MH0004 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Coastal Flood

Definition

Coastal flooding is most frequently the result of storm surges and high winds coinciding with high tides. The surge itself is the result of the raising of sea levels due to low atmospheric pressure. In particular configurations, such as major estuaries or confined sea areas, the piling up of water is amplified by a combination of the shallowing of the seabed and retarding of return flow (WMO, 2011).

Reference

WMO, 2011. Manual on Flood Forecasting and Warning. WMO-No. 1072. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/flood_forecasting_warning/WMO%201072_en.pdf Accessed 18 November 2019.

Annotations

Synonyms

Storm Surge, Coastal inundation.

Additional scientific description

Major deltas such as the Mississippi and Ganges are prone to coastal flooding when affected by hurricanes (cyclones). Another sensitive area is the southern North Sea in western Europe, as a result of particular tracks of winter depressions. If the surge takes place near the mouth of a river issuing into the sea, the river flow will be obstructed due to the surge, resulting in severe flooding over and near the coastal areas. Tsunamis resulting from sub-seabed earthquakes are a very specific cause of occasionally severe coastal flooding (WMO, 2011).

Coastal flooding is largely a natural event, however human influence on the coastal environment can exacerbate coastal flooding (Dawson et al., 2009). Extraction of water from groundwater reservoirs in the coastal zone can enhance subsidence of the land increasing the risk of flooding (Nicholls, 2002).

Seawater can flood the land via several paths:

- *Direct flooding*: the sea height exceeds the elevation of the land, often where waves have not built up a natural barrier such as a dune system.
- *Overtopping of a barrier*: the barrier may be natural or human engineered and overtopping occurs due to swell conditions during storm or high tides often on open stretches of the coast. The height of the waves exceeds the height of the barrier and water flows over the top of the barrier to flood the land behind it. Overtopping can result in high velocity flows that can erode significant amounts of the land surface which can undermine defence structures (Gallien et al., 2011).
- *Breaching of a barrier*: the barrier may be natural (sand dune) or human engineered (sea wall), and breaching occurs on open coasts exposed to large waves. Breaching is where the barrier is broken down or destroyed by waves allowing the seawater to extend inland and flood the areas.

Metrics and numeric limits

The extent and magnitude of coastal flooding is a function of the elevation inland flood waters penetrate, which is controlled by the topography of the coastal land exposed to flooding; storm surge conditions; and the broader bathymetry of the coastal area (Bell et al., 2017).

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

The governance structure of coastal zones may be strengthened in different ways (WMO, 2013):

- Promoting better co-operation between different levels and sectors of government, taking into account trends of decentralisation and the need for (national) coordination.
- Facilitating cooperation between government and the private sector, taking into account trends of privatisation but also the need to safeguard the public interest.
- Better involvement between stakeholders and citizens in development and management issues, to promote societal acceptance of development projects as well the long-term sustainability of development projects (arrangements and incentives for maintenance).
- Creating arrangements for dealing with uncertainties and sharing of risks (insurance).

Flooding constitutes a particular challenge in low-lying areas as deltas and coastal plains and land subsidence caused by sediment deficits or ground water extraction can further exacerbate the problem.

Coastal flooding can result in considerable economic losses and casualties. Moreover, coastal flooding can result in a wide range of environmental impacts on different spatial and temporal scales. Flooding can destroy coastal habitats such as coastal wetlands and estuaries and can erode dune systems (Hunt and Watkiss, 2011).

There are many ways in which humans are trying to prevent the flooding of coastal environments. Technical measures for flood control include dike or seawall or levee construction (hard engineering structures) (Short and Masselink, 1999), maintenance of natural dune systems, protection of coastal ecosystems (natural defence) (Alongi, 2008) and different flood proofing and accommodation activities. Engineered protection structures along the coast such as sea walls, if not well planned, can alter the natural processes of the beach, often leading to erosion on adjacent stretches of the coast which also increases the risk of flooding (Pope, 1997).

Non-structural mechanisms also exist to mitigate coastal flooding: building regulations; coastal hazard zoning; urban development planning; spreading risk through insurance; and enhancing public awareness (Snoussi et al., 2008; Dawson et al., 2011).

Generally, even moderate flooding hazards should be taken very seriously due to the potentially disastrous consequences, and flood protection is a key aspect in coastal disaster risk reduction.

