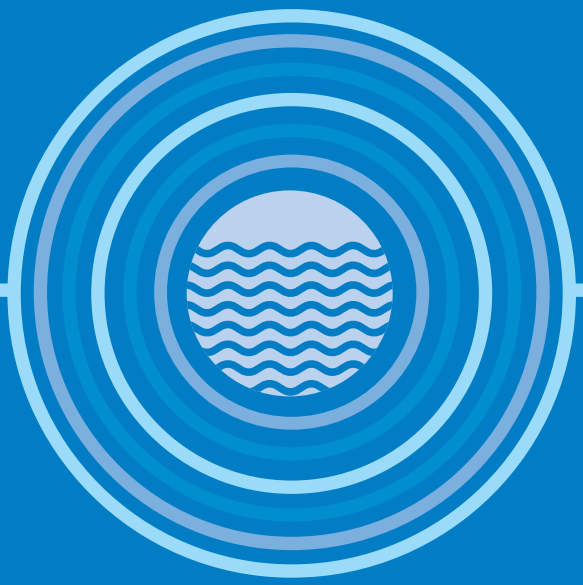
CHEMICAL RELEASES ASSOCIATED WITH FLOODS



This leaflet provides brief information about Natech and other chemical releases caused directly or indirectly by floods. It is an extract from the WHO publication *Chemical releases caused by natural hazard events and disasters – information for public health authorities*. The full document provides additional information on the roles of the health sector in prevention, preparedness, response and recovery in relation to Natech events.

World Health Organization

WHAT IS A FLOOD?

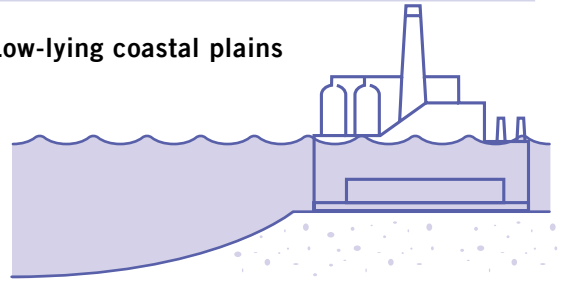
Floods are the most common natural hazard event and are the leading cause of deaths from disasters worldwide *(1)*. The frequency of major flooding events is increasing as a consequence of climate change, urbanization and other factors *(2, 3)*.

A flood is a temporary situation where normally dry land is covered with water, e.g. as a result of the following *(1, 2)*:

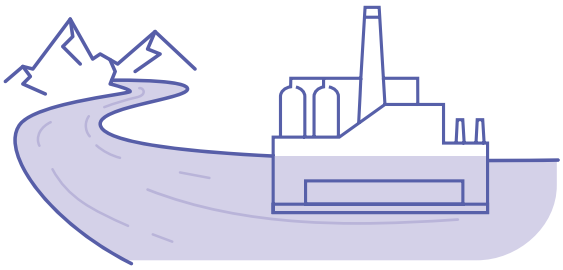
- **Gradually rising inland water**, such as rivers, lakes and groundwater, due to heavy rainfall or snowmelt.
- **Coastal flooding** caused by a tropical cyclone, storm surge or tsunami.
- **The accumulation of water on the surface** due to prolonged rainfall resulting in water-logging and the rise of the groundwater table above the surface.
- **The breaching of a dam** or levee.
- **Sudden flooding** with short duration as a result of heavy rainfall in a storm or a release from a dam. This is known as a flash flood, and is particularly destructive on a sloping terrain where the water flows very rapidly.

Some areas are particularly prone to flooding, for example:

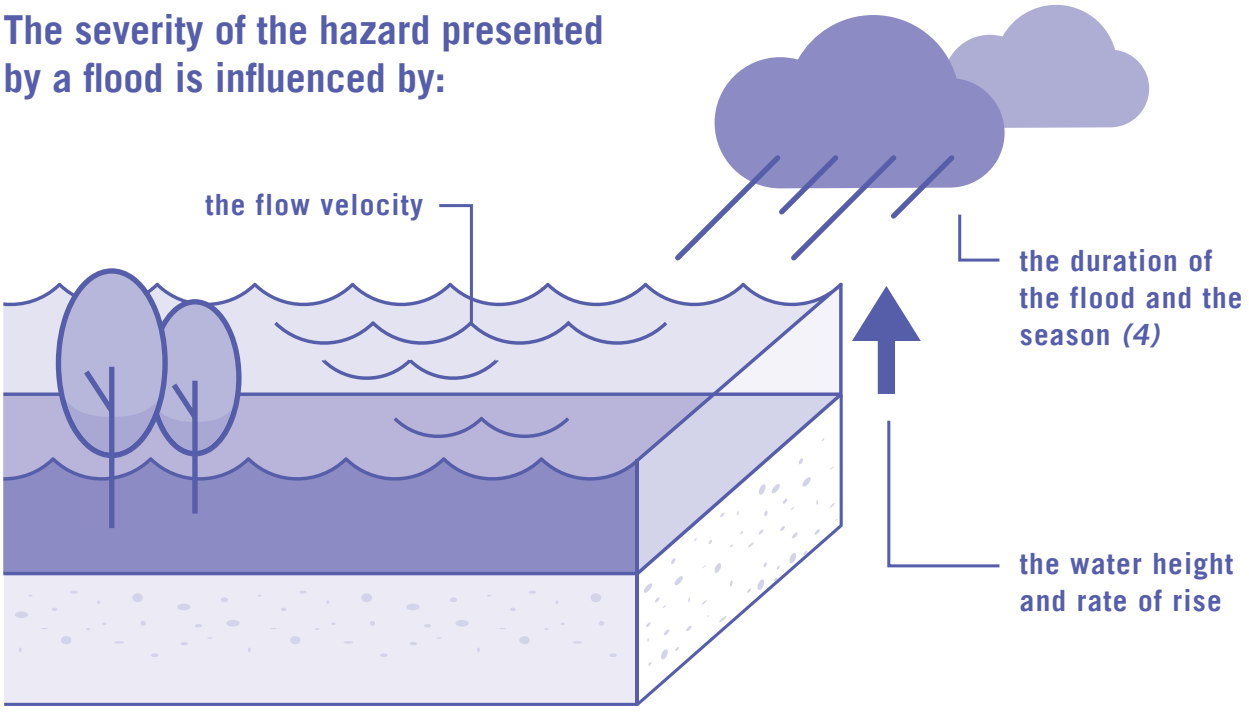
Low-lying coastal plains



Areas along rivers. These river floods are often seasonal.



The severity of the hazard presented by a flood is influenced by:



RISK FACTORS FOR CHEMICAL RELEASE

An analysis of past events suggests that storage tanks and pipework are particularly vulnerable to damage by floods *(5).*

FACTORS THAT INCREASE THE VULNERABILITY OF AN AREA TO CHEMICAL RELEASE DURING FLOODS INCLUDE THE FOLLOWING *(1, 3):*

Location

- Location of industrial facilities in flood-prone areas.
- High population density around industrial sites.
- Land with little capacity for absorbing rain, e.g. because of erosion, deforestation or impermeable coverings such as concrete.

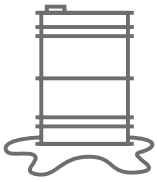
Structures

- Structures that are not flood resilient.
- Inadequate planning and building regulations.

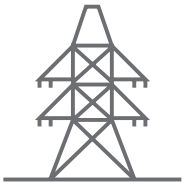
Preparedness and warning systems

- Inadequate warning systems.
- Inadequate safety measures or emergency planning.
- Lack of public awareness about flood risks.

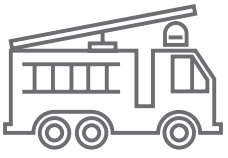
A FLOOD MAY INCREASE RISKS BY REDUCING RESPONSE CAPACITY IN THE FOLLOWING WAYS *(6, 7)*:



The release of hazardous materials may hamper search and rescue operations.



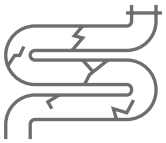
Damage to on-site emergency equipment will hamper response, as will **damage to essential infrastructure,** such as the power supply, water supply and telecommunications.



Off-site emergency-response personnel and other resources may not be available as they may be occupied in dealing with the consequences of the flood.

