GUIDANCE NOTE 7

Climate Data for WASH Programming

Guidance for Humanitarian Practitioners

Table of Contents

Need to find something quickly?

To navigate this document, simply click on the relevant section listed above. You can also jump directly to individual sections at any time by using the navigation bar located at the top of each page.

List of Tables

Abbreviations

CCKP	Climate Change Knowledge Portal
GDACS	Global Disaster Awareness and Coordination System
GRI	Global Resilience Index
HDX	Humanitarian Data Exchange
JRC	Joint Research Centre
SPI	Standard Precipitation Index
WASH	Water, Sanitation and Hygiene
WCM	World Meteorological Organisation Coordination Mechanism
WMO	World Meteorological Organisation

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1 Introduction

In the face of accelerating climate change, humanitarian Water, Sanitation and Hygiene (WASH) programmes must rapidly adapt to a shifting environment. Climate extremes are increasingly disrupting water supplies, damaging sanitation infrastructure, and heightening health vulnerabilities through compromised hygiene practices.

This guidance supports humanitarian field staff and WASH practitioners working in fragile and conflict-affected contexts to assess the information required for climate-adaptive programming and to source and analyse that information. The Guidance Note focuses specifically on the data needed for the design and implementation of climate-adaptive WASH programmes described in the other Guidance Notes in this series.

Section 2 outlines the range of hazards that can impact WASH services and infrastructure, and Section 3 provides an overview of the types of information typically required. Sections 4, 5 and 6 look in depth at the hazard, impact and early warning information required to adapt to the three major hazards of flooding, tropical cyclones and drought.

For detailed information requirements for extreme heat, see *Guidance Note 12: Programmatic Response to Extreme Heat.*

Each section provides links to freely available global tools and sources of information. These web-based resources and tools for analysis, mapping and secondary data sources are expanded and listed in the Annexes.

2 Climate Hazards and WASH Impacts

Climate hazards, as defined by the Intergovernmental Panel on Climate Change [1], are the potential occurrence of climate-related physical events or trends that may cause adverse impacts. In humanitarian contexts, these hazards directly and indirectly affect WASH systems, amplifying existing vulnerabilities and undermining service delivery.

Escalating threats of hazards, such as flooding, drought, and tropical cyclones, are already placing increasing strain on fragile sanitation systems and water resources, threatening to reverse development gains and exacerbate disease risks [2]. Across low, middle-income and crisis-affected settings, water supply systems are being disrupted by droughts, heatwaves, and floods. Sanitation and hygiene facilities are being increasingly damaged or rendered unsafe by extreme weather and rising temperatures [3], [4].

Emerging sector guidance highlights the need to design climate-resilient WASH services that anticipate, absorb, and adapt to these evolving threats [5]. Research on rural and urban systems demonstrates that hazards, such as intense rainfall, landslides, saline intrusion, and wildfires, directly affect infrastructure reliability, water quality, and hygiene behaviours [6], [1].

Table 1 summarises the main categories of climate hazards most relevant to humanitarian WASH programming and outlines their typical impacts. While the nature and severity of these impacts vary by geography, context, and system resilience, understanding common effects helps practitioners anticipate risks and design adaptive, climate-informed interventions.

Table 1: Climate hazards and typical WASH impacts in humanitarian contexts

Climate Hazard	Typical WASH Impacts
Flooding	Contamination of surface and groundwater; latrine collapse or submersion; damage to sanitation and hygiene facilities; increased risk of waterborne disease outbreaks such as cholera.

