# Toward Risk-Aware and Climate-resilienT communities (TRACT)

## Strengthening climate services and impact-based multi-hazard early warning in Maldives

## Annex 10
## Economic Analysis

## CONTENTS

***The content of this document has been redacted in accordance with the GCF Information Disclosure Policy, as names and contact details are confidential under the disclosure policy of the Accredited Entity.***

# 1. EXECUTIVE SUMMARY

The proposed Toward Risk-Aware and Climate-Resilient Communities (TRACT) Project aims to enhance climate resilience and disaster risk management in the Maldives through improved hydrometeorological services and multi-hazard early warning systems. Given the country's vulnerability to extreme weather events, rising sea levels, and economic dependence on climate-sensitive sectors such as tourism and fisheries, strengthening early warning capabilities is crucial for mitigating losses and ensuring long-term sustainability.

## 1.1 Key findings

**Economic and Social Impact:** The project has the potential to deliver significant economic and societal benefits. Estimated total benefits range from USD 927.02 million (3% discount rate) to USD 357.81 million (12% discount rate). The project is expected to contribute to a 36.25% reduction in disaster-related economic losses, with direct productivity gains across key sectors such as fisheries, tourism, transport, and energy estimated between USD 326.38 million (3% discount rate) and USD 125.98 million (12% discount rate).

**Cost-Benefit Analysis:** The cost-benefit analysis demonstrates the project's strong economic viability. The Net Present Value (NPV) is projected to range from USD 891.53 million (3% discount rate) to USD 322.96 million (12% discount rate), with a Benefit-Cost Ratio (BCR) between 26.12 and 10.27, indicating high returns on investment. These figures highlight the economic efficiency of the proposed interventions.

*Table 1: Cost-Benefit Analysis Summary.*

| Discount rate (%) | 3.0 | 6.0 | 12.0 |
|---|---|---|---|
| Implementation Costs | 25.00 | 25.00 | 25.00 |
| Operations and Maintenance Costs | 10.49 | 10.15 | 9.86 |
| Total costs | 35.48 | 35.15 | 34.86 |
| Potential direct gains (improved Disaster Risk Management) | 409.10 | 290.42 | 157.91 |
| Unblocked economic productivity (Fisheries, Energy, Tourism & Recreation, Transport) | 326.38 | 231.70 | 125.98 |
| Benchmarking impacts (end users improved decision making) | 191.54 | 135.98 | 73.93 |
| Total benefits | 927.02 | 658.09 | 357.81 |
| Net Present Value (NPV) | 891.53 | 622.94 | 322.96 |
| Benefit-Cost Ratio (BCR) | 26.12 | 18.72 | 10.27 |

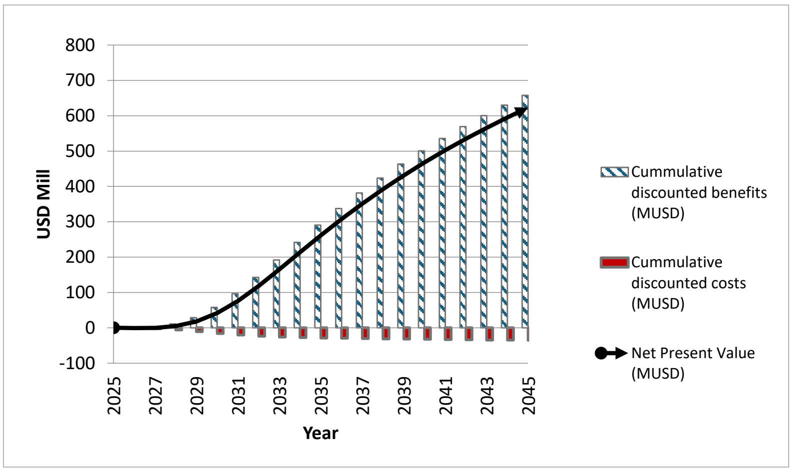


*Figure 1: Cumulative Net Present Value (NPV) over 20 Years.*

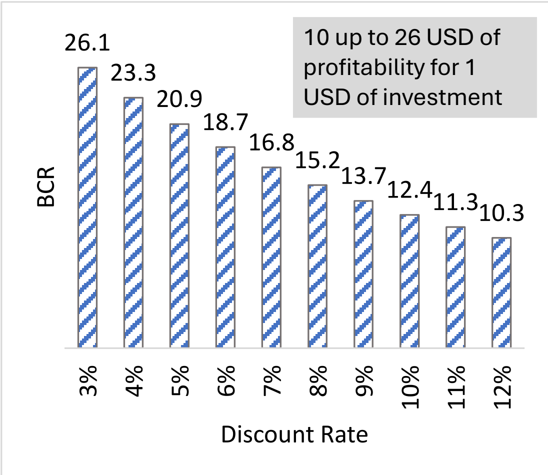


*Figure 2: Sensitivity Analysis of Benefit-Cost Ratio (BCR).*

## 1.2 Strategic considerations

**Alignment with National and Global Priorities**: The project aligns with Maldives' national renewable energy roadmap (*i.e.*, achieving provision of 33% renewable energy by 2028) and global climate resilience initiatives, reinforcing its relevance to ongoing climate adaptation efforts.

**Enhancing Early Warning Systems (EWS)**: Investments in Impact-Based Forecasting (IBF), community outreach, and multilingual early warning dissemination will be crucial for increasing public awareness and response effectiveness. A key priority is ensuring that migrant workers and tourists receive timely and accessible alerts.

**Long-Term Sustainability**: Ensuring financial sustainability will require continued support from both national and international funding sources. Strengthening public engagement and trust in climate services will be essential to maximizing the benefits of improved hydrometeorological information systems.

## 1.3 Conclusion and recommendations

The TRACT project presents a highly promising opportunity to enhance climate resilience, reduce economic losses, and improve decision-making for communities and industries across the Maldives. However, achieving these outcomes will require robust implementation strategies, sustained investments in technical capacity, and institutional coordination. Addressing identified gaps, particularly in localized forecasting, data accessibility, and public awareness, will be critical for maximizing long-term project benefits and ensuring national resilience to climate-related risks.

## 2. INTRODUCTION

The Republic of Maldives faces significant climate change threats due to its small size, low elevation, and heavy dependence on natural resources. The high vulnerability score and high readiness score of Maldives places it in the upper-right quadrant of the Notre Dame Global Adaptation Index (ND-GAIN) Matrix. Maldives experiences rising temperatures, extreme weather events, and sea-level rise, impacting multiple sectors including health, infrastructure, and tourism. Improving climate data management and forecasting is critical for the country. Figure 3 shows the added value to the GDP of the different economic sectors. Tourism, which accounts for almost one-third of the economy, has seen rapid growth in the post-Covid period. This economic growth is expected to be maintained.[1] Although this may be seen as a development outcome, there are some signs of concern. It is important to have a balanced approach to economic development that includes increased competitiveness, improving infrastructure, and involve diversifying the economy to reduce dependence on a single sector or market, which can be dangerous. In Maldives, the heavy reliance on tourism and limited sectoral diversification remains a key structural challenge that makes the country highly vulnerable to adverse hydrometeorological conditions.

Climate change and the subsequent sea level rise are contributing to the warming of oceans and the increased occurrence of more intense and frequent tsunamis and floods in Maldives. Floods frequently result in the contamination of groundwater and sewage systems, causing outbreaks of diseases within the country and causing important socioeconomic losses.

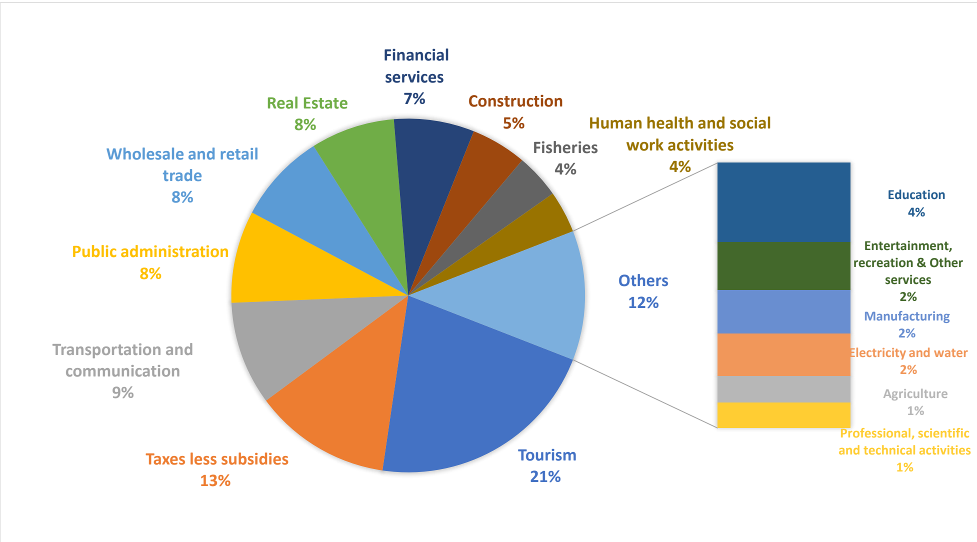


*Figure 3: Sectoral structure in Maldives: Added Value contribution to GDP by sectors. Own elaboration from WBdata.*[2]

Tourism is the sector contributing more to the GDP. Climate services and impact-based multi-hazard early warning may contribute to the resilience of this and other sectors in Maldives, such as agriculture, energy and marine and fisheries and therefore unlock economic growth in the medium and long term.