INDUSTRIAL SITE EMERGENCY-RESPONSE PLANS SHOULD INCLUDE FLOOD SCENARIOS, so that workers and managers will be prepared for the specific conditions that exacerbate an emergency situation during and following a flood.

MECHANISMS OF CHEMICAL RELEASE



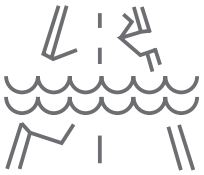
Displacement of storage tanks and rupturing of pipework

Rising floodwaters can displace and overturn chemical-storage tanks and rupture pipework and pipelines. Drums of chemicals can be lifted and carried in the floodwater. They can get damaged by collisions and release their contents.

Toxic reactions and fire

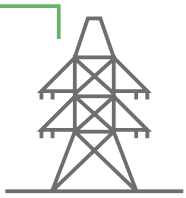
Released chemicals can mix and react with the water, potentially generating toxic reaction products or a fire or explosion hazard *(5)*. When flammable hydrocarbons are released into floodwaters, ignition can result in pool fires. These are buoyant flames above a horizontal pool of vaporizing hydrocarbon fuel and can carry a fire to new sources of flammable material or into residential areas *(8)*. They are a particular risk at storage depots or refineries for petroleum products.

HEAVY RAIN AND RISING FLOODWATERS



Toxic runoff

The inundation of an area with water can cause chemical release in other ways *(2, 9)*. In rural areas, runoff from flooded areas can carry with it eroded soil containing **fertilizers, herbicides and insecticides.** Runoff from motorways, roads and bridges may contain **heavy metals, petroleum hydrocarbons and polycyclic aromatic hydrocarbons.** Runoff from inundated waste sites may contain a **variety of toxic chemicals, depending on what was stored on the site** *(10)*.



Damage to power supply

Damage to the power supply can cause process upsets and affect safety measures such as temperature and pressure monitors and control valves, potentially resulting in runaway chemical reactions and blow-down.

Release of waste from chemical plants, mines and dams

Flooding of internal plant drainage systems may release waste oil or other chemical waste if not segregated from surface water drainage systems. **Abandoned mines, such as coal mines, may flood,** releasing acidic water containing sulfuric acid from the oxidation of sulfides upon exposure of the water to air *(9)*. **Tailings dams containing mining waste may burst** under the pressure of water, releasing highly toxic waste and mud *(4)*.

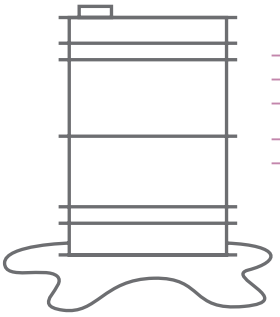
CHEMICALS IN FLOODWATERS MAY CONTAMINATE DRINKING-WATER SOURCES and, as floodwaters recede, may be deposited on farmland and in buildings such as homes and schools. Contaminated farmland may remain unfit for agricultural use for many years *(3)*.

POTENTIAL IMPACTS ON HUMAN HEALTH

Chemicals released following a flood can cause dermal, respiratory and systemic toxic effects following direct exposure of victims and rescuers.

Toxic effects and injuries may also result from environmental contamination, fires and explosions. The general public, rescuers and those involved in clean-up operations may be exposed to a range of hazards, which can be divided into those related to chemicals and those unrelated *(10, 11)*. Examples are given below.

Chemical-related



- **Burns** from fires and exposure to corrosive chemicals (formation of toxic and/or flammable vapours upon reaction of the released chemicals with the floodwaters).
- **Respiratory tract injury** from inhalation of irritant gases, including combustion products.
- **Poisoning from exposure to spilled toxic chemicals** and the consumption of contaminated food or water. Depending on the speed, volume and flow of floodwaters, however, the risk of chemical exposure may be reduced by dilution in the water.
- **Carbon monoxide poisoning** resulting from the incorrect use of fuel-burning generators for electricity, barbeques, braziers or buckets of coal or charcoal for heating and cooking, or petrol-driven pumps and dehumidifiers to dry out flooded rooms *(1, 2, 12)*.
- **Injuries and poisoning** in workers involved in rescue and clean-up, including excessive exposure to pesticides used for vector and rodent control.

