# Small Island States in Indian and Atlantic Oceans: Vulnerability to Climate Change and Strategies for Adaptation

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**Abstract**

Small Island Developing States (SIDS) are among the world's nations that are most vulnerable to climate change. SIDS have neither the resources nor the expertise to effectively evaluate the risks associated with climate change, nor the ability to adapt to potential changes. Compared to islands in the Pacific Ocean and the Caribbean Sea, SIDS in the Indian Ocean and eastern Atlantic Ocean off of the west coast of Africa are among the poorest and least studied of the SIDS. In this United Nations supported study, five Indian Ocean SIDS (Comoros, Madagascar, Mauritius, Seychelles, and Maldives) and two Atlantic Ocean SIDS (Cape Verde, and the Republic of Sao Tome & Principe) are evaluated for their vulnerability to climate change, with an emphasis on impacts on water resources and coastal zone resources. Due to significant differences between the SIDS studied in terms of size, topography, geology, precipitation, population density, storm patterns and intensities, relative sea level rise, indicators of wealth (such as GDP/capita), and other island characteristics, each SIDS faces its own unique challenges. This paper describes the major findings of the study. One important finding is that relative sea level rise at present appears most significant on one of the SIDS (Maldives), and a number of other SIDS appear to be emerging slightly at a rate high enough to presently offset the effects of global sea level rise. However, analysis shows that at sometime during the 21st century, should sea level rise accelerate as climate models now suggest, that all the SIDS will become vulnerable to sea level change. Further, an existing stress on most of the SIDS is the human population density and tourism that have increased dramatically at most SIDS over the past several decades. Tourism provides both economic benefits to the islands, while at the same time tourists consume resources at rates typically far in excess of the native population. Therefore, stresses on water resources and the coastal zone due to human population are factored into the climate change stresses that are projected to increase over this century. Finally the paper describes capacity building efforts and strategies for adaptation that are intended to bring attention, resources, and expertise to the aid of the SIDS. One vehicle to do this is through the development of an Internet portal, eventually to be hosted and maintained by one of the SIDS.

## Introduction

SIDS are small island countries that are primarily located in the tropical Pacific, Atlantic, and Indian Ocean. At present 37 SIDS are members of the United Nations and 14 other SIDS are not members. Of the seven SIDS that are the focus of this study, five are located in the Indian Ocean (Comoros, Madagascar, Mauritius, the Seychelles, and the Maldives) and two are located in the Atlantic Ocean (Cape Verde and the Republic of Sao Tome & Principe). See Figure 1.