The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health issues (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing risk of water-borne diseases as well as the proper functioning of health facilities, including cold chain (WHO, no date).

Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

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WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

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Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0005 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Estuarine (Coastal) Flood

Definition

Estuarine flooding is flooding over and near coastal areas caused by storm surges and high winds coincident with high tides, thereby obstructing the seaward river flow. Estuarine flooding can be caused by tsunamis in specific cases (WMO, 2011).

Reference

WMO, 2011. Manual on flood forecasting and warning. WMO-No. 1072. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/flood_forecasting_warning/WMO%201072_en.pdf Accessed 17 April 2020.

Annotations

Synonyms

Flood, Flooding, Coastal flooding.

Additional scientific description

Estuaries are inlet areas of the coastline where the coastal tide meets a concentrated seaward flow of fresh water in a river. The interaction between the seaward flow of river water and landward flow of saline water during high tides may cause a build-up of water or inland-moving tidal bore. Frequently, the funnel shape characteristic of many estuaries causes an increase in high water levels in the upper, narrowing reaches of the associated river. These types of flood are mostly experienced in deltaic areas of rivers along the coasts, for example the mouths of the Ganges. They are more frequent and less severe in terms of inundated depth and area than flooding caused by storm surges (WMO, 2011).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Storm surges and high winds coinciding with high tides are the most frequent cause of estuarine/coastal flooding. The surge itself is the result of the raising of sea levels due to low atmospheric pressure. In particular configurations, such as major estuaries or confined sea areas, the piling up of water is amplified by a combination of the shallowing of the seabed and retarding of return flow. Major deltas such as the Mississippi and Ganges are prone to this type of flooding when affected by hurricanes (cyclones). Another sensitive area is the southern North Sea in western Europe, owing to particular tracks of winter depressions. If the surge takes place near the mouth of a river issuing into the sea, the river flow will be obstructed due to the surge, resulting in severe flooding over and near the coastal areas. Tsunamis resulting from sub-seabed earthquakes are a very specific cause of occasionally severe coastal flooding (WMO, 2011).

Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health issues (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases, as well as the proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

WHO, no date. Flooding and communicable diseases fact sheet. World Health Organization (WHO). www.who.int/hac/techguidance/ems/flood_cds/en Accessed 4 October 2020.

WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

WMO, 2011. Manual on flood forecasting and warning, WMO-No. 1072. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/flood_forecasting_warning/WMO%201072_en.pdf Accessed 17 April 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0006 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Flash Flood

Definition

A flash flood is a flood of short duration with a relatively high peak discharge in which the time interval between the observable causative event and the flood is less than four to six hours (WMO, 2006).

Reference

WMO, 2006. Technical Regulations. Volume III: Hydrology, WMO-No. 49. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/technical_regulations/49_III_E_supplement1.pdf Accessed 20 November 2019.

Annotations

Synonyms

Storm-driven flood, Freshet, Huayco.

Additional scientific description

A flash flood is generally characterised by raging torrents after heavy rains, a dam or levee failure or a sudden release of water in a previously stopped passage (i.e., by debris or ice) that rips through riverbeds, urban streets, or mountain canyons sweeping away everything in its path. Steep terrain tends to concentrate runoff into streams very quickly and is often a contributory factor. Changes in soil properties (e.g., burn areas from wildfires), hydrophobic or impervious soils, removal of surface vegetation, and excess runoff from warm rainfall on significant snowpack can also be important contributors (NOAA, no date a; AMS, 2017).

Metrics and numeric limits

A flash flood is a flood that begins within 6 hours, and often within 3 hours, of a heavy rainfall (NOAA, no date b).

Flash floods are highly localised in space: they are restricted to basins of a few hundred square kilometres or less. They are also restricted in time: response times not exceeding a few hours or even less. This means very little time for warning (NOAA, no date b).

Flash flood hazard measurement and modelling requires a complex approach as more environmental factors must be considered and regularly monitored: topographic parameters (average slope, slope range and valley density for the catchment), soil and surface parameters (surface runoff, infiltration and interception: soil depth, physical soil type, the ratio of barren/vegetation-covered surfaces), and hydrological parameters (precipitation, consecutive rainy days, etc.) (Liu and Smedt, 2005).

