Key Findings

Maldives UN Joint Project funded by SDG Funds for SIDS

Strengthening National and Subnational Capacity for Sustainable Disaster Risk Reduction, Climate Change Adaptation and Mitigation in Maldives

Capacity Building on National and Subnational Planning for Sustainable Disaster Risk Reduction, Climate Change Adaptation, and Mitigation

January 30, 2024

Prangya Paramita Gupta
Climate change and its relevance for Maldives

Number of cyclone/storm/surge in the Maldives during 2014 – 2021

Number of rainwater floods in the Maldives during 2014 – 2021

(Source: Disaster database, NDMA, Maldives)
Climate change and its relevance for Maldives

- Weather events are exacerbated by a changing climate - intensified storms, more frequent sea-surge events and longer dry periods leading to water shortages.

- All of them are already detectable across both natural and human systems.

- The country is vulnerable to coastal flooding due to the islands’ low elevation; this vulnerability is worsened by climate change.

- **Projected changes** says that the wave climate superimposed on sea level rise will rapidly increase flooding in small islands.

- A 5-10 cm additional sea level rise (expected for ~2030-2050) will double flooding frequency in much of the Indian Ocean.
Overview

1. How we did

2. What we did

3. What we can do with these information
Risk analysis: Data and scenario

Scenario generation process

- Defining shared socio-economic pathways
- Integrated Assessment Models
- Classification of scenarios against climate targets
- Calibration / Emulation
- Emission harmonisation
- Reduced complexity and gas cycle models
- Earth System and General Circulation Models
- Species, human and socio-economic impact models
- Ecosystem and biodiversity models
- Geophysical Impact Models
- Adaptation

Data
- Drivers: GDP, Population, Technology...
- Emissions: CO₂, CH₄, N₂O, HFCs, aerosols, land-use patterns
- Concentrations: CO₂, CH₄, N₂O, HFCs, ozone, and aerosol loadings
- Climate Projections (incl. radiative forcing, temperatures, precipitation, snow cover, sea ice, sea level, etc.)
- Geophysical impacts (incl. river runoff, coastal erosion, ecosystem shifts, wildfire modelling, etc.)
- Species-level and Human impacts (incl. infectious diseases, heat stress, species distributions, insurance losses etc.)

Models

Source: Pirani et al. 2024
Risk analysis: Data and scenario

Downscaled climate projection data with 5 km spatial resolution received from Asia-Pacific Climate Change Adaptation Information Platform (AP-Plat)

Climate variables:
- Precipitation/Rainfall
- Average temperature
- Surface wind
- Sea level rise

Time period:
- 2021-2040
- 2041-2060

Climate scenario:
- SSP2
- SSP3

Source: climatedata.ca
Enhanced granularity in data

Sources: ESCAP calculations based on IPCC WGII Interactive Atlas – Coupled Model Intercomparison Project Phase 6 (CMIP6) 2021 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives.

Notes: 1. The baseline period is 1981-2000.
2. The baseline period is 2011-2040.
3. Mid-term period is 2041-2080

Disclaimer: The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
Landuse/landcover maps
Risk analysis: methodology

Hazards:
- Flood (increased precipitation)
- Drought (increased temperature)
- Cyclone (increased wind speed)
- Sea level rise (sea surface anomaly)

Sectors:
- Total Population
- Female population
- Landuse and land cover
- Transport and energy
- Critical infrastructure
- Healthcare infrastructure
- Education infrastructure
Overview

1. How we did

2. What we did

3. What we can do with these information
Updated landuse maps

- The landuse and land cover has been updated for the entire country using high resolution satellite images of 2021-2022

Source: ASCAP calculations based on ESRI BaseMap, AOA 2020 and Maldives Land and Survey Authority.
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Updated landuse maps