In response to a request from Maldives' Ministry of Tourism and Environment (MTE), the United Nations Environment Programme (UNEP), is developing a project proposal titled "Toward Risk-Aware and Climate-resilient Communities (TRACT)" for the Green Climate Fund (GCF). This project aims to enhance the resilience and reduce the vulnerability of Maldives' population through science-based, risk-informed decision-making, and establishing a nationwide multi-hazard early warning system.

The key goal of the TRACT project is to increase resilience and reduce vulnerability to climate change impacts by ensuring the availability and access to reliable climate services and people-centred impact-based multi-hazard early warning system (MHEWS). The value of information-based MHEWS is rooted

[1] World Bank, 2023
2 https://data.worldbank.org/

in the principle that access to precise, timely, and relevant information enables better decision-making, which in turn can lead to improved outcomes in terms of safety, economic efficiency, and resilience.[3,4,5]

The socio-economic value of the TRACT project value chain (VC) results from a series of processes that begin with the observation of weather- and climate-related data and information. The observations are then transformed into actionable insights through data processing, analysis, and forecasting. The final stage involves the dissemination of this information to end-users in a manner that is easily accessible, understandable, and actionable. This comprehensive approach ensures that the generated information can be effectively utilized in decision-making processes, thereby improving societal outcomes.[6]

The TRACT project's efforts in improving climate services are designed to bridge the gap between data generation and practical application. By focusing on the effective communication and dissemination of information, the project aims to ensure that the Maldives Meteorological Service (MMS) can deliver forecasts and warnings in formats that end-users can readily obtain, comprehend, and use. This involves not only the technical aspects of data analysis and forecasting but also the strategic dissemination of information through various channels, such as digital platforms, community networks, and public advisories. The goal is to maximize the usability of the information, enabling communities to make informed decisions that enhance their preparedness and resilience.

The present Inception Report (ICR) is aimed to provide details on the complexion of the economic analysis of the TRACT project, evaluate the costs and benefits of the proposed interventions, produce a comprehensive economic analysis report, and provide a cost-benefit analysis with internal rate of return (IRR) and sensitivity analyses

[3] Macauley, M., K. 2006. “The value of information: Measuring the contribution of space-derived earth science data to resource management”. Space Policy 22 (2006) 274–282.
[4] WMO, World Bank, GFDRR and USAID. 2015. Valuing Weather and Climate. Economic Assessment of Meteorological and Hydrological Services. WMO-No. 1153. Geneva, Switzerland.
[5] World Bank/GFDRR. 2018. Socio-Economic Analysis of the Potential Benefits of Modernizing Hydrometeorological Services in the Lao People’s Democratic Republic.
[6] WMO, World Bank, GFDRR, and USAID, 2015

# 3. CONCEPTUAL APPROACH TO ECONOMIC VALUE

## 3.1 General considerations

Accurate, timely, and relevant forecasts and warnings can significantly influence decision-making, leading to substantial benefits for society. These benefits include improved public safety, reduced economic losses, and increased resilience to adverse events. For instance, farmers can use weather forecasts to optimize planting and harvesting schedules, thereby improving crop yields and reducing losses. Similarly, disaster management agencies can use early warnings to coordinate evacuations and allocate resources more effectively, ultimately saving lives and reducing the impact of disasters.

The TRACT project's focus on enhancing information services across hydrometeorological and climate domains is integral to its mission of building disaster resilience and improving societal outcomes of disasters. The present evaluation focuses on the impacts resulting from ensuring that valuable information is effectively communicated and utilized for decision-making process. This strategic approach not only enhances the immediate benefits of Climate Information and Early Warning Systems (CIEWS) but also aims to evaluate long-term sustainability and resilience.

Improving CIEWS provides a range of benefits in several sectors and for the general public. This makes the economic analysis of potential impacts a complex task; therefore, instead of trying to be an exhaustive compendium of all the expected impacts, the socioeconomic benefits (SEB) analysis aims to evaluate some of these for which quantitative information can be obtained and to establish conservative assumptions with the intention of considering only the impacts attributable to the project. In this way the evaluation proposed can be understood as a lower limit of the benefits, which will undoubtedly be broader.

On the one hand, there are direct economic effects of better climate information systems affecting productive sectors such as agriculture or energy that can be measured with market information. But on the other hand, several other indirect effects derive from the improved decision-making processes also generate economic value. These are however not being considered in market mechanisms (*i.e.*, reductions of mortality rates, environment protection, reduction of conflicts, etc.). Therefore, it is necessary to consider a combination of market and non-market methods in the economic assessment.

## 3.2 Hydrometeorological Information Value Chain

The Hydrometeorological Value Chain (HVC) shows that value, in socio-economic terms, is ultimately at the end of the process that starts with observations of weather, water, and climate elements through to decision-making and outcomes.[7] Once information is created it must be disseminated and communicated through channels and in formats such that it can be obtained, understood, and used in stakeholder decision making to improve societal outcomes. As such, the value of accurate, timely and relevant hydrological and meteorological information, forecasts, and warnings is only realized if information can potentially be used in decision-making to generate beneficial outcomes at the end of the process. Merely improving observations or forecasts will not necessarily generate economic value without the entire value chain process working to facilitate end-user decision making. For the purposes of this analysis assessing economic benefits of improved HVC, it has been assumed that information is created, disseminated, and used for decision-making. The economic and social values that can derive from the project will require not only investing in infrastructure but in all processes that ensure that outcomes are realized. Figure 4 shows an example of simplified HVC to understand the way in which modifications in the responses to hydro-meteorological events can lead to improved socio-economic values.

[7] Lazo 2016


*Figure 4: Simplified Hydrometeorological Value Chain.*[8]

It is important to note that investing in HVC often generates benefits that occur in the long term, *e.g.*, 25 years after the start of the investment. Figure 5 summarizes the proposed approach to be considered in the current evaluation: it shows the actual benefits of an investment starting from zero and gradually increasing during the years (black curve). The resulting benefits are expected to be higher than what would have been without the investment (baseline, bottom red line); they are also expected to be lower than the potential benefits that could ideally be realized (potential, top red line).

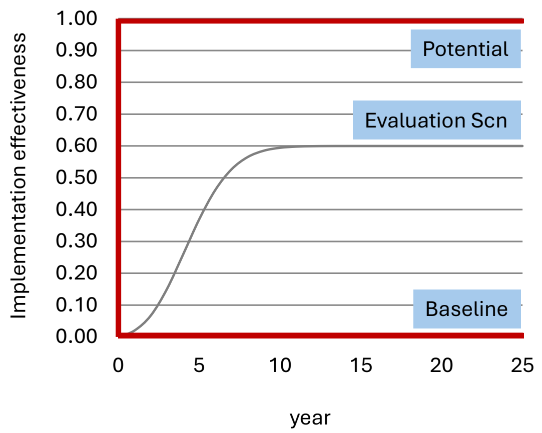


*Figure 5: The implementation effectiveness rate.*[9]

In the following evaluation we will estimate the implementation effectiveness rate as the degree to which a specific investment (scenario) contributes to the achievement of the potential benefits. The analysis will have the following steps:

(i) An assessment of the potential benefits of implementing TRACT in Maldives is provided,

(ii) An implementation effectiveness rate is proposed for two scenarios in order to calculate the effective benefits: an optimal implementation scenario and a baseline. As the implementation process of the TRACT project will take some time, the potential benefits, will gradually surface in the short, intermediate and long term;

[8] World Bank, 2020
[9] World Bank, 2020

(iii) The Net Present Value (NPV) of the annual benefits is calculated for the proposed period (2026-2045) considering a discount rate of 6%; and

(iv) A sensitivity analysis the response to discount rates variations between 3 and 12%.

### 3.3 Value of Information

The concept of "value of information" (VOI) encompasses the theoretical and practical methods in economics that assess the impact of hydrometeorological information services on societal welfare. With roots in decision sciences and probability theory developed from the mid-20th century,[10] the VOI approach continues to evolve with advances in economic modelling and data analysis.[11]

The VOI approach addresses key questions such as "How does information available before an event occurs influence the decision to take or avoid action?" and "What is the decision maker's willingness to pay (WTP) for information about a potential event before making a decision?". VOI assesses how individuals or "economic agents" respond to new information when faced with climate-related risks. Various models have been developed to study the decision-making process and the value derived from hydrometeorological information. The formal mathematical expressions and empirical evaluations linking VOI to expected decision outcomes can vary widely, depending on the specific decision context and research methods used. The approach used here will consider some decisions at agent level, focusing on utility maximisation or loss minimisation,[12] and their effects on society at the macroscale.[13] This approach aims to shed light on how economic agents value and use information to mitigate risk and improve decision outcomes.

