of Natural Resources and Environment
DPI Department of Planning & Investment
DPH Department of Public Health
DPWT Department of Public Works and Transport
DWR Department of Water Resources
EbA Ecosystem-based Adaptation
GEDSI Gender Equality, Disability, and Social Inclusion
GRET Group for Research and Technology Exchanges
ICFMS Integrated Climate-Resilient Flood Management Strategy LPC Luang Prabang City
IWRM Integrated Water Resource Management
LPC Luang Prabang City
LPSIUS Luang Prang Smart and Integrated Urban Strategy
LSWO Labour and Social Welfare Office of Luang Prabang District
LWU Lao Women's Union
MPWT Ministry of Public Works and Transport
NbS Nature-based Solutions
O&M Operation and Maintenance
PAFO Provincial Agriculture and Forestry Office
PONRE Provincial Office of Natural Resources and Environment
PWTO Public Works and Transport Office
RUCAS Resilient Urban Centres and Surrounds
UNDP UnitedNations Development Programme
UNEP United Nations Environment Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
USO Urban Services Office
WHMD World Heritage Management Division
WSCA Water Sensitive Cities Australia

Note: All photos by Alluvium, unless stated otherwise.
Cover image of UNESCO World Heritage Pond in LPC managed on private land as part of a hotel and restaurant complex (February 2024).

1. BACKGROUND

Ecosystems provide a wide variety of benefits to people in the form of valuable goods and services. People depend on the services they provide such as the provision of fertile soil, food, clean water, protection from flood and drought while at the same time building resilience against the impacts of climate change.

Ecosystem-based Adaptation (EbA) means using biodiversity and services provided by ecosystems to help people adapt to the effects of climate change. It builds on healthy ecosystems and thus requires managing the ecosystems for their long-term benefits. As a holistic development approach, EbA is applied to many sectors such as agriculture, forestry, tourism, city planning and water management. It involves a range of approaches for conservation and ecosystem restoration through integrated adaptation approach.

There is an increasing recognition that a healthy natural environment is key for supporting human quality of life through the provision of ecosystem services. Thus, the conservation paradigm has shifted from traditional development approaches and begun to integrate the conservation, management and restoration of ecosystems into their work to address societal challenges. This approach is now widely referred to as Nature-based Solutions (NbS) and has been shown to have multiple benefits for both society and biodiversity at the local and global scales.

In fact, EbA measures play an important role in the context of climate change adaptation. They complement or even substitute purely technological infrastructure approaches and offer economic, social and ecological co-benefits and opportunities for flood management and disaster risk reduction.

Overview of Luang Prabang City

As climate continues to change, Luang Prabang City (LPC) is increasingly experiencing frequency and intensity of floods and droughts in the rural headwater and lowland communities of the Xe Bang Hieng River Basin in addition to threatening assets and infrastructure of urban communities Consequently, anthropogenic drivers such as increasing urbanization, ecosystem degradation and deforestation have exacerbated vulnerability of these communities to climate hazards—specifically floods and droughts. Incidences of flooding during monsoon season are becoming more common with impacts that disproportionately affect low-income communities who rely heavily on natural resources and agriculture for their livelihoods. As we are beginning to see the limitations of traditional, grey infrastructure approaches to water management, there is now increased understanding that the restoration, management and conservation of ecosystems can strengthen the resilience of the city to climate-led water challenges providing multiple benefits to both communities and biodiversity.

Luang Prabang City is characterized by diverse tourism potential. Action is needed to mainstream ecosystem-based approaches into climate change adaptation strategies to make full use of their many opportunities. EbA interventions generate a range of significant social, economic, and environmental co-benefits by reducing society's vulnerability to natural hazards, improving the availability of ecosystem services essential to support livelihoods and protecting biodiversity through sustainably managing ecosystems.

Evidences from various studies has shown that as part of an integrated adaptation approach, EbA requires comparatively small investment relative to the long-term social, economic and environmental benefits it generates. However, despite the numerous advantages of EbA, its implementation remains limited by three key challenges: lack of information, lack of financial resources and institutional resistance.

2. Introduction

Integrated water resource management and reducing risks from flood hazards are major concerns for Lao PDR. The UNDP-GEF LDCF "Integrated Water resources Management and Ecosystem-based Adaptation in the Xe Bang Hieng River Basin and Luang Prabang City" Project aims to support the government of Lao PDR to promote the integrated management of land and water resources at target sites in the Xe Bang Hieng River Basin and Luang Prabang city. This will increase the climate resilience of communities to the impacts of floods and droughts—both of which are projected to become more intense and frequent under future climate scenarios. The project, being implemented by the Department of Water Resources of the Ministry of Natural Resources and Environment, aims to strengthen climate resilience of communities in two particularly vulnerable areas of Lao PDR—namely, Savannakhet Province and Luang Prabang City—particularly focusing on the impacts of floods and droughts. This improved resilience will be achieved through three complementary project components, specifically:

Component 1: Developing national and provincial capacities for Integrated Catchment Management (ICM) and integrated urban Ecosystem-based Adaptation (EbA) for climate risk reduction;

Component 2: Ecosystem-based Adaptation (EbA) interventions, with supporting protective infrastructure and livelihood enhancement; and

Component 3: Knowledge management and Monitoring and Evaluation (M&E).

The IWRM-EbA Project embraces the integrated management approach through sustainable and wise use of resources in supporting communities to cope with climate change impacts. The project attempts to demonstrate how EbA interventions can help alleviate major pressures from climate change on ecosystems by managing and restoring ecosystems and the services they produce and in turn enhancing the adaptive capacity of local communities of Luang Prabang Province. This is primarily done through (i) generating public awareness about the importance of ecosystem-based adaptation; (ii) strengthening collaboration between sectors involved in managing ecosystems and benefiting from ecosystem services; (iii) involving local institutions and stakeholders as key actors in adaptation planning so as to enhance participation and compliance; and (iv) promoting resilient ecosystems and nature-based solutions and provide co-benefits in addressing climate change impacts in the city.

3. Rationale of the Study

Ecosystem-based adaptation (EbA) is increasingly being recognized as a strong and cost-effective means of dealing with the impacts of a changing climate. To this end, an assessment of urban ecosystem services of Luang Prabang City was undertaken to increase the understanding of EbA implementation and especially to gather information regarding their economic costs and benefits, in order to make the case for investing in nature-based solutions for climate change.

Accordingly, this report presents information related to ecosystem services in Luang Prabang City (LPC). The report presents a qualitative description of ecosystem services being provided by the natural environment and lays the groundwork for a description of the factors affecting ecosystem services delivery. This information is provided to support the decision makers with options to mitigate flooding issues identified by the government stakeholders in LPC. The report consists of four main sections, including:

- Economics field mission—which describes the activities undertaken as part of the economics field mission and data and information collected.
- Desktop review—which summarizes several reports of relevance to valuing ecosystem services

in LPC
- Economic value of ecosystem services—which provides an overview of an ecosystem services framework and approaches used for valuing ecosystem services.
- Case studies—which provides case studies that explore the existing uses and values of ecosystems in LPC.

This report adopts a qualitative approach to assessing ecosystem services in Luang Prabang. This approach has been used due to limited data being available to quantify the level of ecosystem services being provided by urban ecosystems and to monetize these values. This includes in relation to how the level of ecosystem services being provided are likely to change with different built or nature-based interventions that aim to address flood risk.

Although neither a full assessment of all ecosystem services, nor valuation exercises to determine the true economic values of the services identified were within the scope of this study, this assessment highlights ecosystem services provided as co-benefits that have both market and non-market values. Furthermore, the case studies explore different types of options than were anticipated as they focus on addressing flood risk at a city-scale rather than at specific sites. This increases the complexity of applying the ecosystem services framework to value ecosystem services due to the more varied nature and condition of ecosystem involved.

1 Scoping mission

A scoping mission was undertaken in LPC during July-August 2024 to collect data and information related to valuing urban ecosystem services in LPC. The mission involved:

- a workshop to provide stakeholders with an overview of the mission's objectives and to finalize the
  mission plan;
- meetings between the consultant team and UNDP and government departments to collect relevant data and information; and
- visits to sites impacted by flooding to gain an appreciation of the local context.

1.1 **Stakeholder workshop and meetings**

The stakeholder workshop and meetings with government officials provided insights into topics such as existing flood risk and impacts in LPC, urban ecosystems and the services they provide in LPC, and related data and information availability. A summary of the findings is provided in Table 1.

Table 1. *Summary of findings from the stakeholder workshop and meetings with government departments*

Activities	Summary of key findings
Stakeholder workshop	• Drinking water is sourced from groundwater rather than urban rivers or streams. Flooding disrupts drilling of bore and can also contaminate bores, which can limit availability of drinking water during flood events. • Wastewater regulations are not strictly adhered to. Impacts from flood events exacerbated by water being contaminated by waste. • Sections of the upper catchment surrounding the city are privately owned. This limits government control of how this land is used. Agricultural activity on private land is a cause of deforestation. • Flood events can affect businesses, tourism, and agricultural areas. Large roads into the city are believed to be more affected by flooding than local roads, with a reported incident of a significant road into the city being affected, limiting access by bus. Tourism resorts located near the river are also susceptible to impacts from flooding and wastewater exposure. • Limited use of urban waterways by communities. High water levels can limit the small amounts of food production that occur on the sides of rivers. • Flooding and exposure to wastewater are believed to contribute to health issues including the spread of dengue fever.
Meeting with PONRE and DONRE	• Regulations are in place to limit development near waterways. • There are examples of new developments encroaching waterways in the upper catchment, contrary to regulations. These developments are believed to be exacerbating flood issues. • The upper catchment surrounding LPC includes protected and privately owned areas. Some areas are used for subsistence activities. Some areas are used for small- scale tourism (e.g. guided walks). • No information related to carbon sequestration in nearby forests is believed to be available. • A recent project was undertaken, with a Vietnamese organization, focused on the management of the upper catchment surrounding LPC. • No observed impacts from flooding on cultural sites.