Drought	Reduced groundwater recharge and surface water; drying of wells; longer water collection times; reduced ability to maintain hygiene practices due to water scarcity.
Heatwaves	Accelerated chlorine degradation; higher drinking water demand; stress on shallow sources; increased risk of heat-related illnesses in overcrowded or unshaded settlements.
Heavy Rainfall & Storms	Overwhelmed drainage systems; collapse of sanitation structures; contamination of stored water; damage to WASH facilities; restricted road access disrupting repairs and response.
Landslides	Destruction of pipelines, latrines, and spring sources; disruption of water access; isolation of communities due to blocked routes.
Sea Level Rise & Storm Surges	Saline intrusion into shallow aquifers; flooding of sanitation systems; contamination of drinking water; the need to relocate water and sanitation infrastructure in coastal areas.
Wildfires	Destruction of WASH infrastructure; contamination of water with ash and debris; additional demand on limited water sources.
Dust Storms	Reduced water quality; contamination of hygiene items and water storage; challenges for maintaining safe hygiene behaviours.

Source: IPCC 2022, World Bank 2025, WHO 2024, UNICEF 2023, SWA 2024, Howard et al. 2021.
Adapted by Ibex Ideas (2026)

3 An Overview of Data and Information Types for Climate-Adaptive WASH Programming

Good information is the foundation for designing humanitarian WASH programmes that can anticipate, withstand, and adapt to climate change. As described in *Guidance Note 1: Climate Change Adaptations for WASH* [7], risk analysis involves 'identifying hazards and longer-term impacts linked to climate change, prioritising the hazards impacting WASH services, determining WASH-related vulnerabilities, and describing the possible impacts on WASH services and people's needs.'

In practice, this means that teams conducting climate-adaptive WASH programming will need two main types of information:

1. Hazard Data to help answer the question: 'Is a particular location likely to be affected by climate impacts (weather hazards, like tropical storms; hydrological hazards, like flooding; or long-term impacts, like water stress) now or in the near future?'

2. Impact Data to help answer the question: 'If a hazard occurs, how will it affect WASH needs and services, especially for the most vulnerable people in the community?'

In addition, to develop preparedness, early action or anticipatory action programmes (see *Guidance Note 8: Anticipatory Action in the WASH Sector*), it may be helpful to have:

3. Early Warning Information to help answer the question: 'How do we know if a weather or hydrological hazard is about to happen?'

Note that in most countries, the National Meteorological and Hydrological Service is the *only* entity legally allowed to issue life-safety alerts on the basis of early warning information. Even where this is not the case, it is good practice for a government service to be the only source of public alerts as this prevents the public receiving multiple – potentially confusing – messages.

This section outlines general information needs about climate hazards and the WASH-related impacts of these hazards. Sections 4, 5 and 6 look in more detail at the information needs related to three specific hazard types: floods, tropical cyclones and droughts.

3.1 Hazard Information

Climate change is having a significant impact on the water cycle in all parts of the world; increased air temperatures, for example, increase the rate of evaporation, the rate at which glaciers melt, and the amount of water that the air can hold, all of which ultimately lead to changes in water availability.

But the specific impacts of climate change differ from one place to another. While everywhere will - on average - get hotter, some places are likely to get drier; some will get wetter. And while the frequency and intensity of most weather-related hazards will increase overall, not all places will be affected in the same way.

In many cases, areas that have historically suffered from extreme weather hazards will continue to suffer these same hazards. As such, information about past and current hazards is a good starting point for understanding future hazards. This information (often from communities themselves, but also from a variety of secondary sources) should include:

- the nature and frequency of past hazards
- the seasonality of past hazards (at what times of year they have occurred)
- the geographical extent of past hazards (the areas affected)

But information about the past is not sufficient to understand future hazards. Over the next 10-20 years, the frequency and intensity of hazards in a particular place may become much greater – or may decrease. And communities might also be facing new hazards for the first time. This is where tools that project future hazards are useful. Typically, these tools take information about current and past occurrences of a particular hazard (such as river floods) and then, using information from climate prediction models (such as future rainfall in a particular place), determine the risk of these hazards occurring in a particular place in the future. They often present the results of this analysis on a map, so that the user can see how different areas within a country are likely to be affected.

