Climate Risk Analysis for the Maldives

Case Study for Major Islands

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Background and introduction

Maldives' rich marine ecosystem is extremely vulnerable to recurrent hazards such as increased rainfall, cyclonic winds, storm surges, saltwater intrusion, and coastal floods, as well as human activities such as infrastructure development projects. As one of the lowest-lying and most geographically dispersed countries in the world, Maldives is ranked as 143 out of 182 in terms of vulnerability related to its exposure, and sensitivity to the negative impact of climate change. Over 90% of the islands have been reported to flood annually, with 97% reporting shoreline erosion. 64% of the islands experiencing erosion report the issue as severe. In response, the government is committed to strengthening coping and adaptive capacity through low-emission sustainable development, and mainstreaming climate considerations in operational functions of financial market actors.

The UNEP Center at Frankfurt School of Finance and Management – with modelling and analytics support from the InsuResilience Solutions Fund (ISF) – has undertaken a Development Finance Assessment (DFA) for the Maldives, as part of the Integrated National Financing Framework (INFF) diagnostic stage. The report provides insights for the finance strategy development and seeks to increase engagement across agencies and project level activities to mainstream climate and gender considerations in all financing operations. The report recommends policy options the government can implement to tap into previously untapped domestic and international resources. To inform investment (adaptation) requirements, an event-based climate risk assessment (CRA) was conducted using a similar framework to the probabilistic CRA tool CLIMADA. Key takeaways from the report are presented here with a focus on the modelling case study. The scope of the study encompasses the following, to the extent given (limited) data availability:

1. Estimating affected areas by sea level rise (SLR) events under different future climate scenarios on major islands.
2. Identifying and evaluating open-source exposure and loss data for assets at risk from climate-related hazards.

Case study: set up and findings

Case studies around a hypothetical flood event were set up for Kulhudhuffushi, Addu Atoll, Male, and Fuvahmulah islands, and the potential loss to a subset of houses was estimated in the current and future climate. The study found that climate related loss due to coastal flood events in the Maldives will increase, primarily due to rising sea levels. Large swell events can also be expected to increase since the meridional, i.e., south north component of the south Asian summer monsoon circulation, is expected to increase with climate change. This in turn will increase the likelihood of swell events especially on the southern and southwestern coastlines particularly in spring and summer months. The magnitude and impact of previous large swell events (e.g., in April 1987 or May 2007) will likely be exceeded due to continuous SLR and monsoon circulation changes. The study also demonstrates through examples the non-linear loss effects SLR could have across two different flood events, depending on the average sea surface height. Other acute extreme events, such as tropical cyclones, storms, and flooding, as well as ocean changes (e.g., acidity) due to an increased temperature change are further secondary drivers. Loss of marine, coastal, terrestrial biodiversity and ecosystem services over time can cause submergence of reef islands, increase water insecurity, destroy infrastructure, degrade health and well-being, shrink the economy and livelihoods, and result in loss of cultural resources and heritage.

Due to a lack of island-specific models and freely available open-source exposure and validation data, it is difficult to identify which adaptation measure is most adequate in this context. However, in general, it is recommended that effective financial risk management strategies include a combination of risk reduction measures and risk transfer mechanisms for low-frequent and high-impact events. Economic development will increase potential future losses, which gives further motivation to implement adaptation measures sooner rather than later to avoid damages in the very near term. Adaptation measures can include anything from community-based adaptation (early warning systems) to ecosystem-based adaptation (mangroves) and infrastructure (seawalls).

Note: Study Limitations
The results presented here should not alone be used as a basis for decision making. They should rather be considered as illustrative examples of what an in-depth risk assessment using a framework like CLIMADA could yield. Some limitations:

- In this simplified case study, only one event was analysed and thus no probabilities were calculated.
- Interaction effects with other hazards, such as cyclones, storm surges, floods, drought events, and coastal erosion, are not considered. Thus, economic and social effects are possibly underestimated, especially given the non-linear interaction between SLR and wave dynamics, and cascading effects due to the high interconnectedness of the island systems.
- Study inputs projected local realities only in a very limited manner, relying strongly on simplification and assumptions regarding affected assets.

CLIMADA allows to assess a comprehensive portfolio of adaptation measures, quantifying the damage aversion potential and cost-benefit ratio for each measure. In the flood event case studies, a hypothetical risk reduction measure against flood would reduce the impact by around 5% under current climate conditions and 20% under future conditions (considering future socio-economic development and population growth). Illustrative financial calculations are presented in the table below for the islands of Kulhudhuffushi and the Addu Atoll. While the assumed reductions could be realistic, real engineering costs and proven benefits are essential for decision support cost-benefit analysis. In this context, adaptation measures could include rehabilitation of the eastern coastal ridge, coastal protection in the southern and northern side, maintaining the Environmental Protection Zone, establishing a proper drainage system, maintaining the northern side wetlands, or measures to reduce socioeconomic vulnerability to disasters.

Table 1: Comparing lost assets with and without adaptation measure in Kulhudhuffushi and Addu Atoll

	Kulhudhuffushi		Addu Atoll	
	1m flood height	1m flood height (under SLR)	1m flood height	1m flood height (under SLR)
Affected buildings of available exposure data in %	8%	25%)	7%	9%
Affected assets with one adaptation measure	15%	25%	15%	25%
Increase in losses of affected assets with one adaptation measure	Around 90%		Around 70%	
Affected assets without adaptation measures	20%	45%	20%	45%
Increase in losses of affected assets without one adaptation measure	Around 105%			
Reduced relative damage through implementation of one adaptation measure (in %)	-25%	-44%	25%	-44%

Outlook and recommendations

Currently, adaptation measures in the Maldives are still dominated by minor modifications to the business-as-usual, which might support communities on the short-term, but more extensively, transformative change is needed. To inform these decisions, some recommendations to improve on the model used in the study are listed here. One is to develop a storm flood event assessment. Secondly, future climate risk assessments should also consider hazards profiles that potentially affect the Maldives under climate change conditions. These may include marine heatwaves, which pose a threat especially to coral reefs (and thus the tourism sector), tsunamis, which are expected to increase in frequency and intensity due to SLR particularly on the eastern shores, and lastly, storm surge/tide events with reference to the multiple hurricanes and storms that have or would pass through Southwest Asia.

The integration of climate risk assessments in decision making can provide public and private decision makers with the necessary basis to make informed investment decisions, prioritise most cost-efficient adaptation (behavioral, physical, and financial) measures, and thus increase physical and financial resilience. As a result, decision makers will also understand which risks may need to be retained or transferred despite these measures and plan their climate and disaster risk finance and insurance (CDRFI) strategies accordingly.