



The contribution of the National Meteorological Service to the economy and society of Belize

Statements

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About this report and funding

This report provides an indicative socioeconomic benefit analysis of the National Meteorological Service of Belize (NMSB). It has been undertaken in response to the NMSB's request for an independent study to assess the value of its service for the economy and society of Belize. This study has been funded by the Met Office and the UK Voluntary Cooperation Programme (VCP). Completing this report was made possible through the collaboration of the NMSB, and from the WMO for sharing collected evidence on socioeconomic benefit case studies related to weather, climate and water services.

About the authors

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Disclaimer

This report was completed following a 14-day visit of the research team to Belize. The analysis is therefore based on a short visit to deliver benefit analyses in a timely and cost-effective manner and may therefore not reflect the full depth and scale of data gathering or stakeholder engagement that a larger project would allow.

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Executive summary

This report provides an economic benefit analysis and social impact assessment of the National Meteorological Service of Belize (NMSB, conducted collaboratively by the Met Office (UK) and London Economics during a 14-day visit to the country in October 2024. It was funded by the UK's contribution to the UK Voluntary Cooperation Programme (VCP) and the Met Office. The focus for both these programmes is to work in partnership with meteorological services globally to support sustainable financing for early warning services.

Belize is particularly vulnerable to climate-related impacts due to its geographic location and economic conditions¹ such as the economic reliance on natural resources the viability of which are threatened by the changing climate (UNDP, 2009). Belize is facing frequent and intense weather events, including hurricanes, flooding and droughts² (CCKP, 2021). The impacts of these already place significant economic and social pressures on the nation, a trend that can be expected to continue in the future. Therefore, **effective meteorological services can play a key mitigating role.**

The analysis shows the substantial value of the NMSB, indicating that for every dollar invested, Belize realises an estimated range of \$3.30 to \$6.80 in economic and social benefits, which currently equates to \$5.7 - \$11.8 million p.a. for Belize. Evidence suggests that these benefits could potentially be higher, with a plausible range extending to as far as \$11.00 in social and economic benefits for every Belizean Dollar invested into the NMSB. These benefits are primarily realised from improved weather forecasting, early warnings and aviation services. These services help to mitigate the impacts of severe weather and climate by protecting lives and supporting key stakeholders across sectors such as agriculture, tourism and transport in their ability to respond.

This report provides evidence that, through timely weather information and services, the NMSB enhances national resilience and strengthens Belize's ability to respond proactively to climate challenges. Therefore, investments in meteorological services contribute to safeguarding the economic and social stability of Belize and provide a high return on investment that supports sustainable development and disaster resilience, as discussed in the section on investment needs of this report.

This report also summarises views from stakeholders across the Belizean economy around current performance and how the service could evolve and considers the risks and challenges associated with inadequate investment in meteorological services.

“Weather and climate information is a very important part of planning”

Department of Civil Aviation

¹ Richardson Robert B, Belize and Climate Change: The Costs of Inaction (Michigan, United Nations Development Programme (UNDP), 2009)









² Climate Change Knowledge Portal, Belize Vulnerability (World Bank, Climate Change Knowledge Portal (CCKP), 2021)

³ World Bank, Resilience and Conservation in a Changing Climate: The Case of Belize (World Bank Group, 2021); World Bank, Belize Prepares for current and future emergencies (World Bank Group, 2023)

⁴ Belize's First Biennial Update Report: To the United Nations Framework Convention on Climate Change (Belmopan, National Climate Change Office, 2020)

History of the National Meteorological Service of Belize

The National Meteorological Service of Belize (NMSB) is the authoritative institution in Belize on weather and climate, providing vital services that protect lives and livelihoods and support national safety, economic stability and sustainable development. Its origins trace back to 1887⁵, when meteorological observations in Belize began. Official weather observations commenced in the early 20th century, when the U.S. Weather Service established a station in Belize City as part of a Caribbean network. This station remains in operation today at Philip Goldson International Airport, where the NMSB's headquarters are located.

1887 First meteorological observations are recorded in Belize 	1967 First radio broadcasts of local weather forecasts by the Belize Weather Bureau 
1905 Official weather observations in Belize carried out by the US Weather Service 	1972 The National Meteorological Service of Belize (NMSB) is established 
1951 Caribbean Meteorological Organisation is Established 	1978 NMSB take over the upper air and marine forecasting centre from UK & US 
1966 First trained Meteorological Officer is appointed to Belize 	1981 Independence of Belize results in nationally recognised and autonomous NMSB 

Today, the NMSB operates with just 32 members of staff, including meteorologists, forecasters, technicians and support staff, who ensure that Belize receives accurate and timely meteorological information.



National Meteorological Service of Belize

⁵ NMSB History – National Meteorological Service, (National Meteorological Service of Belize, 2024).

URL: [History | National Meteorological Service of Belize](https://www.nmsb.gov.bz/history)

Services provided by NMSB

The NMSB provides a wide range of services across most sectors of Belizean society and to international partners. The NMSB is proactive in responding to the needs of multiple government sectors. Given this, **an official mandate is yet to be established which correctly reflects their national contribution**. There are also regular requests for additional services and the NMSB endeavour to respond to these requests.

