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Sustainable Asset Valuation of Mangroves and Wetlands for Coastal Resilience in Mozambique

An economic valuation of ecosystem-based adaptation in three estuaries

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Sustainable Asset Valuation of Mangroves and Wetlands for Coastal Resilience in Mozambique: An economic valuation of ecosystem-based adaptation in three estuaries

October 2025

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All authors are listed in alphabetical order. Ronja Bechauf contributed to defining the scope of the analysis and writing the report. Edvin Andreasson and Nathalia Niño developed the Excel-based model and the integrated cost-benefit analysis, and Nathalia Niño led the writing of the report.

Executive Summary

Mozambique's coastal regions are increasingly vulnerable to climate-induced risks, such as cyclones, floods, storm surges, and saline intrusion. These challenges are exacerbated by ecosystem degradation driven by urbanization, deforestation, and unsustainable agricultural practices.

To address these threats, the Government of Mozambique is planning to invest in nature-based infrastructure (NBI) as part of wider efforts for ecosystem-based adaptation (EbA). The Government of Mozambique is working with the United Nations Environment Programme (UNEP) and the Green Climate Fund to mobilize funding for these interventions. This Sustainable Asset Valuation (SAVi) report assesses the economic, social, and environmental impacts of the following planned NBI interventions for flood and cyclone management in Mozambique:

1. **Wetland restoration:** The project targets the restoration of 7,500 ha of wetlands in total, with 2,500 ha restored in each of the Bons Sinais, Zambezi, and Limpopo estuaries. Wetlands play a crucial role in regulating water flow and groundwater, reducing flood peaks, and improving water quality.
2. **Mangrove restoration:** The project aims to restore a total of 3,800 ha of mangroves in the three estuaries to protect coastal areas from storm surges and saltwater intrusion.
3. **Ecosystem conservation:** The project plans to conserve 30,000 ha of ecosystems across the three estuaries, especially mangrove forests that might otherwise be at risk.

The planned NBI will directly benefit about 211,000 people. This represents 20% of the population in the five targeted districts and three towns (Quelimane, Chinde, and Xai-Xai), as well as surrounding areas in the Bons Sinais, Zambezi, and Limpopo estuaries. Indirectly, over 1 million people across these regions stand to gain from the measures.

Using the SAVi methodology, we developed an integrated cost-benefit analysis (CBA) for the proposed NBI interventions in the three estuaries, including added benefits and avoided costs, such as flood protection, job creation, carbon storage, and food provisioning. Given the uncertainty about the extent and monetary value of these benefits, we modelled a variety of conservative and optimistic scenarios, which are explained in Table ES1. In addition, we analyzed the outcomes of investing in the NBI under three climate change scenarios: the Shared Socioeconomic Pathway (SSP) 1-2.6[1] scenario, which represents a low-emission pathway; the SSP3-7.0 scenario, a medium-emission projection; and the SSP5-8.5 scenario, a high-emission pathway.

[1] The SSP1-2.6 scenario is often likened to the Representative Concentration Pathway (RCP) 2.6 scenarios (same radiative forcing); the SSP3-7.0 scenario is normally paired with RCP7.0; and the SSP5-8.5 linked to RCP8.5.

Table ES1. Overview of valuation NBI scenarios

Valuation scenario	Description
High Valuation–High Carbon Price Scenario	The most optimistic scenario using the costs and benefits provided in the pre-feasibility study (Baastel, 2021) and assuming a shadow price of carbon of USD 50/tonnes of carbon dioxide (tCO_2).
High Valuation–Low Carbon Price Scenario	Optimistic scenario using the costs and benefits provided in the pre-feasibility study (Baastel, 2021) but assuming a lower shadow price of carbon at USD 30/tCO_2.
Low Valuation–High Carbon Price Scenario	A more conservative scenario using lower benefits from literature sources for ecosystem services such as fisheries, ecotourism, and water and air pollution control, paired with a shadow price of carbon of USD 50/tCO_2.
Low Valuation–Low Carbon Price Scenario	Conservative scenario using values from literature for the ecosystem services and a lower shadow price of carbon at USD 30/tCO_2.
Low Valuation–Tangible Only Scenario	Conservative scenario that uses the values from literature and focuses only on tangible benefits, such as avoided climate impacts, increased fisheries value, job creation, and enhanced provisioning of food, energy, and timber, without accounting for broader ecosystem services.

Source: Authors.

The CBA confirms the economic viability of the NBI interventions across all scenarios (see Table ES2). Analyzing a time frame from 2025 to 2051, the benefits of implementing the NBI far outweigh the costs in all scenarios, even when using a relatively high discount rate of 20%. The diverse valuation and climate scenarios show a large range of results, which can help the government and donors make informed decisions despite high uncertainty about the precise outcomes of the investments. Overall, the CBA demonstrates that the NBI effectively protects coastal communities in Mozambique from flooding and cyclone protection while also providing valuable co-benefits for livelihoods, food security, and healthy ecosystems.

With a total investment of USD 41.73 million (discounted) allocated equally across the three estuaries, the project delivers substantial net benefits. The High Valuation–High Carbon Price Scenario demonstrates the most favourable outcomes, generating net benefits of USD 537.54 million, an internal rate of return (IRR) of 311.06%, and USD 13.88 in return for society for every dollar invested. This scenario reflects the highest valuation of ecosystem services, particularly for fisheries, ecotourism and recreation, water and air purification, and flood regulation, underscoring the significant economic returns from comprehensive ecosystem restoration.

Even in the Low Valuation–Tangible Only Scenario, which focuses solely on direct economic benefits such as avoided flood damage and benefits for fisheries, the project remains viable, with net benefits of USD 29.94 million and a benefit-to-cost ratio (BCR) of 1.72, meaning that every dollar invested in the NBI yields direct benefits of USD 1.72.

The reduction of pollution and flood damages is a key benefit of wetland and mangrove restoration, with the avoided costs of pollution reaching up to USD 81.56 million and avoided flood damages ranging from USD 42.63 million to USD 47.51 million, depending on the climate scenario (SSP). Notably, the SSP1–2.6 scenario, which anticipates moderate warming but frequent extreme wet events up to 2050, yields the highest avoided costs, highlighting the immediate benefits of NBI in mitigating flood risks. In contrast, SSP3–7.0 and SSP5–8.5 are projected to experience greater variability and more intense climate impacts after 2050, emphasizing the long-term resilience benefits of ecosystem restoration.

In addition, the interventions provide critical social and environmental co-benefits. Restoring and protecting wetlands and mangroves enhances biodiversity, supports fisheries, and boosts ecotourism, directly benefiting people in the three estuaries. In the scenarios that assume a high shadow price of carbon, the added benefit of carbon sequestration accounts for a large share of the value provided by the NBI, reaching up to USD 103.35 million. The NBI interventions also improve water quality, reduce sedimentation, and mitigate health risks associated with saline intrusion and waterborne diseases, further contributing to the well-being and resilience of local communities. The project's ability to generate jobs further underscores its socio-economic value, creating benefits of USD 0.19 million for all scenarios. Employment opportunities created through restoration and conservation activities not only enhance household incomes but also contribute to poverty alleviation and economic development in vulnerable coastal regions.

Table ES2. CBA indicators summary in million USD, cumulative (2025–2051) discounted values (20% rate)

CBA, cumulative discounted values from 2025 to 2051	High Valuation–High Carbon Price Scenario	High Valuation–Low Carbon Price Scenario	Low Valuation–High Carbon Price Scenario	Low Valuation–Low Carbon Price Scenario	Low Valuation–Tangible Only Scenario
Total costs	**41.73**	**41.73**	**41.73**	**41.73**	**41.73**
Implementation costs	14.54	14.54	14.54	14.54	14.54
Operations and maintenance (O&M) costs	27.20	27.20	27.20	27.20	27.20

CBA, cumulative discounted values from 2025 to 2051	High Valuation–High Carbon Price Scenario	High Valuation–Low Carbon Price Scenario	Low Valuation–High Carbon Price Scenario	Low Valuation–Low Carbon Price Scenario	Low Valuation–Tangible Only Scenario
Total added benefits	**448.63**	**407.29**	**132.39**	**91.05**	**29.03**
Job creation	0.19	0.19	0.19	0.19	0.19
Increased fisheries value added	177.34	177.34	4.51	4.51	4.51
Carbon sequestration	103.35	62.01	103.35	62.01	-
Increased ecotourism and recreation value added	146.03	146.03	2.62	2.62	2.62
Increased food provisioning	15.93	15.93	15.93	15.93	15.93
Increased energy resources	3.19	3.19	3.19	3.19	3.19
Increased wood and timber provisioning	2.56	2.56	2.56	2.56	2.56
Increased honey production	0.04	0.04	0.04	0.04	0.04
Total avoided costs	**130.64**	**130.64**	**55.04**	**55.04**	**42.64**
Avoided flood damage	42.64	42.64	42.64	42.64	42.64
Avoided saline intrusion costs	0.43	0.43	0.43	0.43	-
Avoided pollution	81.56	81.56	5.96	5.96	-
Avoided sedimentation	6.01	6.01	6.01	6.01	-
Net benefits	**537.54**	**496.19**	**145.69**	**104.35**	**29.94**
BCR	13.88	12.89	4.49	3.50	1.72
IRR	311.06%	252.20%	170.63%	108.93%	34.50%

Source: Authors.

The analysis of individual estuaries reveals notable differences in economic performance.

- The Limpopo estuary consistently delivers the highest returns across scenarios, driven by the large population exposed to flood risks and saline intrusion. Under the Low Valuation–High Carbon Scenario, Limpopo achieves net benefits of USD 65.09 million, with a BCR of 5.68 and an IRR of 188.17%. This means that every dollar invested in the NBI yields about USD 5 in social, economic, and environmental benefits.
- In comparison, the Bons Sinais estuary yields net benefits of USD 44.97 million and a BCR of 4.23, reflecting its moderate population impact and higher vulnerability to saline intrusion.
- The Zambezi estuary, despite its ecological significance, demonstrates the lowest economic returns due to a smaller population affected by climate risks, achieving a net benefit of USD 35.64 million and a BCR of 3.59 in the same scenario.

In conclusion, this SAVi assessment highlights the transformative potential of NBI interventions as a sustainable, cost-effective solution for climate adaptation and disaster risk reduction in Mozambique. By leveraging ecosystem-based approaches, the project enhances the resilience of coastal communities, supports biodiversity conservation, and contributes to national and global efforts to mitigate and adapt to climate change. Policy-makers, investors, and development partners are encouraged to prioritize and scale up NBI investments to secure long-term socio-economic and environmental benefits for Mozambique's coastal regions.

Glossary

Discounting: A financial process to determine the present value of a future cash value.

Indicator: Parameters of interest to one or several stakeholders that provide information about the development of key variables in the system over time and trends that unfold under specific conditions (United Nations Environment Programme [UNEP], 2014).

Internal rate of return (IRR): An indicator of the profitability prospects of a potential investment. The IRR is the discount rate that makes the net present value of all cash flows from a particular project equal to zero. Cash flows net of financing give us the equity IRR.

Methodology: The theoretical approach(es) used for the development of different types of analysis tools and simulation models. This body of knowledge describes the underlying assumptions used, as well as qualitative and quantitative instruments for data collection and parameter estimation (UNEP, 2014).

Nature-based infrastructure (NBI): A subset of nature-based solutions with a focus on nature-provided infrastructure services. The NBI Global Resource Center defines NBI as follows: "natural ecosystems or functional landscapes that can be conserved, rehabilitated, and maintained to enhance capacities and reduce the need for grey infrastructure, as well as hybrid infrastructure that combines engineered and NBS" (Bechauf et al., 2022).

Net benefits: The cumulative amount of monetary benefits accrued across all sectors and actors over the lifetime of investments compared to the baseline, reported by the intervention scenario.

Scenarios: Expectations about possible future events used to analyze potential responses to these new and upcoming developments. Consequently, scenario analysis is a speculative exercise in which several future development alternatives are identified, explained, and analyzed for discussion on what may cause them and the consequences these future paths may have on our system (e.g., a country or a business).

Simulation model: Models can be regarded as systemic maps in that they are simplifications of reality that help to reduce complexity and describe, at their core, how the system works. Simulation models are quantitative by nature and can be built using one or several methodologies (UNEP, 2014).

