Final Report: TEEBAgriFood Uganda Study for Mabamba Bay Wetlands

Scenario Analysis Based on the TEEBAgriFood Evaluation Framework of Policies for Urban and Peri-Urban Agriculture and Wetland Restoration for the Mabamba Bay Wetland System in Uganda.

March 2021

Acknowledgements

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The research for this report involved bilateral discussions with a range of government stakeholders, local authorities, business operators and individuals impacted by the Mabamba Bay Wetland System, as listed in Annex 1.

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Study Background

I. Global overview of the TEEBAgriFood Initiative

The Economics of Ecosystems and Biodiversity for Agriculture and Food programme (TEEBAgriFood) was developed to apply whole systems thinking to the economics of agriculture, which is concerned with complex and extensive eco-agri-food value chains - from supporting ecosystems, to productive farms, to intermediaries such as aggregators, wholesalers and retailers, to food and beverage manufacturers, to distributors and consumers.

The true economics of agriculture can only be understood after recognizing and accounting for all significant "externalities" along these value chains. In eco-agri-food systems, these externalities include the huge but hidden costs and benefits of agriculture and food systems, which need to be unravelled, understood, and evaluated if the world is ever to be able to work out how to feed and nourish billions of people in a manner that provides everyone with adequate nutrition, in an equitable manner, without seriously damaging ecological security or environmental sustainability.

The TEEBAgriFood Evaluation Framework[1], developed through collaboration with over 150 scholars from 33 countries representing a wide range of disciplines, backgrounds and perspectives, has been designed to guide the evaluation of food systems and their complex linkages to the environment, society and human health.

To create real change, this scientific framework of analysis has been applied at the ground level, to influence policies and practices. TEEBAgriFood is currently applying two major multi-country and multi-year applications, funded by the EU Partnership Instrument (Brazil, China, India, Indonesia, Malaysia, Mexico, and Thailand) and the International Climate Initiative (IKI) of the German Environment Ministry (Colombia, Kenya, Tanzania, and Thailand). To expand on the number of TEEBAgriFood country applications and using limited flexible funding, a pilot "lite" application in Uganda was undertaken over six months. The study is coordinated by the Nile Basin Initiative (NBI) in collaboration with national and local government agencies, local research institutions and private sector businesses and networks.

II. Regional overview of the Nile Basin Initiative

The Nile Basin Initiative (NBI) is an intergovernmental partnership of 10 Nile Basin countries, namely Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda. Eritrea participates as an observer. NBI was established on 22nd February 1999, as an all-inclusive basin-wide institution responsible for providing a forum for consultation and coordination among the Basin States for the sustainable management and development of the shared Nile Basin water and related resources for win-win benefits. The shared vision objective of the Nile Basin Initiative is to achieve sustainable socio-economic

[1] TEEBAgriFood Evaluation Framework: http://teebweb.org/our-work/agrifood/understanding-teebagrifood/evaluation-framework/

development through the equitable utilization of, and benefit from, the common Nile Basin water resources. The highest decision and policy-making body of NBI is the Nile Council of Ministers (Nile-COM), comprised of Ministers in charge of Water Affairs in each NBI Member State. The Nile-COM is supported by the Nile Technical Advisory Committee (Nile-TAC), comprised of 20 senior government officials, two from each of the Member States.

III. Key events leading to the selection of Mabamba Bay Wetland System and Urban and Peri-Urban Agriculture for this study.

The Uganda TEEBAgriFood project applies the TEEBAgriFood analytical framework on the ground, and was first introduced at the Regional TEEBAgriFood Symposium for Africa in February 2021[2] at which UNEP and Ugandan stakeholders (including Ministry of Water & Environment, and the National Environment Management Authority) discussed the policy and modalities scoping for the study.

The symposium considered five options that had been identified through a desk policy review of national priorities for sustainable eco-agri-food systems, including:

(i) Sustainable livestock sector development
(ii) Sustainable urban/peri-urban agriculture (UPA) development
(iii) Wetlands restoration and regeneration
(iv) Sustainable shea commodities production
(v) Sustainable Gum Arabic production and development

The consensus was that policy options on wetland restoration (iii) and sustainable urban and peri-urban agriculture (ii) aligned strongly with national priorities concerning the sustainable management of wetlands and the country's environmental conditions, and specifically the National Development Plan III. A dedicated stakeholder consultation workshop on May 18th 2021[3] refined the purpose of the evaluation, the spatial scale and scope of the value chain, and the general terms of reference of the study based on the Mabamba Bay Wetland System. The workshop was namely attended by stakeholders representing the Ministry of Water and Environment, the National Environmental Management Authority, the National Forestry Authority, the Ministry of Finance, the Kampala Capital City Authority (KCCA), Makerere University, the Food and Agricultural Organisation of the United Nations (FAO), and the International Union for the Conservation of Nature (IUCN).

IV. Overview of the Mabamba Wetland System

Mabamba Wetland System is a permanent wetland located in central Uganda about 35 kilometres south-west of Kampala, the capital city of Uganda. The wetland borders the northern-most shores of Lake Victoria through a long and narrow bay, and acts as a sedimentation and siltation buffer for water discharge into the lake. It plays an important

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[2] TEEBAgriFood Africa Regional Symposium, February 2021: http://teebweb.org/news-and-training/events/teebagrifood-regional-symposia-2021/
[3] TEEB AgriFood Uganda Project Scoping Workshop, May 2021: http://teebweb.org/wp-content/uploads/2021/08/1-TEEBAF-UG-Scoping-Workshop-Outcome-Report.pdf

hydrological role for the ecosystem, as well as providing numerous ecosystem services for the natural environment and local communities. Such include food security through small-scale agriculture, fisheries activities, a source of raw materials for local crafts and medicinal purposes, and a cultural site promoting ecotourism.

Although the Mabamba Wetland System generates considerable amounts and value of ecosystem services and was hence designated a Ramsar site and Important Bird Area (IBA) in 2006, the wetland has experienced increased degradation pressure from 2015 onwards. The main causes of wetland loss and degradation included agricultural encroachment, population growth and urbanization, unsustainable resource extraction, infrastructure development and climate change.

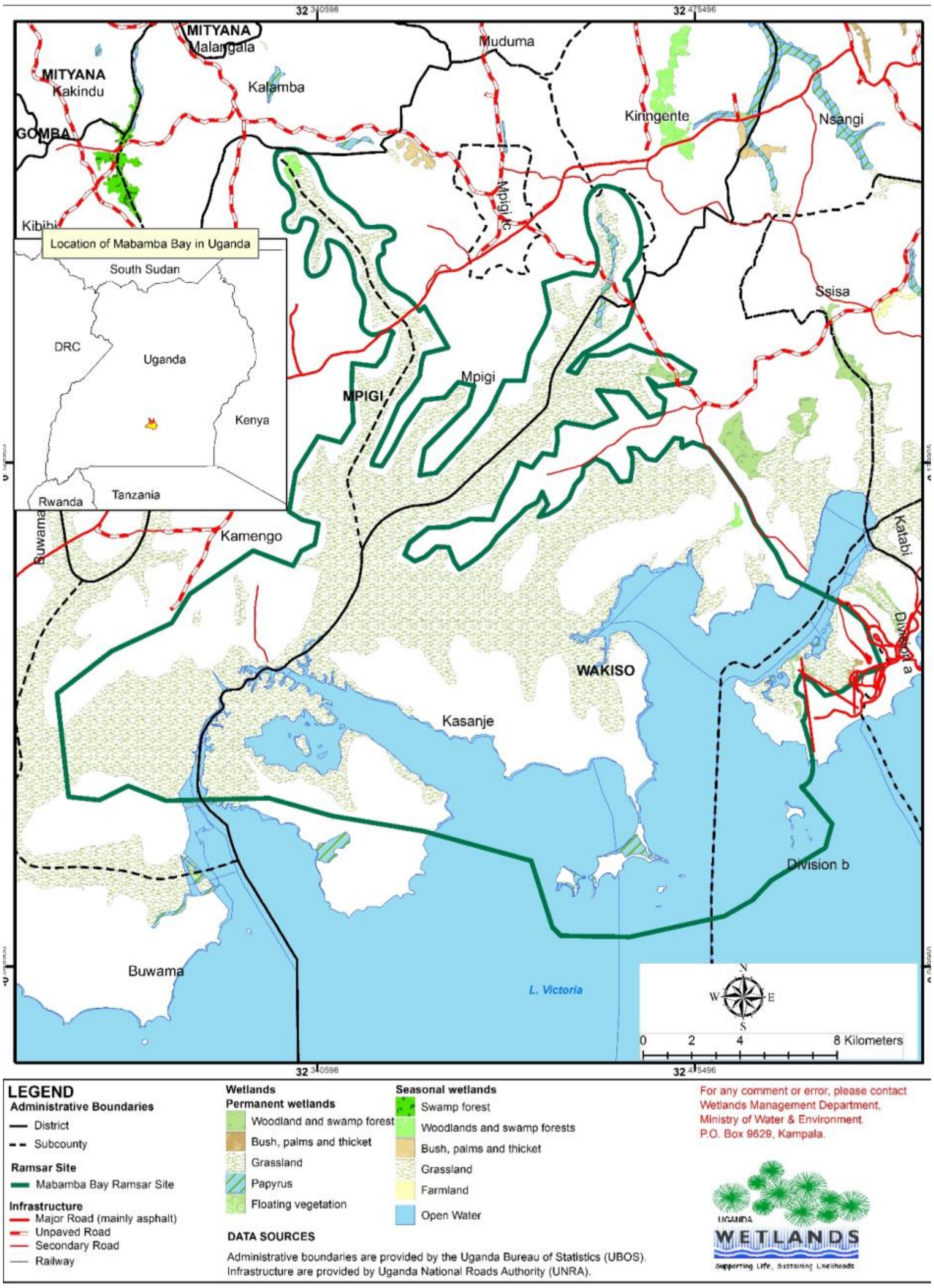

Figure 1: Map of the Mabamba Bay Wetland System

Source: Wetlands Management Department, Ministry of Water and Environment

Box 1: Mabamba Bay Wetland System, Key Facts

- Mabamba Bay is a designated Ramsar Site and Important Bird Area, established on the 15th September 2006.
- Initially 2,424ha in size, the Ramsar site's size was revised in 2021 to include contiguous wetlands in Ssisa sub-county. The Ramsar site now encompasses 22,375.4ha.
- Mabamba Bay is situated in the Lake Victoria Regional mosaic biogeographic zone, and exhibits a tropical climate with predominately a wooded savannah. The Wetland System is adjacent to the complex papyrus swamp in a medium altitude semi-deciduous moist forest.
- The current rate of wetland loss at Mabamba is ±0.367% per annum, calculated using remote sensing data in 2015.
- Mabamba Bay regularly supports over 200,000 waterbirds annually, and regularly supports over 10% of individuals of a waterbird species population (White-winged Black Tern, *Chlidonias leucopterus*).
- Mabamba Bay acts as a refuge for birds of conservation interest, including the globally threatened Shoebill (*Balaeniceps rex*), large congregations of migrant birds such as the Blue Swallow (*Hirundo atrocaerulea*), White winged Tern (*Chlidonias leucopterus*), Gull-Billed Tern (*Geloelidon nilotica*) and endemic bird species such as the Papyrus gonolek (*Laniarius mufumbiri*) and the Papyrus Yellow Warbler (*Calamonastides gracilirostris*).

V. Policy, legal and institutional framework

Uganda developed a policy and legal framework for wetlands management in 1995. The national policy operationalized the constitutional provisions for the management and protection of wetlands and other environment and natural resources in the country. The National Environment Act 2019 and the regulations thereof are the specific laws that protect wetlands from encroachment while regulating permitted activities in wetlands. Whereas the policy, legal and institutional framework for wetlands management in Uganda is comprehensive, many challenges to wetlands management in the Mabamba Wetland system were noted in the course of this research. This study hence aimed at conducting scenario analysis based on the TEEBAgriFood Evaluation Framework to understand the types, causes, location and extent of the threats afflicting the Mabamba Wetlands System in Wakiso and Mpigi Districts.

Study Approach and Methodology

VI. The TEEBAgriFood Analytical Framework

The TEEBAgriFood Analytical Framework uses whole systems thinking to guide the evaluation of food systems and their complex linkages to the environment, society and human well-being in order to improve policy and decision making. This study used the framework to evaluate the interactions within the Mabamba Wetland System including bird watching-based ecotourism, various ecosystem services such as sand mining, water transport, fishing, wetland edge cultivation, and the implied livelihood benefits the communities derive from the wetland using a scenarios analysis approach.

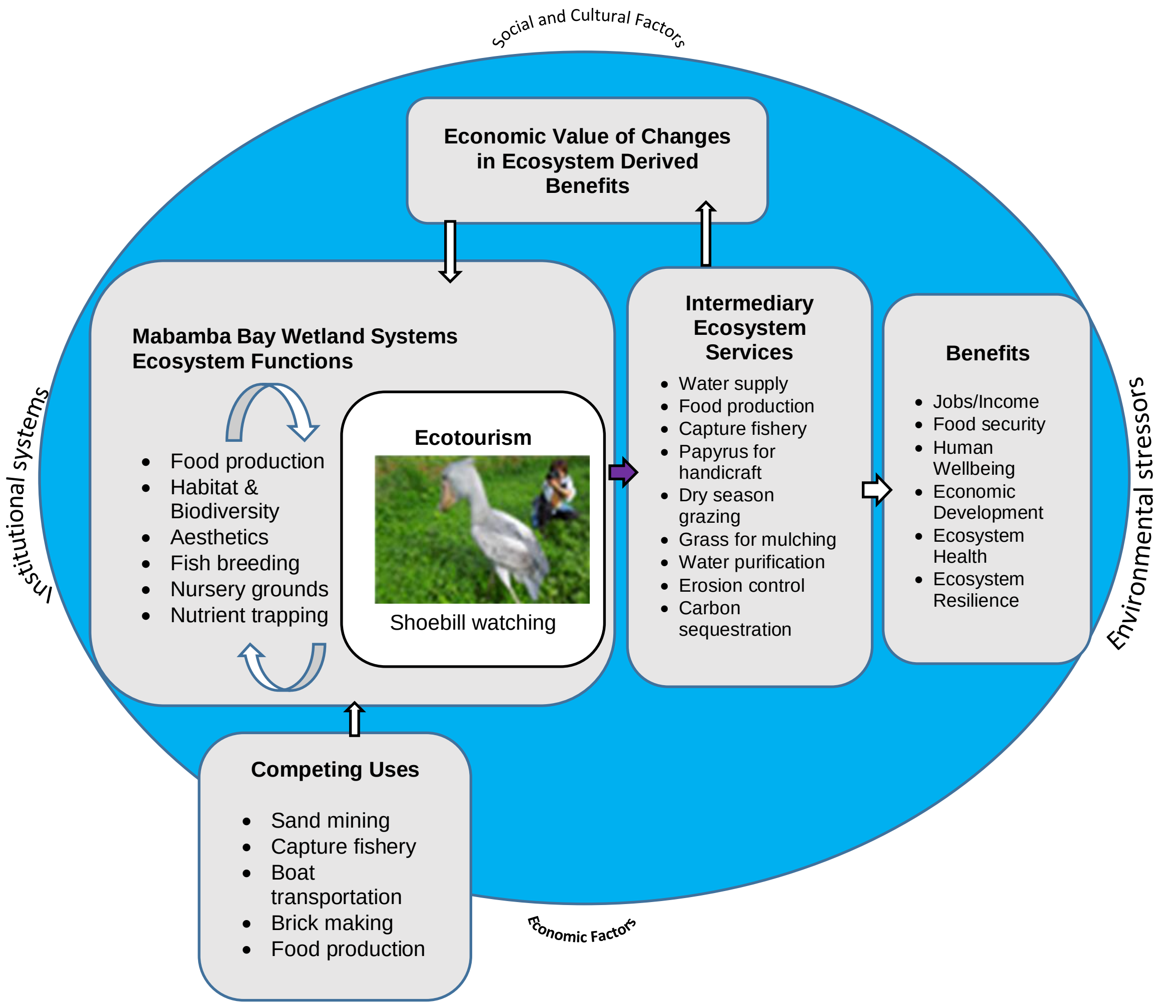

Figure 2: TEEBAgriFood Analytical Framework for the Mabamba Bay Wetland System

VII. Stakeholder engagement

The purpose of the stakeholder mapping and analysis exercise was to identify the interests, beneficiaries and benefits derived from the Mabamba Wetlands landscape. The identification of stakeholders was based on the geographical location of the wetland i.e. engagement of populations and local leaders of areas surrounding the wetland. The primary entry point for stakeholder identification was the local council system. This enabled the research team to identify key players across the 37 villages surrounding the wetland. The other important stakeholders identified during the study included the local government authorities of Kasanje Town Council & Bussi Sub-County (Wakiso district), and Kamengo Sub-County & Mpigi Town Council (Mpigi district). The list of people consulted during the study is included in Appendix I. The study further engaged with the Wetlands Management Department (WMD) in the Ministry of Water and Environment and the National Environment Management Authority (NEMA). Several discussions were held on issues affecting wetlands management in Uganda. The WMD facilitated the study through sharing some data particularly on changes in wetland area and maps on the revised Mabamba Bay Wetland System.

VIII. Valuation of wetland ecosystem services

Economic valuation of key ecosystem services was undertaken to determine the baseline conditions of the wetland system (via the wetland extent and current degradation rate, as inferred from academic literature). The main approach of the study was market analysis and benefits transfer which were the most feasible approaches in view of the limited time and other resources available for the study (Appendices III and IV). Identification of urban and peri-urban agriculture value chains and linkage with Mabamba Wetlands landscape ecosystem services were conducted through literature review, stakeholder consultations and field observations.

The key ecosystem services assessed at this stage included water supply for domestic and livestock use, dry season and wetland edge farming, capture fisheries, breeding, spawning and nursery function, dry season grazing and fodder, grass for mulching, sand mining, water purification and erosion control, carbon sequestration, water transport and biodiversity and habitat values. Individual economic values were computed for each ecosystem service to constitute the baseline value of the ecosystem.

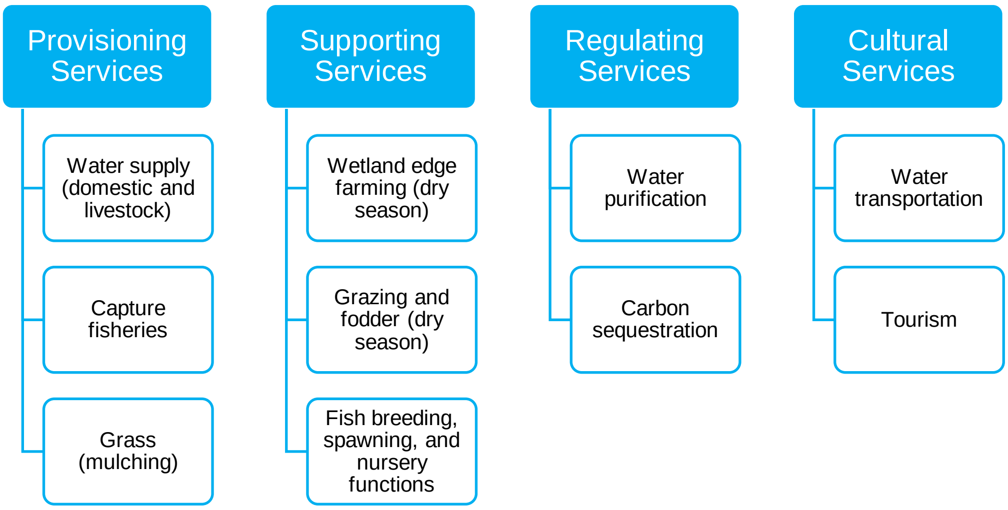

Figure 3: Summary of the ecosystem services assessed in the Mabamba Bay Wetland System

IX. Scenario setting

Using the TEEB 6 step approach (Figure 3), scenario development and modelling is recommended to determine plausible future outcomes of policies and human activities. This is achieved through defining potential outcomes through a participatory and policy-relevant scenario development process, identifying a suitable time horizon for the scenario analysis, and identifying the natural capital and ecosystem services associated with the scenarios. As such, the chosen scenarios allow the TEEB Country Study to provide information on the comparative change of ecosystem services under different scenarios, and over change in time and space.

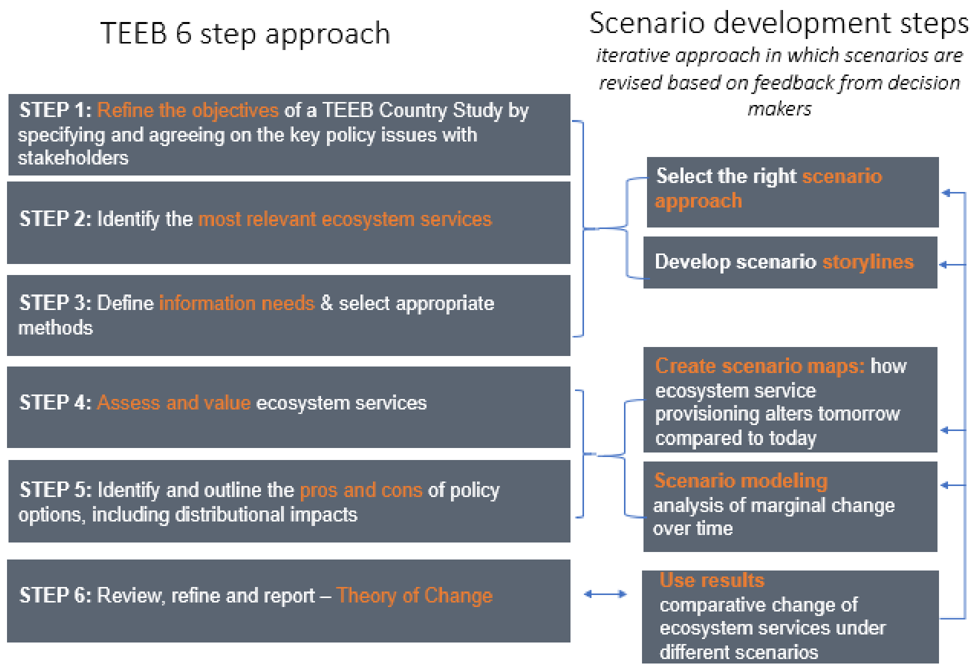

Figure 4: TEEB 6-Step Approach and Scenario Development

This study, in-line with the TEEBAgriFood Framework proposed three scenarios to unravel the possible interactions between natural, produced, human and social capital and the respective flows and value chains in the Mabamba Wetland System with a view to generating knowledge and some consensus on possible actions to address the conservation and development challenges in the wetland system. The three scenarios were (i) the Business-as-Usual (BAU) Scenario, (ii) the Green Scenario, and the (iii) Grey Scenario. The study applied respective rates of wetland loss to the values of ecosystem services to visualize the change impacts on the quantities and value of ecosystem services over a period of 15 years starting from 2021. Three scenarios benchmarked against the National Development Plan (NDPIII) programs on agro-industrialization, infrastructure development and intensification of urban and peri urban agricultural activities and increased ecotourism were constructed with the following characterizations.

Business-as-Usual (BAU) Scenario	Grey Scenario	Green Scenario
• Projected as the baseline conditions of wetland degradation with little, if any, conservation intervention. • Characterised by moderate land cover change, through encorachment, pollution, sand mining, and a reduced capacity of ecosystem service generation.	• Projected as the intensification of agriculture and agro-industrialisation, sand mining, infrastructure development, and population influx without development controls or conservation considerations. • Characterised by high land cover change to arable land.	• Projected by the green growth aspirations in the National Development Plan and National Organic Agriculture Policy. • Reinforced by a strong conservation agenda, policies, enforcement and implementation. • Characterised by low land cover change to arable land.