Table 1 illustrates the range of services. Additionally, the NMSB plays a critical role in providing climate data and scientific guidance to government related to climate change. As such, the NMSB is the focal point for the Intergovernmental Panel on Climate Change (IPCC) in Belize. Through the National Climate Change Office (NCCO), the NMSB also provides annual support to the Conference of the Parties (COP) reports.

	Now	Days	Months
Aviation	Coded weather observations and landing forecasts for aviation	Coded, graphical and script forecasts	
Tourism		Daily general forecast, Sargassum Impact Forecasts, tropical cyclone warnings, severe weather alerts	
Agriculture	Observations of rainfall, temperature, humidity, soil moisture, etc	Tailored 4-day forecasts	National Climate Outlook Forum, agromet bulletin, drought forecast, monthly and seasonal rainfall and temperature forecasts, training for agricultural extension officers
Disaster Management (NEMO, CEMO, Fire Service, etc)	Severe weather alerts	Tailored tropical cyclone warning service for emergency planners. Severe weather alerts (Heat/Excessive Rainfall/Strong Thunderstorms/Strong Winds)	National Climate Outlook Forum, identifying specific risks for emergency planners
Public	WMO-compliant observations, monthly rainfall and temperature summary, live observation data via app, observation data requests, severe weather alerts	Daily general weather forecast out to 2 days, updated 3 times per day, 4-Day forecasts issued once per day, daily municipal forecast.	Monthly and seasonal rainfall and temperature forecasts, National Climate Outlook Forum, rainfall and temperature for health sector

Table 1: Services Provided by NMSB

Severe weather and climate risks for Belize

The World Bank estimates that the number of Belizeans affected by weather and climate is significant, impacting over 60,000 citizens on average for several events in the past. More recently this figure has reached more than 170,000 individuals, as seen with Hurricane Lisa in 2022 - more than 40% of the entire population were therefore directly impacted by severe weather and climate change⁸.

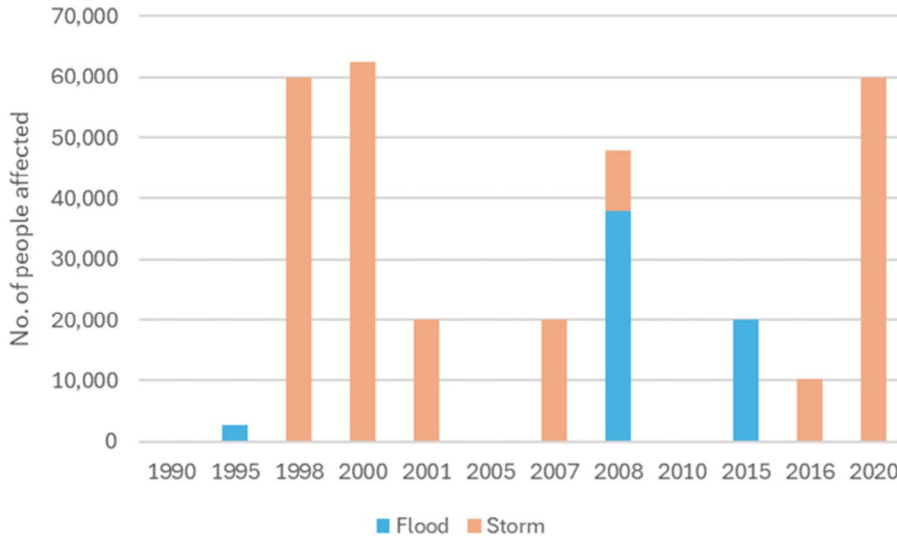


Figure 1: Belizeans affected by natural disasters 1990 to 2020⁸

As noted by the International Monetary Fund in 2018⁶, Belize is one of the countries in the world that is most at risk, both economically and socially, from the impacts of severe weather and climate.

“A bad hurricane can already knock back the economy 5 to 10 years almost instantly”

Ministry of Economic Development



EXPOSURE

Among small states, Belize ranks 3rd at risk for natural disasters, and 5th at risk from climate change⁶



ECONOMIC LOSS

Belize’s annual average loss from floods and strong winds averages just under BZD \$246 million, or 7 percent of GDP⁶



FUTURE RISK

It is predicted that climate change and weather hazards will result in a loss of 75–100 percent of GDP for Belize by 2100⁶

Figure 2: Belize at risk to weather and climate

Severe weather and climate risks for Belize

Climate change is already affecting Belize⁶ in significant ways. The value of losses from severe weather events is at least 7% of GDP today, set to increase year by year. Over 40% of the population of Belize is already at risk to severe weather and climate change, and this number is projected to grow as events increase in magnitude⁶.