These tools often give projections for different future timescales – some give projections for a fixed date in the future (such as 2050), and some allow the user to consider a variety of future dates – often 2030, 2050 and 2100. They also differ in how geographically specific they are – some provide maps that show the flood risk for a 1 square kilometre area. Others are less detailed, giving projections for areas of 10 or 50 km^2. Most tools allow the user to decide whether they want to use an 'optimistic' or 'pessimistic' future climate change scenario as the basis of the projection. Optimistic scenarios are those which assume widespread action by governments and society to address climate change, pessimistic scenarios assume less action. These different assumptions about how much greenhouse gas will be in the atmosphere lead to different projections for temperature, humidity and rainfall in different parts of the world, and so to different risks of flooding or heatwaves.

All these tools - and all climate projections - should be used with caution. They do not provide 100% accurate predictions of the future. They cannot predict future human behaviour or perfectly simulate all the complex interactions by which greenhouse gases influence the likelihood of a given hazard. Because models differ, users should compare a variety of different projections based on different models. While they do not perfectly predict the future, they can usefully show likely future trends and risks.

Another challenge for humanitarians using information about future hazards is how much risk is ‘acceptable’, and how much risk is ‘too much’ and requires changes to standard programming. Should a programme include additional flood defences if the annual likelihood of flooding is 1%? Or 0.1%? Or 10%? A widely used standard is the ‘1 in 100-year’ rule – a 1% annual chance of hazard occurrence.

For a list of freely available tools for data analysis and mapping, see Annexe A.

3.2 Potential Impact

Knowledge of the state of the existing WASH infrastructure, of how the community accesses it, and of the needs and vulnerabilities of different groups is essential to understand and plan for the impacts a hazard might have on communities. The specific impact depends on the hazard (see Table 1), but the following main types of information needed are:

Assessment of WASH needs and WASH-related behaviours. This will include information, usually from community consultation and key informants, on issues such as: what are people’s current water and sanitation needs, where do people access water, how do they store it, and what do they use it for? Critically, what are the particular needs and conditions of vulnerable groups in the community? See *Guidance Notes 1 (Climate Change Adaptations for WASH)* and *3 (Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH)* for step-by-step information on how to assess risks, needs, behaviour and vulnerabilities.

WASH infrastructure mapping provides a baseline of service locations, functionality, and coverage (see *Guidance Note 1*). Combined with hazard information (ideally, overlaid on the same map) this information assesses how well existing assets can withstand the impacts of identified hazards.

Water resource mapping and monitoring are vital to assess the availability and sustainability of surface and groundwater sources, as well as their vulnerability to contamination and drought (see *Guidance Note 1* and *Guidance Note 5* (*Improving the Resilience of Groundwater Infrastructure to Climate Change*). Such hydrogeological and monitoring data may be kept by local authorities, national Water Ministries or local actors who have data loggers in their boreholes.

Topographic data. Elevation, slope, and drainage patterns shape how rainfall and runoff behave in different landscapes (see *Guidance Note 5*). Combining elevation and slope data with infrastructure mapping helps assess whether facilities are located in high-risk zones and how well they can withstand or deflect hazard impacts.

Population location and density. The scale of WASH impacts depends on the hazard itself and on how many people and assets are exposed. High-density camps, informal settlements and areas with major changes in population density are likely to be at higher risk compared to sparsely populated areas.

Information on water quality, pathogens, chemical risks and waterborne illness that might occur in the event of drought or flooding is essential to inform actions that mitigate these risks. Local authorities may collect such data; otherwise, consult other WASH and health actors and local clinics.

Institutional and regulatory context. It is equally important to understand who is responsible for collecting and managing climate and WASH data, how frequently datasets are updated, what databases or platforms exist, and whether policies or hazard atlases are in place to ensure data is credible, accessible, and an effective decision-making tool.

3.3 Primary and Secondary Data

A wide variety of information and information sources is useful in the design of climate-adaptive WASH programming. This information can be split into two types: 'primary' data and 'secondary' data (see Table 2). Combining both data types provides the most accurate understanding of WASH risks.