- Landuse maps are updated based on the 2016 maps produced as part of ADB led Multi-hazard risk assessment project.
- The landuse and land cover has changed since then in many islands. E.g.
  - Urban and agricultural areas have expanded.
  - New resort islands are developed.
  - Reef areas are reclaimed for landuse development.
  - Uninhabited islands are converted Island resort and agricultural lands.
<table>
<thead>
<tr>
<th>Land use/ Land cover category</th>
<th>Area in 2016 (sq.km)</th>
<th>Area in 2022 (sq.km)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural area</td>
<td>6.65</td>
<td>11.58</td>
<td>74.13↑</td>
</tr>
<tr>
<td>Forest</td>
<td>40.86</td>
<td>30.96</td>
<td>24.22↓</td>
</tr>
<tr>
<td>Urban area</td>
<td>31.40</td>
<td>52.45</td>
<td>67.03↑</td>
</tr>
<tr>
<td>Inland water</td>
<td>2.97</td>
<td>2.33</td>
<td>21.54↓</td>
</tr>
<tr>
<td>Island resorts</td>
<td>16.77</td>
<td>33.60</td>
<td>100.35↑</td>
</tr>
<tr>
<td>Palm tree</td>
<td>50.10</td>
<td>40.21</td>
<td>19.74↓</td>
</tr>
<tr>
<td>Wetland</td>
<td>3.39</td>
<td>2.19</td>
<td>35.39↓</td>
</tr>
</tbody>
</table>

**Updated landuse maps**

![Updated landuse maps graph](image)
Updated landuse maps: reclaimed lands

- Reclaimed lands were identified using high resolution satellite images of two time periods - 2010 and 2022.

- Around 15.38 sq.km area has been reclaimed post 2010.

- Kaafu atoll tops the list in land reclamation by 2022.
Updated landuse maps: reclaimed lands

Sources: ESCAP calculations based on Google Earth Pro, 2013-2022 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2016.

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Hazard trend – Precipitation

Projected total annual precipitation (mm)

Total annual precipitation (mm)
- < 2008.48
- 2008.49 - 2215.19
- 2215.2 - 2380.35
- > 2360.35

Sources: Asia-Pacific Climate Change Adaptation Information Platform (AP-Plat), 2023 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2016.

Notes:
1. The baseline period is 1981-2000.
2. Near-term period is 2021-2040
3. Mid-term period is 2041-2060

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Hazard trend – Precipitation

- Rainfall is likely to increase across the country compared to baseline period. Central atolls - Kaafu, Alifu Alifu, Alifu Dhaalu, Vaavu, Faafu, Dhaalu and Meemu are likely to receive maximum rainfall across all scenario and timelines.

- More of atolls/ islands are likely to receive highest rainfall in the worst-case scenarios (SSP3) than business-as-usual scenarios (SSP2).

- Many of the flood prone islands are likely to face occurrence of similar events in both near and mid-term scenario.

- Some of the central atolls are likely to receive up to 100mm increase in total annual rainfall from the baseline period.
Hazard trend - Temperature

Projected annual average temperature (°C)

Sources: Asia-Pacific Climate Change Adaptation Information Platform (AP-PIA), 2023 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2016.

Notes: 1. The baseline period is 1981-2000.
   2. Near-term period is 2021-2040
   3. Mid-term period is 2041-2060

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Risk analysis: Hazard – Temperature

• The average annual temperature shows an increasing trend across the country under all the climate change scenarios.

• It is likely to increase more in the northern and central atolls - Haa Alifu, Haa Dhaalu, Alifu Alifu, Alifu Dhaalu, Faafu, Vaavu and Thaa.

• In some of the atolls the increase in average temperature may go up to 1.6 °C from the baseline period under the business-as-usual scenario (SSP2 4.5) by 2040.

• Under worst-case scenario (SSP3) the average annual temperature may increase up to 1.7 °C in all the atolls except Seenu and Gnnaviyani by the end of 2060.
Risk analysis: Hazard – Surface wind

Projected seasonal average surface wind (m/s)

Sources: ESCAP Calculations based on Asia-Pacific Climate Change Adaptation Information Platform (AP-Flat), 2023 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2016.

Notes: 1. The baseline period is 1981-2000.
   2. Near-term period is 2021-2040.
   3. Mid-term period is 2041-2060.

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Hazard trend – Surface wind

• The future trends in seasonal surface wind (May to October) follows the baseline trends across all the scenario and time period however the wind speed is likely to decrease in both near and mid-term period.

• The highest wind speed is observed across the northern atolls namely Haa Alifu, Haa Dhaalu, Shaviyani, Noonu, Lahviyani, Kaafu, Raa and Baa.

• The northern atolls with existing risk of cyclone and storm like events, have highest likelihood of similar events in future. However, southern and central atolls are likely to have the baseline like situation.
Hazard trend - Sea Level Rise

Sea level anomaly (m)

- Atoll boundary
  - 0.824 - 0.829
  - 0.829 - 0.834
  - 0.834 - 0.839
  - 0.839 - 0.844
  - 0.929 - 0.934
  - 0.934 - 0.939
  - 0.939 - 0.944
  - 0.944 - 0.989

Sources: ESCAP calculations based on IPCC Interactive Atlas, 2021; Copernicus Climate Change Service, Climate Data Store, (2018) and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2016.