Recent weather and climate related disasters illustrate the economic risk that Belize faces:

- the **2019 drought led to a \$50 million loss in crop value** due to a 30% reduction in cane yields and widespread crop failures across 25,000 acres of corn, pushing Belize into recession, causing constraints in food security and to exports of agricultural produce⁷;
- in **2022, Hurricane Lisa inflicted an estimated \$200 million in damages**, with 500 homes destroyed, city-wide power outages, and 172,000 people affected, including over 5,000 who sought emergency shelter. This hurricane disrupted housing, infrastructure, health services, energy and water access, underscoring the extensive social and economic vulnerabilities Belize faces from climate-related events⁸; and
- in **2024, wildfires caused an estimated \$8 million in damages**, with over 250 houses destroyed and 10,000 acres of farmland lost.

These cases **emphasise the critical role a resilient meteorological service can play in mitigating such impacts and supporting Belize's capacity to prepare for and respond to future events**. Stakeholders across the economy provided evidence of the NMSB's current impacts:

- during past floods, the information provided by the NMSB enabled Belize Water Service Limited (BWSL) to make decisions mitigating risks to the general public such as in preventing wastewater overflows onto the streets, which can result in diseases being spread more widely across populations; and
- during droughts the seasonal forecasts provided by the NMSB have allowed BWSL to prepare by adapting operations to protect water sources and prepare water reserves¹⁰.

There is already strong awareness of weather and climate risks: 9 out of 10 stakeholders who participated in this study stated that they were currently already at risk from severe weather and climate change. **All participants stated that they expected weather and climate information to be an essential part of their operations in the future.** The Ministry of Finance stated that if risks remain unmitigated, there will be "implications on central government to provide financial assistance"¹¹.

⁶ IMF, Belize, Climate Change Policy Assessment (International Monetary Fund, Western Hemisphere Department, 16 Nov 2018)

⁷ CDEMA Caribbean Disaster Emergency Management Agency (2024) URL: <https://www.cdema.org/images/2024/05/CDEMA%20Sitrep%201-Belize%20Wild%20Fires.pdf> | Date Accessed: 07/10/2024

⁸ National Hurricane Center Tropical Cyclone Report (2022) URL: [Hurricane Lisa \(noaa.gov\)](https://www.nhc.noaa.gov/archive/2022/2022092601.shtml) | Date Accessed 07/10/2024

⁹ Central Bank of Belize (2019). URL: [ICG Pres\(Letter\) \(centralbank.org.bz\)](https://www.centralbank.org.bz/press-releases/2019/07/10/drought-costs-farmers-50-million-gob-declares-state-of-emergency) | Date Accessed: 07/10/2024 – Source: The San Pedro Sun (2019). URL: [Drought costs Farmers \\$50 Million - GOB declares State of Emergency - The San Pedro Sun](https://www.sanpedrosun.com/news/drought-costs-farmers-50-million-gob-declares-state-of-emergency) | Date Accessed: 07/10/2024

¹⁰ From stakeholder engagement meeting with a representative from BWSL (02/10/24)

¹¹ From survey response from the Ministry of Finance

Literature evidence of the impacts of national met services

The economic literature provides compelling evidence of the substantial benefits that meteorological services bring to the economy and wider society. These studies provide evidence across different sectors highlighting the broad range of economic and social benefits enabled by meteorological services. The critical importance of meteorological services in improving decision-making, mitigating risks and enhancing operational efficiency is also well documented.

Many of these studies provide strong quantitative evidence on the magnitude of benefits, demonstrating sizeable socioeconomic returns on investments in meteorological services. Table 2 gives examples of such studies from economies either with a similar socioeconomic context or experiencing similar meteorological challenges to Belize:

Study	Geographic Location	Sectors	What was measured	Benefit-to-cost ratio
Benefits of Ethiopia's LEAP Drought Early-Warning and Response System (Law, 2012)	Ethiopia	Households	Quantification of avoided livelihood losses and decreased assistance costs	3:1 to 6:1
The Benefits to Mexican Agriculture of an El-Nino-southern oscillation (ENSO) Early Warning System (Adams et al., 2003)	Mexico	Agriculture	Change in social welfare based on increased crop production with use of improved information	2:1 to 9:1
Benefits and Costs of Improving Met-Hydro Services in Developing Countries (Hallegatte, 2012)	Emerging economies	National level and weather-sensitive sectors	Benefits-transfer approach to quantify avoided asset losses, lives saved, and total value added in weather-sensitive sectors	4:1 to 36:1
Social Economic Benefits of Enhanced Weather Services in Nepal – part of the Finnish Nepalese Project (Perrels, 2011)	Nepal	Agriculture, transport, and hydropower		10:1
Socio-Economic Study on Improved Hydro-Meteorological Services in the Kingdom of Bhutan (Pili-Sihvola et al., 2014)	Bhutan	National level	Benefits transfer, expert elicitation, cardinal rating method	3:1
Benefits of economic assessment of cyclone early warning systems - A case study on Cyclone Evan in Samoa (2019)	Samoa	Weather-dependent sectors, households	Quantification of avoided costs and productivity gains	6:1
A Strategic Roadmap for Advancing Multi-hazard Impact-based Early Warning Systems and Services in the Caribbean (2021)	Caribbean	Agriculture, Energy, Tourism, Transport,	Avoided fatalities	2:1 to 8.2:1
The Socio-Economic Benefits of the WISER Programme (2021)	Kenya Tanzania Uganda	Fishing Marine transport	Informant interviews and focus groups	16:1
The socio-economic benefits of the Wiser Programme (2019)	Ethiopia Djibouti Kenya Sudan South Sudan Somalia	Weather-dependent sectors	Co-benefits: Increase in skill due to the use of indirect forecast modelling and calibration	14:1

Table 2: Examples of socioeconomic benefit studies of meteorological services

Overall benefits to economy and society

The analysis undertaken for this study estimates the current socioeconomic benefits of the National Meteorological Service of Belize to be in the range of between \$5.7 million and \$11.8 million annually (central estimate).

