RAPID RISK ASSESSMENT

Extreme rainfalls and catastrophic floods in western Europe

29 July 2021

Summary

The extreme rainfalls of 14 and 15 July 2021 and subsequent flooding in Belgium, Germany, Luxembourg, and the Netherlands have taken a high number of human lives and caused substantial damage of community infrastructure and environment.

This rapid risk assessment focuses on the most common infectious diseases and health risks associated with flood-affected areas, taking into account evidence from past similar experiences in Europe.

In addition to food- and water-borne diseases, zoonoses, vector-borne diseases, vaccine-preventable diseases and other health hazards associated with previous natural disasters in Europe, the current risk assessment also takes into account the challenges of responding to such a complex crisis during the COVID-19 pandemic.

Risk assessment for the EU/EEA

The rapid response put in place in the affected countries, providing access to healthcare, potable water and rescue shelters, has substantially mitigated the infectious disease risk for the affected population and the risk of further spread of infection or outbreak to other areas of the European Union and European Economic Area (EU/EEA).

In this risk assessment, the remaining risk posed by infectious disease related to the event is stratified by two groups of affected population (general population and vulnerable individuals) and by two levels of disease prevalence: very low and low – e.g. West Nile virus (WNV) infection and other mosquito-borne diseases, tetanus, measles, varicella, hepatitis A, *Legionella* infections), and intermediate or high – e.g. SARS-CoV-2, *Escherichia coli*, *Salmonella* spp., *Cryptosporidium* spp., and norovirus infections.

Based on the combination of the probability of infection and of the impact of such an infection, we assess the infectious disease risk posed by this event to the affected populations as ranging from very low for diseases that are uncommon in these countries and among otherwise healthy individuals, to high for diseases that are more frequent and among vulnerable individuals.

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COVID-19 is considered separately, as the risk of spread of SARS-CoV-2 in individuals unvaccinated or with an incomplete vaccination course is high, particularly in communities living in close contact with displaced people, or among groups of displaced/evacuated people, due to the overcrowding and potential difficulties in maintaining non-pharmaceutical interventions (NPIs). Although the risk of severe COVID-19 is low in fully vaccinated individuals, stringent implementation of NPIs are encouraged in all risk groups to prevent infections among the unvaccinated or partially vaccinated individuals.

Options for response

Floods are the most common type of natural disasters in Europe. Flash floods are significant emergencies, challenging to predict and accompanied by remarkable destruction. Such events are becoming more common in the recent years and expected to increase due to climate change.

Affected regions and countries, face an immediate surge of injuries and trauma, while they may also, depending on the scale of disruption and their public health capacities, need to organise syndromic and event-based surveillance systems. A list of events that needs to be immediately reported to local and national public health authorities in order to prompt a rapid response include suspect cases of severe infectious diseases, including clusters of respiratory and gastrointestinal symptoms, rashes etc.

COVID-19 vaccination should remain a priority and attempts should be undertaken to limit any potential disruptions in the flood-affected areas. Non-pharmaceutical interventions such as hand hygiene, physical distancing and wearing of face masks remain essential, particularly in displaced populations housed in shelters. Testing and contact tracing should remain a priority.

Collaboration with other local authorities (civil protection, municipalities) to ensure access to clean water as soon as possible for the affected communities is needed. Water management plans should minimize the risk for *Legionella* growth. Flooded areas need to be monitored for mosquito growth and control measures may need to be considered. Early detection and awareness for disease clusters should be enhanced and availability of immunizations should be ensured.

Risk communication to the affected communities is a critical part of the response to the flood crisis and it should be undertaken in a structured way for delivery of messages and listening to the affected community's needs. Key principles include the identification of a trusted spokesperson and the delivery of clear and actionable advice with messaging tailored to the needs of the affected communities.

Event background

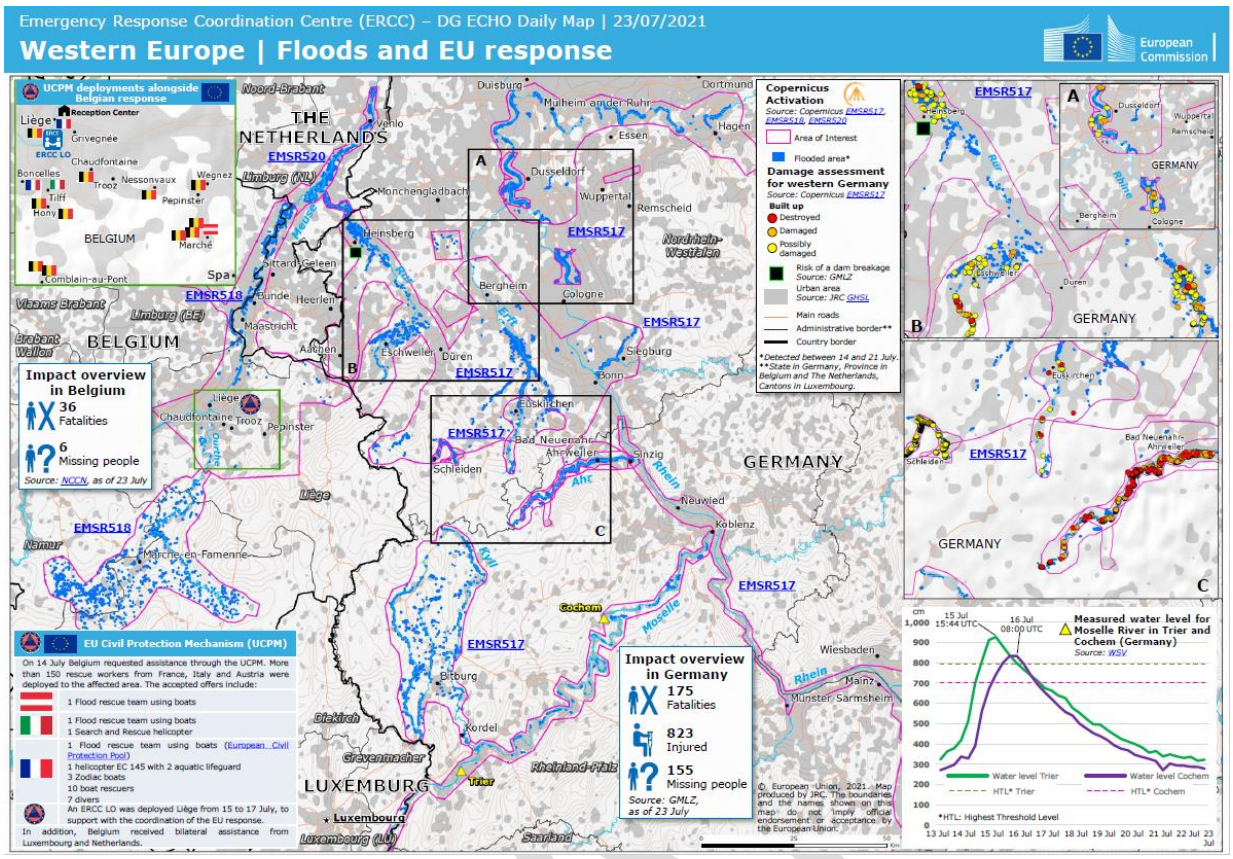
Heavy rainfall leading to disastrous floods in Belgium, Germany, Luxembourg, and the Netherlands, occurring during 14 and 15 July 2021, affected a large population and caused devastating destruction to infrastructures [1-5] (Figure 1). The worst-affected areas are in the western regions of Germany (Rhineland-Palatinate and North Rhine-Westphalia), as well as eastern Wallonia in Belgium. As of 23 July 2021, at least 212 deaths have been documented, of which 175 were reported in Germany and 37 in Belgium, with an additional 155 people in Germany and 6 people in Belgium who are still missing [6,7]. Much of the telephone network has been destroyed in the affected regions thus further complicating the attempts to reach all affected people

Due to the floods, thousands of people have been evacuated from the affected regions, including from larger cities such as Liège in Belgium, and Limburg, Roermond, and Venlo in the Netherlands [2]. Some of the disrupted areas are considered uninhabitable, therefore people have been provisionally housed in various types of emergency accommodations, especially in the affected areas in the Netherlands and Germany. About 1 000 persons have been reportedly displaced in Luxembourg. Many evacuated or displaced people are currently accommodated with friends or relatives in multi-family homes. In the current situation, many people live in temporary accommodations, and according to anecdotal reports in Germany, some people remain quasi-camped outside of their buildings without running water, sanitation, nor electricity in the vicinity. However, accurate data on the number and conditions of all displaced populations are not available at this point.

Given the disruption to wells and water supply infrastructure, the tap water is considered unsafe to drink in most of the affected regions [10-12].

Just before, during, and after the events described above, other flooding occurred in countries such as Austria [11], France [2], Germany (parts of Bavaria) [11], Italy [12], Poland [2], Romania [2], and Switzerland [12], however, the destruction to infrastructure and disruption to populations was more limited.

Figure 1. Extent and impact of the flood, as of 23 July 2021 [6]



Map produced by European Commission (EC) Emergency Response Coordination Centre (ERCC).

Disease background

Floods are considered the most common natural disaster worldwide and in Europe, and refer to water accumulation in places that are not normally submerged, usually due to heavy rainfall [13]. They are categorised roughly as river inundation (fluvial), caused by heavy rainfall (pluvial) and coastal. Flash floods are a subset of pluvial floods and are sudden events accompanied by widespread destruction, which happen with little early warning (<6 hours) usually because of intense rainfall over a relatively small area. According to a recent report by the European Court of Auditors, serious floods have become more frequent in Europe. In recent years, more than twice as many flash floods of medium to large magnitude have been registered as compared to the late 80s particularly in the Mediterranean countries and in the mountains [14]. Flash floods are difficult to predict and considerable research is underway in the EU/EEA countries to develop better early warning systems [15]. Flood events are recorded in the Emergency Events Database (EM-DAT), under certain criteria that qualify them as disasters [16].

Flood affected communities often suffer injuries and loss of lives, significant economic loss, as well as damage to the environment and cultural heritage. Floods may also lead to long-term health effects [13,14]. The most common infectious disease groups and health risks associated with flood-affected areas are outlined below.

Food- and waterborne diseases and zoonoses

Strong floods can lead to higher immediate, medium- and long-term risks of food- and waterborne infections and zoonoses. In areas that are prone to annual fluvial floods e.g., due to snowmelt or excessive rain, the risks are mainly related to flushing of animal excreta in the soil and land through elevated river water into buildings and water supplies. In urban settings, pluvial floods often consist of street flooding and/or flooding combined with overflow of sewage [17]. When the floods lead to severe disruption of infrastructure and sewage water systems, the direct or indirect risk of gastrointestinal diseases increases due to possibility of immediate exposure to waterborne and zoonotic faecal bacteria, viruses, and parasites. Further, disruption of electrical, refrigeration and cooking systems, may facilitate the transmission of food-borne illness, in particular during warm summer months [18]. In general, the risk is increased for viral infections, such as norovirus, hepatitis A, and rotavirus, infections caused by parasites *Cryptosporidium* spp. and to a lesser extent *Giardia*, and bacterial infections due to *Campylobacter* spp., pathogenic *E. coli,* different *Salmonella enterica* serotypes, and to a lesser degree *Shigella* spp.

In addition, the risk for leptospirosis transmission is increased through abrasions of the skin or of the mucous membranes coming into contact with flood water, damp soil or mud that has been contaminated with urine or tissue from infected animals, most commonly rats [21,22]. Occasionally, transmission occurs through drinking or inhalation of tiny droplets (aerosols) of contaminated water.

Medium- and long-term risks for gastrointestinal diseases due to floods have been described in several EU countries. In Germany, an outbreak of *Cryptosporidium hominis* infections was detected among children in 2013 after the floodplain had dried out. As a response measure, authorities recommended to avoid playing, swimming and having picnics in the flood-affected area [21]. These risks could be relevant in the current event in those areas, which are less severely damaged along the Moselle and Rhine rivers. In 2005, Austria reported a norovirus outbreak due to direct exposure to sewage water due to flooding [22]. A study in the Netherlands showed a significant association between contact with floodwater and gastrointestinal complaints during a four-week observation period after pluvial flooding [23]. In a Dutch follow up study, contact with floodwater was significantly associated with acute gastroenteritis (AGE), (aOR 4.2, 95% CI: 2.1-8.4). Risk factors for AGE were skin contact with floodwater (aOR 4.0, 95% CI: 1.8-9.0), performing post-flooding cleaning operations (aOR 8.6, 95% CI: 3.5-20.9) and cycling through floodwater (aOR 2.3, 95% CI: 1.0-5.0) [17]. In 2010 in Belgium, river water contaminated a tap water system causing a large multi-pathogen waterborne outbreak including isolations of norovirus, rotavirus, *Campylobacter* spp. and *Giardia lamblia* in stool samples from clinical cases [24].

Legionellosis

Legionella bacteria are environmental organisms found in water, such as lakes, streams, artificial water reservoirs, and soil. Typically, they are transmitted to humans via the inhalation of contaminated aerosols and can cause pneumonia or Pontiac fever [25]. In late summer after the seasonal rainfall, sporadic cases of legionellosis are common in Europe. After heavy flooding, disturbances in the water supply, broken water infrastructures, use of temporary piping and tanks and failure to follow appropriate water management plans, the risk for *Legionella* outbreaks and sporadic cases is increased [26]. People in the affected area as well as recovery workers are at risk of exposure to aerosols generated from soil or sediment containing *Legionella* species while attempting to clean flooded areas (e.g., through flushing with water) [27]. Moreover, an elevated *Legionella* risk can be associated with temporary or poorly designed or maintained water infrastructures (water tanks, piping) in the temporary shelters or any temporary healthcare facilities. Finally, there is evidence that the risk of *Legionella* infections may increase when there is warm weather following heavy rain [30-32].

Legionella pneumonia, leptospirosis and COVID-19, as well as a number of other viral respiratory infections, can present with similar clinical symptoms and signs, characteristically as an influenza-like illness.

COVID-19 and other vaccine preventable diseases

COVID-19

The overall case notification rate for COVID-19 in the EU/EEA was 151.0 per 100 000 population in week 28. This has been increasing in the earlier three weeks mostly as result of the of the spread of the Delta variant of concern (VOC) [31].

During week 28, the COVID-19 14-day notification rate per 100 000 population was 147.0 in Belgium, 17.0 in Germany, 276.0 in Luxembourg and 670.4 in the Netherlands, with increasing trends in recent weeks observed in all the four affected countries. COVID-19 vaccination rates for cumulative uptake of full vaccination among adults (18+ years) in the affected countries for week 28 are 60% (Belgium), 55.5% (Germany), 59.2% (Luxembourg) and 56.3% (the Netherlands), respectively [32]. The majority of new COVID-19 infections in the EU/EEA, including in the affected countries, are occurring among unvaccinated younger individuals [33].

Evacuated or displaced persons from the flood affected communities will need to either be accommodated in shelters (e.g., community buildings, hotels etc) or by friends and relatives in multi-family homes. In both cases, overcrowding can occur and difficulty in implementing appropriately NPIs as advised. This, in conjunction with the overall low full vaccination coverage of the general population and the increasing circulation of Delta VOC increases the risk of local outbreaks.

For information on the latest scientific evidence relating to COVID-19, SARS-CoV-2, virus transmission, diagnostic testing, infection, clinical characteristics, risk factors and risk groups, immunity, treatment and vaccines please visit ECDC's dedicated webpage: https://www.ecdc.europa.eu/en/covid-19/latest-evidence and the Weekly COVID-19 country overview.

Tetanus

The risk of tetanus does not rise with simple contact with flood water. However, when clearing flooded spaces there is increased possibility of suffering injuries and open wounds from contact with debris. These should be treated according to the type/depth of wound, and status of tetanus immunization. Tetanus prophylaxis should be offered according to existing national guidelines [34].

In 2019, 64 cases of tetanus have been reported in the EU/EEA, none from the four most flood-affected countries. Belgium reports that 62% of the adult population has received a tetanus booster in the past 10 years [35]; for Germany this is reported at 72% [36], while for the Netherlands protective antibodies against tetanus toxin are reported at >90% of the population [37]. No data on tetanus seroprevalence are available for Luxembourg [38].

Hepatitis A

Hepatitis A is transmitted through the faecal oral way, mostly through contaminated food or water. All four currently affected countries (Belgium, Germany, Luxembourg and the Netherlands) were classified with very low incidence rate for hepatitis A according to 2000-2014 data, and none of them include immunization against Hepatitis A in their National Immunization Schedules, although it is administered in special high-risk groups or travellers [39]. Therefore, it is likely that these populations have substantial levels of susceptibility for hepatitis A outbreaks [40]. The detection of hepatitis A outbreaks/clusters is usually delayed due to long incubation period of 15-50 days.

Other vaccine preventable diseases

If displaced persons and families are temporarily housed in close proximity in shelters, there is an increased risk of transmission of vaccine preventable diseases such as varicella, measles, meningitis and influenza, in addition to COVID-19.

Outbreaks of vaccine preventable diseases like measles, varicella or meningitis are of immediate concern in displaced populations, albeit the risk is higher in countries with limited resources and suboptimal vaccination coverage [42].

Vaccine coverage for measles (second dose of measles containing vaccine -MCV) in the four affected countries is reported between 85-93% (Belgium 85%, Germany 93%, Luxembourg and the Netherlands 90%), thus below the 95% target. Furthermore, the COVID-19 pandemic impacted negatively on the national immunization programmes in the European region with regular vaccination visits being delayed or postponed for many young children [43]. This could have led to a higher proportion of children being susceptible to vaccine preventable diseases.

Vector-borne diseases

Stagnant water remaining after floods (e.g., in basements, gardens, parks, agricultural and rural areas) could create suitable sites for mosquito breeding; therefore, heavy rainfall and floods increase the risk of mosquito-borne diseases. A higher density of mosquitoes may primarily increase nuisance levels, while the risk of mosquito-borne diseases may increase if i) mosquito-borne pathogens are present, and ii) if competent mosquito vectors of those pathogens are present in the flooded areas.

Outbreaks of mosquito-borne diseases associated with floods or heavy rainfall have mainly been reported in tropical areas (e.g., outbreaks of malaria, dengue fever and Rift Valley fever [40,41]). In Europe, extreme rainfall and flooded basements have been linked to the occurrence of chikungunya [46] and West Nile virus (WNV) infections [47], respectively. The circulation of WNV in Europe has been documented since the 1950s, and it appears to be expanding its geographical range [48], however, its circulation has not been documented in the affected regions. The principal vector, the common house mosquito *Culex pipiens*, is widespread in Europe [49]. Other mosquito-borne viruses (e.g., Usutu virus, Sindbis virus, Tahyna virus, Inkoo virus) are also endemic in some European countries; however, with low prevalence and pathogenicity in humans.

Imported cases of exotic mosquito-borne diseases (e.g., malaria, dengue fever, chikungunya, Zika virus disease, yellow fever, Rift Valley fever) occur regularly in Europe. However, autochthonous transmission of these pathogens requires competent mosquito vector species.

The Asian tiger mosquito *Aedes albopictus*, may serve as vector for several viruses, and over the past decades it has been expanding its range in Europe [50]. *Aedes albopictus* has been implicated as vector of outbreaks of dengue fever, chikungunya and Zika virus disease in Southern Europe, but it is not considered established in the affected regions.

Malaria is not endemic in Europe. Considering the ecology and epidemiology of malaria, the probability that the recent floods would facilitate vector-borne autochthonous transmission from any imported malaria infections in the affected regions is very low.

Other health risks

Injuries and soft tissue wounds that come into contact with the debris that is associated with flooding can lead to soft tissue infections. Bacteria that are often responsible for soft tissue infections are *Staphylococcus*, *Streptococcus Vibrio* spp. (e.g. *Vibrio vulnificus*), or fungi [51].

Animal bites (wild animal, e.g., rodents) are frequently reported as animals may seek refuge in the flooded houses and become aggressive upon contact with humans [52,53]. Similarly, domestic animals can also become aggressive in stress situations like floods when people are approaching them (e.g., to rescue).

Studies have reported fungal growth in homes that have been flooded and household goods that have been submerged, particularly as waters recede gradually. The extent and type of fungal growth depends on the local climate and the type of building structure. Pulmonary and systemic fungal infections (usually airborne and dust borne *Aspergillus*) or mycotoxin exposure have been reported following flooding [20,49]. Persons can be exposed through skin, ingestion or inhalation. Immunocompromised persons are more vulnerable to fungal infections after inhalation, which can be localised or disseminated. Prolonged exposure to mould (usually occupational exposure) can cause rhinitis, hypersensitivity pneumonitis (e.g., farmer's lung) and asthma [50,51].

While this risk assessment focuses on infectious diseases risks after the extensive flooding in western Europe, as per ECDC's mandate, it is important to note that these do not represent the biggest risks to health and wellbeing of the flood affected communities in the current crisis. Several other health risks are mentioned in the literature, including e.g., disruption of healthcare (particularly chronic care), other environmental hazards (carbon monoxide poisoning, exposure to dangerous chemicals), and psychological stress, accompanied by potentially long-lasting health effects and increase of all-cause mortality [13,57].

ECDC risk assessment for the EU/EEA

This assessment is based on information available to ECDC at the time of publication and, unless otherwise stated, the assessment of risk refers to the risk that existed at the time of writing. It follows the ECDC rapid risk assessment methodology, with the overall risk determined by a combination of the probability of an event occurring and its consequences (impact) for individuals or the population [58].

Risk assessment questions

What is the risk of infectious diseases posed to the population affected by catastrophic floods in Belgium, Germany, Luxembourg and the Netherlands?

The degree to which infectious disease outbreaks occur after a natural disaster like floods is associated with the regional incidence of specific diseases, the nature and scope of the event, the robustness of public health infrastructure in place both before and after the event, and the efficacy of the disaster response [45].

In this particular event, the relatively limited geographical area of destruction, and the proximity of unaffected areas, has facilitated the disaster response and the access of survivors to rescue shelters and potable water, possibly mitigating the risk of infection.

In this assessment, we stratify the population affected by this event into two groups: the general population and the vulnerable individuals, at higher risk of exposure and/or severe outcome of infectious disease, including persons and groups such as the elderly, pregnant women, young children, the immunocompromised and disabled persons. In this second population group, we also include the people who had to leave their home and were displaced into temporary shelters, due to their higher possibility of exposure to infectious disease pathogens in communal accommodation, and the disruption of their regular healthcare provision.

We stratified the infectious diseases potentially connected to flooding events into two groups according to their epidemiology in the four affected countries, taking also into consideration the type of post-flood infectious disease outbreaks reported in the literature. Therefore, for the purposes of this assessment, we considered vector borne infections (WNV infection, *Aedes*-borne infections), tetanus, measles, varicella, hepatitis A, and *Legionella* infections as infectious diseases present at a baseline very low prevalence, and COVID-19, foodborne infections (*E. coli*, *Salmonella* spp., *Cryptosporidium* spp.) and leptospirosis as diseases present at a baseline intermediate or high prevalence.

Based on the combination of the probability of infection and of the impact of such infection should it occur on the two population groups described above, we assess the infectious disease risk posed by this event as ranging from **very low** to **high** (Table 1).

Table 1. Probability, impact, and overall risk of infection for the general population and vulnerable individuals associated with infections at very low/low prevalence and intermediate/high prevalence

Population	Tetanus, hepatitis A, measles, varicella, meningitis, influenza, legionellosis, vector-borne diseases	FWD, COVID-19, leptospirosis
General population	Probability: Very Low Impact: Low **Risk: Low**	Probability: Moderate Impact: Low **Risk: Moderate**
Vulnerable populations	Probability: Very Low Impact: High **Risk: Moderate**	Probability: Moderate Impact: High **Risk: High**

SARS-CoV-2 is endemic in the community throughout the EU/EEA, including in the flood-affected areas. Considering the increasing prevalence of the Delta variant of concern (VOC) and the fact that substantial proportions of the population are unvaccinated, the probability of increasing circulation of SARS-CoV-2 in the flood-affected areas is high. Additional factors that may contribute to the increased risk of COVID-19, include the potential disruption of testing and tracing programmes and the difficulties in implementing isolation and quarantine measures. Finally, the disruption of the COVID-19 vaccine rollout and the difficulty in maintaining NPIs by flood victims in community or in multi-family accommodation adds to the risk.

There are immediate, medium- and long-term risks of food- and waterborne infections and zoonoses, e.g. leptospirosis, connected to flooding. Due to full disruption of sanitation and drinking water systems in some areas there is a moderate risk of infections with various enteric pathogens which tolerate environmental conditions well, such as norovirus, rotavirus, pathogenic *E. coli*, *Salmonella* spp., and *Cryptosporidium* spp. The risk of infection with other food- and waterborne pathogens is low. Therefore, the probability of food- or waterborne disease clusters or outbreaks is considered moderate in areas where access to clean water and good hygiene measures cannot be ensured. Due to the possible contamination of water used for agricultural purposes, a limited risk of contamination of fresh fruits and vegetables with enteric pathogens if grown in the vicinity of the affected areas exists. Children are particularly at risk due to higher direct or indirect oral transmission of pathogens from contaminated water or surfaces affected by floodwater.

The risk of leptospirosis cases is assessed as a moderate after a flooding, as the scattering of garbage, debris, and food may contribute to the amplification of rodent populations [59].

Sporadic *Legionella* infections are expected after the summer rainfalls and the flooding adds to that risk, mostly through occupational exposure of persons cleaning or maintaining piping in flooded buildings, particularly if aerosolisation of mud or dust happens.

Considering the likely low natural immunity levels, outbreaks of hepatitis A may occur in the affected areas through consumption of contaminated food or accidental swallowing of sewage-contaminated water [60]. Occupational exposure to HAV in construction of sanitation systems and cleaning workers has been reported [61].

Finally, although mosquito nuisance is likely to increase due to the existence of abundant breeding sites in the flooded areas, mosquito-borne diseases are included in the very low/low prevalence group. WNV circulation has not been documented in the affected regions, neither is *Aedes albopictus* considered established there, which could transmit several aedes-borne viral diseases. Onwards autochthonous transmission of malaria in the affected regions from imported cases is also considered unlikely.

What is the risk of infectious diseases and outbreaks spreading from the affected areas to other areas of the EU/EEA?

For most of the diseases taken into consideration in this assessment, the probability of spread to other areas of the EU/EEA is considered very low and, should such risk materialise, its impact is assessed as low.

However, the probability of spread of SARS-CoV-2 and of food- and waterborne infections and outbreaks is considered higher than that of the other groups of diseases discussed above.

SARS-CoV-2 is circulating in the communities of all four flood-affected countries with a 14-day case notification rate per 100 000 population ranging from 17.0 (Germany) to 670.4 in the Netherlands. At the same time, full vaccination among adults (18+ years) in the affected countries ranges from 56-60%. Therefore, there is a risk that any localised increase in transmission resulting from disruption to NPIs or healthcare delivery in the flooded areas

could result in increased spread of SARS-CoV-2 to communities neighbouring the affected areas. The need to deploy COVID-19 vaccination as a priority to the flood-affected and displaced populations in the four countries, as well as the volunteers to these areas is underlined again, together with the stringent implementation of non-pharmaceutical interventions (NPIs) for all.

The probability and impact of spread of food- and waterborne infections to other populations than those from the affected areas is considered very low. However, there is a theoretical risk of exporting fresh fruits and vegetables which have been irrigated with contaminated surface water, thus leading to outbreaks outside of the affected areas.

Options for response

Floods are the most common type of natural disasters in Europe and extreme events, like the flash floods that affected Belgium, Germany, Luxembourg and the Netherlands recently, are expected to increase in frequency as outlined in the latest Intergovernmental Panel on Climate Change [62]. As a consequence, preparedness planning for the management of the health effects of climate related disasters needs to be strengthened [62,63].

Affected areas can experience disruption of health care services and increased initial demand to respond to injuries, trauma patients and the management of fatalities. Since EU/EEA countries are still responding to the needs of the COVID-19 pandemic this can cause additional strain and support may be needed from nearby non-affected areas.

To rapidly detect and respond to possible infectious disease threats in the affected areas, national authorities should consider setting up syndromic and event-based surveillance systems.

Syndromic surveillance systems are based on the ongoing reporting of clinical presentations/syndromes (e.g. diarrhoea with/without fever, fever with rash, cough with fever, etc.) to public health authorities. Depending on existing surveillance infrastructures the reporting can be real-time, daily, or weekly, using simple reporting methods and forms. Due to the disruption of networks (e.g., electricity, internet etc) alternative ways of reporting such as by phone, should also be considered until the situation stabilises and regular reporting methods are available again. Alternative communication pathways may cause delays in reporting, therefore delay in recognizing a new health event (e.g., a new cluster). Regular analysis of incoming syndromic data could allow for the rapid detection and control of outbreaks.

Public health authorities should also consider defining a list of serious events (event-based surveillance) which require immediate notification by phone in order to prompt rapid investigations and implementation of prevention and control measures (e.g., a suspect measles case, a case of meningitis, cases of unusually severe respiratory or gastrointestinal illness) [64,65].

COVID-19

Response to the on-going COVID-19 pandemic should follow the options outlined in the latest ECDC RRA "Assessing SARS-CoV-2 circulation, variants of concern, non-pharmaceutical interventions and vaccine rollout in the EU/EEA, 15th update" [66] as well as the Threat Assessment Brief Implications for the EU/EEA on the spread of the SARS-CoV-2 Delta (B.1.617.2) variant of concern [67].

COVID-19 vaccination campaigns should remain a priority for the affected countries. In flood-affected areas, given the risks posed by the local conditions for further spread of COVID-19, efforts to ensure the provision of COVID-19 vaccines and facilitate access to vaccination should be prioritised, particularly if the communities are displaced either into communal shelters or multi-family homes. Initiatives can include mobile vaccination units (as for example the 'vaccination bus' deployed in affected areas in Germany [68]), drop-in, flexible scheduling, and community delivery strategies to ensure the delivery of doses to unvaccinated. If capacity is reduced, prioritising risk groups, including the elderly and those with underlying medical conditions, will have the biggest impact on severe COVID-19 and mortality. Humanitarian workers and volunteers to the affected areas should be included in the priority groups. In addition, a risk assessment of the cold chain for transportation and maintenance of COVID-19 vaccines should be undertaken in the affected areas due to the severe damage of all the utility networks to ascertain proper function.

Some preventive measures are currently being taken to curb the spread of COVID-19 in the affected regions, as the risk of disease spread in emergency housing is increased, given the proximity of large groups of people. For example, in Germany [69], buses are providing testing and offering vaccination without appointment, and temporary medical infrastructure has replaced much of the destroyed or unusable medical establishments. In addition, having a dedicated website on what to do in the event that the floods have disrupted vaccination or testing appointments has been created in Belgium [70].

Non-pharmaceutical interventions

To reduce the risk of SARS-CoV-2 transmission, it is essential to maintain or re-establish NPIs (physical distancing, hand- and respiratory hygiene, use of face masks, etc.) in areas where flooding has resulted in increased crowding

or disruption to health services, as part of the public health response. Such measures should be implemented by the affected countries particularly among displaced populations considering the local epidemiological situation, the vaccination coverage in the general population and the prevalence of VOCs. While volunteering, assisting, or staying in shelters, face masks should always be worn, and hand- and respiratory hygiene measures should be practised meticulously.

Testing and contact tracing

Testing and contact tracing of SARS-CoV-2 positive cases remains important. This will be crucial in situations where populations may have been displaced or services interrupted. The spread of SARS-CoV-2 can be minimised by expecting and planning for potential outbreaks/cluster of cases, particularly in congregate settings. A robust system for contact tracing should remain a priority.

Other flood-related infectious diseases

Activities for public health authorities in the short and mid-term after the floods also include:

- Ensuring the rapid detection of potential clusters or outbreaks of vaccine preventable diseases (e.g., establish alerts from surveillance systems), particularly in displaced individuals, and ensure availability and access to the necessary immunizations for outbreak control.
- Ensuring access to clean water to the affected communities by collaborating with other local authorities, where water and sanitation systems have been damaged. Water quality monitoring systems are needed and communication of the results of water quality to the affected communities through appropriate information pathways.
- Making sure that water management plans minimize the risk of growth or exposure to Legionella and other waterborne pathogens
- Providing hand hygiene stations or facilities throughout shelters and community spaces
- Providing information to humanitarian workers, first responders, construction workers assisting in the recovery and in general anyone involved in cleaning flooded edifices and debris, should wear appropriate personal protective equipment to avoid exposure to potential pathogens.
- If water removal is not possible within the next few weeks, public health authorities should monitor mosquito populations in the flooded areas. If intensive mosquito breeding is detected, deploying control measures (such as larvicide treatments) should be considered.

Risk Communication

Communication among all the stakeholders is very important in the response to such complex emergencies. A large part of the involvement of public health authorities in the management of the health effects of flooding has to do with risk communication to the affected population, which should address all the different risks outlined above. Risk communication during the response to a disaster is considered a critical function and should be carefully planned, focusing on three key principles: use of a trusted voice or representative as a spokesperson; provision of clear, actionable advice; tailoring of messages and communication methods to the community needs [71].

Communicators should focus on expressing empathy, explain risks, promote action, and describe response efforts. In addition, community engagement should be prioritised to address rumours and misinformation or misunderstandings [72]. At the same time the "listening" aspect of risk communication should be developed by regional and national authorities to enable better community engagement and gathering feedback on how messages are received. Examples of such activities include the organisation of hotlines, monitoring social media and organising community meetings for providing feedback on their needs and the response to the crisis [72,73].

Messages and advice that need to be addressed by public health authorities in their risk communication activities to target groups (affected communities, health professionals, volunteers and humanitarian workers in the affected areas) include the following:

General hygiene messages

Provide advice on the following to affected communities, healthcare workers and humanitarian workers and volunteers working in the flooded areas:

- careful hand hygiene with soap and clean water or use appropriate alcohol-based hand rub solutions particularly after handling any item or materials that have been potentially contaminated by flood water, using the toilet and before preparing food, eating, drinking or smoking;
- drinking only clean, safe water and eat only food that has not been in contact with floodwater or surfaces that have been in touch with floodwater or sludge;
- not to use floodwater or well water or water that has been contaminated with floodwater:
- for personal hygiene (e.g. washing or brushing teeth);
- to wash dishes, vegetables or fruits, cook food or prepare baby food;
- waiting on official announcements or advice as to when the tap water is safe to drink;

- when in doubt, to throw away any food and water that may have come into contact with floodwater;
- not to eat fruits and plants from gardens that have been flooded, unless they are well washed with clean water;
- not to eat refrigerated or melted food that has been exposed to warm temperatures for more than two hours, e.g. due to electricity disruption;
- not to swim in floodwater or lakes, rivers that have been flooded, and not to use recently flood-affected areas for playing (e.g. children in day care centres) or picnics;
- practicing respiratory hygiene (cover cough, sneezes, safe use of tissues), particularly in sheltering conditions;
- being aware of immunization status for tetanus and other vaccine preventable disease pathogens;
- seeking prompt medical advice when having clinical symptoms (according to surveillance needs regionally);
- removing stagnant water (as part of the recovery / reconstruction works) by draining flooded areas and removing debris that could act as water containers.

Specific communication towards health care professionals could also include:

- increase awareness for reporting to the event-based surveillance system, if applicable, or increase awareness about a specific list of diseases according to local management decisions (e.g., gastrointestinal, respiratory, rash etc.);
- increase awareness about the detection of clusters of communicable diseases, particularly for health professionals serving displaced population groups (e.g., food- or waterborne diseases, vaccine preventable diseases, Legionella pneumonia, etc);
- increase awareness of health professionals for the similarities between clinical presentation of COVID-19 and other respiratory syndromes that should be included in the differential diagnosis (e.g., Legionella or Leptospira infections)
- provide advice on the management of wounds (reminder about tetanus prophylaxis);
- increase awareness about potential vaccine preventable diseases such as hepatitis A, measles or varicella that may emerge in the displaced population, and their management and notification procedures according to national guidelines.

General messaging on disasters

- Disease outbreaks happen due to the destruction of infrastructure (e.g., sanitation systems).
- Corpses do not pose a public health risk for disease outbreaks because most pathogens can no longer survive in a dead body, and microorganisms involved in putrefaction (decay processing) are not pathogenic [74].

Limitations

This assessment is undertaken based on facts and data known to ECDC at the time of publication.

Source and date of request

ECDC internal decision, 19 July 2021.

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All experts have submitted declarations of interest, and a review of these declarations did not reveal any conflict of interest.

Disclaimer

ECDC issues this risk assessment document based on an internal decision and in accordance with Article 10 of Decision No 1082/13/EC and Article 7(1) of Regulation (EC) No 851/2004 establishing a European Centre for Disease Prevention and Control (ECDC). In the framework of ECDC's mandate, the specific purpose of an ECDC risk

assessment is to present different options on a certain matter. The responsibility on the choice of which option to pursue and which actions to take, including the adoption of mandatory rules or guidelines, lies exclusively with the EU/EEA countries. In its activities, ECDC strives to ensure its independence, high scientific quality, transparency and efficiency.

This report was written with the coordination and assistance of an Internal Response Team at the European Centre for Disease Prevention and Control. All data published in this risk assessment are correct to the best of our knowledge at the time of publication. Maps and figures published do not represent a statement on the part of ECDC or its partners on the legal or border status of the countries and territories shown.

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