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SUMMARY

Small island states are the countries likely to be most vulnerable to climate variability and long-term climate change, particularly extreme weather and climate events (such as cyclones, floods and droughts) and sea-level rise. Many small island states share characteristics that increase their vulnerability, these include their small sizes, isolation, limited fresh water and other natural resources, fragile economies, often dense populations, poorly developed infrastructures and limited financial and human resources. To understand better the potential health impacts of climate variability and change in small island states and to build capacity to cope with climate change through adaptation planning, a series of workshops and a conference were organized by the World Health Organization (WHO) in partnership with the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP)(WHO 2000; Aron et al. 2003; WHO 2003). This report synthesizes the information presented and identifies key recommendations for improving the health sector's capacity to anticipate and prepare for climate variability and change.

There is ample evidence that many small island states currently are vulnerable to climate variability. Climate change projections increase the level of concern because models suggest that small island states will experience not only warmer temperatures, but also increased climate variability. The consequences of increased climate variability are likely to be related to changes in rainfall, soil moisture budgets, prevailing winds (speed and direction), regional and local sea levels and patterns of wave action. El Niño events are likely to strengthen the short-term and interannual variations. In addition, global mean sea level is projected to increase by 0.09 m to 0.88 m by 2100. To understand better the potential human health consequences of these projected changes, the following questions were addressed.

Key questions

1. Does climate have an impact on health?

A variety of adverse health outcomes are climate sensitive; that is, weather and climate affect their incidence and distribution. Some adverse health outcomes are related directly to weather, such as drowning and injuries in floods or increased morbidity and mortality during heat-waves. Other health outcomes are related indirectly to weather and climate, such as vector-, food- and water-borne diseases, fish poisoning and others. Estimates of the global burden of disease suggest the amount of disease attributed to climate change is larger than the amount attributed to air pollution in many regions.

2. What is the current distribution and burden of climate-sensitive diseases in small island states?

Specific climate-sensitive diseases vary among the small island states. The high priority diseases identified in the workshops include: malaria, dengue, diarrhoeal disease, heat stress, skin diseases, acute respiratory infections and asthma, fish toxins and malnutrition. Although the disease burdens vary, most of these countries experience one or more climate-sensitive diseases. These could be reduced by implementing additional interventions, including the development of early warning systems to alert the population and public health authorities to possible outbreaks.

3. What are the potential future health impacts of climate change in small island states?

There has been only limited modelling of the potential future health impacts of climate change. The results suggest that many climate-sensitive disease burdens can be expected to increase unless public health agencies and authorities begin to implement adaptation policies and measures to increase resilience.

4. What interventions are being used to reduce the current burden of climate-sensitive diseases?

There were many examples of the strategies, policies and measures that small island states have implemented to reduce the current burden of climate-sensitive diseases. Many of these initiatives recognized that the potential health impacts of climate variability and change do not need to be addressed individually; health outcomes with common risk factors, such as malnutrition and diarrhoeal diseases associated with the dry season, may be reduced together by the development of appropriate interventions. Most of these initiatives included the development of an early warning system to enhance opportunities for disease control. Development of early warning systems must be site-specific to take account of local climate/health relationships and local cultural factors.

5. What additional interventions are needed to adapt to current and future health impacts?

Although many small island states have implemented interventions to reduce the current burden of climate-sensitive diseases, clearly there is ample opportunity for improvement. Each workshop generated a long list of potential interventions that are needed both locally and regionally, such as better surveillance systems to facilitate improved detection of, and response to, climate-related risks; more, and more effective, early warning systems; effective health education programmes; strengthened health care infrastructures; disaster preparedness plans; vector monitoring and control; and appropriate sewage and solid-waste management practices.

6. What are the health implications of climate variability and change in other sectors?

Climate change will interact with, and exacerbate, other factors that contribute to the vulnerability of a particular region, such as water, agriculture, fisheries and coral reefs. For example, many small island states rely on a single water supply source such as groundwater, rainwater, surface reservoirs or shallow wells. These sources are climate sensitive and changes in precipitation or rising sea levels may affect fresh water availability, which will present additional challenges to public health.