Activity	Key findings
Meeting with PAFO and DAFO	• The main agricultural activity near the city is production of rice (about 4.7 tons of rice per hectare, per year). Some livestock is farmed in the city. • Irrigation channels are in place to take water from rivers. Development near rivers affects access to water. This can mean channels need to be moved or become less effective. • Agricultural production is impacted by flooding. Typically, about 20% of output is lost. If more than 40% of output is lost, compensation is paid. Often floods impacts infrastructure more than crops (e.g. irrigation channels). • Agricultural production is decreasing due to urban development. People buy agricultural land to build houses. No controls are in place to restrict this type of development • Subsistence uses of nearby forests by the community include collection of timber, bamboo and mushrooms. Hunting is no longer undertaken.
Meeting with DPWT	• Only minor flooding occurs in the city. In some cases, roads are affected temporarily. • Floods occurred in 2018 related to dam construction. • The construction of a dam in the past three years appears to have exacerbated flooding at the connection points of waterways to the Mekong River. • An island in the Mekong River has been flooded due to the higher water level after the dam was built. This island was culturally important and visited as part of New Year's Eve celebrations. There are plans to rebuild/restore the island. • Public works responsible for clearing blockages in drainage system when notified. No budget provided for clearing blockages. • Planning controls are meant to limit development within 3 meters from streams and 25m from rivers (Mekong and Nam Khan). • Plans for a water gate have been long proposed as have plans to build a tunnel under a frequently flooded road.
Meeting with DPH	• Flooding can spread disease and contaminate crops and vegetables. • Flooding and poor water quality contribute to health issues such as stomach aches and dengue fever. Poor water quality is less of an issue in the city center where use of bottled drinking water is more common. • Communities less reliant on subsistence lifestyle today than previously. • The city has become hotter in recent decades. Urban heat is an issue for the city. All departments are working to maintain trees. Planning controls aim to reduce heat (use wood, no mirrors). Limited people severely impacted by heat—mainly elderly. Some instances of heat stroke have occurred during events. • Poor air quality is not a major issue in the city anymore. Previous issues related to dust from roads (roads now paved). Smoke from slash and burn agriculture is still an issue. • Degradation of ponds is believed to make mosquitos more prevalent and attract mosquitos carrying diseases. There are programs to install fish farms to help manage mosquitos. • Wastewater creates a bad smell.
Meeting with DICT	• The city economy is heavily reliant on tourism activity. Tourism data is collected as tourists leave through surveys at exit points such as airports and train stations. There is believed to be no data related to the impact of flooding on tourism.

Activity	Key findings
	• COVID-19 caused tourism to stop. Many tourism workers left or found new roles. Now there are labor shortages in the tourism sector. • Ecotourism includes hiking; however, limited hiking occurs near the city. Development has meant that the best trails are now located in villages further away from LPC. Some of these are being lost due to development. • Tourist tax in place since 2008. The tax has always been 10,000 Kip per person and is paid by tourism companies. 60% of the tax revenue comes back to LPC province with the remaining portion going to central government. Some money, but not all, is reinvested back into the tourism industry. • Tourism is believed to lead indirectly to lots of garbage in the drainage system (i.e. through incorrect disposal by businesses). • The new dam raised water levels and affected restaurants by the river. • It is very expensive for locals to live in the city, including because of heritage requirements. Locals are moving to the outskirts of the city and in some cases building homes where they are not supposed to, based on existing planning regulations. • Future development plans exist for the less developed side of the Mekong River in LPC. • Many houses are being constructed near waterways as seen in Kokyiew village. • The rise in tourism has driven up housing costs in the city, prompting people to relocate to suburban areas and build homes near waterways. • Urban development on land previously used for rice production reduces water storage capacity and contributes to increased flood occurrences. • It is anticipated that 1.7 million people will visit LPB in 2024.
Meeting with DLWS	• After flood events, a flood committee is established to manage impacts and estimate damage costs. The committee involves multiple departments, with individual departments responsible for estimating costs in their areas of work. • Damage from flooding to houses is generally minor. • Some urban development has led to nuisance flooding. For example, developments on one block causing flooding to neighbors. • Lao has a disaster recovery fund. Funds are raised through a tax of 15,000 Kip per household per year and 20,000 per household per year for government employees. • Government can provide food after natural hazard events. • A flood in 2022 in the upper catchment affected 1,223 people, 34 hectares of rice fields, 35 hectares of other agricultural land and 3km of road. Associated costs were estimated to be 2.3 billion Kip. • The province has allocated a natural disaster budget of 100 million Kip.

Meeting with Provincial DPI	• Work is ongoing to ensure businesses on the Mekong River comply with buffer rules. No work is being done related to stream buffers.
	• Various nationwide surveys are undertaken each year. A natural disaster survey was proposed but never implemented. Surveys include:
	  ○ Lao Expenditure and Consumption Survey (conducted every few years).
	  ○ Commodity Price Survey (monthly).
	  ○ Economic Survey (Enterprise Survey) (conducted every 2 years).
	  ○ Agriculture Survey (conducted every 5 years).

Activity	Key findings
	○ Population Census (conducted every 10 years). • The central government identified a special economic zone on the other side of the Mekong River for development. This would be controlled 70% by the central government and 30% by the provincial government. This is a similar structure to elsewhere in Lao. The site was identified without a detailed on-ground assessment. A site near the intercity train station is also confirmed for development. • The Economic Zone was initially planned to cover 12,000 hectares but has now been confirmed to be 4,000 hectares. • A potential mining site being considered in the upper catchment area. • Ambitions for LPC to become a smart city but this ambition is challenged due to heritage rules (e.g. traffic lights). • Environmental impact assessments (EIA) are required before major developments. However, some investment can be approved by the central government without an EIA. • Private companies are responsible if they cause or contribute to flooding.
Meeting with Urban Management and service office (LPC)	• DPWT is responsible for planning approvals. The Provincial office is responsible for approvals on sites of more than 400 sqm and district office for sites less than 400 sqm. • Urban management office is responsible for clearing drainage channels of waste. Previous budget of $400 M Kip for maintenance of channels (until around 2016). No budget since then. The city has about a $1 billion Kip annual maintenance budget. • Across the city there are examples of buildings built near waterways causing flooding. There are only a limited number of cases when buildings have been made to comply with regulations after being built. For example, a private company built a building for a bank over a waterway. This was not approved, and the bank pulled out of the purchase. A family covered a waterway with a house, which caused flooding to neighbor. This is not yet resolved. There is an opportunity to issue fines, but fines are rarely used. • There have been efforts to reduce waste in drainage channels, including awareness raising campaign, monitoring (CCTV), work to separate garbage, and monthly cleaning by a cooperative of hotels and restaurants.

1.2 **Site visits**

The mission included visits to three sites that have a history of flooding. These visits provided an opportunity to better understand the urban environment and issues related to flooding. The site locations are shown on Figure 1 and described, with photos below:

- Site 1 (Nasangvuey village) — this site experienced flooding during 2016, with one person washed downstream. It provides an example of an urban waterway which has been encroached by urban development.
- Site 2 (Phouxangkham village) — this site experienced flooding during 2016 and 2018 linked with high water levels in the Nam Khan River. It provides an example of a development which encroaches the waterway buffer zone contrary to planning controls (i.e. an entrance way to a property over the waterway)
- Site 3 (Kokngiew Village) — the road at this site experiences flooding every year. An alternative road for traffic is available. The floor heights of nearby buildings appear to be near or at ground level suggesting a high risk of inundation.

Figure 1. *Locations of sites visited*


Figure 2. *Site 1*

Figure 3. *Site 2*

Figure 4. *Site 3*

2 Desktop review

A desktop review of publicly available reports was undertaken to identify information and data relevant to valuing ecosystem services in LPC. A summary of key reports identified is provided in Table 2.

Table 2: *Summary of key public reports reviewed as part of this project*

Report	Author and Date	Description	Geographic focus
Economic Valuation of Ecosystem Services from Urban Wetlands in Lao PDR under Climate Change	Brander et al., 2022	This report presents an economic valuation of ecosystem services from urban wetlands under climate change in Lao PDR. The study focuses on sites in four urban areas in central and southern provinces of the Lao PDR.	Lao PDR
Lao PDR Biodiversity: Economic Assessment	Bouttavong et al, 2002	This report provides a comprehensive assessment of the economic value of biodiversity in Lao PDR. This information is used to identify needs for the use of incentives, financing mechanisms and other economic measures in the National Biodiversity Strategy and Action Plan.	Lao PDR
Post disaster needs assessment 2018 floods Lao	Government of Lao People's Democratic Republic, 2018	This report describes the impacts of the disaster on the provincial and national economies of Lao PDR. It also provides data against which recovery and reconstruction plans can be designed and progress can be monitored.	Lao PDR
Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Lao PDR	Talberth, 2015	This report provides a 7-step process for valuing ecosystem services and outlines where ecosystem service valuation can play a role in decision making.	Lao PDR
Luang Prabang Smart and Integrated Urban Strategy	Rambol, 2023	The Strategy identifies smart city solutions to facilitate sustainable urban and tourism growth, address urban management problems, and preserve Luang Prabang's distinctive built, natural, and intangible heritage.	LPC, Lao PDR
Environmental Challenges for Green Growth and Poverty Reduction: A Country Environmental Analysis for the Lao People's Democratic Republic	World Bank, 2021	This report investigates linkages between environmental quality, economic growth, and social well-being in Lao PDR. It includes economic analyses to quantify and prioritize the costs of environmental degradation, natural resource degradation, and natural disasters.	Lao PDR

The Economic value of Ecosystem services in the Mekong Basin	Emerton, 2013	This study synthesis existing data on ecosystem values for the major ecosystem services in the Lower Mekong and uses it to assess the costs and benefits associated with alternative plausible development scenarios.	Lower Mekong
Report	Author and Date	Description	Geographic focus
Freshwater Nature-Based Solutions in the Mekong Sub-Region	Royal Haskoning DHV, 2024	This study investigates and quantifies the benefits related to using NbS in the Upper Mekong River and floodplain ecosystems in Thailand, Laos, Cambodia and Vietnam. This includes benefits related to climate resilience.	Upper Mekong
Economic Analysis of Nature-based Solutions for Flood and Drought Resilience of the 9C-9T Sub-basin Report	Mekong River Commission, 2023	This report describes an economic analysis to evaluate the performance of proposed NbS for the 9C-9T sub-basin in Cambodia and Thailand. This work aims to provide an understanding of the expected economic value of the benefits provided by NbS to address floods and introduce tools and methodologies for the economic evaluation of NbS.	Cambodia and Thailand

3 Economic value of ecosystem services

This section provides an overview of an ecosystem services framework and approaches used for valuing ecosystem services.