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Drivers of flash flood: The intensity of the rainfall, the location and distribution of the rainfall, the land use and topography, vegetation types and growth/density, soil type, and soil water-content all determine how quickly flash flooding may occur, and influence where it may occur (NOAA, no date b).

Outcomes and impacts of flash flood: Flash floods account for approximately 85% of flooding cases and have the highest mortality rate (defined as the number of deaths per number of people affected) among different classes of flooding (e.g., riverine, coastal). With more than 5000 lives lost to flash flooding each year, flash floods are among the world's deadliest natural hazards and have significant social, economic and environmental impacts (WMO, 2019).

Control and monitoring measures of flash flood: Flash floods are a major natural hazard throughout the world. Flash floods are the number one killer among all weather-related hazards. A vast majority of deaths from flash floods, as high as 90% in tropical countries, are due to drowning from victims being caught by rapidly rising waters (Smith, 1992).

Predicting flash floods requires accurate detection and estimation of rainfall events, which are typically intense and very localised. Operational prediction methods include flash flood monitoring and prediction algorithms (FFMPA) used in Europe and the United States. FFMPA alerts forecasters when flash flooding is imminent based on radar-estimated rainfall amounts compared to hydrologic model-based rainfall thresholds. Advances in forecasting convective rainstorms help to improve the performance of FFMPA by providing a longer lead time of impending flash floods (Hong et al., 2013).

Reducing societal exposure to flash floods is key to any mitigation measure. The combination of non-structural measures and small-scale structural measures could be more effective in managing flash flood risk. There are many non-structural measures that can reduce the impact of floods such as land-use planning, building construction codes, soil management, acquisition policies, insurance and risk transfer, awareness raising, public information, emergency system, and recovery plans. Structural activities including property protection such as relocation and reinforcement, and structural engineering projects such as levees, diversions, and channel improvements are some of the actions that mitigate the societal impacts of flash floods (Colombo et al., 2002).

Flash floods differ from river floods in various ways. Notably they manifest and dissipate in less time and occur in more condensed spatial areas. These factors make their forecasting a unique challenge compared to traditional flood forecasting approaches. In this regard, the World Meteorological Organization has launched the Flash Flood Guidance System (FFGS) with global coverage. A system such as the FFGS is an important tool for providing operational forecasters and disaster management agencies with real-time informational guidance products pertaining to the threat of small-scale flash flooding. The FFGS provides remotely sensed precipitation estimates (e.g., radar and satellite-based rainfall estimates) and allows product adjustments based on forecaster experience with local conditions, incorporation of other information (e.g., Numerical Weather Prediction output) and any last minute local observations (e.g., non-traditional rain gauge data) (WMO, 2019).

Health impacts from floods including flash floods: The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health issues (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as the proper functioning of health facilities, including cold chain (WHO, no date).

Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

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Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0007 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Fluvial (Riverine) Flood

Definition

A fluvial flood is a rise, usually brief, in the water level of a stream or water body to a peak from which the water level recedes at a slower rate (WMO, 2012).

Reference

WMO, 2012. Definition number 543. International Glossary of Hydrology. WMO-No. 385. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/international_glossary/385_IGH_2012.pdf Accessed 16 April 2020.

Annotations

Synonyms

Flood, Flooding.

Additional scientific description

Fluvial flooding occurs over a wide range of river and catchment systems. Floods in river valleys occur mostly on flood plains or wash lands as a result of flow exceeding the capacity of the stream channels and spilling over the natural banks or artificial embankments (Fernandez, 2015).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Drivers of fluvial flood: Fluvial (riverine) flooding primarily results from an extended precipitation event that occurs at, or upstream from, the affected area. It can also occur when traditional flood-control structures, such as levees and dikes, are overtopped (NOAA, no date).

Outcomes and impacts of fluvial flood: Flooding of areas used for socio-economic activities produces a variety of negative impacts. The magnitude of adverse impacts depends on the vulnerability of the activities and population and the frequency, intensity and extent of flooding. Some of these factors include loss of lives and property, loss of livelihoods, decreased purchasing power and production power, mass migration, psychosocial effects, hindering of economic growth and development, and political implications (APFM, no date).