RECOMMENDATIONS

► *Enhance awareness of climate variability and change's potential impacts on human health. This includes building awareness in small island states across the full range of stakeholders; incorporating a consideration of climate/health interactions in planned and ongoing development programmes as well as in global, regional and local environment and disaster-management planning; and developing advocacy messages for decision-makers and policy audiences.*

► *Enhance development of adaptation strategies, policies and measures to reduce potential impacts. This includes developing, improving and implementing early warning systems and other preventive strategies; monitoring and evaluating the effectiveness of these systems and strategies; developing long-term adaptive strategies for sea-level rise; and assessing the costs and benefits of intervention options.*

► *Address data needs, including the collection of more valid and comprehensive health, meteorological, environmental and socioeconomic data at the appropriate local, regional and temporal scales. Data management systems require improvement, and appropriate national and regional institutions need to be engaged in handling and analysing the data collected.*

► *Address high priority research questions, including expanding the knowledge of climate-sensitive diseases of importance to small island states through national and regional research; conducting basic entomological research; improving understanding of the complex relationships between the risks posed by climate variability and change and by other factors that influence population health; developing and evaluating indicators of the potential health impacts of climate variability and change; and understanding the links between climate and other sectors, such as agriculture and water supply, and how these could impact on health.*

► *Increase capacity building by developing institutional arrangements for knowledge sharing at national, regional and international levels; improving education and training; encouraging programmes of action and public/private partnerships; and transferring knowledge of adaptation options to countries with similar climate/health concerns.*

► *Develop and improve national and regional climate forecasts. In addition, create partnerships between climate/meteorology and public health/medical specialists to improve awareness of the use and uses of climate forecast information.*

► *Address resource needs by improving international, national and regional facilities and funding for capacity building, interdisciplinary research and regional/national assessments.*

INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) identified small island states as the countries likely to be most vulnerable to climate variability and long-term climate change (IPCC 2001). Former President Leo Falcam of the Federated States of Micronesia noted "for Pacific Island States, climate change and its associated effects are our main security concern" ("Death by warming", Honolulu Advertiser, 12 August 2001).

The world's island states are located mainly in the tropics and subtropics, spanning the Pacific, Indian and Atlantic Oceans, as well as the Caribbean and Mediterranean Seas. Small island states share many features that constrain their ability to adapt to current climate variability and future climate change, including their small or very small physical sizes; remoteness from major land masses; limited natural resources (often with unique animal and plant life); vulnerability to natural disasters and extreme weather and climate events; economies sensitive to external shocks; populations with high growth rates and densities; poorly developed infrastructures; and limited financial and human resources (Nurse et al. 2001).

Small island states also display a great deal of diversity. They may be single islands or groups. The islands differ in geological type, size, elevation, soil composition, drainage characteristics and natural resources. There are barrier, continental, coral, volcanic and mixed type islands. Some of the larger islands have significant elevation; others are low-lying small coral atolls. Natural resources, including water, range from scarce to abundant. Some islands have abundant surface water while others are completely dependent on groundwater; water requirements are just as diverse. Social, cultural and economic settings vary. The islands have achieved different levels of development. Sometimes infrastructures, including health, are poorly developed. Some islands have large commercial or industrial centres; others have extensive agriculture. Human communities range from large densely populated cities to small villages and dispersed populations.

Small island states' diversity in demographic, health, economic, environment and climate indicators is shown in the tables in Annex 1. As shown in Annex 1 Table 1, population ranges from 2000 in Niue to more than 11 million in Cuba; the population living in urban areas ranges from 13% in Papua New Guinea to 100% in Nauru. Particularly in Asia and the Pacific, many small island states have young populations, with a significant fraction below 15 years of age. Most small island states have healthy life expectancies (HALEs) in the 50s and 60s (compared with HALEs of 70 years and more in most developed countries), with approximately 7-8 years of healthy life lost in males and 9-10 in females. As shown by the probability of dying under 5 years old, the young experience most of the lost healthy years. Annual growth rates 1992-2002 ranged from negative in several small island states to more than 3%. Growth rates are not associated with GDP per capita; 3% or higher growth rates were experienced in Comoros with a GDP of $278 and in Bahrain with a GDP of US$12 012.

Annex 1 Table 2 shows the diversity of small island states in environment and climate indicators. As mentioned earlier, most small island states have tropical climates, with a narrow range of minimum and maximum temperatures and expected precipitation patterns. CO_2 emissions range from just a few thousand megatons to more than 35 500 megatons in Singapore. Energy consumption per capita has a similar broad range. Although small island states account for less than 1% of global greenhouse gas emissions, they are likely to be among the nations most seriously affected by climate change.

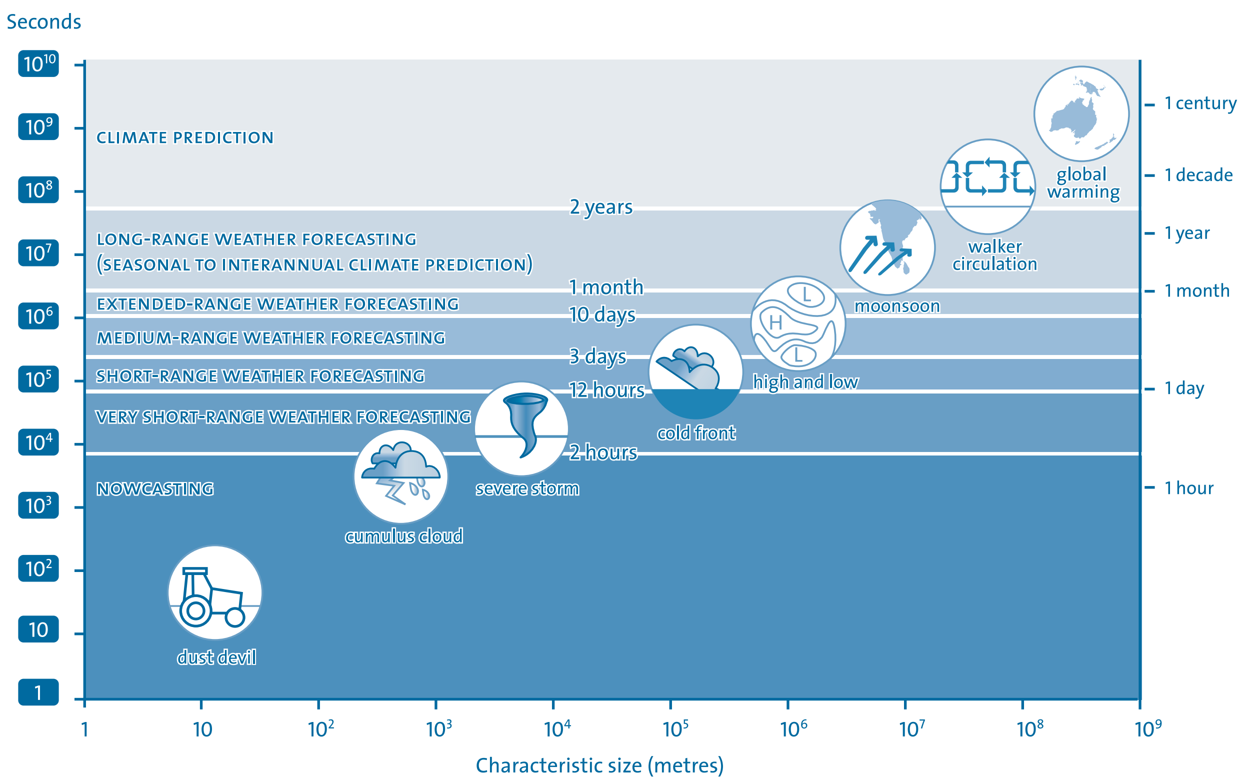
To understand better small island states' vulnerability to current climate variability and to build capacity to cope with climate change through adaptation planning, the World Health Organization, in partnership with the WMO and UNEP, organized a Pacific (Samoa, 25-28 July 2000), Caribbean (Barbados, 23–25 May 2002) and a global workshop (The Maldives, 1–4 December 2003). This report synthesizes the information presented at these workshops (and at a conference on the same topic held in Barbados, 21–22 May 2002) to identify key recommendations for improving the health sector's capacity to anticipate and prepare for climate variability and change.

CLIMATE VARIABILITY AND CHANGE

Often the terms weather and climate are used interchangeably even though they represent different parts of a continuum. Weather is the complex and continuously changing condition of the atmosphere considered on a timescale from minutes to weeks. Climate is typically described by the summary statistics of a set of atmospheric and surface variables, such as temperature, precipitation, soil moisture and sea surface temperature, in a particular region over a particular timescale, usually 30 years. Put more simply - climate is what you expect and weather is what you get.