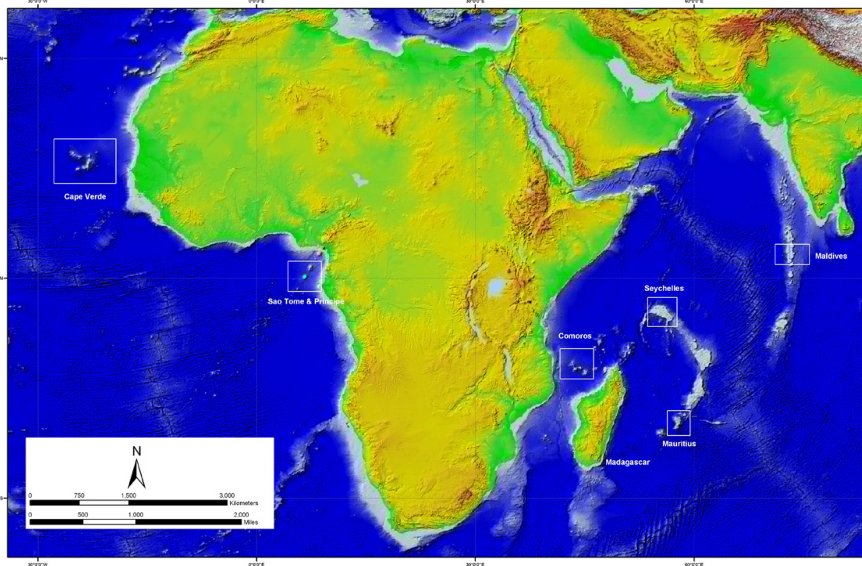


**Figure 1.**
Location of SIDS being studied.

While Madagascar, the fourth largest island in the world, is technically not a SIDS, the United Nations included this country in the study due to the similarity of problems it faces compared to the other six SIDS. To provide some historical perspectives on issues with respect to SIDS, the timeline shown in Figure 2 that extends from 1992 to 2008 was created. In January 1992 the Earth Summit was held in Rio de Janeiro. This United Nations conference focused on the need to plan for sustainable develop in all the world's countries. Also developed was the United Nations Framework Convention on Climate Change (UNFCCC) that concluded the nations of the world had a responsibility not to cause climate change that was dangerous to earth. In April-May of 1994 the United Nations Global Conference on Sustainable Development of SIDS was held in Barbados. The conference developed and adopted the Barbados Programme of Action (BPoA) in support of sustainable development for SIDS. Also created at this conference was the Alliance of Small Island States (AOSIS) with a membership of 43 SIDS that was intended to give a single, more powerful voice to the small nations. In 1999 the United Nations convened a session on SIDS, where representatives from the SIDS voiced their concerns about increasing vulnerabilities and problems their nations faced, and the need for action. At the World Summit on Sustainable Development (WSSD) held in New York City in September 2002, SIDS continued to focus on issues they faced and inactions on addressing them. A resolution of that summit was a call for a review of the BPoA at a conference planned for Mauritius in 2004. During the following two years (2003 and 2004) a number of planning meetings attended by the SIDS were held to prepare for the Mauritius meeting, which had been changed to 2005 due to disruption of planning and construction activities by tropical cyclones. Before the meeting could be held, the December 26, 2004 Indian Ocean tsunami swept across the Indian Ocean devastating many low-lying countries, and impacting a number of Indian Ocean SIDS as well. Two weeks later in January 2005, the BPoA +10 meeting was held in Mauritius. A renewed sense of action regarding the plight of SIDS emerged from that conference. In this paper, the work completed in the pre-Mauritius planning phase for this project is presented along with recommendations for addressing future climate related issues.