Table of Contents

1.0 Introduction ... **1**

2.0 Methodology and Scenarios ... **4**

2.1 Sustainable Asset Valuation ... 4

2.2 Systems Thinking ... 5

2.3 Causal Loop Diagram ... 5

2.4 Climate Data Analysis ... 7

2.5 Scenarios and Indicators of the Integrated CBA ... 14

2.5.1. Scenarios ... 14

2.5.2. Indicators ... 15

3.0 Results of the Integrated CBA ... **17**

3.1 Results for the Main Scenarios ... 17

3.2 Results for the Bons Sinais, Zambezi, and Limpopo Estuaries Individually ... 20

3.3 Results for the Climate Scenarios ... 23

4.0 Conclusions ... **26**

References ... **28**

Appendix A. Data Inputs, Methods, and Assumptions ... **31**

Appendix B. Undiscounted Results ... **41**

List of Figures

Figure 1. Wetland in the study area ... 2

Figure 2. The SAVi methodology ... 4

Figure 3. CLD of the assessment ... 7

Figure 4. Average monthly temperature from 2000 to 2100 in Bons Sinais ... 8

Figure 5. Average monthly precipitation from 2000 to 2100 in Bons Sinais ... 9

Figure 6. Extreme wet percentile from 2000 to 2100 in Bons Sinais ... 9

Figure 7. Average monthly temperature from 2000 to 2100 in Zambezi ... 10

Figure 8. Average monthly precipitation from 2000 to 2100 in Zambezi ... 11

Figure 9. Extreme wet percentile from 2000 to 2100 in Zambezi ... 11

Figure 10. Average monthly temperature from 2000 to 2100 in Limpopo ... 12

Figure 11. Average monthly precipitation from 2000 to 2100 in Limpopo ... 13

Figure 12. Extreme wet percentile from 2000 to 2100 in Limpopo ... 13

Figure 13. BCR comparison across scenarios ... 19

Figure 14. Net benefits of the Low Valuation–Tangible Only Scenario per site ... 23

List of Tables

Table ES1. Overview of valuation NBI scenarios v

Table ES2. CBA indicators summary in million USD, cumulative (2025–2051) discounted values (20% rate) vi

Table 1. Description of the CBA indicators 15

Table 2. Integrated CBA results in million USD, SSP3–7.0 scenario, cumulative discounted between 2025 and 2051 (20% discount rate) 17

Table 3. Integrated CBA table for cumulative benefits per estuary in million USD, discounted at 20% 21

Table 4. Integrated CBA table for cumulative benefits per climate scenario in USD million, discounted at 20% 24

Table A1. Variables used as input for the investment and cost indicators 31

Table A2. Variables used as input for the added benefits indicators 33

Table A3. Variables used as input for the avoided costs indicators 38

Table B1. Integrated CBA results in million USD, SSP3–7.0 climate scenario, cumulative undiscounted between 2025 and 2051 41

Table B2. Integrated CBA table for cumulative benefits per estuary in million USD, undiscounted 42

Table B3. Integrated CBA table for cumulative benefits per climate scenario in million USD, undiscounted 44

1.0 Introduction

Mozambique is among the most vulnerable countries to climate change, facing an array of climate-induced risks that threaten its economy, ecosystems, and communities. With a coastline stretching over 2,700 km along the Indian Ocean, Mozambique's geographical location makes it highly susceptible to extreme weather events, including cyclones, floods, and droughts. Over the past two decades, the frequency and intensity of tropical cyclones, storm surges, and associated flooding have escalated, compounding the existing vulnerabilities of coastal populations. In 2019, Cyclone Idai killed over 600 people in Mozambique, displaced hundreds of thousands, and left 1.8 million people in need of urgent assistance (United Nations Environment Programme [UNEP], 2021). Vast agricultural areas were destroyed, depriving families of food and income, while critical infrastructure, such as schools and health facilities, was severely damaged.

During storm surges, saltwater is pushed into river estuaries, flooding low-lying areas and contaminating freshwater resources. In addition, the saltwater degrades soil quality and reduces agricultural productivity, threatening the livelihoods of families depending on subsistence farming. Coupled with these risks, climate-induced droughts have become more prolonged and severe, affecting water availability for both human consumption and agriculture. These challenges emphasize the critical need for integrated, proactive approaches to climate adaptation that safeguard both natural ecosystems and human livelihoods in least developed countries.

Several anthropogenic drivers amplify Mozambique's climate vulnerabilities. Rapid urbanization, particularly around estuary areas, has led to unplanned settlements and the degradation of critical ecosystems. Mangroves, which serve as natural buffers against storm surges and provide essential ecosystem services, have been extensively depleted due to logging, charcoal production, and land conversion.

Deforestation and agricultural practices further aggravate the situation. Slash-and-burn farming methods, along with expanding cropland and deforestation for fuelwood, have contributed to the loss of forest cover and reduced the capacity of natural ecosystems to mitigate flooding and support biodiversity. In addition, the construction of upstream dams, such as the Cahora Bassa Dam on the Zambezi River, has altered natural hydrological patterns, leading to changes in sedimentation processes and further stressing estuarine ecosystems. Together, these drivers contribute to ecosystem degradation and rising climate risks for Mozambique's coastal communities.

Recognizing the multifaceted challenges posed by climate change and anthropogenic drivers, the Government of Mozambique aims to invest in ecosystem-based adaptation (EbA). These efforts are supported by UNEP. EbA uses natural ecosystems to reduce climate change impacts by restoring, protecting, and sustainably managing ecosystems to provide critical services, such as flood regulation, coastal protection, and improved livelihoods. It involves investments in nature-based infrastructure (NBI) assets, such as mangroves and wetlands.

To support its broader climate adaptation strategy, the Government of Mozambique is preparing a funding proposal to the Green Climate Fund to secure investments in EbA. These investments aim to restore and conserve critical ecosystems to mitigate the impacts of cyclones, floods, and salinity on coastal communities. By embedding NBI into its national and subnational development strategies, Mozambique not only aims to address immediate climate risks but also to build long-term resilience and advance the Sustainable Development Goals (SDGs).

The Sustainable Asset Valuation (SAVi) analysis looks at the NBI interventions of this project: mangrove and wetland restoration and conservation across three estuaries. The assessment was developed to support the Green Climate Fund proposal application. This report focuses on the integrated cost-benefit analysis (CBA) of restoration and conservation efforts in the Bons Sinais, Zambezi, and Limpopo estuaries. These areas are among the most vulnerable to climate impacts, with populations heavily reliant on subsistence agriculture and fisheries for their livelihoods.

Figure 1. Wetland in the study area

Source: Juliana Castro Escobar.

These interventions align with several national policies, including the National Climate Change Mitigation and Adaptation Strategy (2013–2025) and the Master Plan for Disaster Risk Reduction (2017–2030). They also directly contribute to achieving multiple SDGs, such as SDG 13 (Climate Action), SDG 14 (Life Below Water), and SDG 15 (Life on Land).

The proposed interventions are estimated to cost approximately USD 20 million and are expected to directly benefit 211,000 people. This represents 20% of the population in the five targeted districts and three towns (Quelimane, Chinde, and Xai-Xai), as well as surrounding areas in the Bons Sinais, Zambezi, and Limpopo estuaries. Indirectly, over 1 million people across these estuarine regions stand to gain from the NBI measures.

Apart from improved flood protection, local communities can benefit from a range of co-benefits from the planned NBI. These benefits include improved water quality and availability through reduced salinity intrusion, as well as better groundwater recharge, which supports both agriculture and daily needs. The interventions also promote food security by sustaining fisheries dependent on healthy estuarine ecosystems, benefiting biodiversity in the area, contributing to climate change mitigation by storing carbon, and providing resources such as fuelwood.

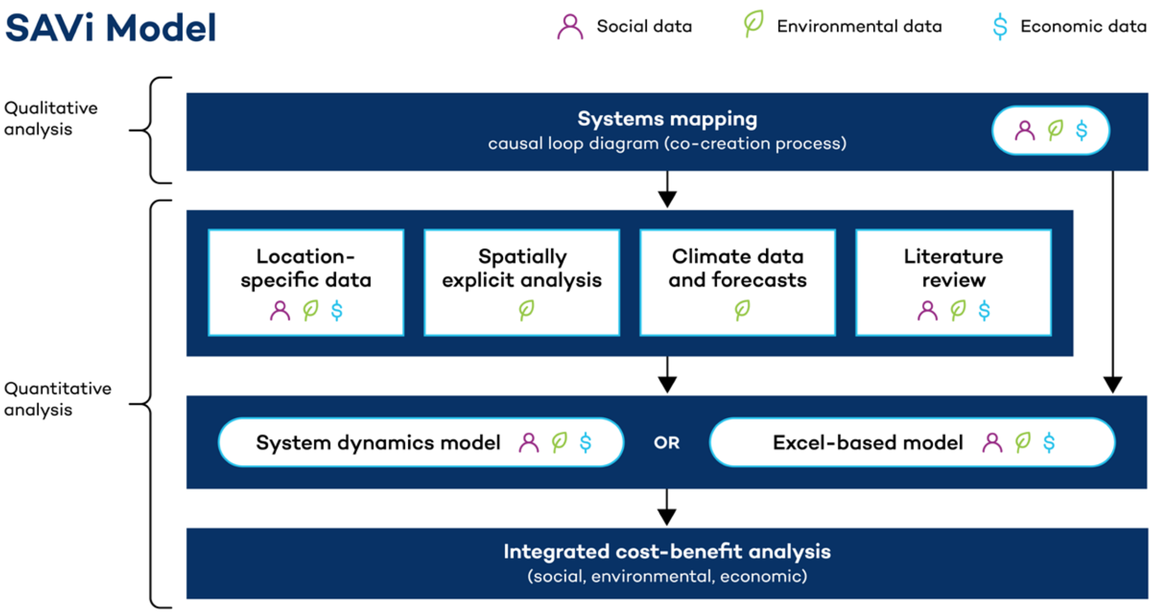
2.0 Methodology and Scenarios

The analysis was conducted using the SAVi methodology, which applies a multi-method approach. The process began with the creation of a system map that allows us to understand the interrelations among social, environmental, and economic variables of the system, validated by the UNEP team and project experts. This was followed by an analysis of past climate data and a literature review of observed impacts and projected climate trends. These insights informed the development of scenarios and the quantification of climate impacts in an Excel-based model using a simplified approach grounded in local data. The model also incorporates future trends under different climate scenarios, including the probability and magnitude of extreme weather events. Further details on the SAVi methodology are provided in the following sections.

2.1 Sustainable Asset Valuation

SAVi is a methodology designed to provide policy-makers and investors with a detailed evaluation of the total life-cycle costs of infrastructure projects and portfolios, incorporating risks often excluded from conventional assessments. By integrating economic and financial modelling, SAVi identifies and evaluates the environmental, social, economic, and governance risks associated with infrastructure investments (see Figure 2). It also assigns a monetary value to externalities resulting from these projects. This methodology equips policy-makers and investors with the tools to base their decisions on a comprehensive understanding of risks and the broader contributions of their investments. SAVi assesses how projects align with national development goals, address climate change mitigation and adaptation, and support the UN SDGs.

Figure 2. The SAVi methodology



Source: IISD.

2.2 Systems Thinking

The SAVi approach relies on systems thinking, a holistic methodology that considers the intricate connections among various factors within a system (see Figure 2). By employing this approach, our study explores how different indicators and variables within the system interact. It delves into the complex relationships and interdependencies among key indicators across social, economic, and environmental dynamics. Understanding these interconnections provides a more nuanced perspective, enabling us to identify the fundamental drivers and dynamics influencing the livelihoods of local communities.

Systems thinking also aids in identifying policy entry points—specific areas or aspects within the system where interventions or policies can yield the greatest impact. A systemic understanding allows for a strategic approach to policy formulation by revealing leverage points and areas where interventions can be most effective. Policy-makers equipped with knowledge about these entry points can prioritize and target their efforts, thereby maximizing the efficiency and effectiveness of policy interventions.

In summary, by applying systems thinking, our study achieves several key objectives: gaining a comprehensive understanding of the problem, recognizing the interconnectedness of key indicators, uncovering key drivers and dynamics, and discerning the most impactful policy entry points.

2.3 Causal Loop Diagram

The causal loop diagram (CLD) in Figure 3 is created based on available project materials and validated with UNEP and project experts. It illustrates the dynamics that intensify flooding and climate change impacts in the three estuaries under study.

At its core, the diagram highlights how rapid urbanization occurs through a reinforcing feedback mechanism (loop R1). As the urban population increases, urban development expands, attracting even more population and unlocking further growth. This expansion increases the demand for (i) settlement land and infrastructure, (ii) agricultural land, and (iii) fuelwood consumption, all of which contribute to deforestation.

This deforestation, however, sets off a series of regulating mechanisms that counterbalance these pressures over time. For example, the reduction of carbon sequestration increases environmental degradation costs, which in turn discourages both public and private investments in development. As investment slows, so too does urban growth, ultimately reducing the demand for land and infrastructure (loop B1). A similar dynamic occurs with the loss of mangroves and wetlands. As these areas decline, the value of their ecosystem services diminishes, leading to reduced investment in development and urban expansion. This, in turn, slows the expansion of settlements and infrastructure, which helps reduce deforestation. As deforestation pressures ease, the decline of mangrove and wetland areas stabilizes, allowing for a gradual recovery of ecosystem services (loop B2). In parallel, biodiversity loss further amplifies environmental degradation costs, reinforcing this self-regulating behaviour (loop B4).

Beyond carbon sequestration and biodiversity, the degradation of mangroves and wetlands undermines key ecosystem services, such as food and wood provisioning, tourism, and energy resources. As these services decline, economic activity diminishes and saline intrusion worsens, negatively affecting freshwater quality and availability (loop B3). Poor water quality leads to heightened health risks, driving up healthcare costs (loop B7) and undermining food security (loop B6).

These impacts are compounded by external stressors. Saline intrusion and associated risks are further intensified by (i) floods, (ii) droughts, (iii) sea level rise, and (iv) tropical cyclones and storm surges. As coastal ecosystems decline, food insecurity increases, which in turn aggravates both health risks and economic burdens (loop B5). Additionally, environmental degradation raises the frequency and severity of natural disasters, contributing to increased mortality and morbidity (loop B8) and inflating the costs of disaster response and reconstruction (loop B9). These adverse effects are exacerbated by the same external climatic events.

Amid these cascading challenges, social dimensions—particularly gender equity—are also strained. Health risks, food insecurity, and the impacts of natural disasters disproportionately affect vulnerable groups, contributing to the erosion of gender equity and social resilience.

In response, the diagram identifies a set of potential intervention options (shown in orange), including (i) mangrove restoration, (ii) wetland restoration, and (iii) broader ecosystem conservation. These measures aim to reverse coastal ecosystem degradation, bolster the provision of critical ecosystem services, and mitigate the wide range of adverse impacts described above.