Table 2: Understanding Primary and Secondary Data

Type of Data	Description	Typical Sources/Examples
Secondary Data	Information already collected, analysed, or published by other organisations. It provides a broad context and is useful for initial hazard identification and trend analysis.	Global hazard information portals (e.g., World Bank Climate Change Knowledge Portal (CCKP), GRI Risk Viewer, Copernicus, national statistics, National Adaptation Plans (NAPs), previous WASH assessments, topographical and hydrological maps, HDX datasets. (See Annexe B)
Primary Data	Information collected directly by field teams to fill gaps, validate or update existing data. It provides local, timely, and context-specific evidence.	Field surveys, community mapping, focus groups, Key Informant Interviews, infrastructure inspections.

3.3.1 Secondary Data Collection

Secondary data should always be the starting point in climate-WASH analysis. Global and regional portals provide a wide range of relevant datasets, including historical climate records and descriptions of the frequency and scale of past hazards, projections of future hazards, hydrological information, and mapping of populations and (some) infrastructure. These datasets help frame the overall context, identify potential hazards, and highlight information gaps.

A consolidated list of recommended secondary data sources and portals is provided in Annexe B.

3.3.2 Primary Data Collection

Secondary data is rarely sufficient on its own. In many humanitarian contexts, global datasets lack the resolution or timeliness required for decision-making. Field-level, primary data collection is essential to complement and validate remote or global datasets.

- **Physical/observation surveys:** to assess infrastructure, water availability, and environmental stressors.
- **Community engagement and household surveys** are essential to understand the experience, knowledge and behaviour of people living in a community. See *Guidance Note 3* and *Guidance Note 6: Risk Communication and Community Engagement Strategies for Climate Change Adaptation in WASH Programming* for guidance on qualitative and digital community data collection.
- **Collaboration with local institutions:** partner with universities, meteorological services, and technical agencies for access to unpublished or localised datasets.

By systematically combining secondary and primary data, field teams can build robust climate-WASH assessments that are both evidence-based and context-specific.

4 Data and Information about Flooding

Floods are the most common form of 'natural' disaster, accounting for between one-third and half of all natural disasters in the past 30 years [8]. There are three main types of flooding: riverine, flash and estuarine. *Riverine flooding* occurs when the levels of water bodies, such as rivers or lakes, rise beyond normal high-water limits and encroach onto productive land, settlements or infrastructure. It is mainly caused by high levels of rainfall, usually over a long period of time and a wide area. The degree to which rainfall translates into flooding is also determined by the ability of the ground to absorb water. River floods often have a lead time of several days [9] and can last for weeks, or even months [10]. They can cover extremely large areas and affect large numbers of people [11].

Unusually large amounts of rainfall in a short time can lead to *Flash Floods* (also called 'pluvial' floods), where the quantity of water falling exceeds the ability of the ground to absorb it, and large amounts run across the ground or through small channels (such as streambeds, valleys and culverts) towards a river system. The main cause of flash flooding is intense precipitation combined with topography (for example, steep, narrow valleys channel large amounts of runoff) and the absorptivity of the ground. Flash flooding is particularly common in cities, where concrete and tarmac prevent water from being absorbed into the ground, and in steep, rocky mountain areas. These floods evolve very differently from riverine floods. They have a very short lead time (less than six hours after rainfall), a short duration [12] and occur over limited areas of a few hundred square kilometres or less [13]. However, they can be extremely destructive and lead to high mortality [18] because of the strong flow of water and the large amounts of debris that are often caught up in the water. This form of flooding is also often associated with landslides [14].

Estuarine flooding occurs in coastal areas and is caused by storm surges and high winds coincident with high tides, thereby obstructing the seaward river flow. According to the World Meteorological Organisation (WMO), estuarine floods are more frequent but typically less severe in terms of inundated depth and area than flooding caused by storm surges. Tsunamis are an example of rarer, but severe coastal flooding. Estuarine flooding is not further described as many of its data sources can be found in the sections below on Riverine (4.1) and Flash flooding (4.2). Some coastal flooding adaptations are also beyond the scope of this Guidance Note. They include preventative infrastructural solutions (for example, the construction of tidal barriers), or nature-based solutions, such as mangrove restoration and reforestation.