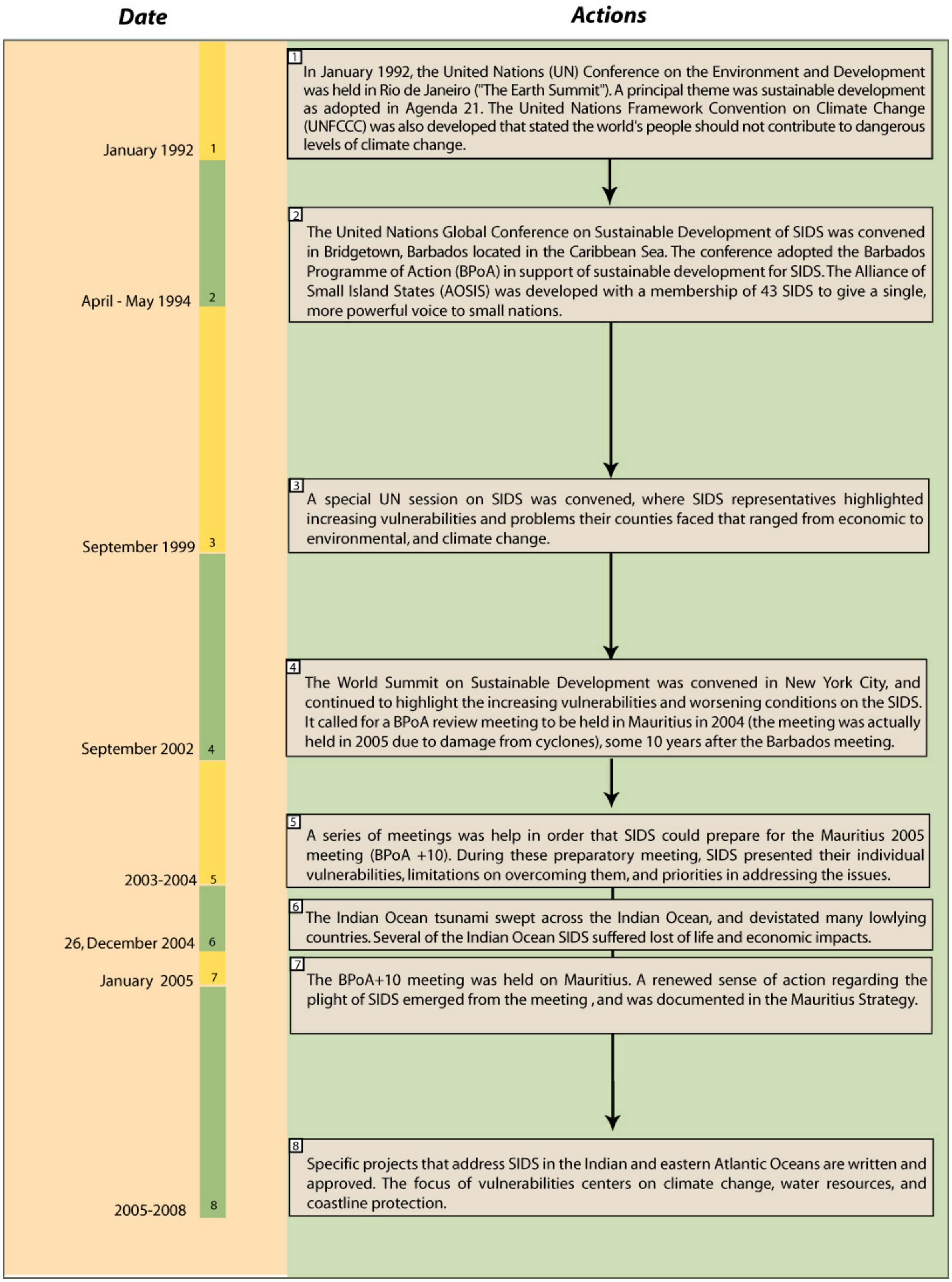


**Figure 2.**
Timeline relevant to recognizing and addressing vulnerabilities associated with Small Island Developing States.

## Characteristics of SIDS Under Investigation

The locations of the seven SIDS under study are shown in Figure 1. They are located between 18° N and 26° S. The two SIDS in the eastern Atlantic Ocean are located hundreds of kilometers off the coast of Africa, while several of the Indian Ocean SIDS (Mauritius, the Seychelles, and the Maldives) are located a thousand or more kilometers from a continental land mass, all testimony to their remoteness. A summary of basic information about the islands is included in Table 1. All of the SIDS, except Madagascar, consist of multiple island groups, with the largest numbers being the Maldives (1190), Seychelles (115), and Cape Verde (10). The islands within a given SIDS can be dispersed hundreds of kilometers (Seychelles and Maldives) from each other, an indication of their remoteness and difficulty in assessing vulnerabilities. The population on the islands ranges from 17,500,000 on Madagascar to 81,000 on the Seychelles. However, due to the small land area on each island except Madagascar, the population density on the six remaining SIDS is high, exceeding 100 people per square kilometer. Each of the islands has a major city, where typically 10 to 30% of the people live, with the exception of 47% on Sao Tome. All of the islands experience environmental problems, as summarized in Table 1. Common problems include soil and coastline erosion, water supply limitations, coral reef loss, and loss of habitat for threatened and endangered species. The island group most susceptible to sea level rise is the Maldives, low-lying coral islands where elevations are no more than 2.4 meters above mean sea level (msl). Together, the islands have nearly 8000 km of coastline, nearly twice the distance from San Francisco to New York City.

**Table 1.** Basic SIDS information.

| SIDS | Number of Major Islands | Land Area, (km2) | Population | Largest City & Population | Population Density (km2) | Highest Elevation (m) | Coastline Length (km) | Terrain |
|---|---|---|---|---|---|---|---|---|
| **Cape Verde** | 10 | 4033 | 412,000 | Praia 101,000 | 102 | 2829 | 965 | Steep, rugged, rocky, volcanic. |
| **Sao Tome & Principe** | 8 | 960 | 143,000 | Sao Tome 67,000 | 150 | 2024 | 210 | Volcanic, mountainous |
| **Comoros** | 3 | 2170 | 652,000 | Moroni 60,000 | 300 | 2360 | 340 | volcanic, interiors vary from steep mountains to low hills. |
| **Madagascar** | 1 | 581,540 | 17,500,000 | Antanarivo 1,390,800 | 30 | 2876 | 4,828 | Narrow coastal plain, high plateau and mountains in center. |
| **Mauritius** | 4 | 2030 | 1,220,000 | Pont Louis Pop:160,000 (577,000 in Metropolitan Area) | 600 | 828 | 177 | Small coastal plain rising to discontinuous mountains with central plateau. |
| **Seychelles** | 43 Granitic 72 Coralline | 455 | 80,900 | Victoria 23,000 | 177 | 905 | 491 | Mahe group is granitic & narrow coastal strip. Others are coral, flat, with reefs. |
| **Maldives** | 1190 Coral Islands grouped in 26 atolls | 300 | 254,000 | Male 82,000 | 1130 | 2.4 | 644 | Flat with sandy white beaches. |
| Totals | 1331 | 591,500 | 20,262,000 | 1,884,000 | 34 | - | 7660 | |