Climate variability is the variation around the average climate, including seasonal variations as well as large-scale variations in atmospheric and ocean circulation such as the El Niño/Southern Oscillation (ENSO). Climate change operates over decades or longer. Changes in climate occur as a result of internal variability within the climate system and external factors (natural and anthropogenic). Although climate is always changing, over the past 10 000 years it has been both relatively stable and warm. Figure 1 shows the links between weather and climate.

FIGURE 1 **LINKING WEATHER TO CLIMATE**



Source: Nyenzi, Maldives workshop

Many small island states suffer negative health impacts from current climate variability, particularly extreme weather events. The El Niño/Southern Oscillation (ENSO) cycle is one of Earth's dominant modes of climate variability that affects small island states. ENSO is the strongest natural fluctuation of climate on interannual timescales, with global weather consequences (Glantz 2002; Ebi et al. 2003). An El Niño event occurs approximately every two to seven years. Originally the term applied only to a warm ocean current that ran southwards along the coast of Peru about late December. Subsequently an atmospheric component, the Southern Oscillation, was found to be connected with El Niño events. The atmosphere and ocean interact to create the ENSO cycle; there is a complex interplay between the strength of surface winds that blow westward along the equator and subsurface currents and temperatures. The ocean and atmospheric conditions in the tropical Pacific fluctuate somewhat irregularly between El Niño and La Niña events (which consist of cooling in the tropical Pacific) (Philander 1990). The most intense phase of each event usually lasts about one year. Figure 2 shows the links between ENSO and disease.

Although strongest in the tropical Pacific, changes in sea surface temperature during the ENSO cycle also affect temperature and precipitation over much of the subtropics and some mid-latitude areas (Glantz 1996, Glantz 2002). The impacts of El Niño events vary geographically and their severity varies from event to event. For example, during an El Niño year storm tracks in the Pacific shift to the west and tropical cyclones near the Marshall Islands are 2.6 times more likely than in a regular year (Spennemann & Marschner 1995). Similarly, the number of tropical cyclones observed in the north Australasia cyclone season is related to El Niño events and can be forecast by monitoring an ENSO index in the months preceding the cyclone season (Nicholls 1985).

In addition to cyclones, precipitation patterns change with El Niño and La Niña events. Western Pacific islands may be drier during an El Niño event, while eastern Pacific islands may expect more rain than usual (Ropelewski et al. 1987). These changes can have a strong effect on the health of individuals and populations because of associated droughts, floods, heat-waves and other changes that can disrupt food production (Glantz 2002). For example, the strong El Niño of 1997–1998 led to droughts in the Federated States of Micronesia, Fiji, Papua New Guinea, Kiribati and the Marshall Islands. The weather changes experienced during El Niño events may provide clues to the environmental and health impacts that may be expected with long-term climate change. Since the 1970s, El Niño events have been more frequent, persistent and intense than in the previous 100 years.

Scientists have become increasingly able to predict El Niño events nine months or more in advance. This provides an opportunity to develop early warning systems to prepare for adverse health impacts associated with projected changes in temperature and precipitation.

Past climatic trends

The Third Assessment Report of the IPCC summarized climatic changes that occurred over the twentieth century (Nurse et al. 2001). During this time it is likely that precipitation in the northern hemisphere increased by 0.5–1.0% per decade over most of the middle- and high-latitude land areas and decreased by about 0.3% per decade over most of the subtropical land areas (Albritton & Meira-Filho 2001). Precipitation increased 0.2–0.3% per decade over tropical land areas. No consistent changes have been detected in the southern hemisphere.

In small island states' regions, temperatures have been increasing by as much as 0.1 °C per decade and sea level has risen by 2 mm per year. Increases in surface air temperatures have been greater than global rates of warming in areas such as the Pacific Ocean and the Caribbean Sea. For example, based on data from 34 stations in the Pacific from about 160 °E and mostly south of the equator, surface air temperatures increased by 0.3–0.8 °C during the twentieth century (Nurse et al. 2001). Figure 3 shows the percent of days when temperatures exceeded the 90th percentile in the Caribbean over the period 1955-2000.

FIGURE 2 **ENSO AND HEALTH IMPACTS**

ENSO events cause physical effects such as droughts and floods (large circle) which may interact with specific ecological and socioeconomic conditions (within dotted lines), and may cause disease outbreaks (dark shaded area).