Notes: 1. Sea level anomaly refers to the height of water over the mean sea surface
2. The baseline period is 2014
3. Near-term period is 2021-2040
4. Mid-term period is 2041-2060

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Hazard trend – Sea level rise

• The increase in the sea level is likely to occur across the country compared to the level of 2014 in all the climate projection scenarios.

• The rise high around the northern and eastern part of the central atolls and relatively low towards the southern atolls.

• The highest rise is likely to happen in Haa Alifu, Haa Dhaalu, Shaviyani, Noonu, Lahviyani, Kaafu, Vaavu, and Meemu.

• The northern and central atolls may experience increase in sea level up to 0.95 m by 2040 and up to 1.08m under worst case scenario (SSP3).
Trend - Multi-hazard (precipitation, temperature, surface wind and sea level rise)

- There is increasing trend of multi-hazard likely across the country from baseline to the mid-term worst-case scenario (SSP3).
- Northern, central atolls namely - Haa Alifu, Haa Dhaalu, Shaviyani, Noonu, Lahviyani, Baa, Alifu Alifu, Alifu Dhaalu, Kaafu, Faafu, Dhaalu, Thaa, Vaavu, and Meemu may experience more intense multi-hazards than the rest.
Around **50% of the total population** of Maldives is likely to be exposed to **high precipitation** under business-as-usual (SSP2) scenario and around **55%** under worst-case scenario (SSP3) by 2060.
Exposure – Population

• **Around 19% of the total population** are likely to be exposed to up to **1.6 °C increase** in annual average temperature.

• **Around 14% of the urban area with 0-1m elevation are under risk of 1 m increase in sea level under future climate scenario**
• **Up to 99%** of female population are likely to be affected by **multi-hazard** by 2060 under worst-case scenario

• **55%** of female population are exposed to high precipitation and **16%** to the 1m increase in sea level under worst-case scenario
Exposure – Agriculture

• Up to **26%** of the agricultural lands in the country are likely to be exposed to intense precipitation under worst-case scenario (SSP3) by 2060.

• **86%** of the total agricultural land is exposed to up to 1.6 °C increase in average temperature.
13% of the agricultural areas with 0-1m elevation are under risk of 1m increase in sea level under future climate scenario by 2060 under SSP3 7.0 climate scenario.
Exposure – Energy and critical infrastructure

- Around 47% of total energy capacity of the country is exposed to the highest amount of precipitation by 2060 under both SSP2 and SSP3 climate change scenarios.

- 22% of the energy capacity are located at 0-1m elevation and are under risk of 1m increase in sea level under future climate scenario by 2060 under SSP3 7.0 climate scenario.

- Seenu atoll (100%), Meemu atoll (62%), Faafu atoll (47%), Noonu atoll (40%) and Lhaviyani atoll (39%) are likely to be most impacted due to sea level rise in terms of energy capacity.
## Risk matrix: Multi-hazard - Population

### Baseline

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<tr>
<th>Probability</th>
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<th>Probability</th>
<th>Impact</th>
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<tr>
<td></td>
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<td>Sh, HDh, HA</td>
<td>B, Lh, AA, Dh, F, V, M, Adh, N</td>
<td>Sh, Th, HDh, K</td>
<td>R, HA, Male</td>
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<tr>
<td></td>
<td>R, S, Male</td>
<td>L, Th, K</td>
<td>Gn, GA, GDh</td>
<td>L</td>
<td>S</td>
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### SSP2 2021-2040

<table>
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<th>Probability</th>
<th>Impact</th>
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<tr>
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<td>High</td>
<td>Medium</td>
<td>B, Lh, AA, Dh, F, V, M, Adh, N</td>
<td>Sh, Th, HDh, K</td>
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<tr>
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<td>Medium</td>
<td>Sh, HDh, HA</td>
<td>Low</td>
<td>B, Lh, AA, Dh, F, V, M, Adh, N</td>
<td>Sh, Th, HDh, K</td>
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<tr>
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<td>B, Lh, AA, Dh, F, V, M, Adh, N</td>
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### SSP3 2041-2060