Figure 5: Summary of the three scenarios for the Mabamba Bay Wetland System

Results and Discussions

X. Analysis of various management scenarios

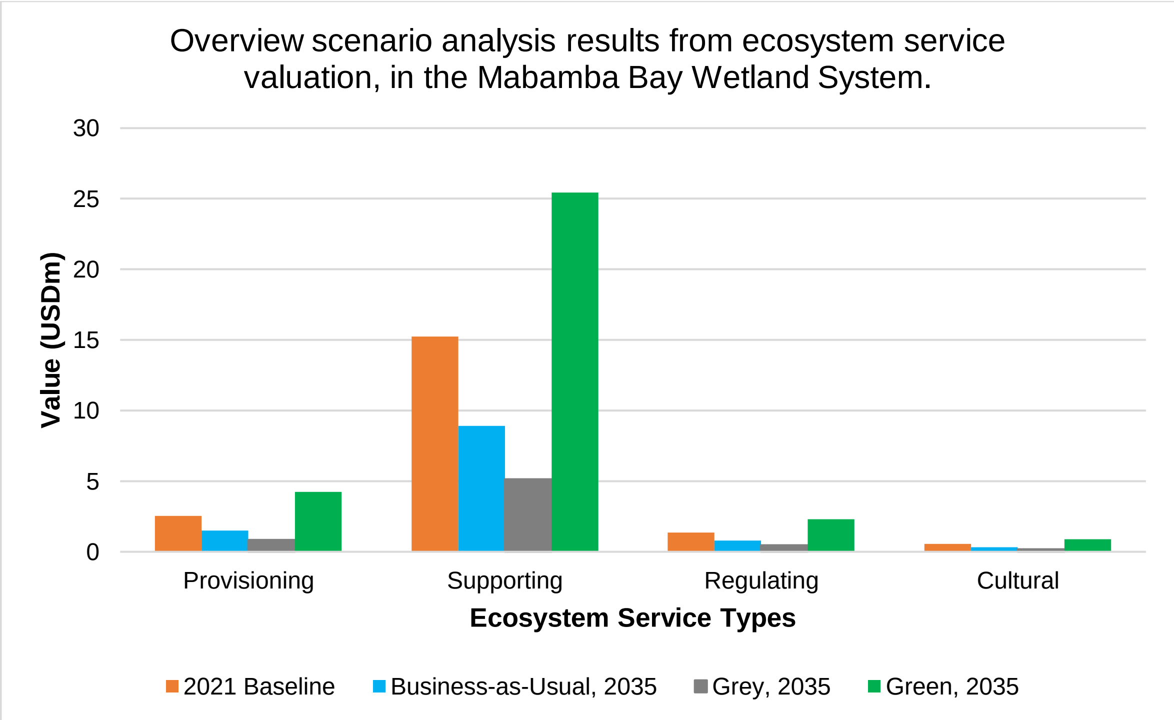

Figure 6: Overview chart of scenario analysis results from the ecosystem services in the Mabamba Bay Wetland System

The analysis of the various scenarios explored the interactions between the various ecosystem services and how such interactions are affecting the integrity of the wetland, its capacity to supply ecosystem services, support to employment, revenue generation, governance and decision making in the short to medium term. The study noted that the Green Scenario is most successful in ensuring sustainability and generating a high revenue potential, however it requires a strong political commitment and an understanding of the role of ecosystem services. The Grey and Business-as-Usual Scenarios will see a potential collapse of most employment sectors and ecological support systems that maintain the economy and livelihoods of the local communities. Additionally, sand mining negatively impacts the integrity of the Mabamba Wetland System, despite its relatively large revenue contribution in the short run. Sustainable tourism that allows communities to benefit from a preserved wetland has good welfare prospects should be promoted instead.

XI. Policy Mainstreaming

The study was able to identify a number of policies at the national and sub-national level providing guidance on environmental and food security management, however relatively limited information on local value chains. The study thereby recommends the following government interventions to improve the development prospects at the local level:

(i) improve the road network in the area;
(ii) expand the electricity grid and improve the efficiency in the provision of power;
(iii) ensure improved access to land and land tenure security;
(iv) ensure improved access to quality agricultural inputs such as seeds, fertilisers, veterinary drugs and agro-chemicals;
(v) improve agricultural marketing;
(vi) increase the effectiveness and efficiency of the agricultural extension system;
(vii) create and support the development of community based organisations so that people can effectively and profitably participate in the supply chains of the various enterprises in the area.

More widely, the study conducted at Mabamba Bay supports and evidences the commitment of Uganda and international partners to promote the international environmental conservation agenda. Such include the national outcomes on the UN Food Systems Summit (September 2021) where Uganda committed to improving its compliance to environmental protection policies and legislation especially on wetland use and management, meanwhile establishing sustainable food systems in the context of urban and peri-urban agricultural production. At a greater scale, the study contributes to the onset of the UN Decade on Ecosystem Restoration (2021-2030) and the Agenda 2030 on Sustainable Development, by providing the preliminary economic evidence to suggest increased conservation and wetland recovery may promote long-term economic viability for livelihoods and ecological support services.

Future project extension opportunities involve the continued inventory and documentation of ecosystem-specific datasets and the capacity building in spatial analysis techniques, to deliver national-level programs on ecosystem classification and the modelling and mapping of ecosystem services, which can help inform policy decisions.

XII. Key conclusions and policy recommendations

- Mabamba Bay Wetland system is still fairly intact (currently standing at 0.367% degradation rate per annum compared 3.74% national wetland degradation rate per annum) and capable of generating many key ecosystem services.
- The wetland system delivers a number of key ecosystem services, including: dry season grazing and fodder, dry season wetland edge farming, water supply for domestic use and livestock and sand mining. Others included: carbon sequestration, grass for mulching, habitat and biodiversity (tourism), capture fishery, fish breeding, spawning and nursery grounds, water purification & erosion control, and water transport.
- The supply and use of these key ecosystem services generate considerable livelihood benefits as indicated by the respective monetary values. There are also key employment, social, and health implications, particularly in view of the wetland’s interaction with a growing urban and peri-urban agricultural system.
- The supply and use of some ecosystem services however, generate trade-offs and even conflicts which require harmonious actions and future management interventions. For

example, wetland edge farming and cultivation activities provide an important source of food security and incomes for local communities, however may proliferate unsustainably if activities continues without regulation, with high intensification, and high expansion with indirect drivers of change such as population influx.

- The ecosystem services analysis provided an insight into the impact of these various interactions with the green scenario indicating considerable improvement in the productivity of the Mabamba Bay Wetland system and its contribution to peoples' livelihoods, food security, health, and social networks.
- Whereas explicit spatial analysis was not done due to time, data and other resource constraints, the wetland system is clearly experiencing unsustainable extraction of provisioning services including sand mining, and pressure from urban population growth, infrastructure and settlement developments.
- The development of wetland-specific datasets on wetland ecosystem services supply and use patterns and its relationship with wetland ecosystem degradation is an important area for future research.
- Capacity building in spatial analysis techniques including the INVEST model should also be considered for wetland managers and other key stakeholders.

1. Introduction

1.1 Background

1.1.1 Global overview of the TEEBAgriFood Initiative

The Economics of Ecosystems and Biodiversity for Agriculture and Food programme (TEEBAgriFood) was developed to apply whole systems thinking to the economics of agriculture[4], which is concerned with complex and extensive eco-agri-food value chains - from supporting ecosystems, to productive farms, to intermediaries such as aggregators, wholesalers and retailers, to food and beverage manufacturers, to distributors and consumers.

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The TEEBAgriFood Evaluation Framework[5], developed through collaboration with over 150 scholars from 33 countries representing a wide range of disciplines, backgrounds and perspectives, has been designed to guide the evaluation of food systems and their complex linkages to the environment, society and human health.

To create real change, this scientific framework of analysis has been applied at the ground level, to influence policies and practices. The Uganda TEEBAgriFood study is one of sixteen country studies around the world, and is complemented by two other country studies in Eastern Africa – Kenya and Tanzania. The study is coordinated by the Nile Basin Initiative (NBI) in collaboration with national and local government agencies, local research institutions and private sector businesses and networks.

1.1.2 Regional overview of the Nile Basin Initiative

The Nile Basin Initiative (NBI) is an intergovernmental partnership of 10 Nile Basin countries, namely Burundi, DR Congo, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania and Uganda. Eritrea participates as an observer. NBI was established on 22nd February 1999, as an all-inclusive basin-wide institution responsible for providing a forum for consultation and coordination among the Basin States for the sustainable management and development of the shared Nile Basin water and related resources for win-win benefits. The shared vision objective of the Nile Basin Initiative is to *achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources*. The highest decision and policy-making body of NBI is the Nile Council of Ministers (Nile-COM), comprised of Ministers in charge of Water Affairs in each NBI Member

[4] http://teebweb.org/our-work/agrifood/understanding-teebagrifood/systems-thinking-approach/
[5] http://teebweb.org/our-work/agrifood/understanding-teebagrifood/evaluation-framework/

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1.1.3 Key events leading to the selection of Mabamba bay Wetland System and Urban and Peri-urban Agriculture for this study

The Uganda TEEBAgriFood project applies the TEEBAgriFood analytical framework on the ground, and was first introduced at the Regional TEEBAgriFood Symposium for Africa in February 2021 at which UNEP and Ugandan stakeholders (including Ministry of Water & Environment, and the National Environment Management Authority) discussed the policy and modalities scoping for the study.

The symposium considered five options that had been identified through a desk policy review of national priorities for sustainable eco-agri-food systems including:

(i) Sustainable livestock sector development
(ii) Sustainable urban/peri-urban agriculture (UPA) development
(iii) Wetlands restoration and regeneration
(iv) Sustainable shea commodities production
(v) Sustainable Gum Arabica production and development

The consensus was that policy options on wetland restoration and sustainable urban and peri-urban agriculture aligned strongly with national priorities concerning the sustainable management of wetlands in particular and the environment in general and the National Development Plan III. A dedicated stakeholder consultation workshop on May 17th 2021 refined the purpose of the evaluation, the spatial scale and scope of the value chain and the general terms of reference of the study based on the Mabamba Bay Wetland System.

1.1.4 Overview of Wetlands in Uganda

Wetlands are recognised nationally as land that is permanently or seasonally saturated with water – comprising of 11% of Uganda's land area in marshes, swamps, and bogs (GoU, 2016). Over 80% of people living adjacent to wetland areas in Uganda directly use wetland resources for their household food security needs, meanwhile contributing to a vast wealth of ecosystem services (Turyahabwe et al., 2013).

Wetland resources in Uganda play a particularly vital role in contributing to food security, through the following mechanisms (Kakuru et al., 2013): (1) enabling the direct availability of products such as fish, crops grown along the wetland peripheries, wild fruits and vegetables, and game meat; (2) providing a cash income from the sale of raw materials and processed products such as crafts, sand, clay, bricks, and ecotourism; of which are sold for cash that is used for purchasing and accessing food; and (3) contributing to the increased crop and livestock yield as a result of improved productivity from the use of water, silt, and through climate moderation.

Upon the cultivation of wetland areas by means of small-holder agricultural expansion, it is found that wetlands provide the conditions to enable the growth of a wider range of crops than dry lands. Therefore, this provides ready food supplies to wetland adjacent communities during unfavourable conditions that are otherwise unavailable for traditional crops grown in the uplands. The common crops grown on the wetland peripheries include: *Disoscorea* spp (yams), beans, *Zea mays* (maize), *Ipomoea batatas* (sweet potatoes), *Manihot esculenta Crantz* (cassava), *Brassica oleracea var. capitatata* (cabbages), *Saccharum officinale* (sugar cane), and low land rice.

Wetland resources have continued to be overlooked in national economic development planning, and thereby the current development pathways will continue to underestimate wetland resources and miss opportunities for reducing food insecurity and assert the sustainable management of wetlands (Turyahabwe et al., 2013). The development of interventions for sustainable wetland management has repercussions in the agenda to achieve the National Food Security targets and the Agenda 2030 Sustainable Development Goals.

To guide decisions upon wetland management options, it is important to express the benefits derived from wetland resources in quantified monetary terms, as the basis for economic valuation. Wetland economic valuation is defined as a way of attaching quantitative and monetary values to wetland goods and services, whether or not market prices are available, so that they can be directly comparable with other sectors of the economy when activities are planned, policies and formulated, and decisions are made. A better understanding of the benefits and costs of utilising wetland resources will also provide important information for understanding and addressing the economic causes of wetland degradation and loss.

1.1.5 Overview of the Mabamba Bay Wetland System

The Mabamba Wetland System is a permanent wetland located in central Uganda in the two districts of Wakiso (Kasanje and Bussi Sub-Counties) and Mpigi (Kamengo Sub-County and Mpigi Town Council) (Figure 1). The wetland is approximately 9 km south west of the Kasanje trading centre and 35 km south west of Kampala City along the margins of Lake Victoria (Byaruhanga and Kigoolo, 2005). The wetland is a vast marsh of silvergrass (*Miscanthus sp*) stretching through a narrow and long bay fringed with Nile grass (*Cyperus papyrus*) towards the main body of the lake. There are several channels of marsh filled water and lagoons with blue lotus flowers (*Nymphea caerulea)*, swamp sawgrass (*Cladium mariscus*) and at times roving islands of papyrus vegetation. The outer edges of the wetland are lined with forests dominated by dabema (*Piptadeniastrum africanum*), silk trees (*Albizzia*) and nettle trees (*Celtis*) and occasional clumps of palm (*Phoenix sp*).

Mabamba Bay Wetland System measures 2,424 hectares in size. This area has been recently revised to include other contiguous wetlands in Ssisa Sub-County to 22,375 hectares. The wetland lies at an altitude of 1,150 m above sea level and is a site of special conservation interest. The wetland was therefore designated a Ramsar Site and Important Bird Area on 15th September 2006. The wetland is home to over 300 bird species including the globally threatened Shoebill (*Balaeniceps rex*), large congregations of migrant birds such as the Blue Swallow (*Hirundo atrocaerulea*), White winged Tern (*Chlidonias leucopterus*), Gull-Billed Tern (*Geloelidon nilotica*) and papyrus endemic bird species such as the Papyrus gonolek

(*Laniarius mufumbiri*) and the Papyrus Yellow Warbler (*Calamonastides gracilirostris*). Other species of interest include the Goliath Heron (*Ardea goliath*), Lesser Jacana (*Microparra capensis*), Spur winged Goose (*Plectropterus gambensis*) and Squaco Heron (*Ardeola ralloides*). The system supports lucrative fisheries activities across six landing sites, and is therefore a source of fish for home consumption and commercial use. It is a source of raw materials for local crafts, building materials, water for domestic and livestock use, as well as non-wood forest products such as medicinal plants and mushrooms.

Other cultural values at the Mabamba Bay Wetland System include the Nansubuga cultural hill; this is the most important cultural site for the Mamba Kakoboza clan of the Bugunda Kingdom, featuring tombs of ±600 years in age, rocks with board games created by early inhabitants (*omweso*) and sacred forests (Zake, 2014). The Mabamba caves at the site are also a key cultural site, as used by early people for shelter and are today used by local fishermen for shelter (ibid).

The wetland acts as a buffer for Lake Victoria and plays an important hydrological role for the waters entering the lake from the surrounding catchments by trapping incoming sediment and silt. The system maintains a steady discharge of water and supplements the supplies of water to the lake during the dry season. The area experiences two rainy seasons including the long rains during April and May and the short rains from October to November. The mean annual rainfall is 1400mm and average temperature is 22ºC (Byaruhanga and Kigoolo, 2005). However, climate change is a reality in this area and manifests through seasonal variability and extreme weather events such as floods and drought or prolonged dry periods. These impact heavily on small-holder farmers in the area and their associated food security and food systems.

The Mabamba Wetland System is still relatively intact given that it is remote and far from the urban pressure in Kampala and Wakiso. There are however isolated cases of wetland degradation driven by population increase, agricultural encroachment, sand mining, urbanization and climate change. The high land values in Kampala and Entebbe have pushed migration and settlements into this peri-urban and rural area. As such, smallholder farmers undertake farming activities for food security and income generation, cultivating crops such as bananas, cassava, beans, maize, and livestock rearing under a zero grazing system (Zake, 2014).

The site is managed by both the Community Action and Management Plan, as formulated by the Mabamba Wetland Eco-Tourism Association (MWETA, 2014) and the National Important Bird Areas Conservation Strategy, as developed by NatureUganda as Mabamba Bay forms one of Uganda's 30 International Bird Areas (IBAs). The latter strategy highlights measures and strategies between people and birds, aiming to conserve biodiversity for sustainable livelihoods. The strategy focuses on strengthening mechanisms for institutional collaboration, establishing mechanisms for effective conservation actions at IBA's, increasing knowledge and awareness, and promoting the sustainable utilisation of IBA resources for development.

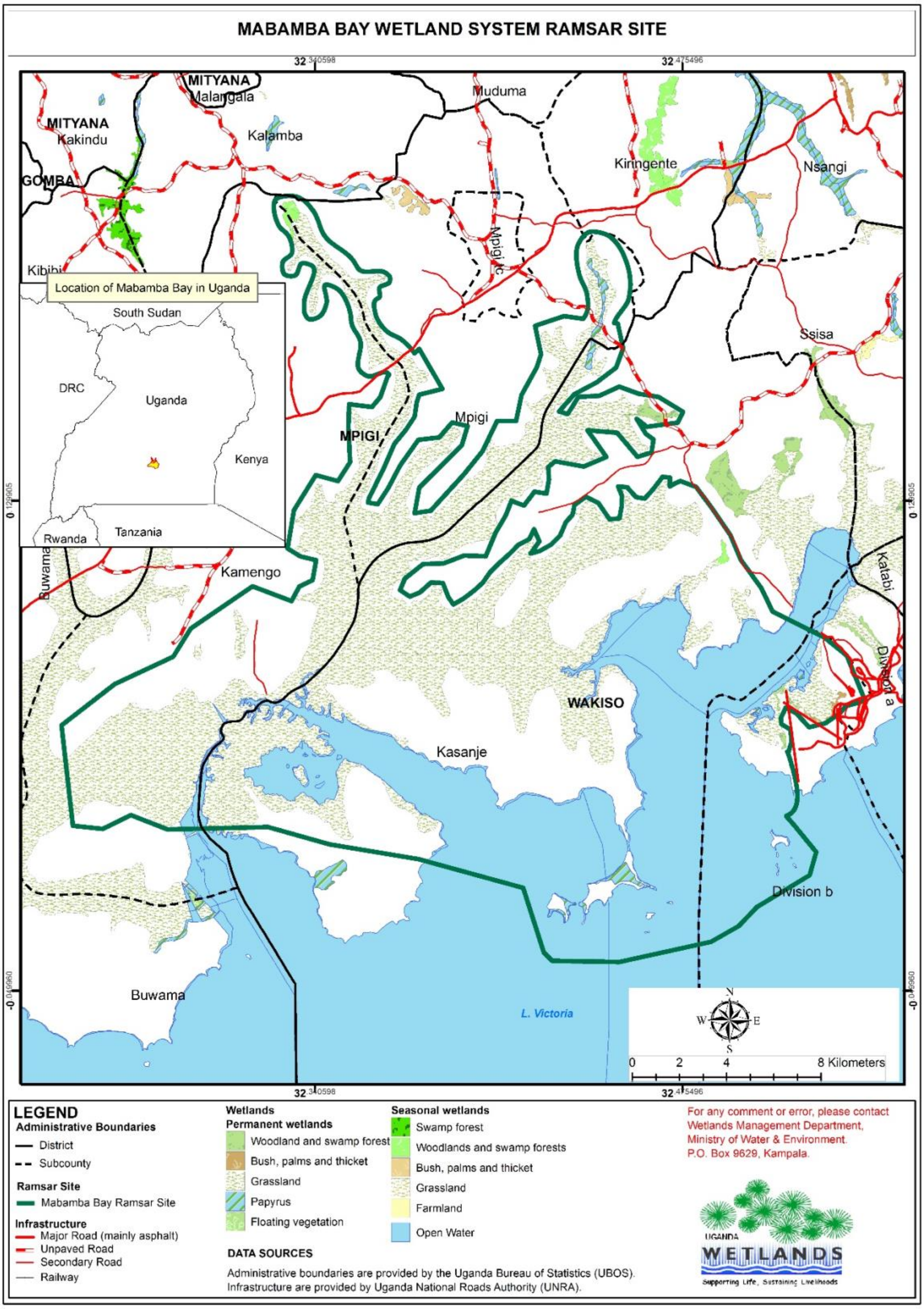


Figure 1: Map of Mabamba Bay Wetland System

Source: Wetlands Management Department, Ministry of Water and Environment

1.1.6 Overview of Kampala and Urban- and Peri-Urban Agriculture

Situated on the northern shores of Lake Victoria, the capital Kampala consists of flat-topped hills, valleys, and wetlands, of which urban agriculture is recognised as a visible character of its life (KCCA, 2019). The city was established as a municipality in 1947 and became Uganda's Capital City in 1962 following the country's independence. Since then, Kampala has grown to become the largest urban centre and the only city in Uganda, hosting its political seat, the economic hub for 80% of industrial and commercial activities, and generating >60% of the national GDP (KCCA, 2019). It is also home to an estimated 1.75 million residents, with an annual population growth rate of 5.2% (ibid). 23% of the Kampala's area is fully urbanised, 60% is semi-urbanised, and the remainder is considered as rural settlements (KCCA, 2019).

The favourable tropical rainforest climate and accessible water supply from Lake Victoria have made the city an optimal site for subsistence and commercial farming practices (KCCA, 2019). There are two annual wet seasons, a long season from August to December, and a short season from February to June (ibid). Urban and peri-urban farming has been present in Kampala since the 1890s, however the practices have experienced proliferation under the civil unrest, changing government structures, and structural adjustment policies from 1986 (Yap, 2013).

The UPA sector in Kampala contributes to the following purpose typologies, as indicated from extensive studies dating back to the 1980s, of which the last two categories form the vast majority: commercial, food self-sufficiency, food security, and survival (Lee-Smith, 2008). In particular, crops are grown for home consumption, meanwhile livestock production is mainly undertaken for income generation (Sabiiti et al., 2014). Of the households in Kampala, only 1.1% (4,727) depend upon subsistence farming as a main source of income. On the other hand, 91.9% of households (368,975) have at least one member engaged in a non-agricultural household-based enterprise (KCCA, 2019).

Farming and the associated livelihood systems in Kampala have been identified across the city, including in the urban centres, dense urban slums, the peri-urban periphery and mixed sites of "transition", and in the underdeveloped wetlands adjacent to the capital. Natural capital assets may also dictate the distribution of UPA across Kampala (Prain and Lee-Smith, 2010), specifically through the amount of land available for farming and access to water. For instance, occupants of new slum areas of Kampala may access the adjacent wetlands for farming, whereas cultivation in the inner city is done on small plots around homesteads. In peri-urban areas, plots are bigger and there is a greater choice of location. Livestock production will also be more common-place in peri-urban areas where free-range or grazed production may take place, meanwhile zero-grazing and bird cages are essential in urban areas (Sabiiti et al., 2014).

A small proportion of farmers in Kampala are also engaged in fish farming, as a consequence of capital-intensive and considerable up-front investment (Hyuha et al., 2011). Nile tilapia (*Oreochromis niloticus*) and the African catfish (*Clarias gariepinus*) are the predominate fish species produced in Kampala, and overall production in the city is low. Findings indicate that farm-raised fish is high from on-farm live purchases, despite the supply from Lake Victoria, citing preferences in quality (Sabiiti et al., 2014).

1.1.7 International context and priorities

UN Food Systems Summit 2021

Convening in September 2021, the UN Food Systems Summit aimed to launch bold new actions to transform the production and consumption of food globally, meanwhile delivering progress on the 17 Sustainable Development Goals across systemic approach. The hybrid virtual-in person event brought together more than 500 experts from approximately 250 organisations and representatives from farmers, youth and indigenous peoples to deliver the "People's" and "Solutions" Summit.

Over 147 Member States led national Dialogues, of which outcomes were consolidated in national food systems transformation pathways to establish clear visions of what governments, together with various stakeholders, expect of food systems by 2030. Action Tracks were established to cluster the rich inputs to build communities of practice and foster new partnerships. Various groups were additionally utilised to channel knowledge and partnerships, including the Scientific Group, the UN Task Force, the Champions Network, and the Global Food Systems Summit Dialogues.

Food systems in Uganda are regarded as complex, involving entities and stakeholders affecting the way food is produced, stored, processed, distributed, and utilised in the diet for optimal nutrition, health, and sustainable development. Uganda is considered to be a country with a high potential to achieve food security, due to its favourable climate and agro-ecological conditions (UN Food Systems Summit, 2021). Despite this, approximately a quarter of Ugandans are affected by food security, and smallholder subsistence farmers are affected by shocks and stressors to their production, including COVID-19, natural disasters, and land cover change.

Arising from the UN Food Systems Summit (UN Food Systems Summit, 2021), Uganda's National Food Systems Transformation Pathway identified the expectations of increased sustainability of food systems in Uganda in the coming decade to contribute to regenerating natural ecosystems and substantial reductions in greenhouse gases. The outcomes of the Food Systems Summit was expected to facilitate the:

- Increased adoption and promotion of climate smart agriculture;
- Accelerated use of improved and sustainable land use management practices;
- Improvement in compliance to environmental protection policies and legislation, especially on wetland use and management and the regulated use of agro-chemicals, amongst others;
- Establishment of mechanisms to prevent food loss and sustainably manage food waste and other by-products from the food system value chains; and,
- Increased green cover through reforestation and afforestation, amongst others.

As supported by the Uganda Food Systems Transformation Pathway, the TEEBAgriFood Uganda study application directly supports Uganda's ambitions to establish sustainable food systems and especially in the context of urban and peri-urban agricultural production. The policy brief arising from the TEEBAgriFood application and opportunities for further project extensions is therefore set to inform government policy priorities by providing scientific evidence and the economic case for change.

UN Decade on Ecosystem Restoration 2021-2030

The UN Decade on Ecosystem Restoration was proclaimed at the UN General Assembly in March 2019, following a proposal for action by over 70 countries globally. Led by the UN Environment Programme and the Food and Agricultural Organisation of the United Nations, the UN Decade builds a strong and broad-based global movement to build political momentum for restoration and action towards securing a sustainable future. The UN Decade will seek to inspire and support governments, UN agencies, NGOs, civil society, children and youth, private sector companies, indigenous peoples, farmers, women's groups, local communities, and individuals globally to collaborate and develop the appropriate skillsets for catalysing and successfully implementing restoration initiatives across the world.