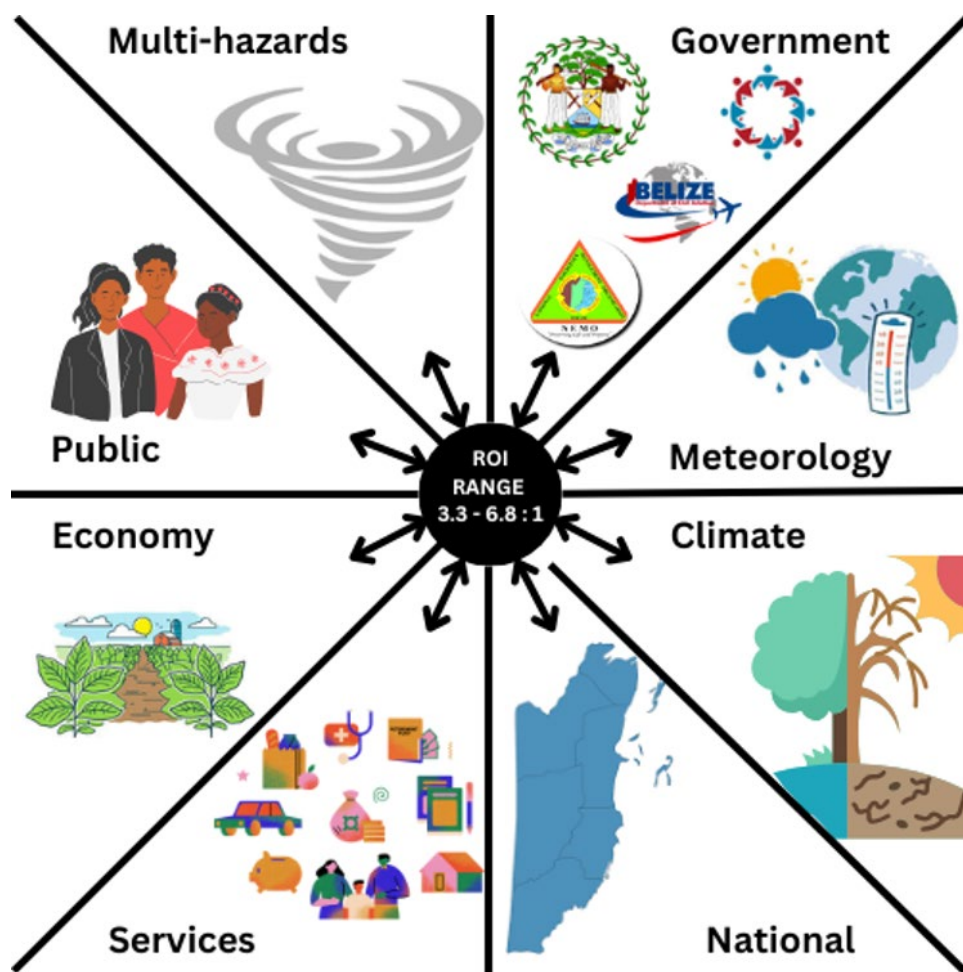


Figure 3: Range of the ROI in NMSB to key areas of impact

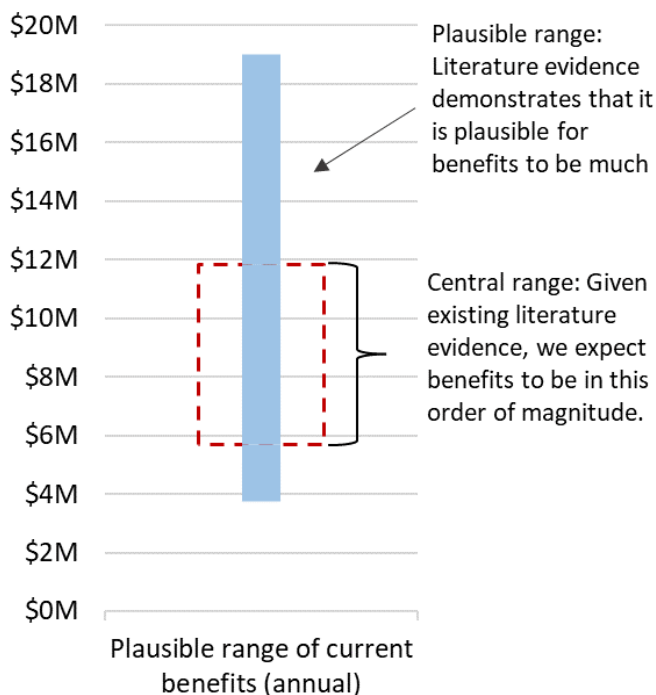
Figure 3 illustrates the key areas of impact for the the central estimate of the benefit to cost ratio of the National Meteorological Service of Belize. These include economic contributions, public benefits, loss prevention during multi-hazard events and support for various government departments. The areas of impact have been estimated with inputs from both stakeholder engagement and from existing literature.