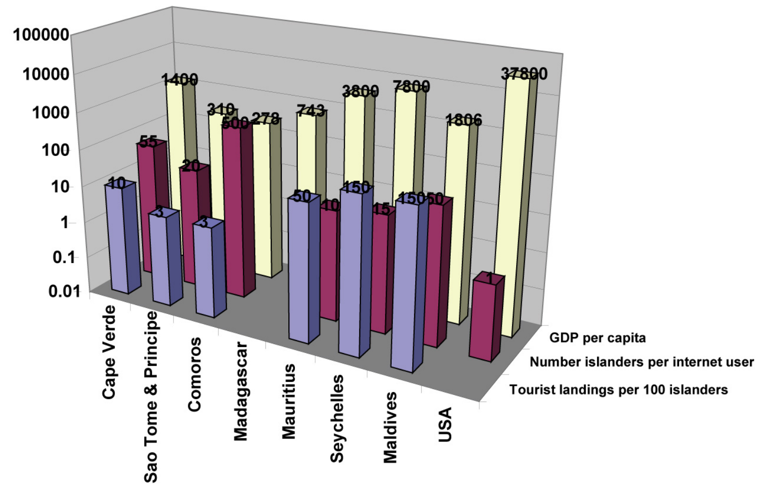


**Figure 3.**
Economic indicators for the SIDS.

Several important economic indicators for the SIDS are shown in Figure 3 and compared to the United States. The United States gross domestic product (GDP) per capita is approximately 100 times that of two of the islands, Comoros and the Republic of Sao Tome & Principe, and 10 to 20 times the GDP per capita for the remaining islands, except the Seychelles. The Seychelles has a GDP per capita of about 20% that of the United States, largely due to the strong tourist industry and small population. The numbers of annual tourist landings normalized to 100 islanders shown in the figure indicate that the Seychelles and the Maldives have about 150 tourist landings per 100 islanders. On the other end of the spectrum are Comoros and the Republic of Sao Tome & Principe, with only 3 tourist landings per 100 islanders. The number of inlanders per Internet user for all of the islands is quite large compared to the United States, where most people use the Internet. On Comoros only one in 500 people are Internet users, where as in Mauritius 1 in 10 people use the Internet.

**Planning Study Results for BPoA + 10**

As shown previously in Figure 2, planning for the BPoA +10 meeting held in Mauritius in January 2005 began several years ago. During that time one of the projects executed was to identify data sources that could be used as a beginning point to address the issues of climate change impacts on the SIDS, with an emphasis on how such changes would influence water resources. A summary of the major data categories reviewed during the study with respect to climate change implications and associated limitations are shown in Table 2. The first data category identified has to do with the availability of high resolution and detailed maps that will be needed throughout the project for many applications. During the review project, not a single high-resolution map of a single country was located. One of the most important reasons such maps are needed is to accurately delineate the 1-meter elevation contour (and 2 m and 3 m contours, etc.) above present day sea level on each island in order to evaluate susceptibility to sea level rise. The horizontal distance on an island that corresponds to a 1-meter elevation increase will, of course, vary from island to island, but typically this distance exceeds 100 meters. On maps of a scale 1:100,000 (the scale of maps now produced by the Global Land Cover Network (GLCN) for small African countries to be used for this project), 100 meters would translate to a map distance of 0.1 cm. Such a small distance would not be distinguishable. Considerations of map resolution, accuracy, and information displayed will need to be continuously re-evaluated.

