

Given the frequent occurrence of floods in various countries of the Region of the Americas and in the context of the COVID-19 pandemic, the Pan American Health Organization / World Health Organization (PAHO/WHO) urges Member States to strengthen post-flood epidemiological surveillance strategies in order to timely identify and control events that could have a serious impact on public health.

Introduction

Between November 2021 and January 2022, floods or flood alerts of various magnitudes have been reported in countries in the Region of the Americas, including in Bolivia (1-3), Brazil (3-6), Colombia (7), Ecuador (8), the United States of America (9,10), Haiti (11), Peru (12-15), the Dominican Republic (16), and Uruguay (17), among others. In addition, the La Niña phenomenon, which is expected to last until March 2022, will have a heterogeneous impact across South America.

Heavy rainfall is a recurring and seasonal meteorological phenomenon, which is followed by flooding in susceptible areas. Depending on the magnitude of the flooding, these can cause the collapse of critical infrastructure and human settlements as well as changes in the environment, which could lead to any of the following:

- Disruption of public services for water supply, energy, communication, health, and education, among others
- Overflow of sewage systems
- Contamination of crops or stored and prepared foods with flood water
- Displacement of population and fauna
- Inadequate disposal of solid waste and excreta
- Increase in vectors such as mosquitoes and rodents
- Possible disruption of essential supply chains, such as food and commerce, including medical materials and supplies, among others

The aforementioned increases the risk of bacteriological contamination (due to wastewater, general waste, human and animal tissues or fluids, among others), and chemical and physical contamination (due to sediment) of drinking water and food for consumption, which consequently may lead to public health risks of varying magnitude.

During and after a flood, depending on its scale and the affected area, population displacement to makeshift shelters may occur. Displaced populations in shelters are vulnerable to risk factors such as overcrowding, poor sanitation, and lack of access to drinking water, to which they are frequently exposed to in the shelters. This, along with the interruption of health and sanitation services and in the context of the COVID-19 pandemic, increases the risk of exposure among displaced populations to events such as: injuries caused by poisonous animals, non-communicable diseases exacerbated by stress, skin infections, foodborne diseases, vaccine-preventable diseases due to lack of access to immunization services, acute respiratory infections, leptospirosis, arboviruses in endemic areas, and acute diarrheal diseases, including the risk of cholera re-emergence.

Epidemic-prone diseases to consider during post-flood surveillance

During post-flood surveillance, enhanced monitoring of the following events that have epidemic potential should be conducted:

- **Acute diarrheal diseases** (cholera, salmonellosis, shigellosis, among others)
- **Acute respiratory diseases**
- **Vaccine-preventable diseases**
- **Leptospirosis**
- **Dengue, chikungunya, and Zika** (in endemic areas)

At the same time, national surveillance systems may have limited capacity or may be interrupted or non-existent during and after a flood or other similar event, which may lead to the collapse of the health system at the local level and require support from a regional and/or national level.

All of the above can lead to excess morbidity and mortality due to outbreaks (e.g., cholera, vaccine-preventable diseases, leptospirosis, among others), and the potential widespread increase in transmission of endemic diseases in the population affected by the flood. Therefore, one of the priorities before, during, and after a flood or other emergency is to establish an early warning and response system (EWARS).

Guidance for national authorities

Given the frequent occurrence of floods in countries of the Region of the Americas and the current La Niña phenomenon, the Pan American Health Organization / World Health Organization (PAHO/WHO) recommends that Member States:

1. Strengthen coordination mechanisms

In the context of the COVID-19 pandemic and in the event of floods or similar events, it is recommended to maintain and reinforce:

- Coordination between the different technical areas of the health sector
- Timely access to information and hydrometeorological alerts, as well as information from the entities in charge of risk management, in order to facilitate the rapid activation of emergency plans and the implementation of adequate preventive measures in health facilities.

- Activation of emergency operations committees and centers, which are essential both for monitoring events and intervention actions, as well as for the rapid assessment of damages and needs, in order to guide decision-making.

2. Adapt the surveillance system

The surveillance system must be adequate for the rapid detection and early warning of public health events that require an immediate response. For this, it is recommended to establish an early warning and response system (EWARS) that considers the seasonality and recurrence of floods or other disasters in the areas affected by these phenomena (18, 19).

Information sources that can be used for the early warning function include disease-based surveillance, syndromic surveillance, environmental/ecological surveillance (e.g., vector density, water/air quality), community-based surveillance, and health-related behavioral information (e.g., drug and product sales, social media). It is important that the EWARS is sensitive enough to quickly detect and respond to signals from formal and informal sources, inside and outside the health sector.

After the occurrence of a flood or other similar event, the surveillance system must be adapted to support the analysis and management of the situation, including:

- Evaluating the risks and the magnitude of the impact on health services and the health of the affected population, with emphasis on children under 5 years of age, pregnant women, people over 60 years of age, people with disabilities, and migrants, among others.
- Adapting health services' response to the demand
- Determining excess morbidity and mortality caused by the event
- Early detection of the onset of epidemic-prone diseases
- Assessing the effectiveness of the response to the event

Following is a series of strategies that can be implemented at the local level:

i. Sentinel surveillance in community care centers near the event site

In community care centers for those affected and for victims of the flood, it is recommended to collect daily information on the reasons for medical consultation and monitor the trends. The information collected must be compared with the health situation in the area prior to the flood. Therefore, it is necessary to maintain continuous monitoring of the health situation of the population, preferably using the forms and records previously established by the country.

It is important to determine which epidemic-prone diseases may be relevant for the context, which will serve in determining the necessary public health actions.

ii. Community-based surveillance

To obtain timely information in the areas affected by a flood, surveillance should be extended at the community level. As such, the following is recommended:

- Identify and include people from the community (such as community leaders, religious leaders, women's and youth groups and associations, teachers, and

influencers, among others) to take on the role of key informant or community health watchdogs.

- Identify and define the indicators for which information is required for the rapid implementation of interventions during and after the flood.
- Prepare, validate, and distribute forms to be used in community-based surveillance. The forms must be simple, designed to collect essential data on epidemic-prone diseases and on risk factors of the populations that remain in the area affected by the flood and that are in shelters.

iii. *Surveillance of populations in shelters*

The populations living in shelters require strict monitoring of their health status because they are exposed to several risk factors. This surveillance should be carried out by collecting data on epidemic-prone diseases and risk factors. Additionally, a census of those affected or displaced should be taken. In the context of the COVID-19 pandemic and considering the potential for overcrowding in shelters, the implementation of infection prevention and control measures is critical to reduce the probability of outbreaks. The PAHO/WHO provisional guide for shelter management in the context of COVID-19 is available in Spanish at: <https://bit.ly/3gwF6X4>

3. Prevention measures

Following is a summary of prevention measures to apply at the community level, in shelters, and in health services.

Drinking water consumption (20-22)

During a flood, contamination of water resources may occur: bacteriological (e.g., by wastewater, tissues and fluids of humans and animals), chemical, and physical (by sediment). Therefore, the local level health systems are recommended to implement the following prevention measures:

- Quickly assess damage and needs of safe water supply at the community level, in shelters, and in health services
- Disinfect water tanks in homes, shelters, and health services, and ensure the protection of environmental elements and vectors
- Implement continuous monitoring of the water quality for human consumption and for food preparation
- Provide safe water in sufficient quantities and provide adequate information to populations to guarantee the sustainability of its provision.

Food safety and security (23)

Following a flood or other emergency, food safety risks are primarily related to unsafe food storage, handling, and preparation. In many cases, cooking may be impossible during natural disasters due to lack of facilities or fuel. Lack of access to clean water and sanitation facilities can aggravate the risks. Considering that people who suffer the direct effects of the flood could be at risk due to malnutrition, exposure, stress, and other factors, it is essential that the food they consume is safe.

