



**NATURE-BASED INFRASTRUCTURE  
GLOBAL RESOURCE CENTRE**

# The Role of Nature in the Development of Geopark Teskei

**An integrated cost–benefit  
analysis of sustainable tourism  
interventions on the south  
shore of Issyk-Kul**

**IISD REPORT**

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**The Role of Nature in the Development of Geopark Teskei:  
An integrated cost-benefit analysis of sustainable tourism  
interventions on the south shore of Issyk-Kul**

March 2026

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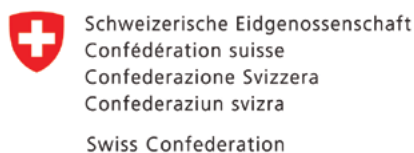


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## Executive Summary

The Geopark Teskei, located along the southern shore of Lake Issyk-Kul in Kyrgyzstan, encompasses approximately 8,090 km<sup>2</sup> and is home to over 156,000 people. The region combines unique natural, cultural, and geological assets but faces significant environmental challenges, including frequent landslides and mudslides, as well as temperatures rising above global averages. These climate-related risks threaten local livelihoods, ecological integrity, and tourism potential, highlighting the need for sustainable and resilient development strategies.

To address these challenges, the Center of Renewable Energy and Energy Efficiency Development (CREEED)—in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH’s Green Economy and Sustainable Private Sector Development program and the Destination Management Organization (DMO) South Shore—has proposed integrating nature-based infrastructure (NBI) and ecotourism development into the ongoing geopark development plans, including expanding access to the shoreline and boat launches. Key interventions include native vegetation planting, wetland restoration, sustainable agricultural practices, and low-impact tourism infrastructure, such as natural trails, eco-friendly visitor facilities, and birdwatching platforms. These measures aim to reduce climate risks, stabilize landscapes, enhance ecosystem services, and generate new economic opportunities such as tourism.

A Sustainable Asset Valuation (SAVi) model was developed to assess the full range of costs and benefits associated with two alternative tourism development pathways in the geopark. The first pathway, the Conventional Tourism Scenario, reflects a continuation of current tourism practices, characterized by mass tourism, limited environmental safeguards, and greater pressure on local infrastructure and ecosystems. The second pathway, the Sustainable Tourism Scenario, models a shift from conventional tourism toward ecotourism, where visitors typically spend more per trip but cause significantly lower environmental impacts.

**Table ES1.** Cumulative CBA discounted values between 2025 and 2051 (discount rate = 3.5%)

	Units	Conventional Tourism Scenario	Sustainable Tourism Scenario
<b>Direct costs</b>	<b>USD million</b>	<b>10.54</b>	<b>32.82</b>
Total capital expenditures (CAPEX)	USD million	2.76	4.72
Total operational expenditures (OPEX)	USD million	7.79	28.09
<b>Avoided costs</b>	<b>USD million</b>	<b>-7.23</b>	<b>32.99</b>
Avoided infrastructure damage	USD million	-	0.07
Avoided soil loss	USD million	-	0.07



	Units	Conventional Tourism Scenario	Sustainable Tourism Scenario
Avoided waste and wastewater costs	USD million	-7.19	32.65
Avoided health costs	USD million	-	0.16
Avoided costs for the lake ecosystem	USD million	-0.04	0.04
<b>Added benefits</b>	<b>USD million</b>	<b>36.45</b>	<b>258.26</b>
Conventional tourism revenue	USD million	18.92	- 189.24
Sustainable tourism revenue	USD million	8.11	386.97
Revenue from local leisure	USD million	4.83	4.83
Income from tourism employment	USD million	2.39	2.39
Income from agricultural employment	USD million	-	37.10
Carbon sequestration	USD million	-	0.15
Government revenues	USD million	2.20	16.06
<b>Key performance indicators</b>			
Net benefits	USD million	18.68	258.43
Benefit–cost ratio (BCR)	USD/USD Invested	2.77	8.88
Internal rate of return (IRR)	%	27.11%	118.84%

The cost–benefit analysis comparing conventional and sustainable tourism pathways in the Geopark Teskei highlights substantial differences in economic performance, environmental outcomes, and long-term viability (Table ES1). The Conventional Tourism Scenario requires total direct costs of USD 10.54 million, including CAPEX of USD 2.76 million and OPEX of USD 7.79 million. Added benefits in this scenario total USD 36.45 million, primarily from conventional tourism revenue (USD 18.92 million), sustainable tourism revenue (USD 8.11 million), local leisure income (USD 4.83 million), and income from tourism employment (USD 2.39 million). Avoided costs are negative, totalling –USD 7.23 million, reflecting the absence of significant interventions to mitigate environmental degradation. This scenario yields net benefits of USD 18.68 million, a BCR of 2.77, and an IRR of 27.11%, indicating positive but relatively modest returns concentrated in the short term.

In contrast, the Sustainable Tourism Scenario involves higher total direct costs of USD 32.82 million (CAPEX USD 4.72 million; OPEX USD 28.09 million), reflecting the broader scope of investments in infrastructure, management, and NBI. Added benefits reach USD 258.26 million, driven by sustainable tourism revenue (USD 386.97 million), conventional



tourism revenue (USD 189.24 million), agricultural employment income (USD 37.10 million), government revenues (USD 16.06 million), and minor contributions from carbon sequestration (USD 0.15 million) and local leisure income (USD 4.83 million). Avoided costs are substantial at USD 32.99 million, including reductions in infrastructure damage (USD 0.07 million), soil loss (USD 0.07 million), waste and wastewater management costs (USD 32.65 million), health-related costs (USD 0.16 million), and impacts on the lake ecosystem (USD 0.04 million). These interventions not only protect the environment but also generate measurable socio-economic returns. The scenario produces net benefits of USD 258.43 million, a BCR of 8.88, and an IRR of 118.84%, demonstrating that each dollar invested in sustainable tourism delivers nearly nine times its value in benefits and generates significant long-term returns compared to the conventional approach.

Overall, this model illustrates that while sustainable tourism requires higher initial and operational investments, it substantially outperforms conventional tourism by combining economic, environmental, and social benefits. The inclusion of avoided costs and ecosystem service valuation underscores the importance of integrating NBI into development planning to achieve resilient and inclusive growth in the geopark.



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## Glossary

<b>Discounting</b>	A finance process to determine the present value of a future cash value.
<b>Indicator</b>	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 Program [UNEP], 2014).
<b>Internal rate of return (IRR)</b>	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.
<b>Methodology</b>	The theoretical approach(es) used for the development of different types of analysis tools and simulation models. This body of knowledge describes both the underlying assumptions used as well as qualitative and quantitative instruments for data collection and parameter estimation (UNEP, 2014).
<b>Model transparency</b>	The degree to which model structure and equations are accessible and make it possible to directly relate model behaviour (i.e., numerical results) to specific structural components of the model (UNEP, 2014).
<b>Model validation</b>	The process of assessing the degree to which model behaviour (i.e., numerical results) is consistent with behaviour observed in reality (i.e., national statistics, established databases) and the evaluation of whether the developed model structure (i.e., equations) is acceptable for capturing the mechanisms underlying the system under study (UNEP, 2014).
<b>Net benefits</b>	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.
<b>Scenarios</b>	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).



## 1.0 Introduction

The Geopark Teskei, located along the southern shore of Lake Issyk-Kul in Kyrgyzstan, represents a rare convergence of ecological richness, cultural heritage, and economic potential. Encompassing approximately 8,090 km<sup>2</sup> and home to more than 156,000 people, the geopark is both an environmental treasure and a livelihood base for local communities. However, the region faces mounting environmental pressures, including rising temperatures, increasingly frequent landslides and mudslides, and land degradation driven by unsustainable land-use and tourism practices (Center of Renewable Energy and Energy Efficiency Development [CREED] & Directorate of Geopark “Teskey Ala-Too,” 2025). These interlinked challenges threaten not only ecosystems and biodiversity but also the long-term viability of tourism—the primary economic driver in the area.

Recognizing these risks, CREEED—in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH’s Green Economy and Sustainable Private Sector Development program and Destination Management Organization (DMO) South Shore—has proposed a new development approach that integrates nature-based infrastructure (NBI) with a transition toward ecotourism and nature-positive tourism. This approach reframes tourism not as a source of environmental strain, but as a vehicle for ecological regeneration, economic diversification, and community empowerment. The initiative seeks to demonstrate that economic growth and sustainability can be mutually reinforcing when natural capital is preserved and leveraged as a productive asset.

The project emphasizes the restoration and protection of key ecosystems through interventions such as native vegetation planting, wetland rehabilitation, erosion control, and sustainable agricultural practices. These measures are intended to reduce exposure to climate hazards, enhance carbon sequestration, and improve water regulation, thereby strengthening the resilience of both ecosystems and local livelihoods. At the same time, investments in low-impact tourism infrastructure—such as eco-trails, renewable-powered facilities, and biodiversity interpretation centres—will position the geopark as a leading destination for eco-conscious travellers. By attracting visitors who value environmental stewardship and are willing to pay more for authentic, sustainable experiences, the project promotes a model of tourism that prioritizes quality over quantity.