The main methods of achieving success in the UN Decade include (United Nations, 2021):

- Providing a global movement focussing on restoration;
- Developing legislative and policy frameworks to incentivise restoration;
- Developing innovating financing mechanisms to fund operations on the ground;
- Detailing a values-based imperative to conserve, restore, and care for nature;
- Undertaking social and natural science research on restoration in terrestrial, freshwater, estuarine, as well as marine environments;
- Monitoring global progress on restoration; and,
- Building the technical capacity of restoration practitioners globally.

Furthermore, the UN Decade is also well-positioned to assist the world's economic recovery from the COVID-19 pandemic through highlighting the job-creation and income-generating opportunities that ecosystem restoration presents, and how decision-makers can take advantage of these opportunities. This is supported by robust evidence supporting the investments into large-scale ecosystem restoration to trigger long-term and sustainable economic returns, generating more livelihoods per dollar spent than other sectors (United Nations, 2021).

The TEEBAgriFood Uganda application contributes to the onset of the UN Decade on Ecosystem Restoration by providing the preliminary economic evidence to suggest that a Green Scenario of increased conservation and wetland recovery may promote long-term economic viability for livelihoods and ecosystem service sustainability. This may be realised through the green growth aspirations of Uganda's Development Strategy (2017/18-2030/31) and ensuring low land cover change, and strong environmental regulations and policies through enforcement and implementation.

2030 Agenda for Sustainable Development

The 2030 Agenda for Sustainable Development seeks to end poverty, conserve biodiversity, combat climate change and improve livelihoods for everyone, everywhere. These objectives, encapsulated in 17 Sustainable Development Goals (SDGs), pledge for the common and urgent action by all countries in a global partnership. The SDGs builds on decades of work by countries and the United Nations, from the 1992 Earth Summit adopting Agenda 21, to the adoption of the Millennium Declaration and Summit in 2000 leading to the eight Millennium Develop Goals to reduce extreme poverty.

As specific to ecosystem restoration and the TEEBAgriFood Uganda study application, the following SDGs will be particularly supported both directly and indirectly, whereby:

- The quality and area of ecosystems will be improved, with specific regard to Life Below Water (SDG 14) and Life on Land (SDG 15).
- Ecosystem improvements will in turn help societies mitigate and adapt to climate change (SDG 13), improve the health of societies in rural and urban environments (SDG 3, SDG 11), and increase the supplies of clean water (SDG 6) and sustainable food (SDG2, SDG 12).
- Opportunities to apply and extend cross-sectoral collaboration, leaning, and innovation on the use of ecosystem services at local and regional scales (SDG 4, SDG 7, SDG 9, and SDG 17).
- Further project extension scoping involved in assessing opportunities of investments in restoration, with resulting impacts on work opportunities and local income streams (SDG 1, SDG5, SDG 8, SDG10, and SDG16).

1.1.8 National and sub-national legal, policy, and institutional context and priorities

The **National Constitution (1995)** is the overarching legal framework for Uganda. The constitution has specific provisions for the management and protection of natural and environmental resources including wetlands. The National Environment Act 2019 is the specific law for the management and sustainable use of wetlands. The law allows traditional uses of wetlands but singles out a number of activities that are prohibited. These include reclamation or drainage of wetlands, erection, construction or placement of structures and buildings in wetlands, destroying, damaging or disturbing any wetland in a manner that is likely to have adverse effects on plants, animals or their habitat and introducing or planting toxic or alien plants or animals that could turn harmful or invasive. Specific regulations including the National Environment (Wetlands, River Banks and Lake Shores Management) regulations of 2000 and the Environment Impact Assessment Regulations of 1998 operationalize provisions under the National Environment Act 2019 that protect wetlands from encroachment and regulate activities in wetlands. The Land Act Cap 227 reiterates the public trust doctrine enshrined in the Constitution to ensure that wetlands are sustainably used and that prohibited, indiscriminate and uncontrolled encroachment on these resources is avoided.

The management of wetlands in Uganda involves a three-tier institutional arrangement including the National Environment Management Authority and the Wetlands Management Department at the national level, the district council at the district level and the sub-county government at the sub-county level. The National Environment Management Authority (NEMA) monitors, supervises and coordinates all aspects of the environment including wetlands. The Wetlands Management Department provides policy oversight to both central and local government agencies to ensure sustainable conservation and management of wetlands. The management of wetlands is a decentralized function of Local Governments implying that Local

Governments through District Environment Committees and Local Environment Committees have the primary responsibility of managing wetlands in their areas of jurisdiction.

The **National Development Plan III (2020/21 – 2024/25)** provides the overall national economic policy framework for Uganda. The vision of the plan is a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years. The goal of the plan is increased household incomes and improved quality of life of Ugandans while the theme is sustainable industrialisation for inclusive growth, employment and wealth creation. The National Development Plan area-based commodity planning approach clusters Uganda into nine agro-ecological zones with preferred agricultural commodity mixes and prescribed support to maximise value addition for the selected commodities. Mabamba Bay Wetland System is located in the Lake Victoria Crescent agro-ecological zone which is prescribed for banana growing, horticulture, robusta coffee, poultry/piggery and aquaculture development and prioritisation. The area is also identified for nature based eco-tourism focusing on bird watching especially of the rare Shoebill (*Balaeniceps rex*) and the threatened Blue Swallow (*Hirundo atracaerulea*), the Papyrus Gonolek (*Laniaruis mufumbira*) and the Papyrus Yellow Warbler (*Chloropeta gracilirostris*).

The National Development Plan is operationalized through District Development Plans (DDPs) at the sub-national level. The vision of the current DDPs for Wakiso District and Mpigi Districts is a transformed society from a peasant to modern and prosperous districts. Its theme and mission are competitiveness for sustainable wealth creation, employment and development. The DDPs emphasized tourism and commercialisation of agriculture, increased production, agro-processing and marketing and value addition in line with the National Development Plan's programming for agriculture and agro-industrialisation.

The National Development Plan is cognisant of the challenges of agricultural intensification including encroachment of wetlands and natural forests, loss of biodiversity including agricultural biodiversity, soil erosion and sedimentation of river and lake systems and pollution. The plan therefore emphasized the role of sector agencies responsible for environmental management, agricultural extension education, wetland management, forest conservation and their respective policy instruments and relevant regulatory frameworks. The plan highlights the following cross-cutting roles.

The **National Environmental Management Authority** is responsible for the National Environment Management Policy (2017) and sets the overall goal, objectives and key principles for environmental management in Uganda. The policy provides a basis for the harmonization of sectoral and cross-sectoral policies and provides a multi-sectoral approach to resource planning and management, a comprehensive legal framework, and the development of a new sustainable conservation culture. The overall policy goal is to 'achieve sustainable social and economic development which maintains or enhances environmental quality and resource productivity on a long-term basis that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The policy sets cross-sector policy objectives, guiding principles, strategies and key initial actions needed for the management of biological diversity, access to genetic resources, water resources, wetlands, land use, natural heritage site, pollution and waste management and regulates the use of urban and peri urban spaces especially wetlands for livestock rearing, agriculture and aquaculture.

The National Environment Management Authority developed Uganda's second national biodiversity strategy and action plan (NBSAP II 2015-2025) in 2014. The second NBSAP was based on the theme of "Supporting Transition to a Middle-Income Status and Delivery of the Sustainable Development Goals" and was guided by the goal "to enhance biodiversity conservation, management and sustainable utilization and fair sharing of its benefits by 2025". The planned actions in the NBSAP contribute to achieving the goals of "Uganda Vision 2040", the National Development Plan, the 2030 Agenda for Sustainable Development, the Strategic Plan for the Cartagena Protocol on Biosafety and the CBD Gender Plan of Action. The implementation of the NBSAP II is harmonized with the implementation of the two sister Rio Conventions and other multilateral environmental agreements and has also benefited from a CBD Secretariat-led Voluntary Peer Review mechanism/methodology that assesses and reviews the level of implementation of NBSAPs, examines country commitments to biodiversity conservation, builds national capacity in NBSAP Voluntary Peer Reviewing (VPR) and shares experiences and lessons learnt from other countries.

The Wetlands Management Department - Ministry of Water and Environment
Uganda developed a policy and legal framework for the management of wetlands in 1995 becoming the first African country and second country in the world (after Canada) to adopt a National Policy for the Conservation and Management of Wetland Resources. The policy responded to a number of historical challenges including the policy recommendation in 1955 to allow drainage of wetlands for agriculture in areas of the country where the population had increased tremendously such as in the districts of Kabale, Rukungiri, Kisoro and Bushenyi (Gibb, 1955; Kabagambirwe 1972).

The goals of the National Policy for the Conservation and Management of Wetland Resources in Uganda include establishing the principles by which wetland resources can be optimally used now and in the future; controlling practices which reduce wetland productivity, maintaining the biological diversity of natural and semi natural wetlands, maintaining wetland functions and values and integrating wetland concerns into the planning and decision making processes of other sectors.

In order to successfully pursue the above-mentioned goals, Government acknowledged that wetland resources are an integral part of the environment and their management must be pursued in the context of an interaction between conservation and the national development plans, strategies and programs. Secondly, that wetland conservation can only be achieved through coordinated and cooperative approaches involving all the concerned people and organizations in the country including local governments and communities.

The **Directorate of Agricultural Extension Services** is responsible for the National Agricultural Extension Policy 2016. The purpose of the National Agriculture Extension Policy 2016 is to transform agricultural extension from a system of parallel institutionally fragmented public and non-state actors to well-coordinated, harmonised, regulated pluralistic services with multiple providers addressing diverse needs. The second dimension of the new policy direction is to address the extension needs along the entire value chain to achieve synergistic integration with other agricultural support services for optimum returns on investment.

The **National Agriculture Extension Policy 2016** is operationalized by the National Agricultural Extension Strategy. The strategy itself is designed to achieve high level national policy objectives including the Comprehensive National Development Policy Framework 2009, the National Development Plan as well as the continental Comprehensive African Agricultural Development Program (CAADP) and the UN Sustainable Development Goals.

Both the National Agriculture Policy and the National Agriculture Extension Policy identify urban and peri-urban agriculture as practices that may increase agricultural productivity in the face of a changing climate. Both policies cross reference other relevant policies to ensure that agricultural expansion and productivity including urban and peri urban agriculture does not jeopardise Uganda's ecosystems and exacerbate climate change. The green growth aspirations in the agriculture sector are further strengthened by the **National Organic Agriculture Policy (2019)**. The policy aims to promote and propagate a competitive and sustainable organic agriculture sub-sector that contributes to better farm incomes and sustainable livelihoods benefiting from increased farm productivity with limited use of external farm inputs.

The Directorate of Fisheries Resources Management is responsible for the **National Fisheries and Aquaculture Policy 2018**. The National Fisheries and Aquaculture Policy 2018 replaced the National Fisheries Policy of 2004 that previously guided the management and development of the fisheries sector in Uganda. The rationale for the new policy derives from the Uganda Vision 2040, the National Development Plan II and the UN Sustainable Development Goals 2 and 14 which aim to end hunger, achieve food security, improve nutrition and promote sustainable agriculture as well as increasing the economic benefits to least developed countries from the sustainable management of fisheries respectively. The new policy also addresses some aspects of the Comprehensive National Development Policy Framework 2009 that ushered in the Vision 2040 and the National Development Planning dispensation which the old policy did not address.

The vision of the National Fisheries and aquaculture Policy 2018 is a modern, productive, profitable and sustainable fisheries and aquaculture sub-sector. The mission is to transform the fisheries and aquaculture sub-sector into a highly productive sub-sector through improved governance and use of appropriate technologies for sustainable development. The policy goal is to increase fisheries and aquaculture production including through urban and peri urban aquaculture systems to 1.7 million tonnes of fish output annually so as to contribute to food security, nutrition and economic growth. See Appendix II for national policy priorities and governance instruments.

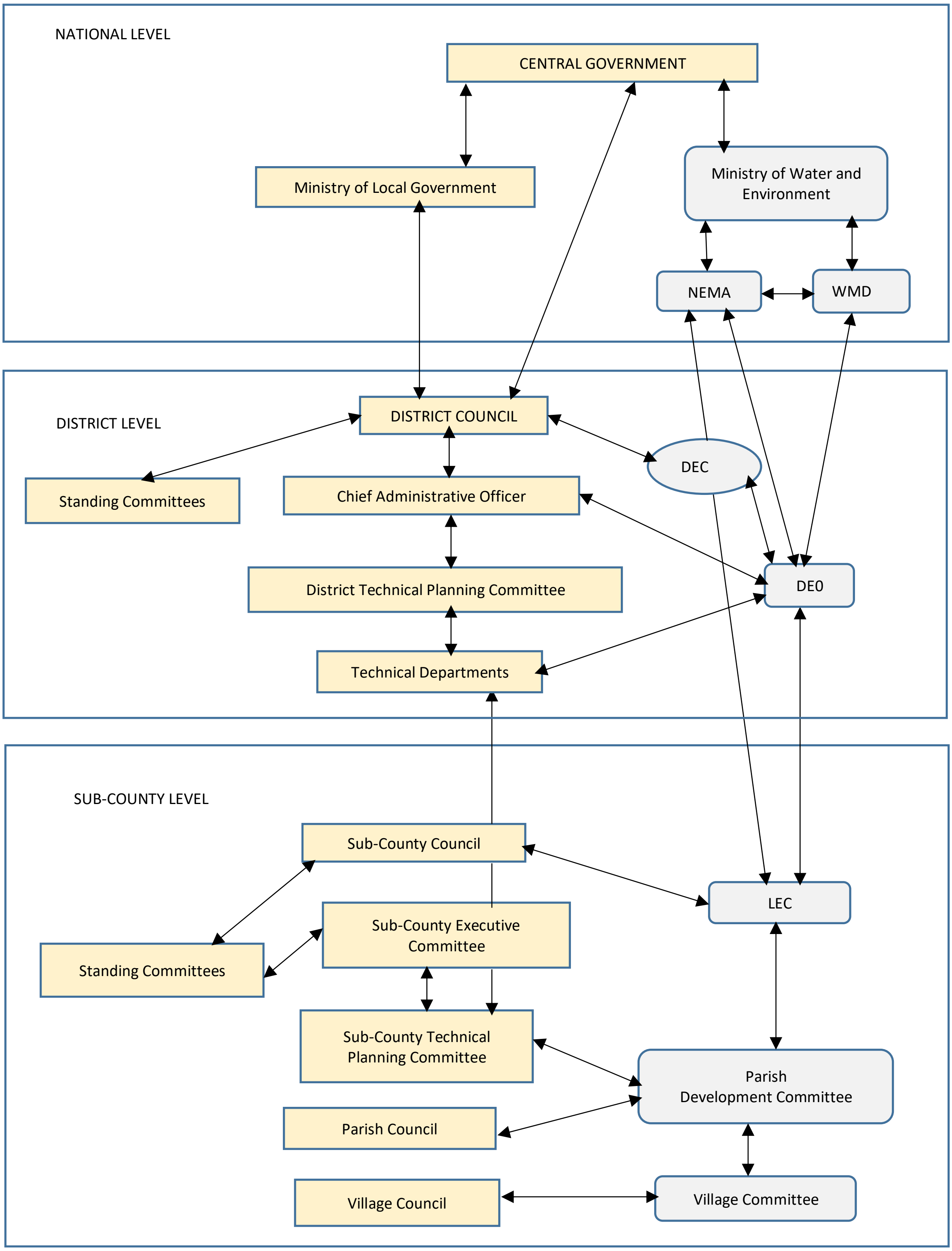


Figure 7: Institutional structure for Wetlands Management in Uganda

NEMA; National Environment Management Authority, Wetlands Management Department;
DEC: District Environment Committee;
DEO: District Environment Officer;
LEC: Local Environment Committee.

2. Study Approach and Methodology

2.1 The TEEBAgriFood Analytical Framework

The TEEBAgriFood Analytical Framework uses whole systems thinking to guide the evaluation of food systems and their complex linkages to the environment, society and human well-being in order to improve policy and decision making. This study applied the TEEBAgriFood analytical framework to evaluate the interactions within the Mabamba Wetland System including the bird watching-based ecotourism in the wetland, various ecosystem services such as sand mining, water transport, fishing, wetland edge cultivation and the implied livelihood benefits the communities derive from the wetland.

The interactions in the wetland system result in trade-offs but even conflicts that affect the level of economic welfare generated from the wetland through ecotourism among other things. The interactions are further influenced by surrounding institutional, social, cultural, environmental and economic conditions. The diagram below illustrates the interrelationships in the Mabamba wetland system.

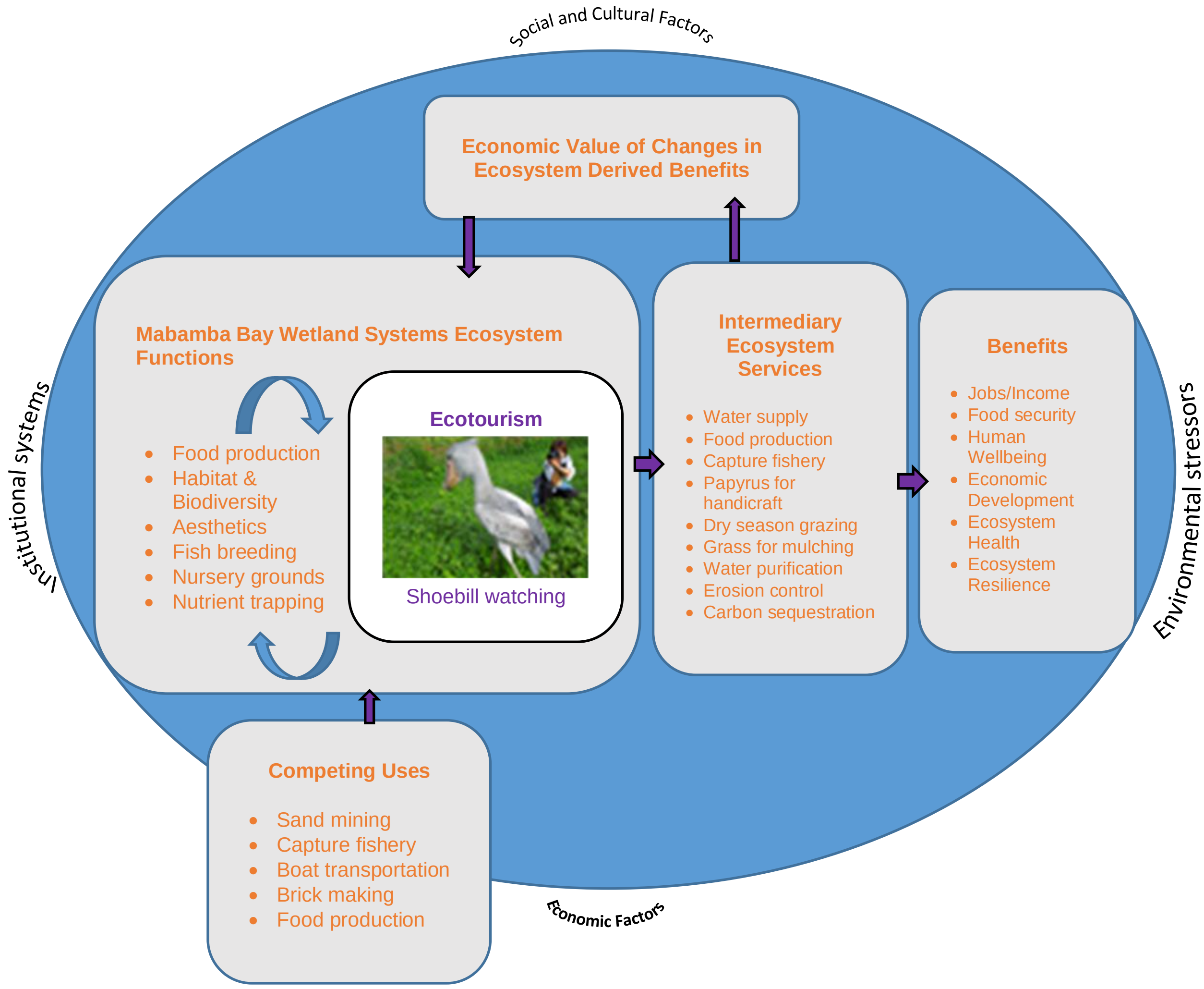


Figure 2: TEEBAgriFood Analytical Framework for the Mabamba Bay Wetland System

2.2 Stakeholder Engagement

The purpose of the stakeholder mapping and analysis exercise was to identify the interests, beneficiaries and benefits derived from the Mabamba Wetland System landscape. The identification of stakeholders was based on the geographical location of the wetland i.e. engagement of populations and local leaders of areas surrounding the wetland. The primary entry point for stakeholder identification was the Local Council System. This enabled the research team to identify key players across the 37 villages surrounding the wetland. The other important stakeholders identified during the study included the local government authorities of Kasanje Town Council & Bussi Sub-County (Wakiso district), and Kamengo Sub-County & Mpigi Town Council (Mpigi district). The list of people consulted during the study is included in Appendix 1. The study further engaged with the Wetlands Management Department (WMD) in the Ministry of Water and Environment and the National Environment Management Authority (NEMA). Several discussions were held on issues affecting wetlands management in Uganda. WMD facilitated the study through sharing data on wetland degradation (changes in wetland area) and the revised extent of the Mabamba Conservation area and Ramsar site.

2.3 Valuation of the Wetland Ecosystem Services

Economic valuation of key ecosystem services was undertaken to determine the baseline conditions of the wetland system. The main approach of the study was market analysis and benefits transfer which were the most feasible approaches in view of the limited time available for the study (Appendicies III and IV). Identification of urban and peri-urban agriculture value chains and linkage with the Mabamba Wetland System ecosystem services were conducted through literature review, stakeholder consultations and field observations.

2.4 Scenario Setting

The key ecosystem services and functions derived from the wetland system and its catchment included:

a) Provisioning of water for domestic and livestock use,
b) Provisioning of fish for home consumption and commercial purposes,
c) Provisioning of grass for mulching
d) Provisioning of construction materials especially, sand and clay bricks,
e) Regulating water flow and underground water re-charge and controlling the natural water cycle,
f) Regulating the local micro-climate,
g) Supporting fish breeding activities especially in the wetlands,
h) Supporting ecotourism activities and enterprises including bird watching,
i) Supporting agricultural productivity,
j) Supporting fish breeding, spawning and nursery grounds,

k) Sinking and storing carbon through carbon sequestration and storage in the soil, in below and above ground wetland biomass.

A number of underlying factors related to changing economic opportunities due to industrialization, livelihoods/income generation, agricultural growth, human settlements and tourism were found to impact the continued supply of the above-mentioned ecosystem goods and services. Notably, dry season incursion into the swamps by fishermen, extensive sand mining, housing growth and the associated land use changes and agricultural intensification continue to exert pressure on the wetland system and the services it can provide.

Uganda registered an average rate of wetland and forest loss of up to 3.74 percent and 1 percent per annum respectively, costing the national economy US$ 3.8 – 5.7 million per year (NEMA 2009). Although currently standing as fairly intact, the wetlands at Mabamba Bay are currently exhibiting a 0.367% degradation rate per annum, however they remain at threat of extensive forest and wetland destruction, habitat fragmentation, and biodiversity loss. The implementation of the National Development Plan III and its infrastructure and agro-industrialization program could exacerbate current rates of habitat fragmentation, environmental damage and biodiversity loss if not strengthened with the appropriate regulatory measures, frameworks and green growth interventions. This study therefore projected a number of interacting factors to construct three scenarios management and outcome scenarios which are described in the next section.

2.5 Specific scenario settings

Changes in the productivity of the wetland system for the above-mentioned key ecosystem values were modelled to depict the behaviour of the wetland under various scenarios including the Business-as-usual (BAU) Scenario, the Green Scenario envisaging implementation and roll out of the enhanced National Important Bird Area Conservation Strategy that focuses on Wetland Conservation and Wise Use (WCWU), and the Grey Scenario that envisaged increased settlements pressure, sand mining and intensive agricultural production resulting in extensive wetlands encroachment.

The three scenarios, benchmarked against the National Development Plan (NDPIII) programs on agro-industrialization, infrastructure development and intensification of urban and peri-urban agricultural activities and increased ecotourism, were constructed with the following characterizations. The Business-as-usual (BAU) Scenario envisaged projection of baseline conditions into the future with little if any deliberate conservation intervention, the Grey Scenario envisaged intensified agriculture and agro-industrialization, infrastructure development, sand mining and population influx into the area without the requisite development controls and conservation investments, while the Green scenario envisaged increased conservation and recovery of the wetland over a period of 15 years.

The Grey Scenario therefore underlined declining productivity and overall reductions in the values of key ecosystem goods and services. The Green Scenario (Wetland Conservation and Wise Use) on the other hand envisaged the implementation of an enhanced National Important Bird Area Conservation Strategy (involving interventions of wetland restoration and wise use, modern urban- and peri-urban farming with fish farming, afforestation and modern animal husbandry). The analysis was initially planned to apply the Integrated Valuation of Ecosystem Services and trade-offs models (InVEST) to reveal the response of ecosystem productivity to conservation interventions or non-intervention. However, due to data and time constraints as well as limited familiarity with the INVEST model other modelling methods relying on remote sensed data were used in the study.