**Table 2.** Examples of major categories of data examined for climate change implications and data limitations.

| ***Data Category*** | ***Limitations*** |
|---|---|
| Island topographic data, latitude/longitude readings that delineate spatial grid of island points, infrastructure delineation, detailed maps, and remote sensing data | Practically no high resolution maps of the islands have ever been created, the data to provide a basis for detailed maps has generally not been collected nor digitized. Recently available space shuttle imagery will be very useful to helping to overcome some of these limitations. |
| Sea level change data | Periods of record at tide gauge stations on the islands is typically less than 10 years. 40 to 60 years of sea level change data are needed to detect long term trends. |
| Water resource data | Very little inventories of available water resources (surface and subsurface) and their variability have been completed. Mauritius is an exception where long-term average characterizations are available. |
| Coastal resources data | Little island specific data are available, and is not unexpected because of the large number of islands, thousands of kilometers of coastlines, and accessibility limitations. |
| Historical climate change and variability | Historical climatic data for the past 30 years are available, but resolution is not high enough to show spatial variabilities that exist on different islands within a single island state, nor by elevation differences, important on six of the seven SIDS. |
| Projected climate change and variability | Climate change models today generally are not adequate to make predictions at the small spatial scales of concern. |
| Changes in storm frequencies | Predictions of changes in storm frequencies, such as the occurrence of tropical cyclones on specific islands, are even more problematic than predicting climate change. |
| Abrupt climate change or extreme events | Rapid sea level rise, say due to destabilization of large ice sheets on Antarctica where 3 meters or more abrupt sea level rise could occur, would inundate much of the population since the maximum elevations of many islands is less than 3 m, and on most islands the population lives along the shoreline. The vulnerability to extreme sea level rise could be partially and rapidly assessed by examining the extent of inundation from the December 26, 2004 tsunami. |

In the USA, the United States Geological Survey produces the most widely used topographic maps at the 1:24,000 scale, and coverage of the entire country is complete (56,000 maps). These maps incorporate the results of aerial photography so that surface features and vertical elevations can be included (such as buildings, surface waters, mountain ranges and peaks, elevation contours, and many other features). Shorelines can generally be shown, as appropriate. Contours on such maps can range from 100 m contour intervals in mountainous areas to 2 m contours in relatively flat areas. However, even maps of this resolution (1:24,000) may not be of high enough resolution for some of the small islands. Horizontal scales of 1:1,000 and vertical contours of one meter or less, at least around coastlines, may be required. This is higher resolution than the USGS maps. In the past, each USGS map has taken up to five years to prepare, so this level of detail will not be possible to attain over the next several years. Interestingly, some of the highest resolution maps of small islands were created during World War II. On Wake Island (Otori-Shima) in the Pacific Ocean, maps of horizontal scales of 1:10,000 were created, for example, although elevation contours were not included. Vertical elevations at a high resolution have recently become available from the Space Shuttle Radar

Topography Mission (SRTM). Nearly entire coverage of the earth was obtained and has generated a new global digital elevation model of the earth at horizontal elevations of between 30 m and 90 m.

The second category of data evaluated was sea level change. Sea level data from the Permanent Service for Mean Sea Level (PSMSL) (http://www.pol.ac.uk/psmsl/whatispsmsl.html) were identified. Data are available for at least one island for each of the SIDS and at three to five locations for a number of island groups, for a total of 20 locations. The periods of record for each station range from one year to 19 years. However, data collection at many of the stations was discontinued decades ago, and it appears no more than a handful of stations at two of the SIDS are still operational today. Even 19-year data records are not long enough to reliably detect long term changes in mean sea level. The PSMSL recommends having 40 years or more of continuous data at a station to get a true picture of sea level change.

The sea level data at the locations with the longest periods of record have been analyzed to estimate historical rates of relative sea level change (sea level change relative to the local datum), and then projections of relative sea level change were made to the end of the 21st century. MAGICC (Wigley, 2003) was used to make the predictions. There are uncertainties in how rapidly sea level will rise, and some of these uncertainties can be reflected in the simulations performed by MAGICC. Second, even if relative sea level is presently dropping at some island sites, in the future, this could reverse if the island stops rising and starts to subside, or if global sea level increases accelerate (as many models predict they will).

Table 3 provides predictions of relative sea level change for the end of the 21st century. Predictions are made at stations located on six of the island groups (10 stations in all). For each location, two predictions were made using MAGICC: absolute sea level increases by 500 mm by the end of the century (a median case), and absolute sea level increases by 900 mm at the end of the century (a more extreme case). The relative sea level increases incorporate island subsidence (or emergence) over the period of predictions based on historically calculated levels.

By scanning down the two columns of predicted relative sea level changes, it is immediately apparent that the relative sea level is not predicted to increase at all locations, and to increase dramatically at other locations. These differences are largely due to island submergence rates. The SIDS that is predicted to be most impacted by relative sea level rise during the 21st century is the Maldives. Relative sea level is predicted to increase by 730 mm to 1560 mm at this group of islands. Given that the maximum elevation on the island is about 2400 mm (2.4 m), this increase would devastate the islands.