This report used the literature to uncover the sectors and benefit streams associated with the value of the NMSB in the context of Belize. Public expenditure on the NMSB by the Government of Belize is currently estimated to be around \$1.7 (BZD) million per year between 2023/24 and 2025/26¹², it is worth noting that we consider these estimates to be conservative¹³.

This implies an expected return on investment of between \$3.3 to \$6.8 for every \$1 of public money invested into the NMSB, please see Figure 4 for more detail of this range and how it was estimated.

¹² Government of Belize, Approved estimates of revenue and expenditure for fiscal year 2023/2024 (Belmopan, Institute of National Statistics, 2023)

¹³ See Annex B on "Could the estimates be higher?"



Metric	Estimated benefits (annual, 2024/25)	Benefits : Costs ratio
Central range – lower estimate	\$5.7M	3.3
Central range – upper estimate	\$11.8M	6.8
Plausible range – lower estimate	\$3.7M	2.2
Plausible range – upper estimate	\$19.0M	11.0

Figure 4: Plausible range of socioeconomic benefits (annual, 2024/25)

Note: This assessment is a simple indicative assessment of the plausible magnitude of benefits of the NMSB. It is based on literature evidence from quantitative (economic and non-economic) socioeconomic benefit case studies related with weather, climate and water services from countries around the world. The central range represents the weighted median estimate of the lower and upper bounds of benefits to costs ratios from relevant studies. The plausible range represents the weighted 25th and 75th percentiles of benefits to costs ratios from relevant studies. Further details on the assessment approach are provided in Box 1.

London Economics analysis of 155 socioeconomic benefit case studies related to weather, climate and water.

Context for these estimates

While estimates at the upper end of the range may appear high, they need to be understood in the Belizean socioeconomic, climatic and geographical context:

- **Belize's economy heavily relies on tourism and its international airport. Agriculture, fisheries and marine also play an important part in providing livelihoods for many Belizeans particularly in rural communities.** Accurate and timely weather and climate information plays an important role for these sectors. This is evidenced by the consultation undertaken with sector representatives for this study, all of whom stressed the critical importance of the NMSB to their sector (see further discussion in Table 3 in the following section).
- **Additionally, Belize is vulnerable to severe weather events such as hurricanes, droughts and flooding (see figure 2).** One severe example, hurricane Keith, which struck in 2000, inflicted substantial damage to the Belizean economy, estimated at \$560 million - almost half (45.7%) of Belizean GDP at the time (ECLAC, 2000). While hurricane Keith is an extreme example, severe weather events remain a regular risk for Belize (See page 7). Accurate and timely weather predictions and early warnings are of critical importance to help manage disaster risks, mitigate economic damage where possible, and save lives.

Further, as shown in Table 2, other evaluation studies indicate that the benefits could potentially be even greater than the upper end of the plausible range provided in this study.

Benefits to different sectors of the economy

A well-resourced meteorological service directly leads to essential benefits to both economic, societal resilience and wellbeing in relation to the impacts of weather and climate (Table 2). Table 3 illustrates benefits of NMSB for key sectors, as was expressed by sector representatives during this research project. The evidence shows that by providing timely, accurate weather data and forecasts, the NMSB contributes to economic stability and sectoral resilience and stakeholders reported that the ability to forecast severe weather events helps protect the communities of Belize by providing early warnings, reducing the risk of casualties and damage to property.

“Weather and climate information is important because it affects the marine environment as well as the economic activities that are generated from the use of it”

Coastal Zone Management Authority & Institute (CZMAI)

“We depend on weather and climate information to make important decisions”

Belize City Emergency Management Organisation (CEMO)

Aviation	Safety	Real-time forecasts mitigate the risk of weather-related incidents and support safer takeoffs and landings.
	Efficiency gains and savings	Accurate forecasts help to optimise flight paths, reducing costs in fuel and delays.
	Compliance	Enables compliance with international standards, ensuring that the international airport can remain operable.
Agriculture	Production and Resource Management	Seasonal forecasts protect agricultural yields by enabling farmers to avoid planting or harvesting in unsuitable weather conditions.
	Loss avoidance	Reduces crop loss due to drought or flooding, protecting the agriculture sector from significant financial losses.
	Disaster Preparedness	Severe weather warnings allow agricultural workers to safeguard livestock, crops, and infrastructure from extreme weather, mitigating the consequences of severe weather.
City Planning & Infrastructure	Urban Resilience	Weather data informs city planners about areas prone to flooding or extreme heat, helping develop resilient urban spaces.
	Efficient Infrastructure Investment	Facilitates infrastructure investments, such as improving drainage in flood-prone areas, reducing future repair costs.
	Public Safety	Enhances public safety in the development of disaster centres for extreme weather reducing the risk to life associated with urban flooding.