See *GN 9: Nature-Based Solutions to Address Climate Change in WASH*.

The number of floods recorded globally has been steadily increasing since the 1990s [15]. There has been a 400% increase in recorded flooding in the tropics since 1985 [16]. Globally, the number of floods is expected to continue to increase – partly as a result of climate change, and partly because of increased urbanisation and changes to land use and land cover [16], [17]. But there is significant uncertainty about some areas – particularly in the sub tropics – where the frequency and intensity of flooding may decrease [19]. Elsewhere, flooding is also likely to occur in areas that have not previously been flooded [20].

4.1 Hazard Information for Riverine Flooding

Communities at risk of riverine flooding will usually have a good knowledge of how often floods have occurred in the past. Areas that have flooded in the past are often more likely to flood in the future, providing an important 'baseline' sense of the possibility of flooding. But this is not always the case (see above), so it is important to compare community information with other projections of future flooding.

National hydrological and meteorological services will often have detailed projections - including maps - of areas that are at risk of future riverine flooding. This information may also be available (although often in a less detailed form) in government documents, such as National Adaptation Plans, Nationally Determined Contribution Statements, national, sectoral or sub-national disaster management strategies, or water use/water management strategies.

At the global level, the ThinkHazard! website gives a general overview of river and coastal flood risk for areas of countries. It uses a scale of high/medium/low/very low. Although its spatial resolution is low, it does provide a text description and contact details for further information.

A number of freely accessible websites provide projections of riverine flood risk to a fairly high degree of spatial resolution. These include:

1. **The GRI Risk Viewer**: this shows areas that are likely to flood and the possible depth of flooding now and in the future (2030, 2050). It uses two different models for projection – the World Resources Institute (WRI) Aqueduct model and the European Commission's Joint Research Centre (JRC) global flood maps. These two sources can give different results, so look at both. Both models allow the user to select the level of risk by using the 'return period' function.

The projections given in the GRI Risk Viewer based on the Aqueduct Global Flood Analyzer model are also available at the **WRI site**. This site also enables the user to add a satellite layer to better understand which locations may flood in the future.

2. **The JRC global river flood hazard maps** are available at the **Joint Research Centre**, but they require a knowledge of GIS to use them (see Annexe A for GIS tools).

4.2 Hazard Information for Flash Flooding

Any historical experience of flash flooding strongly suggests that there is a risk of it happening again. C**ommunities and local and municipal authorities** will be able to describe past events and the frequency with which they have happened in the past.

In some cases, people of concern to humanitarian actors may move into previously uninhabited areas that have a history of flash flooding. This is particularly the case with displaced people in urban environments, who may be forced to make use of land in (normally dry) valleys or drainage channels. Again, the host community and local authorities should be aware of the historical risk of flash flooding in these areas.

Areas that have previously experienced flash flooding can often be identified through observation - look for:

- Channels where soil has been scoured out down to the bedrock
- Channels with vertical cut banks
- Large river stones or flat rocks that are stacked against each other like tilted dominoes
- Lines of dry vegetation or refuse high in trees or shrubs
- Fan-shaped spreads of soil or rocks at the base of hills or valleys (suggesting that the area above the fan has suffered recurrent flooding)

And in urban environments:

- Horizontal stain lines on bridge pilings, retaining walls, or older buildings
- Undercutting of road edges near streams or drainage ditches

It is more difficult to identify areas that have not flooded in the past but that are at risk of flash floods in the future. **Hydrological or planning departments** may have maps that identify areas at risk – generally, these are called 'surface water' maps. This information may also be available (although often in a less detailed form) in government documents, such as **National Adaptation Plans**, **Nationally Determined Contribution Statements**, national, sectoral or sub-national disaster management strategies, or water use/water management strategies.

At a global level, ThinkHazard! has flash flooding information, which gives the risk of flash floods (Low/Medium/High), under 'Urban Flooding'. However, the categorisation covers larger areas and may not be specific enough for project design.