Control and monitoring measures of fluvial flood: Floods are important components of the natural hydrological regime. They are a major source of water; they flush pollutants and sediment from river networks. It is also natural for rivers to overtop their banks with greater or lesser frequency and occupy their flood plains. As a result, floods can cause property damage and bring death and injury to many communities. While there is no evidence as yet that the frequency or magnitude of flooding has increased world-wide, flood-prone areas are becoming increasingly densely populated and thus more vulnerable. Consequently, a series of major flood disasters has occurred in recent years, with death and destruction being caused by such events on every continent (GWP, 2013).

There is a need for an approach to flood management that improves the functioning of the river basin as a whole, recognising that floods have beneficial impacts and can never be fully controlled. Such an approach seeks to maximize the net benefits from the use of floodplains and to minimise loss of life, subordinating flood loss reduction to the overall goal of maximising the efficient use of the floodplain (APFM, 2020).

Integrated Flood Management (IFM) is a process that promotes an integrated, rather than fragmented, approach to flood management. It integrates land and water resources development in a river basin, within the context of Integrated Resources Management, with a view to maximising the efficient use of floodplains and to minimising loss of life and property. IFM, like Integrated Water Resources Management, should encourage the participation of users, planners and policymakers at all levels. The approach should be open, transparent, inclusive and communicative; should require the decentralisation of decision-making; and should include public consultation and the involvement of stakeholders in planning and implementation. IFM calls for a paradigm shift from the traditional fragmented approach and encourages the efficient use of the resources of the river basin, employing strategies to maintain or augment the productivity of floodplains, while at the same time providing protective measures against losses due to flooding (APFM, no date).

Health impacts of floods including fluvial (riverine) floods: Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning, to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases, as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

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WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0008 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Groundwater Flood

Definition

A groundwater flood is the emergence of groundwater at the ground surface away from perennial river channels or the rising of groundwater into man-made ground, under conditions where the 'normal' ranges of groundwater level and groundwater flow are exceeded (BGS, 2010).

Reference

BGS, 2010. Groundwater flooding research overview. British Geological Survey (BGS). www.bgs.ac.uk/research/groundwater/flooding/groundwater_flooding.html Accessed 18 November 2019.

Annotations

Synonyms

Flood.

Additional scientific description

Groundwater flooding is a different type of hazard than river or surface water flooding in that the onset is not an immediate process where water suddenly encroaches areas not normally inundated. In contrast, the water levels within permeable strata will gradually rise over time giving rise to the formation of springs and ephemeral streams, areas of ponding, surcharging of wells and boreholes, and water ingress in basements, tunnels, or other below ground structures. Water levels can remain high for many weeks or even months, depending on the nature of the underlying strata and meteorological and hydrological conditions (WMO, no date).

Groundwater flooding occurs when the natural underground drainage system cannot drain rainfall away quickly enough, causing the water table to rise above the ground surface. It can pose a significant flood hazard for many rural communities and its increased frequency in recent years highlights the need for further research (Geological Survey Ireland, 2021).

Both perched groundwater and periodic springs can be causes of floods:

- *Perched groundwater*: a groundwater body, generally of moderate dimensions, supported by a relatively impermeable stratum and which is located between a water table and the ground surface (WMO, 2012).
- *Periodic spring*: a spring flowing irregularly in relation to the hydrological regime of groundwater or in connection with karstic conditions is generally known as a periodic or seasonal spring (WMO, 2012).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

European Union Floods Directive (2007/60/EC): The Directive on the assessment and management of flood risks entered into force on 26 November 2007. It requires member states to assess if all water courses and coastlines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas, and to take adequate and coordinated measures to reduce this flood risk. The Directive also reinforces the rights of the public to access this information and to have a say in the planning process (European Commission, 2007).

Examples of drivers, outcomes and risk management

Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases, as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

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Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0009 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Ice-Jam Flood Including Debris

Definition

An ice jam flood including debris is defined as an accumulation of shuga including ice cakes, below ice cover. It is broken ice in a river which causes a narrowing of the river channel, a rise in water level and local floods (WMO, 2012).

Shuga is defined as accumulation of spongy white ice lumps, a few centimetres across, formed from grease ice or slush, and sometimes from anchor ice rising to the surface (WMO, 2012).

Reference

WMO, 2012. Definition number 1352. International Glossary of Hydrology. WMO-No. 385. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/international_glossary/385_IGH_2012.pdf Accessed 17 April 2020.

