



# Understanding Our Changing Climate Unit 1: Maldives Sea-Level Change Case Study Reading

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*The Republic of Maldives is located in the Indian Ocean southwest of India and Sri Lanka (Figure 1). The chain of 26 atolls are run over 800 kilometers (500 miles) from north to south and include a land area of about 300 square kilometers (115 square miles). The atolls are composed of live coral reefs and sand bars situated atop a submarine ridge that rises from the depths of the Indian Ocean. The population is about 436,000 people. The natural average elevation above sea level is only 1.5 meters and the maximum is 2.4 meters. In some places with human constructions, this has been increased by a couple meters; however, 80% of the county’s land area is coral reefs that rise less than a meter above sea level. Thus, the Maldives are at high risk of being submerged due to rising sea levels. The United Nation’s Intergovernmental Panel on Climate Change warns that at current rates of sea level rise the Maldives could become uninhabitable by 2100.*

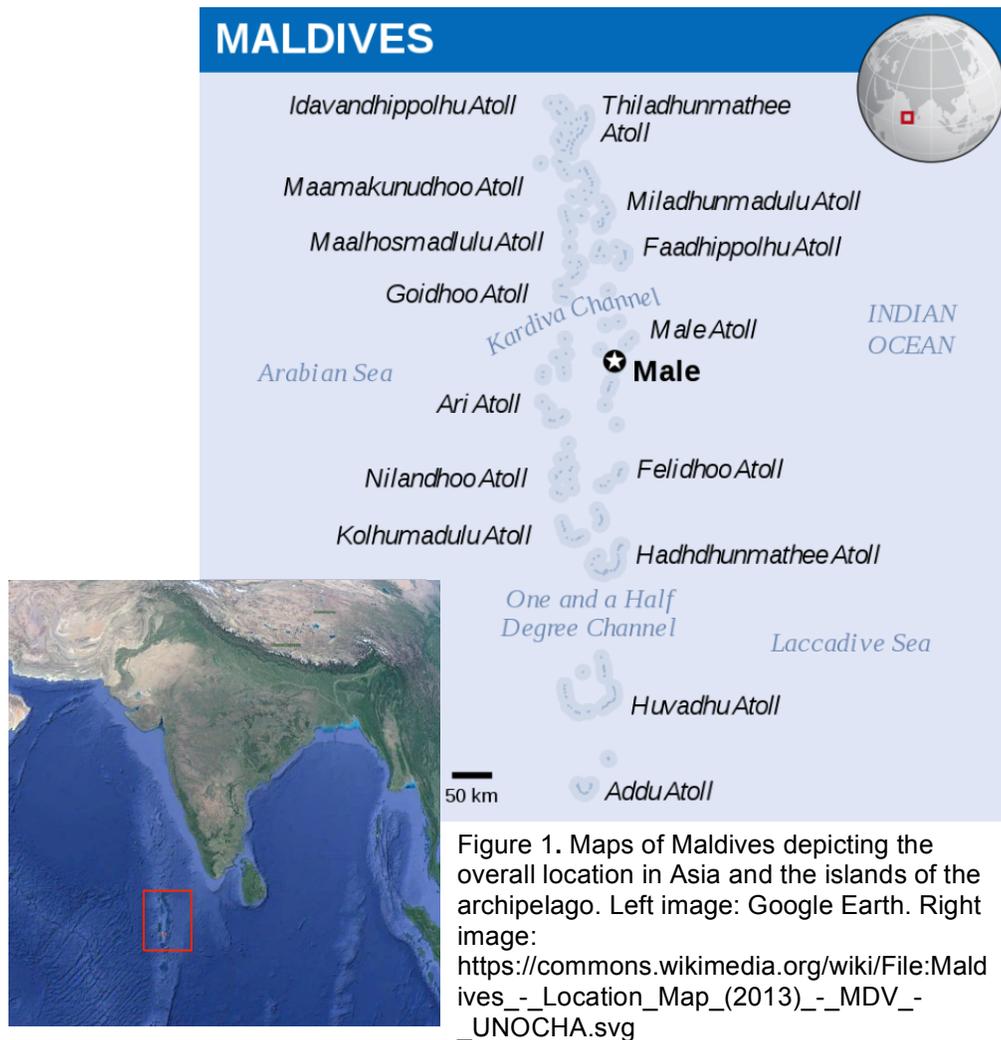


Figure 1. Maps of Maldives depicting the overall location in Asia and the islands of the archipelago. Left image: Google Earth. Right image: [https://commons.wikimedia.org/wiki/File:Maldives\\_-\\_Location\\_Map\\_\(2013\)\\_-\\_MDV\\_-\\_UNOCHA.svg](https://commons.wikimedia.org/wiki/File:Maldives_-_Location_Map_(2013)_-_MDV_-_UNOCHA.svg)

Maldives are part of a group of member states designated by the United Nations as “Small Island Developing States” (SIDS). These include: Antigua and Barbuda, Bahamas, Barbados, Belize, Cabo Verde, Comoros, Cuba, Dominica, Dominican Republic, Fiji, Grenada, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Micronesia (Federated States of), Nauru, Palau, Papua New Guinea, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Samoa, Sao Tomé and Príncipe, Seychelles, Singapore, Solomon Islands, Suriname, Timor-Leste, Tonga, Trinidad and Tobago, and Tuvalu. These nations average 26% land and 30% of the population at <5 meters above sea level. While contributing <1% of the world’s greenhouse gas emissions, these countries are some of the most vulnerable to sea-level rise and at greater risk to economies, livelihoods, and food security.



Figure 2. Maldives coral islands. (Image by Ibrahim Asad, <https://www.pexels.com/photo/white-clouds-1450355/>. All reuse allowed)

## 1: Coral reefs

The islands of the Maldives’ atolls are composed of coral reefs and related sediments (Figure 2). Coral reefs provide a variety of ecosystem services, including habitat for fisheries, shoreline protection, and tourism. A healthy coral reef environment has the capacity to respond to some level of sea-level change by growing vertically as the sea level rises. However, current rates of sea-level rise are more rapid than known rates in the past. Furthermore, coral reefs are being greatly stressed by rising temperatures and pH, reducing their capacity to respond. Since 2014 the Maldives have been struck by severe coral bleaching affecting 60–90% of the coral, depending on the area. Corals are animals that contain symbiotic algae within their tissues, which provide about 80% of its nutrients. Bleaching occurs when corals are under stress from changing conditions, such as rising water temperature, and the coral expels the algae from its tissues, thus turning white. Initially, the coral is not dead, just starving, but prolonged higher temperatures can kill the coral completely. Another stress on coral reefs is coming from ocean acidification. As CO<sub>2</sub> is absorbed into the oceans from the atmosphere, it causes the ocean water to become more acidic (lower pH) and leads to dissolution of the calcium carbonate in the corals. Both these processes together are putting coral reefs under increasing stress and degradation (Figure 3).

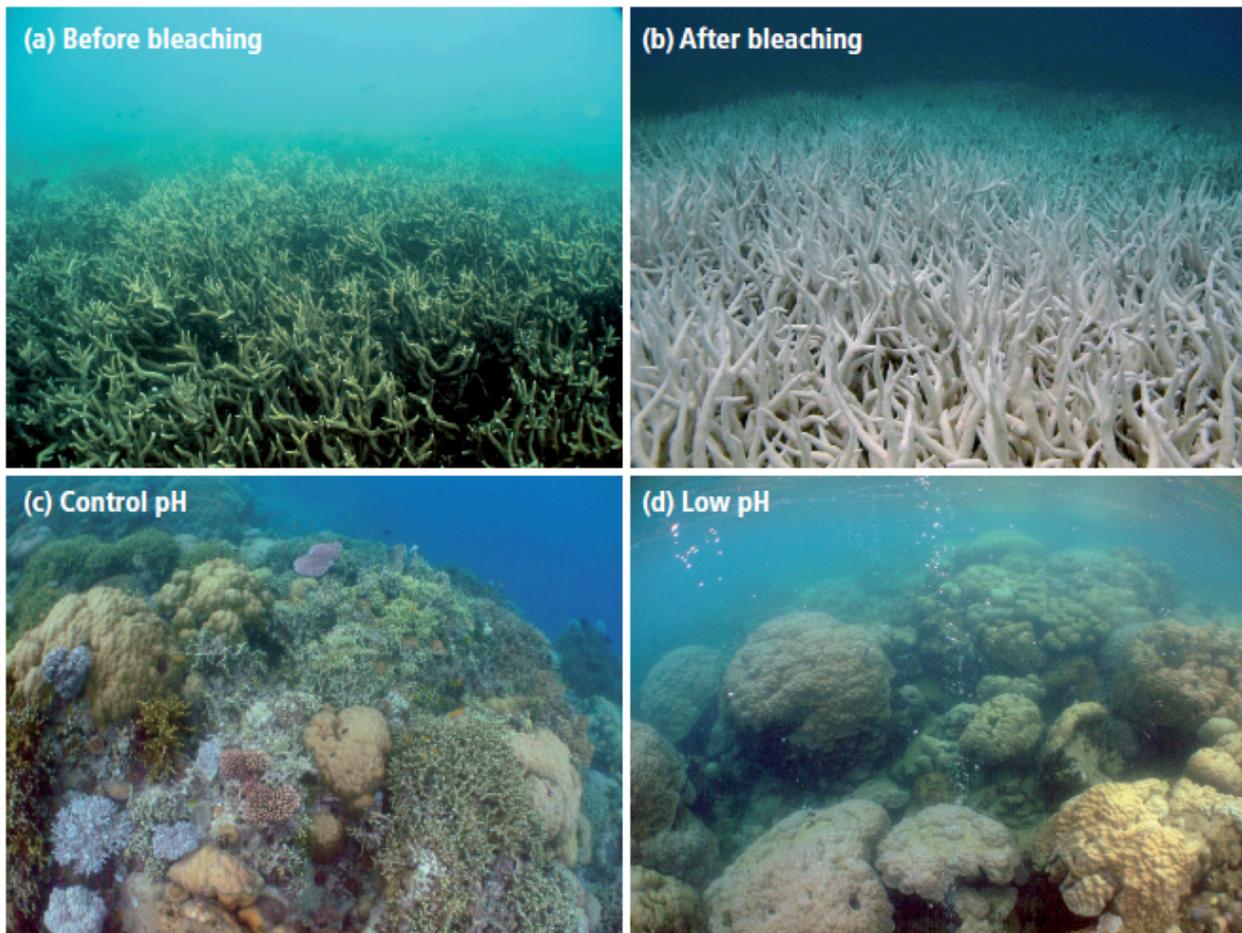


Figure 3. Affect of bleaching and acidification on coral reefs. (Image from IPCC 2014 Part A, <https://www.ipcc.ch/report/ar5/wg2/>)

## 2: Tourism

Tourism is the single largest industry in the Maldives' economy, with more than 1 million visitors per year. Twenty-eight percent of the Maldives GDP comes from tourism and more than 90% of government tax revenue is from import duties and tourism-related taxes. The beautiful natural environment, including stunning coral reefs and beaches, is the major attraction for visitors (Figure 4). Climate-related degradation of the reefs could negatively affect the tourism industry. As early as 2005, nearly 45% of tourist resorts have also reported varying degrees of beach erosion from sea-level rise.



Figure 4. Resort on Thudufushi, Ari Atoll. (Image by Martin Falbisoner. [https://commons.wikimedia.org/wiki/File:Diamonds\\_Thudufushi\\_Beach\\_and\\_Water\\_Villas,\\_May\\_2017\\_-04.jpg](https://commons.wikimedia.org/wiki/File:Diamonds_Thudufushi_Beach_and_Water_Villas,_May_2017_-04.jpg))

### 3: Fisheries

Fisheries contribute about 15% of the country's GDP and engage about 30% of the country's workforce. Fishing is also a deeply rooted part of the Maldives culture as it was the primary element of the Maldivian economy for centuries. Coral reefs provide critical habitat for some of the Maldives fisheries and thus loss of reefs risks these species. Deeper-water species can also be affected by climate change. For instance several years of temperature changes led to a transformation of the biophysical conditions of the pelagic environment, resulting in decreased tuna catch around the islands. Overall, IPCC predicts a "high confidence" reason for concern (RFC) for the "loss of marine and coastal ecosystems, biodiversity, and the ecosystem goods, functions, and services they provide for coastal livelihoods, especially for fishing communities in the tropics and Arctic."



Figure 5. Fisherman in the Maldives. (Image by Canopus Maldives.  
<https://www.flickr.com/photos/whltravel/4972130356/in/photostream/> [CC BY-NC-SA 2.0])

### 4: Loss of land and critical infrastructure

Eighty percent of Maldives land is <1 meter above sea level, putting the nation at significant risk of land loss from sea-level rise. More than 67% of inhabited islands reported beach erosion in 2013 at different scales and severities. Both the international airports are within 50 meters of the coastline. Approximately 50% of houses, 70% of infrastructure for fisheries, 75% of communications infrastructure, and 90% of tourism resort infrastructure within 100 meters of the coastline. Utility facilities (including power and waste) are within 100 meters of the coastline.



Figure 6. Left image: Maldives capital city, Malé ([https://commons.wikimedia.org/wiki/File:Maldives\\_Approach\\_Finals\\_-\\_Rwy\\_36\\_Short\\_Finals\\_1.jpg](https://commons.wikimedia.org/wiki/File:Maldives_Approach_Finals_-_Rwy_36_Short_Finals_1.jpg)).  
 Right image: Malé International Airport ([https://commons.wikimedia.org/wiki/File:Mal%C3%A9\\_im\\_Landeanflug.jpg](https://commons.wikimedia.org/wiki/File:Mal%C3%A9_im_Landeanflug.jpg)).

## 5: Food security

Total cultivatable land on the Maldives is only  $\sim 27 \text{ km}^2$ , making the country extremely dependent on imports. Almost all food items except fresh tuna and coconut are imported. The food security of Maldives is thus vulnerable to climate change–related impacts on the agriculture of other countries. Limited food storage and ad hoc distribution system also lead to a security risk to the population.

## 6: Human Health

Temperature and rainfall changes are causing higher incidence of vector-borne diseases, which are human illnesses caused by parasites, viruses, and bacteria that are transmitted by mosquitoes, various flies, ticks, mites, snails, and lice. It appears that dengue fever outbreaks are becoming more frequent and may be associated with El Nino events. The vulnerability to climate change–related health risks is further compounded by local characteristics such significant malnutrition among children, lack of healthcare access, low incomes, and high population congestion. Climate change–related impacts on fisheries and agriculture, which threaten food security in the Maldives, will have a direct effect on the nutrition status of children and on the overall health of the population.

## 7: Sea-level data

The locally measured sea-level tide gauge data from Maldives also shows that sea levels are rising. Sea levels vary seasonally but the overall direction of change is clear. How much did the local sea level rise in the  $\sim 30$  years over which measurements have being made (Figure 7)?

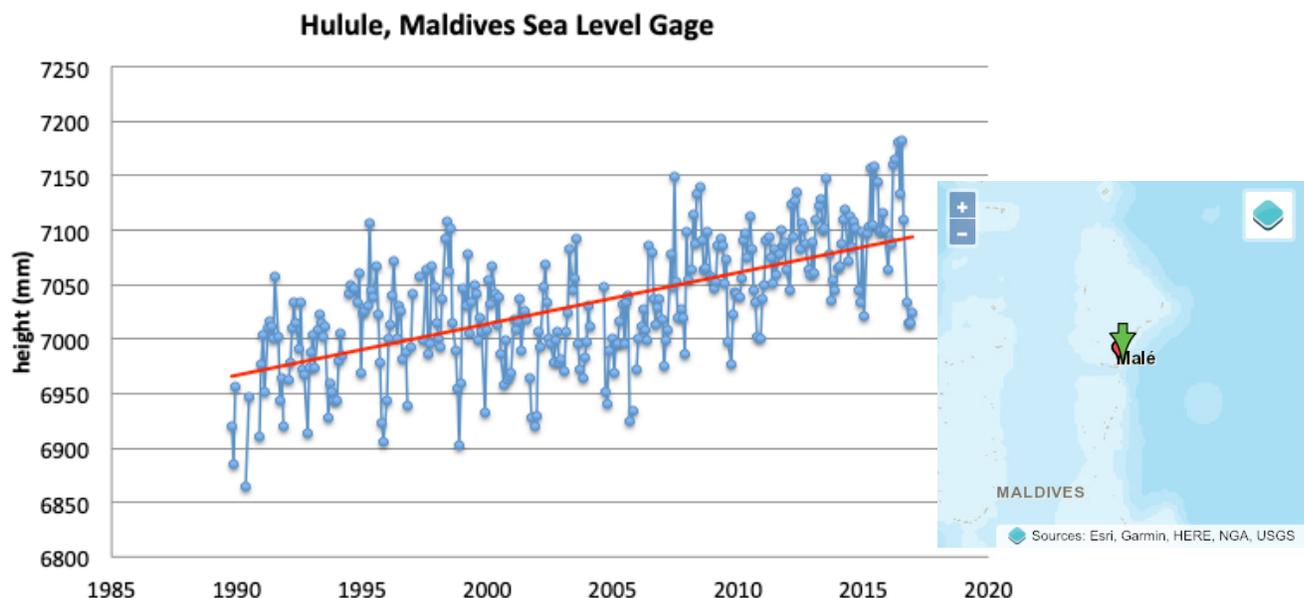


Figure 7. Monthly sea-level tide gauge data from Hulule gauge in the Maldives, 1989–2016.  
<http://www.psmsl.org/data/obtaining/stations/1753.php>

## References

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