Disaster Risk Management	Timely Warnings	Early warning systems are critical for evacuation and preparedness during severe weather events.
	Reduced Human and Economic Loss	Accurate, timely forecasts minimise casualties and damage of assets by enabling efficient response planning.
	Community Resilience	Supports long-term community resilience by enabling better preparedness, especially in vulnerable and flood-risk areas.
Energy Sector	Operational Efficiency	Weather forecasts protect key infrastructure and inform mitigation measures in minimising downtime and damage.
	Cost Savings	Accurate temperature and wind data support the energy sector's demand forecasts, optimising the management and use of resources.
Fisheries and Marine Sector	Worker Safety	Real-time marine weather reports provide safety for the fisheries and others in the marine sector, mitigating the risk to life.
	Sustainable Practices	Helps marine operators adjust practices based on weather patterns, protecting resources and ensuring long-term sustainability.
	Economic Stability	By mitigating the risk of fishing losses due to storms, NMSB forecasts support the economic resilience of the fisheries sector.
Health Services	Health Risk	Weather data can inform the health sector about potential increased risks in weather sensitive health risk, such as vector-borne diseases.
	Public Awareness	Enables health organizations to conduct public health campaigns during and after severe weather improving community resilience.
	Emergency Response	Supports timely responses and resource allocation in the event of weather and climate impacting health facilities or communities.
Tourism	Tourist Safety	Reliable forecasts allow for better planning and ensure the safety of tourists, especially during peak tourist seasons.
	Economic Stability	Prevents losses during severe weather by allowing operators to reschedule activities helping tourism to maintain operations.
	Climate Adaptation	Supports planning by helping resorts and facilities prepare for seasonal weather variations, and to reduce impacts on the changing climate, such as with the impacts of unsustainable tourism on reefs.
Transport and Logistics	Route Optimisation	Provides data that helps optimise transportation routes for safety and efficiency, especially during severe weather.
	Cost Reduction	Minimises delays and damage to goods in transit by providing early warnings of severe weather, mitigating losses in logistics.
	Increased Reliability	Enhances the reliability of all forms of transportation, benefiting trade supply chains as well as tourists and public commuters.
Water services	Water Resource Management	Drought and rainfall data support sustainable water supply management, helping BWS prepare for periods of high demand and/or periods of drought.
	Public Health	Live data on potential flooding allows for efficient wastewater management, mitigating the risks of contamination and waterborne diseases.
	Economic Savings	Prevents damage to infrastructure by allowing water services to adjust operations based on forecasts, reducing maintenance costs.

Table 3: NMSB sector-specific benefits

Stakeholder needs

The team consulted with users of the products and services offered by NMSB. Stakeholders consistently valued the work of the NMSB, highlighting its essential role in providing services tailored to their specific operational needs. However, they also emphasised the urgent need for the NMSB to expand its services and modernise its technology to better support in mitigating the challenges faced across the economy and society of Belize:

Organisation	Needs from NMSB
Department of Civil Aviation	<ul style="list-style-type: none"> ICAO Compliance and access to real time radar data Upgrades of human capacity, capabilities and technology to facilitate longer opening hours of the international airport
Belize Water Services Limited	<ul style="list-style-type: none"> Improved seasonal forecasts and accuracy Better communication of confidence in predictions to enhance long-term mitigation planning
Belize City Emergency Management Organisation	<ul style="list-style-type: none"> Consultation in the construction of levees, floodwalls and pump stations for managing floodwaters Educating residents about disaster preparedness and response to help build community resilience Develop and update emergency response plans to prepare for quick action during severe weather
Ministry of Economic Development	<ul style="list-style-type: none"> New project and development unit for economic impact assessments & seek funding from external bodies (e.g. IDB)
National Emergency Management Organisation	<ul style="list-style-type: none"> Live localised data and impact-based warnings to better understand potential impact of severe weather events Quantification/monetisation of events to understand the economic impacts of events NEMO responds to
Statistical Institute of Belize	<ul style="list-style-type: none"> More accessible data on severe weather and climate to improve statistical models. Impact-based forecasting so that the Statistical Institute of Belize can quantify those impacts
World Food Programme	<ul style="list-style-type: none"> Better understanding of weather and climate impacts on food security Better provision/information for vulnerable individuals and businesses that could mitigate some food insecurity risks
National Hydrological Service	<ul style="list-style-type: none"> Ability to quantify precipitation events and soil moisture and evapotranspiration measurements More stakeholder collaboration to advance climate, weather and water agendas
Inter-American Development Bank	<ul style="list-style-type: none"> Staff development and training for future resilience and viability of NMSB Requirement that DRR and climate change are included in policy and strategy based on services by NMSB
Ministry of Finance	<ul style="list-style-type: none"> Information to mitigate risks from severe weather/climate change, to reduce reliance on financial assistance from central government
FORTIS Belize	<ul style="list-style-type: none"> Incorporate weather/climate info into energy sector products for better decision making and long-term planning
Ministry of Tourism	<ul style="list-style-type: none"> Expand operations in newer technology such as satellite platforms Create more awareness in the tourism sector about climate and weather
Ministry of Agriculture	<ul style="list-style-type: none"> More information on weather and climate change & greater media presence Sector-specific training to understand the information

