Global Water Security Center

# Maldives: Climate Adaptations Mitigate Water Scarcity

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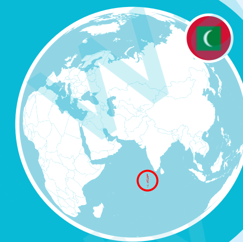
## BOTTOM LINE:

Much of the Maldives' freshwater and energy systems are decoupled from the climate as development has responded to the island nation's already-high vulnerability to climate risk. Energy-intensive desalination processes provide a steady source of freshwater, and energy is derived entirely from imported oil.

## BACKGROUND:

Population density on urban islands, particularly capital Malé City, has soared as people have moved from rural islands that are acutely affected by climate — sea level rise and high rainfall variability — that makes life precarious. Desalination became a major freshwater source in Malé City starting in 1988. Sewage and saltwater had polluted the groundwater, which led to cholera outbreaks in the 1970s that threatened public health.



## Freshwater Supply

Freshwater is predominantly sourced from desalinated sea and groundwater, **making freshwater availability independent from climate.**

- **Groundwater is not a viable source of freshwater** in urban areas due to pollution from sewage and saltwater intrusion.
- By 2050, no changes are projected in the Maldives' highly variable precipitation trends. However, **lack of space for rainwater storage** constrains its viability as a major reliable water source, especially during dry periods.

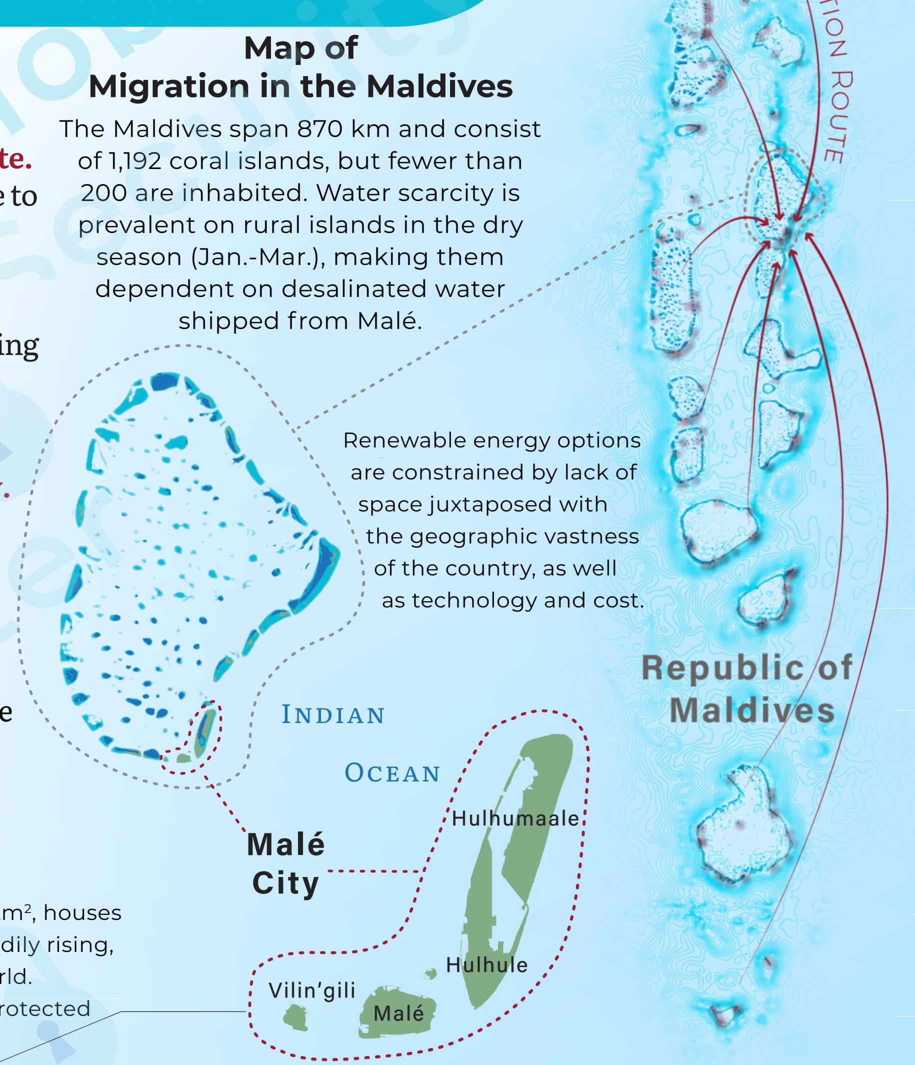
## Energy Supply & Demand

**The Maldives are completely reliant on imported fossil fuels for energy.**

- As urban populations continue to climb, **the outsized demand for energy to support desalination will grow.**
- **Warming temperatures will increase energy demands for cooling**, particularly as living standards improve. By 2050, temperatures are projected to rise by 0.7°C, slower than the global average under extreme warming. However, humidity intensifies how heat feels in the Maldives, thus even under the "middle of the road" scenario, the heat index, which accounts for humidity, could reach 34°C in April and May, the hottest months, potentially straining energy infrastructure.

### Map of Migration in the Maldives

The Maldives span 870 km and consist of 1,192 coral islands, but fewer than 200 are inhabited. Water scarcity is prevalent on rural islands in the dry season (Jan.-Mar.), making them dependent on desalinated water shipped from Malé.




Malé City, comprising 3 islands that together are less than 10 km², houses nearly half of the Maldives' 520,000 people, with numbers steadily rising, making it one of the most densely populated places in the world. Extreme hardening of shorelines and land reclamation have protected these urban islands from immediate sea level rise challenges.

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# Data Analysis Methods:

**SCOPE**: This product was developed for INDOPACOM to provide information on the Maldives related to the constraints presented by a changing climate on the viability of the densely populated islands. The product was developed to place the current hydrometeorological conditions into historical context and synthesize temperature and precipitation projections for 2035 and 2050.

**DATA SETS:**
ERA5 Historical Weather Data [1990-2023] - daily values for precipitation, maximum temperature, minimum temperature, average temperature
NASA Earth Exchange Global Daily Downscaled Projection CMIP6. SSP245 and SSP585 2025-2060. Historical 1985-2014. 17 models were used: ACCESS-ESM1-5, BCC-CSM2-MR, CanESM5, CMCC-ESM2, FGOALS-g3, GISS-E2-1-G, MIROC-ES2L, MPI-ESM1-2-HR, MRI-ESM2-0, NESM3, NorESM2-MM, CNRM-ESM2-1, EC-Earth3-Veg-LR, GFDL-ESM4, INM-CM5-0, IPSL-CM6A-LR, KIOST-ESM

**METRIC CALCULATION:** Each metric was calculated for the ERA5 historical range (1990-2010) to get an approximate ‘2000’ value. The SSPs used in the product were SSP245 and SSP585. The metrics were also calculated for CMIP6 historical range (‘2000’) and the future time periods (‘2035’ and ‘2050’). The CMIP6 future time period was compared to the CIMP6 historical time period to calculate the projected difference. These differences were then added back to the ERA5 historical values to get future projections. To calculate Heat Index, historical monthly normals were used for relative humidity and the R package weathermetrics was used to calculate heat index.

**STATISTICAL ANALYSIS:** Historic trends (1990-2023) through time were examined for mean annual temperature and total annual precipitation. For these metrics, we used values averaged over the country by Koppen-Geiger Zones. Linear models were applied to these metrics over time with a significance threshold of $p<0.05$.

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