PAHO/WHO urges Member States to ensure food safety and security following a flood or other emergency. There are five keys to ensure food safety, available at: <https://bit.ly/3soPPlw>

- Preventive food safety measures after natural disasters
- Food inspection and retrieving as needed
- Provision for safe food and water after a flood or other natural disaster
- Detection and response to outbreaks of foodborne disease
- Consumer education and information on food safety

Vector prevention and control (24-27)

PAHO/WHO urges Member States to effectively use available resources. Prevention and control programs for diseases transmitted by vectors and reservoirs should aim to prevent and/or control vector infestation in affected areas that are still inhabited, in shelters, food warehouses, and in health services. This will be achieved through the implementation of integrated vector control strategies in emergencies, which include, among others:

- 1) Promoting the adoption of vector-borne disease prevention measures at the personal, household, and community levels, including shelters, health facilities, and schools:
 - Elimination of mosquito breeding sites
 - Removal of stagnant water
 - Proper coverage of water storage containers
 - Use of personal protection measures such as the use of insect repellants and mosquito nets treated with long-acting insecticides should be encouraged, mainly in vulnerable groups (sick, injured, pregnant women, children under 5 years of age, the elderly)
 - Ensuring proper food storage
 - Cleaning and sanitation in the home and community, including shelters, health facilities and schools
- 2) If necessary, vector control measures directed at larvae through the use of larvicide products and at adult mosquitoes should be implemented, with the possibility of spatial application of insecticides (ULV) with the aim of quickly eliminating the population of adult mosquitoes and prevent or reduce the transmission of dengue and other arboviruses; insecticides prequalified by the WHO (<https://www.who.int/pq-vectorcontrol/prequalified-lists/en/>) are recommended for these activities and preferably, the choice of insecticide will be based on evidence of susceptibility of the local *Aedes* population to the applied products.
- 3) Indoor residual spray should be applied selectively to *Aedes aegypti* resting places, on dark, moist surfaces. Precautions should be taken not to treat storage tanks for water used for drinking or cooking. This intervention in treated areas is effective for a period of up to 4 months; and can be used in shelters, homes, health services, schools, and others. More details on this activity can be found in the documents: 1) Manual for applying indoor residual spraying in urban areas for the control of *Aedes aegypti*. Available in Spanish at: <https://bit.ly/3GG3P5R> and 2) Control of *Aedes aegypti* in the scenario of simultaneous transmission of COVID-19. Available at: <https://bit.ly/3HLHFk6>

- 4) The presence of rodents in critical areas is not acceptable (e.g., shelters, food warehouses, dining rooms, garbage dumps, health centers, schools, places where people gather). To prevent rodent infestation in these areas, local teams should:
 - Determine the areas of greatest vulnerability to rodent access and contact with people in critical areas and establish prevention measures.
 - Detect the presence of rodents and/or their vectors (fleas, lice, and others) in critical areas.
 - Act immediately in the presence of rodents and/or their vectors in critical areas with immediate measures for their control. Simultaneously investigate the health status of rodents and their vectors to adjust response actions, as needed.
 - Monitor rodent activity in non-critical areas and the health status of their populations. The capture and study of these must be carried out by specialized personnel.
- 5) Risk communication with vector and reservoir prevention and control campaigns, in addition to community mobilization.

4. Clinical Management

Below is a summary of the proper clinical management of two post-flood health events that are among the most frequent to occur:

i. Acute diarrheal diseases

The most serious threat from diarrheal diseases is dehydration. Key measures to treat diarrheal diseases include the following (28):

- Rehydration: with oral rehydration saline solution (ORS).
- Zinc supplements: Zinc supplements reduce the duration of diarrheal episodes by 25% and are associated with a 30% reduction in stool volume.
- Rehydration with intravenous fluids in case of severe dehydration or shock.

ii. Leptospirosis

Leptospirosis cases can increase after a flood, mainly due to the exposure of people to contaminated water.

Mild cases can be treated on an outpatient basis with oral antibiotics. Severe cases require hospitalization, so high-risk patients should be promptly recognized, and aggressive therapeutic measures be applied for hypotension, renal and respiratory failure, and bleeding that accompanies severe leptospirosis. Timely initiation of dialysis and mechanical ventilation are essential to prevent mortality secondary to oliguric renal failure and pulmonary hemorrhagic syndrome, respectively (29).

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