Annotations

Synonyms

Flood, Flooding.

Additional scientific description

An ice jam flood is caused by an accumulation of ice in a river, stream or other flooding source that reduces the cross-sectional area available to carry the flow and forces an increase in water-surface elevation (WMO, 2012).

Metrics and numeric limits

Not applicable.

Key relevant UN convention / multilateral treaty

Not applicable.

Examples of drivers, outcomes and risk management

In rivers/streams that experience seasonal ice formation and melt, if the melting is more rapid upstream than downstream, ice floes can accumulate in rivers, forming constrictions and damming flows, causing river levels to rise upstream of the ice jam. A sudden release of the ‘ice jam’ can cause a flood wave similar to that caused by a dam break, to move downstream. Both meltwater and heavy rainfall in steep areas can cause landslips and debris flows. As the debris picked up by rivers moves downstream, major constrictions can build up. When these build-ups collapse or are breached, severe flooding can result. These phenomena are difficult to predict (WMO, 2011; FEMA, 2018).

Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning, to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

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WHO, no date. Flooding and communicable diseases fact sheet. World Health Organization (WHO). www.who.int/hac/techguidance/ems/flood_cds/en Accessed 4 October 2020.

WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

WMO, 2011. Manual on flood forecasting and warning, WMO No. 1072. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/flood_forecasting_warning/WMO%201072_en.pdf Accessed 25 November 2019.

WMO, 2012. Definition number 1352. International Glossary of Hydrology. WMO-No. 385. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/international_glossary/385_IGH_2012.pdf Accessed 17 April 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0010 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Ponding (Drainage) Flood

Definition

A ponding flood is a flood which results from rainwater ponding at or near the point where it falls because it is falling faster than the drainage system (natural or man-made) can carry it away (WMO, 2006).

Reference

WMO, 2006. Technical Regulations Volume III: Hydrology. WMO-No. 49. Page IX. World Meteorological Organization (WMO). https://library.wmo.int/doc_num.php?explnum_id=4564

Annotations

Synonyms

Drainage flood, Surface retention.

Additional scientific description

A ponding flood is that part of the precipitation which remains on the ground surface, without running off or infiltrating, until it evaporates or transpires (Flood Site, 2008).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

Flood Site (2008). Ponding (fluvial) Flood. Accessible at: www.floodsite.net/juniorfloodsite/html/en/student/thingstoknow/hydrology/ponding.html. Accessed 14 April 2021.

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Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0011 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Snowmelt Flood

Definition

A snowmelt flood is a significant flood rise in a river caused by the melting of snowpack accumulated during the winter (WMO, 2012).

Reference

WMO, 2012. Definition number 1352. International Glossary of Hydrology. WMO-No. 385. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/international_glossary/385_IGH_2012.pdf Accessed 26 November 2019.

Annotations

Synonyms

Flood, Flooding, Melt-induced flooding, Snowmelt-runoff floods.

Additional scientific description

In upland and high-latitude areas where extensive snow accumulates over winter, the spring thaw produces meltwater runoff. If temperature rises are rapid, the rate of melting may produce floods, which can extend to lower parts of the river systems. The severity of meltwater floods will increase if the thaw is accompanied by heavy rainfall and can be further exacerbated if the subsoil remains frozen. Although a seasonal occurrence where major snowfields exist in headwaters, which may produce beneficial flooding in downstream areas, severe effects can occur on smaller scales, especially in areas subject to changes between cold and warmer rainy winter weather (USGS, no date; WMO, no date).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Drivers: High soil moisture conditions prior to snowmelt, frozen ground, heavy snow cover, widespread heavy rain during the melt period, and rapid snowmelt (unseasonably warm temperatures, high humidity, rainfall, etc.) (NOAA, no date).

Outcomes and impacts: The effect of snowmelt on potential flooding, mainly during the spring, causes concern for many people around the world. Besides flooding, rapid snowmelt can trigger landslides and debris flows. In combination with specific weather conditions, such as excessive rainfall on melting snow for example, it may even be a major cause of floods (USGS, no date).