Table 4: Stakeholder demands and requirements

Investment needs

The World Meteorological Organization notes that a well-resourced and sustainably funded met service would allow for more accurate forecasts and tailored information¹⁴ that can be provided to meet the needs of users and stakeholders. To explore how this could be done in Belize, the team

- held an event with many sector representatives to reach consensus on the priority needs;
- conducted an online questionnaire, and;
- conducted an analysis of the current maturity of NMSB using the Country Hydromet Diagnostic (CHD)¹⁵ in October 2023 that identifies the priority areas of the services that require sustained capacity development. The CHD tool rates the maturity level of each of the 10 elements of a National Meteorological Service on a scale from 1 (low maturity) to 5 (high maturity). Table 5 summarises the scores for Belize.

Element	Maturity level score
Governance and institutional setting	2
Effective partnerships to improve service delivery	2.5
Observational infrastructure	3
Data and product sharing and policies	2
Numerical weather prediction model and forecasting tool application	3
Warning and advisory services	3
Contribution to climate services	3
Contribution to hydrology	1
Product dissemination and outreach	3
Use and national value of products and services	2

Table 5: Maturity level scores for Belize

The results of these three activities conclude that the priority areas for investment are:

- Stakeholder engagement, secure mandates and sustainable funding for services.
- Development and communication of products and services through media and other relevant channels.
- Introduce a cost recovery mechanism, including from aviation sector.
- Sustainable succession plan through an increase in human capacity, training and education opportunities.

Box 1: Results on the priority areas for investment

Risks from continued lack of investment

As set out throughout this report, a significant proportion of the economy of Belize is sensitive to weather and climate, with a great dependence on services from the NMSB. Lack of sustainable funding for NMSB, therefore, carries economic risk in and from all sectors.

An immediate and particular risk is to the operations of Philip S.W. Goldson International Airport. It is necessary for a country to be compliant with the International Civil Aviation Organisation (ICAO)¹⁶ to operate an international airport. Currently, the NMSB is unable to provide ICAO-compliant aviation services, posing a real and significant risk to operations, the economy and lives. More than three quarters of the country's tourists enter through Philip S.W. Goldson International Airport. To reach ICAO compliance, the NMSB requires additional and sustainable investment for an increase in staff numbers and the necessary upgrades to infrastructure.

¹⁵ The CHD was developed by the Alliance for Hydromet Development who are major international development, humanitarian and climate finance institutions - Country Hydromet Diagnostics (Alliance for Hydromet Development, 2024)

¹⁶ Annex 3, Meteorological Service for International Air Navigation – URL: <https://www.icao.int/airnavigation/IMP/Documents/Annex%203%20-%202075.pdf>

Figure 5 shows an analysis, based on the existing literature and stakeholder discussions, of risks posed to Belize by unsustainable funding levels for NMSB.

In terms of staffing, the Met Service requires sustainable funding to allow for newly trained meteorologists and forecasters to be put in place, given likely turnover from retirements etc. in the coming years. With limitations in funding and educational opportunities, NMSB must currently train meteorologists outside of Belize. This comes with a significant cost and substantial risk to making sure that NMSB has realistic staffing levels in future years.

LONG-TERM RISKS (More than 5 years)			
Non-resilient economy Weakened ability to adapt to weather and climate challenges	Unprepared society Less equipped to prepare and respond to severe weather events	Non-operable Met Service No sustainable funding framework that allows for training and replacing staff	
IMMEDIATE RISKS (Within 12 months)			
No international flights Failure to meet ICAO compliance standards can result in the suspension of all international flights		Direct impact on sectors The suspension of international flights would disrupt key sectors such as tourism, damaging the Belizean Economy	
DIRECT RISKS (Within 5 years)			
Limited Options Reduced exports	Limited Preparation Economic losses	Limited Forecasts Food insecurity	Limited Warnings Danger to life

Figure 5: Timeline for the risks of doing nothing for the NMSB

Conclusion

The Met Office and the National Meteorological Service of Belize are members of the World Meteorological Organization (WMO), which sets international standards and guidelines for members. WMO members strive to advocate the value of their services to national governments to ensure the necessary resource and technological capability for sustainable service provision to increase national, regional and ultimately global resilience to a changing climate. The partnership between the Met Office, NMSB, London Economics and WMO Climate Risk Early Warning Systems initiative has provided evidence in this context for the country of Belize.