### 3.4 Public goods and societal welfare

As mentioned above, the approach to quantify economic value of the TRACT project will include non-market evaluation methods, such as stated preference techniques, which use surveys to capture individuals' economic values for goods and services that are not directly purchased in the market. These studies typically elicit individuals' WTP, which reflects consumer surplus – *i.e.*, the difference between what consumers are willing to pay and what they actually pay if the service are available for purchase.

It is important to note that the WTP is inherently constrained by income levels and using it to value non-market goods raises ethical and equity considerations, particularly when comparing values across countries with different income levels. For example, the statistical value of life (SVL), which is often used to assess the benefits of reducing mortality risks, can vary significantly between countries due to differences in income levels, raising concerns about fairness and equity in global valuations. For this reason, in the proposed evaluation, the WTP will only be used to evaluate the changes on decision making processes that can increase the agent's income. Fatalities will appear in physical terms and will not be considered in economic terms.

[10] Savage 1954; Howard, R.A. 1966; Macauley, M.K. 2005
[11] Macauley, 2005; Lazo et al., 2010; Millner, Dietz, and Heal, 2013; Quiroga, 2018
[12] Lazo et al., 2010; Conrad et al., 2020
[13] Quiroga, 2018; Dingler et al, 2020

## 4. ECONOMIC APPROACH FOR THE TRACT PROJECT EVALUATION

As pointed out in the previous sections, investing in the Hydrometeorological Value Chain (HVC) can generate a wide array of benefits. This economic analysis approach is a categorization of those benefits according to the triple dividend of resilience framework.[14] This framework highlights the multifaceted advantages of such investments, capturing the immediate, medium, and long-term impacts on various sectors. Figure 6 provides a detailed summary of the types of benefits, or dividends, associated with investments in the HVC that are proposed to be considered in the evaluation analysis.

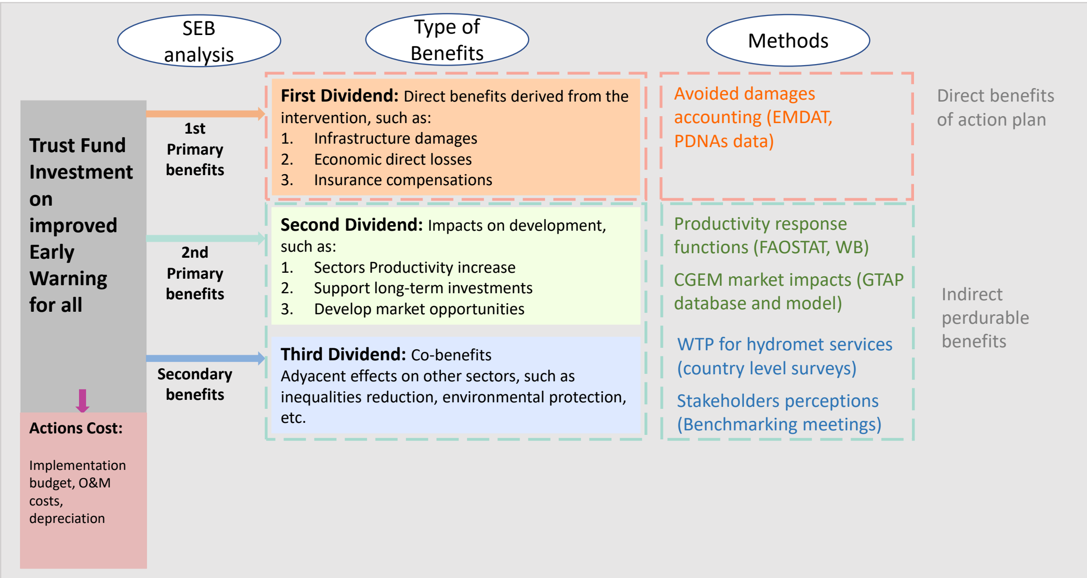


*Figure 6: The triple dividend resilience framework adapted to investment in the HVC.*[15]

The dividends associated with HVC include:

- **Saving lives and reducing damages and losses:** This primary benefit refers to the life-saving potential and reduction in asset losses that can result from an enhanced system for forecasting extreme weather events and issuing and disseminating early warnings. By accurately forecasting disasters such as floods, hurricanes, earthquakes, tsunami, and droughts, Early Warning Systems (EWS) allow for timely evacuations, better preparedness, and other proactive measures that can significantly mitigate the adverse effects of such events. The prevention of fatalities and the reduction of damage to infrastructure and property result in substantial gains in terms of human safety and economic stability. Furthermore, the psychological benefits of having reliable EWS can reduce anxiety and stress among populations at risk, contributing to overall societal well-being.
- **Unlocking economic potential:** Investments in HVC can drive economic growth by increasing risk awareness and improving predictive capabilities. With better weather and climate information, businesses and individuals can make more informed decisions, leading to increased economic productivity. For example, farmers can optimize their planting schedules, businesses can protect supply chains, and investors can confidently allocate resources to long-term productive assets. Furthermore, the improved reliability of extreme event predictions can stimulate the development of new markets and opportunities, fostering innovation and sustainable economic development. This includes the growth of sectors such as agriculture, insurance, tourism, and energy, where accurate climate information is critical for planning and operations.
- **Generating co-benefits:** Enhancing the quality and timeliness of predictions can lead to a multitude of additional benefits beyond immediate risk reduction. These co-benefits span across economic, social, and environmental domains:

[14] Tanner at al., 2015.
[15] Adapted from Tanner at al., 2015, and World Bank, 2020.

Economic co-benefits: Improved weather and climate forecasts can enhance household welfare by enabling better planning and reducing uncertainty. This can lead to more stable incomes, lower insurance costs, and overall greater economic resilience. Businesses can reduce operational costs and increase efficiency by optimizing their activities based on reliable climate information. Importantly, these economic benefits can help reduce inequalities by providing vulnerable and low-income communities with tools to better manage risks.

Social co-benefits: Accurate and timely information strengthens relationships between end-users and service providers, fostering trust and cooperation. It also enhances community resilience by empowering individuals with the knowledge they need to protect themselves and their properties. Improved communication of climate risks can promote community solidarity and collective action in response to extreme events, enhancing social cohesion. Furthermore, these benefits can address social inequalities by ensuring that marginalized and vulnerable communities and groups have equal access to critical information, thereby improving their capacity to respond to and recover from disasters.

Environmental co-benefits: Better EWS contribute to the preservation and enhancement of ecosystem services. For instance, accurate forecasts can aid in the management of natural resources, such as water conservation during droughts or optimizing agricultural practices to reduce environmental degradation. EWS can also support biodiversity conservation by providing timely information that helps protect wildlife habitats from extreme events. These environmental benefits can also contribute to reducing inequalities by improving the livelihoods of communities that depend directly on natural resources, ensuring sustainable use and conservation.

Investing in the HVC is not just about immediate risk mitigation; it is about creating a robust framework that supports long-term resilience and sustainable development. By saving lives, reducing economic losses, unlocking new economic potential, and generating diverse co-benefits, such investments play a crucial role in building a resilient and prosperous society. These benefits highlight the importance of continued support and investment in hydrometeorological services to foster a safer, more productive, and sustainable future for all. Additionally, by addressing inequalities, these investments ensure that the benefits of improved climate services are accessible to all segments of society, particularly the most vulnerable and marginalized, leaving no one behind.

Some direct economic impacts on productive sectors (*e.g.*, aviation, agriculture, industry, energy, etc.) can be measured through market information. However, there are other effects, such as avoided deaths, that also generate economic value even if they are not based on an economic activity. The quantification of these effects is challenging; therefore, qualitative information will also be considered in the Benefit-Cost Analysis (BCA). For reasons described in Section 3.4, avoided deaths will not be evaluated.

The table below outlines the methods proposed to evaluate each expected benefit:

*Table 2: Methods and databases for the analysis of the expected benefits.*

| Expected benefits | Indicators analysed | Methodology | Data Sources |
|---|---|---|---|
| Reducing damages and losses | Analysis of frequency of disasters<br>Average losses per affected people and loss reduction ratio | Avoided losses | EMDAT Database, DRM and Cross Crescent Interviews |
| Unlocking economic potential | Change in productivity<br>Change in GDP | Estimated elasticity<br>Computable general equilibrium model | World Bank database, CRU database, GTAP global database |
| Co-benefits resulting from improved decision-making | Estimation of Loss reduction ratio due to improvements in DRM.<br>Perceptions analysis | Benchmarking Focus Group | Stakeholders Survey; MMS interview |

The evaluation will account for the long-term benefits of the TRACT project's investments, particularly within the second dividend. Investments in EWS or capacity building activities may show incremental benefits in the medium- to long-term as they lead to improved decision-making and reduced economic losses from disasters. To quantify these benefits, we will project the estimated potential benefits for 20 years into the future, a timeframe that aligns with best practices in cost-benefit analysis for climate and disaster resilience investments, as outlined by WMO and the World Bank. A discount rate will be applied to the future benefits to account for the time value of money and to provide a present value of the long-term impacts.