2.5.1 Business-as-Usual (BAU) Scenario

The Business-as-Usual (BAU) Scenario projected current degradation outcomes into the future. The analysis captured baseline wetland degradation rates and assessed their impact over the next 15 years to year 2035. The BAU Scenario was characterized by moderate to increased pressure on the wetland with evidence of encroachment, pollution, sand mining and an underlying reduction in the capacity of the wetland to generate ecosystem services.

2.5.2 Grey Scenario

This Scenario envisaged increased wetland degradation due to intensification of urban and peri urban agriculture, sand mining, infrastructure development and settlements around the wetland. It characteristically had HIGH land cover change outcomes. The Scenario is driven by the agro-industrialization policy of government, urban and peri-urban agricultural intensification and the influx of people for agricultural land.

2.5.3 Green Scenario

This Scenario was based on the green growth aspirations of the agriculture sector as reflected in the National Development Plan and National Organic Agriculture Policy of growing agricultural sector for food security with reduced externalities. Thus, it projects LOW land cover change to arable land. This involves requisite enforcement, investment and reduced corruption in implementation. The Scenario is reinforced by strong water, wetlands and biodiversity protection agenda as captured in associated policies, laws, regulations, strategies and plans and enforcement and implementation of the same.

2.6 Time scale of scenario setting

Uganda developed its National Vision 2040, aimed at transforming the national economy from a peasant economy to a modern and prosperous one. The third National Development Plan (NDP-III) is the third in a series of six NDPs that will guide the nation and deliver the aspirations of the country as articulated in the National Vision 2040. The dominance of agriculture as a source of livelihoods has positioned agro-industrialisation as a central focus of Uganda's national development planning process.

Firstly, agro-industrialisation has presented an avenue for promoting inclusive and equitable growth. Second, Uganda has a positive trade balance in agro-industrial products. Thirdly, agro-industrialisation provides an opportunity to add value to agricultural raw materials in order to support the expansion of the export of processed products. Fourth, it provides an opportunity for import substitution. Fifth, it provides an opportunity to address the high post-harvest losses, minimise losses to disasters, stabilise prices and increase household incomes.

Additionally, the backward and forward linkages between agriculture and agro-processing will necessitate that Uganda sustainably transform agro-value chains to ensure sufficient supply for domestic industries to undertake transformative sustainable manufacturing while creating employment. The goal of the NDP programming in agriculture, therefore, is to increase commercialisation and competitiveness of agricultural production and agro-processing.

The year 2025 marks the end of the implementation of NDP-III. The same year will mark the mid-term implementation of Uganda's Vision 2040's 30-year timeframe whose end term is 2040. This study therefore set 2025 as the short-term time point for scenario analysis, with the baseline considered at 2021. The mid-term time point for scenario analysis was 2030 which marks implementation completion of NDP-IV, and finds the final scenario analysis forecasting timestamp at 2035. By the Year 2040, this indicates the end-term for Uganda's Vision 2040.

3. Results

3.1 Baseline ecosystem values of Mababma Bay Wetland System

The Mabamba Wetland System provides a variety of goods, services and attributes which contribute to local needs, the wider national and regional economy. These benefits constitute considerable ecological, social and economic value, which may be lost when the Mabamba Wetland System is degraded. The array of ecological functions performed by the wetland is quite extensive. This study initially generated a long list of wetland ecosystem services including water supply for domestic, irrigation and livestock, dry season crop farming, dry season animal grazing and harvest of pasture, capture fisheries, harvesting of papyrus and other handicraft materials, fuel wood supply, natural medicine, pottery and clay, carbon sequestration, water purification, sediment control, flood control, education and research. This list was revised and prioritized in line with key informant (Appendix 1) recommendations and personal observations.

The following list of ecosystem services was therefore taken forward for further study and investigation. The services include water supply for domestic and livestock use, dry season horticultural farming, capture fisheries especially of the African lungfish (*Protopterous spp*) and eels (*Ensonzi*), papyrus for handicrafts, dry season grazing and fodder, grass for mulching, water purification, erosion control, carbon sequestration, breeding and nursery grounds for fish, tourism especially bird watching of the iconic Shoebill (*Balaeniceps rex*), water transportation through the wetland channels and lagoons, habitat and biodiversity values.

3.1.1. Water supply for domestic and livestock use

The role of the Mababma Bay Wetland System in providing water storage and supply functions to communities in the area was assessed in two perspectives. The first perspective was water supply for domestic purposes (drinking water, washing and laundry). The second perspective was water supply for livestock use. Data on household dependence on the wetland for the two purposes was collected through personal observation and focus group discussions with local council chairpersons and other stakeholders.

The average consumption rate of water per household per day for domestic purposes was estimated at 3 (20 litre) jerrycans generating a total use value of 256.6 million litres for all the households per annum. This translated into an annual value of USD 1,054,530 per annum for domestic water use from wetlands, computed from the pricing of UGX 300 per jerrycan. Field data on water supplies for the four major categories of livestock in the area (cattle, pigs, goats and sheep) on the other hand was estimated at 325 million litres per annum valued at USD 1,335,750. As such, the total use value for this category of ecosystem service was calculated at US$2,390,280 per year.

3.1.2. Dry season and wetland edge farming

The Mabamba Wetland System supports a thriving agricultural enterprise by providing the water required for crop cultivation, as well as depositing sediments and nutrients that maintain soil fertility. The major crops grown in the area include yams and sugar cane, potatoes, beans, maize, ginger, pineapples, miraa and various leafy vegetables.

The average land holding per household area was 1.1 hectares, with each homestead growing crops on at least 0.5 hectares of land each of the two main cropping seasons. The total agricultural output was estimated using field household data and land productivity estimates from the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF, 2020). The total crop output in the area for beans as a representative crop was 7,264,540 kilograms per annum valued at USD 3,980,570.

Figure 8: Beans and maize gardens at the periphery of the Mabamba Bay Wetland, near the Muzina landing site.
Photo Credit: Agaton Mufubi

3.1.3 Capture fisheries, especially of Lung Fish and Mudfish

The Mabamba wetland system is an important spawning and nursery ground for fish. It is also an important habitat for a number of fish species including lung fish (*Protopterous spp,* known locally as *emamba*), catfish (*Clarias gariepinus*, known locally as emmale) and mudfish (*Protopterous annectens*, known locally as *ensonzi*) and a variety of Uganda haps (*Haplochromis spp*). This study noted that fishing activities in the wetland are however centered on the lungfish and mudfish fishery while other species are caught in the open waters of Lake Victoria. The presence of lungfish in the wetland has additional significance as it constitutes the diet of the rare Shoebill whose IUCN Conservation status is vulnerable but is also a key tourist attraction in the area.

According to key informants and local council leaders (in the study area) (Appendix 1), fishing activities in the wetland system are important as they provide direct employment to over 379 fisher men operating 185 fishing and transport boats and an equal number of other persons in activities such as fish retailing, boat building and repair and artisanal fish processing. The annual value of fish originating from the wetland system was estimated at USD 121,644 while live mudfish used as fishing bait in the Nile perch fishery generated an annual fishing income of over USD 10,000.

Landing site	No of Boats	Average Monthly Catch (kgs)	Estimated Value USD per annum
Mabamba	37	740	24,329
Kagulube	70	1,400	46,027
Kyanvubu	28	560	18,411
Kitinda	06	120	3,945
Gulwe	20	400	13,151
Mukaka	05	100	3,288
Namugobo	19	380	12,493
TOTAL	185		121,644

Table 1: Major landing sites on Mabamba Bay Wetland System
Source: Kasanje Town Council Fisheries Officer

Figure 9: Lungfish caught in the Mabamba Bay Wetland System
Photo credit: Agaton Mufubi

3.1.4. Breeding, spawning, and nursery functions (fish)

The Mabamba Wetland System fringes the northern part of Lake Victoria and acts as a breeding and nursery ground for fish. The fish later migrates to the open lake where they are fished as part of the regular catch. The wetlands are known to provide food and cover to various fish species at their different stages of development. The main species involved include lungfish (*Protopterous spp,* known locally as *emamba*), catfish (*Clarias gariepinus*, known locally as emmale), some tilapia (*Oreochromis niloticus*), mudfish (*Protopterous annectens*, known locally as *ensonzi*) and a variety of Uganda haps (*Haplochromis spp*).

The fish breeding, spawning and nursery ground function of the Mabamba wetland system was estimated using benefits transfer from a study by Kakuru, Turyahabwe and Mugisha (2013) referring to Turpie (2000), in which they estimated the value of the habitat-fishery linkage of wetlands to be USD 6.3 per hectare per year. The fish breeding, spawning and nursery ground value relates mostly to the productivity and recharge of fish populations in the wider open lake, as opposed to catch improvements in the wetland itself. This ecosystem supporting service is therefore discernible from the fish provisioning service in Section 3.1.3., and is not double counting. The annual fish breeding, spawning and nursery ground value of Mabamba Wetland was therefore estimated to be USD 15,271 based on the Ramsar site area of 2,424 hectares.

3.1.5. Dry season grazing and fodder

Thirty-five percent of the households in the thirty-seven villages around the Mabamba Wetland System own an average of 4 heads of cattle per household. Thirty percent own an average of 2 goats or sheep per household. Livestock significantly depend on the wetlands provisioning services of fodder, water and other materials. The total number of livestock units in the area was 25,778 including 16,404 heads of cattle and 9374 sheep and goats. The average daily cost of fodder for stock fed, zero grazed livestock in the area was USD1.64 for cattle and USD0.40 cents for sheep and goats respectively.

If the 25,778 livestock units currently grazed in the wetland system were raised using a cut and carry system, up to USD11,225,534 would be spent on purchasing grass fodder per annum. This amount of money, therefore, represents the annual gross value of the Mabamba Wetland System as a source of pasture for livestock.

Figure 10: Cattle grazing at the edge of Mabamba Bay Wetland System
Photo Credit: Agaton Mufubi

3.1.6. Grass for mulching

Mulching is a common water and soil conservation practice in the peri-urban farms around the Mabamba Wetland System. It is applied in pineapple, coffee, tomato and banana plantations to conserve soil moisture, enhance the nutrient status of the soil, control erosion and suppress weeds. Mabamba wetland is a major source of mulch, comprised mainly of silvergrass (*Miscanthus spp*) and other grasses.

According to local council authorities in the study area, approximately one truck (six ton) load of mulch is removed from the Mabamba Bay Wetland System daily. The farm gate price of each truck load was quoted at USD68 implying an average exchange value of wetland sourced mulch at about USD24,820 per annum. The importance of wetland sourced mulch is expected to increase as agricultural activities intensify to supply growing demand for food and cash crops in this peri-urban environment.

3.1.7. Sand mining

Sand mining is an important resource extraction activity in the Mabamba Wetland System. This is in addition to other resource extraction activities including fuel wood collection, clay mining, and brick making. Two main sand mining sites in the wetland were recorded during this study. They were Kagulube and Nangombe in Kasanje Sub-county, while sites in Kamengo were recently closed. Local government authorities at Kasanje town council estimate that over thirty-five (44 ton or 28m^3) trucks of sand are removed from the two sand mining sites daily, valued at a farm gate price of USD288 per truck implying an annual sand extraction value of USD3,675,000 per annum.

Natural Resource	Monthly Tender Rate US$	Annual Revenue US$
Sand	986.30	11,836
Tourism	328.77	3,945
Fisheries	438.40	5,260
TOTAL		21,041

Table 2: Kasanje Town Council Local Revenue Data, for the Mabamba Bay Wetland System
Source: Kasanje Local Government

Sand mining, however, was clearly in conflict with local conservation objectives. The Mabamba Bay Wetland System is both a Ramsar site and an Important Bird Area (IBA), designated for the protection of biodiversity especially of rare endemic bird species including the shoebill. Sand mining is destructive and illegal, consequentially leading to the degradation of the wetland. Throughout the sand exaction process, wetland vegetation mats are cut and released into the open lake to clear for sand dredging. The floating mats, in addition, to creating navigation hazards, encourage additional destructive fishing activities. The cut wetland mat released into the open lake are submerged by fishers to attract fish, and this creates a localised fishing ground. The sand pits left after dredging are also deep and dangerous, providing breeding grounds for mosquitoes and exacerbating the spread of malaria and diseases in the area (Akwetaireho, 2009). Focus group discussions during the study revealed that while most local leaders were weary of sand mining activities, they admitted to collecting local sand mining revenues through movement permits at higher rates than the equivalent local revenues from tourism and fishing. As a consequence, this practice constitutes a perverse economic incentive for the Mabamba Bay Wetland System.

3.1.8. Water Purification and Erosion Control

The importance of the Mabamba Wetland System regarding water resource management in the Lake Victoria Basin is twofold. Firstly, the wetland is an important reservoir that stores water and allows it to slowly recharge the lake system especially during the dry season. Secondly, the wetland filters and cleans dirty storm water flows from the mainland and island of Bussi. Wetlands can remove up to ninety-five percent of the sediments, nutrients and metals in water making it clean and suitable for use for various purposes.

The value of the wetland for water purification purposes was estimated using values computed by Otieno (2019) in the Sio-Siteko wetland system on the Uganda and Kenya border, which used conventional water treatment costs to impute the value of wetlands for water purification. Otieno estimated that a hectare of wetland performed the equivalent role of USD 444 worth of alum per year to remove turbidity. This marginal value generated a total water purification value for the Mabamba Wetland System of USD 1,076,256 per year.

3.1.9. Carbon sequestration

The Mabamba Bay Wetland System is an important carbon sink and plays a key role in the regulation of the local microclimate. The wetland sequesters carbon and contributes to the overall national greenhouse gas emissions balance. Previous studies indicate that between fifty and ninety percent of wetland carbon is found in the soil and remains sequestered for hundreds of years (Barbier, 2017). Carbon in the plant biomass is stored for several decades. The value of ecosystems as carbon sinks is associated with the measure of all damage caused by an increase in greenhouse gas emissions over time. However, the true price of carbon would be that established by markets for carbon credits for trade or storage compensation. As there is no “global market” for carbon credits, prices vary considerably across markets and are driven by policies.

Barbier (2017) estimated the value of wetland sequestered carbon at USD 413 per hectare in net present value terms. This study however used annual sequestration rates estimated by previous studies in Uganda of 4.8 tC/ha/year for papyrus swamps and the price of USD7.03/tCO2e for issued credits from Climate, Community and Biodiversity Standard (CCBA), Verified Carbon Standard (VCS) and Reduced Emissions from Deforestation and Forest Degradation (REDD+) projects and a factor of 3.67 to convert between tC and tCO^2e (MWE, 2015; Mitsch et al., 2012; Chidumayo. 2013; LTS, 2013). This gave an annual carbon sequestration value for the wetland of about USD 300,189.

3.1.10 Water transport

There are 74 transport boats operating at the landing sites of Kyanvubu (28), Mabamba (30) and Namugobo (16) in the Mabamba Bay Wetland System. These boats transport people and merchandise through the channels and lagoons in the wetland, in particular thorugh the Mabamba-Seeta Bussi channel, the Muziina-Luwala channel, the Namugobo channel and the

Gombe-Bubebere channel. The Mabamba-Seeta-Bussi route also operates a locally fabricated barge that can carry two vehicles. This water crossing facilitates the movement of people and merchandise between the mainland and island of Bussi, and the tourism activities taking place within and across the wetland.

The value of trade facilitated, employment and fuel consumption by the respective transport business segments is considerable. This was however, not computed due to time constraints. Tourist expenditure on boat transport alone was however USD 16,904 in 2020 and grew to USD 23,425 in 2021. Ordinary non tourist traffic generated up to USD 500,000 per year in transport expenditure in the same period. These values were obtained from Mabamba Wetlands Ecotourism Office.

Figure 11: Water transport on the Mabamba-Seeta Channel
Photo credit: Agaton Mufubi

3.1.11 Biodiversity and habitat values

The Mabamba Wetland System is richly endowed with biodiversity resources which underpin the delivery of services and benefits critical to local economic growth and human well-being. The area has over 300 species of birds, several types of fish, forests and agricultural biodiversity. The services and benefits generated by this diversity of species and ecosystems including provisioning, regulating, supporting and cultural services. Biodiversity serves as a key driver for local livelihoods, local economic development.

Figure 12: Tourist vehicles parked at the Mabamba Bay Wetlands Ecotourism Office
Photo Credit: Agaton Mufubi

The tourism aspect of the biodiversity and habitat value of the Mabamba Bay Wetland system was estimated to highlight the value of the Mabamba Wetland System. Tourism revenue based on entry charges grew sevenfold between 2017 and 2021, from USD1,712 to USD11,712, mostly because of the increased marketing of bird watching as a unique tourist product.

Year	Visitor Nos.	Entry Charges US$	Total Value Entry Charges
2017	250	7	1,712
2018	500	7	3,425
2019	988	7	6,767
2020	1,234	7	8,452
2021	1,710	7	11,712

Table 3: Tourism activity at the Mabamba Bay Wetland Ramsar Site
Source: Mabamba Bay Wetlands Ramsar Site, Ecotourism Office

3.2. Scenarios

3.2.1 Trade-offs under alternative management scenarios

The Mabamba Bay Wetland System is still relatively intact, with degradation pressures originally limited to subsistence agriculture and small-scale sand mining. The wetland lost less than 537 hectares between 1995 and 2015 at an annual degradation rate of about 0.367 percent, which was well below the national average degradation rate of 3.74 percent. The wetland recovered some lost area between 2000 and 2005 following the promulgation of the National Environment (Wetlands, Riverbanks and Lake Shores Management) Regulations (SI No 3 of 2000) in 2000 (Figure 13).

The wetland system was designated a Ramsar site and Important Bird Area (IBA) on 15th September 2006, further bolstering the conservation objectives of the wetland. The wetland, however, experienced increased degradation pressure from 2015 with the single year degradation rate rising to 0.5 percent per annum in the same year. The main change factors included agricultural encroachment on the wetland, population growth and urbanization in the immediate vicinity of the wetland, unsustainable wetland resource extraction, improved infrastructure especially roads, and climate change.

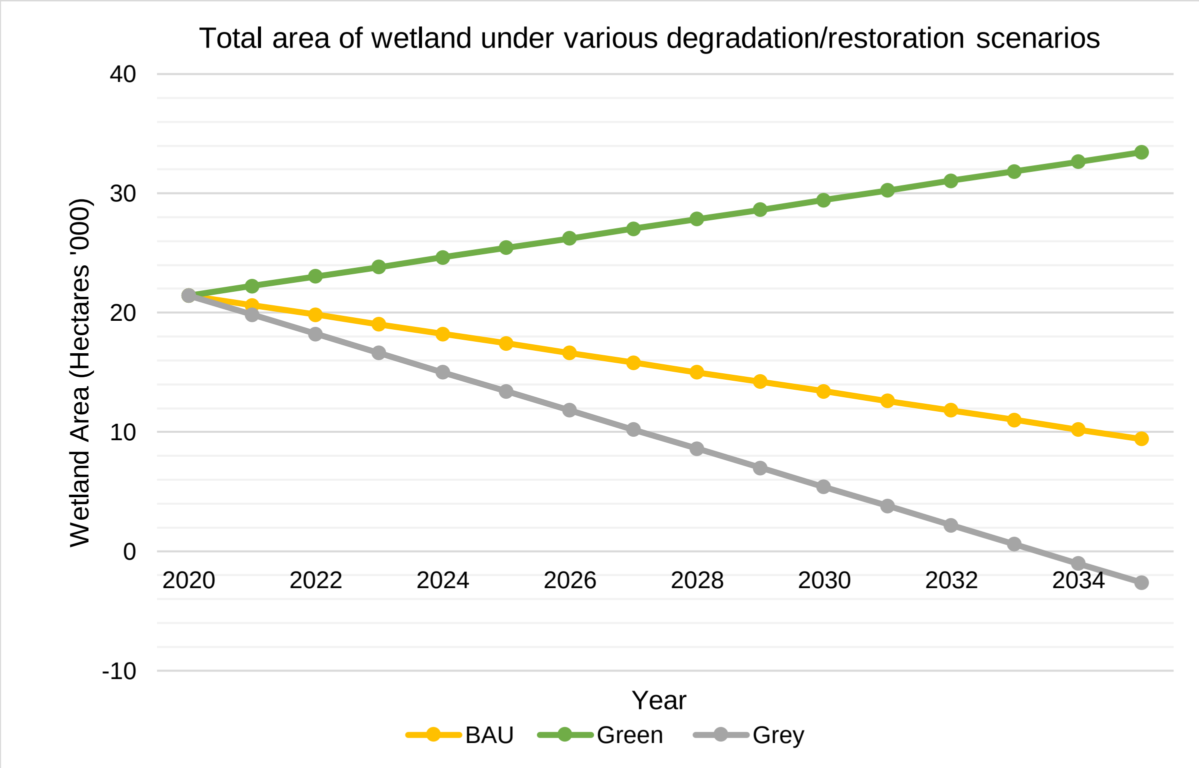


Figure 13: Graph showing the total area of wetland land cover change, under various degradation/restoration scenarios.

These factors, in addition to impacting the condition of the wetland and its ability to generate ecosystems services, increased resource extraction pressures to particularly affect key provisioning services like water, fuelwood, fodder, clay and sand. The patterns of resource extraction hence created conflicts and trade-offs that need to be corrected or addressed at management and policy levels. Sand extraction at Kagulube and Nangombe threatened the integrity of the wetland system and its continued functioning as a breeding, spawning and nursery ground for fish and appropriate habitat for the shoebill.

This study, in line with the TEEBAgriFood framework proposed three scenarios to unravel the possible interactions between natural, produced, human and social capital and the respective flows and value chains in the Mabamba Wetland System with a view to generating knowledge and some consensus on possible actions to address the conservation and development challenges in the wetland system. The three scenarios were: (i) the Business as Usual Scenario (BAU), (ii) the Green Scenario, and (iii) the Grey Scenario.

In the graphs (Figure 14, Figure 16, Figure 18) below, the ecosystem services discussed in Section 3.1 were clustered together into their broader categories of provisioning, supporting, regulating and cultural. Water supply for domestic use and livestock, capture fisheries, and grass for mulching were aggregated under provisioning services. Dry season wetland edge farming, fish breeding, spawning and nursery function as well as dry season grazing were categorized under supporting services. On the other hand, water purification and carbon sequestration were categorized as regulating service while water transport and tourism were categorized as cultural services. The clustering was done to facilitate graphical presentation and visualization of the changes in various ecosystem services under different scenarios. Sand mining, being generally illegal and counterproductive to the long term supply of the other ecosystem services, was treated separately in the three scenario presentations.

3.2.2. Business-as-Usual (BAU) Scenario

The Business-as-Usual Scenario (BAU) carries forward baseline social, economic and environmental policy and management practices in the wetland system and builds on the implementation of the National Development Plan 2020/21 – 2024/25 and subsequent revisions. The scenario is set within a broad framework of transforming Uganda from a peasant to a modern and prosperous country within 30 years in-line with the national vision 2040.

The scenario envisages continued wetland degradation at the baseline rate of 3.74 percent per annum as published in the National State of the Environment Report (NEMA, 2017). Due to mounting pressure on the Wetland from the surrounding Island, mainland and the cities of Kampala and Entebbe, and the opening of the wetland to commercial activity, this study used the national wetland degradation rate of 3.74 percent per annum for the purposes modelling and scenario analysis. The main drivers of wetland loss are agricultural encroachment, infrastructure development and unsustainable resource extraction, particularly sand mining at various sites within the wetland system.

If the situation continues without intervention, wetland degradation will increase as a consequence of encroachment and illegal resources extraction from the wetland, particularly sand mining. Approximately 801.4 ha of the wetland will be degraded annually (Figure 13). This is likely to translate into a greater proportionate loss in ecosystem services and degradation of habitat condition. Ultimately, this may impact the ultimate loss of biodiversity, particularly the endangered Shoebill, the near threatened Papyrus Gonolek, vulnerable Blue Swallow and Papyrus Yellow Warbler. This will adversely affect tourism and other associated activities and services linked with Mabamba's biodiversity. This scenario shows a marked increase in unsustainable and illegal activities in the wetland (i.e. Sand mining), at the expense of the other wetland ecosystem services (Figure 14-15, Appendix 5).