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<th>Probability</th>
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<td>High</td>
<td>B, Lh, AA, Dh, F, V, M, Adh, N</td>
<td>SH, Th, HDh, K</td>
<td>R, HA, Male</td>
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<tr>
<td>Medium</td>
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<td>GA, Th, GDh</td>
<td>L</td>
<td>S</td>
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<tr>
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<td>Low</td>
<td>GDh</td>
<td>L</td>
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</table>
### Risk matrix: Multi-hazard - Agriculture

#### Baseline

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<th>Probability</th>
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<td>High</td>
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<td>Green</td>
<td>Yellow</td>
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<td>Medium</td>
<td>HA</td>
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<td>Sh, HDh</td>
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<td>B, S, GA, Th, N</td>
<td>AA, L, GDh, K</td>
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#### SSP2 2021-2040

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<th>High</th>
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<tbody>
<tr>
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<tr>
<td>Medium</td>
<td>Lh, R, Dh, F, M, ADh, GDh</td>
<td>B, Th, HA, N</td>
<td>Sh, AA, HDh, K/Male</td>
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<tr>
<td>Low</td>
<td>Gn</td>
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<td>S, GA</td>
<td>L, GDh</td>
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#### SSP3 2041-2060

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<th>Probability</th>
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<th>Medium</th>
<th>High</th>
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<tr>
<td>High</td>
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<tr>
<td>Medium</td>
<td>Gn, Th</td>
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<td>S, GA</td>
<td>L, GDh</td>
</tr>
<tr>
<td>Low</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Flood scenario – Hulhule January 2024

Locations of past rainwater flood events in high precipitation areas

Total annual precipitation (mm)

- No data
- < 2,000.49
- 2,000.49 - 2,215.19
- 2,215.2 - 2,365.35
- > 2,360.35

Sources: ESCAP calculations based on Asia-Pacific Climate Change Adaptation Information Platform (A-PI platforms), 2023, National Disaster Management Authority, Maldives, 2022 and Ministry of Environment, Climate Change and Technology, Govt. of Maldives, 2018.

Notes: 1. The baseline period is 1981-2000.
2. Near-term period is 2021-2040.
3. Mid-term period is 2041-2060.

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Flood scenario – Thaa atoll January
Overview

1. How we did

2. What we did

3. What we can do with these information
Risk informed development

Land use planning in hazard prone areas

- Expansion of urban areas
- Climate smart agriculture
- Expansion of agricultural areas
- Planting resilient species.
- Land reclamation
- Infrastructure development and protect the existing
Prioritizing climate action and investment in adaptation
Inclusive social development

Identifying vulnerable population in the risk hotspot for inclusive development

Population with disabilities at the atoll level

Develop risk informed and inclusive policy for disaster risk reduction
Contribution to EW4ALL, NAP and SDG

The overall goal of the JP is to anchor Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) at the heart of national and subnational development planning to address sustainability and leave no one behind elements of the Agenda 2030.

Pillar 1: EW4ALL

Source: ITU
Contribution to EW4ALL, SAP/NDC and SDG

Strategic Action Plan (SAP) 2019-2023 : *Jazeera Dhiriulhun*

**Policy 1:** Strengthen adaptation actions and opportunities, and build climate-resilient infrastructure and communities to address current and future vulnerabilities

- Strategy 1.2 (Action 1.2a)
- Strategy 1.3 (Action 1.3a, 1.3c)
- Strategy 1.4 (Action 1.4b, 1.3c)

**Policy 2:** Promote environmentally sound technologies and practices towards building sustainable climate resilient island communities

- Strategy 2.3 (Action 2.3a)

**Policy 5:** Strengthening national level disaster management information, communication and coordination system

- Strategy 5.1 (Action 5.1b)
In NDCs announced by Government of Maldives in 2020-

- Strengthening adaptation actions and building climate resilience is considered as a high national priority.

- Special emphasis has been given on infrastructure resilience, early warning and DRR and DRM.

- Climate governance and capacity building has been identified as cross cutting issues
Contribution to EW4AL, NAP and SDG

Through the project interventions the adaptive capacity to climate-related hazards and natural disasters both nationally and subrationally is enhanced.

Through project interventions enhanced community participation in CCA/CRR activities through capacity building of island communities and policy makers.

The national and subnational capacity of the government institutions are strengthened to make gender-sensitive, equity-based policy decisions.
Thank you!
Any Question?

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Udit Rana, Intern, SSWA, ESCAP
Doyoon Kim, Intern, IDD, ESCAP