# 5. ESTIMATION OF BENEFITS

## 5.1 Focus Group Description

A joint meeting with high level informed stakeholders was arranged for the benchmarking process. Table 3 displays the institutions of the Focus Group's participants. The selection of the stakeholder to be included was done in collaboration with UNEP and Maldives representatives in the project and later refined during the mission in Male' in February 2025. Appendix 1 presents the full questionnaire used in the benchmarking exercise, while the list of participants is reported in Appendix 2.

*Table 3: Institutions of the Focus Group participants.*

| Institutions of the Focus Group participants |
|---|
| Maldives Civil Aviation Authority |
| Maldives Meteorological Service |
| Maldives National University |
| Maldives Space Research Association |
| Maldives Water and Sewerage Company |
| Ministry of Agriculture and Animal Welfare |
| Ministry of Cities, Local Government and Public Works |
| Ministry of Construction, Houring and Infrastructure |
| Ministry of Fisheries and Ocean Resources |
| Ministry of Tourism and Environment |

## 5.2 Benchmarking and expected impacts

Figures 7 to 9 display the quantitative results gathered from the focus group survey regarding (a) country's vulnerability perceptions and estimated climate-related economic damages, (b) the perceived quality of hydrometeorological services, and (c) the expected loss reduction from the implementation of the TRACT project.

(a) Perceived vulnerability and economic losses: Survey respondents identified various factors influencing climate vulnerability in Maldives, including sea-level rise, extreme weather events, and the geographic exposure of low-lying islands. On average, participants assessed that climate- and weather-related damages could account for 13.68% of the total Maldives' GDP. The most frequently cited damages included infrastructure destruction, property losses, and disruptions in key sectors such as fisheries and tourism. (Figure 7).

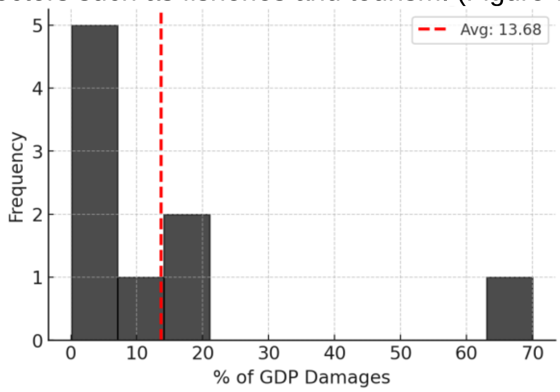


*Figure 7: Distribution of Perceived % GDP Damages in Maldives.*

(b) Perceived quality of hydrometeorological services and gaps: Respondents provided feedback on the current quality of the Maldives Meteorological Service (MMS). The perceived quality score of MMS averaged 5.78 out of 10, indicating room for improvement. Some stakeholders emphasized the importance of localized forecasting and access to impact-based warnings, particularly for disaster risk management and maritime operations. Limited data granularity and the availability of sector-specific climate information were also highlighted as areas requiring further development (Figure 8).

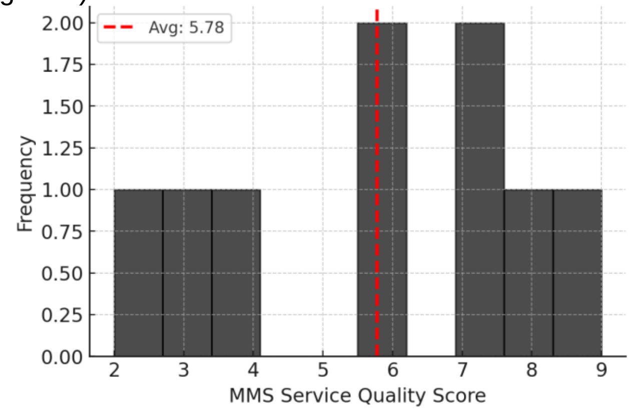


*Figure 8: Quality of MMS (Maldives Meteorological Service).*

(c) Expected loss reduction from the TRACT project implementation: The potential reduction in economic damages due to the TRACT project implementation was assessed using the Loss Reduction Ratio (LRR). The average expected reduction across sectors was 36.25%, reflecting optimism regarding the role of enhanced forecasting capacity and early warning systems. Respondents from fisheries, tourism, and disaster management expressed particular confidence in the benefits of improved preparedness and impact-based forecasting (Figure 9).

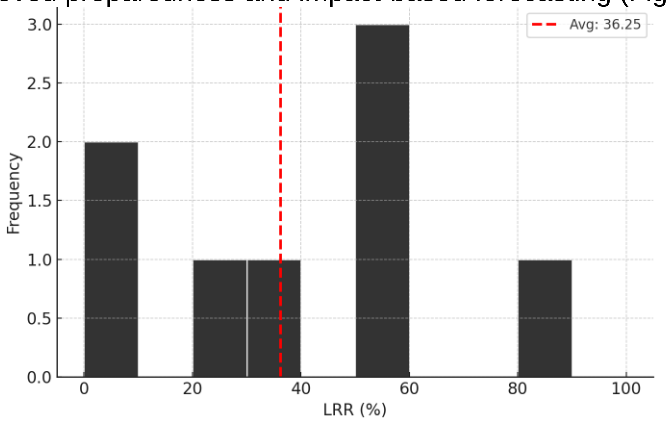


*Figure 9: Loss reduction ratio as perceived by relevant stakeholders in Maldives.*

While respondents acknowledged the benefits of the TRACT project, they also identified challenges that could limit its effectiveness and ways to address them, for instance:

- Need to strengthen institutional coordination for the implementation of early warning systems across different sectors;
- Current limited accessibility and user-friendliness of hydrometeorological services for local communities and vulnerable groups;
- Need to ensure that early warning messages are available in multiple languages and disseminated through a range of communication channels, including social media, radio, and mobile alerts; and
- Need to invest in meteorological infrastructure and capacity-building initiatives to enhance forecasting accuracy and reliability.

Overall, the findings indicate that the TRACT project is expected to play a critical role in improving climate resilience in Maldives. However, addressing existing gaps in service provision and institutional coordination will be essential for maximizing the long-term effectiveness of the interventions.

## 5.3 End-users' qualitative perceptions[16]

The Focus Group discussions and one-on-one interviews exposed the growing concerns of the involved stakeholders (see list in Appendix 2) about climate change impacts across multiple sectors in Maldives and the need for improved resilience strategies. During these discussions, sector-specific challenges and the expected benefits of enhanced Climate Information and Early Warning Systems (CIEWS) were highlighted. The perceptions of the stakeholders that emerged from the discussions are summarized below.

Sectoral Climate Sensitivity and Needs: Stakeholders from telecommunications and broadcasting noted the increasing disruption of network infrastructure due to rising wind speeds, affecting connectivity. Tourism industry representatives emphasized the sector's exposure and vulnerability to extreme weather events, underscoring the need for enhanced forecasting to reduce travel disruptions. Fisheries stakeholders reported concerns over shifting fish stocks and harsher maritime conditions, which complicate navigation and resource management. Agriculture remains highly vulnerable, with crop damage exacerbated by extreme weather, requiring better CIEWS and seasonal forecasts to optimize planting and harvesting cycles.

Energy Provision and Infrastructure Development: Participants expressed optimism regarding Maldives' ambitious goal to achieve 33% renewable energy by 2028, with solar energy expansion seen as a key opportunity. However, concerns remain about the feasibility of scaling wind and hydropower, given the geographic and climatic limitations. The strong dependence on imported fuel – currently representing about 99% of the energy supply – was identified as a critical vulnerability, driving calls for more diversified energy sources.

Disaster Risk Management and Forecasting Improvements: CIEWS were widely regarded as essential for mitigating disaster impacts. Stakeholders noted the importance of expanding communication channels beyond social media and television to include cell broadcasting and multilingual alerts for migrant workers and tourists. Institutional coordination remains a challenge, with calls for improved collaboration between meteorological agencies, emergency response organizations, and industry actors. Investment in technological infrastructure, including modern calibration systems and additional automated weather stations, was identified as a priority to enhance forecast accuracy and accessibility.

TRACT Project Expectations and Challenges: Stakeholders viewed the TRACT project as a significant opportunity to improve climate resilience in Maldives. The anticipated benefits include more accurate sector-specific forecasting, enhanced decision-making for agriculture, transport, and fisheries, and better preparedness for extreme weather events. However, key challenges were also identified, including limited access to localized climate data, slow public adoption of warning systems, and institutional constraints that may hinder full project implementation. Ensuring sustained investment and improving public awareness were highlighted as crucial factors for success.

Overall, the qualitative feedback underscores the urgent need for better climate services, stronger disaster preparedness, and greater integration of meteorological information into economic and policy planning. Addressing these challenges will be vital in ensuring Maldives' long-term resilience to threats related to climate change.

