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### HEALTH IMPACT OF THE SOUTHERN OSCILLATION (EL NIÑO)

The Southern Oscillation (El Niño) is notable for its wide geographic influence and prolonged extremes. The fact that El Niño is associated with extended climate events with large-scale effects makes it extremely important to the public health sector. The ability to project future El Niño events gives the public health sector the opportunity to prepare for and to better control the transmission of disease.

Both the health services infrastructure and basic sanitation services were damaged by El Niño in 1997-1998. At present, no concrete data are available that demonstrate that the incidence of infectious diseases is consistently and reliably related to El Niño events.

There is a need to develop a scientific agenda that will examine the impact of extreme events such as the Southern Oscillation (El Niño) on human and animal health, as well as on health infrastructure and services. Attention should be paid to the vulnerability of ecosystems to this phenomenon, how disease incidence will respond to extreme climatic events, and how health programs will adjust to changes in morbidity and mortality caused by climate change.

This document summarizes existing knowledge of the effect of El Niño on health. Much is known, but there is much more to be learned. The document was presented to the 122nd Session of the Executive Committee of PAHO to inform it of the latest data on the impact of El Niño and to seek input from the Committee on the role that PAHO should play in addressing the health effects that could occur due to this environmental phenomenon. As a result of the presentation and ensuing discussion, the Committee approved a recommendation that the Pan American Sanitary Conference adopt a resolution (CE122.R11) which is annexed to this document. Both the document and the proposed resolution are presented to the Conference for consideration and discussion.

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## EXECUTIVE SUMMARY

The Southern Oscillation (El Niño) is a natural phenomenon that causes anomalies in normal patterns of rainfall and temperature. Compared with other climate changes, El Niño events are notable for their wide geographic influence and the long duration of their extremes. The fact that these are extended climate events with large-scale effects makes them extremely important to the public health sector. The ability to project future El Niño events gives the public health sector the opportunity to prepare for and better control the transmission of disease.

The physical infrastructure of the health services has been seriously affected by El Niño, which has produced flood damage; damage to equipment and furniture, as well as to roofs, walls, windows, materials, and supplies; and problems with drainage and sewerage systems, water supply, and electricity, gas, and fuel services.

At present, there are no concrete data that demonstrate that an increase or decrease in infectious diseases is consistently and reliably related to El Niño events. However, some associations from retrospective studies and preliminary data from ongoing studies suggest that El Niño has had an impact on the incidence of certain infectious diseases. El Niño's impact on disease transmission should be considered within the context of disease ecology (epidemiological endemic levels, existing vector reservoirs, host/parasite interactions), the severity of the El Niño event, other climatic influences, and social change. The relationship between El Niño and health is complex.

There is a need to develop a scientific agenda that will examine the impact of extreme conditions such as El Niño events on human and animal health. Attention should be paid to the vulnerability of ecosystems to El Niño, how disease incidence will respond to extreme climatic events, and how health programs will adjust to the changes in morbidity and mortality caused by this phenomenon.

This document was presented to the 122nd Session of the Executive Committee to inform it of the latest data and conclusions about the direct and indirect impact of El Niño on human health and to request input about the role that PAHO should play in responding to this environmental phenomenon. As a result, Resolution CE122.R11 was adopted (see Annex), recommending that the 25th Pan American Sanitary Conference adopt a resolution inviting Member States that already have them to review and update their disaster mitigation programs and those that do not to develop such programs, placing emphasis on reducing damage to health facilities and water distribution systems, using a multidisciplinary approach that includes the components of epidemiological surveillance, disease control, environmental quality, environmental sanitation, vector control, and hospital and community planning. It also requests the Director to strengthen technical cooperation with the Member States and promote regional and country efforts to ensure the creation of an institutional memory with respect to El Niño 1997-1998.

## 1. Introduction

Public interest and concern over the Southern Oscillation (El Niño) are rising. Traditionally, meteorological changes and the environmental impact of the phenomenon have been the focus of press coverage. After the severe climate events of 1982-1983, major social, economic, and other consequences were reported.

Only rarely are predictions on El Niño and other climate changes (7) utilized in the planning and administration of health programs. In fact, the existing meteorological data are seldom used to analyze seasonal differences in the incidence of diseases.

As El Niño receives greater attention, the public demand to know more about grows. El Niño is second only to seasonal changes in its impact on world climate. This paper reviews what is known about El Niño and health and explores the health impact of this extreme phenomenon. It then discusses the steps that PAHO can take to assist Member States that are experiencing its effects.

The 40th Directing Council of the Pan American Health Organization (1997) adopted Resolution CD40.R13, which refers to preparedness for health emergencies produced by El Niño events. At the 122nd Session of the Executive Committee (1998) Resolution CE122R.11 was adopted, recommending that the 25th Pan American Sanitary Conference adopt a resolution inviting the Member States that already have them to review and update their disaster mitigation programs and those that do not to develop such programs, placing emphasis on reducing damage to health facilities and water distribution systems, using a multidisciplinary approach that includes the components of epidemiological surveillance, disease control, environmental quality, environmental sanitation, vector control, and hospital and community planning. It also requests the Director to strengthen technical cooperation with the Member States and promote regional and country efforts to ensure the creation of an institutional memory with respect to El Niño 1997-1998.

### 1.1 *The Southern Oscillation (El Niño)*

In the 1920s, Sir Gilbert Walker observed a "seesaw" relationship among barometric pressures in the southern Pacific Ocean; when the pressure was high in the western Pacific, it was low in the eastern Pacific, and vice versa, causing dramatic shifts in surface wind direction and velocity. He named the occurrence the Southern Oscillation. Later, as other scientists learned more about wind patterns and ocean temperatures in that region, they were able to link Walker's pressure seesaw with the periodic strong, warm ocean current along the coasts of Ecuador and Peru known as El Niño. More importantly, they discovered that El Niño was a weather phenomenon responsible for monsoon rains,

droughts, and other climate changes across much of the globe, including the equatorial Pacific, the United States, Canada, Latin America, and Africa.

During an El Niño event, the eastern Pacific and monsoon areas experience heavy rains, while the climate in the western Pacific is dry. Unlike annual weather patterns, which are predictable, El Niño occurs at irregular intervals every two to seven years and is never the same. It typically begins around Christmas and lasts from 12 to 18 months. The most severe El Niño event ever recorded took place in 1982-1983. Another occurred in 1986-1987, and there was an extended El Niño event from 1990-1995. We are presently experiencing an event that is expected to last until mid-1998.

La Niña, the cold phase of the Southern Oscillation, is a situation in which the surface temperatures in the eastern and central equatorial Pacific are low. In the western Pacific, a La Niña event increases precipitation, a phenomenon that is not analyzed in this document.

## 1.2 *Forecasting El Niño*

There has been considerable progress in forecasting El Niño events. Atmosphere-ocean forecast models have been developed which can predict El Niño from four months to a year in advance. The warming of the surface of the sea in the tropical Pacific was predicted one year before the El Niño phenomenon of 1986-1987. The ability to reliably link sea surface temperature data with changing climate conditions in a variety of locations will facilitate prediction of both the occurrence and effects (flooding or drought) of El Niño events (6).

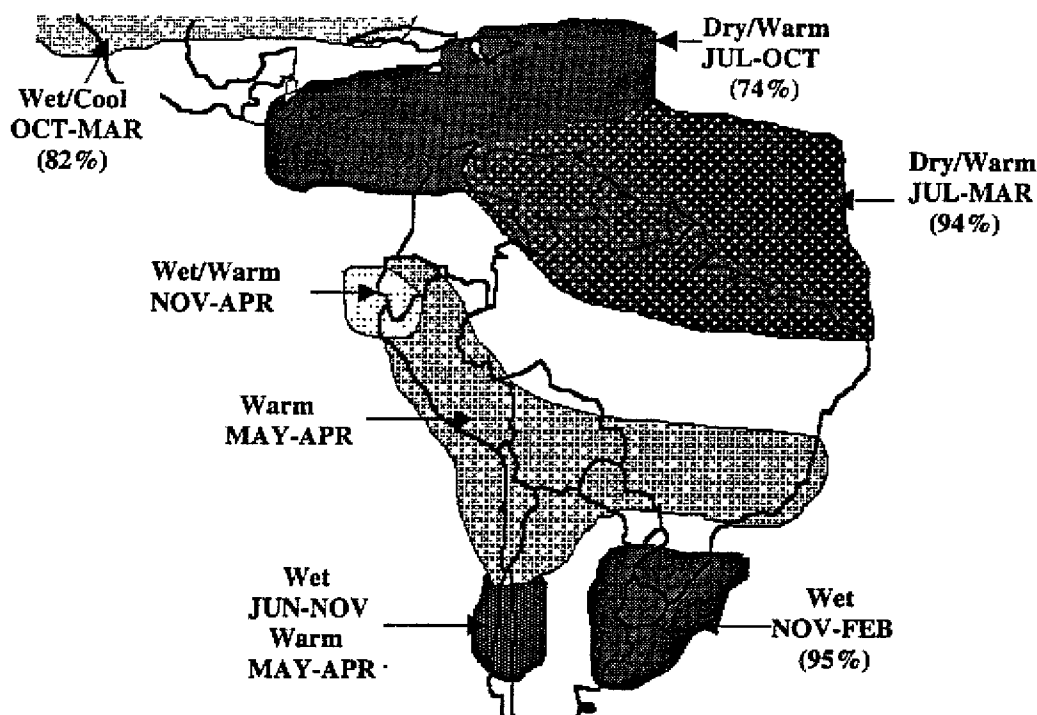
At present, climate forecasts related to upcoming rainy seasons (on the Pacific Coast of South America) are based on the wind and water temperatures in the tropical Pacific region and the output of numerical prediction models. Four forecast possibilities exist: (1) near normal conditions; (2) a weak El Niño with slightly wetter than normal growing seasons; (3) a full-blown El Niño with flooding; or (4) cooler than normal waters offshore, with higher than normal chance of drought (12).

We now have a general idea of where and when extreme meteorological conditions will occur as a result of El Niño. We can therefore determine which regions are more vulnerable and at higher risk of epidemics and begin to take climate changes into account in the planning of health programs. As better forecasting models become available, it will be possible to update and utilize them.

### 1.3 *El Niño in the Americas*

In the Americas there are several general changes in precipitation patterns associated with El Niño events (14). In North America there is generally greater than normal precipitation in the Gulf and northern Mexico regions from October to March (Figure 1). In the Great Basin of the United States there is greater than normal precipitation from April to October.

**Figure 1. Potential Impact of El Niño on Mexico, Central America, and South America**



Percentages refer to precipitation occurrences after El Niño

Source: U.S. National Oceanic and Atmospheric Administration (NOAA), 1997

In Central America and the Caribbean, precipitation is lower than normal and the dry season will occur from July to October during El Niño. It is suggested that a region of El Niño-related precipitation extends from southern Mexico and Guatemala southward into Panama and eastward into the Caribbean. South America generally experiences extremes of dryness or wetness (Figure 1), depending on the region.

In the northeast region of South America (north equatorial Brazil, French Guiana, Guyana, Suriname, and Venezuela) there is less precipitation from July to March. In southeastern South America (southern Brazil, Uruguay, and parts of northeastern

Argentina), there is greater than normal precipitation from November to February (Figure 1).

The Pacific coast of South America in Ecuador and Peru also experiences more rainfall than normal during El Niño years.

In the Amazon region low rainfall does not coincide with El Niño events but lags one year behind (4). However, due to the lack of long-term precipitation data from this region and the region's complex rainfall patterns, it is hard to construct a regional index for the entire basin (4). In other words, less than normal rainfall would more than likely occur, but precipitation extremes are not as highly correlated with El Niño as they are in other parts of South America. The Andean region is also affected by the phenomenon. There is, however, insufficient information available to make generalizations.

In all regions, the specific timing and duration of the climate events associated with El Niño may vary, depending on such factors as the season of onset (e.g., the 1997 El Niño began in May-June, which is much earlier than usual). Within this overall picture El Niño exhibits different strengths and patterns in specific localities. Thus, disease patterns may vary within an El Niño-affected area.

#### **1.4 Health Impact**

Rarely has such complete information been available on a meteorological phenomenon as in the case of El Niño 1997-1998. Every country in the world received information on the possible impact of this phenomenon, and since March or April 1997 prevention and mitigation programs have been in place in several countries.

For example, Table 1 lists the El Niño events and the preliminary figures on deaths, injuries, and disappearances directly attributed to this phenomenon in 1997-1998 and 1982-1983 for several countries of the Region.

## **2. Physical Infrastructure of the Health Services**

The physical infrastructure of the health services was seriously affected by El Niño, which produced flood damage; damage to equipment and furniture, as well as to roofs, walls, windows, materials, and supplies; and problems with drainage and sewerage systems, water supply, and electricity, gas, and fuel services.

For example, in Peru it was reported that 9.5% (437/4,576) of health facilities had been damaged, with hospitals showing a damage rate of 2% (9/443) and other health centers a rate of 10.3% (428/4,133). Approximately US\$ 1,500,000 has been allocated to keep these facilities in operation by waterproofing roofs, installing drains, digging

ditches, protecting equipment, installing generators, and building alternative water supply systems.

**Table 1. El Niño Events and Deaths, Injuries, and Disappearances during the 1997-1998 Episode, and Deaths Attributed to this Phenomenon in 1982-1983**

Country	Impact	Deaths 1982/1983	Deaths 1997/1998*	Injuries 1997/1998*	Disappearances 1997/1998*
Bolivia	Heavy rains in the Cordillera, with roads connecting the capital with Cochabamba and Santa Cruz washed out, freezing temperatures, and hail. New outbreak of cholera in La Paz, Cochabamba, and Oruro.	50	43	400	40
Ecuador	Heavy rains with flooding along the coast and bridges and roads destroyed. Cases of leptospirosis and cholera detected in the south.	220	183	91	35
Paraguay	Heavy rains with flooding of the Paraná and Paraguay Rivers and major flooding in the areas along the rivers. The capital stricken by a tornado accompanied by a storm, flooding homes, schools, and hospitals.	65	49	---	---
Peru	Heavy rains in the northern and Amazon regions of the country, with major flooding, mudslides, and damage to roadways. Significant increase in the number of cholera cases in the northern region of the country. Health conditions are currently poor in these areas.	380	203	107	No data

\*Cumulative to March 1998

Source: Web page. Programa desastres OPS/Ecuador. <http://www.salud.org.ec/desastre/>

In Ecuador 2.3% (7/299) of the hospitals were damaged, mainly by flooding, mud, damage to the already defective sewerage systems, and problems with drinking water supply. At the present time, there is no information on conditions in smaller facilities.



The majority of the damage to the physical infrastructure of health facilities from El Niño is perfectly predictable, except in this case there was a more intense manifestation of problems that occur at this time of year in the countries. The vast majority of these problems is due to shortcomings and errors in the planning, design, and construction of the facilities, and to the lack of disaster mitigation programs. Contributing factors are the characteristics of the sites selected, i.e., the location of the land, its geology and climate, building systems and materials, water supply and electricity services, and geographical accessibility. It should be underscored that whenever a natural disaster occurs, the health services infrastructure will be affected.

### **3. Impact on the Environment and Infrastructure**

El Niño has indirectly affected the health of individuals, due to its impact on the environment and infrastructure, manifested in various ways (flooding, droughts).

Heavy rains have caused rivers and lakes to overflow, leading to flooding and the contamination of drinking water. Sewerage systems have collapsed. Refuse has not been collected or disposed of in a proper or timely manner owing to the destruction or blockage of roadways, equipment, and other installations. For example, in Peru's Piura region the heavy rains have not only raised the water level of the Piura River, but they have also oversaturated the soil, causing area dwellers (complete with their livestock and meager belongings) to move to temporary shelters on the outskirts of Piura. Some 700 families have been displaced to date. However, if the situation persists, this number is expected to rise to 1,200.

In extensive areas, El Niño has manifested itself in a lack of rainfall, jeopardizing the production and/or survival of large population groups. In Bolivia, estimates put the number of persons affected by the drought at more than 300,000. The most significant impact of the drought has been a shortage of drinking water, followed by a decrease in the water available for irrigation and livestock.

During periods of drought the risk of forest fires increases, leading to a loss of green areas, property, livestock, and human lives, and to atmospheric pollution increases due to the suspension of particulate matter in the air. In the Roraima region in northern Brazil, there have been more than 200 fires which have destroyed 37,000 Km<sup>2</sup> of forest and endangered the lives of over 45,000 area residents. No casualties have been reported to date, but if these fires continue the population will be seriously affected.

#### **4. National Activities for Disaster Prevention, Mitigation, and Preparedness**

Practically all the countries have contingency plans in place to deal with the effects of El Niño and have prepared projects aimed at mitigating and responding in the best possible manner to the health impact of disasters attributable to El Niño.

Several proposals to improve health conditions and the management and distribution of water and investment resources have been submitted to international organizations and financial institutions. Examples of these include projects in Bolivia for US\$ 4 million; Ecuador, \$1 million; and Panama, \$600,000. In Peru a budget of \$1.5 million for the health sector was approved to deal with the effects of El Niño.

The response to the emergencies, which consisted largely of floods and mudslides, differed in each country. Activities ranged from immediate care for the injured to the organization and management of temporary camps or settlements for displaced persons. Part of the response included active surveillance for diseases regarded as a risk in these cases, especially water-, food-, and vector-borne diseases (malaria and dengue) and acute respiratory infections.

In several countries, Ecuador and Peru for example, an ongoing response to the needs of the population was necessary, and the national structure acted in a timely manner. In Bolivia departmental offices were organized to respond to the effects of El Niño.

The countries developed Internet search and communication systems. The main achievements in this area, efforts which began before the acute manifestations of the phenomenon, were:

- information searches through networks and regional and worldwide meteorological organizations;
- information exchange among countries, especially the sharing of contingency plans and information on the response of the health sector and on the damages and needs identified;
- Web pages maintained by PAHO (through the Program on Emergency Preparedness and Disaster Relief, the Subregional Office in Quito, and CEPIS) that offer the latest information available on El Niño.

Unfortunately, only a handful of individuals in these countries have access to the Internet, which makes it possible to take part in discussion groups on disasters in Central

and South America. Moreover, the number of people skilled in the use of this tool is still small.

## **5. Infectious Disease Transmission**

Following an El Niño event, the potential risk of communicable diseases is influenced not only by changes in the environment, but also by changes in population density, the disruption of public utilities, and the interruption of public health services. It should also be noted that the risk of communicable diseases following an El Niño event is related to the endemic level of the disease in the community; therefore, there is little risk of a given disease if the causative organism is not present beforehand (13). This underscores the need for an effective disease surveillance program prior to an El Niño event.

To date there is little definitive data directly linking El Niño to infectious disease transmission. The consequence of El Niño on disease transmission, however, must be considered within the context of disease ecology (2), the degree of the El Niño event anomalies, and social change.

To underscore the difficulties involved in linking El Niño with changes in health conditions, data on several of the most important communicable diseases in the Americas are presented below.

### **5.1 Malaria**

Global climate models used to analyze scenarios of climate change and malaria transmission (10) predict a worldwide increase in the disease associated with increases in temperature, humidity, and rainfall (1,3).

It has been reported that major epidemics of malaria occurred during the El Niño year 1983 in Bolivia, Ecuador, and Peru (11). A review of the data reported by each country on malaria (1970-1996 PAHO malaria reports) shows that the incidence of this disease began to rise in all the countries in 1983 (Figure 2). However, the overall trend from 1970 to 1996 was an increase in the number of cases reported, while in other El Niño years (1971-1972, 1976-1977, 1991-1992) the incidence of malaria seldom increased over that of previous years. An increase in number of malaria cases was observed in Colombia during the same period as in the rest of South America. It is known that, during this time, national malaria control programs in Latin America switched from a strategy of rigid eradication to flexible control. That alone could have caused the increase observed. Conversely, a good eradication program may have been masking the impact of El Niño in previous El Niño years.