3.1 Overview of an ecosystem services framework

An ecosystem services framework provides a structure for identifying, categorizing and valuing the benefits provided by ecosystems in LPC. It involves linking the ecosystem assets to the services they provide and then linking these services to associated economic and social values. An overview of an ecosystem service framework is shown in Figure 5.

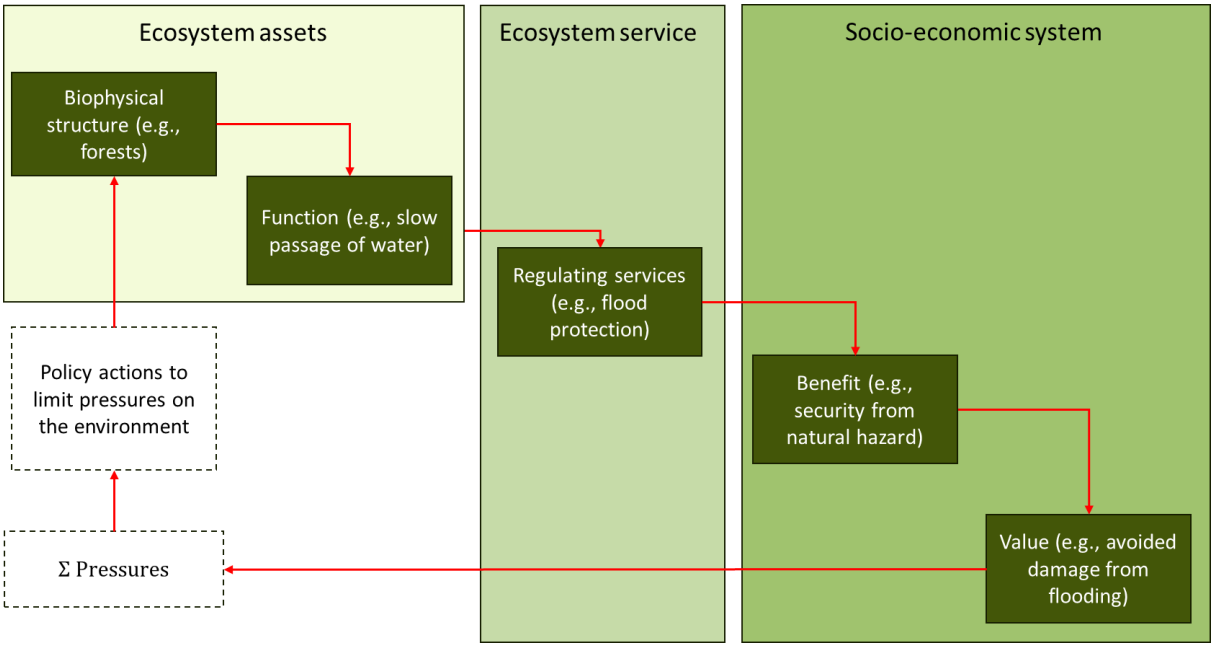

Figure 5. *Overview of ecosystem services framework*

The general approach for using this framework is described as follows.

1. Firstly, the ecosystem assets are identified, including the extent and condition. This is the ecosystems from which ecosystem services and their economic and social benefits are derived.
2. Secondly, the ecosystem services that flow from the assets are identified and measured (where possible). This step involves exploring how the ecosystem assets are used, and other benefits being derived.
3. Thirdly, the economic and social values of the ecosystem services are estimated in monetary terms. This can include estimating the values attributable to consumptive uses (e.g. food) and non-consumptive uses (e.g. tourism). The ability to undertake this step is contingent on the necessary data and information being available. In this study, ecosystem services have been primarily discussed qualitatively due to the lack of robust data on the ecosystem assets and the services they provide.
4. Finally, through an understanding of the ecosystem services, potential beneficiaries of interventions can be identified, which can inform the design of interventions and potential investors and/or collaborators (this is not the focus of this study).

Ecosystem services are often categorized into three key categories. These categories are described below.

- **Cultural services**: services directly experienced by humans.
- **Provisioning services**: services describing the material or energy outputs from ecosystems.
- **Regulating services**: services ecosystems provide through their ability to control or moderate natural systems.

A fourth category called supporting services (ecological functions) is often used to describe services that underpin other ecosystem services categories. However, supporting or intermediate services may be better described as "structures, processes and functions that give rise to services" rather than being a final service (Fabis Consulting, 2018).

The ecosystem services framework allows for a wide range of values to be captured. This includes values for good and services that are typically traded in markets (e.g. food, materials), as well as the economic values that are not traded in markets (e.g. climate regulation).

3.2 Approaches to valuing ecosystem services

Estimating monetary values for ecosystem services (step 3 of the ecosystem service framework) can assist in increasing the visibility of the benefits being provided by natural environments. It can also assist with incorporating the values being provided by the environment into decision-making and to analyze trade-offs across different land uses or interventions. Furthermore, it supports the development of business cases for protection and enhancement of ecosystems, as well as nature-based solutions (NbS).

The most common approach to economic valuation is linked to expenditure on a good or service—a market valuation based on corresponding prices. Such approaches provide a very basic representation of economic value but may also provide a substantial proportion of economic value for an environmental asset.

However, many ecosystem services are not explicitly traded in markets, leading to various other non-market-based approaches also being used. These non-market valuation approaches generally fall within two categories: revealed preference and stated preference methods. The former is based on observable behaviour in existing markets while the latter utilizes consumer survey-based techniques to elicit values through hypothetical markets.

Furthermore, where there are constraints (time or resource) in undertaking a dedicated revealed or stated preference study for incorporation into an economic value, a benefit transfer approach can be applied. This approach involves transferring values from an existing study, in a comparable context, to a new study. Several matters need to be considered to perform benefit transfer robustly, including how similar the ecosystem assets (e.g. extent, condition) and socio-economic context (e.g. population characteristics) are compared to the original asset studies.

A summary of the key economic valuation methods used to estimate values from ecosystem services are presented in Table 3.

Table 3. *Summary of economic valuation approaches*

Method	Based on…	Examples	Strengths	Weaknesses
Revealed preference methods—using observed behaviour in existing markets				
Market price	Market transactions	Market value of access	• Well-defined representation of direct use value • Methodologies are easy to implement and data relatively easy to obtain	• Market data is available for limited set of goods and services • Impacted by seasonality and other price factors • Difficult to measure the value of larger scale changes that are likely to affect supply or demand
Cost-based methods (e.g., avoided costs)	Market value as a proxy	Value of urban heat management through avoided cooling costs Value of flood protection through avoided replacement costs from damage	• Adequate representation of physical protection values • Consistent with some industry approaches (e.g., insurance) • Moderately data/resource-intensive	• May not represent actual benefit from protection • Does not capture social values of service that may be above costs
Travel cost method	Non-market values from analysis of cost/expenditure for visiting a site or participating in an activity	Value of recreational activities such as recreational fishing, swimming, or general visitation	• Based on actual behaviour and thus, defined value of service • Approach is established and generally well-understood	• Added costs from data collection and user participation • Only captures value for a point in time, not accounting for temporal or condition changes • Method requires specific expertise • Debate on assumptions used in methodology • May not reflect true value for all visitors (e.g., value may be underestimated if travel expenditure is low)
Hedonic pricing method	Non-market values from analysis of market prices for differentiated goods, based on characteristics of corresponding services	Amenity values based on residential prices	• Based on actual behaviour and thus, defined value of service	• Scope for services is limited to related market goods

Method	Based on…	Examples	Strengths	Weaknesses
			• Some market values (e.g., property values) are efficient in responding to information on value of services • The method is versatile and can be adapted to consider several possible interactions between market goods and environmental quality • Data is typically reliable and relatively easy to obtain	• Only captures value for perceived benefits and not actual benefits/consequences • Assumes services drive value rather than income • Method requires specific expertise • Resource intensive and costly
Stated Preference Methods—using survey-based methods in hypothetical markets				
Discrete choice experiments	Consumer values for changes to attributes of an environmental asset	Value of amenity provided by environmental asset (use and non-use)	• Can be used to estimate use and non-use values • Considers individual socio-demographics and preference factors in values • Allows estimation of hypothetical or ex-ante changes	• Survey-design and analysis is resource intensive, costly and requires specific expertise • High risk of biases including hypothetical bias • Estimation of non-use values may not be robust
Contingent valuation	Consumer values for changes to an environmental asset	Value of changes to biodiversity within a natural asset		
Other techniques				
Benefit transfer	Corresponding values estimated in similar locations using other techniques	Transfer of use values for a natural asset or non-market values for changes to attributes of natural asset	• Less resource intensive and costly • Requires less expertise to implement • Can provide a basis to suggest primary study	• May not provide accurate reflection of values, given original studies tend to be policy, user or site-specific • Reference study may be difficult to find • Relevant studies for the policy or issue in question may not be available

4 Case studies

This section provides case studies that explore the existing uses and values of ecosystems in LPC.

4.1 Case study 1. Unregulated development of the land in the foothills surrounding LPC

Summary
Urban expansion into the foothills surrounding LPC is being driven by significant growth in tourism. If poorly regulated, this may increase urban flood risk. The foothills surrounding LPC comprise protected forested land as well as land used for agricultural. This land is expected to support a range of uses and values, including flood protection for the city, rice production, wild foods, materials, erosion control, and water quality improvements. Stronger regulation of urban development is expected to see most ecosystem service values increase, relative to the 'do nothing differently' scenario. This includes natural hazard and flood protection, which is believed to be particularly important given climate change is expected to increase the frequency and severity of flooding.