The Seychelles appear to be the second most severely impacted, especially on the coralline islands where the topographic relief is small. Relative sea level increases on Madagascar are predicted to range from 620 mm to 1020 mm. However, Madagascar is much larger then any of the other SIDS, so that island may be less vulnerable than the others.

The data for the Cape Verde Islands appear to show that relative sea level will drop through the 21st century regardless of the rate of absolute sea level rise. These predictions should be a continuation of past trends, so local qualitative observations should be used for confirmation.

On Mauritius, predictions are mixed, as seen by comparing Part Louis II data sets. Rodriquez Island (adjacent to Mauritius and part of this SIDS) is presently emergent, and is predicted to remain emergent through the 21st century if absolute sea level rises by the median amount, and to submerge only slightly if absolute sea level increases by the more extreme estimate.

Fresh water resources are very limited on all of the SIDS, and are critical on the poorest islands. On the Grand Comores (the largest island of the Comoros), the typical water consumption is only 18 liters per capita per day. Only a few of the larger and mountainous islands like Madagascar and Mauritius (the two most populated islands as well) have large reservoirs to attempt to provide a sustainable water resource for water supply, industry, agriculture, and in some cases, hydropower production. On the very flat islands, such as the Maldives and the low-lying coralline Seychelles, practically no surface water resources exist other than from rainwater catchments. Fresh groundwater lens are in jeopardy of being depleted by increasing demand and rising sea levels.

It is presently not possible to perform a detailed assessment of the status of water resources and the potential impacts of climate change on the islands. There are few weather stations maintained, and long-term precipitation data by season or year is not available. Since each of the SIDS experiences a dry season, information on their durations and severity are critical for water resources planning. Mauritius is the single SIDS that has begun to examine water resources in a quantitative manner, and the impacts of pollution on these resources. Both liquid and solid wastes are issues, and the discharge of such wastes has had a detrimental impact on both fresh and coastal waters.

**Table 3.** Comparisons of past and projected sea level changes for selected SIDS in the Indian and Atlantic Oceans.

| Island | Station # | Period of Record | Estimated Historical Relative Sea Level Rise, mm | Estimated Global Sea level Rise During This Period, mm* | Calculated Island Subsidence mm/period** | Absolute Sea Level Rise During 21st Century (mean case) | Relative Sea Level Rise During 21st Century (mean case) | Absolute Sea Level Rise During 21st Century (more extreme case) | Relative Sea Level Rise During 21st Century Mean Case (more extreme case) |
|---|---|---|---|---|---|---|---|---|---|
| **Mauritius Island** – Port Louis | 450011 | 1942-65 | 20 mm/ 30 yr | 54 mm/ 30 yr | -34 mm/ 30 yr | 500 mm | +390 mm | 900 mm | + 790 mm |
| – Port Louis II | 450012 | 1986-2000 | -100 mm/ 16r | 29 mm/ 16 yr | -129mm/ 30 yr | 500 mm | -300 mm | 900 mm | + 94 mm |
| – Rodriquez Island | 450021 | 1986-2000 | -110 mm/ 16 yr | 29 mm/ 16 y r | -139 mm/ 16 y r | 500 mm | -370 mm | 900 mm | + 31 mm |
| **Seychelles-** – Combination of Victoria and Port Victoria B | 442001 442002 | 1976-1992 | 65 mm/ 25 yr | 45 mm/ 25 yr | +20 mm/ 25 yr | 500 mm | + 580 mm | 900 mm | + 980 mm |
| **Maldives** – Male B Hulule | 454011 | 1989-2000 | 45 mm/ 14 yr | 20 mm/ 11 yr | +25 mm/ 11 yr | 500 mm | +730 mm | 900 mm | + 1130 mm |
| – Ga II | 454002 | 1987-2000 | 75 mm/ 14 yr | 25 mm/ 14 yr | +50 mm/ 14 yr | 500 mm | 860 mm | 900 mm | + 1250 mm |
| – Hanimaadhoo | 454021 | 1991-2000 | 100 mm/ 12 yr | 21 mm/ 12 yr | 79 mm/ 12 yr | 500 mm | 1150 mm | 900 mm | + 1560 mm |
| **Comoros** | 438001 | 1985-1995 | 30 mm/ 11 yr | 20 mm/ 11 yr | 10 mm/ 11 yr | 500 mm | 590 mm | 900 mm | + 990 mm |
| **Cape Verde** | 380002 | 1990-1995 | -60 mm/5 yr | 10 mm/ 5 yr | -70 mm/ 5 yr | 500 mm | -900 mm | 900 mm | -500 mm |
| **Madagascar** | 440002 | 1987-1998 | 30 mm/ 10 yr | 18 mm/ 10 yr | 12 mm/ 10 yr | 500 mm | 620 mm | 900 mm | + 1020 mm |