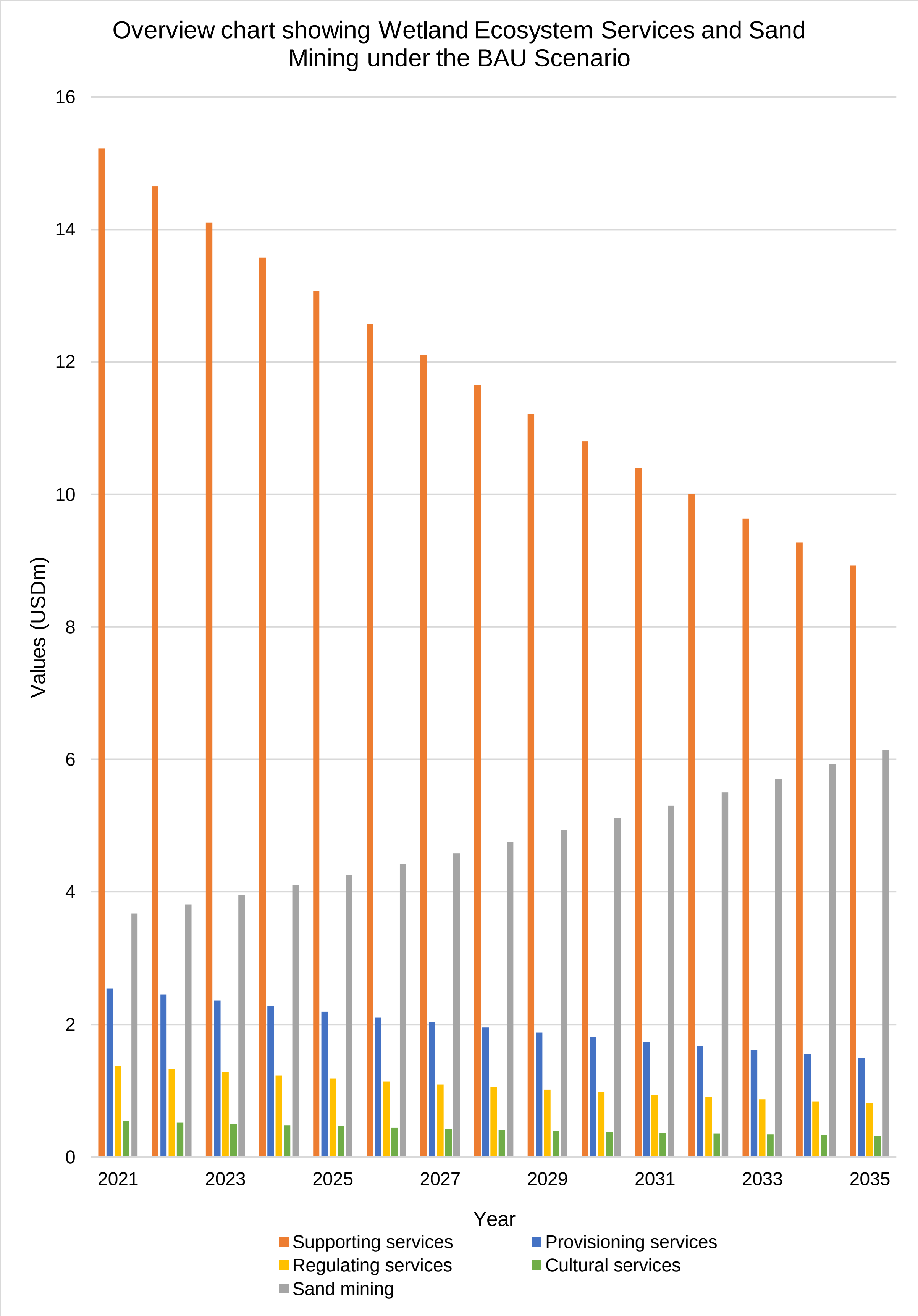
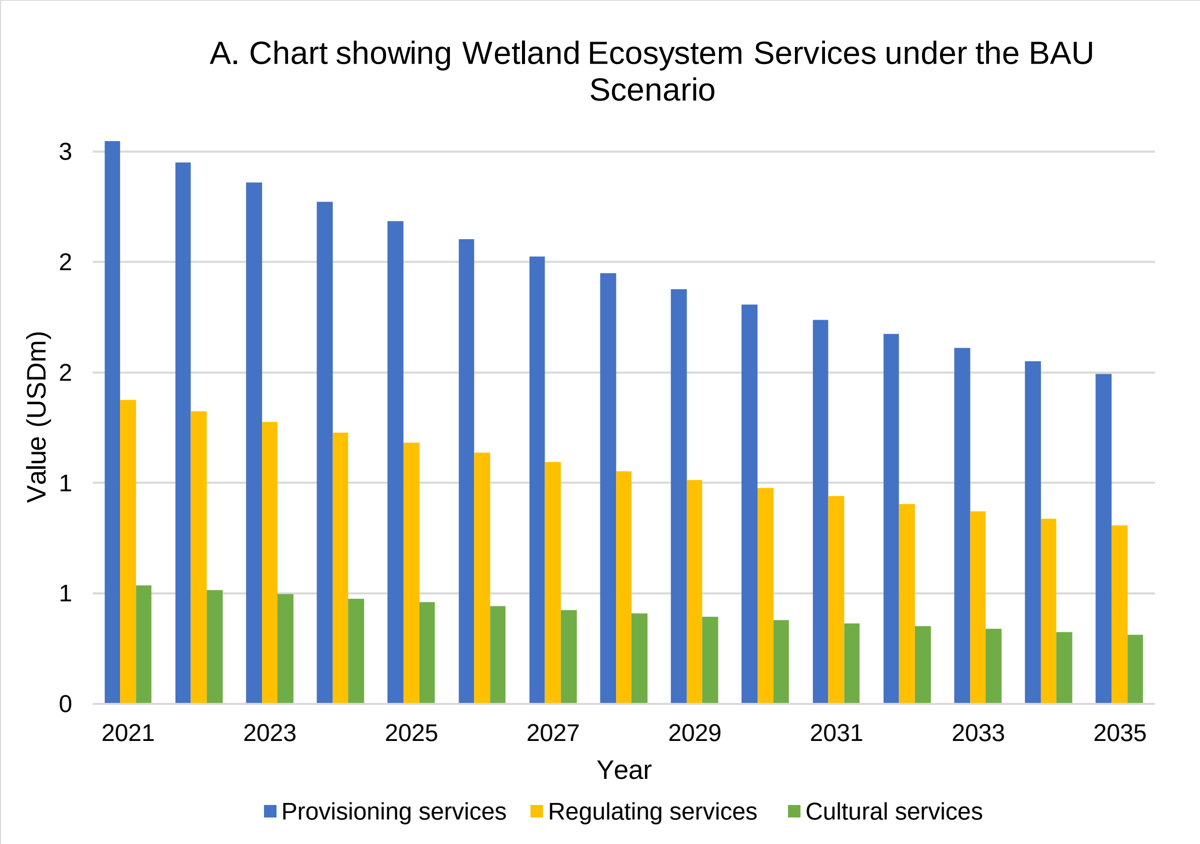


Figure 14: Overview chart showing the changes in the value of wetland ecosystem services (by type) and sand mining, under the BAU Scenario.



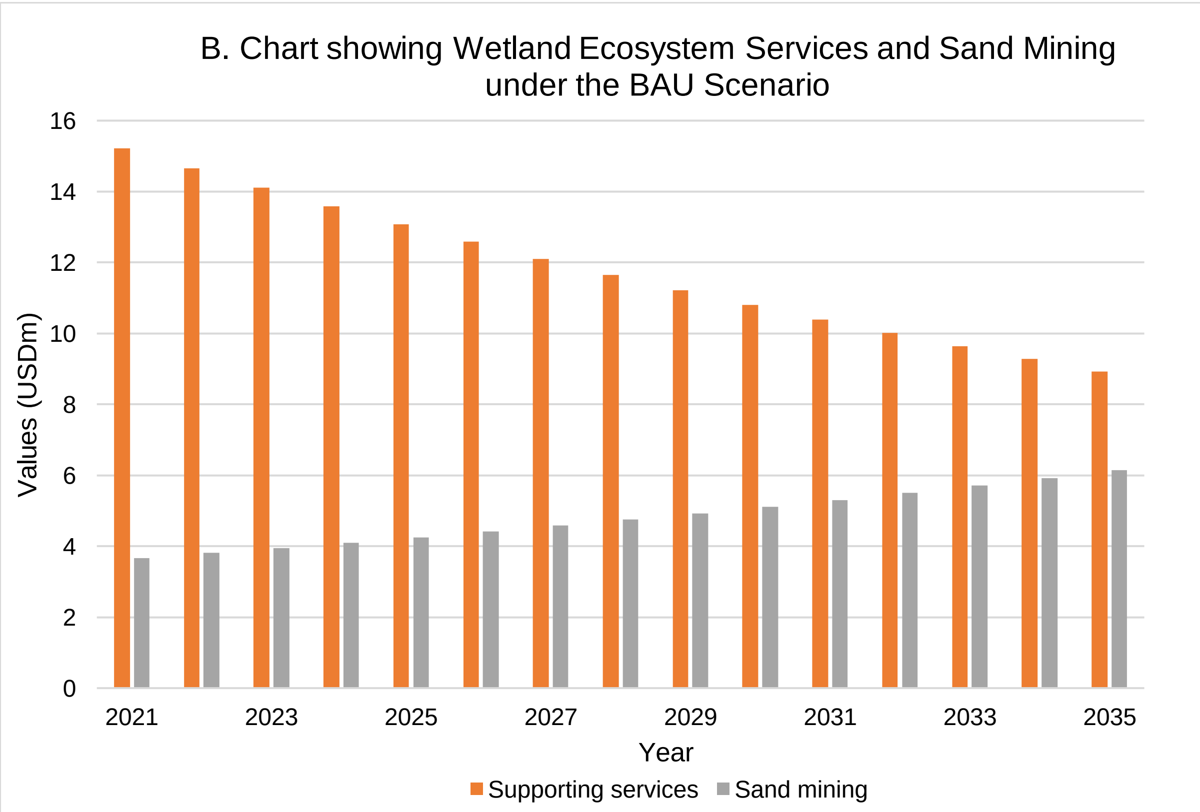


Figure 15: Charts showing the changes in the value of wetland ecosystem services (by type), under the BAU Scenario.

3.2.3. Green Scenario

The Green Scenario is based on the green growth aspirations of the country as articulated in Uganda's Green Growth Development Strategy 2017/18 – 2030/31. The scenario envisages development within a broad framework of improved environmental governance with the requisite environmental monitoring, compliance and enforcement outcomes. The scenario acknowledges the proposed designation of a further area of the Mabamba Wetland System (up to 22,375.39 ha) as a Ramsar site and Important Bird Area, promulgation and implementation of the new Wetlands Management Act, protection of the wetland and prevention of unsustainable resource use and extraction activities including sand mining.

These actions are projected to cause recovery of lost wetland area at a modest rate of 3.74 percent per annum. This translates into a recovery rate of 801.4 ha /annum. This is projected to result into recovery of 12,021 ha over the next 15 years (2020-2035) (Figure 13). This will enhance wetland ecosystem conditions and increase its capacity to supply ecosystem services as reflected in the GREEN scenario (Figure 16-17, Appendix 6). This scenario if augmented with the requisite infrastructure developments as well as sustainably managed urban and peri urban farming systems, agro-industrialization and tourism development will increase the stock and flow of natural capital and human, social and produced capital stocks in the area.

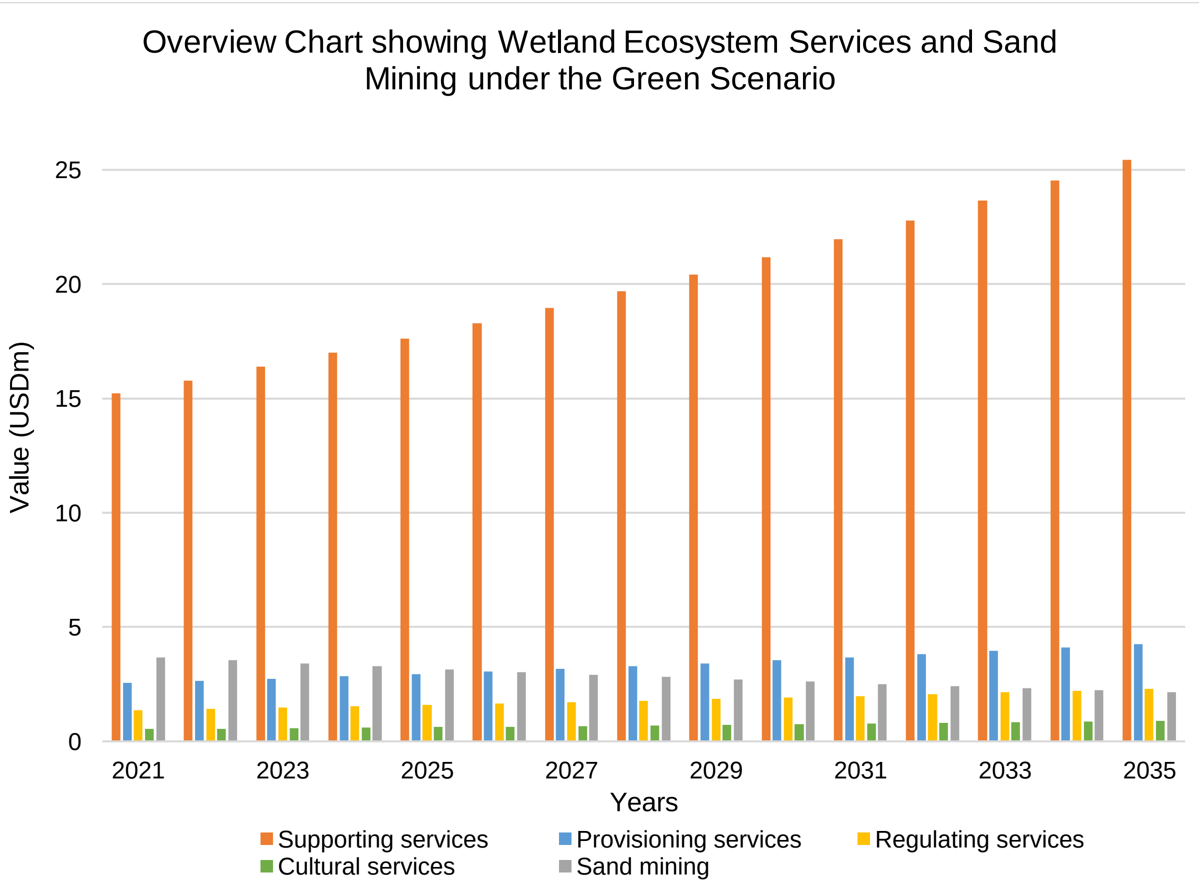
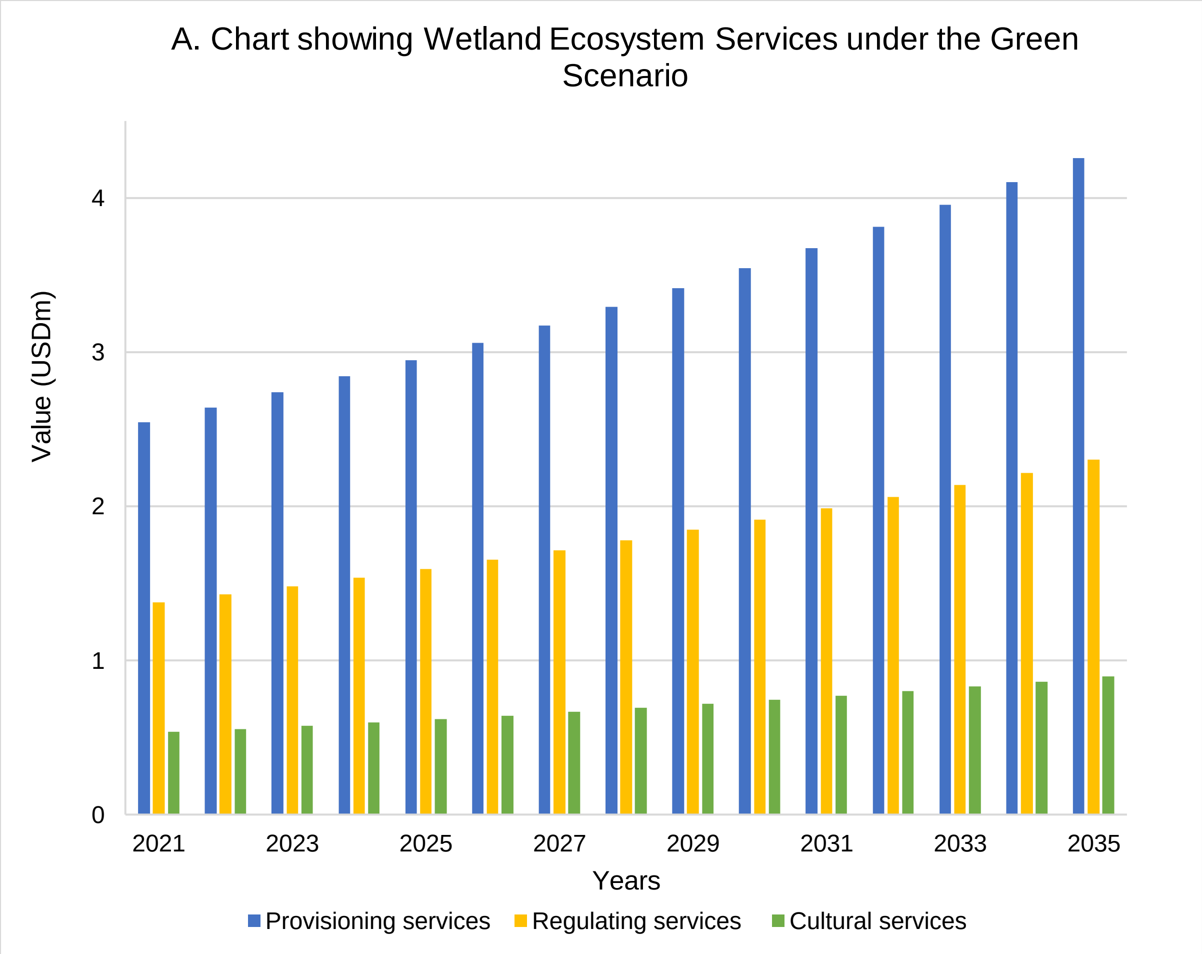


Figure 16: Overview chart showing the changes in the value of wetland ecosystem services (by type) and sand mining, under the Green Scenario.



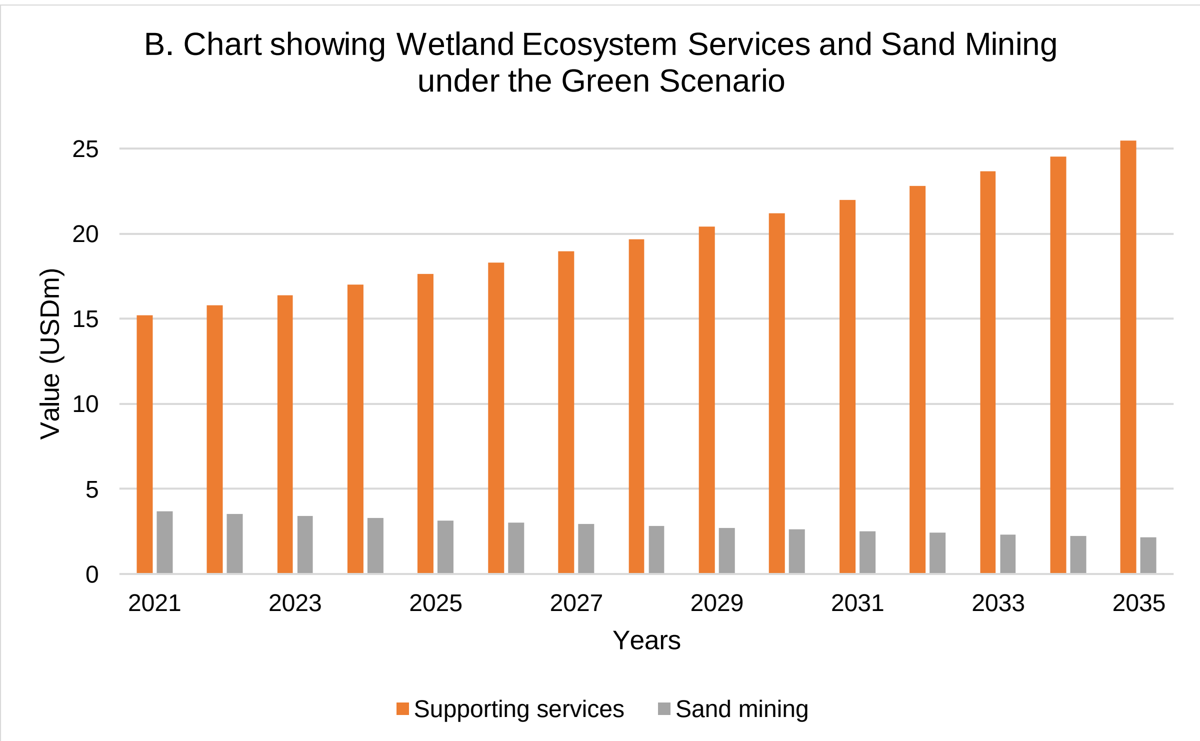


Figure 17: Charts showing the changes in the value of wetland ecosystem services (by type), under the Green scenario.

3.2.4. Grey Scenario

The Grey Scenario on the other hand is a pessimistic scenario and assumes the breakdown of law and order and expansion of agriculture, urbanization, infrastructure and human settlements without the requisite development controls. It involves increased land cover change and wetland conversion and degradation due to agricultural encroachment, sand mining and development of infrastructure including roads through the wetland.

The Grey Scenario projected an overall rate of wetland loss of 7.48 percent per annum, mostly associated with sand mining, human settlements and agricultural encroachment. This is the worst case scenario, and is projected to double the current national wetland degradation rate of 3.74 percent (under the BAU scenario). This translates into an annual loss of wetland area of 1,602.8 ha, implying a loss of more than half of the current wetland area by 2035. That level of degradation would compromise the wetland's capacity to supply critical ecosystem services (Figure 18-19, Appendix 7) including its habitat value especially for the endangered and threatened bird species like the Shoebill (*Balaeniceps rex*), the near threatened Papyrus Gonolek (*Laniarius mufumbiri)*, the vulnerable Blue swallow (*Hirundo atrocaerulea*) and Papyrus yellow Warbler (*Calamonastides gracilirostris*).

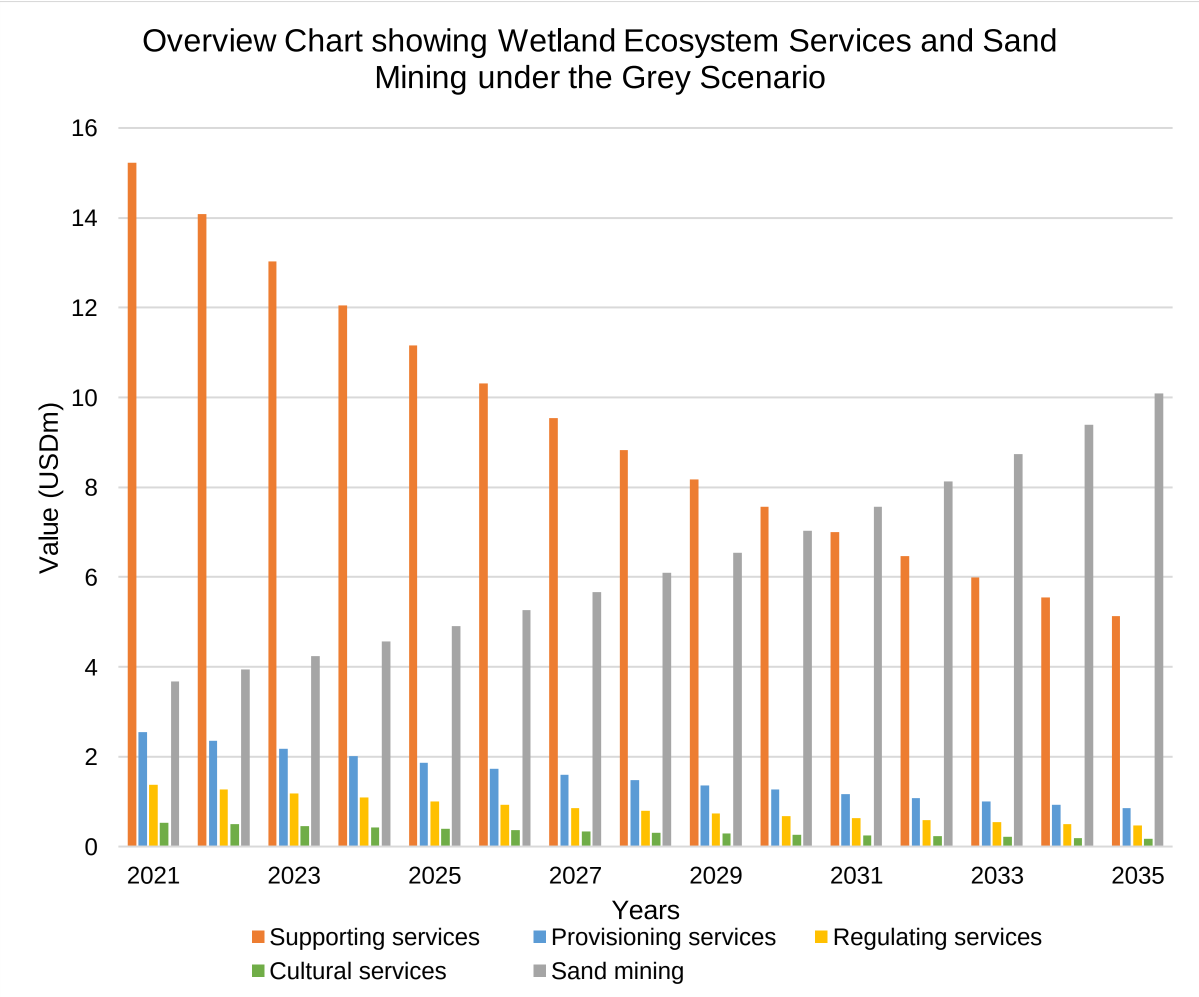
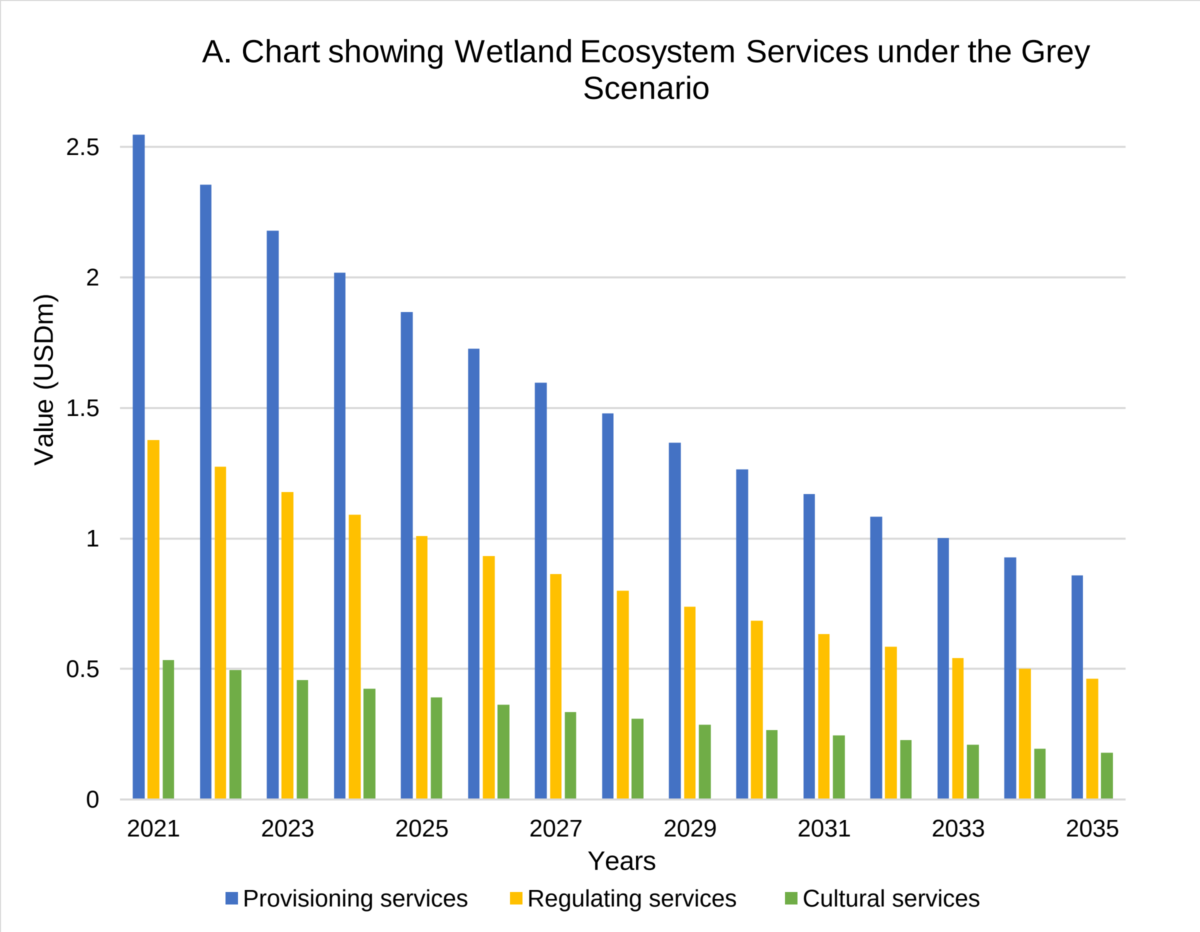


Figure 18: Overview chart showing the changes in the value of wetland ecosystem services (by type) and sand mining, under the Grey Scenario.