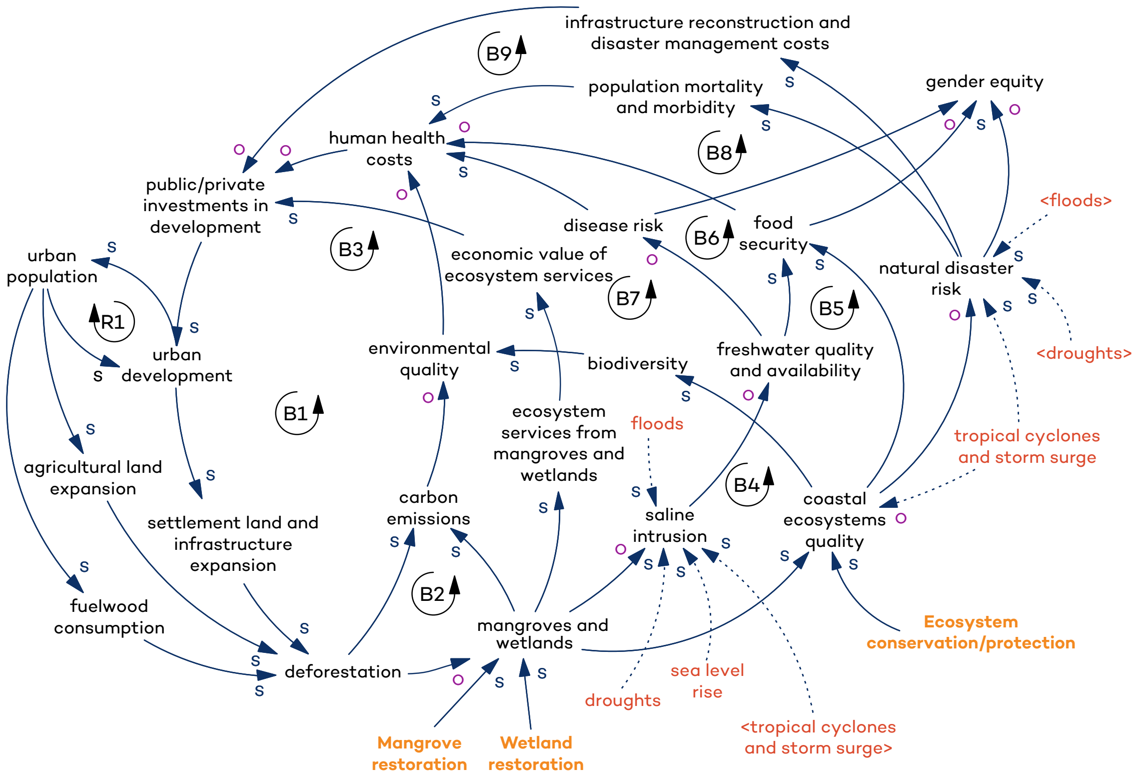
Box 1. Reading a CLD

A CLD is a tool used to support systems thinking by illustrating the relationships between components within a system. Arrows represent causal links, while the letters "s" and "o" indicate the direction of causality. An "s" (for "same") signifies a positive correlation, meaning that the cause and effect move in the same direction: when one increases, so does the other, and when one decreases, the other also decreases. An "o" (for "opposite") indicates a negative correlation, meaning the variables move in opposite directions: when one increases, the other decreases, and vice versa.

For example, an arrow with an "s" between deforestation and carbon emissions implies that increased deforestation leads to higher carbon emissions, and reduced deforestation leads to lower emissions. Conversely, an arrow with an "o" between deforestation and mangrove cover suggests that as deforestation increases, mangrove cover decreases, and when deforestation decreases, mangrove cover increases.

CLDs also identify feedback loops, which are categorized as either reinforcing (R) or balancing (B). A reinforcing loop amplifies change, leading to exponential growth or decline, while a balancing loop counteracts change, promoting stability within the system.

Figure 3. CLD of the assessment



Source: Authors.

2.4 Climate Data Analysis

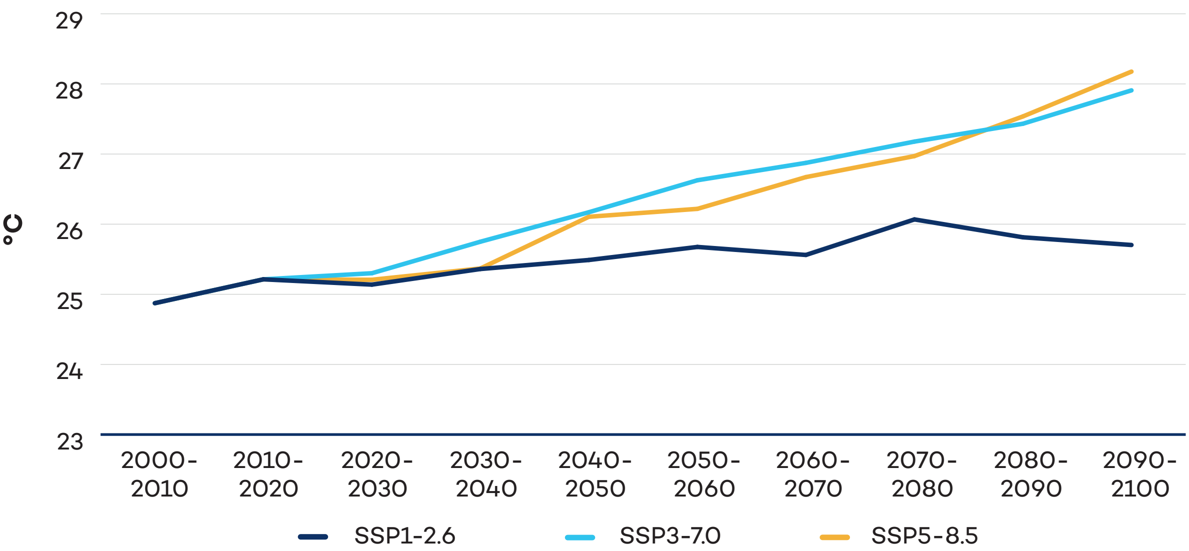
The climate data considered in this analysis is based on Shared Socioeconomic Pathway (SSP) scenarios. SSPs define different baselines that could occur based on various underlying factors, such as population, technological, and economic growth, which can lead to different future greenhouse gas emissions and warming outcomes (Hausfather, 2018). SSPs are based on diverse narratives that describe broad socio-economic trends that can shape future societies. Specifically, we consider the following SSPs, as described by Meinshausen et al. (2020). The model considers the annual patterns of rainfall and temperature for the estimation of externalities such as flood damages and drought damages.

- SSP1–2.6 or the “2°C scenario,” comparable to the RCP2.6[2] scenario, assumes that global temperatures are expected to increase by 2°C by 2100.
- SSP3–7.0, comparable to the RCP7.0 scenario, is a medium-high reference scenario.
- SSP5–8.5 corresponds to a high reference scenario (RCP8.5) in a high-fossil-fuel-use world throughout the 21st century.

[2] The Representative Concentration Pathways (RCPs) are greenhouse gas concentration trajectories developed for the Intergovernmental Panel on Climate Change’s *Fifth Assessment Report* (AR5). They are defined by the level of radiative forcing (measured in watts per square metre, W/m^2) reached by 2100. For instance, RCP2.6 assumes strong mitigation, while RCP8.5 reflects very high emissions. Some SSPs are paired with RCPs based on their comparable radiative forcing values (e.g., SSP1–2.6 with RCP2.6, SSP3–7.0 with RCP7.0, SSP5–8.5 with RCP8.5), but unlike the RCPs, the SSPs also describe the underlying social, economic, and technological developments that drive emissions.

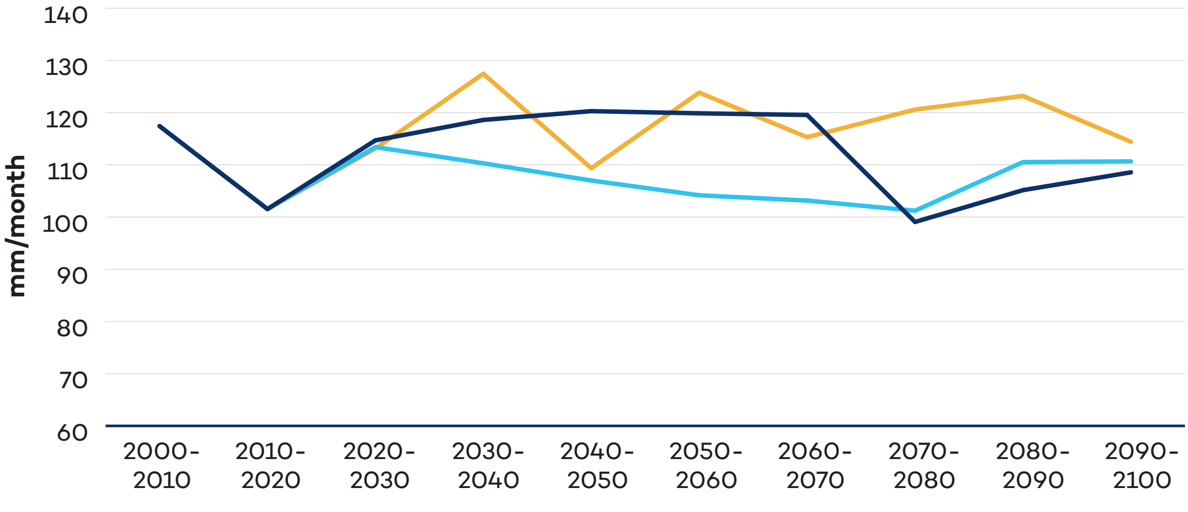
Climate projections for Bons Sinais indicate consistent increases in temperature, shifts in precipitation patterns, and more frequent extreme wet events. Average monthly temperatures (see Figure 4) are projected to rise across all scenarios. Under SSP1–2.6, the increase is modest, approximately 0.7°C by 2100 compared to the 2000–2010 average. In SSP3–7.0 and SSP5–8.5, the temperature increases are more pronounced, reaching 2.5°C and 3.5°C increases, respectively, compared to 2000–2010 levels. These changes reflect a general warming trend over time. Precipitation projections indicate gradual changes post-2030 for all scenarios (see Figure 5). Under SSP1–2.6, average monthly precipitation increases to a maximum value of 120 mm/month by 2060–2070, to then stabilize at around 110 mm/month by 2100. In SSP3–7.0, precipitation decreases steadily until 2070–2080 to around 103 mm/month and then stabilizes at 110 mm/month by 2100. SSP5–8.5 exhibits the most variable pattern, oscillating between 127 mm/month (highest peak) and 109 mm/month (lowest peak), ending up at around 114 mm/month by 2100. Extreme wet events, as indicated by the extreme wet percentile (see Figure 6), show a gradual decrease under SSP1–2.6 and CCP3–7.0 scenarios, suggesting a decrease in extreme wet events and a significant rise under SSP5–8.5, indicating more frequent and intense wet events in the future.

Figure 4. Average monthly temperature from 2000 to 2100 in Bons Sinais



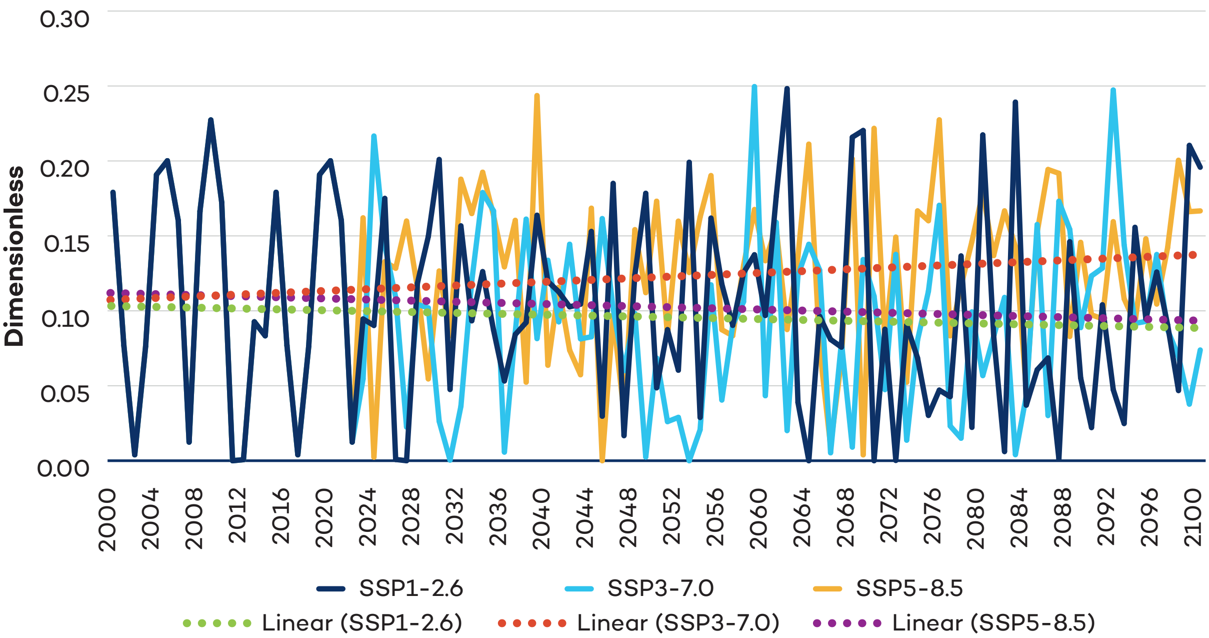
Source: Copernicus Climate Data Store, 2024.

Figure 5. Average monthly precipitation from 2000 to 2100 in Bons Sinais



Source: Copernicus Climate Data Store, 2024.

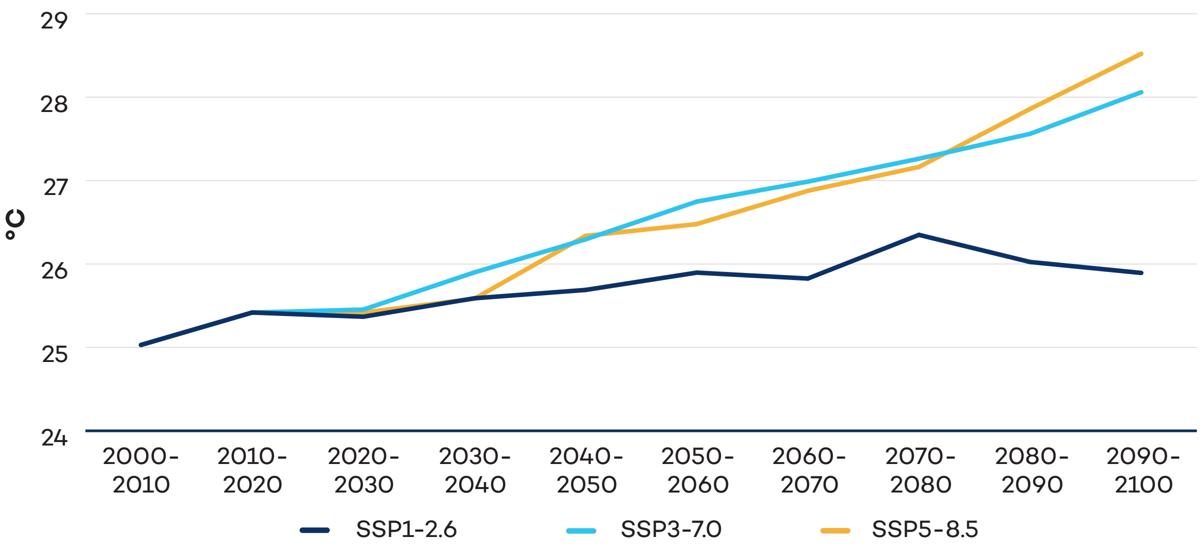
Figure 6. Extreme wet percentile from 2000 to 2100 in Bons Sinais



Source: Copernicus Climate Data Store, 2024.

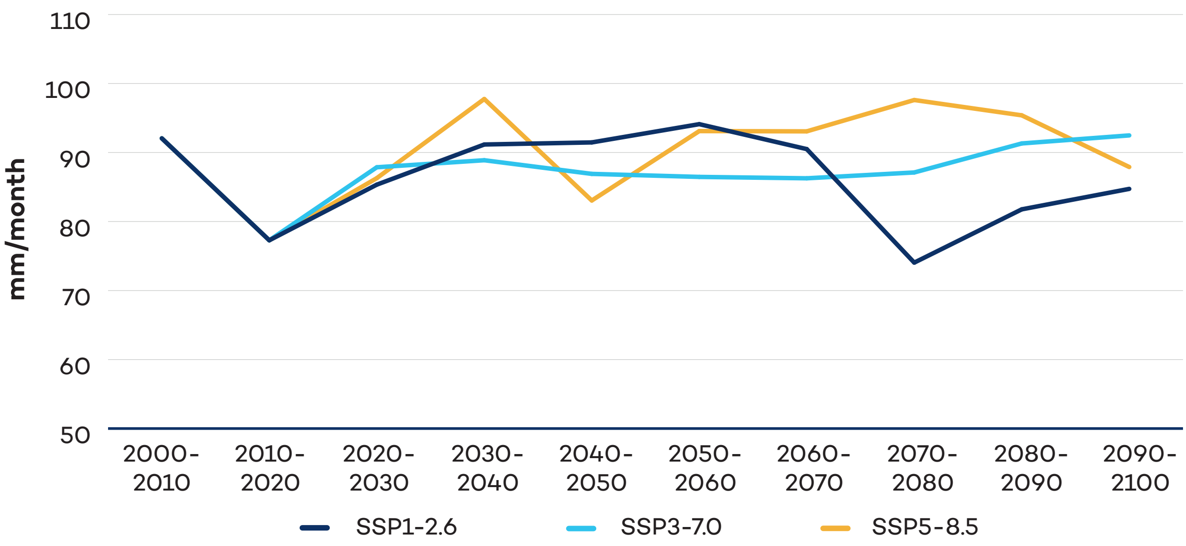
The Zambezi region shows significant changes in temperature, high variability in precipitation, and an increase in extreme wet conditions across all scenarios. Average temperatures are projected to rise steadily, with SSP1–2.6 showing a 0.6°C increase by 2100 compared to 2020–2030 levels (see Figure 7). SSP3–7.0 and SSP5–8.5 indicate larger increases of 2.6°C and 3.0°C by 2100 compared to 2020-2030 levels, respectively, highlighting a gradual warming trend over time. While the current period shows relative stability, projections suggest increasing variability in precipitation (see Figure 8). SSP1–2.6 anticipates a slight increase over time, reaching precipitation levels of 94 mm/month by 2050–2060. After that decade, precipitation drops significantly to 74 mm/month by 2070-2080 and then increases again, ending up at a level of 84 mm/month by 2100. In SSP3–7.0, monthly averages are quite stable until 2070–2080 at a level of around 87 mm/month. After that decade, monthly precipitation shows an increase, ending up at a level of 93 mm/month by 2100. SSP5–8.5 projects higher monthly precipitation compared to the other scenarios and higher variability as well, oscillating between 98 mm/month (highest peak) and 83 mm/month (lowest peak), finally reaching a level of 88 mm/month by 2100. Extreme wet events (see Figure 9) are expected to rise for the SSP3–7.0 and SSP5–8.5 scenarios, with the SSP5–8.5 scenario having the most rapid increase by 2100. For the SSP1–2.6 scenario, extreme wet events stay relatively stable, with a slight decrease by 2100. These changes point to the increasing frequency of high-rainfall events in scenarios SSP3–70. and SSP5–8.5.

Figure 7. Average monthly temperature from 2000 to 2100 in Zambezi



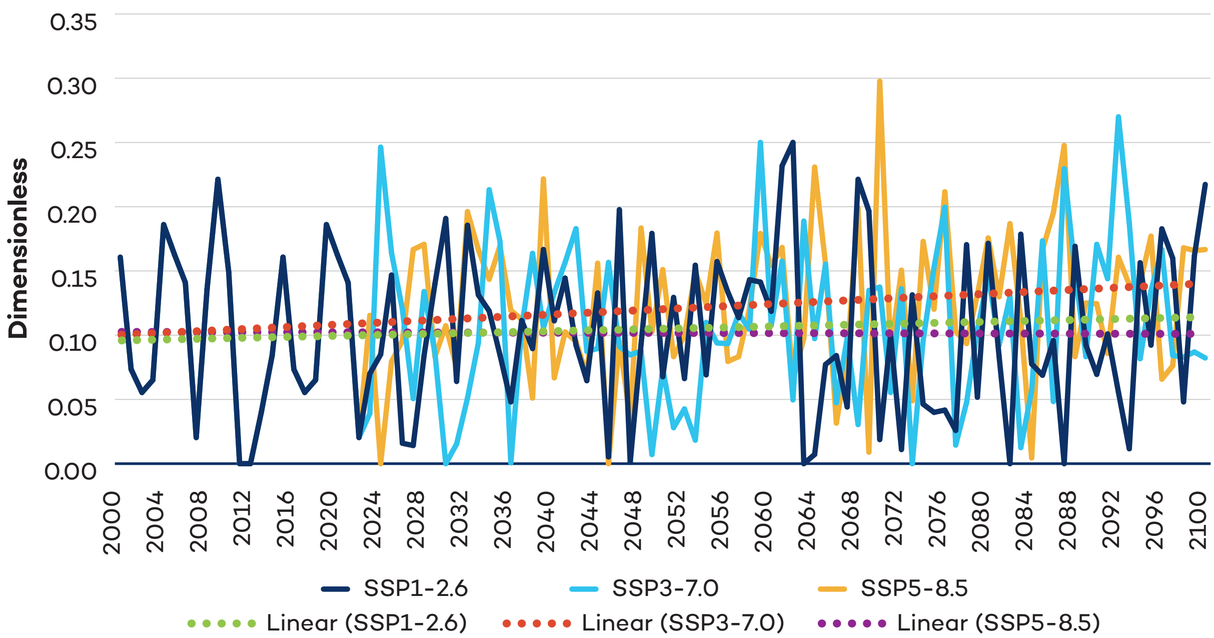
Source: Copernicus Climate Data Store, 2024.

Figure 8. Average monthly precipitation from 2000 to 2100 in Zambezi



Source: Copernicus Climate Data Store, 2024.

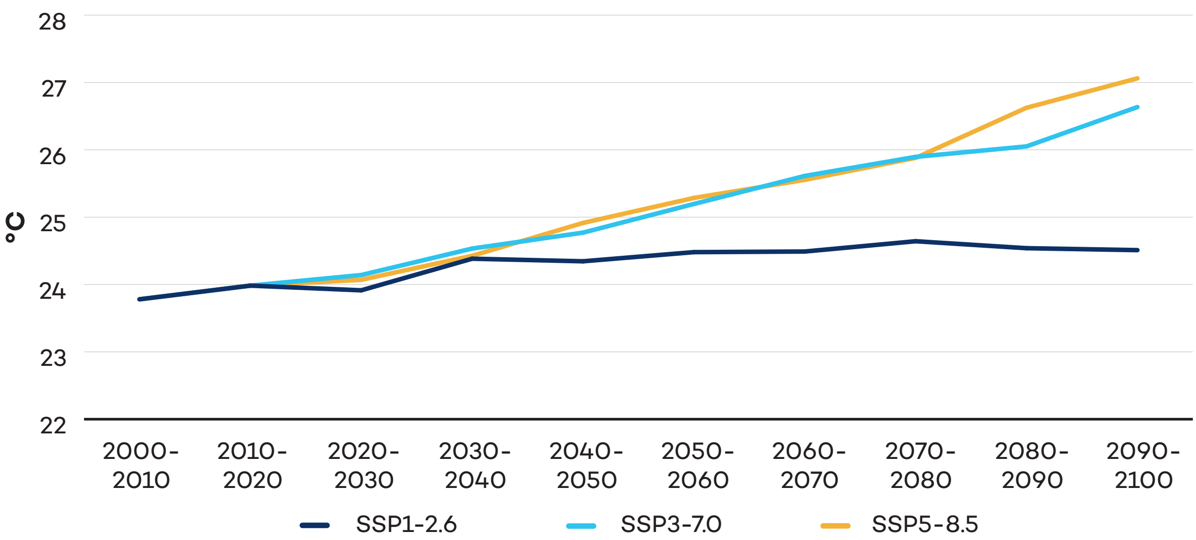
Figure 9. Extreme wet percentile from 2000 to 2100 in Zambezi



Source: Copernicus Climate Data Store, 2024.

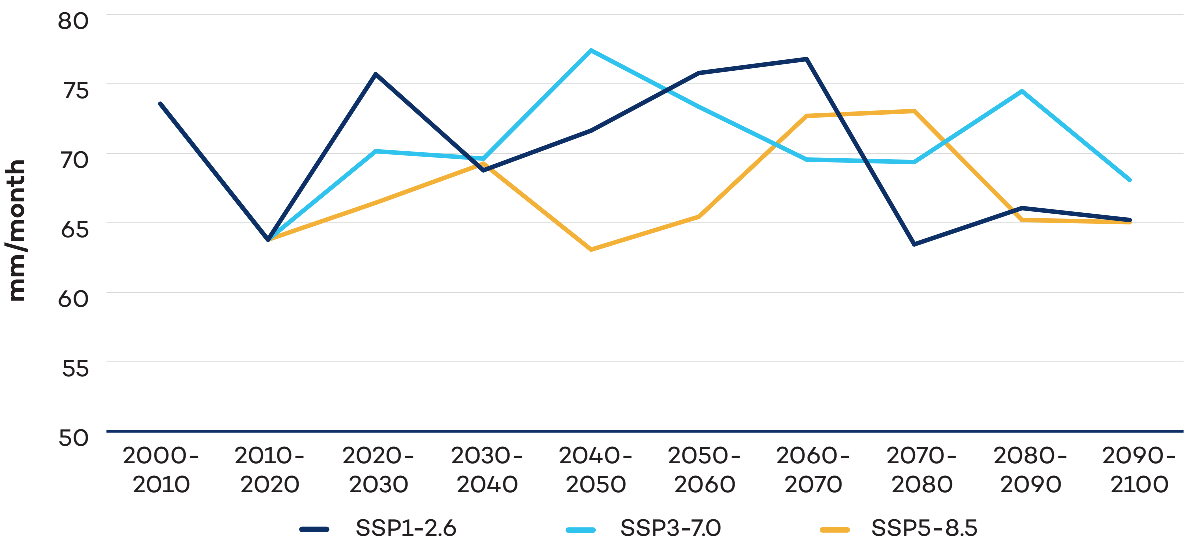
Climate trends in Limpopo indicate rising temperatures for all scenarios, more variable precipitation compared to the other two sites, and a notable increase in extreme wet conditions for two scenarios. For the case of average monthly temperatures, it shows a rise across all scenarios, with SSP1–2.6 indicating a gradual increase of 0.6°C by 2100 compared to 2020–2030 levels (see Figure 10). SSP3–7.0 and SSP5–8.5 show larger increases of 2.5°C and 3.0°C by 2100 compared to 2020-2030 levels, respectively, consistent with broader warming trends. Precipitation patterns show relatively high variability for all scenarios (see Figure 11). Under the SSP1–2.6, monthly precipitation oscillates between 77 mm/month (highest peak) and around 63 mm/month (lowest peak), ending up at around 65 mm/month by 2100. SSP3–7.0 presents the highest peak and the highest levels of monthly precipitation compared to the other two climate scenarios, oscillating between around 78 mm/month and 68 mm/month, staying at 68 mm/month by 2100. SSP5–8.5 projects a more pronounced downward trend, with monthly precipitation oscillating between around 74 mm/month and 65 mm/month, staying at this last level by 2100. Extreme wet events are projected to increase in the SSP3–7.0 and SSP5–8.5 scenarios, with a slightly higher increase in the SSP3–7.0 scenario (see Figure 12). For the SSP1–2.6 scenario, the extreme wet events are stable over the analyzed period. These figures reflect a growing trend in intense rainfall events over time for the SSP3–7.0 and the SSP5–8.5 scenarios.

Figure 10. Average monthly temperature from 2000 to 2100 in Limpopo



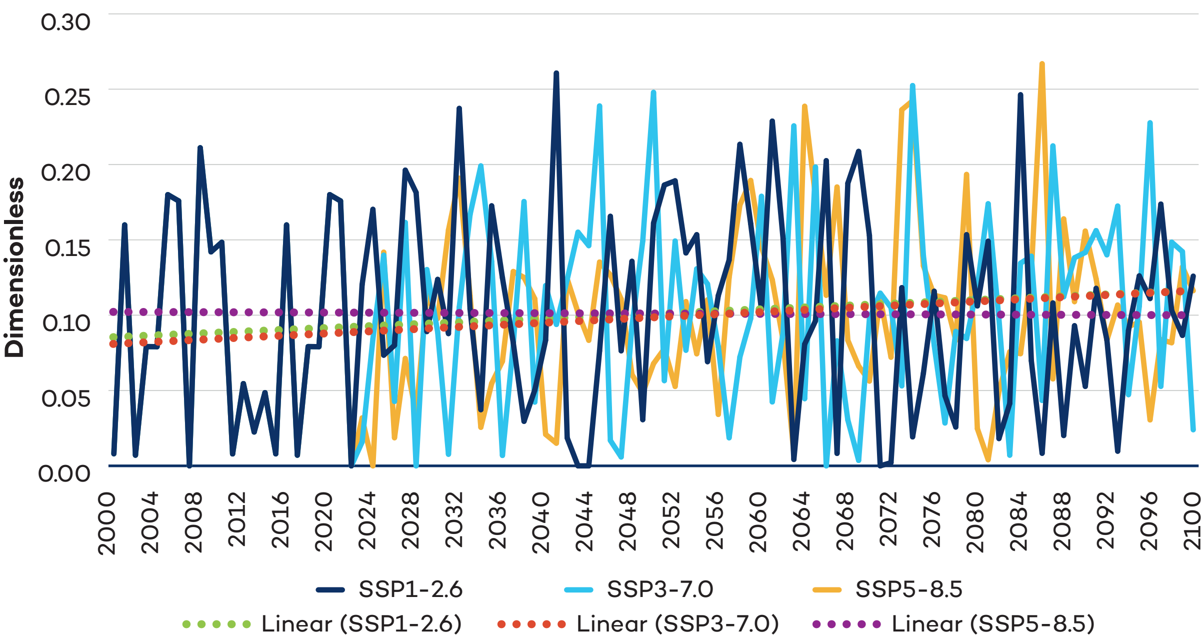
Source: Copernicus Climate Data Store, 2024.

Figure 11. Average monthly precipitation from 2000 to 2100 in Limpopo



Source: Copernicus Climate Data Store, 2024.

Figure 12. Extreme wet percentile from 2000 to 2100 in Limpopo



Source: Copernicus Climate Data Store, 2024.

Across Bons Sinais, Zambezi, and Limpopo, the trends reflect an overall warming climate, with higher temperatures and variable precipitation patterns in all scenarios. SSP1–2.6 demonstrates more moderate changes, with temperature rises between 0.6°C and 0.8°C and relatively stable trends in extreme wet events. In contrast, SSP5–8.5 shows the most significant changes, with temperature increases of up to 3.5°C and extreme wet events showing a sharper increase. SSP3–7.0 represents an intermediate pathway, with an intermediate increase in temperatures (2.6°C) and moderate variability in precipitation. These projections highlight clear trends toward more intense rainfall and rising temperatures under less mitigative scenarios (SSP3–7.0 and SSP5–8.5).

2.5 Scenarios and Indicators of the Integrated CBA

This report employs an integrated CBA to evaluate the economic, social, and environmental impacts of NBI interventions across three estuaries in Mozambique. The analysis spans a 26-year period, from 2025 to 2051, using an Excel-based model that incorporates scenario analysis and various indicators presented in Section 2.4.2. A discount rate of 20% is applied to calculate net present values, based on finance information of the government-led program Sustenta, which establishes that "there are no charges of interest rates, to access the funds, but the applicants must comply with formalities regarding their legal statutes and financial records and contribute at least 20% of the total cost of the loan" (UNEP, 2021). Detailed assumptions, data inputs, and calculation methods are presented in Appendix A.

2.5.1. Scenarios

This assessment evaluates two primary scenarios to measure the impact of nature-based interventions in the Bons Sinais, Zambezi, and Limpopo estuaries. These scenarios provide a comparative analysis of the net change generated by the proposed NBI investments.

Business-as-Usual (BAU) Scenario: The BAU scenario represents a "no-action" baseline where no interventions are undertaken to address the ongoing climate-related challenges affecting the three estuaries.

NBI SCENARIO

This scenario involves large-scale ecosystem restoration and conservation activities across the three estuaries:

- Restoration of 7,500 ha of wetlands, with 2,500 ha restored in each of the three estuaries.
- Restoration of 3,800 ha of mangroves, distributed equally with 1,267 ha per estuary.
- Conservation of 30,000 ha of ecosystems, with 10,000 ha conserved in each estuary.

The NBI scenario is further divided into five sub-scenarios based on varying assumptions regarding unitary costs and the shadow price of carbon, reflecting different levels of economic and environmental ambition:

- **High Valuation–High Carbon Price Scenario:** The most optimistic scenario using the costs and benefits provided in the pre-feasibility study (Baastel, 2021) and assuming a shadow price of carbon of USD 50 per tonne of carbon dioxide (tCO_2).
- **High Valuation–Low Carbon Price Scenario:** An optimistic scenario using the costs and benefits provided in the pre-feasibility (Baastel, 2021) study, but assuming a lower shadow price of carbon at USD 30/tCO_2.
- **Low Valuation–High Carbon Price Scenario:** A more conservative scenario using lower benefits from literature sources for ecosystem services such as fisheries, ecotourism, and pollution control (i.e., air and water pollution), paired with a shadow price of carbon of USD 50/tCO_2.
- **Low Valuation–Low Carbon Price Scenario:** A conservative scenario using values from literature for the ecosystem services and a lower shadow price of carbon at USD 30tCO_2.
- **Low Valuation–Tangible Only Scenario:** A conservative scenario that uses the values from literature and focuses only on tangible benefits, such as avoided climate impacts, increased fisheries value, job creation, and enhanced provisioning of food, energy, and timber, without accounting for broader ecosystem services.

2.5.2. Indicators

An Excel spreadsheet model was developed to estimate the required investment, avoided costs, and aggregate benefits related to project implementation. The indicators assessed in the model include capital costs, operation and maintenance (O&M) costs, and various socio-economic and environmental benefits, such as job creation, increased fisheries value, carbon sequestration, ecotourism revenue, food and energy provisioning, and avoided costs related to climate impacts, saline intrusion, pollution, and sedimentation. A brief description of each indicator included in the integrated CBA is presented in Table 1.

Table 1. Description of the CBA indicators

Direct costs	
Capital Costs (CapEx)	Initial costs associated with implementing the NBI interventions, including construction, labour, materials, and other one-time expenditures.
O&M costs	Ongoing costs required to keep the NBI interventions functional over time, such as the maintenance of mangroves and wetlands.
Added benefits	
Job creation	Economic value of new jobs generated through the implementation and maintenance of mangroves and wetland restoration. It represents the portion of the income creation that goes back to the economy, known as discretionary spending.

Added benefits (continued)	
Increased fisheries value added	Increased economic benefits from nursery and aquaculture as a result of the ecological services mangroves provide.
Carbon sequestration	Carbon sequestration refers to the process by which mangroves and wetlands capture and store atmospheric CO_2 in their biomass and soils.
Increased ecotourism and recreation value added	Refers to the economic benefits generated from mangroves attracting visitors for activities such as birdwatching, kayaking, and nature tours.
Increased food provisioning	Enhanced availability of food resources supported by mangroves and wetlands, particularly through the restoration and maintenance of habitats for fish, crustaceans, and other marine species.
Increased energy resources	Increased energy resources from natural systems, such as mangroves and wetlands, stem from their ability to contribute biomass for bioenergy production or support sustainable resource management.
Increased wood and timber production	Mangroves and wetlands increase the capacity to provide raw materials for construction, fuel, and other uses while maintaining their ecological integrity, supporting both local economies and environmental conservation efforts.
Increased honey production	Increased honey production from mangroves stems from the flowering plants they support, which provide nectar for bees.
Avoided costs	
Avoided flood damage	Avoiding flood damage, particularly concerning floods related to cyclones, is a critical benefit of mangrove and wetland ecosystems. By acting as natural buffers, these ecosystems reduce the intensity of storm surges and mitigate flood risks, thereby protecting coastal infrastructure, reducing economic losses, and safeguarding lives.
Avoided saline intrusions	Mangroves act as natural barriers against the encroachment of saltwater into freshwater systems, such as rivers and groundwater reserves. The avoided saline intrusion costs refer specifically to the health costs of saline intrusion.
Avoided pollution	The reduction of water and air contaminants and pollutants, such as sediments, heavy metals, and nutrients from agriculture and industry, entering water bodies and the atmosphere through natural filtration processes provided by mangrove ecosystems.
Avoided sedimentation	A reduction in the accumulation of sediments in water bodies, which can be caused by erosion and runoff from land. By reducing sedimentation, mangroves and wetlands help maintain water quality, protect aquatic life, and support the sustainability of coastal ecosystems.

Source: Authors.

3.0 Results of the Integrated CBA

The following section presents the results of the integrated CBA, which evaluates the economic, social, and environmental performance of NBI interventions. The analysis covers a 26-year period (2025–2051) and applies a 20% discount rate, as outlined in the project concept, under different valuation and climate scenarios. Results are presented in terms of investment and operating costs, added benefits, avoided costs, and the resulting net benefits relative to a BAU scenario. The section is organized into three parts: first, the outcomes for the main valuation scenarios are described, highlighting the variation in returns under different assumptions about carbon pricing and ecosystem service valuation; second, the results are disaggregated for the Bons Sinais, Zambezi, and Limpopo estuaries to capture regional differences in performance; and finally, the analysis explores the sensitivity of results to climate projections across SSP1–2.6, SSP3–7.0, and SSP5–8.5 scenarios, providing insights into how future climate variability influences the economic case for NBI.

3.1 Results for the Main Scenarios

The results of the integrated CBA for the main scenarios are presented in Table 2, discounted at 20%. The discount rate corresponds to the discount rate suggested by the Concept Note of the project (UNEP, 2021). All the scenarios presented in this subsection are modelled under the climate scenario SSP3–7.0. The results in the table are presented in relative terms to the BAU scenario, indicating the net change generated by the NBI investment.

Table 2. Integrated CBA results in million USD, SSP3–7.0 scenario, cumulative discounted between 2025 and 2051 (20% discount rate)

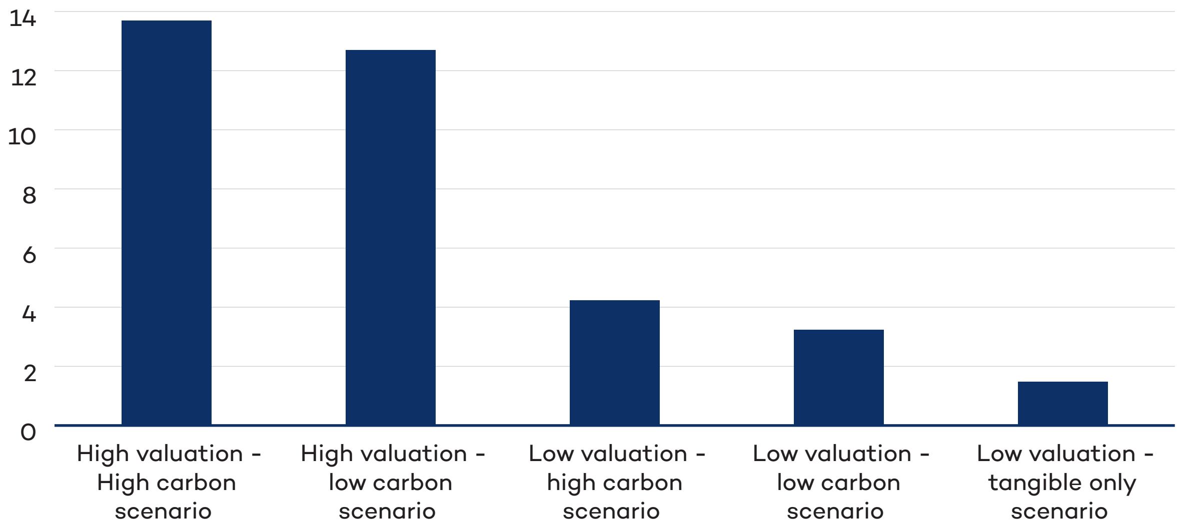
CBA, cumulative discounted values from 2025 to 2051	High Valuation–High Carbon Price Scenario	High Valuation–Low Carbon Price Scenario	Low Valuation–High Carbon Price Scenario	Low Valuation–Low Carbon Price Scenario	Low Valuation–Tangible Only Scenario
Total costs	**41.73**	**41.73**	**41.73**	**41.73**	**41.73**
Implementation costs	14.54	14.54	14.54	14.54	14.54
O&M costs	27.20	27.20	27.20	27.20	27.20

CBA, cumulative discounted values from 2025 to 2051	High Valuation–High Carbon Price Scenario	High Valuation–Low Carbon Price Scenario	Low Valuation–High Carbon Price Scenario	Low Valuation–Low Carbon Price Scenario	Low Valuation–Tangible Only Scenario
Total added benefits	**448.63**	**407.29**	**132.39**	**91.05**	**29.03**
Job creation	0.19	0.19	0.19	0.19	0.19
Increased fisheries value added	177.34	177.34	4.51	4.51	4.51
Carbon sequestration	103.35	62.01	103.35	62.01	-
Increased ecotourism and recreation value added	146.03	146.03	2.62	2.62	2.62
Increased food provisioning	15.93	15.93	15.93	15.93	15.93
Increased energy resources	3.19	3.19	3.19	3.19	3.19
Increased wood and timber provisioning	2.56	2.56	2.56	2.56	2.56
Increased honey production	0.04	0.04	0.04	0.04	0.04
Total avoided costs	**130.64**	**130.64**	**55.04**	**55.04**	**42.64**
Avoided flood damage	42.64	42.64	42.64	42.64	42.64
Avoided saline intrusion costs	0.43	0.43	0.43	0.43	-
Avoided pollution	81.56	81.56	5.96	5.96	-
Avoided sedimentation	6.01	6.01	6.01	6.01	-
Net benefits	**537.54**	**496.19**	**145.69**	**104.35**	**29.94**
Benefit-to-cost ratio (BCR)	13.88	12.89	4.49	3.50	1.72
Internal rate of return (IRR)	311.06%	252.20%	170.63%	108.93%	34.50%

Source: Authors.

The results reveal strong economic viability across all scenarios, with varying degrees of net benefits depending on the assumptions. The BCR of all scenarios is presented in Figure 13, showing higher returns in the High Valuation scenarios and the lowest returns when the valuation uses more conservative values and includes only the tangible indicators. The total costs, comprising CapEx and O&M, remain consistent across all scenarios, amounting to USD 41.73 million (discounted values). This includes USD 14.54 million in initial implementation costs and USD 27.20 million for long-term O&M.

Figure 13. BCR comparison across scenarios



Source: Authors.

Added benefits differ across scenarios. In the High Valuation–High Carbon Price Scenario, the benefits reach USD 448.63 million, driven by substantial contributions from carbon sequestration, fisheries enhancement, and ecotourism. The corresponding net benefits in this scenario amount to USD 537.52 million, yielding a high BCR of 13.88 and an IRR of 311.06%. This underscores the significant economic returns associated with ecosystem restoration and the high valuation of carbon sequestration in this scenario.

In comparison, the High Valuation–Low Price Carbon Scenario yields slightly lower benefits, totalling USD 407.29 million. This reduction is primarily attributed to the lower assumed shadow price of carbon. Despite this, the scenario remains highly viable, with net benefits of USD 496.19 million, a BCR of 12.89, and an IRR of 252.20%.

The Low Valuation scenarios, which adopt more conservative cost assumptions for ecosystem services, present lower but still positive economic outcomes. The Low Valuation–High Carbon Price Scenario generates USD 132.39 million in added benefits, with net benefits of USD 145.69 million, a BCR of 4.49, and an IRR of 170.63%. The reduced benefits reflect the more cautious valuation of ecosystem services; however, the scenario still demonstrates substantial returns, particularly from avoided climate impacts and fisheries.

Similarly, the Low Valuation–Low Carbon Price Scenario yields USD 91.05 million in benefits, resulting in net benefits of USD 104.35 million, a BCR of 3.50, and an IRR of 108.93%. This scenario highlights the economic viability of ecosystem restoration even under conservative valuation assumptions and lower carbon pricing.

The Low Valuation–Tangible Only Scenario, which focuses solely on direct economic benefits, produces the lowest outcomes, with total benefits of USD 29.03 million and net benefits of USD 29.94 million. The BCR in this scenario is 1.72, and the IRR stands at 34.50%. While still economically viable, this scenario underscores the importance of incorporating broader ecosystem services to fully capture the value of nature-based interventions.

Across all scenarios, carbon sequestration and fisheries values emerge as key drivers of economic benefits. In the High Valuation scenarios, carbon sequestration alone contributes between USD 62.01 million and USD 103.35 million, while increased fisheries value added is approximately USD 177.34 million in both High and Low Carbon scenarios. Avoided flood damage consistently contributes USD 42.64 million across all variations, highlighting the resilience benefits of the interventions.

In conclusion, the analysis demonstrates that NBI investments in the Bons Sinais, Zambezi, and Limpopo estuaries offer substantial economic, social, and environmental returns. While conservative scenarios provide lower returns, they remain economically viable, reinforcing the resilience and sustainability of these interventions over the long term. The results emphasize the critical role of comprehensive ecosystem valuation in maximizing the economic and societal benefits of climate resilience projects.

3.2 Results for the Bons Sinais, Zambezi, and Limpopo Estuaries Individually

NBI scenarios for each of the Bons Sinais, Zambezi, and Limpopo estuaries were analyzed individually to assess the economic viability of the interventions in each region, and the results are presented in Table 3. All the simulations use the climate scenario SSP3–7.0, a medium emissions pathway scenario.

Table 3. Integrated CBA table for cumulative benefits per estuary in million USD, discounted at 20%

	Bons Sinais		Zambezi		Limpopo	
CBA, cumulative discounted values from 2025 to 2051	**Low Valuation– High Carbon Price**	**Low Valuation– Tangible Only**	**Low Valuation– High Carbon Price**	**Low Valuation– Tangible Only**	**Low Valuation– High Carbon Price**	**Low Valuation– Tangible Only**
Total costs	**13.91**	**13.91**	**13.91**	**13.91**	**13.91**	**13.91**
Implementation costs	4.85	4.85	4.85	4.85	4.85	4.85
O&M costs	9.07	9.07	9.07	9.07	9.07	9.07
Total added benefits	**44.13**	**9.68**	**44.13**	**9.68**	**44.13**	**9.68**
Job creation	0.06	0.06	0.06	0.06	0.06	0.06
Increased fisheries value added	1.50	1.50	1.50	1.50	1.50	1.50
Carbon sequestration	34.45	-	34.45	-	34.45	-
Increased ecotourism and recreation value added	0.87	0.87	0.87	0.87	0.87	0.87
Increased food provisioning	5.31	5.31	5.31	5.31	5.31	5.31
Increased energy resources	1.06	1.06	1.06	1.06	1.06	1.06
Increased wood and timber provisioning	0.85	0.85	0.85	0.85	0.85	0.85
Increased honey production	0.01	0.01	0.01	0.01	0.01	0.01

	Bons Sinais		Zambezi		Limpopo	
CBA, cumulative discounted values from 2025 to 2051	**Low Valuation–High Carbon Price**	**Low Valuation–Tangible Only**	**Low Valuation–High Carbon Price**	**Low Valuation–Tangible Only**	**Low Valuation–High Carbon Price**	**Low Valuation–Tangible Only**
Total avoided costs	**14.75**	**10.58**	**5.42**	**1.30**	**34.87**	**30.76**
Avoided flood damage	10.58	10.58	1.30	1.30	30.76	30.76
Avoided saline intrusion costs	0.18	-	0.13	-	0.13	-
Avoided pollution	1.99	-	1.99	-	1.99	-
Avoided sedimentation	2.00	-	2.00	-	2.00	-
Net benefits	**44.97**	**6.35**	**35.64**	**(2.93)**	**65.09**	**26.52**
BCR	4.23	1.46	3.56	0.79	5.68	2.91
IRR	168.26%	29.94%	154.51%	14.48%	188.17%	53.15%

Source: Authors.

Despite consistent costs and equal investment across the three regions—USD 13.91 million in total, split between implementation and operational expenses—the economic performance of each estuary varies. These differences are primarily driven by the number of people impacted by climate change and saline intrusion in each estuary.

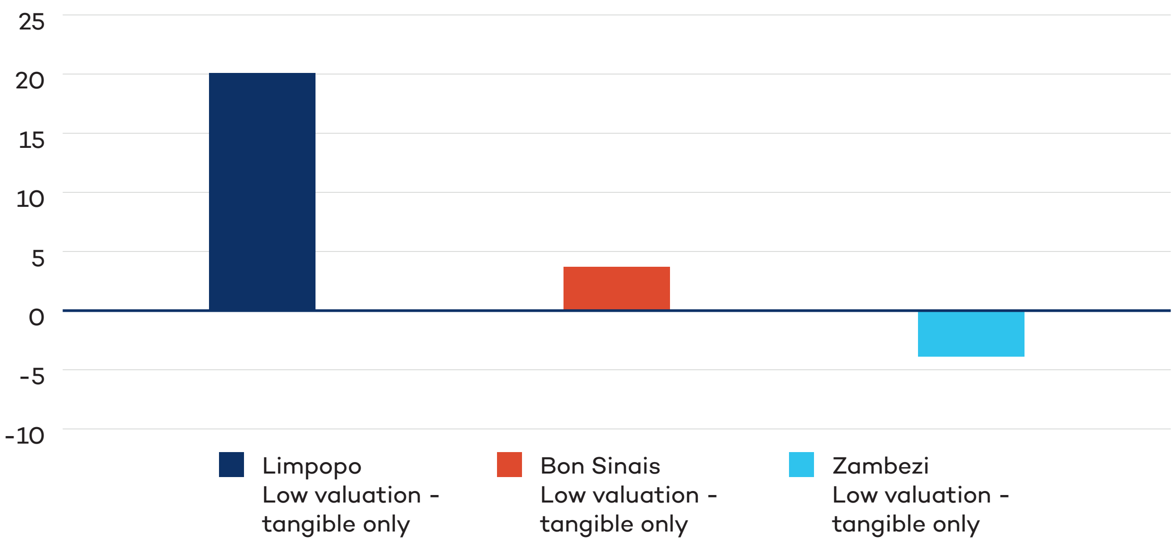
The Limpopo estuary exhibits the most favourable economic performance across both valuation scenarios. This can be attributed to the fact that Limpopo accounts for the largest share of the total population affected by climate change impacts, representing approximately 73% of the 276,151 people impacted across all three estuaries by 2020. This substantial population impact leads to higher avoided costs and greater societal benefits, resulting in net benefits of USD 65.09 million, a BCR of 5.68, and an IRR of 188.17% in the Low Valuation–High Carbon Price Scenario.

In contrast, the Bons Sinais estuary, while benefiting from a substantial number of people impacted by saline intrusion (70,000 people per year), accounts for only 24% of the total population affected by climate change. Consequently, its economic returns, while still positive, are lower than Limpopo's. For instance, under the Low Valuation–High Carbon Price Scenario, Bons Sinais yields net benefits of USD 44.97 million and a BCR of 4.23. When focusing on only tangible indicators, in the Low Valuation–Tangible Only Scenario, the benefits decline significantly, with net benefits of USD 6.35 million and a BCR of 1.46, reflecting the limited tangible benefits relative to the broader impacts in Limpopo.

The Zambezi estuary presents the least favourable outcomes, primarily due to its relatively small share of the population impacted by climate change (only 3% of the total). This limited impact reduces the potential for avoided costs and societal benefits. As a result, while the Zambezi estuary achieves a positive net benefit of USD 35.64 million and a BCR of 3.56 in the Low Valuation–High Carbon Price Scenario, it fails to remain economically viable under the Low Valuation–Tangible Only Scenario, with a negative net benefit of USD -2.93 million and a BCR of 0.79.

Overall, the analysis highlights that while the interventions are designed with consistent costs across the three estuaries, the economic viability of each intervention is highly dependent on the scale of the population impacted by climate change and saline intrusion. As presented in Figure 14, Limpopo performs the best when looking at the net benefits for the Low Valuation–Tangible Only Scenario, and Bons Sinais follows it, while Zambezi presents negative net benefits, struggling to demonstrate economic viability when focusing on tangible benefits alone.

Figure 14. Net benefits of the Low Valuation–Tangible Only Scenario per site



Source: Authors' calculations.

3.3 Results for the Climate Scenarios

An analysis of climate scenarios examines the performance of NBI interventions across SSP1–2.6 (low impact), SSP3–7.0 (moderate impact), and SSP5–8.5 (high impact) scenarios in the Bons Sinais, Zambezi, and Limpopo estuaries. Results are presented in Table 4.

Table 4. Integrated CBA table for cumulative benefits per climate scenario in USD million, discounted at 20%

CBA, cumulative discounted values from 2025 to 2051 in USD million	Low Valuation–High Carbon Price Scenario			Low Valuation–Tangible Only Scenario		
	SSP1–2.6	SSP3–7.0	SSP5–8.5	SSP1–2.6	SSP3-7.0	SSP5–8.5
Total costs	**41.73**	**41.73**	**41.73**	**41.73**	**41.73**	**41.73**
Implementation costs	14.54	14.54	14.54	14.54	14.54	14.54
O&M costs	27.20	27.20	27.20	27.20	27.20	27.20
Total added benefits	**132.39**	**132.39**	**132.39**	**29.03**	**29.03**	**29.03**
Job creation	0.19	0.19	0.19	0.19	0.19	0.19
Increased fisheries value added	4.51	4.51	4.51	4.51	4.51	4.51
Carbon sequestration	103.35	103.35	103.35	-	-	-
Increased ecotourism and recreation value added	2.62	2.62	2.62	2.62	2.62	2.62
Increased food provisioning	15.93	15.93	15.93	15.93	15.93	15.93
Increased energy resources	3.19	3.19	3.19	3.19	3.19	3.19
Increased wood and timber provisioning	2.56	2.56	2.56	2.56	2.56	2.56
Increased honey production	0.04	0.04	0.04	0.04	0.04	0.04
Total avoided costs	**59.91**	**55.04**	**58.30**	**47.51**	**42.64**	**45.90**
Avoided flood damage	47.51	42.64	45.90	47.51	42.64	45.90
Avoided saline intrusion costs	0.43	0.43	0.43	-	-	-
Avoided pollution	5.96	5.96	5.96	-	-	-
Avoided sedimentation	6.01	6.01	6.01	-	-	-
Net benefits	**150.56**	**145.69**	**148.95**	**34.81**	**29.94**	**33.20**
BCR	4.61	4.49	4.57	1.83	1.72	1.80
IRR	169.97%	170.63%	167.17%	37.52%	34.50%	36.24%

Source: Authors.

Although the investment remains the same across all scenarios, the added benefits and avoided costs differ based on projected climate conditions up to 2050. In the Low Valuation–High Carbon Price Scenario, total added benefits are identical across all SSPs at USD 132.39 million, with carbon sequestration as the primary contributor (USD 103.35 million). Other ecosystem services, such as food provisioning, fisheries enhancement, and ecotourism, remain constant due to their reliance on restored ecosystems rather than external climate variability. The variation lies in the avoided costs. Interestingly, SSP1–2.6 results in the highest avoided costs (USD 59.91 million), surpassing SSP5–8.5 (USD 58.30 million) and SSP3–7.0 (USD 55.04 million). This is due to the climate projections up to 2050, which show more frequent extreme wet events in SSP1–2.6, leading to greater opportunities for NBI interventions to mitigate flood risks. After 2050, however, SSP3–7.0 and SSP5–8.5 are expected to exhibit greater climate variability and more intense extreme weather, which may shift the balance of avoided costs in the long term.

In the Low Valuation–Tangible Only Scenario, which excludes carbon sequestration, total added benefits drop to USD 29.03 million across all SSPs. Avoided costs follow a similar pattern, with SSP1–2.6 providing the highest savings (USD 47,51 million), followed by SSP5–8.5 (USD 45.90 million) and SSP3–7.0 (USD 42.64 million). The higher avoided costs in SSP1–2.6 reflect its increased risk of flood-related damages up to 2050, where interventions have a greater mitigating effect. SSP3–7.0 shows the lowest avoided costs due to relatively lower flood risks during the analysis period, limiting the potential impact of NBI.

Overall, these results underscore that while added benefits from ecosystem restoration remain stable across scenarios, avoided costs are closely tied to the timing and intensity of climate impacts. Up to 2050, SSP1–2.6 presents the greatest flood risk, making NBI interventions most effective in this scenario, whereas SSP3–7.0 and SSP5–8.5 are projected to become more severe beyond 2050.

4.0 Conclusions

The results of the integrated CBA confirm that NBI interventions, particularly mangrove and wetland restoration across the Bons Sinais, Zambezi, and Limpopo estuaries, are economically viable and generate substantial returns on investment. With consistent capital and operational costs of USD 41.73 million, the interventions produce positive net benefits across all valuation scenarios.

The High Valuation–High Carbon Price Scenario yields the most favourable outcomes, achieving a BCR of 10.15 and an IRR of 256.22%, demonstrating the substantial economic value of comprehensive ecosystem restoration. Even under the more conservative Low Valuation–Tangible Only Scenario, the project remains viable, with a BCR of 1.30 and positive net benefits.

In addition to delivering robust economic returns, the NBI interventions significantly reduce climate-related risks. Mangrove and wetland restoration mitigate flood impacts, protect coastal infrastructure, and reduce damage from storm surges and rising sea levels. Avoided flood and cyclone-related costs consistently contribute to overall project benefits, particularly in the SSP1–2.6 climate scenario, which experiences frequent extreme wet events through 2050. Protecting and restoring mangroves and wetlands enhances climate resilience for vulnerable coastal communities and provides long-term protection as climate variability intensifies in the SSP3–7.0 and SSP5–8.5 scenarios.

The individual analysis of the estuaries reveals notable differences in economic performance, driven by the scale of the population exposed to climate risks and the varying levels of ecosystem degradation. The Limpopo estuary consistently delivers the highest returns across scenarios, reflecting its large population affected by flooding and saline intrusion. With a BCR of 4.97 and an IRR of 175.18% in the Low Valuation–High Carbon Price Scenario, Limpopo demonstrates the greatest economic viability and resilience benefits. In contrast, the Bons Sinais estuary shows moderate returns, with a BCR of 3.79 in the same scenario, reflecting its exposure to saline intrusion and moderate flood risk. The Zambezi estuary, while ecologically significant, yields the lowest economic returns due to its smaller population impacted by climate risks, with a BCR of 3.25 in the Low Valuation–High Carbon Price Scenario.

Beyond climate resilience, the NBI interventions offer critical socio-economic benefits for local communities and public institutions. Restoration efforts generate jobs, support fisheries, boost ecotourism, and improve food security, contributing to local livelihoods and poverty alleviation. These co-benefits directly benefit 211,000 people and indirectly impact over 1 million residents across the three estuaries, promoting economic development and social resilience in vulnerable coastal regions.

Furthermore, the interventions contribute to environmental sustainability by improving water quality, reducing sedimentation, and enhancing biodiversity. The external benefits, such as carbon sequestration, avoided pollution, and sedimentation control, underscore the value of integrating ecosystem services into national and regional climate adaptation strategies.

These results can be leveraged by various stakeholders to inform policy, funding, and investment decisions. Policy-makers can use the findings to prioritize ecosystem-based solutions in national climate adaptation and disaster risk reduction strategies. Development agencies and international donors, including the Green Climate Fund, can view the demonstrated economic viability and co-benefits as a strong case for scaling up investment in NBI. Additionally, local governments and community organizations can use the results to advocate for sustainable infrastructure that promotes economic growth, environmental protection, and social resilience, aligning with both local development needs and global climate goals.

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Appendix A. Data Inputs, Methods, and Assumptions

This appendix outlines the methodology used to calculate the indicators for the integrated cost-benefit analysis (CBA), translating biophysical impacts—such as hectares restored, jobs created, and people protected—into economic terms. By expressing these impacts in monetary values, the analysis facilitates direct comparison between costs and benefits across diverse categories, including job creation, fisheries enhancement, carbon sequestration, and avoided climate-related costs. The section details the sources of data, assumptions, and formulas used to estimate each indicator, ensuring transparency and consistency in the valuation process.

Direct Costs

The direct costs of the mangrove restoration project are divided into capital costs and operation and maintenance (O&M) costs. The capital costs represent a one-time investment, which in this case is USD 20 million in 2025, distributed in equal parts among the estuaries, resulting in an investment of USD 6.66 million per estuary. In addition, the project incurs annual O&M costs, which are essential for the long-term sustainability of the mangrove and wetland ecosystems. These costs are calculated by multiplying the average annual cost per hectare of wetlands and mangroves by the restoration areas for each ecosystem type (Table A1).

These costs are assumed to be evenly distributed across the restoration site, reflecting the even implementation distribution. The O&M costs ensure that the mangrove and wetland ecosystems continue to thrive, providing long-term ecological and economic benefits.

Table A1. Variables used as input for the investment and cost indicators

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Capital costs	Distribution of interventions among sites	33.3%	33.3%	33.3%	Assumption[3]
	Total cost of the interventions per estuary (USD)	6.66 million	6.66 million	6.66 million	Concept Note (United Nations Environment Programme [UNEP], 2021, p. 41)

[3] Given the lack of information about the intervention sizes in each estuary, the model assumes an equal distribution of the intervention (hectares of implementation) among the three estuaries, giving as a result a 33.33% distribution for each.

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
O&M cost	Wetland restoration area (ha)	2,500[4]	2,500	2,500	Total restoration goal: 7,500 ha based on the Concept Note (UNEP, 2021, p. 24)
	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Ecosystem conservation area (ha)	10,000	10,000	10,000	Total restoration goal: 30,000 ha based on the Concept Note (UNEP, 2021, p. 24)
	Average annual O&M cost per ha of mangrove (USD/ha/year)	1,000	1,000	1,000	World Bank Group, 2022
	Average annual O&M cost per ha of wetland (USD/ha/year)	500	500	500	Ludwig, 2023

Source: Compiled by authors.

Additional Benefits

The additional benefits from the mangrove restoration project are calculated through a series of formulas that take into account the area of mangroves being restored and the corresponding economic values for each benefit (Table A2). For job creation, the benefit is derived by multiplying the investment in restoration by the number of jobs created per million USD spent in restoration, then by the average salary in Mozambique, and finally adjusting for discretionary spending. The job creation indicator considers only the share of discretionary spending of the income, as it is the share that is reinvested in the economy, showing the economic benefits of job creation.

For increased fisheries value added, the economic value is obtained by multiplying the mangrove restoration area by the economic value provided per hectare of mangrove for fisheries. Carbon sequestration is quantified by estimating the total carbon benefit from the project and

[4] The implementation of the wetland restoration, mangrove restoration, and ecosystem conservation interventions are assumed evenly among the three estuaries. This means that from the total 7,500 ha of wetland restoration, each estuary implements a third part, resulting in 2,500 ha per estuary. Same logic for the other two interventions.

multiplying it by the World Bank's shadow price of carbon to determine its monetary value. Increased ecotourism and recreation value added is calculated by multiplying the mangrove restoration area by the economic value per hectare for ecotourism and recreation. Similarly, for increased food provisioning, the benefit is determined by multiplying the restoration area by the economic value per hectare of mangrove for food provisioning.

For increased energy resources, the benefit is found by multiplying the mangrove restoration area by the economic value provided per hectare of mangrove for energy resources, while increased wood and timber provisioning is calculated by multiplying the restoration area by the economic value per hectare for wood and timber production. Lastly, for increased honey production, the calculation involves multiplying the mangrove restoration area by the economic value per hectare for honey production. Each of these benefits is directly tied to the size of the mangrove restoration area and the specific economic value associated with each category, providing a clear framework to assess the broader societal, environmental, and economic advantages of the project.

Table A2. Variables used as input for the added benefits indicators

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Additional benefits					
Job creation	Jobs per million USD spent for land restoration projects (jobs/USD million)			19[5]	Edwards et al., 2013; UN Convention to Combat Desertification, 2023
	Capital costs for restoration per estuary (USD)	USD 6.66 million	USD 6.66 million	USD 6.66 million	Concept Note (UNEP, 2021, p. 41)
	Jobs created in wetland and mangrove restoration per estuary	127	127	127	Calculated based on the jobs per million USD spent and the capital costs
	Discretionary spending (%)[6]	28.4%	28.4%	28.4%	Numbeo, 2024
	Average salary in Mozambique (USD/year)	2,400 [7]	2,400	2,400	TimeCamp, 2024

[5] Based on the two sources listed, the value of 19 jobs due to land restoration per million USD invested was chosen. The paper from Edwards et al. (2013) calculated an average of 19 jobs per million USD for riparian coastal restoration in the U.S., and the range provided by UNCCD (2023) was between 7 and 40 jobs per USD 1 million invested for least developed countries.

[6] The share of discretionary spending is the sum of the shares of expenses for Mozambique in restaurants (17.0%), sports and leisure (8.3%), and clothing and shoes (3.1%), and equates to 28.4% (Numbeo, 2024).

[7] The values correspond to the average salary in 2024 based on TimeCamp (2024).

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Increased fisheries value added	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Fisheries (nursery and aquaculture) economic value (USD/ha/year) – High Valuation scenarios	USD 17,090 by 2007. After the value is adjusted to inflation, it results in USD 25,977.			Mukherjee, et al., 2014[8]
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025
	Fisheries (nursery and aquaculture) economic value (USD/ha/year)– Low Valuation scenarios	USD 500[9] by 2014. After the value is adjusted to inflation, it results in USD 660.			Food and Agriculture Organization of the United Nations (FAO), 2024
	Inflation correction factor 2014-2024	1.32			CPI Inflation Calculator, 2025
Carbon sequestration	Estimated carbon benefit from the project (tCO_2)	2,261,095	2,261,095	2,261,095	Total estimated mitigation impact: -6,783,286 tCO_2 (UNEP, 2021)
	Shadow price of carbon (USD/tonne) – High Carbon Price Scenario	50	50	50	World Bank, 2017
	Shadow price of carbon (USD/tonne) – Low Carbon Price Scenario	30	30	30	World Bank, 2017

8 Reference used in the project's pre-feasibility study by Baastel (2021).

9 FAO references Hutchinson et al. (2014), who established a global median value that ranges from USD 213 per ha per year and USD 10,000 per ha per year (in the most productive locations) for mixed species fisheries. From that range, the model assumes a value of USD 500 per ha per year.

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Increased ecotourism and recreation value added	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for ecotourism and recreation (USD/ha) – High Valuation Scenario	USD 14,072 by 2007. After the value is adjusted for inflation, it results in USD 21,389.			Mukherjee, et al., 2014
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025
	Economic value of 1 ha of mangrove for ecotourism and recreation (USD/ha) – Low Valuation scenario	USD 200 by 1998. After the value is adjusted for inflation, it results in USD 384.			Cabera, et al., 1998
	Inflation correction factor 1998–2024	1.92			CPI Inflation Calculator, 2025
Increased food provisioning (fish)	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for food provisioning (USD/ha)	USD 1,535 by 2007. After the value is adjusted to inflation, it results in USD 2,333.			Mukherjee et al., 2014
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025
Increased energy resources	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for energy resources (USD/ha)	USD 307 by 2007. After the value is adjusted to inflation, it results in USD 467			Mukherjee, et al., 2014
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Increased wood and timber provisioning	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for wood and timber provisioning (USD/ha)	USD 247 by 2007. After the value is adjusted to inflation, it results in USD 375			Mukherjee, et al., 2014
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025
Increased honey production	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for honey production (USD/ha)	USD 4 by 2007. After the value is adjusted to inflation, it results in USD 6			Mukherjee, et al., 2014
	Inflation correction factor 2007–2024	1.52			CPI Inflation Calculator, 2025

Source: Compiled by authors.

Avoided Costs

The avoided costs associated with the mangrove restoration project are determined by several factors that highlight the environmental and economic benefits of the intervention. The data inputs used to calculate each indicator are presented in Table A3. Avoided flood damages are calculated by multiplying the number of people affected by floods per estuary by the cyclone damage cost per person. People impacted per estuary is calculated by multiplying the baseline people impacted (2020 values) by the extreme wet indicator (based on the SSP data projections) to account for the proportional impact of smaller or larger climate events. When the extreme wet index is at its highest value, it represents the impact of large flood events, and when it is at its minimum value, it represents the impact of small flood events. The cyclone damage cost per person is calculated by dividing the total cost of damage to buildings, infrastructure, and agriculture in Cyclone Idai in 2019 by the total number of people affected. After the cost of flood damages is calculated, we apply an 80% reduction in damages: 30% due to the wetland (Kurki-Fox, et al., 2022) and 50% due to mangrove restoration (Menéndez et al., 2020) to calculate the avoided costs. This reflects the cost savings from the reduced flood-related damages due to the flood mitigation role played by the mangroves.

In the case of avoided saline intrusion costs, the calculation involves multiplying the number of people currently affected by saline intrusion by the reduction in water salinity by the mangroves. This result is then adjusted by the health cost of saline intrusion per household per year. The calculation emphasizes the mangroves' contribution to improving water quality and reducing the health-related economic burden on local communities.

Similarly, the avoided pollution costs are determined by multiplying the mangrove restoration area by the economic value per hectare of mangrove for pollution reduction. This measure reflects the benefits in terms of cleaner air and water provided by the mangrove ecosystem. Additionally, avoided sedimentation costs are calculated by multiplying the mangrove restoration area by the economic value per hectare for preventing sedimentation. This highlights the role of mangroves in preserving the health of coastal ecosystems by reducing sediment accumulation that could negatively impact marine life and water quality.

Together, these avoided costs illustrate how mangrove restoration can provide significant environmental and economic value, safeguarding both natural resources and community well-being while reducing the long-term costs associated with flood damage.

Table A3. Variables used as input for the avoided costs indicators

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Avoided flood damage	Current people affected by climate change impacts in the three estuaries			300,000	IISD project survey
	Share of people impacted by climate events per estuary	23.24%	2.93%	73.83%	Calculated[10]
	People affected by floods per estuary (people/year)	69,727	221,489	8,784	Calculated[11]
	Total people affected by Cyclone Idai in 2019 in Mozambique (people)			1,800,000	World Meteorological Organization, 2019

[10] The shares were calculated based on the information available in the project Concept Note (UNEP, 2021) about the people impacted per estuary by 2020 storm surges of 6 m. For Bons Sinais, people affected was 64,184 (23.24% of the total people affected); for Limpopo, people affected was 8,086 (2.93% of the total people affected), and for Zambezi, people affected was 203,881 (73.83% of the total people affected).

[11] The people impacted by climate change per estuary are calculated by multiplying the current people affected by flood damages in the three estuaries by the share of people impacted per estuary (variables above).

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Avoided flood damage (continued)	Total cost of damages to buildings, infrastructure, and agriculture by Cyclone Idai in 2019 in Mozambique (USD)	USD 773,000,000 by 2019. After the value is adjusted to inflation, it results in USD 950,790,000			UNEP, 2021, p. 8
	Inflation correction factor 2019–2024	1.23			CPI Inflation Calculator, 2025
	Cyclone damage cost per person (USD/person)	528.22	528.22	528.22	Calculated[12]
	Reduction in flood damage per hectare of mangrove	50%	50%	50%	Fernandez et al., 2020
	Reduction in flood damage per hectare of wetland	30%	30%	30%	Kurki-Fox et al., 2022
Avoided saline intrusion costs	Current people affected by saline intrusion (people/year)	70,000	50,000	50,000	UNEP, 2021, p. 15
	Reduction in water salinity due to mangrove restoration (%)	4%	4%	4%	Glamore & Indraratna, 2009
	Health cost of saline intrusion per household per year (USD/person/year)	USD 28.38 by 2007. After the value is adjusted for inflation, it results in USD 34.91.			Kumar Das et al., 2019
	Inflation correction factor 2019–2024	1.23			CPI Inflation Calculator, 2025

12 The damage cost per person is calculated by dividing the total cost in damages from Cyclone Idai by the total people impacted by the cyclone.

Indicator	Data input	Bons Sinais	Limpopo	Zambezi	Source
Avoided pollution	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Mangrove restoration area (ha)			1,266	1,266
	Inflation correction factor 2007–2024			1.52	CPI Inflation Calculator, 2025
	Economic value of 1 ha of mangrove for avoided pollution (USD/ha) – Low Valuation scenarios			USD 753 by 2021. After the value is adjusted for inflation, it results in USD 873.	Hernandez-Blanco et al., 2021
	Inflation correction factor 2021–2024			1.16	CPI Inflation Calculator, 2025
Avoided sedimentation	Mangrove restoration area (ha)	1,266	1,266	1,266	Total restoration goal: 3,800 ha based on the Concept Note (UNEP, 2021, p. 24)
	Economic value of 1 ha of mangrove for avoided sedimentation (USD/ha)			USD 579 by 2007. After the value is adjusted to inflation, it results in USD 880.	Mukherjee et al., 2014
	Inflation correction factor 2007–2024			1.52	CPI Inflation Calculator, 2025

Source: Compiled by authors.

Appendix B. Undiscounted Results

The undiscounted results of the integrated cost-benefit analysis (CBA) for the main scenarios, the CBA per estuary, and the CBA per climate scenario are presented in Table B1, Table B2, and Table B3, respectively. The results presented in Table B1 and Table B2 are based on the SSP3–7.0 climate scenario.

Table B1. Integrated CBA results in million USD, SSP3–7.0 climate scenario, cumulative undiscounted between 2025 and 2051

CBA, cumulative undiscounted values from 2025 to 2051 (USD million)	High Valuation–High Carbon Scenario	High Valuation–Low Carbon Scenario	Low Valuation–High Carbon Scenario	Low Valuation–Low Carbon Scenario	Low Valuation–Tangible Only Scenario
Total costs	**216.30**	**216.30**	**216.30**	**216.30**	**216.30**
Implementation costs	20.00	20.00	20.00	20.00	20.00
Operation and maintenance (O&M) costs	196.30	196.30	196.30	196.30	196.30
Total added benefits	**4,469.16**	**4,333.50**	**684.64**	**548.97**	**345.47**
Job creation	0.26	0.26	0.26	0.26	0.26
Increased fisheries value added	2,122.30	2,122.30	53.92	53.92	53.92
Carbon sequestration	339.16	203.50	339.16	203.50	-
Increased ecotourism and recreation value added	1,747.52	1,747.52	31.37	31.37	31.37
Increased food provisioning	190.62	190.62	190.62	190.62	190.62
Increased energy resources	38.12	38.12	38.12	38.12	38.12
Increased wood and timber provisioning	30.67	30.67	30.67	30.67	30.67

CBA, cumulative undiscounted values from 2025 to 2051 (USD million)	High Valuation– High Carbon Scenario	High Valuation– Low Carbon Scenario	Low Valuation– High Carbon Scenario	Low Valuation– Low Carbon Scenario	Low Valuation– Tangible Only Scenario
Increased honey production	0.50	0.50	0.50	0.50	0.50
Total avoided costs	**1,598.19**	**1,598.19**	**693.47**	**693.47**	**545.10**
Avoided flood damages	545.10	545.10	545.10	545.10	545.10
Avoided saline intrusion costs	5.10	5.10	5.10	5.10	-
Avoided pollution	976.09	976.09	71.36	71.36	-
Avoided sedimentation	71.90	71.90	71.90	71.90	-
Net benefits	**5,851.05**	**5,715.38**	**1,161.80**	**1,026.13**	**674.27**
Benefit-to-cost ratio (BCR)	28.05	27.42	6.37	5.74	4.12
Internal rate of return (IRR)	311.06%	252.20%	170.63%	108.93%	34.50%

Source: Authors.

Table B2. Integrated CBA table for cumulative benefits per estuary in million USD, undiscounted

CBA, cumulative discounted values from 2025 to 2051 (USD million)	Bons Sinais		Zambezi		Limpopo	
	Low Valuation– High Carbon	Low Valuation– Tangible Only	Low Valuation– High Carbon	Low Valuation– Tangible Only	Low Valuation– High Carbon	Low Valuation– Tangible Only
Total costs	**72.10**	**72.10**	**72.10**	**72.10**	**72.10**	**72.10**
Implementation costs	6.67	6.67	6.67	6.67	6.67	6.67
O&M costs	65.43	65.43	65.43	65.43	65.43	65.43
Total added benefits	**228.21**	**115.16**	**228.21**	**115.16**	**228.21**	**115.16**
Job creation	0.09	0.09	0.09	0.09	0.09	0.09

CBA, cumulative discounted values from 2025 to 2051 (USD million)	Bons Sinais		Zambezi		Limpopo	
	Low Valuation– High Carbon	Low Valuation– Tangible Only	Low Valuation– High Carbon	Low Valuation– Tangible Only	Low Valuation– High Carbon	Low Valuation– Tangible Only
Increased fisheries value added	17.97	17.97	17.97	17.97	17.97	17.97
Carbon sequestration	113.05	-	113.05	-	113.05	-
Increased ecotourism and recreation value added	10.46	10.46	10.46	10.46	10.46	10.46
Increased food provisioning	63.54	63.54	63.54	63.54	63.54	63.54
Increased energy resources	12.71	12.71	12.71	12.71	12.71	12.71
Increased wood and timber provisioning	10.22	10.22	10.22	10.22	10.22	10.22
Increased honey production	0.17	0.17	0.17	0.17	0.17	0.17
Total avoided costs	**176.32**	**126.47**	**66.20**	**16.94**	**450.94**	**401.69**
Avoided flood damage	126.47	126.47	16.94	16.94	401.69	401.69
Avoided saline intrusion costs	2.10	-	1.50	-	1.50	-
Avoided pollution	23.79	-	23.79	-	23.79	-
Avoided sedimentation	23.97	-	23.97	-	23.97	-
Net benefits	**332.43**	**169.52**	**222.31**	**60.00**	**607.06**	**444.75**
BCR	5.61	3.35	4.08	1.83	9.42	7.17
IRR	168.26%	29.94%	154.51%	14.48%	188.17%	53.15%

Source: Authors.

Table B3. Integrated CBA table for cumulative benefits per climate scenario in million USD, undiscounted

CBA, cumulative undiscounted values from 2025 to 2051 (USD million)	**Low Valuation–High Carbon Scenario**			**Low Valuation–Tangible Only Scenario**		
	SSP1–2.6	**SSP3–7.0**	**SSP5–8.5**	**SSP1–2.6**	**SSP3–7.0**	**SSP5–8.5**
Total costs	**216.30**	**216.30**	**216.30**	**216.30**	**216.30**	**216.30**
Implementation costs	20.00	20.00	20.00	20.00	20.00	20.00
O&M costs	196.30	196.30	196.30	196.30	196.30	196.30
Total added benefits	**684.64**	**345.47**	**684.64**	**345.47**	**684.64**	**345.47**
Job creation	0.26	0.26	0.26	0.26	0.26	0.26
Increased fisheries value added	53.92	53.92	53.92	53.92	53.92	53.92
Carbon sequestration	339.16	-	339.16	-	339.16	-
Increased ecotourism and recreation value added	31.37	31.37	31.37	31.37	31.37	31.37
Increased food provisioning	190.62	190.62	190.62	190.62	190.62	190.62
Increased energy resources	38.12	38.12	38.12	38.12	38.12	38.12
Increased wood and timber provisioning	30.67	30.67	30.67	30.67	30.67	30.67
Increased honey production	0.50	0.50	0.50	0.50	0.50	0.50
Total avoided costs	**707.38**	**559.01**	**693.47**	**545.10**	**673.90**	**525.53**
Avoided flood damage	559.01	559.01	545.10	545.10	525.53	525.53
Avoided saline intrusion costs	5.10	-	5.10	-	5.10	-
Avoided pollution	71.36	-	71.36	-	71.36	-
Avoided sedimentation	71.90	-	71.90	-	71.90	-
Net benefits	**1,175.72**	**688.18**	**1,161.80**	**674.27**	**1,142.23**	**654.70**
BCR	6.44	4.18	6.37	4.12	6.28	4.03
IRR	169.97%	37.52%	170.63%	34.50%	167.17%	36.24%

Source: Authors.

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