Control and monitoring measures: The Flash Flood Guidance System (FFGS) of the World Meteorological Organization takes into account estimated precipitation from several sources, such as satellites, radar as available, and gauges as available to be input into a snow model (SNOW -17) which estimates snow water equivalent (SWE) and melt that are input into the Sacramento-soil moisture accounting model (SAC-SMA) to estimate upper soil moisture (soil water deficit). SNOW-17 uses air temperature as an index to determine energy exchange across the snow-air interface. In addition to temperature, the only other input variable needed to run the model is precipitation. Air temperature is also used to estimate snowmelt. SWE is referred to as the depth of water produced if a snow cover is completely melted on a horizontal surface. The SWE product generated by FFGS is a direct output of the SNOW-17 accumulation and ablation model. Melt is the estimate of ablation due to melt processes and is the direct output of the SNOW-17 model (WMO, 1999).

Health impacts from floods: Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning, to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of communicable diseases (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

NOAA, no date. Snowmelt flooding. National Weather Service Training Portal, National Oceanic and Atmospheric Administration (NOAA). https://training.weather.gov/nwstc/Hydrology/flooding_factsheet.pdf Accessed 17 April 2020.

USGS, no date. Snowmelt Runoff and the Water Cycle. United States Geological Survey (USGS). www.usgs.gov/special-topic/water-science-school/science/snowmelt-runoff-and-water-cycle?qt-science_center_objects=0#qt-science_center_objects Accessed 17 April 2020.

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Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0012 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Surface Water Flooding

Definition

Surface water flooding is that part of the rain which remains on the ground surface during rain and either runs off or infiltrates after the rain ends, not including depression storage (WMO, 2012).

Reference

WMO, 2012. Definition number 1465. International Glossary of Hydrology. WMO-No. 385. World Meteorological Organization (WMO). www.wmo.int/pages/prog/hwrp/publications/international_glossary/385_IGH_2012.pdf Accessed 17 April 2020.

Annotations

Synonyms

Surface detention, Depression storage, Surface retention.

Additional scientific description

Surface water flooding is caused when the volume of rainwater falling does not drain away through the existing drainage systems or soak into the ground but lies on or flows over the ground instead. This type of flooding is usually short-lived and associated with heavy downpours of rain, thunderstorms etc. (NFU, 2019). The UK Government provides a real time flood information service which is easily accessible (UK Government, no date).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Floods tend to be caused by a number of natural events such as rain from slow moving or stationary low-pressure areas, thunderstorms, and tropical cyclones. The amount and duration of the rainfall, soil type and saturation, geography and whether it is an urban area can affect the magnitude and impacts of the flooding. Flooding can occur at the place of a heavy rain event or far downstream away from the causal rain event. Flooding can also be caused by other factors such as storm surge, tsunamis, ice jam, glacial lake outburst, as well as being human influenced such as dam burst, improper land use planning, etc. (Geoscience Australia, no date).

Floods are one of the most common hazards. The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

Geoscience Australia, no date. Flood. www.ga.gov.au/scientific-topics/community-safety/flood#:~:text=In%20coastal%20areas%2C%20water%20inundation%20can%20be%20caused,Other%20factors%20which%20can%20contribute%20to%20flooding%20include%3A Accessed 23 March 2021.

NFU, 2019. Environment Agency (EA) maps show risk from surface water flooding. National Farmers Union (NFU). www.nfuonline.com/cross-sector/environment/water/flooding/ea-maps-show-risk-from-surface-water-flooding Accessed 2 October 2020.

UK Government, no date. Flood information service. https://flood-warning-information.service.gov.uk/warnings Accessed 2 October 2020.

WHO, no date. Flooding and communicable diseases fact sheet. World Health Organization (WHO). www.who.int/hac/techguidance/ems/flood_cds/en Accessed 4 October 2020.

WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO).

MH0013 / **METEOROLOGICAL AND HYDROLOGICAL / Flood**

Glacial Lake Outburst Flood

Definition

A 'glacial lake outburst flood' is a phrase used to describe a sudden release of a significant amount of water retained in a glacial lake, irrespective of the cause (Emmer, 2017).

References

Emmer, A., 2017. Glacier Retreat and Glacial Lake Outburst Floods (GLOFs). https://oxfordre.com/naturalhazardscience/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-275?print=pdf#page=1 Accessed 7 October 2020.

Annotations

Synonyms

GLOF.