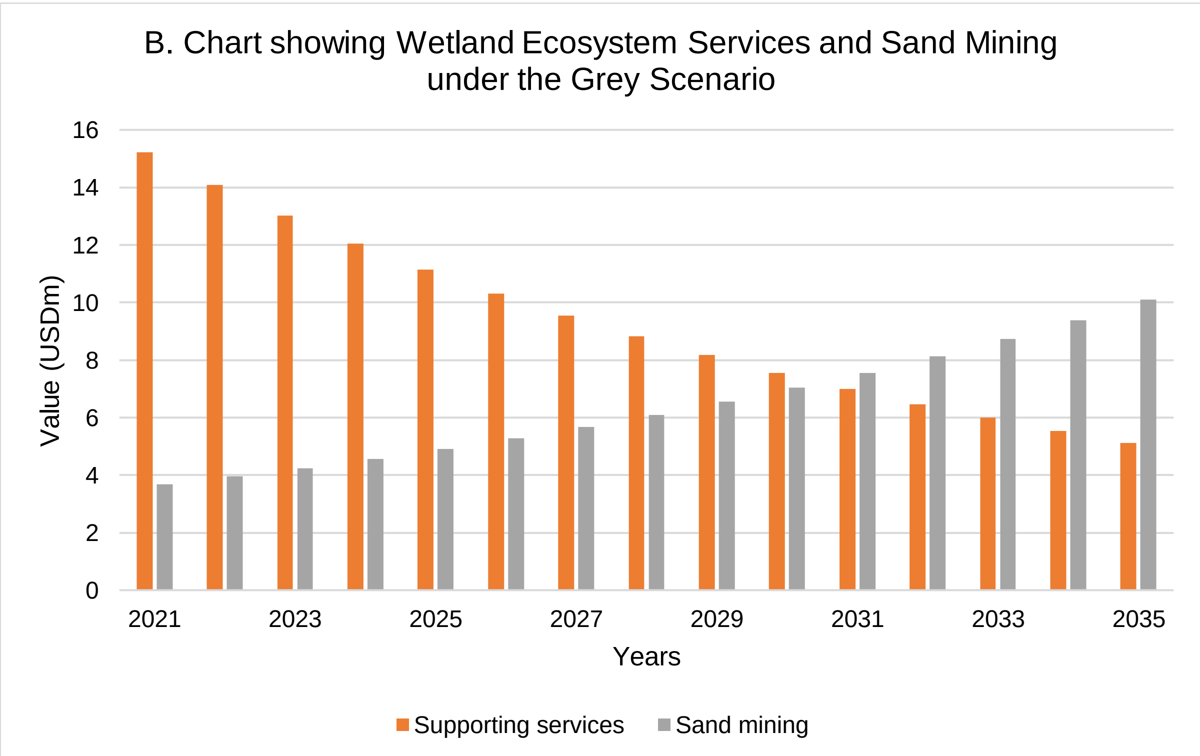


Figure 19: Charts showing the changes in the value of wetland ecosystem services (by type), under the Grey scenario.

4. Discussion

4.1 Analysis of the various management scenarios

The analysis of the various management scenarios is based on the potential land cover changes in the wetland under the different scenarios and the implications of such change for the wetland's capacity to generate and supply ecosystem services, the ecological implications and associated livelihood implications of these interactions. The wetland supports jobs in the fishing, ecotourism, water transport and wetland resource extraction segments including sand mining. Overwhelmingly, it is found that the visible and marketed provisioning, regulating, and cultural services at the Mabamba Bay are greatly dwarfed by supporting ecosystem services.

The Grey Scenario will see a potential collapse of most employment segments except wetland resource extraction (mainly sand mining) as the impacts of wetland degradation bear on the ecological support systems that maintain the Shoebill-based tourism activities in the wetland. The Shoebill feeds on lung fish (*Protopterus spp*) and needs a pristine wetland habitat for its survival. The wetland is also critical to the survival of juvenile Shoebills, especially after their expulsion from the parent colony.

The Green Scenario on the other hand will preclude sand mining and collapse the employment opportunities and revenue implications thereof. Whereas many stakeholders including the local political leadership decried the negative impacts of sand mining, they acknowledged the high revenue potential the sector generated compared to the other activities in the wetland system. The driving force behind the Green Scenario will therefore require political commitment and an understanding of the growth potential and dynamic revenue generation opportunities associated with the other ecosystem services. The ecotourism sector for instance demonstrates a large revenue growth and employment potential and can transform the livelihoods of the people in the wetland system in the short to medium term. Once the road network in the area is improved, the urban and peri urban farming opportunities in the area can be up scaled. The fertile soils, good micro-climate and availability of water for livestock and irrigation will support a flourishing eco-agricultural-food value chain.

The Grey Scenario is unsustainable and envisages the gradual collapse of the wetland system and the ecosystem services it generates. Sand mining which is a key ecosystem service from the wetland would irreversibly undermine the integrity of the wetland system, eventually extinguishing the revenue and employment opportunities associated with the other ecosystem services.

4.2 Natural, human, social, and produced capital interactions in the Mabamba Bay Wetland

The Mabamba Bay Wetland Area is a richly endowed ecological system with a broad range of flora and fauna. The wetland comprises of an extensive marshland inhabited by several species of birds and fish of great touristic value. The fish are an important component of the natural capital stocks in the wetland, providing food for the Shoebill and other fauna in the wetland, but also contributing to the nutrition needs of the local and urban and peri urban communities in Kampala, Entebbe, Wakiso and Mpigi. The Shoebill is an important tourist attraction and tourism income based on entry fees alone grew from US$1,712 in 2017 to more than US$11,712 in 2021 (nearly 700 percent growth). The other natural capital stocks in the area include fertile soils for urban and peri urban farming, water, a suitable micro-climate for a wide range of crop and livestock farming, large deposits of high grade sand and stocks of below and above ground carbon. This study quantified and valued the baseline flows from the above-mentioned stocks of natural capital. The study using scenario modelling techniques, also assessed the impact of environmental degradation on future flows of ecosystem services. The modelling was simple and abstracted the impact of resource scarcity and inflation on future prices.

The close proximity of the wetland system to major urban centres provides many livelihood opportunities which has led to a visible influx of people into the area. The population of Kasanje Town Council for example increased from30,600 persons in 2015 to more than 42,300 people in 2020 registering a population growth rate of 6.7 percent per annum well above the national average of 3.3 percent per annum in the same year (UBoS, 2019). The livelihood opportunities in the area include fishing, tourism, sand mining, small retail businesses and food vending, transport by boat and motorcycles (*boda bodas*), and a big growth opportunity in the accommodation and hotel sub-sector. This study recorded at least six new hotel businesses including Nkima Forest Lodge, TJJ Resort Mabamba, Faultfree Safari Motel, Skyway Hotel and Prestige Resort Cottages among others.

In order to take advantage of the livelihood opportunities but to also respond to environment degradation in the area, a number of community grass roots organisations have come up. The community around Mabamba Landing Site alone are organised into three groups under an umbrella community-based organisation known as the Mabamba bay Wetland Eco Tourism Association (MWETA). The three groups bring together bird guides, boat riders and fishermen and the crafts and hunters' group (Nature Uganda, 2014). The other key stakeholder was the Catholic Church who own the largest single contiguous parcel of land to the wetland.

Key informant interviews revealed plans to construct paved road infrastructure through the wetland from Muzina landing site (on the mainland) to Gombe village on Bussi Island. The road is intended to enhance traffic flow between the mainland and the island to boost the local economy in the area. The road could cause habitat fragmentation and affect the habitat size for some of the threatened and endangered species in the area (especially the Shoebill, *Balaeniceps rex,* and Sitatunga antelope, *Tragelaphus spekii*). Increased traffic could also result in pollution (noise and emissions) that will compromise habitat quality. Additionally, there is a danger of accidents involving vehicles on the proposed road and wildlife in the wetland particularly for non-flying animals. To prevent habitat fragmentation and accidents (involving vehicles and wildlife), the proposed road from Muzina landing site (mainland) to Gombe village (Bussi Island) should be a suspended road or bridge. The road will however, improve trade flows and stimulate further investments in urban and peri urban agriculture around the wetland and in Bussi Island.

This study noted that a number of ecosystem services underpin food security, employment and social benefits although respondents mostly recognised provisioning services related to basic needs and immediate benefits, especially those that generated income. Anecdotal information from key informant interviews suggested that the good nutritional standard, clean and healthy environment and remoteness of the Mabamba Bay Wetland area kept most communicable diseases including COVID-19 at bay with Bussi Island reporting zero cases by the dates of this study.

The Mabamba Bay Wetland System faces increasing pressure from settlements and urban development from both the surrounding areas on the mainland and the Island. This pressure is causing encroachment on the wetland. Agricultural expansion into the wetland is equally a contributing factor to wetland encroachment. The activities if unchecked will accelerate land cover change in the wetland escalating the situation into the BAU and Grey Scenarios which will affect the wetland's capacity to provide its ecosystem services (Figures 14-19). The current and future interacting influences between and within the broad spectrums of natural, human, social and produced capital stocks in the area are further discussed under the above-mentioned scenarios.

5. Policy mainstreaming and further work

5.1 Policy mainstreaming and recommendations

The ultimate thrust of this study was to assess and document the influence and collective impact of various policies, laws and institutions on the eco-agri-food value chains in the Mabamba Bay Wetland System. The study therefore appraised national policies and laws on the environment, forestry, water, wetlands, land, climate change, relief, disaster preparedness and management, local government, urban development, agriculture including inorganic agriculture, food and nutrition, employment and the economy in general with a view to recognising, valuing and proposing measures to mitigate or take advantage of the negative and positive externalities of all human activities in the wetland system respectively.

The study noted a plethora of policies at the national level and the necessary attempt to provide guidance on several aspects of governance in the country. There was also a visible attempt to translate this to the sub-national level as evidenced by the physical presence of policy documents and articulation of policy positions by officers in the local government offices visited during this study. This study noted however, that although most government and community leaders were well versed with government policy direction on key issues, they lacked the tools, power or good will to implement several government policies on the ground. The Local council Chairman Kasanje Town Council for instance decried the degrading impact of sand mining in the lakeshores and wetlands in the area and lamented the inability of his local government to stop this illegal and destructive activity citing central government interference. The Local Government at the same time collected local revenue on sand transportation through the Town Council.

There was also fundamental lack of understanding of the operations of most of the local value chains due to a dearth of agricultural and trade statistics. There was no information on business enterprises, gross margins, prices, production volumes, losses and local consumption, significantly hampering revenue collection and effective planning. Mabamba Bay Wetland Area hence, though clearly a high potential area for tourism, fisheries, agriculture and agro-industrialisation, remains under serviced with no paved roads, modern water transport, piped water, electricity and decent housing which are essential for local economic development.

This study therefore recommends the following government interventions to improve the development prospects at the local level:

(viii) improve the road network in the area;

(ix) expand the electricity grid and improve the efficiency in the provision of power;

(x) ensure improved access to land and land tenure security;

(xi) ensure improved access to quality agricultural inputs such as seeds, fertilisers, veterinary drugs and agro-chemicals;

(xii) improve agricultural marketing;

(xiii) increase the effectiveness and efficiency of the agricultural extension system;

(xiv) create and support the development of community-based organisations so that people can effectively and profitably participate in the supply chains of the various enterprises in the area.

5.2 International applications of the TEEBAgriFood Uganda study in the Mabamba Bay Wetlands System

5.2.1. Promoting Sustainable Urban and Peri-Urban Agriculture (UPA) for healthy, sustainable, and nutritious diets in Kampala, Uganda.

Led by the UN Environment Programme's Economy Division, the project aims to conduct an efficiency analysis on the social, economic, and environmental returns on investment (SROI) of UPA, as compared against the traditional food supply chains provisioning Kampala City. It is supported by Rikolto, an international network organisation specialising in farmer organisations and food chain stakeholders, to address the challenges of food security, safeguards, and accessibility in food smart cities. In turn, the partnership and project will aim to benefit the creation of a more resilient and sustainable food system and urban food environment in Kampala.

The project, akin to the TEEB for Agriculture and Food application in Uganda, recognises that urban agriculture remains vibrant and critical to the well-being of many households in Kampala, however the sector and practices faces many short-term and long-term challenges ahead. Such include the increased risk of urban encroachment onto agricultural lands, declining water quality, high feed prices for urban livestock, and the loss of productivity associated with flooding and high vulnerability to climate change.

The project's target audience involves policy makers and stakeholders located in Kampala, specifically those with the designation to influence the development of local strategies. Other cities may also benefit from investment and planning for sustainable urban farming as a consequence, such as Mbale, Jinja, and Gulu. This will be acquired as a result of the project analysis comparing the return on investment of UPA with conventional (long) food chains that currently supply Uganda's capital. These may include benefits from improved food safety, food nutrition, education on sustainable and healthy eating, avoiding food losses and wastes, and money invested in the local economy. In doing so, the study may therefore formulate recommendations to optimise the efficiency of UPA.

The research methodology which will be employed consists of the Social Return on Investment (SROI) methodology, to allow a broader range of expected social and environmental benefits to be mapped and included in the efficiency calculation – along with the economic benefits. The analysis will cover nutrient dense foods like vegetables (leafy greens, cabbage, tomatoes, onions, bitter tomatoes, etc) and spices (chili, mint, coriander, rosemary, etc). Model farmers have also been trained to promote urban farming using simple technologies and methodologies to enable food security and safety in the urban and peri-urban space, including sack gardens, food towers, integrated pest management, aquaponics, and vermiculture (Rikolto, 2021; KCCA, 2022).

By enabling knowledge sharing and capacity building between urban and peri-urban projects in Kampala and providing a space for policy-makers and experts to collaborate, such as through the Workshop on Sustainable Urban and Peri-Urban Agriculture for Healthy, Sustainable and Nutritious Diets (26th October 2021), the interlinkages between sustainable food consumption, production, and circular economy practices in Kampala may be strengthened. Furthermore, this supports the creation of an enabling environment for sustainable urban- and peri-urban agricultural practices across all areas of Kampala and its environs (such as the Mabamba Bay Wetland System).

5.2.2. Beyond Food: The contribution of urban agriculture to the well-being in the metropolis of Sao Paulo, Brazil

Led by the UN Environment Programme and technically supported by Instituto Escolhas, the project aims to assess and evaluate UPA in the Metropolitan Region of São Paulo using the TEEB for Agriculture and Food (TEEBAgriFood) framework, by internalising considerations for relevant ecosystem services, impacts, and dependencies from other capitals (Instituto Escolhas, 2021). The study will support policy dialogues within the scope of the project with the Government of São Paulo, and other relevant stakeholders on the links between UPA from a food systems perspective.

Five ecosystem services were assessed between 1985 and 2019 (water yield, flood mitigation, heat mitigation, erosion mitigation, and food supply), as to inform the contribution of agriculture to the supply and maintenance of ecosystem services in the metropolis of São Paulo (Instituto Escolhas, 2021). Two scenarios were simulated and assessed with the forecasting until 2030, namely the business-as-usual (BAU) scenario, and the scenario of expansion of sustainable agriculture (Scenario 1). The study concluded that in comparing the BAU scenario against Scenario 1, agriculture is found to be able to mitigate the negative impact of urban expansion in the São Paulo metropolis if it is conducted sustainably (ibid). This would be enabled through the practices of ecological soil management, the maintenance of trees in the productive system, the non-use of agrochemicals, and the use of more efficient irrigation techniques.

The alignment of scope and methodological opportunities between the TEEBAgriFood Brazil UPA application in São Paulo and the one conducted by the Nile Basin Initiative in the Mabamba Bay Wetland System demonstrates an area of shared learning and knowledge-exchange. Further extension opportunities assessing UPA production in Uganda and their impacts upon local ecosystem services, without a wetlands dimension, would be able to draw on the Brazilian case study and be applied to another Ugandan city with observed UPA activities and production contributing highly to local sources of livehoods. Such may include Mbarara, Mbale, or Fort Portal.

5.3 Further work and extension opportunities

Tentative opportunities to extend the “lite” TEEBAgriFood Uganda project in a Phase 2 may seek to be informed by the outcomes derived from the current application discussed in this report. Such include the inclusion of sand mining as a green-grey option for scenario analysis, as stakeholder discussions have indicated that there is no appetite to ban the activity as a result of its high revenue potential in the wetland system. Further discussions and project scoping on the marginal change between degradation activities upon ecosystem services would also be beneficial, whereby activities such as eco-tourism and other cultural values are expected to maintain monetary and socioeconomic value to Mabamba Bay despite incidences of small-scale or isolated degradation activities.

The Nile Basin Initiative study, upon application of possible further project extension opportunities, also recommends the application of national level programs on ecosystem characterisation, inventory and documentation to generate ecosystem specific datasets be undertaken to enlighten policy on development opportunities and potential trade-offs. Capacity building in spatial analysis techniques including the INVEST model and various earth observation approaches will provide an important input into this national program.

In consequence to the capacity building recommendations from the Nile Basin Initiative, the UNEP World Conservation Monitoring Centre has further explored the opportunities for a spatially-explicit analysis of the unique ecosystem services and resulting impacts of future scenarios at Mabamba Bay. Numerous participatory and desk-based modelling and mapping approaches are identified and recommended for the study, with consideration of location-specific limitations and trade-offs. Such include the accessibility of high resolution and time-series spatial data in Eastern Africa, and scoping of the modelling approaches to consider the supply, demand, and use of ecosystem services in tandem. Detailed data accessibility, methods, and limitations are also identified and discussed for carbon, water, habitat quality, recreation and tourism, as specific to tools such as InVEST and WaterWorld.

Overall, the UNEP World Conservation Monitoring Centre study contribution recommends for the targeted assessment of the capacity status, location, and needs to inform where the gaps are, in order to successfully conduct a spatially-explicit analysis of ecosystem service impacts of future scenarios of Mabamba Bay and the wider environs.

6. Appendices

Appendix 1: Persons consulted during the TEEBAgriFood Uganda study

#	Name	Designation	Jurisdiction	Contact
		National Level		
1	John Birantana	Senior Policy Analyst	MAAIF, Department of Agricultural Planning	0752699075 birajohnnie@yahoo.com
2	Lucy Iyango	Commissioner, Wetlands	Ministry of Water and Environment	Iyangol2010@gmail.com
3	Carol Kagaba	Senior Wetland Officer	Ministry of Water and Environment	ckagaba2001@yahoo.com
4	Nicholas Magara	Regional Wetland Coordinator/Central	Ministry of Water and Environment	magaranik@yahoo.com
5	Oliver Namirimu	Wetland Officer/Ramsar Sites	Ministry of Water and Environment	olivnamirimu@gmail.com
6	Peter Ndugga	Wetland Officer, GIS	Ministry of Water and Environment	npetermichael@gmail.com
7	Asadhu Ssebyoto	Wetlands Officer, GIS	Ministry of Water and Environment	0778283618

		Wakiso District, Regional Level		
8	Kityo Moses	Fisheries Officer	Kasanje Sub County	0701524530
9	Mukasa Archilles	Agriculture Officer	Kasanje Sub County	0701005282
10	Lubega Arnold	Veterinary Officer	Kasanje Sub County	0774851249
11	Lubulwa Henry	District Agriculture Officer	Wakiso District	0770957297
12	Yonesani Gayira	Chairman LC III	Kasanje Sub-county	0757040071
13	Hannington Kasasa	Chairman, Community Tour Guides	Mabamba Landing site	0782945185
14	Wilson Ssenfuma	Tour Guide	Kasanje Sub-County	0780351047/ 0758830133
15	Kamanyi Bob	Chairman LC 1	Gulwe Village	0782374239
16	Eddy Batanudde	Chairman LC 1	Gombe Village	0785756053
17	Rachael Namatovu	Chairperson LC1	Kisaba Village	0788702463
18	Innocent Muhuza	Tour Guide	Mabamba Tourism	0778026896
19	Robert Odiambo	Chairman LC 1	Seeta-Bussi Village	0782096261
20	Denis Sebutunda	Chairman LC 1	Bulumbu-Bubebere Village	0757572197
21	Vicent Muyambi	Chairman LC 1	Ziiba–Mabamba Village	0779373531

		Mpigi District, Regional Level		
22	Azalia Kaggwa	District Agriculture Officer	Kamengo Sub County	0772323867
23	Francis Kakande	Farmer and LCI Chairman	Kamengo Sub-County, Luwala Village	0753902446
24	John Paul Asiimwe	Tour Guide	Kamengo Sub County	
25	Fred Bakaluba	Boat Rider	Kamengo Sub County	0772584767
26	Baker Kiwanuka	Chairman LC 1	Busomba Village	0773447779