* Based on 1.8 mm/yr
** Subsidence corresponds to positive numbers.  Emergence corresponds to negative numbers.

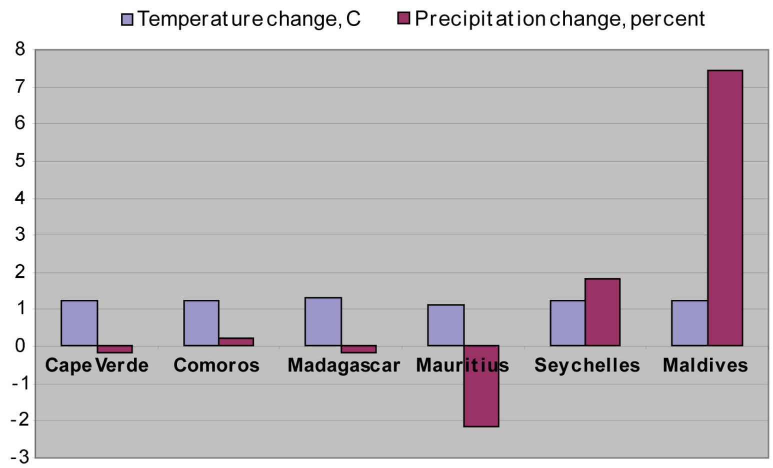


**Figure 4.**
Changes in temperature and precipitation from baseline to 2050.

Predictions of annual temperature and precipitation changes for the year 2050 were made for each island and are shown in Figure 4. These predictions were made using MAGICC/SCENGEN (Wigley, 2003) using a business-as-usual scenario. The temperature increases are similar across the islands at about 1.2 °C. Precipitation is predicted to remain nearly the same on Cape Verde, Comoros, and Madagascar; to decrease by two percent on Mauritius; and to increase on the Seychelles (1.8%) and the Maldives (7.2%). These predictions do not account for the spatial changes that may occur on the islands due to topographic effects, nor is the resolution high enough to examine differences in specific islands within the more dispersed of the SIDS. Nevertheless, the effect of the increasing temperatures should increase evapotranspiration, and may offset any of the beneficial effects of small increases in precipitation.

Two additional climate change areas examined are projected changes in magnitudes and frequency of tropical cyclones, and abrupt climate change issues. At present, it is not possible to predict how climate change will offset severe storm patterns. However, typhoon climatology is available for the Indian Ocean (Figure 5) that shows the Maldives, Comoros, Madagascar, and Mauritius are all located in the paths of typhoons. The Southern Indian Ocean SIDS are most vulnerable, where 28 typhoons per year have been documented to occur over a 21-year period from 1981-2001. In the northern Indian Ocean, five tropical cyclones per year have occurred over the 26-year period from 1975-2001.

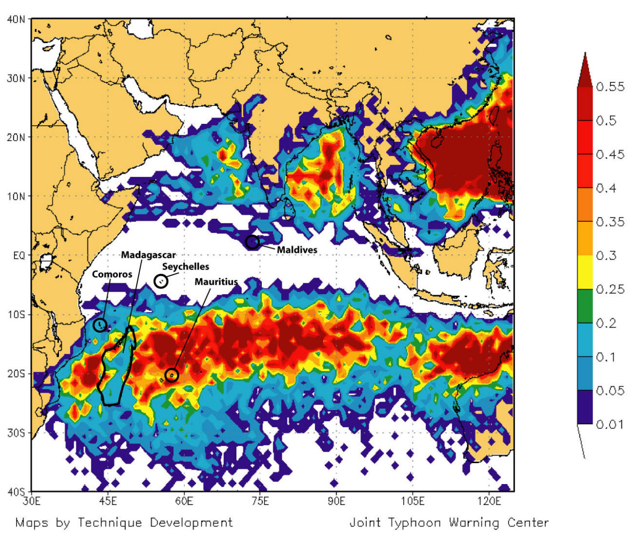


**Figure 5.**
Number of best track positions passing through 1x1 box for all months (1972-2001).

In the area of abrupt climate change, an event that could substantially affect these small islands is rapid sea level rise due to destabilization of large ice sheets on Antarctica where 3 meter or more sea level rise could occur (Ball, 2004). Should such a sea level rise occur, many of the low-lying SIDS, including all of the Maldives, would be permanently submerged.