The table below presents a structured summary of stakeholders' needs to cope with their recognized vulnerabilities. The information in the table was extracted from stakeholders' interviews during a mission in Male' in February 2025, including a Focus group discussion and survey run for Benchmarking purpose. The participants synthesized key insights on vulnerability perceptions, expected damages, and recommendations for improving hydrometeorological services in the Maldives. It captures perspectives from different sectors, highlighting common concerns and sector-specific challenges.

*Table 4: Summary of stakeholder needs to cope with their recognized vulnerabilities.*

| Beneficiaries | Weather and Climate Sensitivity | Benefits of hydromet products and services | Type of products and services required | Gaps identified by the stakeholders |
|---|---|---|---|---|
| Agricultural sector | Agricultural productivity is highly impacted, especially | Decisions related to the date of sowing, harvesting, post-harvest | Develop seasonal cropping calendars. Additionally, flood early | Agrometeorological information cannot be fully captured from |

[16] Sources: focus group discussions and interviews.

| Beneficiaries | Weather and Climate Sensitivity | Benefits of hydromet products and services | Type of products and services required | Gaps identified by the stakeholders |
|---|---|---|---|---|
| | by pests, strong winds, rain, floods, storm surges, and saltwater dispersion. | processing, and management of production (including, irrigation, pesticides application, etc.) may improve significantly with more accurate cropping calendars based on seasonal forecast. | warnings are required. | MMS website. Not all the relevant information is available for all the islands. More local information needed. |
| Transport and civil aviation | Marine and flight operation is highly dependent on accurate weather information and forecast. This affects public security. | According to conventions of the International Maritime Organization (IMO), vessels need to be provided terrestrial and space radio communication services daily. | Meet the Safety of Life at Sea (SOLAS) convention requirements for maritime transport. For aviation, establish a Quality Management System (QMS) to improve information quality. | Improved information for the marine and aviation sectors, especially for the inter-islands transportation. |
| Civil protection | Disasters such as tsunamis, floods, cyclone storms, etc, impact people and properties, increasing risk and need for civil protection, affecting for example Cost Guard work. | CIEWS and increased lead time allow for forecast-based actions, and better disaster preparedness response plans to avoid deaths, damages, and losses. | Strengthening CIEWS, develop high alert messages. Generally, information needs to be more impact-based. | Increasing awareness of the public in these issues will reduce losses. The current awareness is perceived to be very low. Existing warning apps need to be disseminated more widely. Alerts currently take too much time to be issued. |
| Water sector | Impacts on water resources and groundwater contamination due to raising sea level. | Improving the timeline of the information. | Improved climate models to identify impacts of climate change on water resources. | Sometimes information presents delays that may make operations difficult. |
| Health | Bacterial diseases (*i.e.*, cholera) and virus diseases (*i.e.*, dengue) are highly related to the consequences of climate change. | Assessing vulnerability and patterns to identify communities at risk allows for better public health systems response. | CIEWS, improved impact-based forecasts and dissemination of alert messages. | Necessity for increased awareness at the community-level about climate change impacts on health and on regulation on environmental health issues. |
| Tourism | Tourists may be exposed to extreme events. Consequences of climate change and maritime security highly affect the development of the tourism sector. | Planning of alternative routes when storms may affect tourism. | Tailored product development and impact-based forecast, assessment of climate resilience of tourist infrastructure. | Climate information oriented to the tourism sector is needed. Currently limited coastal defence to protect from storm surges and sea level rise. |

## 5.4 Productivity gains through the use of CIEWS

### Changes in productivity

To estimate the impact of improved climate services, we need to analyse the sensitivity of the Maldivian economy to climate conditions. We consider four important sectors that are intensively vulnerable to regional climate: (i) Agriculture & Fisheries, (ii) Energy & Water, (iii) Tourism, and (iv) Recreation & Transport. The average changes in the productivity of these sectors have been estimated through statistical functions of production response and their effects in the economy, which have been computed using a Computable General Equilibrium Model (CGEM).

The changes in productivity for the different economic sectors have been quantified through the estimation of production functions in a range of studies for several countries.[17] In this case, for the estimation of the productivity response to climate risks in Maldives, Added Value (AV) historical data from the World Bank were correlated with relevant historical climate information from the database of CRU International.[18] Figure 10 illustrates the relationship between sectoral growth (AV Growth %) and different climate variables, with Pearson correlation coefficients providing a measure of association.

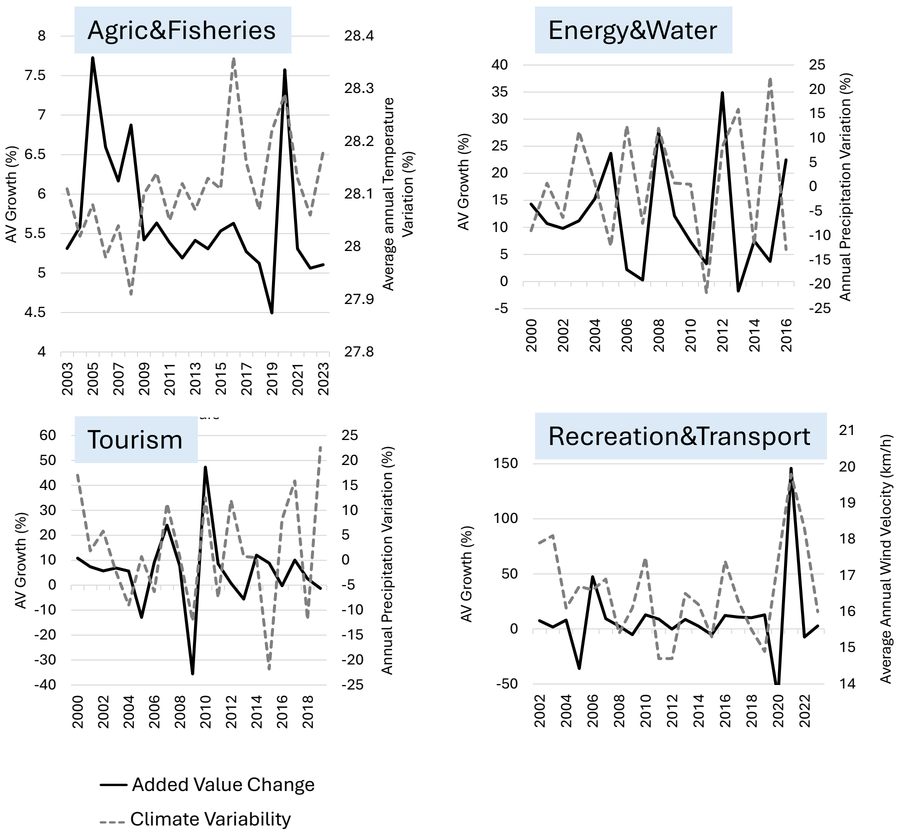


*Figure 10: Sectors' response to annual weather conditions.[19]*

(i) Agriculture & Fisheries: The sector shows a moderate positive correlation with temperature variations. Growth tends to increase when temperatures rise, although the relationship is not perfectly linear. There are periods of sharp fluctuations, suggesting that external shocks, such as extreme weather events or policy changes, may also influence sectoral performance.

(ii) Energy & Water: The correlation is near zero, indicating that precipitation has little direct impact on sector growth. Despite precipitation variability, electricity and water services exhibit distinct cycles of expansion and contraction, likely driven by infrastructure development and energy demand rather than climatic conditions.

[17] Quiroga and Iglesias 2009; Quiroga and Suárez 2016, Iglesias et al. 2012
[18] CRU Group: Home - CRU Group
[19] Own elaboration of economic specialist, Ms. ***.

(iii) Tourism: A moderate positive correlation suggests that tourism activity benefits from higher precipitation levels, possibly due to increased freshwater availability or ecosystem health. However, extreme variations in growth rates, including significant declines, point to the influence of other economic and environmental factors.

(iv) Recreation & Transport: The sector demonstrates a moderate positive correlation with wind velocity, suggesting that changes in wind conditions may affect transport efficiency and recreational activities. The sharp spike in growth around 2020-2021 aligns with an increase in wind velocity, though broader economic disruptions during this period should also be considered.

Table 5 shows the estimated elasticity response of sectors to climate. Elasticity measures the responsiveness of sectoral growth to changes in climate variables.[20] For example, the elasticity of 18.33 for Agriculture & Fisheries implies that a 1% increase in average annual temperature is associated with an 18.33% increase in sectoral growth, assuming a linear relationship. Similarly, the lower elasticity of 2.00 for Tourism suggests a less pronounced but still significant dependence on precipitation.

*Table 5: Added Value elasticity response to climate (LS based elasticities on log bases).*[21]

| Sector | Climate Variable | Pearson Correlation. | Estimated elasticity |
|---|---|---|---|
| Agriculture & Fisheries | Annual Average Temperature | 0.43 | 18.3 |
| Electricity & Water | Annual Total Precipitation | -0.05 | 3.0 |
| Tourism | Annual Total Precipitation | 0.31 | 2.0 |
| Recreation & Transport | Annual Average Wind Velocity | 0.39 | 6.0 |

## 5.5 Disaster losses due to climate-related hazards

Disasters in Maldives are of important magnitude and occur with relatively high frequency. Having solid, evidence-based information is crucial to improving disaster management and reducing negative impacts. The data on disaster impacts on people and properties reported by the Emergency Events Database (EM-DAT)[22] were used to estimate disasters related damages. Figure 11 shows the number of people affected by disasters in Maldives from 1975 to 2024.

[20] $E = \frac{\%\ \Delta\ Sector\ Growth}{\%\ \Delta\ Climate\ Variable}$

[21] Own elaboration of economic specialist, Ms. ***.

[22] EM-DAT - The international disaster database

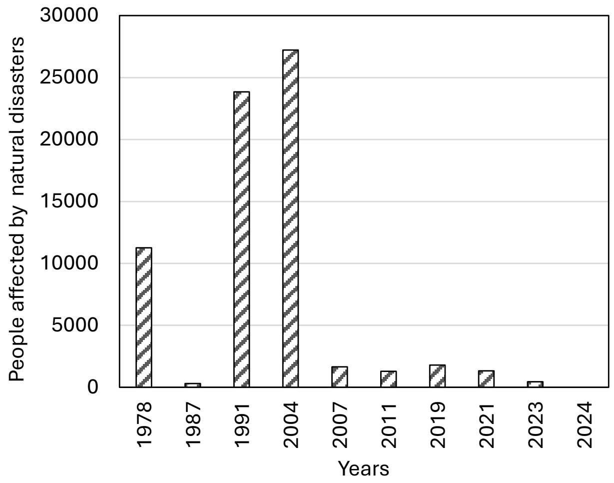


*Figure 11: People affected by disasters in Maldives (1975-2024).[23]*

To note is that the number of affected people and the monetary value of damages caused by disasters at the household or community level is not always available. The ratio of damages per affected people from the reported data has been used as proxy for the disaster events for which more specific data on damages is not available. To estimate the damages that can potentially be averted by enhancing CIEWS in Maldives, a Loss Reduction Ratio (LRR) has been applied. The analysis uses a LRR of 0.36, which is the average of estimated loss reduction recorded during the stakeholder consultation process. The LRR used in the analysis also falls in the range supported by studies around the globe as a parameter in Socioeconomic Benefits (SEB) analysis.[24]

[23] EM-DAT
[24] Examples: According to WMO (2015), World Bank considers 0.2-0.6 as a common range in a number of studies; Abramovitz (2001) reports 0.13; UNEP guidelines for reducing flood losses suggest 0.35)

# 6. BENEFIT-COST ANALYSIS

## 6.1 Net Present Value and Benefit-Cost Ratio

A Benefit-Cost Analysis (BCA) compares the total quantifiable benefits and costs in each year of the project's life and derives present value of net benefits by using a discount factor.[25,26,27] The most widely used indicators of project evaluation are Net Present Value (NPV) and Benefit-Cost Ratio (BCR).

The NPV can be obtained as follows: NPV = ∑ {BN/(1 + r)^N. In this equation, BN is the net cash flow/net benefits during the year(s) being considered, r is the discount factor, and N is the number of years considered for the evaluation of the project.

The BCR is the ratio of the discounted benefits to the discounted costs. Each approach uses the same benefit and cost information but summarizes them differently. Generally, a project increases societal welfare when the NPV is greater than zero and the BCR is greater than 1.

## 6.2 Discount rate and time period

Different analysts, countries, and agencies have different views on the correct discount rate to use for the BCAs. A 2007 survey studied discount rates used for public projects around the world and found rates from 2 percent to 15 percent, with lower rates more common in developed countries and higher rates more common in developing countries.[28] Analyses conducted for multilateral development banks (*e.g.*, World Bank) tend to use discount rates in a higher range. The World Bank provides discount rate guidance in its *Handbook on Economic Analysis of Investment Operations*,[29] noting that it has traditionally applied discount rates in the 10–12 percent range.[30] For purposes of our analysis, we use a 6 percent rate of discount and then conduct sensitivity analysis using a lower bound of 3 percent and an upper bound of 12 percent.

We have chosen a 20-year analysis period to develop the aggregated Socioeconomic Benefits (SEB) estimates. With a high discount rate (*i.e.*, 12 percent), benefits that will occur in more 20 years have a minimal present value; therefore, truncating the analysis after 20 years is not likely to have a significant impact on project decisions. The maximum effectiveness rate of the plan is not achieved in a linear trend, but a path of accumulating improvements has been defined based on stakeholders' perception of the modernization scenarios proposed.

## 6.3 Values for economic analysis

Figure 12 illustrates the distribution of potential gains related to the TRACT project's implementation, breaking down the total effect into direct losses, unblocked productivity, and end users' potential gains benchmarking. Direct losses represent the largest share, highlighting the immediate financial and infrastructural damage caused by extreme weather events, rising sea levels, and disruptions in key sectors such as fisheries and tourism. Unblocked productivity accounts for a significant portion, suggesting that economic inefficiencies and lost opportunities due to climate-related disruptions play a major role in overall resilience challenges. General public benchmarking, while the smallest component, reflects broader societal impacts, including the effectiveness of preparedness measures, adaptation strategies, and institutional responses. This distribution aligns with concerns described in previous sections regarding increasing disaster costs, the need for improved early warning systems, and the importance of strengthening institutional coordination to mitigate long-term economic vulnerabilities.

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[25] Beier, G. 1990. "Economic Analysis in Project Appraisal." Discussion Paper, WB, Washington DC.
[26] Chapman, R. 1992. Benefit-Cost Analysis for the Modernization and Associated Restructuring of the National Weather Service. Washington, DC: National Institute of Standards and Technology, United States Department of Commerce.
[27] Adler, M. D., and E. A. Posner, eds. 2001. Cost-Benefit Analysis: Legal, Economic, and Philosophical Perspectives. Chicago: University of Chicago Press.
[28] Zhuang et al. (2007). Theory and practice in the choice of social discount rate for cost-benefit analysis: A survey.
[29] Belli P, Anderson JR, Barnum HN, Dixon JA, Tan JP (2001) Economic analysis of investment operations. World Bank Institute. In Internet: http://documents1.worldbank.org/curated/en/792771468323717830/pdf/298210REPLACEMENT.pdf
[30] WMO (2015). Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services. In Internet: https://library.wmo.int/doc_num.php?explnum_id=3314.

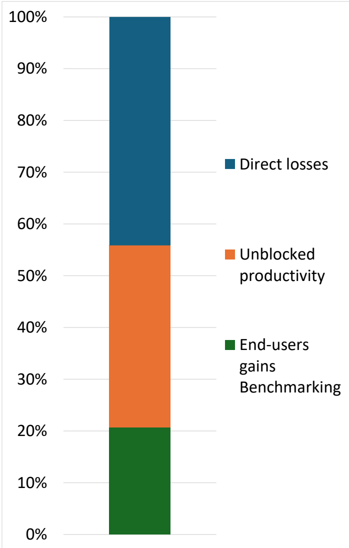


*Figure 12: Distribution of potential gains through the enhancement and use of Climate Information and Early Warning Systems.*[31]

Annualized values for the budgeted actions in each component have been considered for the BCA. A detailed description of the actions and associated costs can be found in the project description. Operation and maintenance (O&M) costs of 15% have been added after the project ends (*i.e.*, after year 5).

## 6.4 Baseline economic analysis

Table 8 presents the BCA of the project implementation, evaluated at three different discount rates (3.0%, 6.0%, and 12.0%). The project maintains a highly positive NPV across all discount rates, with an NPV of 891.53 million USD at a 3% discount rate, decreasing to 322.96 million USD at a 12% discount rate. The BCR, which measures the efficiency of the investment, remains well above 1 in all cases, ranging from 26.12 at 3% to 10.27 at 12% discount rates, demonstrating strong economic viability. These results indicate that the project is highly beneficial, with returns that significantly outweigh costs, even under conservative assumptions. However, the decreasing benefits at higher discount rates suggest that much of the value is derived from long-term resilience and productivity gains, reinforcing the importance of sustained investment in climate adaptation and disaster preparedness.

*Table 6: Net Present Value of Benefits and Costs for implementing TRACT project in Maldives (actualized 20 years).*[32]

| **Discount rate (%)** | **3.0** | **6.0** | **12.0** |
|---|---|---|---|
| **Present Value of Costs** | | | |
| Implementation Costs | 25.00 | 25.00 | 25.00 |
| O&M Costs | 10.49 | 10.15 | 9.86 |
| Total costs | 35.48 | 35.15 | 34.86 |
| **Present Value of Benefits** | | | |
| Potential direct gains (Improved DRM) | 409.10 | 290.42 | 157.91 |
| Unblocked economic productivity (Fisheries, Energy, Tourism & Recreation, Transport) | 326.38 | 231.70 | 125.98 |
| Benchmarking impacts (end users improved decision making) | 191.54 | 135.98 | 73.93 |

[31] Own elaboration of economic specialist, Ms. ***.
[32] Own elaboration of economic specialist, Ms. ***.

| | | | |
|---|---|---|---|
| Total benefits | 927.02 | 658.09 | 357.81 |
| **Net Present Value** | | | |
| NPV | 891.53 | 622.94 | 322.96 |
| BCR | 26.12 | 18.72 | 10.27 |

Figure 13 illustrates the cumulative discounted (6% discount rate) benefits, costs, and NPV of the project over a 20-year period (2026 to 2045). The cumulative discounted benefits, represented by the blue-striped bars, show a steady increase over time, reflecting the long-term economic gains generated by improved disaster risk management, enhanced productivity in key sectors, and better decision-making among end users. In contrast, the cumulative discounted costs, shown in red, remain relatively low and stable throughout the timeline, indicating that implementation and operational expenditures are significantly outweighed by the accrued benefits. The black line, representing NPV, follows an upward trajectory, surpassing zero within the early years of the project and continuing to rise, reaching approximately 700 million USD by 2045. This trend underscores the project's strong economic viability, demonstrating that the benefits continue to grow well beyond the initial investment, reinforcing its value in enhancing resilience and economic stability in the Maldives.

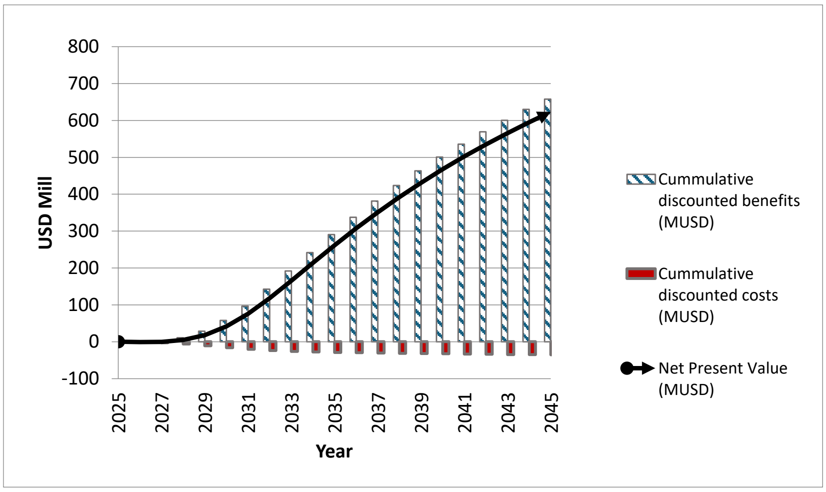


*Figure 13: BCA results for 6% discount rate and 20 years' time horizon for the TRACT project implementation (million USD).*[33]

## 6.5 Sensitivity analysis

The sensitivity analysis assesses how variations in key parameters influence the project's viability. Figure 14 illustrates the impact of different discount rates and adjustments in estimated benefits and costs. As expected, the baseline NPV decreases as the discount rate rises, reflecting the diminishing present value of future benefits. In a more conservative scenario, where benefits decrease by 20% and costs increase by 20% (red dashed line), the NPV remains positive but is significantly lower across all discount rates. Conversely, in the optimistic scenario with a 20% increase in benefits and a 20% reduction in costs (green dashed line), the NPV remains substantially higher, reinforcing the project's robustness. While all cases suggest a net economic gain, the divergence in results highlights the importance of accurate benefit estimations and cost management to sustain long-term project feasibility.

[33] Own elaboration of economic specialist, Ms. ***.

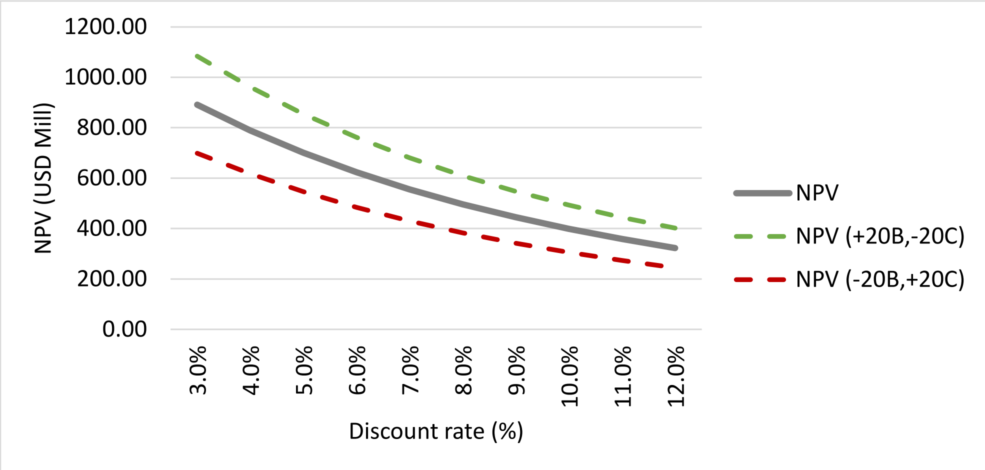


*Figure 14: NPV sensitivity analysis to discount rate.[34]*

## 6.6 Benefit to cost ratio

BCR values were estimated for the modernization of the hydrometeorological network in Maldives. Figure 15 shows the estimated BCR for a range of discount rates. BCR is the level of investment profitability; therefore, the optimal scenario is the one with the highest return on investment. The graph shows that for each 1 USD invested in the enhancement of the hydrometeorological network, the gains range between 10 to 26 USD, making it a highly profitable investment even at the lowest range of benefit.

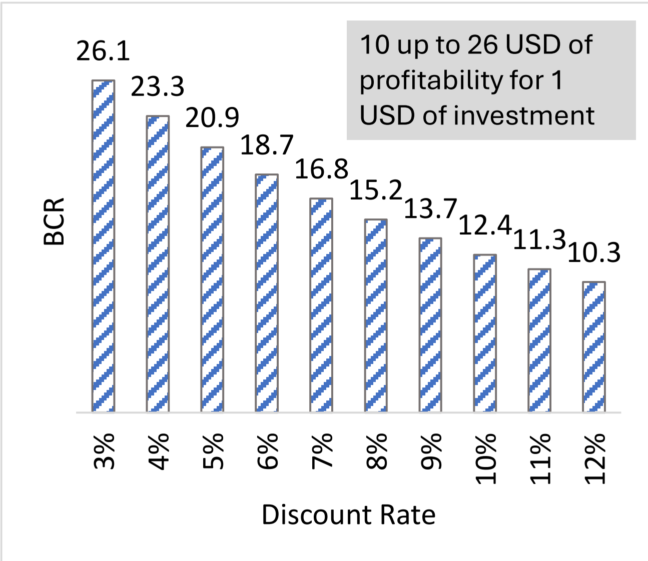


*Figure 15: Estimated Benefit-Cost Ratio (BCR) for the TRACT project implementation.[35]*

## 6.7 Other considerations and limitations

The analysis shows that the contribution of the TRACT project to Maldives's socioeconomic development is expected to be very high, particularly due to the potential benefits of Climate Information and Early Warning Systems (CIEWS) to improve the disasters risk management. The estimates presented in this study can be considered conservative mainly for the following reasons:

- this study has not considered the numbers of deaths from an economic perspective, and
- the potential growth of the GDP has been considered only for the most impacted sectors, in the lower bound of other BCA analysis.

[34] Own elaboration of economic specialist, Ms. ***.
[35] Own elaboration of economic specialist, Ms. ***.

Several potential omissions, biases, and uncertainties are noted in the current analysis given the limited resources, time, and information about the project. Specifically, it is noted that reliable information on the effectiveness rate for the selected scenarios was not available at the time of this analysis, and it was calibrated through end users' perceptions. Being able to calibrate the model with perceptions about the proposed specific actions would be important to assess the relationship with the end-users and the effectiveness of the measures.

Although they are of great importance, nonmarketable co-benefits – such as potential reduction in deaths, health improvement or environmental impacts – are not considered here. Since measures like Statistical Value of Life (SVL) are controversial we have opted to not include the economic value of avoided deaths in the study. All these limitations are expected to increase the potential benefits of the project; the current report is a conservative analysis and can be seen as a lower bound for the real benefits of the TRACT project.

## 7. CONCLUSIONS

The evaluation of the proposed project indicates that it has the potential to generate significant socio-economic benefits for Maldives by enhancing disaster risk management, improving early warning systems, and strengthening climate resilience across key sectors. The proposed interventions align with national priorities and global initiatives aimed at strengthening climate adaptation and disaster preparedness. The enhancement of Multi-Hazard Early Warning Systems (MHEWS) is expected to support national development objectives by reducing vulnerabilities and increasing preparedness for climate-related hazards. Furthermore, the project's focus on end-user engagement and sector-specific climate services responds to the needs identified by stakeholders.

The project's anticipated benefits include increased economic productivity through better risk management and decision-making. If successfully implemented, it could mitigate economic disruptions and losses in highly vulnerable sectors. However, the effectiveness of the project will rely on ensuring the accessibility and usability of climate services, particularly for local communities and vulnerable populations. Coordination among national institutions and relevant agencies will be essential to maximize impact and avoid inefficiencies in service delivery. The project is expected to contribute to national resilience by improving disaster preparedness and response mechanisms, which could lead to a reduction in economic losses from extreme weather events. Key sectors such as fisheries, tourism, transport, and agriculture may experience productivity gains due to more reliable climate information and forecasting.

The benefit-cost analysis suggests that the project could achieve high returns on investments. The estimated Net Present Value (NPV) ranges from USD 891.53 million (3% discount rate) to USD 322.96 million (12% discount rate), with a Benefit-Cost Ratio (BCR) between 26.12 and 10.27, demonstrating strong economic feasibility. Ensuring the optimal allocation of resources and maintaining cost-effectiveness in project execution will be necessary to achieve the anticipated benefits.

The long-term viability of the project will depend on effective implementation, sustained institutional collaboration, continued investment in hydrometeorological infrastructure and capacity-building initiatives, as well as the integration of climate services into national development strategies. Building technical capacity and investing in modern hydrometeorological infrastructure will be crucial for maintaining the quality and reliability of MHEWS over time. Furthermore, fostering public trust and awareness regarding climate services will enhance the project's sustainability by ensuring that end-users effectively utilize the improved information systems.

## APPENDIX 1 – SURVEYS

### Questionnaire for Sectoral Impact Survey (distributed to all the participants to discuss in groups)

*The intention is to provide a link via email to the questionnaire in the guise of a Google Forms document, whereby all of the responses will automatically populate an Excel spreadsheet, allowing easy access to the data for analysis. Questionnaires could be also distributed in paper to allow notes taking in the discussions.*

**Objective**: Develop an estimated order of magnitude about the stakeholders needs and the expected impacts of the TRACT project, focused on the potential improvements derived from EWS.

Name and position ______________________________________________________________

Which department are you from? __________________________________________________

What are your routine roles? ________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

**Hydromet information**

1.1. How do you use hydrometeorological information in your routine works (daily operation)?

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

1.2. Do you use hydromet information for warning purpose? If so, what parameters (e.g. rainfall, temperature, water level, etc.) do you use? Do you know the threshold of these parameters for alerting or for declaring emergency situations?

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

1.3. How do you use hydromet information in your long-termed planning?

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

1.4. Could you offer a subjective evaluation of the early warning information quality in your perception? (from 0 to 10)

________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________

**Socio-economic benefit analysis**

2.1 How does weather/climate/water impact your sector (e.g. agricultural productivity, health expenses in relation with weather/climate/water driven illness such as respiratory diseases and diarrheal, tourism total incomes, losses and deaths due to disasters, etc.)?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2.2 Would you say that your business is impacted by a:

i. 1-10%
ii. 10-20%
iii. 20-30%
iv. More than 30%

______________________________________________________________________________
__________________________________________________

2.3 During the last six months, approximately how many times (if any) did you contact hydromet staff to discuss forecast and/or warning information?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

## Questionnaire for Benchmarking potential socio-economic impacts of the TRACT Project in Maldives (distributed to all the participants to be reflected individually).

*The intention is to provide a link via email to the questionnaire in the guise of a Google Forms document, whereby all of the responses will automatically populate an Excel spreadsheet, allowing easy access to the data for analysis. However, depending of the respondents needs questionnaires could be also distributed in paper.*

**Objective**: Develop an estimated order of magnitude about the benefits of the TRACT project, focused on the potential capacity to improve Early Warning Systems in Maldives.

**Step 1: Subjective evaluation of vulnerability of the country to impacts related to water/weather/climate**

Indicate bellow your personal evaluation of vulnerability (from 1 to 5)

Less vulnerable                                                                                   More vulnerable

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Please, provide a comment about the selected ratio:

| |
|---|
| |

**Step 2: Personal perception of annual average damages related to National Income (Gross Domestic Product)**

Gross Domestic Product in Maldives in 2023 according World Bank statistics is about 6.6 USD Billion. This is the total monetary value for the whole goods and services produced in the country in one year.

Based on your evaluation in Step 1 about vulnerability of the region to water/weather/climate, provide a perceived estimation of annual average value of damages in the country with respect to the National Income (Gross Domestic Product) as bellow:

1: 0.2% of GDP (0.002)

2: 0.4% of GDP (0.004)

3: 0.6% of GDP (0.006)

4: 0.8% of GDP (0.008)

5: 1% of GDP (0.010)

| | | | | |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

Please, provide a comment about the damages considered in your selection:

| |
|---|
| |

**Step 3: Evaluate the quality of Early Warning System products in Maldives.**

In the scale bellow, please indicate the perceived quality for the information provided in your domain. (0 the lower, and 10 the highest)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Please, provide a comment about the selected quality and how may improve in your opinion:

| |
|---|
| |

**Step 4: Assign a reduction ratio for damages or losses.**

Now think on how much damages may be reduced in average because of the TRACT Project Implementation. That is, because of improvements in the end-users decisions based on improved Early Warning Systems. We will refer that as the Loss Reduction Ratio (LRR).

Selecting a LRR you should consider the ability of population, firms, public administrations, such as emergency services to respond when having improved information. For example, if the losses are mainly based on buildings and infrastructures, the Loss reduction ratio should be low. If the opposite occurs, and so losses mainly affect human losses, crops or livestock, the potential for reducing the losses should be high.

Please, indicate your subjective estimation of which percentage of losses or damages may be reduced because of TRACT Project Implementation:

LRR (Loss Reduction Ratio):________________%

Please, provide a comment about the reasons for selecting that ratio:

| |
|---|
| |

# APPENDIX 2 – STAKEHOLDERS CONSULTED

## Consultation for the benchmarking exercise

| | Name | Gender | Designation | Organisation | Email Address | Attended |
|---|---|---|---|---|---|---|
| 1 | ***The content of this document has been redacted in accordance with the GCF Information Disclosure Policy, as names and contact details are confidential under the disclosure policy of the Accredited Entity.*** | Female | Fisheries Officer | Ministry of Fisheries and Ocean Resources | ***The content of this document has been redacted in accordance with the GCF Information Disclosure Policy, as names and contact details are confidential under the disclosure policy of the Accredited Entity.*** | Yes |
| 2 | | Male | Senior Environmental Officer | Maldives Civil Aviation Authority | | Yes |
| 3 | | Male | Assistant Meteorologist | Maldives Meteorological Service | | Yes |
| 4 | | Male | Seismologist | Maldives Meteorological Service | | Yes |
| 5 | | Male | Field Officer | Ministry of Agriculture and Animal Welfare | | Yes |
| 6 | | Male | Research Engineer | Maldives Water and Sewerage Company | | Yes |
| 7 | | Female | Public Health Coordinator | Health Protection Agency | | No |
| 8 | | Female | Public Health Coordinator | Health Protection Agency | | No |
| 9 | | Male | Environment Officer | Ministry of Tourism and Environment | | Yes |
| 10 | | Female | Head of Department of Business and Marketing | Maldives National University | | Yes |
| 11 | | Male | Councillor | Male' City Council | | No |
| 12 | | Female | Councillor | Male' City Council | | No |
| 13 | | Male | Engineering Manager | Maldives Transport and Contracting Company | | No |
| 14 | | Female | Engineer | Ministry of Construction, Housing and Infrastructure | | Yes |
| 15 | | Male | Deputy Minister | Ministry of Cities, Local Government and Public Works | | Yes |
| 16 | | Male | Director | Maldives Space Research Organisation | | Yes |
| 17 | | Male | President | Maldives Marine Journal | | No |

*Percentage of female participants: 35.3%*

## One-on-one consultations

| | Name | Gender | Designation | Organisation | Email Address |
|---|---|---|---|---|---|
| 1 | ***The content of this document has been redacted in accordance with the GCF Information Disclosure Policy, as names and contact details are confidential under the disclosure policy of the Accredited Entity.*** | Male | Head of Technology and RAN | Dhiraagu | ***The content of this document has been redacted in accordance with the GCF Information Disclosure Policy, as names and contact details are confidential under the disclosure policy of the Accredited Entity.*** |
| 2 | | Male | Manager - Products & Presales | Ooredoo | |
| 3 | | Female | Senior Executive Corp & Govt | Ooredoo | |
| 4 | | Female | Policy Manager | National Disaster Management Authority | |
| 5 | | Male | Manager, Programmes & Service | Maldives Red Crescent | |
| 6 | | Male | Assistant Meteorologist | Maldives Meteorological Service | |
| 7 | | Male | Seismologist | Maldives Meteorological Service | |
| 8 | | Male | | Maldives Meteorological Service | |

*Percentage of female participants: 25 %*