Non chemical-related

- **Drowning.**
- **Hypothermia** from immersion in water at less than 24 °C.
- **Venomous bites and stings** from displaced animals *(1)*.
- **Injuries and deaths** as a result of floating debris. Injuries may also occur during the rescue and clean-up phases, e.g. when cutting and moving fallen debris.
- **Consequences of evacuation**, e.g. increased risk of infectious diseases at the evacuation sites, exacerbation of pre-existing health problems during patient transfer, saturation of health-care facilities reducing ability to provide adequate treatment, potential problems with water supply and sanitation, etc. *(13)*.
- **Psychosocial effects**, including post-traumatic stress disorder *(11, 14)*.

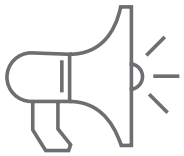
RESPONSE AND RECOVERY CONSIDERATIONS

Key activities for response and recovery are:

Risk assessment

Prevention of exposure

Medical assessment and management



Risk and crisis communication

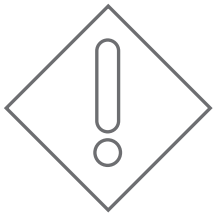
A

Risk assessment

1. Obtain information on potentially affected hazardous sites, including waste dumps, in order to assess the risks to health and determine the appropriate risk-management measures.
2. Identify the chemicals involved in the accident: check if an inventory is available, e.g. in the site emergency plan; if not use the *Flash environmental assessment tool (15)*. Look for labels with hazard information.
3. Collect and consider any clinical information available from exposed individuals, as this may help to identify some chemicals or chemical groups.
4. If feasible, organize the collection and analysis of environmental samples (air, soil, water, crops) in order to identify and quantify contamination by chemicals.
5. Assess the possibility of contamination of drinking-water sources and foods.

B

Prevention of exposure



1. Based on the risk assessments, provide advice as required to the civil defence, fire or other designated service on the need for:
   - containment measures
   - restrictions on access to contaminated sites
   - the need for personal protective equipment (PPE)
   - shelter-in-place or evacuation advisories for affected communities.
2. Ensure that people involved in clean-up and rescue operations are adequately equipped with PPE and are aware of the possibility of chemical spills.
3. Organize facilities for decontaminating chemically-exposed individuals.
4. Provide comprehensive information to the general public regarding precautionary measures (see 'Risk and Crisis Communication' below).

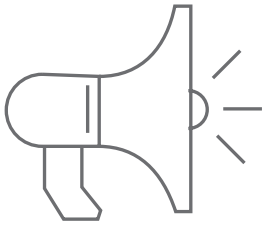
C

Medical assessment and management

1. Ensure that chemically-exposed individuals are decontaminated before they enter the health-care facility.
2. Ensure that health personnel follow procedures for wearing PPE when managing chemically-contaminated victims.
3. Conduct triage and patient assessment. Note that chemical injuries or poisoning may be combined with traumatic injuries.
4. Obtain advice on the management of chemical exposure from a poisons centre, if available.
5. Provide specific medical treatment (e.g. antidotal treatment) as required.
6. Consider the need to collect biological samples from chemically-exposed individuals (including first-responders) in order to identify and, if possible, quantify exposure.
7. Register all exposed individuals and ensure adequate documentation and record-keeping in case there is a need for long-term follow-up.
8. Ensure that after the first response, measures are taken in the recovery stage to prevent indirect chemical effects and long-term exposures. Provide mental health and psychosocial support for affected communities.

D

Risk and crisis communication



1. Provide information, updated as necessary, to the public, first-responders and decision-makers about chemical and other hazards arising from the event. Ensure that the public is informed about:
    - the Natech event(s)
    - who is in charge
    - what is being done
    - the nature and hazards of the chemicals involved
    - what individuals should do to protect themselves and their families
    - when to seek medical attention
    - how to get further information.

2. Some specific health-protection topics include:
    - food and water advisories, in case of contamination
    - prevention of carbon monoxide poisoning
    - precautions during clean-up, e.g. use of personal protective equipment, safe use of cutting equipment, handling of asbestos cement, etc.
    - potential hazards in flood-damaged homes.

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