This shift toward nature-positive tourism is expected to yield multiple benefits. It diversifies local income sources by linking conservation with economic opportunity, fosters community engagement in sustainable resource management, and generates fiscal revenues that can be reinvested in environmental protection. By integrating NBI and sustainable tourism planning, the Geopark Teskei can demonstrate how protecting natural assets not only mitigates climate risks but also enhances long-term economic returns.

This Sustainable Asset Valuation (SAVi) assessment supports evidence-based decision making for the Geopark Teskei by quantifying the economic, environmental, and social implications of integrating NBI and sustainable tourism practices. By combining systems thinking, economic modelling, and climate data, the SAVi methodology provides an integrated framework to assess how nature-positive tourism can simultaneously generate economic growth, enhance



climate resilience, and protect natural capital. The cost–benefit analysis (CBA) illustrates the trade-offs and synergies between conventional and sustainable tourism pathways, showing how investments in ecosystem restoration, low-impact infrastructure, and community engagement can yield higher long-term returns.

The findings can inform strategic planning and policy decisions by national and regional authorities, including the Kyrgyz government and the Issyk-Kul regional administration, by demonstrating the tangible value of coupling tourism development with ecosystem preservation.

In doing so, the SAVi assessment not only strengthens the case for implementing nature-based and ecotourism interventions in the geopark but also encourages broader replication of such approaches across other environmentally sensitive areas in Central Asia. Through this integrated lens, the Geopark Teskei becomes a case study of how economic development, environmental protection, and social well-being can advance together under a unified sustainability framework.

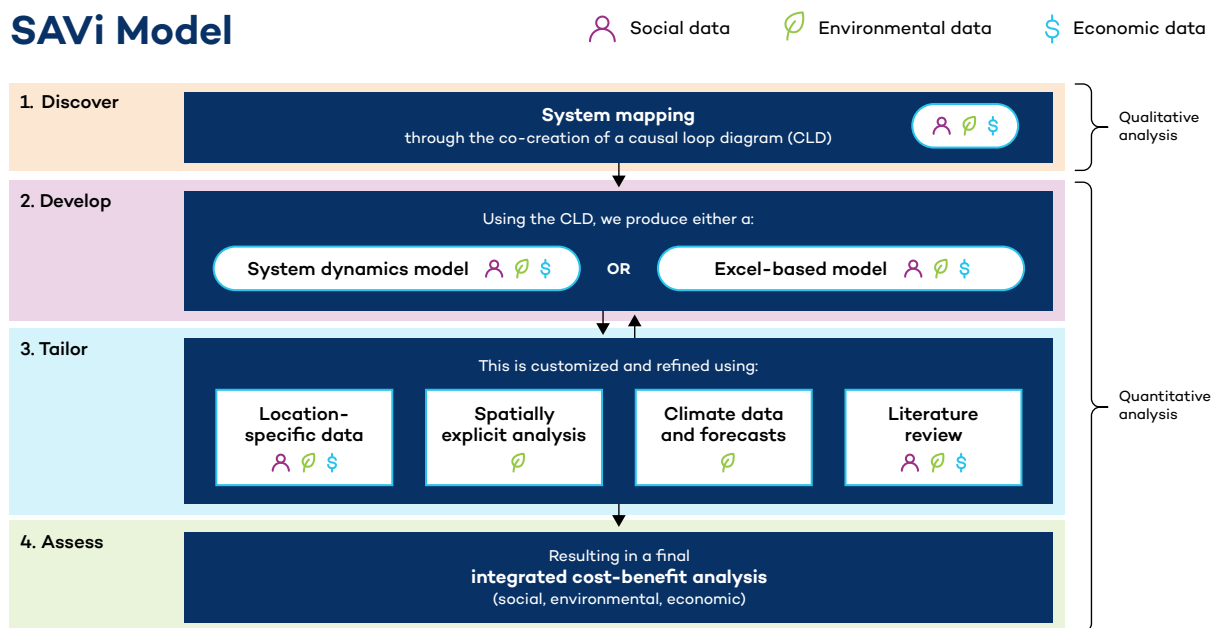


## 2.0 SAVi

This chapter outlines the methodology, analysis, and results of the SAVi methodology applied to the interventions in the Geopark Teskei.

SAVi (Figure 1) 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. SAVi identifies and values the wider environmental, social, and economic costs and benefits associated with infrastructure investments. The 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. A SAVi analysis also provides information on how projects align with national development goals, address climate change mitigation and adaptation, and support the UN Sustainable Development Goals. In doing so, it helps channel investments toward infrastructure that prioritizes sustainability.

Figure 1. SAVi methodology



Source: International Institute for Sustainable Development.

### 2.1 Causal Loop Diagram

SAVi is based on systems thinking, which helps to integrate knowledge from different fields by examining the interconnectedness between economic, social, technical, and environmental factors. In SAVi assessments, we put systems thinking into practice by creating a CLD that captures the system’s relevant dynamics. In a second step of the assessment, the CLD forms the foundation for identifying indicators for the economic modelling and integrated CBA. The



CLD for the development of the Geopark Teskei was developed with GIZ and CREEED. It was validated in workshops in the region with attendance from local authorities and residents, including the chairwoman of DMO South Shore, Jyldyz Asanakunova, and organizations such as Ethno-Village Almaluu.

### Box 1. Reading a CLD

A CLD is a tool that supports systems thinking. It shows relationships between the components of a system. Arrows indicate causality, and plus and minus signs are used to show the direction of causality. A plus sign means that two variables change in the same direction (a positive correlation), while a negative sign means that they change in opposite directions (a negative correlation). Feedback loops are labelled as either reinforcing (R) or balancing (B). A reinforcing loop indicates that a change in one variable will lead to further change in the same direction, whereas a balancing loop dampens change.

The system dynamics of the tourism–environment–economy nexus reveal several interconnected feedback loops that drive the evolution of the region’s socio-economic and environmental conditions (Figure 2).

An increase in tourism stimulates economic activity, which in turn promotes infrastructure development. Expanded infrastructure facilitates further economic opportunities, reinforcing impacts on (or creating a reinforcing feedback loop between) tourism, infrastructure, and local income generation. As economic activity rises, employment opportunities increase, attracting more residents and migrant workers to the area. Tourism growth also encourages second-home ownership, contributing to an overall increase in the total population.

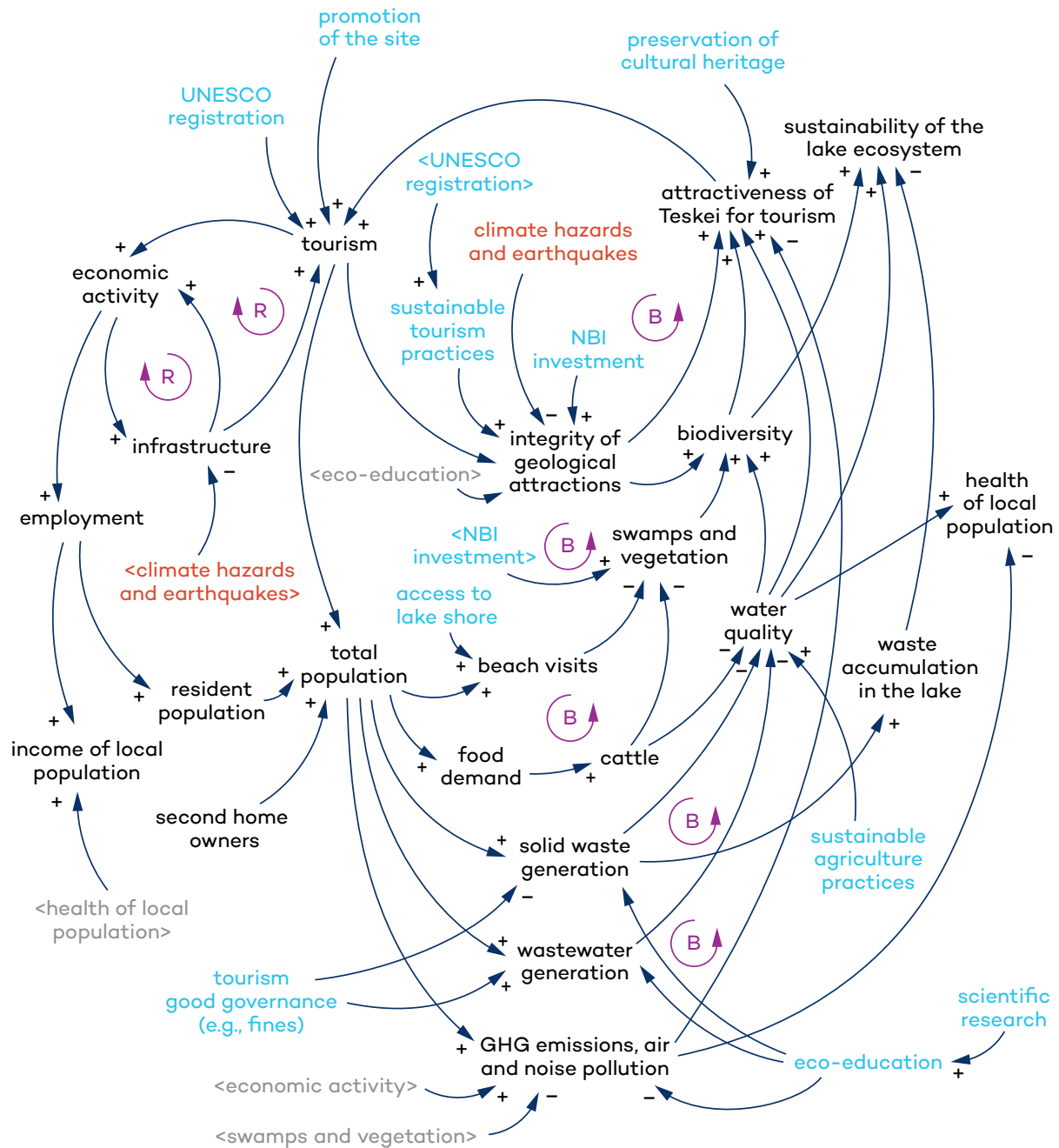
Population growth intensifies resource consumption and environmental pressures. Higher population levels lead to more beach visits, greater food demand, and increased solid waste and wastewater generation. The rise in food demand, particularly for livestock, drives the conversion of swamps and vegetated areas into grazing land. This land conversion results in the loss of natural vegetation and the decline of ecosystem services, such as water purification and flood regulation. Consequently, water quality deteriorates as the cleansing capacity of natural wetlands diminishes.