**Summary and Recommendations for Future Studies**

As documented in this paper, the seven Indian and Atlantic Ocean SIDS under investigation for this work are all quite vulnerable to climatic change stresses that include gradual or abrupt sea level rise, a warming climate with uncertain precipitation changes, potential changes in the severity and frequency of tropical cyclones in an already active area in the world, and their effects on the islands' natural resources, such as freshwater, coastal areas, and abundant and diverse flora and fauna. At the same time, the islands resources to combat their vulnerabilities is limited due to economic limitations, data limitations, the remoteness of the islands, the dispersion of the islands, and the shear magnitude of the issues. With this in mind, the following recommendations are provided:

- **Prioritize.** It will not be possible to address all problems for the more than 1000 SIDS with 8000 km of coastlines in a reasonable timeframe. Therefore, a prioritization of the problems faced on an island-by-island basis is needed, taking into account those issues that are most pressing today, and those issues that might be more pressing at a future time.
- **Complete the analysis of existing data, develop a data collection network, and begin work to evaluate vulnerabilities and adaptation strategies.** To date, the efforts to evaluate existing data have focused on data available on the Internet. While large quantities of data were located, data that may have been stored regionally in paper form, or otherwise not put on an Internet site may be available. Such data may be useful for many purposes, including a better characterization of past conditions on the islands. A data collection network needs to be established with well-defined objectives. However, it will take years before enough data are collected to evaluate natural variability, temperature trends, and sea level changes, for example. Therefore, a strategy to proceed with limited data will be needed. Waiting too long to act will likely make existing vulnerabilities far worse.
- **Develop techniques for rapid map making.** High quality and accurate maps will need to be created to display information as it is generated, to evaluate vulnerabilities, and to perform the important role of facilitating communication between technical people, managers, decision makers, the public, and other concerned parties. Since this could be a monumental task, options for streamlining the work will need to be considered. There is no doubt that remote sensing data (from aerial or satellite imagery) will be needed. More straightforward methods such as individuals with GPS taking extensive digital photographs can also be utilized.
- **Evaluate water resources.** Adequate water resources, with or without climate change, is presently one of the most pressing issues that all SIDS face. To evaluate this problem, a comprehensive approach should be developed that examines both surface water and ground water, and includes the impacts of solid and liquid waste. One specific suggestion would be to analyze water resources on a watershed basis, and develop water balances that can be used to quantify relative magnitudes of water use.

- **Respond to sea level rise.** One of the most imposing and long term issues the islands face is responding to sea level rise. Based on the analysis reported earlier in this paper that shows that sea level rise could reach a meter or so by the end of the century, it is suggested that the one-meter elevation contour above present sea level be accurately determined on the islands of concern. This can be used as an approximate line of demarcation useful in evaluating vulnerabilities.
- **Use knowledge of the December 26, 2004 tsunami impacts to help develop adaptation strategies.** As terrible as the tsunami was in wreaking damage and causing loss of life, the information gained from the tsunami can be used to assist in vulnerability and adaptation planning. Examples include: 1) The height of the tsunami waves as they washed over the islands has been well documented by survivors and evidence such as high water marks on buildings. Such information can be used to estimate the response of a slow long term rising of the level of the sea, and identify particularly vulnerable areas; 2) Islands or parts of islands that were resilient to the tsunami can be examined to determine if natural barriers (such as coral reefs, mangroves, wetlands) or manmade barriers were helpful; and 3) The opposite effect can be examined to determine how man's activities actually increased vulnerabilities.
- **Plan and execute demonstration projects.** Several demonstration projects should be designed and implemented to illustrate how such projects can be effectively carried out on the remaining islands.
- **Develop an Internet web portal** that communicates the progress, issues, and other activities associated with the project to the entire region and to others around the world who have an interest in the project.

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