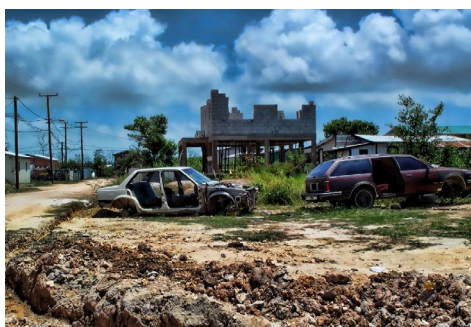
Organisations from across the economy and the public sector in Belize have expressed the NMSB's importance for safeguarding the country's economic stability, societal wellbeing, and resilience to climate-related risks. Through accurate weather forecasting, early warning systems, and provision of quality-controlled climate data, the NMSB helps mitigate the adverse impacts of severe weather and climate events on key sectors. The estimated central range benefit-to-cost ratio for the NMSB is \$3.3 - \$6.8 to every \$1 (BZD) invested. Every dollar invested yields substantial returns for disaster risk reduction, resource management and overall economic productivity.

This report shows that the NMSB's services currently enhance the ability of Belizeans to prepare for and respond to extreme weather. A reliably funded meteorological service could further nurture national stability by supporting sustainable practices, climate adaptation efforts, and long-term mitigation planning, strengthening Belize's resilience to economic and societal challenges caused by worsening weather and climate.

The services NMSB delivers and could provide in future under a sustainable funding arrangement, are fundamental to the ability of Belize in achieving the vision of the Ministry of Economic Development's National Development Framework¹⁷, which serves all the citizens of Belize.

“Belize is a country of peace and tranquillity, where citizens live in harmony with the natural environment and enjoy a high quality of life. Belizeans are an energetic, resourceful and independent people looking after their own development in a sustainable way”

Barnett, Catzim-Sanchez, Humes, 2011



¹⁷ [Final Report: Preparing Horizon 2030 - Long Term National Development Framework for Belize](#)

Annex

Annex A: Approach for assessing the socioeconomic value of the NMSB

Based on an extensive evidence set of case studies, an initial analysis, applying the existing literature evidence on benefits to costs ratios from evaluations of other meteorological services to the products and services offered by the NMSB, was undertaken by London Economics.

The analysis accounted for the types of services evaluated in each case study by considering only the most relevant evidence. Specifically, to evaluate the benefits of the services offered to each key sector only benefit to cost ratios from studies that included similar services were used. For example, only benefit to cost ratios of studies including evaluations of aviation impacts were considered when assessing benefits to the aviation sector.

The socioeconomic evaluation studies that were collected typically evaluated a range of services to derive a benefit to cost ratio. It was therefore not possible, in the short timescales of this report, to isolate the sector-specific impacts. Nevertheless, this approach allowed us to focus on the most relevant evidence available to the extent possible.

Additionally, the analysis considered the socioeconomic relevance of case studies by assigning a higher weight to evidence from studies with similar socioeconomic context to Belize. To derive this weighting OpenAI's GPT-4 model (OpenAI, 2024) was used to assign a relevance ranking: very relevant (weighting of 4 out of 4), somewhat relevant (weighting of 3), somewhat less relevant (2), less relevant (1), with regards to the socioeconomic context of Belize to all case studies¹⁸. The resulting ratings were reviewed manually and found to be sensible. For example, case studies for developed economies such as the UK were assigned a rating of “less relevant”, while small island nations and other developing economies that are reliant on tourism and agriculture were assigned a rating of “very relevant”.

Despite being relatively straightforward this exercise provides a plausible indication of the magnitude of socioeconomic benefits resulting from the products or services provided by the NMSB. Additional work to develop a more nuanced assessment approach is being developed following the publication of this initial analysis.

Annex B: Could the estimates on the socio-economic benefits of the NMSB be higher?

The central range of socioeconomic benefits provides a **reasonable indication of the likely magnitude of benefits**. However, it is **relatively conservative**. It is based on the weighted median lower and upper estimates of the relevant studies. This means that half of the studies report higher (or lower) benefit-to-cost ratios than those used for the upper (or lower) estimates of the central range provided above. However, while the studies showing benefits below the lower estimate generally suggest only slightly lower outcomes, many of the studies reporting benefits above the upper estimate indicate substantially greater benefits.

This is highlighted by expanding the analysis to include more of the available evidence, using the weighted 25th percentile for the lower estimate and the weighted 75th percentile for the upper estimate instead of the median. **This approach, referred to as the plausible range, incorporates a broader portion of the data, while still excluding significant outliers.** Specifically, only 25% of studies imply benefits that are lower or higher than the lower or upper estimate of this range, respectively.

The **plausible range** suggests benefits **ranging from \$3.7 million** on the lower end to **\$19.0 million** on the upper end. This implies a **return on investment of between \$2.2 and \$11.0 for every \$1 of public money invested in the NMSB**. This suggests that benefits could be considerably higher than implied by the conservative central range.

¹⁸ The prompt used was: Can you provide an assessment of the similarities of the following countries to the socioeconomic context of Belize. Please respond in a table with three columns providing in column 1 the country name, in column 2 your relevance rating (please use very relevant, somewhat relevant, somewhat less relevant, less relevant), and in column 3 your reasoning.