Definition of the problem

Unregulated outward urban expansion into the foothills surrounding LPC may increase urban flood risk. This includes through the conversion of agricultural land and forests (i.e. the ecosystem assets) into housing and supporting amenities such as roads, social facilities, and commercial establishments. The built-up area of the city is expanding at a rate of 5% per year (ADB, 2023).

The frequency and magnitude of flooding in LPC is already expected to increase because of climate change, which is also expected to bring more intense rainfall events (BRLi, 2013). Furthermore, urban development may exacerbate this issue by contributing to deforestation and reducing the prevalence of permeable surfaces, which will reduce the land's natural ability to provide water storage and flood protection.

Outward urban expansion is being driven by significant growth in the number of tourists visiting each year and the need for more infrastructure and services to accommodate this influx of people. Luang Prabang's local population is also increasing, in part, in response to the new opportunities being provided by the tourism sector and a planned Economic Zone. By 2040, the population of Luang Prabang (Luang Prabang World Heritage Site and its buffer zone, as defined in the 2012 Urban Planning Regulations for Luang Prabang) is expected to exceed 80,000 people, which is a 20% increase from 2020 (Ramboll, 2023).

A key catalyst for growth in visitor numbers was LPC being designated as a World Heritage Site in 1995. The Lao PDR–People's Republic of China High Speed Railway, which opened in 2021, has also facilitated more people visiting the city. By 2040, the number of visitors to LPC each year is projected to reach more than 3 million people, which is a 450% increase on visitor numbers in 2022 (Ramboll, 2023).

Anecdotal evidence suggests existing planning control for development in LPC are not being effectively enforced. How comprehensively existing controls consider urban flood risk, and the effects of climate change is also unclear. Ensuring planning controls take into account anticipated changes from climate change, with increased enforcement, may provide a cost-effective option for managing flood risk.

Existing values and uses

The foothills surrounding LPC comprises protected forested land as well as land used for agricultural and low-density housing. This land supports a range of uses and values which are described in Table 4, along with expected trends or changes in these values over time. Indicative unit values for key forest ecosystem services in Lao PDR are provided in Table 5. These values help to understand the benefits the forests in the foothills surrounding LPC provide, as well as the costs associated with deforestation.

The values reported in Table 5 are based on existing reports and studies related to ecosystem services values in the region. Importantly, there is often significant variation between reported values across studies and regions, due to factors such as differences in the local context, and differences in the valuation approaches used. As such, these values provide only a rough guide of the benefits forests near LPC provide.

Table 4. *Existing values and uses of land in the foothills surrounding Luang Prabang City*

Category	Service	Evidence from mission and other sources	Expected trend (without intervention)
Provisioning	Cultivated crops	• Small-scale agriculture, with rice being the predominant crop. Rice yield is believed to be about 4.7 tonnes per hectare per year.	Decreasing—Increased competition for land may see agricultural land converted to other land use types such as housing. In some cases, areas of agricultural land may increase through conversion of forest on private land. Existing planning control are not believed to place restriction on this type of development.
	Minerals	• No mining or quarrying is currently believed to occur • The development of a mine is believed to be under consideration for a site in the upper catchment.	No change—mining is not assumed to occur
	Water	• Water for agriculture is sourced from rivers and streams. • Drinking water is believed to be predominantly sourced from groundwater.	Decreasing—Unregulated development near rivers and streams can restrict access to water for agricultural producers or cause the need for irrigation channels to be relocated. Relocating channels may cause them to become less effective at delivering water for irrigation.
	Wild food and raw materials	• Subsistence uses are believed to include collection of timber, bamboo, and mushrooms. • The local community is believed to be less reliant on subsistence practices, including hunting, than in the past.	Decreasing—Further outward expansion of LPC is likely to cause deforestation and reduce opportunities to practice subsistence uses.
Regulating	Natural hazard protection (e.g. floods, storms)	• Forests provide watershed protection by retaining water and regulating run-off to reduce flood volumes. • Anecdotal evidence of urban development and deforestation causing increased frequency of flooding in villages nearby to LPC.	Decreasing—Further outward expansion of LPC is likely to cause deforestation and reduce watershed protection. Urban development may exacerbate this issue through an increase in impermeable surfaces which increase runoff.
	Air quality	• Trees contribute to air quality by removing particles and pollutants from the air. • Air quality in LPC is affected by slash and burn agriculture practices.	Decreasing— Further outward expansion of LPC is likely to cause tree losses and reduce air quality. This assumes that urban expansion will not reduce the prevalence of any nearby slash and burn agriculture.
	Climate regulation (e.g. microclimate	• Land use change and forestry is the largest greenhouse gas emitter in Lao PDR (Government Lao PDR, 2010).	Decreasing—Further outward expansion of LPC is likely to cause deforestation, which will reduce forest carbon stocks and annual carbon sequestration

Category	Service	Evidence from mission and other sources	Expected trend (without intervention)
	regulation, global climate regulation through absorption of greenhouse)	• Forests in Luang Prabang Province are predominantly classified as either mixed deciduous forest or regenerating vegetation, which stock 90 and 17 tonnes of Carbon per hectare, respectively (World Bank, 2018). • Anecdotal evidence of LPC becoming hotter in recent decades. Urban heat a driver for government efforts to maintain trees, which can be lost with further urban development.	
	Erosion control and water quality	• Forests help to prevent soil erosion, which in turn reduces sedimentation in waterways and impacts on water quality.	Decreasing—Further outward expansion of LPC is likely to cause deforestation. This may cause increased erosion and sedimentation in waterways.
Cultural	Spiritual and cultural interactions	• Forests can be used for cultural activities and provide spiritual nourishment.	Decreasing—Further outward expansion of LPC is likely to cause deforestation and reduce the provision of cultural services, especially recreation and hiking related activities.
	Recreation and Tourism	• About 67 percent of international tourism visiting Lao expressed interest in visiting natural sites (World Bank, 2021). • It is anticipated that 1.7 million people will visit LPB in 2024. • Some natural areas near LPC used for small scale ecotourism including a limited amount of hiking. Urban development has led to a loss of hiking trails and as such the best trails are now further away from the city.	

Table 5. *Indicative values of forest ecosystem services in Lao, PDR ($2023 USD)*

Category	Service	Indicative value per unit	Reference point	Source
Provisioning	Cultivated crops (i.e. rice)	$480 - 520 / ha / year	Based on lowland, wet season rice in Lao.	World Bank & FAO, 2012
	Non-timber forest products	$4 - 304 / ha / year	Based on the range in values for local use of non-timber products from a review of existing valuation studies the in Lower Mekong region.	Emerton, 2013
Regulating	Natural hazard protection	$6 - 734 / ha / year		Emerton, 2013
	Climate regulation	$62 - 3,832 / ha / year		Emerton, 2013
	Habitat provision	$0.40 / ha / year	Based on values for Lao PDR, from a global assessment of non-wood forest ecosystem services.	Siikamäki et al. 2015
	Water quality	$1668 / ha / year	Based on the values estimated for the provinces of Attapeu, Champasak and Xekong in Lao PDR as part of the proposed Greater Mekong Subregion Biodiversity Conservation Corridor.	ADB, 2010
	Erosion control	$883 / ha / year		ADB, 2010
Cultural	Recreation and Tourism	Excluded as highly site specific	n/a	n/a

Notes: Values indexed to 2023 United States Dollars based on World Bank (n.d.).

Management options

As visitor numbers and the local population expands in LPC, the local authorities have a choice as to how they manage the associated urban development. Options for LPC officials include the following.

- Option 1: Unregulated development—Under this option, the outward expansion of the LPC proceeds with only limited enforcement of planning controls, with short term needs of the city taking priority over planning. For the purposes of this case study, this represents the base case or 'do nothing' scenario.
- Option 2: Regulated development—Under this scenario, the urban expansion of the city is more heavily regulated, with planning controls more strongly enforced to reduce urban encroachment resulting in loss of forested and agricultural land. This may involve updates to planning controls to take account of the risk of flooding (including increased risks due to climate change) and more detailed urban planning to identify the most suitable areas for future urban development. For the purposes of this case study, this represents the project case. Importantly, there are already examples of work in line with option, such as the Luang Prabang Smart and Integrated Urban Strategy (Ramboll, 2023).

Table 6 present how the level of ecosystem services is expected change with regulated development, relative to the base case. This assessment assumes that the regulated development scenario will lead to the retention of more forest in the in the foothills surrounding LPC resulting in a lower flood risk for the city.

Table 6. *Expected change in level of ecosystem services with regulated development (option 2), relative to the base case (unregulated development, option 1)*

Category	Service	Description	Expected change
Provisioning	Cultivated crops	Regulated development is expected to provide opportunities to increase the preservation of agricultural land. For example, limiting conversion of agricultural land to other land use types when it has high heritage value or where	Increase

Category	Service	Description	Expected change
		conversion to other land use types may exacerbate flood risk.	
	Minerals	Mining is not expected to occur under either option	No change
	Water	Urban development can reduce access to water from rivers and streams for irrigation. Improved planning an enforcement of planning controls near rivers and streams may help ensure continued access to water for agricultural producer.	Increase
	Wild food and raw materials	Stronger enforcement of planning controls may provide increased protection for natural areas, including forests, from development. This will ensure continued access for the community for subsistence uses.	Increase
Regulating	Natural hazard protection (e.g. floods, storms)	Regulated development is expected to provide increased protection for natural areas, including forests. This will ensure they continue to provide natural hazard mitigation. Protecting forests near waterways is expected to be particularly important for ensuring flood risks are not exacerbated.	Increase
	Air quality	Regulated development may provide increased protection for trees. Tree assists to manage air pollution by providing air purification	Increase
	Climate regulation	Regulated development is expected to provide increased protection for natural areas, including forest, from development. This will prevent losses to the regulating services they typically provide.	Increase
	Habitat provision		Increase
	Erosion control and water quality		Increase
Cultural	Spiritual and religious interactions	Regulated development is expected to provide increased protection for natural areas, including forest, from development. This will assist in preserving the cultural services they provide. Conversion of natural areas for the purposes of developing tourism infrastructure (i.e. hotels) may also increase tourism values. Therefore, there is a trade-off between increasing tourism infrastructure to support more tourism and protecting the values which make LPC a tourism destination	Increase
	Recreation and Tourism		Increase

Table 6 highlights that Regulated development (option 2) is likely to see most ecosystem service values increase, relative to the base case. This includes natural hazard and flood protection, which is believed to be particularly important given the effects of climate change on flooding.

A more detailed investigation is required to understand the degree to which flood mitigation and other ecosystem services will change. This includes a need to consider social impacts from limiting development in the surrounding foothills, such as housing affordability in LPC.

Evaluation of options

More information is required to determine which of the two options described is preferred, i.e., which option provides the highest net-benefit. This includes information related to:

- the additional cost of regulating development (Option 2) versus not regulating development (option 1), and
- the relationship between urban development in the foothills surrounding LPC and changes in the level of flood risk (and other ecosystem services) in LPC.

The historic costs of damage and losses from floods in LPC may provide a useful reference point for determining the viability of flood mitigation measures, such as regulating development in the upper catchment. Such estimates can be used to approximate the upper limit of investment that can be made to reduce or avoid proportionate increases in flood risk, before the costs of intervention exceed benefits (i.e. break-even point). When considering the expected costs of different interventions and their effectiveness at reducing flood risk, this information can help to give a rough indication of if an intervention option will be economically viable. This approach is illustrated in Box 1 using indicative estimates, in lieu of historic cost estimates of flooding for LPC.

Box 1. *Illustrative example of how historic costs of flooding can be used to determine the approximate scale of investment available to reduce flood risk*

The Work Bank (2019) suggest that flood events in Lao have annual expected losses equivalent to 2.8% to 3.6% of GDP. Assuming a population of 72,000 people, and GDP per capita of US$2,660, this equates to annual expected losses from flooding of between US$5.4 - $7.0 million dollars per year in LPC. Over 25 years, this equates to a total cost of between $99.1 - $127.4 million, in present value terms.

Using these estimates, the upper limit of investment that could be made to avoid proportionate increases in flood risk can approximated. For example, to avoid a 1% (US$63,000 - $81,000) increase in annual losses from flooding, an investment of up to between US$1.0 - $1.3 million could be made before the costs exceed the benefits of intervention. The level of investment is considerably higher than the avoided losses on an annual basis, as it accounts for the cumulative cost of the increased flood risk through time.

For reference, the preparation of an urban master plan for Luang Prabang (including scale model), was estimated to cost US$1.75 million (Egis, 2022). An urban masterplan is expected to assist with regulating development in the foothills surround LPC, and across the city.

For this example, GDP and population were assumed to grow annually at a rate of 3.8% (DFAT, n.d.) and 0.9% (Rambol, 2023), respectively. Annual costs of flooding were discounted to present value terms using a discount rate of 7%.

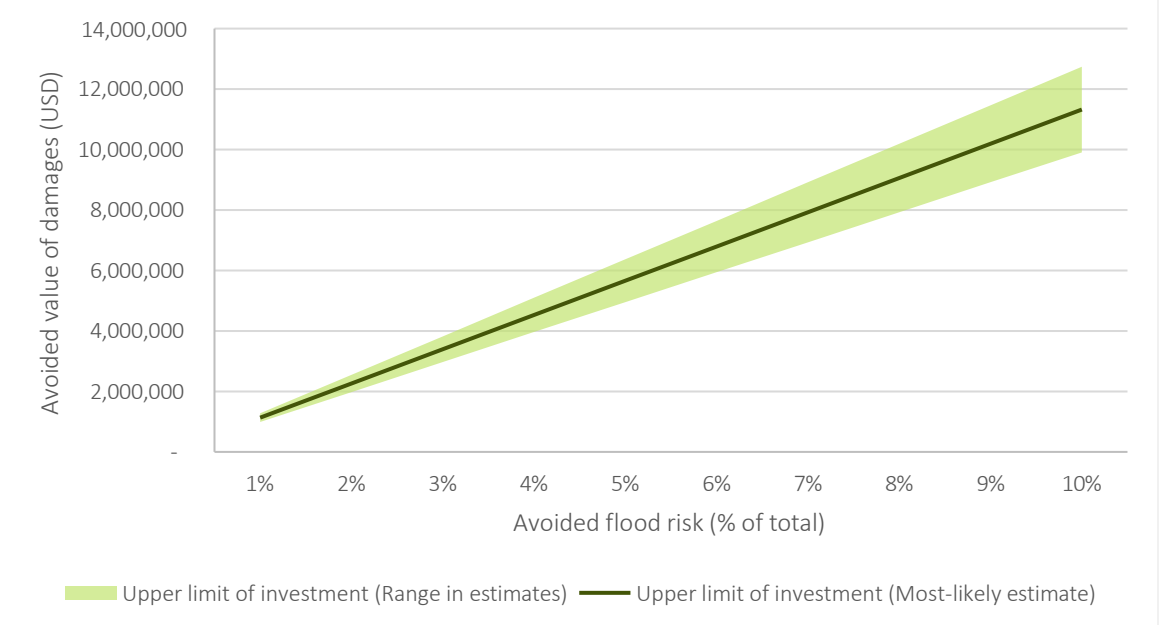

Figure 6. *Linking level avoided costs with level of investment available to address flood risk*

4.2 Case study 2. Urban development encroaching urban waterways in LPC

Summary
LPC's urban waterways are believed to support a limited range of values beyond flood protection. However, several urban waterways across LPC have been encroached by urban development, limiting the flood protection they provide and incidence of localized flooding. Stronger enforcement of the regulations for building near waterways and the protection of existing waterway buffers, may assist to prevent increases to urban flood risk. This is thought to be particularly important given that climate change is expected to increase the frequency and severity of flooding in LPC and because minor recurring flood events can have a significant economic cost.

Definition of the problem

Several urban waterways (i.e. the ecosystem assets) across Luang Prabang have been encroached by urban development. In some cases, these developments are believed to pre-date current planning control. In other circumstances, these developments are believed to have been made contrary to existing regulations.

The encroachment of waterways by urban development may restrict the flow of water during periods of higher-than-normal water level and cause localized flooding. Flow restrictions and flooding are also believed to occur due to blockages from the build-up of rubbish. Enforcing planning controls to maintain existing waterway corridors or "buffers" between waterways and built infrastructure is thought to be required to avoid increasing urban flood risk.

The effects of climate change heighten the need for protecting waterway buffers, with climate change expected to increase the frequency and magnitude of flooding in LPC. The economic cost of relatively small inundation events can be significant, even though they typically cause less widespread damage than larger events, due to the repeating nature of damages and other effects such as continued disruptions to the local community.

Existing values and uses

For the purposes of this case study, we have considered urban waterways to be the natural and constructed drainage channels which make up much of the city's drainage network, but not the larger rivers these channels discharge into. These channels are shown in Figure 7 (p23). LPC's urban waterways are believed to support a limited range of uses and values. In part, this is believed to be due to poor water quality. It estimated that about 10% of households discharge raw sewage directly into waterways. Furthermore, 92% of household release untreated greywater into roadside ditches (ADB, 2023). The existing values (or lack of values) and uses of LPC's urban waterways are described in Table 7, along with expected trends or changes in these values over time.

Figure 7. *Existing drainage system in Zone I and part of Zone II in 2012*

Table 7. *Existing values and uses of natural and constructed drainage channels in Luang Prabang City*

Category	Service	Evidence from mission and other sources	Expected trend (without intervention)
Provisioning	Food (e.g. cultivated crops, fish)	• Urban waterways are not believed to be used for growing food. • Urban waterways are not believed to be used for fishing or aquaculture.	No change—These assets are not believed to be a source of food.
	Water	• Urban waterways are not believed to be a source of drinking water. • Urban waterways can provide water for other purposes (e.g. livestock, crop cultivation, home gardens). It is unclear if, and to what degree this occurs in LPC.	No change—These assets are not believed to be a source of water.
Regulating	Natural hazard protection (e.g. floods)	• Drainage networks aim to prevent stormwater from flowing to low-lying land, and instead direct it into rivers. This contributes to flood prevention. • In 2012, only the World Heritage Area of LPC had a constructed drainage system. This system was believed to have capacity to drain off heavy storm rainwater, when well maintained (BRLi, 2013). • Grey water discharges into drainage channels are reducing capacity for stormwater (BRLi, 2013).	Decrease—In general, further urban development is expected to increase flows into the city's drainage network (e.g. through increased areas of impervious surfaces). Developments which encroach waterways, and restrict capacity, may exacerbate flood risk.
	Climate regulation (e.g. microclimate regulation,	• Waterbodies can assist in cooling the urban environment as can increasing vegetation. Water buffers may provide areas for vegetation to combat urban heat. • Anecdotal evidence suggests LPC is becoming hotter. Public green space makes up less than 1% of the LPC core urban area (ADB, 2023).	Decrease - Further losses of waterway buffers may reduce existing urban vegetation and therefore reduce climate regulation services.
	Pest and disease control	• Degradation of waterways and poor water quality may increase the spread of pests and water relate diseases (e.g., mosquitos, dengue fever). • Flooding can exacerbate the spread of disease by spreading wastewater and contaminating drinking water.	Decrease - Flow restriction to urban waterways due to development and losses to buffer vegetation may exacerbate water quality issues and in turn, prevent pest and disease control.
Cultural	Amenity	• Greywater and sewage discharge as well as rubbish in waterways is believed to contribute to a lack of amenity value being provided by urban waterways. • Reduced waterway buffers also restrict area for vegetation, which can provide amenity value.	Decrease—Further losses of waterway buffers may reduce existing urban vegetation and therefore amenity values.

Management options

As visitor numbers and the local population expand in LPC, the local authorities have a choice as to how they manage the associated urban development. Options for LPC officials include:

- Option 1: Unrestricted developments near urban waterways—Under this scenario, there is only weak enforcement of the regulations for building near waterways leading to new developments which reduce encroach on waterways and reduce the size of waterway buffers. For the purposes of this case study, this represents the base case or 'do nothing differently' scenario.
- Option 2: Restricted developments near urban waterways—Under this scenario, there is strong enforcement of the regulations for building near waterways and existing waterway buffers are protected. This option may also include exploring options to enhance or expand waterway buffers which have been encroached by urban development. For the purposes of this case study, this represents the project case.

Table 8 presents how the level of ecosystem services is expected to change with regulated development, relative to the base case. This assessment assumes that the regulated development scenario will lead to the protection of existing waterways buffer zones, resulting in a lower flood risk for the city. Table 8 highlights that unrestricted developments near urban waterways (option 2) is likely to see most ecosystem service values increase, relative to the base case. This includes flood protection, which is believed to be particularly important given the effects of climate change on flooding.

Table 8. *Expected change in level of ecosystem services with restricted developments near urban waterways (option 2), relative to the base case (unrestricted developments near urban waterways, option 1)*

Category	Service	Description	Expected change
Provisioning	Food (e.g. cultivated crops, fish)	Restricting new urban developments near urban waterways is not expected to impact the provision of food or water, relative to the base case, as urban waterways are not believed to be a source of food or water for the community. Future opportunities to access water or grow food, may be restricted by urban development through reducing access and the size of waterway buffers. However, water quality improvements are likely to be required before such uses occur. This is likely to be driven by improved wastewater management rather than the protection of waterway buffers.	No change
	Water		No change
Regulating	Natural hazard protection (e.g. floods)	Restricting new urban development near urban waterways will assist to maintain existing waterway capacity for stormwater. This will assist with limiting incidence of flooding	Increase
	Climate regulation (e.g. microclimate regulation)	Restricting new urban developments is expected to increase the provision of regulating and cultural services, relative to base case, through maintaining existing vegetation on waterway buffers.	Increase
	Pest and disease control		Increase
Cultural	Amenity		Increase

Evaluation of options

More information is required to determine which of the two options described is preferred. That is, which options provides the highest net-benefit. This includes information related to:

- the additional cost of restricting developments near urban waterways (Options 2) versus not restricting development (option 1), and

- the relationship between building near waterways in LPC and changes in the level of flood risk (and other ecosystem services) in areas across LPC

The costs of damage from recent flood events in LPC may help to illustrate the significant potential cost of allowing developments to encroach waterways and cause or exacerbate incidents of flooding. This information would also be useful for understanding the approximate scale of investment available to intervene (i.e. what are the potential benefits from addressing the problem) and therefore what interventions might be economically viable. How historic costs of damages to houses from flooding can help to illustrate the significant potential cost of allowing development near waterways is illustrated in Box 2, using indicative data, in lieu of estimates from LPC.

Box 2. *Illustrative example – the potential costs of reoccurring minor flood events*

The cost of a minor flood event may or may not be high enough to incentivize efforts to mitigate flood risk. However, when the cumulative cost of these events is considered, a stronger case can be made.

For example, the direct cost of a minor flood event that damages one house in LPC may cost about US$2,400, based on damages equivalent to 10% of the average cost of a house. However, if this is event is expected to occur regularly, say every 2 years, the expected costs related to flooding is much higher than the costs of a single event, being equivalent to US$13,000 over 25 years in present value terms (using a discount rate of 7%). Costs will also escalate as more houses and people are affected. For example, a minor event which occurs every 2 years and damages 5 houses is estimated to have cumulative costs equivalent to US$65,000. An illustration of how cost changes with increases in the number of houses affected and increases in the annual likelihood of flood events is shown in the figure below.

Importantly, there is likely to be additional impacts associated with floods that go beyond direct damages to houses or other infrastructure. For example, indirect costs such as cost related to cleaning up after a flood event, and travel disruptions. Costs can also be occurred through impacts on people health due to factors such as additional stress. Factoring in these additional costs will increase the expected cost of flood events and increase the incentive to mitigate flood risk

For this example, the average cost of a house in Lao is assumed to be US$22,400. This is based on an estimate provided by the World Bank (2021), indexed to 2023 dollars-based World Bank (n.d.).

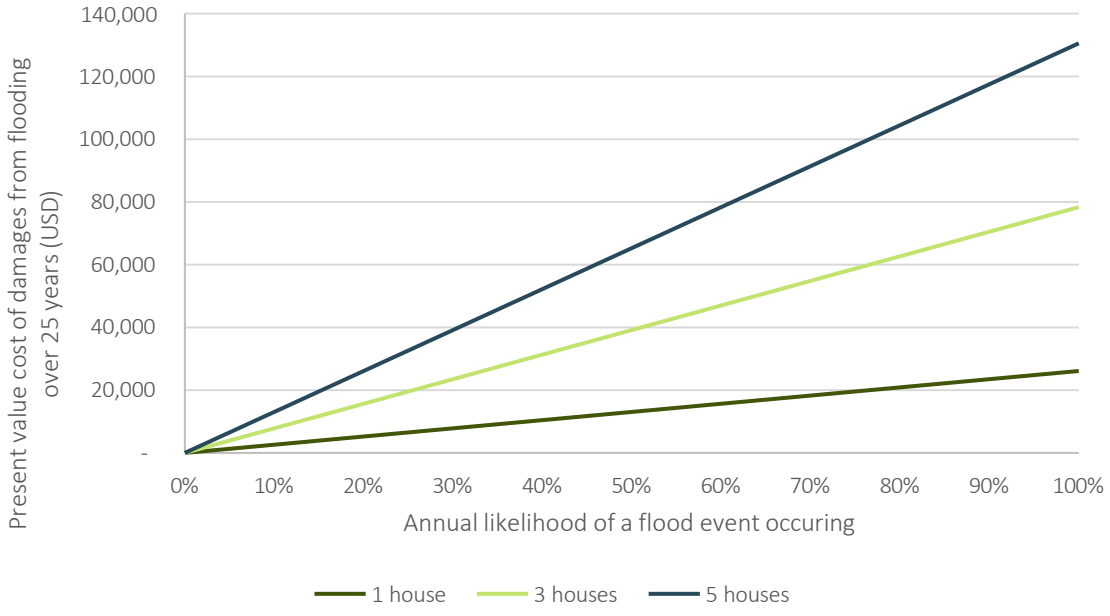

Figure 8. *Cost of flooding for different likelihood and scale scenarios*

4.3 Case study 3. Protecting and restoring wetland ponds in LPC

Summary
Degradation and infilling of wetland ponds in LPC is contributing to a loss of ecosystem services, including cultural heritage values and flood protection. Protecting wetland ponds from urban development and taking steps to improve their environmental health is expected to increase the level of ecosystem services they can provide. Based on a cost-benefit analysis undertaken by WSCA and ICEM (2024), using NbS to protect and restore a set of wetland ponds in LPC could deliver $8.4 worth of benefits for every $1 invested. However, the value of benefits will vary by site.

Definition of the problem

LPC is home to a network of waterways and ponds (Figure 9). These wetland ponds were dug in the 19th century and are part of the city's high value cultural heritage (Department of Luang Prabang Heritage Office, 2019).

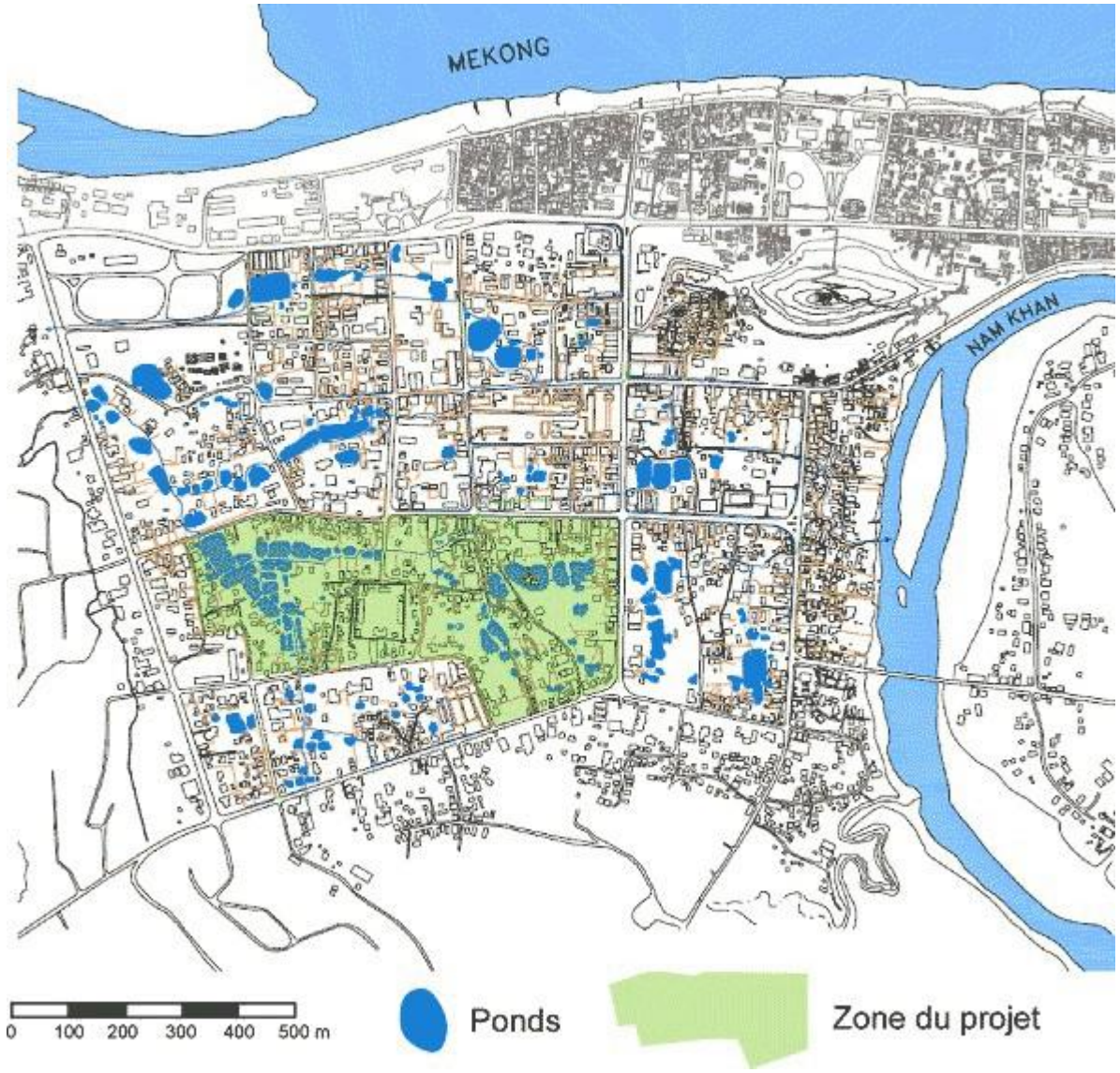

Figure 9. *LPC's network of interconnected urban ponds (GRET, n.d.)*

Wetland ponds (i.e. the ecosystem asset) deliver a range of important ecosystem services. They absorb and retain water helping to reduce incidence of flooding, act as a natural water filter contributing to pollution control and provide a space for farming fish and vegetables (Department of Luang Prabang Heritage Office, 2019).

LPC's wetland ponds are disappearing with only 80 of the 183 ponds that existed in 1999 remaining. Some wetland ponds have been infilled and used for urban development (e.g. Figure 10), while others have dried out due to reduced water inflows. The health of the remaining wetland ponds is also suffering from inflows of wastewater from urban areas and the build-up of weeds and silt (WSCA and ICEM, 2024). LPCs wetland ponds are under a mixture of private and public ownership, further complicating their management and use.

Population growth and urban expansion is expected to place further pressure on LPC's remaining wetland ponds due to increased pollution entering the ponds and increased demand for land. Protecting and maintaining the remaining ponds will ensure they can continue to deliver ecosystem services to the community. Furthermore, enhancing the pond network may assist in mitigating the impacts of climate change, which without intervention is expected to increase the frequency and magnitude of flooding in LPC.

Figure 10. *Top: Pond site under private ownership in the process of being converted from a vegetated pond to a new commercial development (understood to be a restaurant and accommodation) (photo Alluvium February 2024, inset map from GRET 2024)[1]. Bottom: Google Streetview image of the same pond from January 2016 (Google 2024[2]).*

Existing values and uses

Wetland ponds in LPC can provide a range of existing uses and values. These are described in Table 9, along with an assessment of the expected trend or changes in these values over time. This analysis builds on the existing uses of the Ban Mano wetland documented by WSCA and ICEM (2024).

Table 9. *Existing values and uses of wetland ponds in Luang Prabang City*

Category	Service	Evidence from mission and other sources	Expected trend (without intervention)
Provisioning	Food and other produce	• Wetland ponds can be used to produce aquatic animals like fish, snails, and frogs, and vegetables (e.g. morning glory and water spinach).	Decrease – Population growth and urban expansion is expected to place further pressure on LPC's remaining wetland ponds due to increased

[1] Refer https://gret.org/en/projet/sanitation-and-integrated-management-of-urban-hydrosystems-in-luang-prabang/, accessed 20/08/2024.
[2] Refer https://www.google.com.au/maps, accessed 20/08/2024

Category	Service	Evidence from mission and other sources	Expected trend (without intervention)
		• Wetland ponds can also be used to produce ornamental plants.	pollution entering the ponds and increased demand for land. This is expected to decrease the levels of ecosystem services being provided.
Regulating	Water treatment	• Wetland ponds can provide water treatment services. This includes assisting to treat wastewater entering via the urban drainage network. • Discharges into ponds can include greywater and blackwater.	
	Flood mitigation	• Wetland ponds can absorb and retain water reducing incidence of flooding.	
	Climate regulation (thermal regulation and greenhouse gas absorption)	• Water features can have a cooling effect on surrounding areas. This can assist with managing urban heat. • Vegetation in and around wetlands ponds will sequester carbon dioxide.	
Cultural	Amenity	• Public access to wetland ponds is expected to provide amenity value to local communities. • Existing regulations require a 1.5-meter walkway between canals and wetland ponds and private property. Access tracks increase connectivity between different areas of the city for residents and tourists.	
	Recreation and tourism		
	Cultural heritage	• Wetland ponds are believed to contribute to LPC's cultural heritage.	

Management options

Local authorities have a choice as to how they manage wetland ponds into the future. They include:

- Option 1: Limited protection for wetland ponds - Under this scenario, wetland ponds are provided no additional protection to prevent against infill for development or from receiving increased levels of wastewater as the city's population, number of visitors, and levels of urban infrastructure grow. For the purposes of this case study, this represents the base case or 'do nothing differently' scenario.
- Option 2: Protection and restoration of wetland ponds - Under this scenario, regulations are in place and enforced to prevent further ponds being infilled for development. Efforts are also taken to improve the environmental health (including water quality) of the remaining wetland ponds. This may include work to restore vegetation, control invasive species, and to reduce the volume of pollutants entering the wetland ponds. For the purposes of this case study, this represents the project case.

Table 10 presents how the level of ecosystem services is expected to change with protection and restoration of the remaining wetland ponds in LPC, relative to the base case. This assessment assumes that environmentally healthier ponds can provide a higher level of ecosystem services than less healthy ponds.

Table 10. *Expected change in level of ecosystem services with protection and restoration of wetland ponds (option 2), relative to the base case (business as usual, option 1)*

Category	Service	Description	Expected change
Provisioning	Food and other produce	Degraded wetland ponds with poor water quality are not believed to be used by local communities to produce food. Preventing the loss of wetland ponds and improving their environmental health is expected to increase the production of food and other produce.	Increase
Regulating	Water treatment	Preventing the loss of wetland ponds and improving their environmental health is expected to increase their ability to provide regulating services such as water treatment and climate regulation. Preventing the build-up of silt and weeds is likely to increase capacity for flood mitigation.	Increase
	Flood mitigation		Increase
	Climate regulation (thermal regulation and greenhouse gas absorption)		Increase
Cultural	Amenity	Preventing the loss of wetland ponds and improving their environmental health is expected to increase their ability to provide cultural services, including cultural heritage value. Ensuring walkways around ponds are in place will support amenity values and recreational opportunities for local communities and tourism.	Increase
	Recreation and tourism		Increase
	Cultural heritage		Increase

Implementing option 2 is expected to see the level of ecosystem services being provided by wetland ponds increase. Where ponds are publicly owned, the broader community is expected to receive much of the benefit. Where ponds are privately owned, the owners are expected to receive a higher proportion of the benefits. Implementing option 2 is expected to require working closely with private owners of wetland ponds.

Evaluation of options

Estimating the costs and benefits of restoring and protecting wetland ponds across LPC requires more information and data on the current condition of wetland ponds throughout the city and on the types of interventions required.

WSCA and ICEM (2024) prepared a case study report on using NbS to restore and protect the Ban Mano Wetland in LPC. This case study includes a cost-benefit analysis (CBA), which illustrates the potential benefit from a standalone project. This case study and its CBA is described in Box 3.

Box 3. *Benefit-cost analysis of using NbS to restore Ban Mano Wetland in LPC (WSCA and ICEM, 2024)*

Water Sensitive Cities Australia (WSCA) and the International Centre for Environmental Management (ICEM), in collaboration with GRET and the Ministry of Natural Resources and the Environment (MONRE), prepared a case study report about using NbS to restore and protect the Ban Mano Wetlands in LPC. The location of the Ban Mano Wetlands is shown in Figure 11.

Figure 11. *Ban Mano Wetlands Cluster within LPC (GRET, 2022)*

The report includes a CBA to estimate the net-benefit of applying NbS to the Ban Mano wetlands in LPC. The CBA focuses on a hypothetical project to use NbS to enhance Public Pond 70 and to 2 hypothetical, privately owned ponds upstream of Pond 70. The CBA used a 4% discount rate and estimated benefits over 20 years. The estimated present value of benefits, relative to the base case are present in Table 11.

Table 11. *Estimated present value of benefits of applying NbS to the Ban Mano wetlands in LPC ($US)*

Pond	Benefit	USD
Pond 70	Improved water quality	$64,900
	Reduced flood risk	$72,501
	Improved amenity	$62,708
Private Pond 1	Improved water quality	$16,225
	Reduced flood risk	$9,063
	Higher income from sales of higher value-added produce	$2,958
	Biodiversity preservation	$61
	Improved thermal regulation	$538
Private Pond 2	Improved water quality	$24,337
	Reduced flood risk	$9,063
	Higher income from sales of higher value-added produce	$2,958
	Biodiversity preservation	$123
Total		**$265,435**

The CBA estimated the project as having a net present value (NPV) of $233,656. This represents the net- benefit of the project when benefits are compared to costs. The CBA also estimated the project's benefit-cost ratio (BCR) to be 8.4. This indicates that every $1 invested is expected to generate $8.4 worth of benefits. It is suggested that broader consultation is required to refine the concept design, and to improve understanding of the costs and benefits.

Based on the case study developed by WSCA and ICEM, there appears to be significant scope to use NbS to enhance wetland ponds in LPC and to deliver benefits and improve outcomes for local communities Furthermore, WSCA and ICEM suggest that an integrated network of projects is expected to deliver greater return than standalone projects. This is true about the flood benefits of these assets, as a catchment

view where the interconnection and design of the wetland ponds as a system is needed to maximize their flood risk mitigation potential (and value).

The findings by WSCA and ICEM are in line with the findings from other studies. For example, Brander et al (2022) conducted a CBA of 4 urban wetland restoration projects in central and southern provinces of the Lao, PDR. The results showed that benefits exceeded costs for 3 of the 4 sites. For these sites, the BCR's ranged from 2.0 to 10.4.

The results from Brander et al indicate that the use of NbS may not be appropriate at all locations (i.e. the benefits at one of the projects sites were less than the costs of wetland restoration), and that some sites will provide a much higher level of benefits relative to costs than others. The application of NbS at the sites which generate the highest level of benefits should be prioritized.

Conclusions

The existing ecosystem health of Luang Prabang City and the extent to which its functional diversity and general biodiversity is maintained directly affects the degree to which they can provide valuable goods and services to the urban dwellers of LPC. One critically important consideration is that these ecosystems and the services that they generate in Luang Prabang City cannot be viewed in isolation. The delivery of goods and services from natural systems is dependent not only on the condition of the ecosystem but also its functional linkages to associated ecosystems.

The potential for ecosystem services valuation to influence policy will depend on various contextual and procedural factors integrated in the process. A clear policy question and objective is necessary to trigger robust ecosystem services valuation of Luang Prabang City. In addition, it is also recommended that this be based on a local demand for ecosystem services valuation and assessment, including strong local partnerships and stakeholder engagement, that allows discussion of the assumptions behind value calculations and dialogue regarding the perceived values of the services presented.

Finally, this report provides a high-level overview of the ecosystem services being provided by ecosystems in and around LPC. It also highlights how weak regulation of urban development may reduce the delivery of ecosystem services, including flood mitigation, and leave the city less prepared to handle the effects of climate change.

A potential opportunity exists for LPC to use broader, city-wide approaches to address urban flood risk. This includes options for stronger regulation of urban development to protect ecosystem assets, such as forest and waterway buffers in and near the city. In addition to site specific actions, these types of city-wide approaches, and the preservation of natural assets, should be considered as part of future urban flood management plans.

This contention was explored through the lens of three case studies, which considered the value and risks associated with:

- Case study 1: Unregulated development of the land in the foothills surrounding LPC
- Case study 2: Urban development encroaching urban waterways in LPC
- Case study 3: Protecting and restoring wetland ponds in LPC

These case studies indicate that the use of NbS to address flood risk in LPC may provide additional benefits to the community in comparison to hard infrastructure alternatives or 'do nothing differently' scenario (e.g. ack of planning and enforcement to prevent land use change). As was illustrated in the case studies, the preservation and enhancement of natural systems has the potential to reduce flood risk, while also providing co-benefits such as food, climate regulation, and tourism services. Furthermore, NbS may also provide the opportunity to manage multiple issues for the city concurrently (e.g. flooding and urban heat).

Based on these findings, it is recommended that the Integrated Climate Resilient Flood Management Strategy being developed for LPC include actions that support:

- Regulating development, with planning controls more strongly enforced to reduce urban encroachment resulting in loss of forested and agricultural land.
- Restricted developments near urban waterways and protect existing waterway buffers to preserve the flood protection (and other) values they provide.
- Protection and restoration of wetland ponds to prevent further ponds being infilled for development and maintain their drainage and flood protection function.

To gain a better understanding of the cost of 'do nothing differently' and the benefits of intervening to enhance climate resilience, continued efforts to collect and create relevant data and information is recommended. This includes data and information related to the cost and effectiveness of intervention options, and how interventions will change the level of ecosystem services being provided.

- Based on the consultation with stakeholders, suitable data may exist to better understand the costs associated with flooding in LPC. This data is expected to be useful for making a strong argument for the

need for interventions that build climate resilience.

- Data related to other ecosystem services being provided that are specific to the LPC region is believed to be less available. Prioritizing collecting data on the ecosystem services which are expected to see the most material change in value under a given scenario, will help to limit the amount of data required to undertake future ecosystem services valuation studies.

References

ADB (2010). Greater Mekong Subregion Biodiversity Conservation Corridors (RRP REG 40253). Supplementary Appendix B: Valuation of Ecosystem Services of Biodiversity Conservation Corridors in Cambodia, Lao PDR and Viet Nam.

ADB (2023). Urban Environment Improvement Investment Project (RRP LAO 53203). Secor Assessment (Summary): Water and other urban infrastructure services

Bouttavong, S., Emerton, L., Kettavong, L.,Manivong, S., and Sivannavong, S. (2002). Lao PDR Biodiversity: Economic Assessment

Brander, L., Luangmany, D., Guisado Goñi, V., Ho, Y., and Eppink, F. (2022) Economic Valuation of Ecosystem Services from Urban Wetlands in Lao PDR under Climate Change

BRLi (2013). Master Plan. Drainage and Sewerage System.

Department of Foreign Affairs and Trade [DFAT] (n.d.). Laos country profile and action plan

Department of Luang Prabang Heritage Office (2019). The wetlands restoration program. Egis

(2022). LAO: Urban Environment Improvement Investment Project. Main Report Emerton, L.

(2013). The Economic value of Ecosystem services in the Mekong Basin

Fabis Consulting. (2018) Common International Classification of Ecosystem Services (CICES) V5.1. Guidance on the Application of the Revised Structure.

GRET (n.d.). Wise - Protecting and rehabilitating urban ponds in Luang Prabang. Field Project.

GRET (2022). Wetland Improvement and Sanitation Enhancement Project – Wise. Sanitation study in Ban Mano ENHANCEMENT PROJECT - WISE

Government of Lao People's Democratic Republic (2018). Post disaster needs assessment 2018 floods Lao

Government of Lao People's Democratic Republic (2010). Strategy on Climate Change of the Lao PDR

MRC (2023). Economic Analysis of Nature-based Solutions for Flood and Drought Resilience of the 9C-9T Sub- basin Report.

Ramboll (2023). Luang Prabang Smart and Integrated Urban Strategy

Royal HaskoningDHV (2024). Freshwater Nature-Based Solutions in the Mekong Sub-Region.

Siikamäki, J., Santiago-Ávila, F., and Vail, P (2015). Global assessment of non-wood forest ecosystem services

Talbeth, J. (2015). Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Lao PDR World

Bank (2021). Environmental Challenges for Green Growth and Poverty Reduction: A Country Environmental Analysis for the Lao People's Democratic Republic

World Bank & FAO (2012). Lao People's Democratic Republic Rice Policy Study

World Bank (2018). Promoting REDD+ through Governance, Forest landscapes & Livelihoods in Northern Lao PDR

World Bank (2019). Recovery and Resilience in Lao PDR.

World Bank (n.d.). Inflation, GDP deflator (annual %) - Lao PDR.

APPENDICES

Appendix A: Overview of the field mission

Overview of Activities

Table 12. *Overview of the activities undertaken as part of the economics field mission*

Time	Activity
Day 1	Stakeholder workshop with 25 participants from 17 organizations. A list of participants and a meeting agenda is provided in Appendix A.
	Meeting with the Provincial Office of Natural Resources and Environment (PONRE) and District Office of Natural Resources and Environment (DONRE).
	Meeting with the Provincial Agriculture and Forestry Office (PAFO) and District Agriculture and Forestry Office (DAFO)
Day 2	Meeting with the Department of Public Works and Transport (DPWT)
	Meeting with the Department of Public Health (DPH)
	Meeting with the Department of Information, Culture and Tourism (DICT)
	Visit to site 1
	Visit to site 2
	Visit to site 3
Day 3	Meeting with Department of Labour and Social Welfare (DLSW)
	Meeting with Department of Planning & Investment (DPI)
	Meeting with Urban management and service office LPC

Stakeholder Workshop

A stakeholder workshop was held on the 30th of July 2024 at the DIC office to provide stakeholders with an overview of the economic field mission objectives and to finalize the mission plan. The details of the workshop are provided below, which includes a list of participants (Table 13) and the workshop agenda (Table 14).

Table 13. *Workshop participants*

No.	Organizations	Number of participants
1	DWR	3
2	UNDP	2
3	Alluvium/HTC	2
4	PONRE	4
5	PAFO	1
6	DPWT (Public work and Housing)	2
7	DICT	1
8	Dept of Industry and Commerce	1
9	DPH	1
10	World Heritage Office	1
11	DONRE	1
12	DAFO	1
13	Industry and Commerce Office	1

No.	Organizations	Number of participants
14	Public Work and Transportation Office	1
15	Public Health Office	1
16	Information, Culture and Tourism Office	1
17	Souphanouvong University	1
Total number of participants		25

Table 14. *Workshop agenda*

Time	Item	Method	Who
8:00-8:30	Registration	n/a	All
8:30-8:45	Welcome and opening statements	Opening statements	PONRE – Director & DWR - Deputy Director General
8:45-9:00	Presentation on IWRM project overview and objective of the mission	Presentation	UNDP/DWR
9:00-9:30	Overview of project's economics component, including ecosystem services and economic valuation	Presentation	Consultant team
9:30-10:00	Facilitated discussion related to the available data and information	Discussion	Consultant team
10:00-10:30	Coffee break	n/a	All
10:30-11:40	Continue discussion	Discussion	All
11:40-12:00	Closing remark	Closing statement	Chairperson

Appendix B: Glossary of Terms Used

Amenity: A feature that enhances the comfort, convenience, or attractiveness of a place, often linked to the enjoyment or well-being of people (e.g., parks, recreational facilities).

Benefit-cost ratio: The ratio of the total benefits against the total costs of the project, with future values discounted to present value terms.

Cost-benefit analysis (CBA): A method for assessing the merit of an investment by comparing the monetary value of the benefits against the costs incurred for the proposed project.

Discount rate: The rate of return used to discount future cash flows back to their present value. provided by ecosystems in LPC

Ecosystem services: The benefits (goods and services) derived by humans from the environment.

Ecosystem Services Framework: A structure for identifying, categorizing and valuing the benefits provided by ecosystems.

Ecosystem-based Adaptation (EbA): A nature-based strategy for adapting to the impacts of climate change, leveraging biodiversity and ecosystem services to reduce vulnerability and increase resilience.

Microclimate: The local climate of a small, specific area that may differ from the surrounding region, influenced by factors such as vegetation, water bodies, and urban infrastructure.

Nature-based Solutions (NbS): Actions to protect, sustainably manage, and restore natural and modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature.

Net present value: Discounted value of benefits less the discounted value of costs for an investment or project.

Provisioning Service: Ecosystem services that provide direct material benefits, such as food, water, timber, and medicinal resources.

Regulating Service: Ecosystem services that help regulate environmental conditions, such as climate regulation, water purification, and flood control.

IWRM-EbA Project

Project Management Unit

Department of Water and Resources (DWR)

Ministry of Natural Resources and Environment (MONRE)

laoiwrm-eba.com

iwrm.eba@gmail.com

IWRM-EbA Project

IWRM - EbA Project