Appendix 2: Governance instruments appraised

Environment and Wetlands Policy			
No #	**Instrument**	**Brief**	**Link**
1	The National Environmental Management Policy (2017)	Provisions for regulation and management of Urban and Peri Urban Agricultural Spaces, and the management of wetlands.	
2	The National Forestry Policy (2001)	Contains provisions for ameliorating impacts of drought, watershed protection and soil conservation.	https://www.nfa.go.ug/images/UgandaForestryPolicy2001.pdf
3	National Water Policy, 1999	Promotes the principles of Integrated Water Resources Management (IWRM) as a means to ensuring sustainable management and utilization of water resources in Uganda.	http://extwprlegs1.fao.org/docs/pdf/uga158331.pdf
4	Strategic Investment Plan for the Water and Environment Sector Uganda (2018 – 2030)	Guidelines for investments and strategic interventions towards environment and water resources (wetlands) conservation.	https://www.mwe.go.ug/sites/default/files/library/Water%20and%20Environment%20Sector%20Investment%20Plan%20%202018.pdf
5	National Policy for the Conservation and Management of Wetland Resources, 1995	Curb the rampant loss of wetlands, ensure the sustainable utilization of wetland resources, provide for equitable distribution of wetland benefits, support the maintenance of wetland biodiversity and ecosystem functions.	https://www.ramsar.org/sites/default/files/documents/library/national_wetland_policies_-_uganda.pdf
6	Mabamba Bay Wetland Community Action Plan	Intervention action guidelines for the conservation and sustainable use of Mabamba Bay Wetland.	http://www.natureuganda.org/downloads/Mabamba%20Bay%20Community%20Action%20Plan.pdf
7	National Land Use Policy, 2014	Provision for sustainable use of land to meet agricultural, urbanization, habitation and environmental development needs.	https://www.jlos.go.ug/index.php/document-centre/land-justice/366-uganda-national-land-policy/file
8	National Climate Change Policy, 2015	Guidelines towards promoting sustainable development and green economy, which includes UPA and wetlands conservation.	https://www.mwe.go.ug/sites/default/files/library/National%20Climate%20Change%20Policy%20April%202015%20final.pdf
9	The National Policy for Disaster Preparedness and Management, 2010	Contains provisions for reducing the vulnerability of people, livestock, plants and wildlife to disasters in Uganda.	https://www.ifrc.org/docs/IDRL/Disaster%20Policy%20for%20Uganda.pdf

Environment and Wetland Laws			
No #	**Instrument**	**Brief**	**Link**
10	The Water Act, CAP 152	Act provides for, among other things, the use, protection and management of water resources including wetlands.	https://www.mwe.go.ug/sites/default/files/library/Uganda%20Water%20Act.pdf
11	The National Environment Act, 2019	provides protection to wetlands under its clauses 37 and 38. Prohibits reclamation or draining of wetlands, thereby providing guidance towards sustainable use of wetlands resources for UPA purposes.	https://nema.go.ug/sites/all/themes/nema/docs/National%20Environment%20Act,%20No.%205%20of%202019.pdf

12	The National Environment (Wetlands, River Banks and Lake Shores Management) Regulations, No. 3/2000.	Regulation and guidelines for the sustainable management and protection of wetlands in Uganda.	http://nema.go.ug/sites/all/themes/nema/docs/wetlands_riverbanks.pdf
13	The National Environment (Environmental and Social Assessment) Regulations, 2020.	Enabling sustainable development in natural ecosystems (including wetlands) through protection against development impacts.	https://nema.go.ug/sites/all/themes/nema/docs/National%20Environment%20(Environmental%20and%20Social%20Assessment)%20Regulations%20S.I.%20No.%20143%20of%202020.pdf
14	The Local Governments Act, 2005	The Act devolves the management of wetlands to Local Governments to ensue country-wide demarcation, restoration and management planning of wetlands.	https://ulii.org/akn/ug/act/1997/5/eng%402000-12-31
15	The National Environment Bill, 2017	Provides for proper environmental planning at the national and district levels – which is critical for UPA; and sustainable use and proper management of the environment and natural resources including wetlands .	https://nema.go.ug/sites/default/files/NEMA%20Bill%202017%20latest%2024%20Nov%202017.pdf

Cross-cutting/Development Policies			
No #	**Instrument**	**Brief**	**Link**
16	National Development Plan (NDPIII) Programs	Provisions and guidelines for agricultural development in Uganda, with Agriculture as one of the key sectors.	http://www.npa.go.ug/wp-content/uploads/2020/08/NDPIII-Finale_Compressed.pdf
17	The Uganda National Poverty Eradication Action Plan	Recognizes the unique contribution of wetlands and environmental resources to poverty reduction and builds on integrated approaches to sustainable livelihoods while protecting the environment.	https://www.imf.org/external/pubs/ft/scr/2014/cr14354.pdf
18	Uganda's "Vision 2040" Development Agenda	Prioritizes Agriculture as one of the key development sectors in Uganda and provides guidelines for development by 2040.	http://www.npa.go.ug/uganda-vision-2040/
19	Uganda National Urban Policy, 2017	Promoting equitable economic development in urban areas, including promotion of urban agriculture.	https://mlhud.go.ug/wp-content/uploads/2019/07/National-Urban-Policy-2017-printed-copy.pdf

Agricultural Policies			
No #	**Instrument**	**Brief**	**Link**
20	Uganda National Irrigation Policy, 2017	Development and sustainable management of irrigation resources to achieve sustainable agricultural development .	https://www.mwe.go.ug/sites/default/files/library/Uganda%20National%20Irrigation%20Policy.pdf
21	The National Agriculture Policy, 2013	Provides a roadmap and guideline towards increased and sustainable production for UPA.	https://www.agriculture.go.ug/wp-content/uploads/2019/04/National-Agriculture-Policy-1.pdf
22	National Organic Agriculture Policy, 2019	Transformation of agricultural sub-sectors, environmental sustainability and food and nutrition security.	https://www.agriculture.go.ug/wp-content/uploads/2020/09/Nati

			onal-Organic-Agriculture-Policy.pdf
23	Agriculture Sector Strategic Plan 2015/16 – 2019/20	Transformation of the agricultural sector to be more commercial.	https://www.agriculture.go.ug/wp-content/uploads/2019/05/Agriculture-Sector-Strategic-Plan-ASSP.pdf
24	National Strategy for Youth Employment in Agriculture, 2017	Youth involvement in UPA and Agricultural extension services.	https://www.agriculture.go.ug/wp-content/uploads/2019/05/National-Strategy-for-Youth-Employment-in-Agriculture-NSYEA-1.pdf
25	Local Governments Urban Agriculture Ordinance, 2006	Control and regulation of urban agriculture and related matters.	https://www.kcca.go.ug/uploads/acts/Kcc%20Urban%20Agriculture%20Ordnance,2006.pdf
26	Local Governments Livestock and Companion Animals Ordinance, 2006	Critical in informing on Urban and Peri-urban livestock Keeping for the Project.	https://www.kcca.go.ug/uploads/acts/Kcc%20Livestock%20Ordinance.pdf
27	National Agricultural Extension Strategy 2016/17 – 2020.21	Informs on guidelines for commercialization of UPA.	https://www.agriculture.go.ug/wp-content/uploads/2019/04/National-Agricultural-Extension-Strategy-(NAES).pdf
28	National Adaptation Plan for the Agricultural Sector, 2018	Promoting sustainable agricultural sector, improving climate resilience.	https://www.agriculture.go.ug/wp-content/uploads/2019/09/National-Adaptation-Plan-for-the-Agriculture-Sector-1.pdf
29	National Seed Policy, 2018	Inform on regulation, availability, accessibility and affordability of safe and high-quality seeds for UPA.	https://www.agriculture.go.ug/wp-content/uploads/2019/05/Ministry-of-Agriculture-Animal-Industry-and-Fisheries-National-Seed-Policy.pdf
30	Guidelines for Mainstreaming Climate Change Adaptation and Mitigation in Agricultural Sector Policies and Plans	Informs on nature positive production – environmental conservation and UPA.	https://www.agriculture.go.ug/wp-content/uploads/2019/09/Guidelines-for-Mainstreaming-Climate-Change-Adaptation-and-Mitigation-in-the-Agricultural-Sector-Policies-Plans-1.pdf
31	Food and Nutrition Policy, 2003	Promotion of organic farming to produce safe and healthy food for local consumers.	http://extwprlegs1.fao.org/docs/pdf/uga145392.pdf
32	National fertilizer Policy (2016)	Provides for use of both organic and inorganic fertilizers to increase soil fertility with the aim of increasing production of agricultural products to sustain the domestic and international market demands.	http://extwprlegs1.fao.org/docs/pdf/uga172925.pdf
33	National Fisheries and Aquaculture Policy, 2017	Promote sustainable management and utilization of water resources and enhance fisheries production .	http://extwprlegs1.fao.org/docs/pdf/uga201565.pdf

Agriculture Laws			
No #	**Instrument**	**Brief**	**Link**
34	National Agriculture Advisory Services Act, 2001	Informing on institutional arrangement at local and international level though the National Agricultural Advisory Services.	https://www.agriculture.go.ug/wp-content/uploads/2019/04/The-national-Agricultural-Advisory-Services-Act-2001.pdf
35	Agricultural Chemicals Control Act, 2007	Informing on agro-waste management guidelines.	https://www.agriculture.go.ug/wp-content/uploads/2019/04/Agricultural-Chemicals-Control-Act-2007.pdf
36	Agricultural Research (Establishment and Management of the Zonal Competitive Agricultural Research and Development) Regulation, 2004	Guidelines on agricultural research provisions in Uganda.	https://www.agriculture.go.ug/wp-content/uploads/2019/04/Agricultural-Research-Establishment-and-Management-of-the-Zonal-Competitive-Agricultural-Research-and-Development-Fund-Regulation-2004.pdf

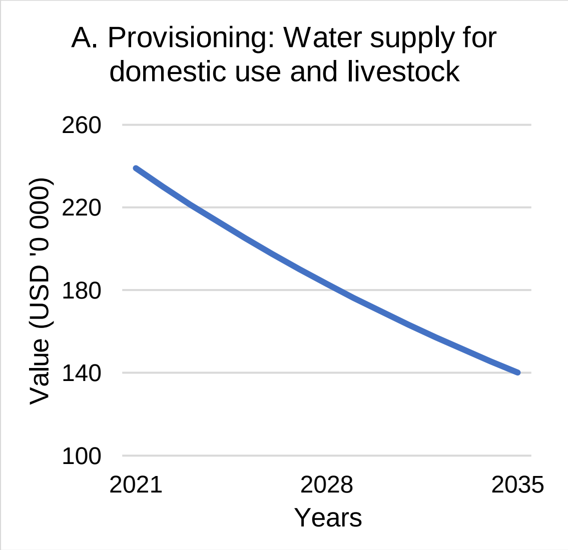
Appendix 3: Data sources and modelling techniques

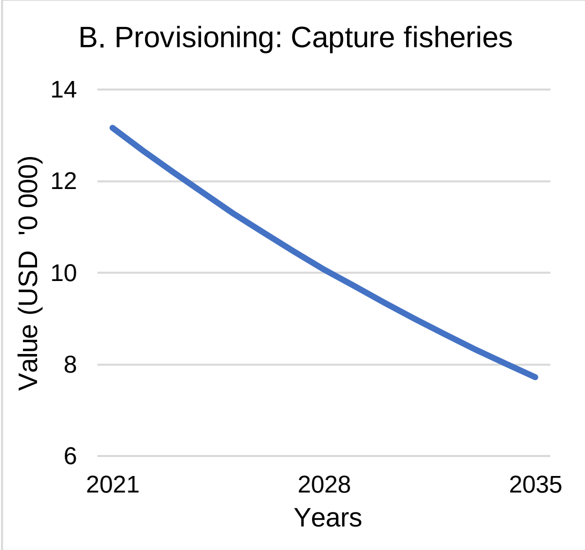
Products/ Ecosystem Services	Valuation Method	Data Needs	Sources of Data
Domestic water supply	Market Price	Number of households whose water source is from the wetland; Average water use per household; Water use price	Uganda Bureau of Statistics, local government and national level reports, stakeholder consultations and field surveys
Communal grazing	Market Price	Number of cattle which graze from the wetland	Review of existing literature, Local government and national level reports, stakeholder consultations and field surveys
Livestock watering	Market Price	Number of cattle which drink water from the wetland; Average amount of water consumed per head per day	Local market price, national and local government level reports, stakeholder consultations and field surveys
Fish	Market Price	Amount of fish extracted per annum; Cost of fish extraction; Price of fish	Local market prices, literature, local government reports, Uganda Bureau of Statistics, stakeholder consultations and field surveys
Fodder	Surrogate, Market prices	Quantity in kg; Sacks and other local measures to be converted to kg; Estimated cost of production	Household surveys, Local market prices, literature, local government reports, Uganda Bureau of Statistics, stakeholder consultations and field surveys
Carbon sequestration	Market Price	Above ground Biomass (AGB); Below Ground Biomass (BGB, Soil biomass); International Voluntary Carbon Market; Total Area Under Vegetation; IPCC Carbon Default Values	Existing literature on estimated CO_2 sequestration at local or regional level, IPCC reports Reports on National and/or regional and/or local level carbon sequestration levels
Water Purification	Market price and/or avoided cost	Total number of households that uses wetland as a major source of water; Cost that would be incurred for water purification	Exciting literature, national and regional level report
Habitat for Biodiversity	Revealed price and/or value transfer	Expenditures (budget allocated) for biodiversity conservation by national and international actors (agents)	National budget allocation, budget set by international actors and NGOs, annual reports and literature.

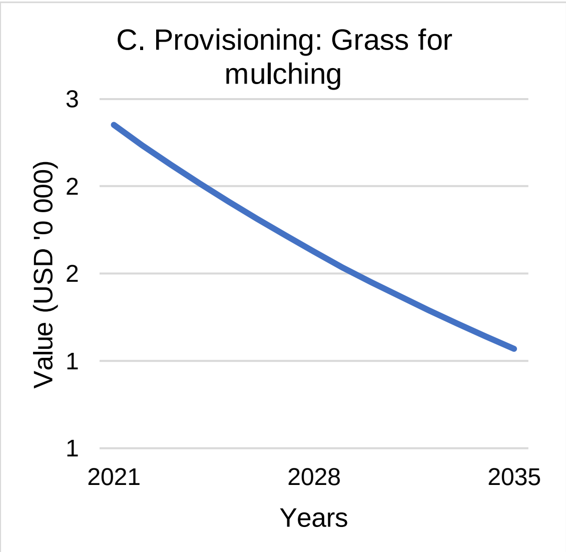
Appendix 4: Models for estimation of the baseline economic values of ecosystem services

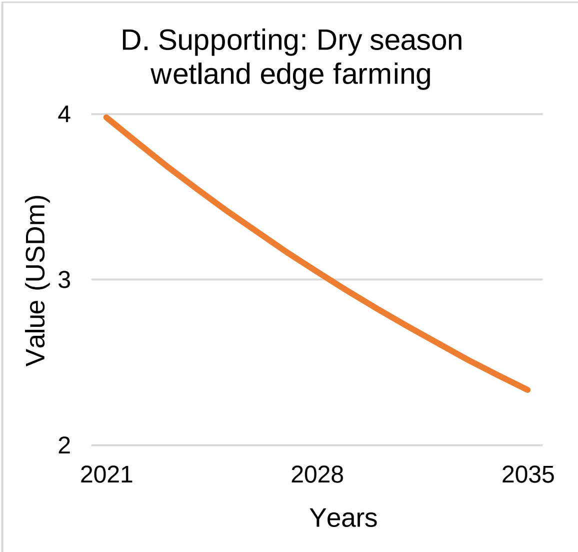
Ecosystem Service	Valuation Technique	Model	Model Explanation
Domestic water supply	Market price	Vw=l*m*n*365 day	l= Household's dependent on wetlands for water supply m=Average use of water per household n= Market price per m^3 (US$) Vw= Gross annual value of water for domestic consumption (US$)
Water for Livestock	Market price	Vlw=p*q*r*365 Adopted from (Kakuru et al., 2013)	Vlw= value of livestock grazing p= Number of cattle obtaining water from wetlands q= Amount of water consumed per day per head of cattle r= Cost of water per 20 liters (US$)
Crop farming in the wetland	Market prices	$\boldsymbol{T_v} = (\boldsymbol{Q_i} * \boldsymbol{P_i}) - \boldsymbol{C_i})$	$\boldsymbol{T_v}$ is the economic value of the product/output, $\boldsymbol{Q_i}$ is the quantity of good/product; $\boldsymbol{P_i}$ is farm gate price of the product, $\boldsymbol{C_i}$ is the cost of production. The value of costs and benefits was calculated per hectare to develop the enterprise budget
Livestock grazing in the wetland	Market price	Vg=o*p*365 Adopted from (Kakuru et al., 2013)	Vg= value of grazing o= Number of cattle raised in wetlands p= Average value of pasture consumed per day per animal (US$)
Grass harvesting	Surrogate, Market prices	$\boldsymbol{T_v} = (\boldsymbol{Q_i} * \boldsymbol{P_i}) - \boldsymbol{C_i})$	Where, $\boldsymbol{T_v}$ is the economic value of the product/output, $\boldsymbol{Q_i}$ is the quantity of good/product; $\boldsymbol{P_i}$ is farm gate price of the product, $\boldsymbol{C_i}$ is the cost of production,
Capture fisheries	Market price	Vf= (Qf*Pf) - Cf	Vf= Value of fish Qf= Quantity of fish harvested Pf= Price of fish, say, per tonne Cf = cost of extracting fish, say, per tonne
Products from papyrus and other grasses	Market price	$\boldsymbol{T_v} = (\boldsymbol{Q_i} * \boldsymbol{P_i}) - \boldsymbol{C_i})$	Where, $\boldsymbol{T_v}$ is the economic value of the product/output, $\boldsymbol{Q_i}$ is the quantity of good/product; $\boldsymbol{P_i}$ is farm gate price of the product, $\boldsymbol{C_i}$ is the cost of production,
Carbon sequestration and storage	Market prices	- $V_R = (Q_r * P_C * S_r) - (Q_d * P_C * S_d)$ This is adapted from InVEST model	VR=the carbon sequestration value of conservation transition; Qr=carbon sequestration (CO2) in restored area; Pc=the international carbon sequestration price; Sr = the area restored (ha); Qd is the carbon sequestration (CO2) in degraded area; Sd is the area degraded (ha)
Water purification	Market price and/or avoided cost	Vp=A*B Adapted from (Verma and Negandhi, 2011)	Vp is the economic value of water purification A= total purification cost per household in the absence of the wetland B= total number of households who uses the wetland as a source of water
Sediment control	Avoided cost	$V_K = K * G \sum_{i=1}^{n} S_i * (d_i - d_0)$	Where Vk is the economic value of soil-erosion regulation; -K is the cost of a ton of sediment removal; -Si is the area of forest-vegetation types in hectares; -G is the ratio of sediment entering rivers or reservoirs to total soil lost; -di is the erosivity of non-restored land (tons/ha); and do is the erosivity of restored land (tons/ha).

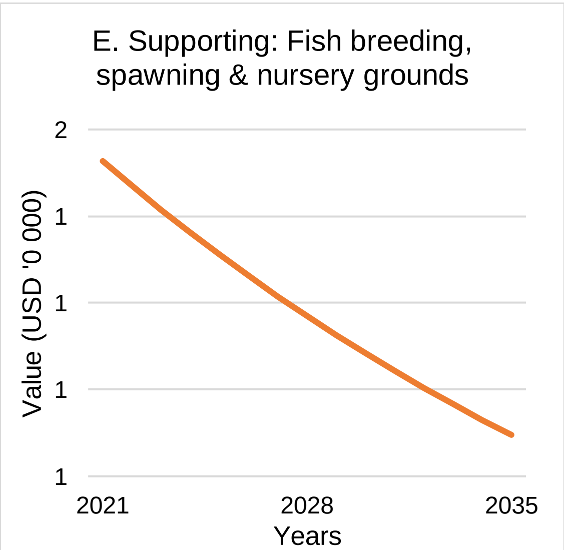
Appendix 5: Charts showing the changes in value of wetland ecosystem services, under the BAU Scenario.

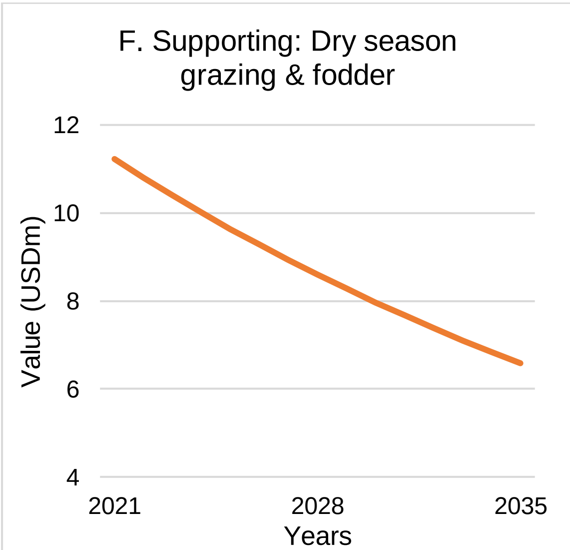


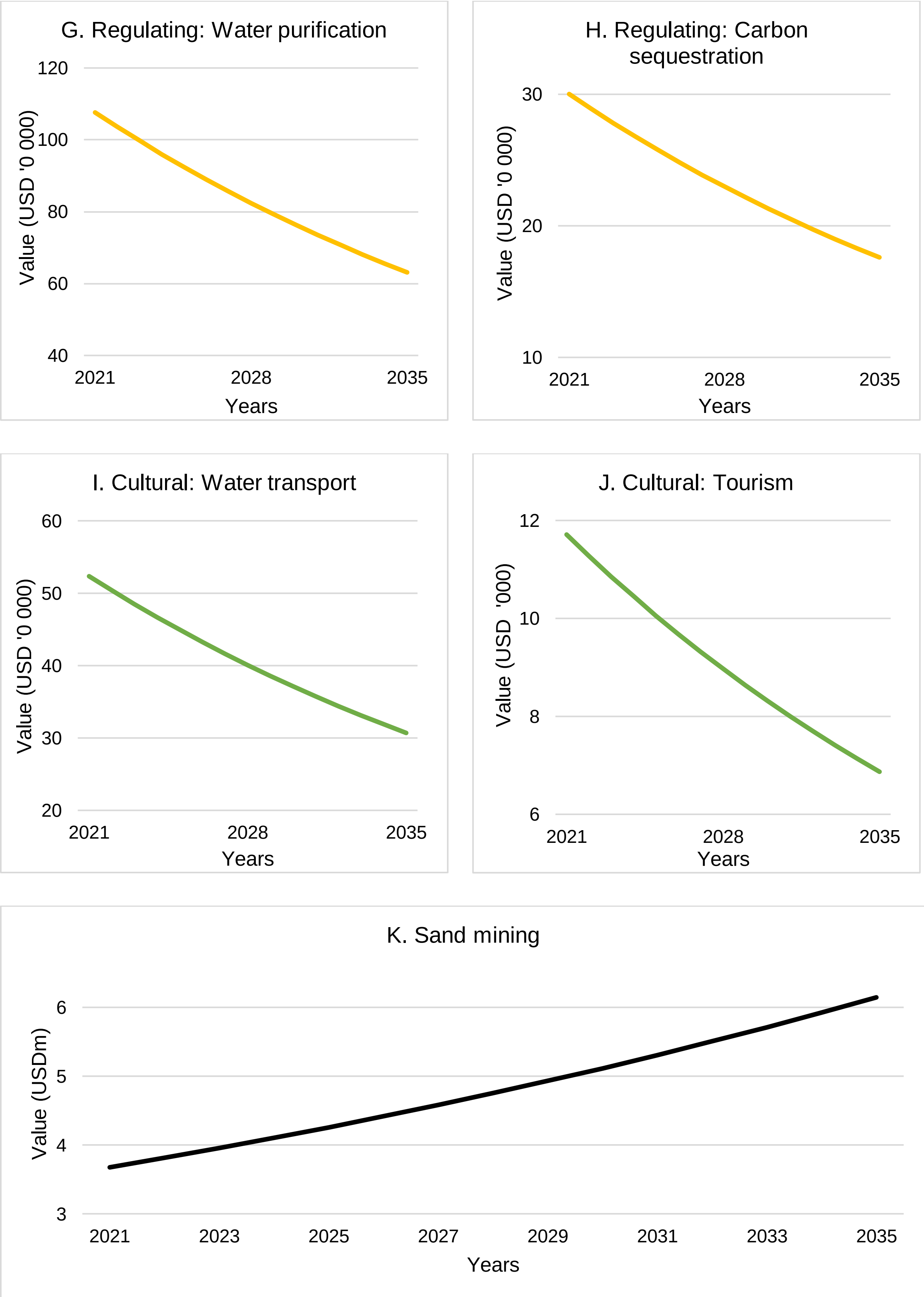




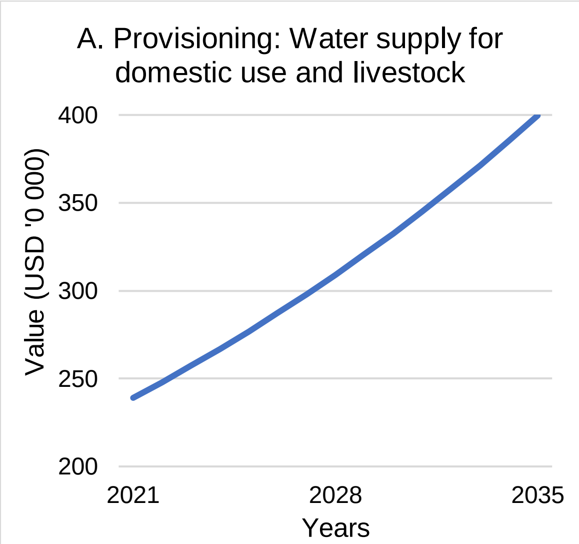


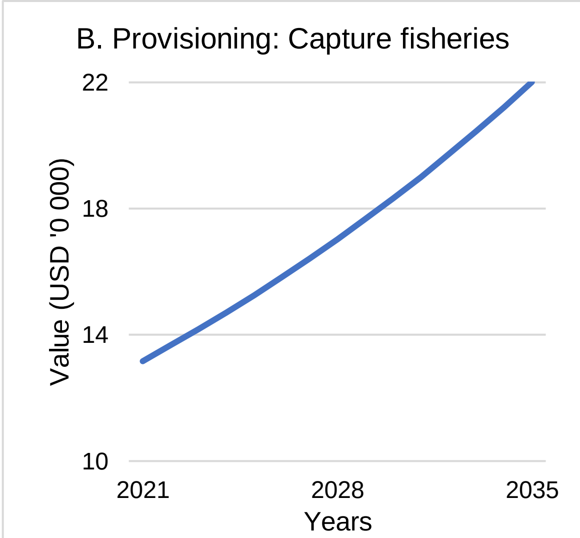


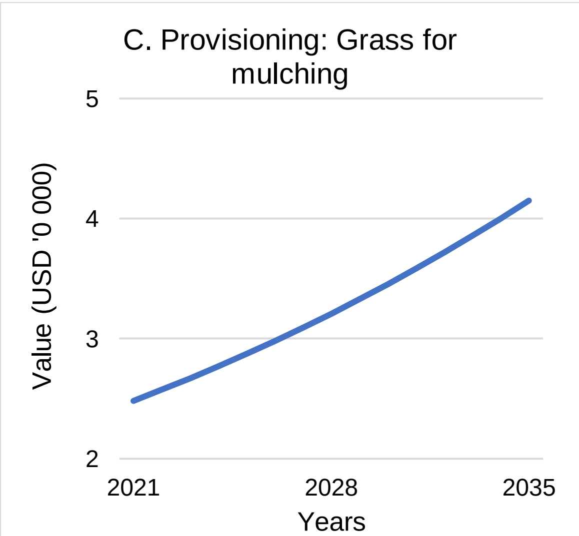


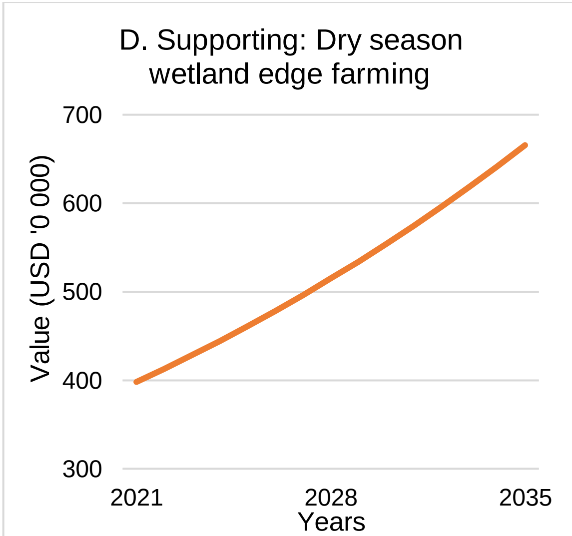

G. Regulating: Water purification
120
100
80
60
40
Value (USD '0 000)
2021
2028
2035
Years
H. Regulating: Carbon sequestration
30
20
10
Value (USD '0 000)
2021
2028
2035
Years
I. Cultural: Water transport
60
50
40
30
20
Value (USD '0 000)
2021
2028
2035
Years
J. Cultural: Tourism
12
10
8
6
Value (USD '000)
2021
2028
2035
Years
K. Sand mining
6
5
4
3
Value (USDm)
2021
2023
2025
2027
2029
2031
2033
2035
Years