Additional scientific description

The term glacial lake outburst flood (GLOF) is used here to refer to the catastrophic release of a water reservoir that has formed either at the side, in front, within, beneath or on the surface of a glacier. Dam structures that impound the water reservoir may be composed primarily of glacial ice, morainic debris, or bedrock (GAPHAZ, 2017).

GLOFs are characterised by extreme peak discharges, often several times in excess of the maximum discharges of hydrometeorological induced floods, with an exceptional erosion/transport potential. They can therefore turn into flow-type movements, such as GLOF-induced debris flow (Emmer, 2017; UN-SPIDER, no date).

Metrics and numeric limits

Not identified.

Key relevant UN convention / multilateral treaty

Not identified.

Examples of drivers, outcomes and risk management

Drivers: Key overarching determinants of GLOF susceptibility and the resulting event magnitude are the size of the glacier lake, the outburst mechanism (and related hydrograph), and the characteristics of the downstream torrent (determined by channel inclination and debris availability). Ice-dammed lakes can develop at the margin of an advancing (or surging) glacier, when side-valleys or depressions at the side of the glacier become truncated and blocked. Many such lakes formed in high mountain regions during the Last Glacial Maximum and more recently during and following the Little Ice Age. Over time, as the glaciers retreat, the support of the ice dam is removed and the lake may drain catastrophically or remain trapped behind lateral moraines of the former glacier (GAPHAZ, 2017; UN-SPIDER, no date).

Susceptibility and control measures: Various schemes have been proposed for assessing the susceptibility of glacial lakes to an outburst flood, mostly drawing on remotely sensed information to characterise semi-quantitatively the cryospheric environment, lake and dam area, and other geotechnical and geomorphic characteristics of the upstream catchment area of the lake. The potential for unstable rock and/or ice to impact into a lake can be determined using worst-case runout distances. Assessment approaches have mostly been developed and tailored towards regional implementation, especially for moraine dammed lakes, for which McKillop and Clague (2007) gave a comprehensive overview of many of the relevant susceptibility factors that may condition or trigger an outburst event (GAPHAZ, 2017).

Health impacts: The effects of flooding on health are extensive and significant, ranging from mortality and injuries resulting from trauma and drowning, to infectious diseases and mental health problems (acute and long-term). While some of these outcomes are relatively easy to track, ascertaining the human impact of floods is still weak. For example, it has been reported that two-thirds of deaths associated with flooding are from drowning, with the other third from physical trauma, heart attacks, electrocution, carbon monoxide poisoning and fire. Often, only immediate traumatic deaths from flooding are recorded (WHO, 2013).

Morbidity associated with floods is usually due to injuries, infections, chemical hazards and mental health effects (acute as well as delayed) (WHO, 2013). Hypothermia may also be a problem, particularly in children, if trapped in floodwaters for lengthy periods (WHO, no date). There may also be an increased risk of respiratory tract infections due to exposure (loss of shelter, exposure to flood waters and rain). Power cuts related to floods may disrupt water treatment and supply plants thereby increasing the risk of water-borne diseases as well as affecting proper functioning of health facilities, including cold chain (WHO, no date). Floods can potentially increase the transmission of the following communicable diseases: water-borne diseases (such as typhoid fever, cholera, leptospirosis and hepatitis A) and vector-borne diseases (such as malaria, dengue and dengue haemorrhagic fever, yellow fever, and West Nile Fever) (WHO, no date).

The longer-term health effects associated with a flood are less easily identified. They include effects due to displacement, destruction of homes, delayed recovery and water shortages (WHO, 2013).

References

Emmer, A., 2017. Glacier Retreat and Glacial Lake Outburst Floods (GLOFs). https://oxfordre.com/naturalhazardscience/view/10.1093/acrefore/9780199389407.001.0001/acrefore-9780199389407-e-275?print=pdf#page=1 Accessed 7 October 2020.

GAPHAZ, 2017. Assessment of Glacier and Permafrost Hazards in Mountain Regions: Technical Guidance Document. Standing Group on Glacier and Permafrost Hazards in Mountains (GAPHAZ). www.gaphaz.org/files/Assessment_Glacier_Permafrost_Hazards_Mountain_Regions.pdf Accessed 20 November 2019.

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WHO, 2013. Floods in the WHO European Region: Health effects and their prevention. World Health Organization (WHO), Regional Office for Europe. https://apps.who.int/iris/handle/10665/108625 Accessed 2 October 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO).