



RAPID RISK ASSESSMENT

Cyclone Idai: risk of communicable diseases in southern Africa

10 April 2019

Main conclusions and options for response

In the aftermath of Cyclone Idai (mid-March 2019), the most immediate risks in the affected areas of Mozambique, Zimbabwe and Malawi are related to the increased transmission of diarrhoeal diseases due to lack of access to safe drinking water and poor sanitary conditions. In addition, the number of acute respiratory infections in children accommodated in overcrowded shelters has gone up. The risk of a major upsurge in cholera cases in affected areas or in bordering areas with previous transmission and flood-specific risks (e.g. tetanus and leptospirosis) should be considered a priority when adopting mitigating measures.

Mozambique reported the first cholera cases a few days after the cyclone in Sofala province, mainly in the provincial capital Beira, with more than 3 500 cases being reported to date. International response support from ministries of health, United Nations organisations, and non-governmental organisations is ongoing. This includes the implementation of cholera treatment centres in Mozambique.

Mosquito-borne diseases represent a risk that should also be taken into account in this context. In the affected areas in Mozambique and Malawi, malaria is endemic, with moderate seasonality. In these countries – while the main risk of malaria is due to disruption of the health services – an epidemic is not expected because of the presumed high levels of acquired immunity in the population. In Zimbabwe, where malaria prevalence and hence immunity levels are much lower, the risk of a malaria epidemic, or an extended malaria season (peak is normally between February and May) is larger.

Surveillance of infectious diseases in the aftermath of a cyclone is important for the early detection and confirmation of outbreaks. Consideration should be given to setting up a syndromic surveillance alert system if there is a need to reinforce surveillance capacity. Laboratory capacity should be assessed for confirming outbreaks of infectious diseases; if required, a referral mechanism can be established for testing samples of epidemic-prone diseases.

Measures to address the potential disruption of national routine vaccination programmes, particularly those for infants, should be considered as part of basic emergency healthcare services.

An assessment of HIV and tuberculosis treatment services should be considered and, where the treatment programme is disrupted, measures should be considered to ensure continuation of treatment.

The overall risk for EU travellers or residents in affected countries is very low if proper personal prevention measures are taken.

The prevention of gastrointestinal illnesses is dependent on adequate sanitation, availability of safe drinking water (chlorinated or boiled), and appropriate good food and hand hygiene, i.e. regularly washing hands with soap, eating thoroughly cooked food, washing fruits and vegetables with bottled or chlorinated water, and avoiding consumption of raw seafood products.

It is also important to prevent the transmission of respiratory infections in crowded settings through early detection, treatment, and appropriate infection control measures.

In flooded areas, there is the possibility of an increase in vector-borne diseases in the aftermath of the cyclone. The best protection from mosquito-borne diseases is to prevent mosquito bites indoors and outdoors. Possible measures include:

- the use of mosquito nets;
- the use of mosquito repellent in accordance with the instructions indicated on the product label;
- wearing long-sleeved shirts and long trousers; and
- sleeping or resting in screened or air-conditioned rooms.

The use of chemoprophylaxis is recommended against malaria along the lines of relevant international and national guidelines.

Additional vaccination measures should also be considered, along the lines of relevant international and national guidelines:

- Vaccination for measles and rubella should be completed for individuals traveling or living in the affected countries.
- Tetanus vaccination and booster doses and the use of tetanus immunoglobulin for those not up-to-date with vaccination (see US CDC webpage^{*}).
- Vaccination against hepatitis A, cholera and typhoid fever for individuals at risk of infection, relief workers, and those involved in the cleaning of wastewater and sewage and in charge of re-engineering the clean water system.
- Vaccination against hepatitis B for workers in rescue and emergency services who may be exposed to blood and other bodily fluids.

Source and date of request

ECDC internal decision, 2 April 2019.

Public health issue

Tropical Cyclone Idai developed on 9 March 2019 and by mid-March affected an estimated two million people in Malawi, Mozambique and Zimbabwe. Heavy rains, strong winds and flooding led to several hundred fatalities, hundreds of thousands of displaced people, and an upsurge of infectious disease outbreaks such as cholera and malaria. The aim of this document is to assess the health risks for the local population, including EU citizens living in the affected countries or travelling to the affected area in relation to communicable diseases that have occurred and may occur in the aftermath of the cyclone.

Consulted experts

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Event background information

Cyclone Idai made landfall near Beira, Mozambique, at 00:00 UTC on 15 March, and brought torrential rains and winds to Sofala, Zambezia, Manica and Inhambane provinces in Mozambique [3]. At 06:00 UTC on 15 March, Idai degenerated into an overland depression and continued to move inland to the southern region of Malawi. Idai hit the eastern region of Zimbabwe with heavy rains and strong winds, especially in Manicaland, Masvingo and Mashonaland East provinces. On 16 March, Idai degenerated into an area of low pressure, and on 17 March, only a wide clockwise circulation remained over Zimbabwe, despite rains from the remnants of the cyclone still affecting the entire region. On 19 March, Idai left the mainland, on 21 March, it dissipated [1].

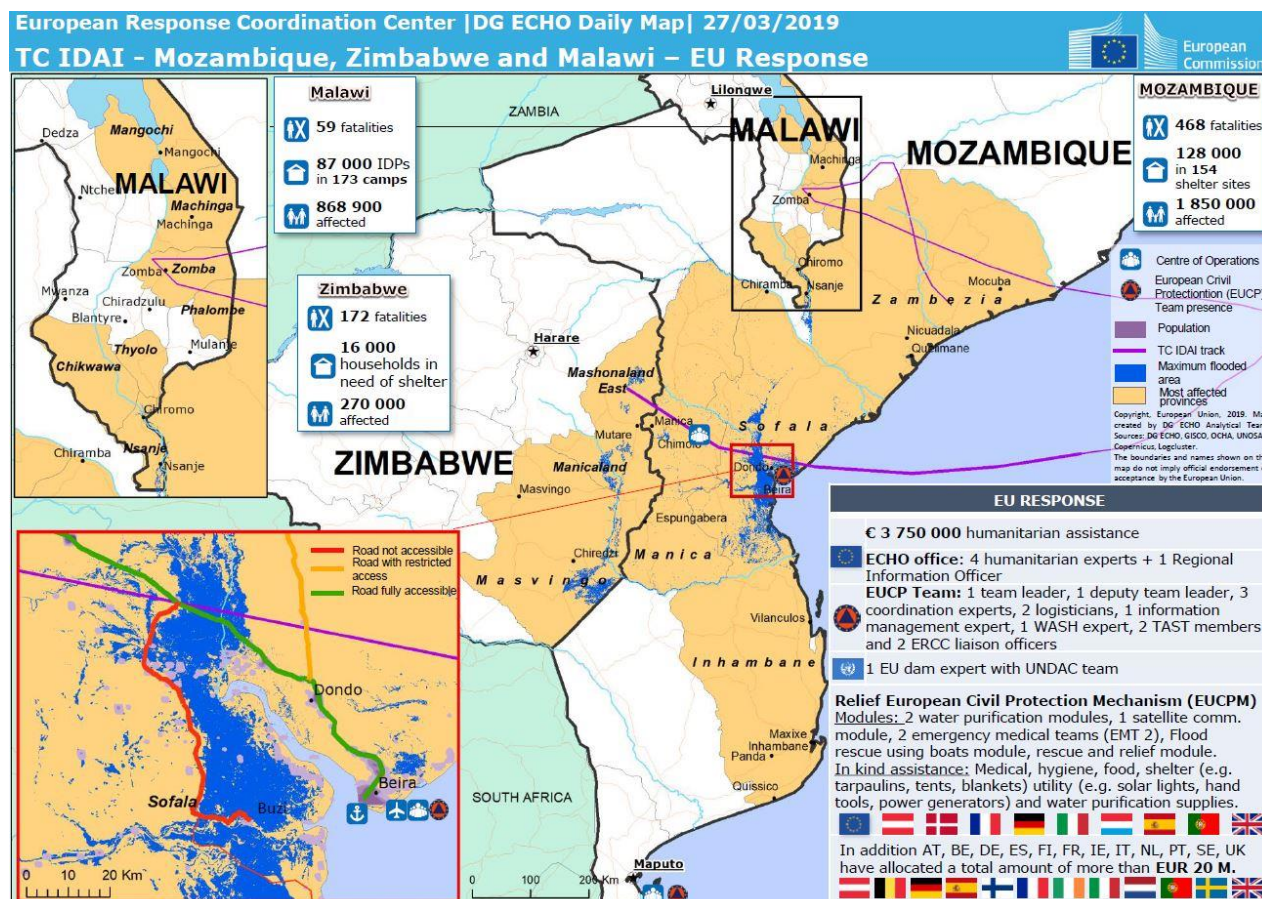
^{*} US CDC webpage on tetanus prevention after a disaster: <https://www.cdc.gov/disasters/disease/tetanus.html>

Table 1. African countries affected by Cyclone Idai, as of March 2019

Country	Date of impact	Country population in 2017	Internally displaced persons (date of report)	Estimation of local population affected	Main EU/EEA citizenship migrants in 2017	EU/EEA travellers in 2017
Mozambique	14–15 March	29 668 834	141 000 (30 March 2019)	1 850 000	4 897 (Portugal)	59 934
Malawi	15 March	18 662 104	87 000 (29 March 2019)	868 900	1 486 (United Kingdom)	20 551
Zimbabwe		16 529 904	4 500 (29 March 2019)	270 000	7 560 (United Kingdom)	80 345

Sources: UNOCHA [4], World Bank [5], ACAPS [6], WHO [7], IOM [8], UN [9], IATA

Figure 1. Cyclone Idai, situation report, Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO), as of 27 March 2019



Source: ECHO daily map, 27 March 2019, EC-JRC/ECHO.

Map catalogue of the ERCC Emergency Response Coordination Centre portal. Available from: <http://erccportal.jrc.ec.europa.eu/Maps> [10]

Context

Cyclones represent a serious threat to lives of the affected populations. The level of destruction caused by meteorological disasters can lead to the rapid spread of infectious diseases. Floods in the aftermath of storms are associated with an increased risk of communicable disease occurrence/spread through displacement of people, changes in the environment, and increased vulnerability to existing pathogens [11-13]. This may result in increased reports of diarrhoeal diseases in areas with limited access to safe water; acute respiratory infections in overcrowded shelters; leptospirosis and tetanus through exposure to contaminated environment; and vector-borne diseases such as malaria, dengue and other arboviral infections when receding waters generate additional mosquito-breeding sites.

The overall risk of infectious diseases in the aftermath of Idai will depend on the pre-existing epidemiological pattern of infectious diseases in the area and factors that influence their impact such as:

- the size of the affected population, in particular those with limited shelter facilities;
- the capacity to rapidly restore essential services, provide access to safe water, ensure appropriate sanitation, and provide shelter facilities; and
- the capacity to prevent, detect and control the spread of infectious diseases.

Cholera situation in Mozambique, Zimbabwe and Malawi

Cholera is endemic in Mozambique, Malawi and Zimbabwe, with major outbreaks reported regularly (see Table 2 and Figure 2) [14].

In Zimbabwe, since the beginning of the outbreak on 5 September 2018 to week 10–2019, 10 730 cases have been reported, including 69 confirmed cases. Among the reported cases in 2019, 79 have been reported in six out of 10 provinces in the country: Mashonaland East (42), Mashonaland Central (23), Midlands (11), Masvingo (1), Mashonaland West (1), and Manicaland (1).

In Malawi, in 2019 and as of week 10–2019, seven cholera cases have been reported [15] in the southern part of the country.

In Mozambique, as of 8 April 2019, OCHA (United Nations Office for the Coordination of Humanitarian Affairs) reported 3 577 cholera cases [16]. Among these cases, six deaths were reported. The main affected areas in Mozambique are Beira, Nhamatanda, and Dondo.

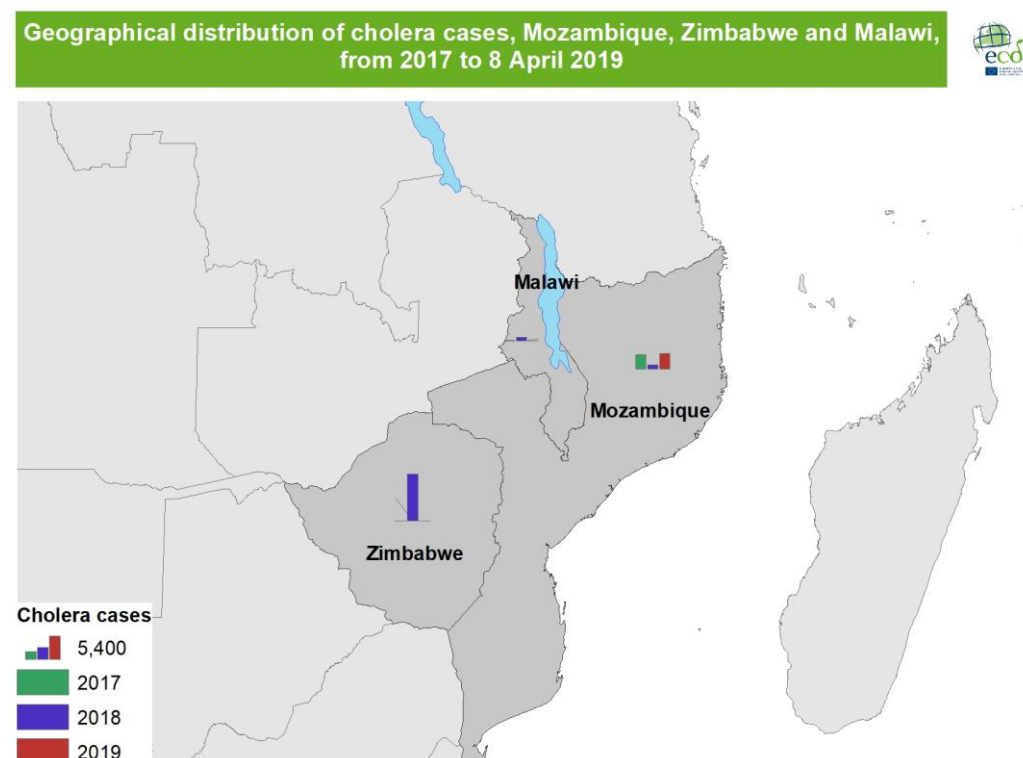
A previous major outbreak was reported between 14 August 2017 and 11 February 2018, with 1 799 cases reported by WHO.

Table 2. Reported cholera cases, per year, 2017 to 8 April 2019

Country	2017	2018	2019
Zimbabwe	6	10 807	79
Mozambique	3 254	863	3 577
Malawi	155	785	7

Sources: Cholera platform [14] and OCHA [16]

Figure 2: Geographical distribution of cholera cases, 1 January 2017 to 8 April 2019



Map produced on 9 April 2019

According to the WHO Regional Office for Africa, on 1 April 2019, an emergency response was implemented by several partners, e.g. the ministries of health, WHO, UNICEF, OCHA, WFP, OIM and NGOs. This response includes the implementation of 11 cholera treatment centres in Mozambique and a cholera vaccination campaign [4].

Other food- and waterborne infections and zoonoses

Floods can increase the risk of outbreaks of food- and waterborne diseases other than cholera, such as typhoid/paratyphoid fever, leptospirosis and gastroenteritis caused by other bacteria (e.g. shigellosis, non-typhoidal salmonellosis, *E. coli* diarrhoea), parasites (cryptosporidiosis, giardiasis, amoebiasis), and viruses (rotavirus and norovirus).

Floods significantly increase the risk for typhoid/paratyphoid fever caused by *Salmonella* Typhi and *S. Paratyphi*, but also the risk of other non-typhoidal *Salmonella* (NTS) infections through contaminated water and/or food. Unlike other strains of NTS, there are no animal carriers of *S. Typhi*, and humans are the only known carriers of the bacteria. Contaminated water sources and inadequate sewage systems exacerbate transmission. Typhoid fever is a life-threatening infection that can be treated with antibiotics. Multi-drug resistant *S. Typhi* strains have become increasingly common and reported in parts of Africa, making treatment more complicated [17].

Though NTS are a common global cause of gastro-intestinal illness, the invasive NTS (iNTS) form of *Salmonella* disease manifests as bacteraemia, which often presents only with high fever. If left untreated, iNTS disease often results in death. The disease is caused mainly by *S. Typhimurium* and *S. Enteritidis*, and is recognised as a problem in developed countries in young infants, the elderly and immunocompromised people. Malawi and Mozambique have the highest proportion of community-acquired bloodstream infections caused by NTS in African countries [18]. Antimicrobial resistance of iNTS to most available antimicrobials has steadily increased in Mozambique, with a predominance of multidrug-resistant strains [19].

Hepatitis A virus (HAV) may be transmitted through the consumption of water with faecal contamination. During floods, hepatitis A outbreaks are usually associated with sewage-contaminated or inadequately treated and disinfected drinking water. While countries with low to intermediate HAV endemicity can be prone to hepatitis A outbreaks, particularly after floods, countries with high endemicity are less prone to outbreaks because most of the adult population is not susceptible to the infection. Children experience mild or asymptomatic infection, and outbreaks are rare [20,21].

Diarrhoeal diseases are transmitted via the faecal-oral route, particularly through contaminated water. Water can be contaminated through sewage overflows (i.e. from centralised sewerage systems and on-site sanitation systems), storm water run-off or agricultural run-off (including spillage of manure). Wells are more exposed to contamination from surface water during flooding. Consumption of contaminated water can lead to enteric diseases and large-scale outbreaks, depending on the water supply network subjected to contamination. Exposure to enteric pathogens generally occurs during the acute phase of the flooding. Most of the enteric pathogens cause acute diarrhoea (incubation period 1 to 10 days), but some parasites have much longer incubation periods (up to several weeks or even months).

Leptospirosis transmission occurs when skin (especially if abraded) or mucous membranes are exposed to water, damp soil or mud that has been contaminated with urine or tissue from infected animals, most commonly rats. Heavy flooding leads to the displacement of rodent populations that come in close contact with humans and favours the spread of *Leptospira* in the environment. Occasionally, transmission occurs as a result of drinking or inhaling tiny droplets (aerosols) of contaminated water [22].

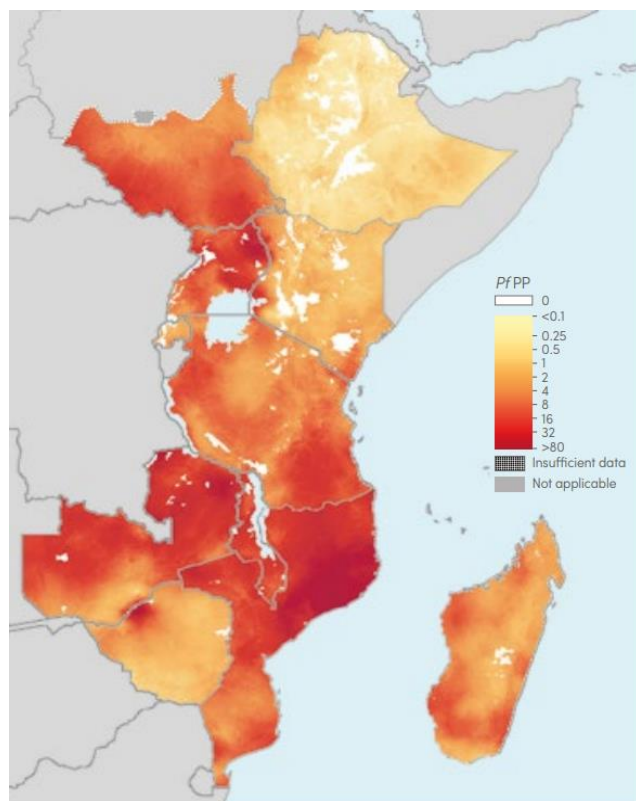
Food handling and the possible contamination of water used for agricultural purposes may increase the risk of fresh or frozen fruits and vegetables becoming contaminated, involving hepatitis A and other foodborne infections associated with the consumption of non-heat-treated foods grown in the affected areas. Food contamination and overcrowding are also factors that increase the risk of transmission and outbreaks of viral foodborne infections.

Vector-borne diseases

Floods and high winds associated with Cyclone Idai are likely to lead initially to a decrease in adult mosquito populations and the washing-away of breeding sites. However, subsequently, when water levels recede, the environmental damage caused by the cyclone may increase the amount of stagnant water and the number of breeding sites, resulting in a higher abundance of mosquito populations. In addition, the destruction of infrastructure and households may increase outdoor exposure of affected populations to mosquito bites.

Malaria

Figure 3. *P. falciparum* parasite prevalence (PfPP) in eastern and southern Africa, 2017



Source: WHO [23]

Malaria is endemic in the region, with *Plasmodium falciparum* accounting for the large majority of the infections (Figure 3). Malaria transmission is stable in most of Malawi and Mozambique but seasonal peaks occur, mainly between January to June (southern Malawi) [25] and between April to June (central Mozambique) [25]. Malaria transmission is highly seasonal in Zimbabwe [23], with a seasonal peak from February to May [26]. From 2010 to 2017, the estimated yearly number of malaria cases was on average 4.3 million in Malawi, 9.4 million in Mozambique, and 0.9 million in Zimbabwe (see Figure 4).

In Malawi, the estimated malaria case incidence has declined from 303 per 1 000 population (212–440) to 231 per 1 000 population (145–342) over the 2010–2017 period. Similarly, malaria death incidence has declined steadily over this period from 0.63 (0.51–0.74) to 0.38 (0.33–0.43) per 1 000 population. In 2018, Malawi had an estimated 4.3 million malaria cases, including 7 100 deaths [23]. In Malawi's southern region, the affected districts (Chikwawa, Nsanje and Thyolo) are classified as having 200 to 300 confirmed cases per 1 000 population, while the remainder of the affected districts (Machinga, Mangochi, Phalombe and Zomba) are classified as having more than 300 confirmed cases per 1 000 population [27]. The *P. falciparum* parasite prevalence in Malawi's southern Region was 26% in children between 6 and 59 months of age in 2017 [28].

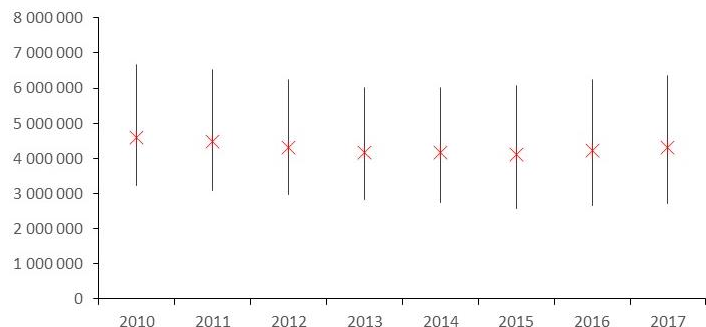
In Mozambique, malaria case incidence has remained stable at around 351 per 1 000 population (258–477) over the 2010–2017 period, while malaria death incidence has been declining steadily over this period from 0.72 (0.59–0.86) to 0.50 (0.41–0.58) per 1 000 population. In 2018, Mozambique reported an estimated 10 million malaria cases and 14 700 deaths [23]. In 2019, as of 30 March, Mozambique has reported 276 cases of malaria in the areas affected by the Cyclone Idai [7]. The city of Beira is classified as having 200 to 300 confirmed cases per 1 000 population, while the remainder of Sofala province and Manhiça and Inhambane provinces are classified as having more than 300 confirmed cases per 1 000 population. In Zambezia province, the malaria incidence varies from 50 to more than 300 cases per 1 000 population [27]. The *P. falciparum* parasite prevalence in children aged between 6 and 59 months in 2015 was 23%, 26%, 32%, and 68% in Inhambane, Manhiça, Sofala and Zambezia, respectively [29].

In Zimbabwe, estimated malaria case incidence and deaths have fluctuated over the 2010–2017 period, with the 2017 malaria case incidence similar to the 2010 incidence at 99 per 1 000 population (55–155) in 2010 and 95 per 1 000 population (63–133) in 2017. Similarly, malaria death incidence in 2017 at 0.24 (0.01–0.49) per 1 000 population was only slightly lower than in 2010, which was reported as 0.25 (0.01–0.56). In 2018, Zimbabwe reported an estimated 1.2 million malaria cases, including 3 200 deaths [30]. The areas affected in Zimbabwe (Manhiçaland province, Masvingo province and Mashonaland East province) is classified as having between 1 and more than 300 confirmed malaria cases per 1 000 population, with incidence varying depending on the district. The

P. falciparum parasite prevalence in Zimbabwe’s Manhicaland province is estimated to be 2% in 2017 in two- to ten-year-old-children [31]

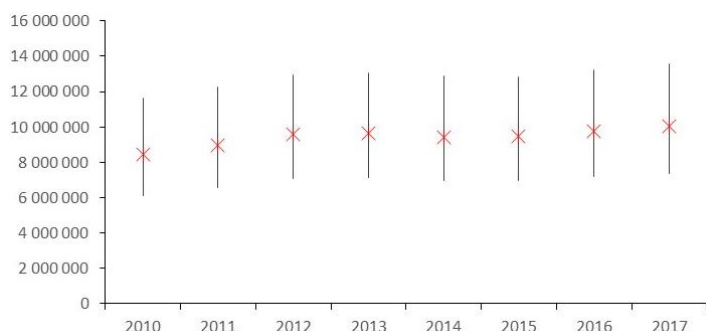
Figure 4. Estimated number of malaria cases: Malawi, Mozambique and Zimbabwe, 2010 to 2017

Estimation of malaria cases, Malawi, 2010–2017



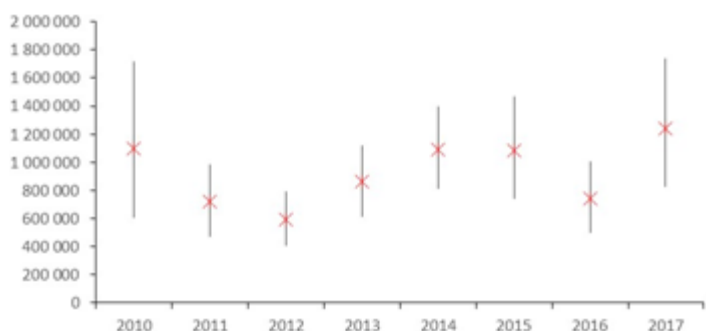
x Case estimation with minimum and maximum values

Estimation of malaria cases, Mozambique, 2010–2017



x Case estimation with minimum and maximum values

Estimation of malaria cases, Zimbabwe, 2010–2017



x Case estimation with minimum and maximum values

Source: adapted from WHO [23]

Other vector-borne diseases

Although surveillance for dengue cases is not available in all three countries, there is a risk of dengue in Malawi [32] and Zimbabwe [33]. Human cases of chikungunya have been reported in Malawi and Zimbabwe, according to WHO [34].

Zika virus has not been previously reported in any of three countries (US CDC) [32].

Acute respiratory infection

In the aftermath of major floods, an increase of acute respiratory infections is frequently observed, either directly from insults to the lung or indirectly, or secondary, i.e. due to overcrowding, the destruction of houses, or the

collapse of healthcare facilities. In the context of a natural disaster such as a cyclone, children are the most vulnerable group at risk of infection in the general population [35].

Tuberculosis

The estimated incidence of tuberculosis (TB) is 133 per 100 000 population in Malawi, 551 in Mozambique, and 221 in Zimbabwe. In 2017, 16 512, 86 515, and 26 401 TB cases were notified, respectively. Mozambique and Zimbabwe are high-burden countries for TB, multidrug-resistant TB (MDR TB), and TB and HIV co-infection, whereas Malawi is a high-burden country for TB and HIV co-infection [36].

TB requires six months of treatment with a combination of antibiotics; patients with MDR TB require 9 to 24 months of treatment. Treatment needs to be taken daily and is often provided in a healthcare facility with observation of drug intake. Floods can affect access to healthcare and the proper functioning of healthcare facilities, thus jeopardising TB treatment. In addition, TB patients who lost their homes and have become part of the displaced population may also have lost access to TB medication. Interruption of TB treatment will result in a recurrence of TB and, if treatment is taken irregularly, drug resistance can develop.

Overcrowding is a risk factor for TB transmission and may result in an increase in TB in the affected population.

HIV/AIDS

The estimated incidence of human immunodeficiency virus (HIV) infection is 239 cases per 100 000 population in Malawi, 475 in Mozambique, and 540 in Zimbabwe [37]. An estimated 1 million people in Malawi (9.6% of the adult population), 2.1 million in Mozambique (12.5% of the adult population) and 1.3 million people in Zimbabwe (13.3% of the adult population) are living with HIV, making these some of the most highly affected countries with HIV globally [37].

HIV requires daily treatment with combination antiretroviral therapy (ART) to prevent an increase of HIV virus in the bloodstream and the resulting devolution of the immune system (increased susceptibility to opportunistic infections). Untreated, the large majority of individuals with HIV will develop acquired immune deficiency syndrome (AIDS) and die due to the inability of their immune system to fight the infection. Currently, approximately 0.7 million people in Malawi, 1.2 million people in Mozambique, and 1.1 million people in Zimbabwe are receiving antiretroviral treatment [37]. Treatment is provided through health centres, often on a monthly basis. The flooding and infrastructure breakdown associated with the cyclone may affect access to healthcare and re-stocking of medical supplies. In addition, HIV patients that are displaced may not have access to ART medication or, with longer-term displacement, may be lost to follow-up or discontinue treatment altogether. Disruption in ART services can result in poorer treatment outcomes for individuals taking ART and could contribute to the development of resistance to one or several of the ART drug classes. Longer-term discontinuation of treatment will result in the development of AIDS, leading eventually to death.

If the cyclone causes disruptions to health system services (i.e. compromised testing programmes, lack of supplies and/or medication stock outs, jeopardised HIV testing services for pregnant women, and intermittent delivery of ART to pregnant and breastfeeding women), the already very high HIV prevalence in the three affected countries could result in increased vertical transmission of HIV to the children of women living with HIV. Each year, these programmes avert an estimated 11 000 infections in newborns in Malawi, 17 000 infections in Mozambique, and 12 000 infections in Zimbabwe.

Vaccine-preventable diseases

The coverage for childhood vaccines varies in the three countries and is considered rather low (below 90%) (Table 3) [38]. In the aftermath of the cyclone, there is a sizeable risk of outbreaks of vaccine-preventable diseases such as measles.

An outbreak of measles (due to overcrowding, high population density and low vaccination coverage) could have a big impact on the health of displaced populations [35]. Given the low vaccination coverage (below 95%) for measles-containing vaccines, the accumulation of susceptible individuals with an increased risk of measles is very likely in all three countries. Due to low vaccination coverage, Malawi [40] and Mozambique experienced a large measles outbreak in 2010 [36]. According to WHO, Malawi reported four measles cases per year for the past three years, while Mozambique reported 379 cases of measles in 2018 and 14 cases in 2019 [36]. Zimbabwe reported one case in 2018 and 16 in 2017 [36].

According to WHO, Mozambique reported 106 cases of rubella in 2018 and 48 cases in 2017 and Malawi reported six cases in 2018 and 25 cases in 2017. Zimbabwe reported one case in 2018 and three cases in 2017 [36]. Due to recently detected rubella transmission, vaccinating non-pregnant women of reproductive age should be considered [40].

The risk of tetanus is known to increase in relation to flooding, as local populations are at greater risk of exposure to tetanus-contaminated soil, water and dust through skin lesions, crush injuries, and contamination of open wounds. WHO estimated first-dose coverage for DTP vaccine (diphtheria toxoid, tetanus toxoid and pertussis) for

Mozambique at 99%. First-dose coverage for Malawi and Zimbabwe was at 90–94% [41]. The third dose coverage for Malawi and Zimbabwe was estimated at 99% and 88–90%, respectively [42].

In January 2019, Mozambique reported two genetically linked circulating vaccine-derived poliovirus type 2 (cVDPV2) isolates from Molumbo district, Zambezia province. The first was from an acute flaccid paralysis (AFP) case with onset of paralysis on 21 October 2018, in a six-year-old girl with no history of vaccination. The second isolate was from a community contact of the first case, a child aged one year [43]. These cases were detected close to the border with Malawi, prompting concerns of a possible international spread [41].

There is also a risk of rabies. Rabies has been found in dogs, bats and other mammals in Malawi, Mozambique and Zimbabwe [44].

The risk of meningitis is low, as the three countries are not part of the 'meningitis belt' of sub-Saharan Africa [43].

There is no detected circulation of yellow fever in Malawi, Mozambique and Zimbabwe, but people arriving from yellow fever risk areas are required proof of yellow fever vaccination [44].

Table 3. Vaccination coverage for diphtheria-tetanus-pertussis (DTP1, DTP3) vaccine; measles-containing vaccine, first (MCV1) and second (MCV2) doses; and polio-containing vaccines, inactivated polio vaccine (IPV) and Pol3 [41]

Vaccine coverage (%)	2013	2014	2015	2016	2017
Malawi					
DTP1	96	97	93	89	93
DTP3	89	91	88	84	88
MCV1	88	85	87	81	83
MCV2			8	61	67
Pol3	89	87	88	83	87
Mozambique					
DTP1	93	93	90	99	99
DTP3	78	88	80	96	99
IPV1		93		84	73
MCV1	85	87	85	91	99
MCV2				51	60
Pol3	78	88	80	91	99
Zimbabwe					
DTP1	98	98	98	94	94
DTP3	95	91	96	90	89
DTP4		83		78	80
MCV1	93	92	94	95	90
MCV2				78	78
Pol3	95	92	96	90	89

Other public health risks

Population displacement is of major concern in Mozambique where, according to IOM estimates (International Organization for Migration), 1.85 million people are affected by Cyclone Idai [45]. According to OCHA, 146 000 displaced people have been reported as of 1 April 2019 [16]. This vulnerable population has an increased risk of catching infectious diseases and a more difficult access to healthcare.

Overcrowding increases the risk of infectious diseases that are more easily transmitted among populations temporarily housed in emergency shelters. This increases the risk of acute respiratory infection transmission, especially among children under five years of age.

Floods can affect healthcare facilities, markedly reducing the capability of the healthcare system to assist patients. The potential increase in the number of patients and damage to healthcare infrastructure is likely to temporarily affect the ability to diagnose and confirm infectious diseases. It will also reduce the level of care. Power shortages and damage to the electrical grid may also affect the cold chain required for certain drugs and vaccines, both in healthcare facilities and distribution channels. This may result in a temporary lack of antibiotics and vaccines. However, most vaccines remain relatively stable at room temperature [44].

Key WHO/CDC documents

- Flooding and communicable diseases fact sheet – [Risk assessment and preventive measures](#). World Health Organization.
- Tropical cyclones – [Technical Hazard Sheet - Natural Disaster Profiles](#). World Health Organization.
- Natural disasters and severe weather – [Prevent Illness and Injury After a Disaster](#). US Centers for Disease Control and Prevention (CDC)
- Natural disasters and severe weather – [After a Flood](#). US Centers for Disease Control and Prevention (CDC).

References

1. Météo-France office in Réunion. Bulletin for cyclonic activity and significant tropical weather in the South-West Indian Ocean [Internet]. 2019 [updated 2019 Mar 1; cited 2019 Apr 4]. Available from: http://www.meteo.fr/temps/domtom/La_Reunion/webcmrs9.0/anglais/activiteope/bulletins/zcit/ZCITA_2019_03011123.pdf.
2. Météo-France office in Réunion. Tropical cyclone forecast warning (South-West Indian Ocean) [Internet]. 2019 [updated 2019 Mar 4; cited 2019 Apr 4]. Available from: http://www.meteo.fr/temps/domtom/La_Reunion/webcmrs9.0/anglais/activiteope/bulletins/cmrs/CMRSA_201903041200_2_11_20182019.pdf.
3. United Nations Office for the Coordination of Humanitarian Affairs. Tropical Cyclone Idai - March 2019. Available from: <https://reliefweb.int/disaster/tc-2019-000021-moz>.
4. United Nations Office for the Coordination of Humanitarian Affairs. Southern and Eastern Africa: Cyclone Idai [Internet]. OCHA; 2019 [cited 2019 Apr 4]. Available from: <https://www.unocha.org/southern-and-eastern-africa-rosea/cyclone-idai>.
5. Bank TW. World Bank Open Data [Internet]. Washington: The World Bank Group; 2019 [cited 2019 Apr 4]. Available from: <https://data.worldbank.org/>.
6. The Assessment Capacities Project. Tropical Cyclone Idai in Zimbabwe, update 1. Briefing note 29 March 2019 [Internet]. Geneva: ACAPS; 2019 [updated 2019 Mar 29; cited 2019 Apr 4]. Available from: https://www.acaps.org/sites/acaps/files/products/files/20190329_acaps_zimbabwe_cyclone_idai_update_i.pdf.
7. World Health Organization Regional Office for Africa. Weekly bulletin on outbreaks and other emergencies. Week 13: 25-31 March 2019 [Internet]. Brazzaville: WHO; 2019 [cited 2019 Apr 4]. Available from: <https://apps.who.int/iris/bitstream/handle/10665/311613/OEW13-2531032019.pdf>.
8. The International Organization for Migration. Malawi, Tropical Cyclone Idai response [Internet]. 2019 [updated 2019 Mar 29; cited 2019 Apr 4]. Available from: https://displacement.iom.int/system/tdf/reports/MWI_DistrictPop_20190329_A4P.pdf?file=1&type=node&id=5401.
9. United Nations. International migrant stock: the 2017 revision [Internet]. New York: UN; [cited 2019 Apr 4]. Available from: <https://www.un.org/en/development/desa/population/migration/data/estimates2/estimates17.asp>.
10. European Civil Protection and Humanitarian Aid Operations. TC Idai - Mozambique, Zimbabwe and Malawi - EU Response [Internet]. 2019 [updated 2019 Mar 27; cited 2019 Apr 4]. Available from: <https://erccportal.jrc.ec.europa.eu/getdailymap/docId/2872>.
11. Cann KF, Thomas DR, Salmon RL, Wyn-Jones AP, Kay D. Extreme water-related weather events and waterborne disease. *Epidemiol Infect.* 2013 Apr;141(4):671-86.
12. World Health Organization Regional Office for Europe. Floods in the WHO European Region: health effects and their prevention [Internet]. Copenhagen: WHO; 2013 [cited 2019 Apr 4]. Available from: http://www.euro.who.int/_data/assets/pdf_file/0020/189020/e96853.pdf?ua=1.
13. Menne B, Murray V. Floods in the WHO European Region: health effects and their prevention 2013. Available from: <http://www.euro.who.int/en/health-topics/environment-and-health/Climate-change/publications/2013/floods-in-the-who-european-region-health-effects-and-their-prevention>.
14. UNICEF Regional Office for Eastern and Southern Africa. East and South Africa regional cholera platform [Internet]. 2018 [cited 2019 Apr 4]. Available from: <http://plateformecholera.info/index.php/eastern-and-southern-africa-plateform>.
15. United Nations International Children's Emergency Fund. Cholera and AWD outbreaks in Eastern and Southern Africa. Regional update for 2019, as of 18 March 2019 [Internet]. Nairobi: UNICEF ESARO; 2019 [updated 2019 Mar 18; cited 2019 Apr 4]. Available from: <http://platefor.mywhc.ca/attachments/article/803/Cholera%20Outbreaks%20Bulletin%20in%20Eastern%20and%20Southern%20Africa%20Region,%20as%20of%2018%20March%202019,%205th%20Issue.pdf>.
16. United Nations Office for the Coordination of Humanitarian Affairs. Southern and Eastern Africa (ROSEA) [Internet]. OCHA; 2019 [cited 2019 Apr 4]. Available from: <https://www.unocha.org/rosea>.
17. von Kalckreuth V, Konings F, Aaby P, Adu-Sarkodie Y, Ali M, Aseffa A, et al. The Typhoid Fever Surveillance in Africa Program (TSAP): Clinical, Diagnostic, and Epidemiological Methodologies. *Clin Infect Dis.* 2016 Mar 15;62 Suppl 1:S9-S16.

18. Uche IV, MacLennan CA, Saul A. A Systematic Review of the Incidence, Risk Factors and Case Fatality Rates of Invasive Nontyphoidal Salmonella (iNTS) Disease in Africa (1966 to 2014). *PLoS Negl Trop Dis*. 2017 Jan;11(1):e0005118.
19. Mandomando I, Bassat Q, Sigauque B, Massora S, Quinto L, Acacio S, et al. Invasive Salmonella Infections Among Children From Rural Mozambique, 2001-2014. *Clin Infect Dis*. 2015 Nov 1;61 Suppl 4:S339-45.
20. Jacobsen K. The global prevalence of hepatitis A virus infection and susceptibility: a systematic review. Geneva, Switzerland: World Health Organization; 2009.
21. WHO's Strategic Advisory Group of Experts (SAGE). WHO position paper on hepatitis A vaccines: June 2012-recommendations. *Vaccine*. 2013 Jan 2;31(2):285-6.
22. European Centre for Disease Prevention and Control. Factsheet about leptospirosis [Internet]. Stockholm: ECDC; 2017 [updated 2017 Jun 26; April 2019]. Available from: <https://ecdc.europa.eu/en/leptospirosis/factsheet>.
23. World Health Organization. World malaria report 2018. Geneva: WHO; 2018.
24. Taylor T, Olola C, Valim C, Agbenyega T, Kremsner P, Krishna S, et al. Standardized data collection for multi-center clinical studies of severe malaria in African children: establishing the SMAC network. *Trans R Soc Trop Med Hyg*. 2006 Jul;100(7):615-22.
25. Brentlinger PE, Mercer MA, Gloyd S, Gimbel-Sherr K, Saúte F, Dgedge M, et al. Prevalence and predictors of maternal peripheral malaria parasitemia in central Mozambique. *The American Journal of Tropical Medicine and Hygiene*. 2007;77(2):228-34.
26. Mabaso ML, Craig M, Vounatsou P, Smith T. Towards empirical description of malaria seasonality in southern Africa: the example of Zimbabwe. *Trop Med Int Health*. 2005 Sep;10(9):909-18.
27. World Health Organization. Malaria country profiles 2018 – Malawi [Internet]. Geneva: WHO; 2018 [cited 2019 Apr 4]. Available from: https://www.who.int/malaria/publications/country-profiles/profile_mwi_en.pdf?ua=1.
28. National Malaria Control Programme (NMCP) and ICF. Malawi Malaria Indicator Survey 2017. Lilongwe, Malawi, and Rockville, Maryland, USA: NMCP and ICF; 2011.
29. Ministério da Saúde (MISAU), Instituto Nacional de Estatística (INE). Mozambique - Inquérito de Indicadores de Imunização, Malária e HIV/SIDA 2015. 2018.
30. World Health Organization. Malaria country profiles 2018 - Mozambique [Internet]. Geneva: WHO; 2018 [cited 2019 Apr 4]. Available from: https://www.who.int/malaria/publications/country-profiles/profile_moz_en.pdf.
31. The Malaria Atlas Project. Zimbabwe [Internet]. Oxford: BDI; 2017 [cited 2019 Apr 4]. Available from: <https://map.ox.ac.uk/country-profiles/#!/ZWE>.
32. Centers for Disease Control and Prevention. Health information for travelers to Malawi - Clinician view [Internet]. Atlanta: CDC; 2019 [updated 2019 Mar 29; cited 2019 Apr 4]. Available from: <https://wwwnc.cdc.gov/travel/destinations/clinician/none/malawi>.
33. National Travel Health Network and Centre. Zimbabwe - Country information [Internet]. London: NaTHNaC; [cited 2019 Apr 4]. Available from: https://travelhealthpro.org.uk/country/248/zimbabwe#Other_risks.
34. World Health Organization. Chikungunya [Internet]. Geneva: WHO; [cited 2019 Apr 4]. Available from: https://www.who.int/denguecontrol/arbo-viral/other_arboviral_chikungunya/en/.
35. Robinson B, Alatas MF, Robertson A, Steer H. Natural disasters and the lung. *Respirology*. 2011 Apr;16(3):386-95.
36. World Health Organization. Global tuberculosis report 2018. Geneva: WHO; 2018.
37. UNAIDS. AIDSInfo 2018 [cited 2019 5 April]. Available from: <http://aidsinfo.unaids.org/>.
38. World Health Organization. Immunization, vaccines and biologicals - Data, statistics and graphics [Internet]. Geneva: WHO; 2019 [updated 2019 Feb 15; cited 2019 Apr 4]. Available from: https://www.who.int/immunization/monitoring_surveillance/data/en/.
39. Minetti A, Kagoli M, Katsulukuta A, Huerga H, Featherstone A, Chiotcha H, et al. Lessons and challenges for measles control from unexpected large outbreak, Malawi. *Emerg Infect Dis*. 2013 Feb;19(2):202-9.
40. World Health Organization. Communicable disease risk assessment and interventions – Cyclone Nargis: Myanmar – May 2008 Geneva: WHO; 2008.
41. World Health Organization. Statement of the Twentieth IHR Emergency Committee - Regarding the International Spread of Poliovirus [Internet]. Geneva: WHO; 2019 [updated 2019 Mar 1; cited 2019 Apr 4].

- Available from: <https://www.who.int/news-room/detail/01-03-2019-statement-of-the-twentieth-ihr-emergency-committee>.
42. World Health Organization. First dose of diphtheria toxoid, tetanus toxoid and pertussis vaccine - Reported estimates of DTP3 coverage [Internet]. Geneva: WHO; 2018 [updated 2018 Sep 21; cited 2019 Apr 4]. Available from: http://apps.who.int/immunization_monitoring/globalsummary/timeseries/tscoveredt3.html.
 43. World Health Organization Regional Office for Africa. Weekly feedback bulletin on cerebrospinal meningitis. Meningitis Weekly Bulletin [Internet]. 2019 [cited 2019 Apr 4]; Week 11. Available from: <https://www.who.int/emergencies/diseases/meningitis/meningitis-bulletin-11-2019.pdf>.
 44. Centers for Disease Control and Prevention. Disaster safety - Impact of power outages on vaccine storage [Internet]. Atlanta: CDC; 2005 [updated 2005 Sep 4]. Available from: <https://emergency.cdc.gov/poweroutage/pdf/poweroutage-vaccinestorage.pdf>.
 45. The International Organization for Migration. IOM appeals for USD 36.4 million as cyclone Idai response expands [Internet]. IOM; 2019 [updated 2019 Mar 26; cited 2019 Apr 4]. Available from: <https://www.iom.int/news/iom-appeals-usd-364-million-cyclone-idai-response-expands>.