At the same time, greater economic and population activity contributes to higher greenhouse gas emissions, air pollution, and noise pollution, further degrading environmental quality. These processes collectively erode biodiversity and reduce the integrity of geological and natural attractions, as intensified visitation and land-use pressure cause physical wear and ecological disturbance.

The deterioration of water quality, air quality, and biodiversity adversely affects public health. Declining health reduces labour productivity and, in turn, local income, presenting a counterforce to the initial economic growth (or creating a balancing feedback loop). Moreover, as environmental quality and natural capital decline, the attractiveness of the region for tourism decreases, potentially leading to a future decline in tourist inflows.



**Figure 2.** CLD of the NBI interventions for the Geopark Teskei



Source: Co-created by CREEED and the authors.

Overall, the system exhibits a reinforcing loop of short-term economic growth fuelled by tourism, counteracted by longer-term environmental degradation that constrains sustainability and tourism potential. Without intervention, the system risks reaching a saturation point where economic and environmental decline undermine the assets that initially drive growth.

To mitigate these dynamics and decouple economic growth from environmental degradation, several policy interventions are proposed by CREEED, GIZ, and DMO South Shore. These include promoting sustainable tourism practices through United Nations Educational,



Scientific and Cultural Organization (UNESCO) World Heritage registration, encouraging a shift toward ecotourism, and investing in NBI that restores and protects swamps, vegetation, and geological features. Such measures weaken the balancing loops of the system by preserving natural capital, maintaining ecosystem integrity, and ensuring that economic benefits from tourism remain sustainable over the long term.

## 2.2 Climate Data Analysis

The assessment incorporates climate dynamics to enhance an understanding of how future climate conditions may affect the region. By including climate projections, the assessment estimates the potential damage to agriculture, soil loss, and general infrastructure damage to the Issyk-Kul region, where the Geopark Teskei is located (Figure 3).

**Figure 3.** Projected damage areas in the Issyk-Kul region



Source: Ministry of Emergency Situations, 2025.

### 2.2.1 Shared Socio-Economic Pathways

To assess the impacts of climate on the Geopark Teskei, Shared Socio-Economic Pathways (SSPs) are used to apply various climate futures in the region to see how the area could be impacted by global climate trends (Riahi et al., n.d.). The SSPs represent a range of possible futures based on different assumptions about socio-economic development, such as population growth, economic trends, and technological advancements. They are used to



explore how these factors might influence global challenges like climate change and the ability to mitigate or adapt to its impacts. The SSPs provide a framework for understanding how varying development trajectories could shape future environmental, social, and economic conditions, offering insights for climate modelling and policy planning. The following three SSPs are included:

- SSP1 (Sustainability – Taking the Green Road) outlines a future focused on sustainable development, where significant investments are made in education, health care, and green technologies. This scenario leads to lower greenhouse gas emissions and more effective climate mitigation. SSP1 envisions a world characterized by global collaboration, slower population growth, reduced inequality, and minimized climate risks.
- SSP3 (Regional Rivalry – A Rocky Road) portrays a fragmented world marked by regional competition, rapid population growth, and sluggish economic progress. In this scenario, countries prioritize self-reliance and national interests, resulting in minimal international cooperation on climate action. High dependence on fossil fuels persists, leading to greater emissions and increased vulnerability to climate extremes, such as more frequent and intense droughts and floods.
- SSP5 (Fossil-Fuelled Development – Taking the Highway) imagines a future of rapid economic expansion driven by fossil fuel use and technological advancements. While this results in significant economic growth, it comes at a high environmental cost, with substantial emissions and accelerated global warming. SSP5 assumes a future in which climate impacts are severe, with an increase in extreme weather events, which present significant challenges for flood risk management and adaptation efforts.

## 2.2.2 Climate Forecasts and Indicators

The SSPs serve as guidelines and trajectories for the climate forecasts. The climate data corresponding to these SSPs are obtained from the European Union’s Copernicus Climate Data Store (Copernicus Climate Change Service, 2025).

To ensure spatial accuracy and representativeness, a series of georeferenced markers was placed around the lake in the Issyk-Kul region. These markers define specific latitude and longitude coordinates, allowing for the extraction of localized climate variables, such as mean annual temperature and total precipitation, which can then be used to calculate the extreme wet/dry index (the probability of higher-than-normal precipitation or temperature per year). The localized extraction process enables the model to capture the climate conditions that directly influence flood risk, runoff dynamics, and ecosystem behaviour in the geopark. By combining the SSP-based global projections with these localized datasets, the SAVi assessment is able to translate broad-scale climate scenarios into site-specific inputs.

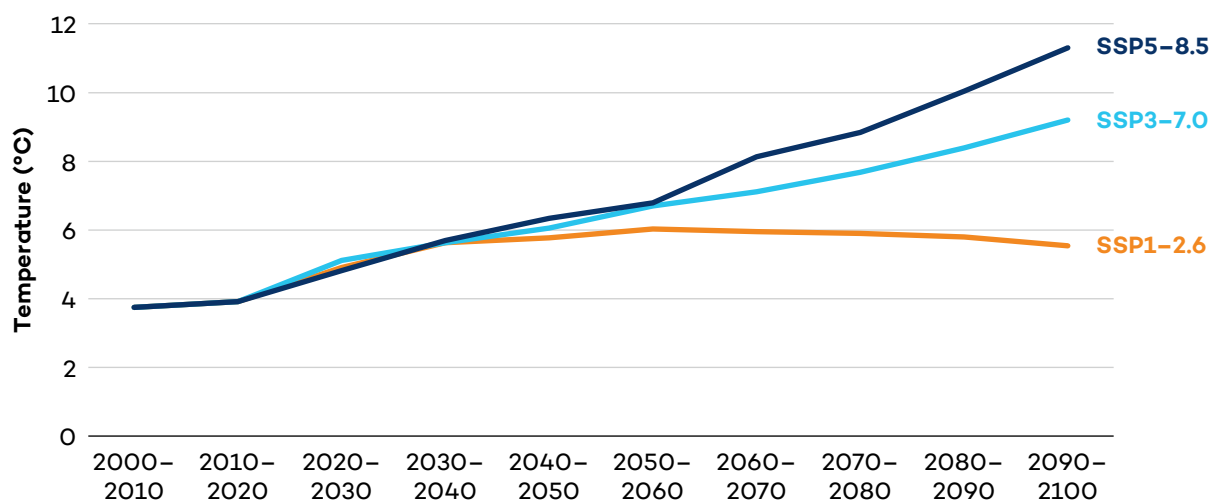
### Average Monthly Temperature

Under the SSP3–7.0 scenario, the average monthly temperature across the geopark area is projected to rise by approximately 4°C between 2010 and 2100. Under the more extreme SSP5–8.5 scenario, temperatures could increase by nearly 4°C beyond those levels,



representing the highest warming trajectory among the scenarios considered (Figure 4). This substantial temperature increase implies significant environmental stress for the geopark's ecosystems, landscapes, and biodiversity. Warmer conditions could intensify evapotranspiration rates, reduce soil moisture, and alter the hydrological balance, leading to shifts in vegetation composition and increased vulnerability of endemic species. Furthermore, higher temperatures may exacerbate the frequency and severity of droughts, heat waves, and wildfires, threatening both ecological integrity and visitor safety. These changes could also influence the geopark's cultural and geological features, accelerating weathering processes and affecting the long-term preservation of natural heritage sites. Overall, the projected temperature rise underscores the need for targeted adaptation and management strategies to safeguard the geopark's ecological, cultural, and educational values under future climate conditions.

**Figure 4.** Average monthly temperature in Issyk-Kul region under various SSPs (°C)



Source: Authors' calculations based on data on Climate Data Store (Copernicus Climate Change Service, 2025).

### Average Monthly Precipitation

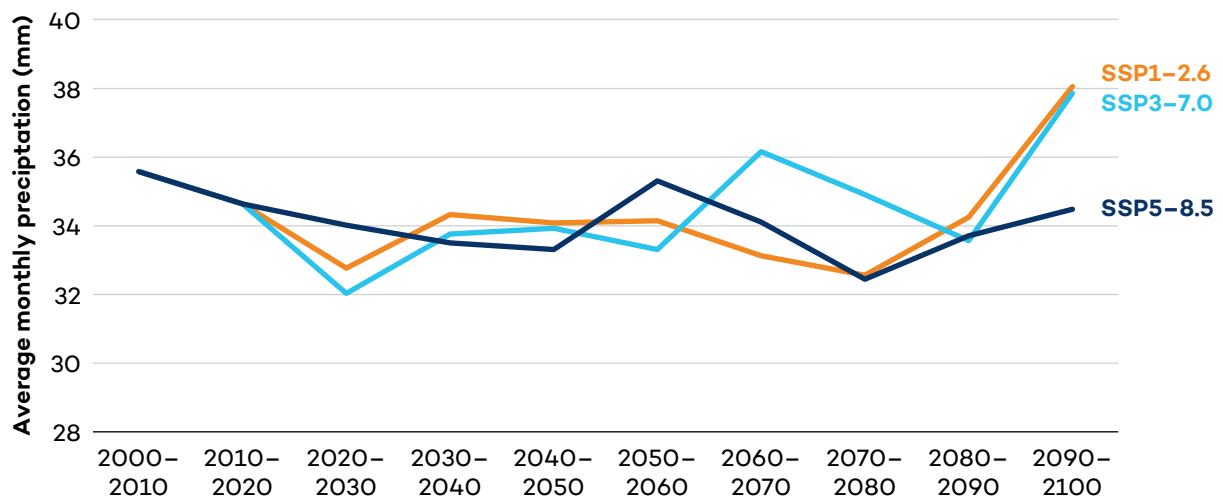
Under the SSP3–7.0 scenario, average monthly precipitation within the geopark is initially projected to decline, followed by a pattern of decadal oscillations characterized by increasingly higher peaks over time (Figure 5). This suggests that while dry periods may become more frequent or intense, episodes of heavy rainfall could also become more pronounced, contributing to greater variability in the hydrological cycle. In contrast, the SSP5–8.5 scenario indicates a more consistent decline in precipitation oscillations, implying a progressive reduction in rainfall variability and potentially more prolonged dry conditions.

For the geopark, these contrasting precipitation trends have important implications for ecosystem stability, water availability, and landscape dynamics. Under SSP3–7.0, heightened rainfall variability could increase the risks of both flooding and erosion during wet phases and water scarcity during dry spells, placing stress on vegetation and soil systems. Under SSP5–8.5, the sustained reduction in precipitation could lead to long-term aridification,



threatening freshwater resources, groundwater recharge, and the resilience of plant and animal communities. These projected changes highlight the importance of adaptive water management, ecosystem restoration, and erosion control measures to preserve the geopark’s ecological balance and geological heritage under future climate conditions.

**Figure 5.** Average monthly precipitation under the various SSPs averaged across the decades (mm/month)



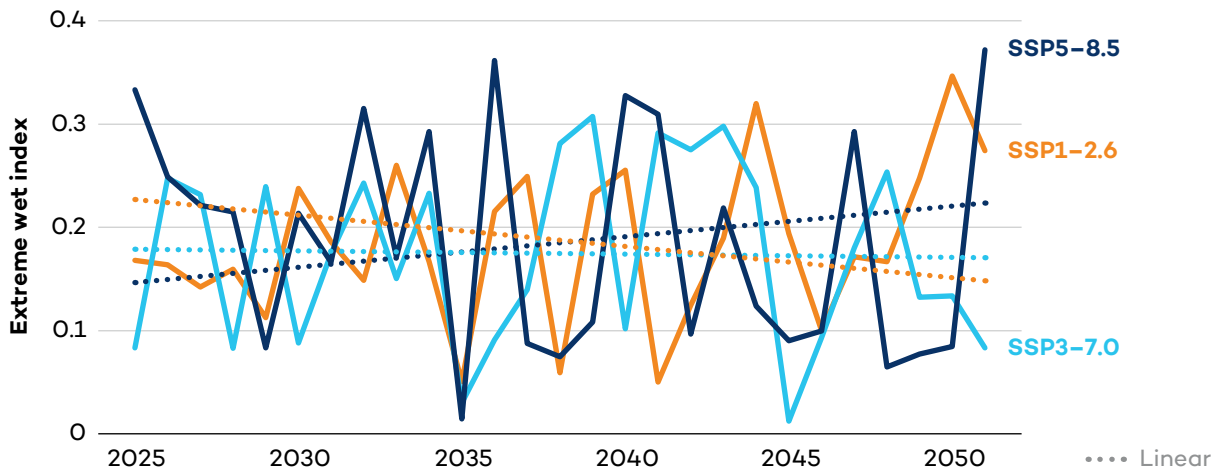
Source: Authors’ calculations based on data from the Climate Data Store (Copernicus Climate Change Service, 2025).

### Extreme Wet and Dry Indices

The indices for extreme wet and extreme dry events are derived from deviations above or below the long-term average monthly precipitation or temperature, respectively, using the Standardized Precipitation Index (SPI). These indices serve as indicators of climatic anomalies that can result in significant physical and economic impacts. An extreme wet event is characterized by conditions substantially wetter than normal and is directly associated with potential damage to infrastructure, such as flooding, landslides, or erosion (Figure 6). Conversely, an extreme dry event captures prolonged periods of below-average precipitation and elevated temperatures, which are used as inputs in the damage equation to estimate the impacts of droughts on ecosystems, agriculture, and water resources (Figure 7).



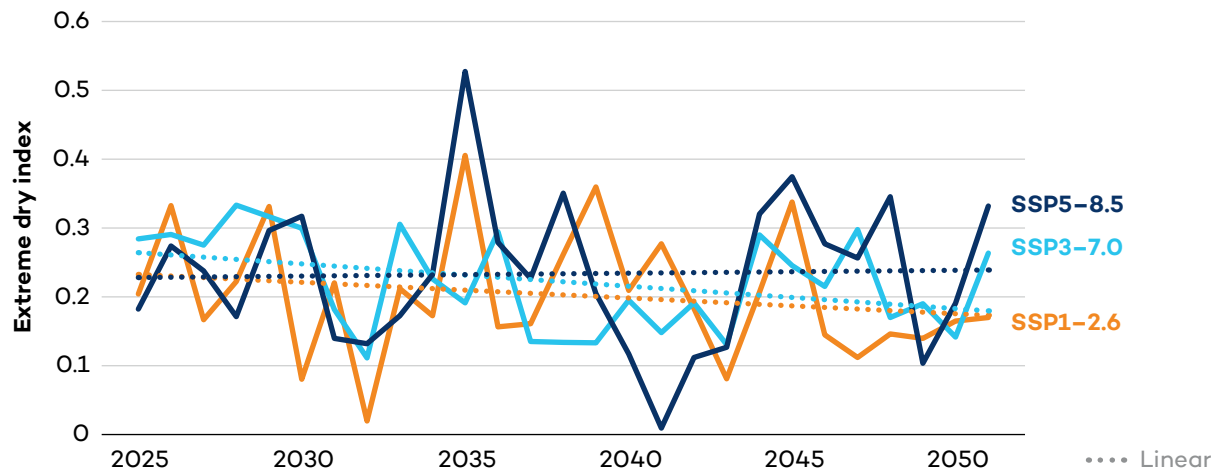
**Figure 6.** Extreme wet index between 2025 and 2051 under the various SSPs (SPI)



Source: Authors' calculations based on data from the Climate Data Store (Copernicus Climate Change Service, 2025).

For modelling purposes, the probability of an extreme wet event is translated into a proportional share of total annual damage. For instance, if the likelihood of such an event is estimated at 20% for a given year, 20% of the maximum potential damage from flooding or related hazards is applied in that year.

**Figure 7.** Extreme dry index between 2025 and 2051 under the various SSPs (SPI)



Source: Authors' calculations based on data from the Climate Data Store (Copernicus Climate Change Service, 2025).

### Lake Eutrophication

Lake eutrophication refers to the excessive enrichment of a lake or water body with nutrients—mainly nitrogen and phosphorus—which stimulates algal growth, depletes oxygen levels, and degrades water quality and ecosystem function. To estimate the potential impacts of eutrophication under projected climatic conditions, a monthly time-step analysis was conducted for the period 2025–2051. The maximum monthly temperature values observed



in 2025 were used as baseline thresholds. For each subsequent year, the number of months in which this threshold was exceeded was counted, indicating how often climatic conditions are favourable toward eutrophication.

For any year in which at least one exceedance occurred, a 30% adjustment was applied to represent the effect of eutrophication on the geopark's performance indicators. Specifically, in those years, total benefits were reduced by 30%, and costs were increased by 30%. This approach captures the annualized impact of eutrophication events, reflecting the environmental degradation, reduced recreational value, and increased maintenance and management expenses associated with deteriorating lake conditions, while maintaining a simplified representation consistent with the model's temporal resolution.

## 2.3 Integrated CBA

This section presents the integrated CBA of tourism strategies in the geopark, emphasizing the benefits and avoided costs associated with sustainable management. First, we describe the methodology and the environmental, social, and economic indicators used in the analysis. For example, the section explains how we estimated the avoided damages from climate-related extreme events and the additional benefits generated by adopting sustainable tourism practices compared to conventional approaches. Next, we outline the scenarios considered in the CBA, covering different tourism intervention strategies and levels of environmental protection. The final part then presents the results of the CBA, highlighting the trade-offs between sustainable and conventional tourism, including the potential for increased resilience, ecosystem preservation, and long-term economic benefits for the geopark.

### 2.3.1 Methodology

The integrated CBA was developed using an Excel-based model structured as an input–output framework. The model uses static input parameters to project the evolution of each indicator over the analysis period. For each scenario, representing conventional versus sustainable tourism approaches, the model calculates the absolute values of individual indicators, such as the costs associated with climate-related damages or the benefits from avoided impacts. The outcomes are then compared across scenarios to quantify the net impact of adopting sustainable tourism measures. This approach captures the direct benefits of interventions, including avoided costs from extreme weather events, ecosystem degradation, and infrastructure damage. Key outputs include aggregated metrics such as total costs, total benefits, net benefits, benefit–cost ratio (BCR), and internal rate of return (IRR), with all results discounted at present value to allow meaningful comparison of future costs and benefits.

The model simulates the period from 2025 to 2051 (26 years), applying an annual discount rate of 3.5% to ensure consistency across economic variables. It integrates locally specific data, including cost estimates, government and project reports, secondary data on climate impacts, and insights from the broader literature on climate modelling, ecosystem services, and tourism management.



This combination of data sources ensures that the analysis reflects both local context and scientific knowledge, providing a robust basis for evaluating the trade-offs and benefits of sustainable versus conventional tourism strategies in the geopark.

### 2.3.2 Indicators

The CBA indicators are derived from the CLD and serve as the quantitative backbone of the analysis, capturing the full spectrum of economic and environmental outcomes associated with different interventions in the geopark. These indicators quantify the costs of implementing measures (both capital expenditures [CAPEX] and operational expenditures [OPEX]), the costs that can be avoided through preventive NBI interventions, and the broader benefits, including ecosystem preservation, improved resilience, and enhanced tourism potential. By linking these indicators to the causal relationships identified in the CLD, the analysis ensures that each intervention's effects are traced through the system, providing a holistic assessment of trade-offs and synergies.

Table 1 presents the cost indicators alongside their definitions and data sources, allowing for transparency in how each metric is calculated and applied. The assumptions have been discussed, validated, and presented at a workshop organized by the Alliance of Kyrgyz Universities for Green Economy and Sustainable Development, by an interministerial working group chaired by the Ministry of Economy and Commerce of the Kyrgyz Republic, together with the Kyrgyz Economic University, GIZ, and local experts from the study, in addition to local sessions with public officials, local residents, activists, and local organizations, including Ethno-Village Almaluu.

**Table 1.** List and definition of the CBA indicators

Direct costs per intervention		Unit	Value		Reference
			CAPEX	OPEX*	
UNESCO registration	Formal recognition of a territory by UNESCO as a geopark, acknowledging its geological heritage, sustainable management, and educational value	USD/year		5,231 <sup>1</sup>	Assumption
Wetland restoration	The process of rehabilitating degraded wetlands to restore their natural hydrology, biodiversity, and ecosystem services	USD/ha	400	244	Strzeciwilk & Grygoruk, 2025

<sup>1</sup> An annual cost of EUR 4,500 euros, converted to USD based on the exchange rate on October 9, 2025.



Direct costs per intervention		Unit	Value		Reference
			CAPEX	OPEX*	
Native vegetation planting	Reintroduction of indigenous plant species to enhance biodiversity, soil stability, and ecosystem resilience	USD/ha	880	500	Gasparinetti, et al., 2022; Van Zatern et al., 2023
Natural trails	Environmentally designed walking paths that allow visitors to experience and appreciate natural landscapes with minimal ecological impact	USD/km	10,000	500	Knoch & Sexton, 2015; Trailism, n.d.
Fishing access points	Designated areas providing safe and sustainable access for recreational or small-scale fishing activities	USD/point	5,000	5,000	Lyon, 2022; Trailism, n.d.
Swimming spots	Natural or managed water areas identified as safe and suitable for public swimming and recreation	USD/point	5,000	5,260	DockGear.com, 2025; Environmental Protection Agency, 2015
Floating docks and boat launches	Structures that facilitate water-based recreation and transport while minimizing shoreline disturbance	USD/dock	10,000	5,000	DockGear.com, 2025; Lyon, 2022
Birdwatching platforms	Elevated or strategically placed observation areas that allow visitors to view bird species without disturbing their habitats	USD/area	5,000	13,200	Elkin & Bamford, 2024; Trailism, n.d.
Educational signage	Informative displays placed throughout the site to communicate scientific, cultural, and environmental knowledge to visitors	USD/sign	1,000	100	Taylor, 2024



Direct costs per intervention		Unit	Value		Reference
			CAPEX	OPEX*	
Soil and water conservation practices	Techniques aimed at preventing erosion, maintaining soil fertility, and protecting water quality and quantity	USD/ha	1,100	772	Parris, 2010; Van Zatern et al., 2023
Scientific facilities	Dedicated spaces or infrastructure supporting research, monitoring, and educational activities related to the geopark's natural systems	USD	150,000	25,000	Mitchell, 2025; Startup Financial, 2025; Serif, n.d.; Ungles et al., 2024
Sustainable agricultural tools	Equipment and practices that enhance productivity while conserving resources and minimizing environmental impacts	USD	100,000		Business Plans, 2025

Source: Authors' elaboration.

\* Annual costs

Table 2 presents the avoided costs and benefits associated with the different tourism development pathways in the geopark. The indicators are derived from the CBA and provide a quantitative basis for assessing the economic and environmental implications of conventional and sustainable tourism scenarios. The table below summarizes these indicators, outlining the expected avoided costs—such as reduced damage from climate-related events, lower infrastructure maintenance, and minimized ecosystem degradation—and the direct and indirect benefits, including enhanced ecosystem services, improved visitor experience, and increased long-term revenue potential. By comparing these values across scenarios, the analysis highlights how sustainable tourism interventions can generate higher cumulative benefits and avoided losses, supporting the case for ecotourism as a resilient and economically viable development strategy for the geopark.

**Table 2.** Avoided cost and benefit variables and definitions

Direct costs per intervention		Unit	Value	Reference
<b>Avoided costs/losses</b>				
Avoided infrastructure damage	The reduction in potential repair or replacement costs resulting from infrastructure being protected against damage by natural hazards or degradation	USD/event	40,400	Kapar Kyzy, 2024
		% reduction from Wetlands	12.5%	Assumption
		% reduction from native vegetation	12.5%	Assumption
Avoided soil loss	Preventing soil erosion and degradation, maintaining land productivity, and reducing the need for costly restoration measures	USD/year	500,000	Mirzabaev et al., 2015; The Global Mechanism of the United Nations Convention to Combat Desertification, 2018
		% reduction with NBI	5%	Assumption
Avoided waste and wastewater costs	Savings achieved by minimizing the generation of waste and wastewater, thereby reducing treatment and disposal expenses	USD/year	4,302,640	Assumption
		% of reduction with sustainable tourists	30%	Assumption
Avoided health costs	A reduction in healthcare expenditures due to improved environmental conditions and decreased exposure to pollutants or disease vectors; based on health costs being 1.2% of GDP, applied to conventional tourism revenue	USD	175,840	Sahoo et al., 2023



Direct costs per intervention		Unit	Value	Reference
Avoided costs for the lake ecosystem	Economic benefits gained from preserving the lake's ecological balance, avoiding costs associated with water quality deterioration and habitat loss	Tonnes/ tourist/year	0.0023	Isnibakueva, 2024
		USD/tonne	3	Assumption
		% reduction in lake ecosystem from wetland restoration	10%	Assumption
		% reduction for the lake ecosystem from native vegetation planting	15%	Assumption
<b>Added benefits</b>				
Conventional tourism revenue	Earnings generated from traditional tourism activities that may not prioritize environmental sustainability or local community benefits	USD/person/ year	35.2	National Statistical Committee of the Kyrgyz Republic, 2025
Sustainable tourism revenue	Revenue derived from tourism practices that promote environmental conservation, cultural preservation, and local economic development	USD/person/ year	70.4	Nickerson et al., 2016
Revenue from local leisure	Income earned from recreational activities and services used primarily by local residents rather than external tourists	Current sites	9	Information from locals
		Additional sites	38	Information from locals
		USD/site	10,285.7	Assumption of KGS 5 per visitor with 200 visitors per day over 90 days, with an exchange rate of KGS 87.5/ USD 1



<b>Direct costs per intervention</b>		<b>Unit</b>	<b>Value</b>	<b>Reference</b>
Income from tourism employment	Wages and salaries generated through employment in tourism-related sectors such as hospitality, transport, and recreation	Full-time equivalent (FTE)/conventional tourist	0.0005	Assumption
		FTE/sustainable tourist	0.00055	Assumption
		USD/person/year	12,500	Assumption
Income from agricultural employment	Earnings obtained from agricultural activities, including crop production, livestock, and related rural enterprises	Number of conventional agriculture fields	530,502.8	Provided by GIZ and a local administrator
		Number of employees per field	0.4	Food and Agriculture Organization of the United Nations, 2020; NationMaster, n.d.
		USD/employee	2,400	Zhylykchiyevna et al., 2025
Carbon sequestration	The process by which ecosystems capture and store atmospheric carbon dioxide, generating potential revenue through carbon credits or climate financing mechanisms	Tonnes of carbon sequestered per year	1	Assumption
		Carbon price	30	Telaye et al., 2019
Government revenues	Funds collected by the government through taxes, fees, or other fiscal instruments associated with economic activities in the region; the value-added tax (VAT) applied to total tourism revenues	VAT	12%	Vanyan & Niyazgulova, 2025

Source: Authors' elaboration.



### 2.3.3 Tourism Assumptions

Tourism represents a key component of the geoparks system, influencing several aspects of the model, including local income generation, infrastructure requirements, and ecosystem management.<sup>2</sup> As a major driver of both economic activity and environmental change, understanding its development over time is necessary for assessing different management and investment strategies. The model focuses on ecotourism as one of the main pathways for future development, allowing for the examination of how variations in tourism composition affect the overall system. Establishing a reliable baseline for tourist numbers is therefore important for analyzing the potential impacts and trade-offs between conventional and sustainable tourism approaches. With tourism influencing several parts of the model, this parameter can be adjusted to test different policy and growth assumptions. It is estimated that the geopark will attract approximately 714,000 visitors in 2024 (Kabar, 2024; Kudrenok, 2025; Kwan, 2025; The Caspian Post, 2025). To project future trends, an annual growth rate of 4.4% is applied, based on the national tourism average between 2001 and 2010 (Department of Trade and Services Statistics, Information and Communication Technologies and Tourism, 2025). This baseline provides a consistent foundation for assessing how interventions such as infrastructure investments, conservation measures, and tourism management strategies may influence visitor numbers, economic outcomes, and the long-term dynamics of the geopark.

### 2.3.4 Scenarios

Building on the established baseline of tourist growth, two scenarios were developed to assess the economic, environmental, and social trade-offs between conventional and sustainable tourism pathways in the geopark. These scenarios capture distinct development trajectories and reflect alternative management strategies for balancing tourism expansion with conservation objectives. The rationale behind their formulation is to evaluate how different tourism models influence visitor composition, economic performance, and long-term ecosystem resilience.

A transition toward recognition as a UNESCO World Heritage Park is assumed across both scenarios, with an assumed associated annual cost of EUR 4,500. This reflects a shared baseline investment in maintaining international conservation standards and promoting the geopark's global visibility. See Table 3 for an overview of interventions considered.

1. **Conventional Tourism Scenario (Scenario 1):** This scenario represents a continuation of traditional tourism development, focusing on expanding infrastructure and services for general visitors. It assumes a 5% increase in conventional tourists and a 2.5% increase in sustainable tourists following the implementation of new interventions. The scenario reflects the potential short-term economic gains of tourism

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<sup>2</sup> Since the model operates with annual totals, it is important to recognize that (i) seasonal concentration of visitors produces short-term but intense pressures on infrastructure and ecosystems, and (ii) several nature-based interventions (such as wetlands) are required specifically to buffer these peak loads rather than annual averages. These dynamics mean that annual visitor numbers may mask critical temporal pressures that must be considered in planning and investment design.



expansion but does not incorporate additional measures to mitigate environmental pressures or enhance ecosystem services.

2. **Sustainable Tourism Scenario (Scenario 2):** This scenario integrates all planned sustainability-oriented interventions, promoting ecotourism, research activities, and environmental education as central components of the geopark's development strategy. It assumes a 50% reduction in conventional tourists, reflecting a shift away from mass tourism, and a corresponding 52% increase in sustainable tourists, including those attracted by scientific facilities and educational programs. This scenario emphasizes long-term ecological integrity, reduced environmental degradation, and the generation of socio-economic co-benefits through sustainable management and value-added visitor experiences.

**Table 3.** Overview of interventions considered between the conventional and sustainable scenarios

Interventions	Conventional Tourism Scenario	Sustainable Tourism Scenario
UNESCO registration	✓	✓
Wetland restoration		✓
Native vegetation planting		✓
Natural trails	✓	✓
Fishing access points	✓	✓
Swimming areas	✓	✓
Floating docks and boat launches	✓	✓
Birdwatching platforms	✓	✓
Educational signage	✓	✓
Soil and water conservation practices		✓
Scientific facilities	✓	✓
Sustainable substitution		✓
An additional increase in price for sustainable tourists		✓

Source: Authors' elaboration.

Together, these scenarios provide a comparative framework for understanding how different tourism strategies affect the geopark's economic performance, environmental sustainability, and contribution to local development goals.



### 2.3.5 Results of the Integrated CBA

The results of the CBA highlight substantial differences between the two development pathways in terms of overall performance and long-term outcomes. While the Conventional Tourism Scenario generates positive economic returns with a BCR of 2.77, the Sustainable Tourism Scenario demonstrates markedly higher efficiency, with a BCR of 8.88. This indicates that every dollar invested in the sustainable approach yields nearly nine times its value in benefits, compared to less than three times under the conventional pathway. The total cost of implementing sustainable interventions is higher (USD 32.8 million) than the conventional approach (USD 10.54 million), reflecting the more comprehensive nature of investments in infrastructure, management, and conservation. However, these costs are outweighed by the total benefits, which reach USD 258.26 million in the sustainable scenario, over seven times greater than those in the conventional scenario (USD 36.45 million).

**Table 4.** Overview of BCR, total discounted costs, avoided costs, and benefits at a rate of 3.5% per year for the two scenarios

Indicators	Conventional Tourism Scenario	Sustainable Tourism Scenario
BCR	2.77	8.88
Total cost (USD million)	10.54	32.8
Total avoided costs (USD million)	-7.18	32.98
Total benefits (USD million)	36.45	258.26

Source: Authors' elaboration.

Moreover, the avoided costs associated with environmental degradation, resource depletion, and loss of ecosystem services are significantly higher under the sustainable pathway (USD 32.98 million) compared to negative avoided costs in the conventional scenario (–USD 7.18 million), indicating that traditional development could lead to additional long-term losses. Overall, these results suggest that while sustainable tourism requires greater initial investment, it provides stronger economic returns, reduces environmental risks, and supports the resilience of the geopark's natural and socio-economic systems over time.

The comparison between the two scenarios highlights the contrasting outcomes of conventional and sustainable tourism pathways in the geopark. Under the Conventional Tourism Scenario, short-term economic gains are achieved through increased visitor numbers and higher immediate revenues. However, these benefits are offset by growing environmental degradation, resource strain, and social pressures, which diminish long-term returns and resilience. In contrast, the Sustainable Tourism Scenario, which integrates NBI and environmentally responsible practices, fosters more stable and diversified growth. By attracting visitors with higher per-capita spending and reducing environmental externalities, this approach enhances both ecological and economic sustainability. Over time, it supports a self-reinforcing cycle of conservation and value creation, positioning the geopark as a resilient and competitive ecotourism destination.



## 3.0 Results

This section presents the results of the discounted CBA for the geopark from 2025 to 2051 using a 3.5% annual discount rate. The analysis compares two development pathways: the Conventional Tourism Scenario (Scenario 1) and the Sustainable Tourism Scenario (Scenario 2). Table 5 summarizes the main outcomes across three key dimensions: direct costs (CAPEX and OPEX), avoided costs, and added benefits. The results capture the overall economic performance of each scenario by integrating costs, avoided damages, and generated benefits from tourism, employment, and ecosystem services. Key performance indicators (net benefits, BCR, and IRR) are used to assess the relative efficiency and long-term viability of each tourism pathway. See Table 5 for the full discounted CBA table.

**Table 5.** Cumulative discounted CBA table (3.5% per year) between 2025 and 2051

	Units	Conventional Scenario	Sustainable Scenario
<b>Direct costs</b>	<b>USD million</b>	<b>10.54</b>	<b>32.82</b>
Total CAPEX	USD million	2.76	4.72
Total OPEX	USD million	7.79	28.09
<b>Avoided costs</b>	<b>USD million</b>	<b>-7.23</b>	<b>32.99</b>
Avoided infrastructure damage	USD million	-	0.07
Avoided soil loss	USD million	-	0.07
Avoided waste and wastewater costs	USD million	-7.19	32.65
Avoided health costs	USD million	-	0.16
Avoided costs for the lake ecosystem	USD million	-0.04	0.04
<b>Added benefits</b>	<b>USD million</b>	<b>36.45</b>	<b>258.26</b>
Conventional tourism revenue	USD million	18.92	-189.24
Sustainable tourism revenue	USD million	8.11	386.97
Revenue from local leisure	USD million	4.83	4.83
Income from tourism employment	USD million	2.39	2.39
Income from agricultural employment	USD million	-	37.10
Carbon sequestration	USD million	-	0.15
Government revenues	USD million	2.20	16.06
<b>Key performance indicators</b>			
Net benefits	USD million	18.68	258.43



	Units	Conventional Scenario	Sustainable Scenario
BCR	USD/USD Invested	2.77	8.88
IRR	%	27.11%	118.84%

Source: Authors' elaboration.

Building on the overall CBA results, the comparison of direct costs highlights the financial implications of pursuing a sustainable tourism pathway in the geopark. Scenario 2 involves substantially higher total direct costs (USD 32.82 million) compared to Scenario 1 (USD 10.54 million), reflecting the expanded scope of sustainability-oriented measures and NBI integrated into the development strategy. Most of this increase is attributed to OPEX, which rises from USD 7.79 million in Scenario 1 to USD 28.09 million in Scenario 2, capturing the ongoing expenditures required to maintain sustainable infrastructure, ecological management, and visitor facilities. CAPEX also increases moderately, from USD 2.76 million to USD 4.72 million, representing the upfront investment needed to establish the necessary infrastructure for ecotourism and environmental monitoring. These higher costs in Scenario 2 therefore reflect a deliberate shift toward long-term sustainability, where greater operational commitments are made to secure larger avoided costs and benefits over time.

While Scenario 1 presents lower direct costs, its avoided costs are negative, indicating higher long-term losses and environmental pressures. The absence of sustainability-oriented interventions results in increased infrastructure strain, waste and wastewater management expenses, and health- and ecosystem-related costs, leading to a net loss of USD 7.23 million. In contrast, Scenario 2 records avoided costs of USD 32.99 million, mainly due to reductions in waste and wastewater-related costs (USD 32.65 million), along with smaller contributions from avoided infrastructure damage, soil loss, and health impacts. These results indicate that, although Scenario 2 involves higher initial expenses and OPEX, it achieves cost savings over time through reduced environmental degradation and improved resource management, which offset the higher direct costs.

In terms of added benefits, the two scenarios display contrasting revenue structures linked to their respective tourism models. Scenario 1 generates a total of USD 36.45 million in added benefits, primarily from conventional tourism revenues (USD 18.92 million), supplemented by sustainable tourism, local leisure activities, and employment-related income. In Scenario 2, the total added benefits increase to USD 258.26 million, reflecting a shift in the visitor composition toward sustainable tourism. While revenues from conventional tourism decline due to reduced visitor numbers, this is offset by higher revenues from sustainable tourism (USD 386.97 million), as eco-tourists typically spend more per visit, generate lower levels of waste, and have a smaller environmental impact. Additional benefits in Scenario 2 include increased agricultural income, government revenues, and minor contributions from carbon sequestration. Overall, the transition to sustainable tourism reshapes the economic profile of the geopark, balancing reduced mass-tourism income with higher-value, lower-impact activities.



Referring to the methodology section, our analysis includes climate-related indicators that affect the CBA. However, for this specific location and contextual conditions, the contribution of climate dynamics to the overall cost–benefit results is relatively small when compared to other indicators. The most important driver affecting environmental dynamics is the number of tourists and the associated waste generation, particularly wastewater. Together with climatic conditions, these factors contribute to eutrophication, which is the variable representing an environmental cost in the analysis. Nevertheless, the use of climate data and climate projections remains relevant and should be considered in future applications, particularly in contexts where climate impacts are expected to play a more significant role.

### 3.1 CBA per Tourist

When expressed on a per-tourist basis, the results offer valuable insights into how the structure and quality of tourism activity influence both economic and environmental outcomes in the geopark. By 2051, visitor numbers are expected to reach around 2.28 million in Scenario 1 and 2.20 million in Scenario 2, consistent with the shift away from mass tourism toward a more targeted and experience-driven ecotourism model. Although the sustainable pathway attracts slightly fewer visitors overall, each visitor contributes substantially more to the local economy and places less strain on natural resources.

In Scenario 1, the negative avoided costs per visitor (−3.17 USD) indicate that each additional tourist contributes to rising maintenance and environmental costs, such as waste and wastewater management, ecosystem degradation, and infrastructure wear. In contrast, Scenario 2 records avoided costs of USD 14.97 per visitor, reflecting the benefits of improved waste reduction, ecosystem restoration, and environmental management. This demonstrates that sustainable tourism not only mitigates ecological pressures but also generates measurable economic savings on a per-capita basis.

**Table 6.** Avoided costs, total benefits, investments, and net benefits on a per tourist basis

	Scenario 1	Scenario 2
<b>Annual visits by 2051<sup>3,4</sup></b>	<b>2,280,275.08</b>	<b>2,203,719.08</b>
Avoided costs per tourist	-3.17	14.97
Total benefits per tourist	15.99	117.19
Investment per tourist	4.62	14.89
Net benefits per tourist	8.19	117.27

Source: Authors' elaboration.

<sup>3</sup> Variations in composition affect the reference base for annual growth calculations (4.4%), producing different projected outcomes under each scenario.

<sup>4</sup> A scenario with a lower increase on sustainable tourism spending can be found in Appendix A.



Similarly, total benefits per tourist increase markedly from USD 15.99 in Scenario 1 to USD 117.19 in Scenario 2. This reflects higher per-capita spending by eco-tourists, greater diversification of income sources (such as sustainable agriculture and educational tourism), and the long-term gains associated with preserved ecosystem services. While investment per tourist rises from USD 4.62 to USD 14.89, the higher expenditure corresponds to a transformation toward value-added and low-impact tourism infrastructure. As a result, net benefits per tourist increase more than fourteenfold—from USD 8.19 to USD 117.27, illustrating how sustainability-oriented tourism can achieve greater economic returns while simultaneously strengthening ecological resilience.

These findings have several implications for policy and investment decisions. First, they show that growth in tourism value does not necessarily depend on increasing visitor numbers but on improving the quality, sustainability, and inclusiveness of tourism experiences. Second, they underline the importance of reinvesting tourism revenues into conservation and infrastructure that maintain ecosystem integrity, which in turn sustains future tourism potential. Finally, the per-tourist analysis reinforces that a shift toward nature-positive tourism can couple economic growth with long-term environmental stability, ensuring that the geopark remains economically viable and a preserved natural heritage site for future generations.

### 3.2 Government Perspective

While the full CBA highlights broad socio-economic and environmental gains, it is also important to assess the intervention from the perspective of a specific stakeholder—in this case, the regional government. Not all benefits and avoided costs are directly relevant to government entities, as many accrue to private actors (such as local businesses or tourists) or reflect broader societal gains. Therefore, by isolating the flows that directly concern the government, it becomes possible to estimate the return on public investment if the regional government were to finance the project.

From this perspective, total direct costs amount to USD 32.82 million, including USD 4.72 million in CAPEX and USD 28.09 million in OPEX (Table 7). The government also captures avoided costs totalling USD 32.79 million, primarily linked to improved waste and wastewater management (USD 32.65 million) and minor contributions from reduced infrastructure damage and soil loss (each USD 0.07 million). Added benefits for the government reach USD 16.06 million, reflecting increased fiscal revenues from tourism-related taxation, which is assumed at 12% in line with Kyrgyzstan's VAT rate.

Overall, the results indicate that for every USD invested by the regional government, approximately USD 1.49 is returned, corresponding to a BCR of 1.49 and an IRR of 15.38%. Although this return is lower than the aggregate scenario (BCR of 8.88 and IRR of 118.84%), it still demonstrates financial viability and highlights the potential for the reinvestment of fiscal gains into other local development priorities.



**Table 7.** Cumulative discounted CBA values, including Scenario 2 and the government perspective, discounted at 3.5%

	Units	Sustainable Tourism Scenario	Government perspective
<b>Direct costs</b>	<b>USD million</b>	<b>32.82</b>	<b>32.82</b>
Total CAPEX	USD million	4.72	4.72
Total OPEX	USD million	28.09	28.09
<b>Avoided costs</b>	<b>USD million</b>	<b>32.99</b>	<b>32.79</b>
Avoided infrastructure damage	USD million	0.07	0.07
Avoided soil loss	USD million	0.07	0.07
Avoided waste and wastewater costs	USD million	32.65	32.65
Avoided health costs	USD million	0.16	-
Avoided costs for the lake ecosystem	USD million	0.04	-
<b>Added benefits</b>	<b>USD million</b>	<b>258.26</b>	<b>16.06</b>
Conventional tourism revenue	USD million	-189.24	-
Sustainable tourism revenue	USD million	386.97	-
Revenue from local leisure	USD million	4.83	-
Income from tourism employment	USD million	2.39	-
Income from agricultural employment	USD million	37.10	-
Carbon sequestration	USD million	0.15	-
Government revenues	USD million	16.06	16.06
<b>Key performance indicators</b>			
Net benefits	USD million	258.43	16.03
BCR	USD/USD Invested	8.88	1.49
IRR	%	118.84%	15.38%

Source: Authors' elaboration.



## 4.0 Conclusions

The integrated CBA provides a comprehensive assessment of the economic, environmental, and social implications of two alternative tourism development pathways in the geopark: conventional tourism and sustainable tourism incorporating NBI. The analysis combined local data, literature-based estimates, and scenario-based modelling to evaluate CAPEX, OPEX, avoided costs, and added benefits for both pathways.

The results show that the Conventional Tourism Scenario, while requiring lower initial investments—CAPEX of USD 2.76 million and OPEX of USD 7.79 million—yields only limited long-term net benefits of USD 18.68 million. Most revenues come from conventional tourism activities (USD 18.92 million) and local leisure income (USD 4.83 million). However, the scenario fails to generate meaningful avoided costs, such as reductions in infrastructure damage, soil loss, or waste and wastewater management. As a result, environmental pressures remain unmitigated, leaving both the ecosystem and local communities increasingly vulnerable to degradation over time. Although this scenario achieves a BCR of 2.77 and an IRR of 27.11%, these returns reflect short-term economic gains that overlook long-term sustainability and resilience. When environmental and social costs are taken into account, the continued strain on the lake ecosystem could accelerate eutrophication, increase externalities, and eventually undermine the tourism activities that drive the local economy.

In contrast, the sustainable tourism pathway requires higher CAPEX (USD 4.72 million) and OPEX (USD 28.09 million) but delivers substantially greater net benefits (USD 258.43 million). This scenario generates higher per-tourist revenues (USD 386.97 million from sustainable tourism) and additional income from agriculture-related employment (USD 37.10 million), reflecting the integration of NBI and community engagement. Avoided costs under the sustainable scenario are significant (USD 32.99 million), including reductions in waste and wastewater management, soil loss, and ecosystem damage, as well as modest gains from carbon sequestration (USD 0.15 million). These factors collectively reduce environmental impacts and operational externalities while supporting the long-term resilience of both the local economy and ecosystem. The sustainable pathway achieves a BCR of 8.88 and an IRR of 118.84%, demonstrating that higher initial investments are financially justified by the long-term returns they generate.

From a stakeholder perspective, the findings provide actionable insights for multiple decision-making levels:

- **Policy-makers and regional authorities:** Investments in sustainable tourism and NBI produce both fiscal and non-fiscal returns. Positive BCR (1.49) and IRR (15.38%) from a government perspective indicate financial viability, while avoided environmental management costs and enhanced ecosystem services strengthen the rationale for conservation-oriented investment.
- **Private sector operators and local enterprises:** Sustainable tourism provides opportunities to diversify income streams, enhance visitor experiences, and target higher-value eco-tourists. The higher per-tourist revenues and reduced operational



environmental costs highlight the pathway's potential to improve profitability and market competitiveness.

- **Local communities:** Sustainable tourism supports inclusive development through increased employment in tourism and agriculture, improved environmental quality, and enhanced resilience of livelihoods. These benefits contribute to long-term stability and equitable growth within the geopark.

However, realizing the sustainable scenario will require overcoming several implementation challenges. Operationalizing a nature-based, community-centred tourism model demands coordinated governance, enforceable regulatory frameworks, and effective cross-sectoral partnerships. Municipalities, in particular, play a critical role, as they serve as the primary interface between land-use planning, tourism management, and environmental stewardship. Their ability to steer investments, safeguard landscapes, and ensure sustainable visitor practices and experiences depends on the availability of clear operational guidelines, robust planning tools, and reliable implementation partners. Strengthening institutional capacity, improving inter-agency coordination, and establishing mechanisms for long-term financing will therefore be essential to translate the modelled benefits of sustainable tourism into tangible outcomes on the ground.

Overall, the comparison between scenarios demonstrates that sustainable tourism, supported by NBI and ecosystem service integration, outperforms conventional tourism across economic, social, and environmental dimensions. Conventional tourism offers short-term gains but exposes the geopark to long-term risks and environmental costs, while sustainable tourism generates higher net returns, improves ecosystem resilience, and supports inclusive and diversified local development.



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## Appendix A. Other Result Tables

The benefits generated from sustainable tourism are highly sensitive to revenue per tourist, highlighting the importance of both tourist type and the activities they engage in. For instance, under Scenario 2, a doubling of revenue per sustainable tourist produces a discounted benefit–cost ratio of 8.88, reflecting substantial long-term returns relative to initial investments. By contrast, a more conservative increase of 20%, consistent with evidence from selected United States-based case studies reporting per-tourist revenue increases between 20% and 70%, results in a discounted BCR of 3.78 (Nickerson et al., 2016). These results demonstrate that variations in tourist spending patterns and preferences can significantly influence the financial viability of sustainable tourism strategies.

In addition to per-tourist revenue, labour deployment and worker density per hectare are important determinants of total economic benefits. In contexts such as Kyrgyzstan, intensification of tourism or agriculture-related activities may reduce employment density, leading to lower aggregate benefits, in line with Food and Agriculture Organization of the United Nations observations on smallholder and family farms (Food and Agriculture Organization of the United Nations, 2020). This indicates that strategies to maintain or enhance local employment are essential for maximizing the socio-economic impacts of sustainable tourism.

Furthermore, the analysis does not explicitly account for potential additional costs associated with scaling operations to meet projected tourism growth. For example, accommodating the anticipated 4.4% annual increase in tourist arrivals may require expanded infrastructure, including transportation, accommodation, and utility services, which could affect capital expenditures (CAPEX) and operational expenditures (OPEX) and, consequently, the net benefits and BCR. Incorporating such growth-related expenditures into future modelling would provide a more comprehensive assessment of sustainable tourism pathways and ensure more accurate estimation of long-term economic, social, and environmental outcomes.

While the results highlight the potential for high returns from sustainable tourism, there is inherent uncertainty associated with key variables, such as tourist spending and agricultural employment. For instance, actual increases in per-tourist revenue may be lower than projected, and intensification of agricultural activities could reduce employment density, thereby lowering associated income. Despite these uncertainties, the analysis shows that the project remains financially robust. Even under a conservative scenario with only a 20% increase in tourist spending or a 50% reduction in agricultural employment, the sustainable tourism pathway maintains positive net benefits, with BCRs of 3.78 and 8.31, respectively. This indicates that while variations in tourist behaviour and labour deployment affect the magnitude of benefits, the overall investment remains economically viable and capable of generating long-term returns, providing resilience against potential deviations from expected outcomes.



**Table A1.** Cumulative discounted CBA table between 2025 and 2051 for the sustainable scenario, sensitivity scenario on sustainable spending, and agricultural intensification (discounted at 3.5%)

	Units	Sustainable Scenario	20% increase in spending by tourists	50% reduction in agricultural employment
<b>Direct costs</b>	<b>USD million</b>	<b>32.82</b>	<b>32.82</b>	<b>32.82</b>
Total CAPEX	USD million	4.72	=	=
Total OPEX	USD million	28.09	=	=
<b>Avoided costs</b>	<b>USD million</b>	<b>32.99</b>	<b>32.99</b>	<b>32.99</b>
Avoided infrastructure damage	USD million	0.07	=	=
Avoided soil loss	USD million	0.07	=	=
Avoided waste and wastewater costs	USD million	32.65	=	=
Avoided health costs	USD million	0.16	=	=
Avoided costs for the lake ecosystem	USD million	0.04	=	=
<b>Added benefits</b>	<b>USD million</b>	<b>258.26</b>	<b>91.06</b>	<b>239.71</b>
Conventional tourism revenue	USD million	-189.24	=	=
Sustainable tourism revenue	USD million	386.97	232.33	=
Revenue from local leisure	USD million	4.83	=	=
Income from tourism employment	USD million	2.39	=	=
Income from agricultural employment	USD million	37.10	=	18.55
Carbon sequestration	USD million	0.15	=	=
Government revenues	USD million	16.06	3.50	=
<b>Key performance indicators</b>				
Net benefits	USD million	258.43	91.23	239.88
BCR	USD/USD Invested	8.88	3.78	8.31
IRR	%	118.84%	18.80%	110.73%

Source: Authors' elaboration.



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