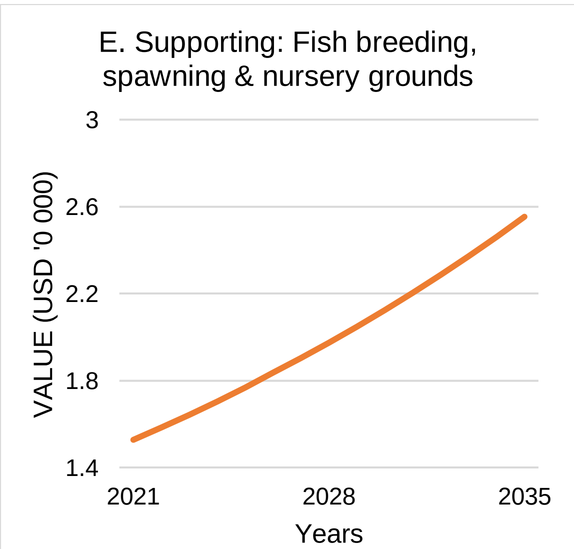
Appendix 6: Charts showing the changes in value of wetland ecosystem services, under the Green Scenario.

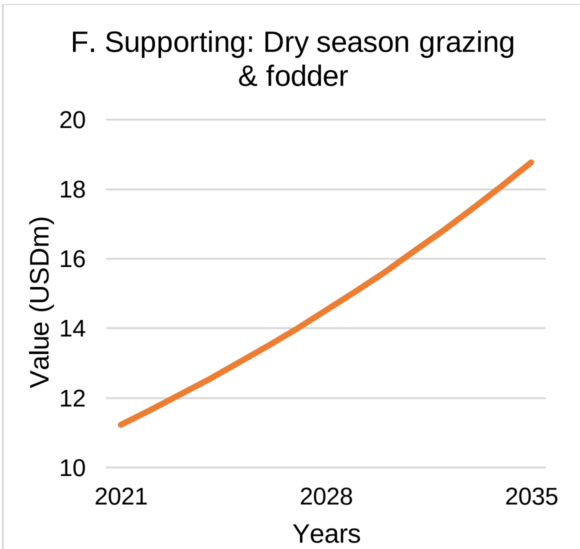


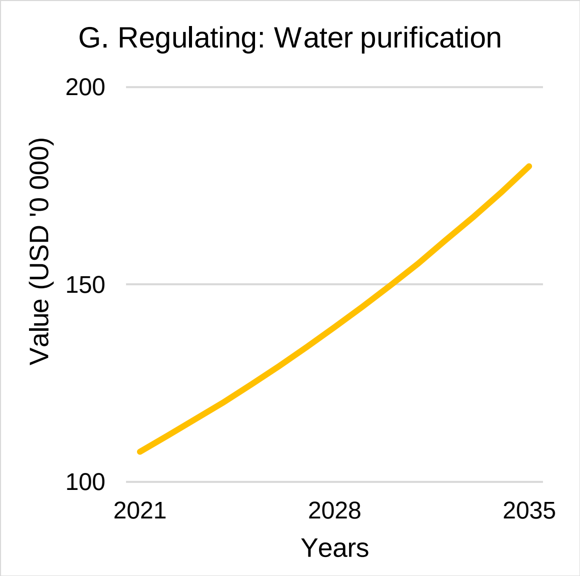


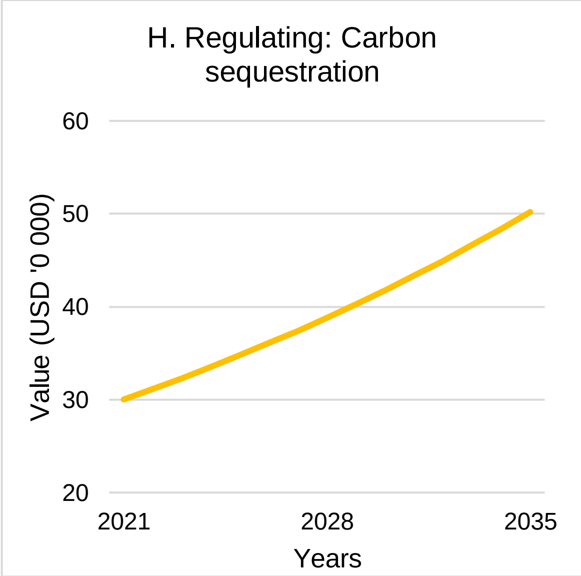


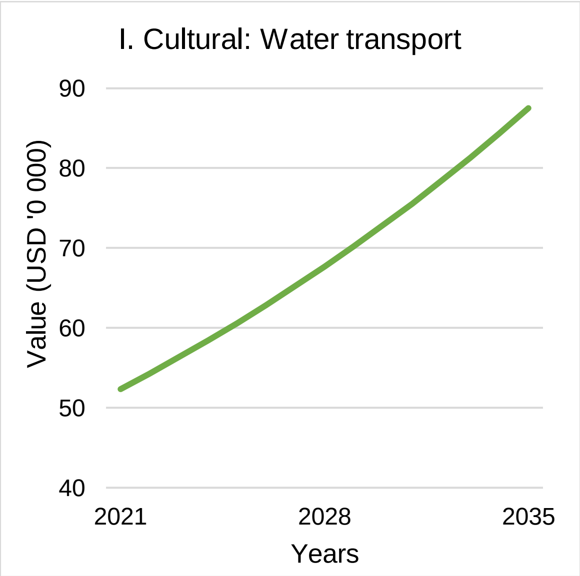


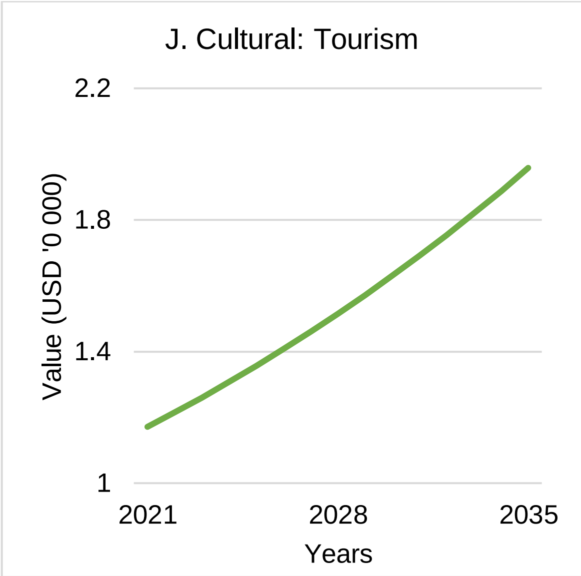


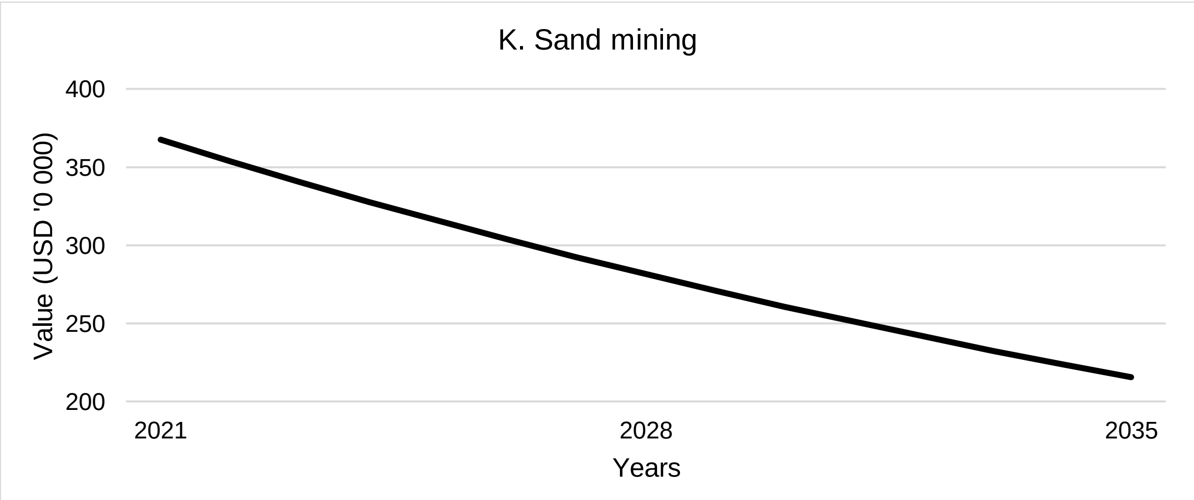



G. Regulating: Water purification
200
150
100
Value (USD '0 000)
2021
2028
2035
Years

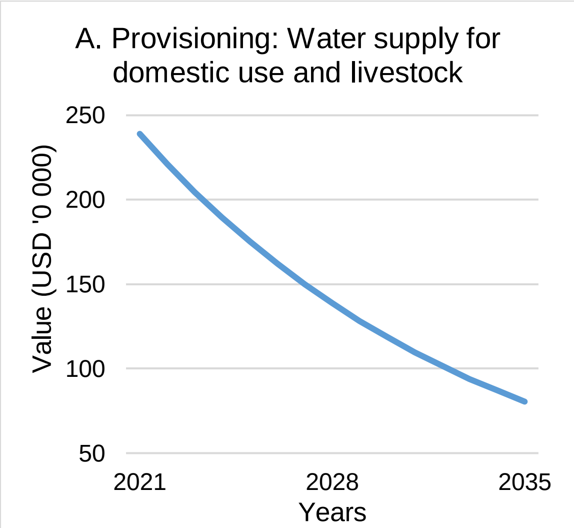

H. Regulating: Carbon sequestration
60
50
40
30
20
Value (USD '0 000)
2021
2028
2035
Years

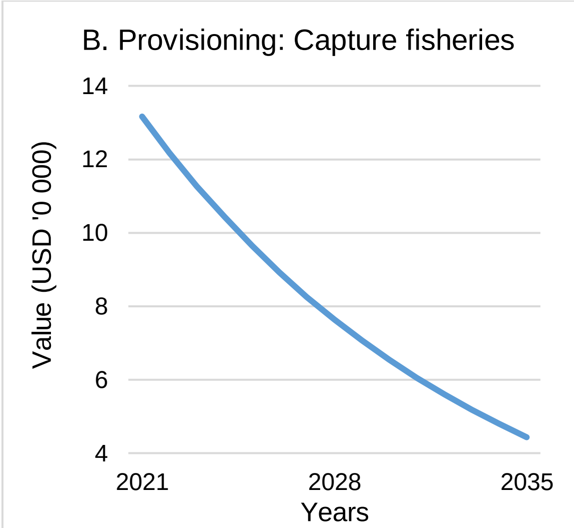

I. Cultural: Water transport
90
80
70
60
50
40
Value (USD '0 000)
2021
2028
2035
Years

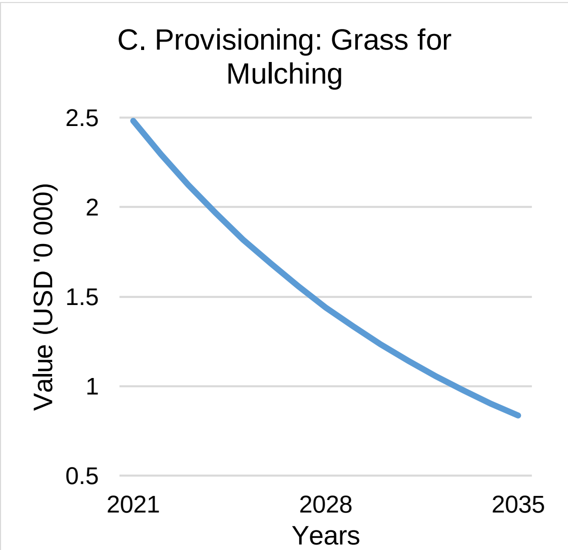

J. Cultural: Tourism
2.2
1.8
1.4
1
Value (USD '0 000)
2021
2028
2035
Years

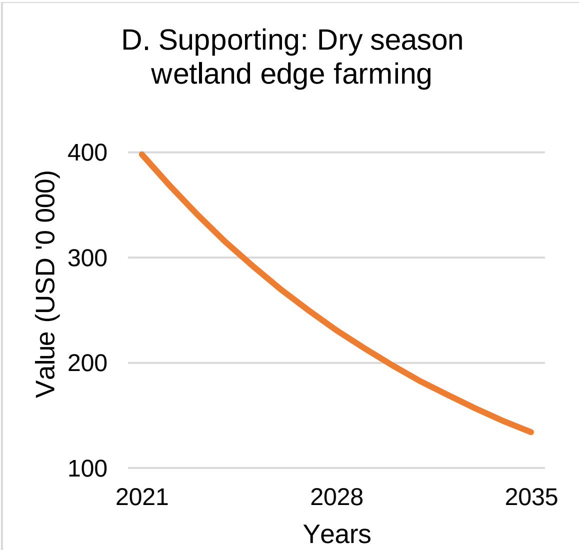

K. Sand mining
400
350
300
250
200
Value (USD '0 000)
2021
2028
2035
Years

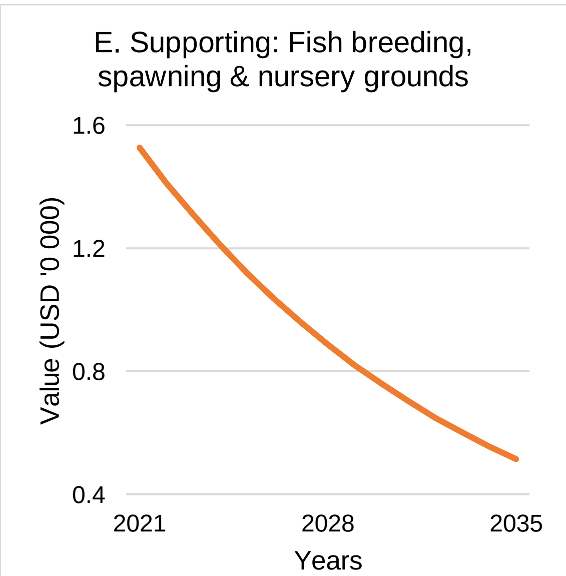
Appendix 7: Charts showing the changes in value of wetland ecosystem services, under the Grey Scenario.

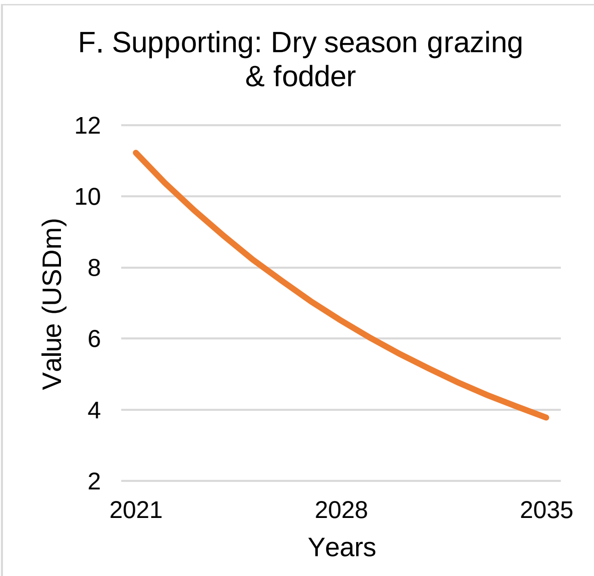


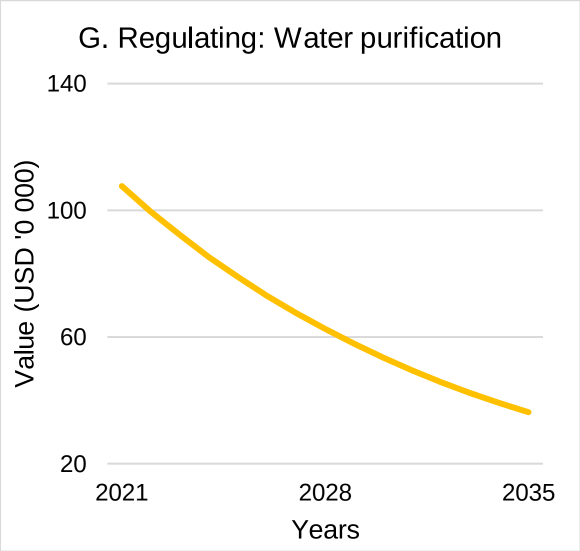


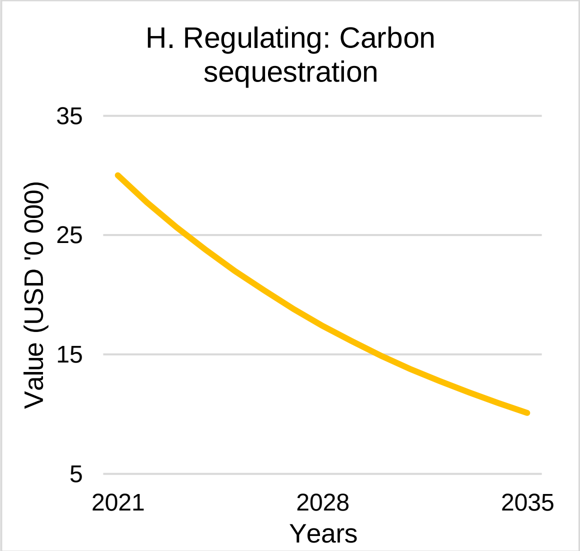


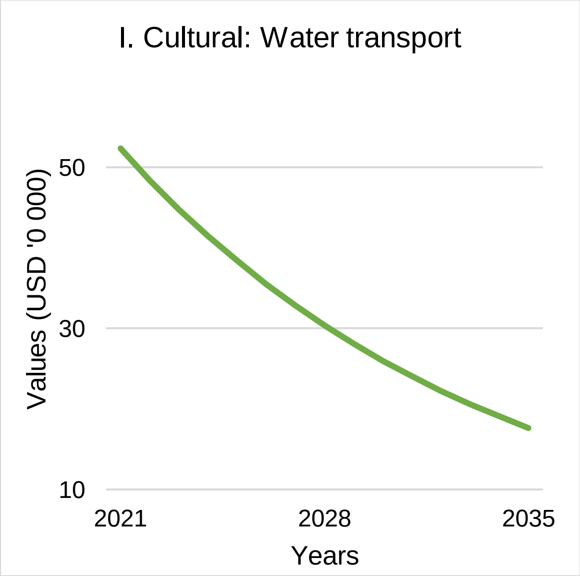


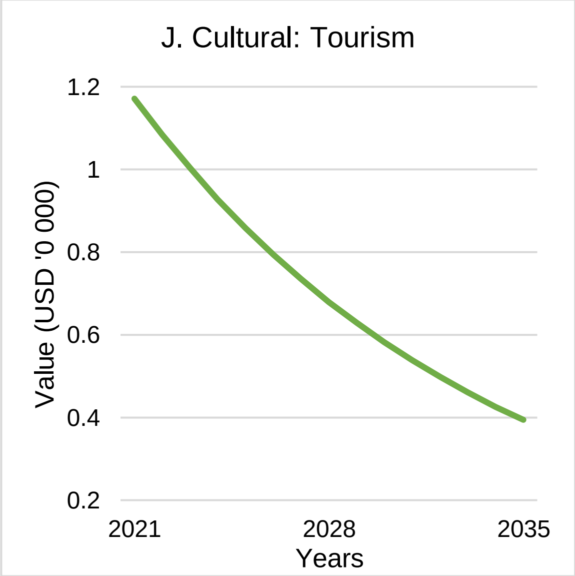


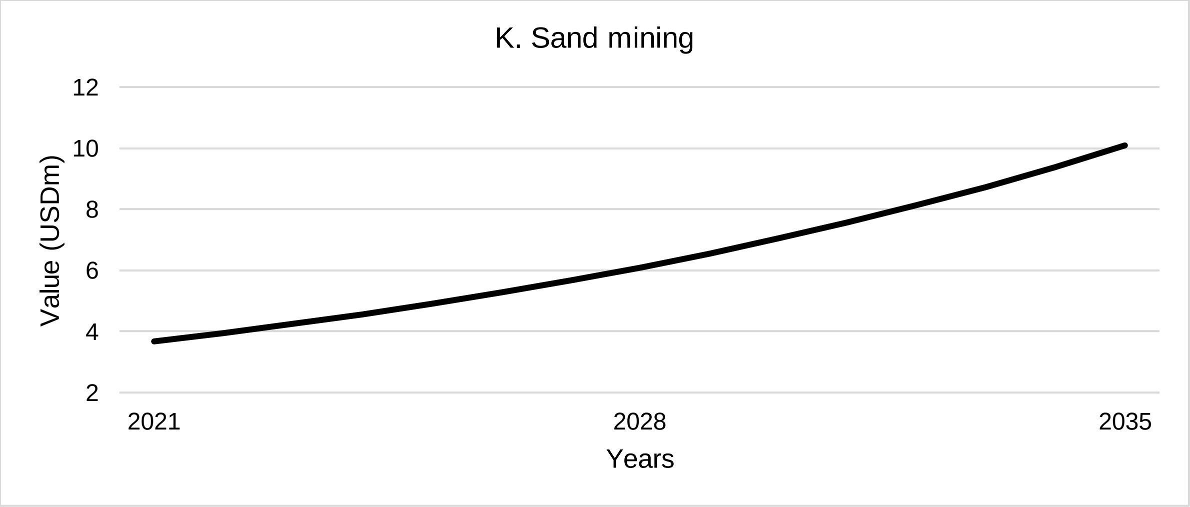



G. Regulating: Water purification
Value (USD '0 000)
140
100
60
20
2021
2028
2035
Years


H. Regulating: Carbon sequestration
Value (USD '0 000)
35
25
15
5
2021
2028
2035
Years


I. Cultural: Water transport
Values (USD '0 000)
50
30
10
2021
2028
2035
Years


J. Cultural: Tourism
Value (USD '0 000)
1.2
1
0.8
0.6
0.4
0.2
2021
2028
2035
Years


K. Sand mining
Value (USDm)
12
10
8
6
4
2
2021
2028
2035
Years

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