Fathom has detailed maps of areas at risk of flash flooding, but these require payment to access. However, datasets for 16 countries can be accessed without payment through an agreement with the World Bank. Contact Fathom for more information.

The World Bank Climate Change Knowledge Portal is developing information on areas at risk of 'extreme precipitation events'. While not providing the risk of flash floods, this information can be a helpful proxy in understanding areas at future risk.

To use:

1. Select country
2. Select climate change deep dives
3. Select extreme precipitation events

Similarly, the Copernicus Interactive Climate Atlas gives projections of extreme precipitation, although at a low degree of spatial resolution.

To use:

1. Click on Mean Temperature
2. Wet and Dry
3. Very heavy precipitation days

4.3 Potential Impact of Flooding – Information Required

Where there is a risk of flooding, it is important for WASH actors to have information on how this flooding might affect both the WASH infrastructure and people's access to it, especially for the more vulnerable individuals or groups in a community.

To design WASH programmes that are more resilient to these risks, WASH actors will generally want to collect information including [21]:

Table 3: Risk Information for Flooding

Risk	Primary Data	Secondary Data
Flooding of water points and latrines leading to contamination of water and the environment (both floodwater and rising groundwater).	Identifying flood prone areas by use of topographical information, observation, and consultation with authorities and the community. Use a sanitary survey to assess potential routes of contamination [21].	Any records of past impacts from local authorities, UN and NGOs. Existing maps of latrines, water points and systems.
Floods preventing access to WASH and health facilities.	Local Knowledge. Identifying routes that might flood by using topographical information, observation and consultation.	Local authority.
Increased disease outbreaks.	Key informant interviews with local health actors for information on current and emerging health trends.	National health data from Health Ministries. DHIS2 (District Health Information Software) or similar data from previous periods of flooding.
Destruction of water pipes and sewage systems.	Observation, Key Informants in the community and local authorities. Especially, look at the durability of any water or sewage pipe fixings on steep hillsides and river crossings.	Maps of latrines, water pipes and sewage systems. Reports about historical damage from local authorities and responding actors, such as the UN or NGOs.

WASH needs in evacuation centres.	Information from key informants on evacuation routes and centres.	Maps of evacuation routes and centres.
Mostly (but not exclusively) associated with Flash Floods: Road washouts/blockages/ mudslides/excessive erosion.	Observation of river beds looking for past flood scouring to bedrock (evidence of flash floods), steep, fragile slopes and the siting and durability of existing facilities - especially the durability of any water pipe river crossings. Local key informant consultations on past events.	Local authority and local news outlets for historical damage information.

Much of this information will be collected as part of a standard project assessment and design. Where additional information is required, communities living in areas affected by flooding in the past will have good knowledge of the previous seasonality, extent and impact of flooding, as will community members with specific knowledge, medical professionals/public health authorities, local government officials, local NGO staff and local journalists.

4.4 Early Warning Information

4.4.1 Early Warning Data for Riverine Flooding

Where flooding is a relatively frequent occurrence, communities will often have their own early warning mechanisms, based on factors such as rising water levels, animal behaviour, and water turbidity [22]. Community consultations can explore these systems, and humanitarian WASH teams can help communities to integrate this local knowledge into national early warning systems.

The main source of flood early warning information in humanitarian contexts should be the national government. Generally, where early warning systems exist, they will be part of the national hydrometeorological office and linked to the government entity responsible for emergency management.

Where flood early warning information is not available from government sources, there are resources available at regional and global levels. These include:

- **The global World Meteorological Organisation Coordination Mechanism (WCM) Global Hydromet Weekly Scan for humanitarian organisations** – a weekly outline of current and possible upcoming hydrometeorological events (at a low degree of spatial resolution).
- **The Global Flood Awareness System (GLOFAS) early warning system** provides early warning of riverine flooding (location and scale of area affected).

To use:

1. Click under 'Map viewer'
2. Select 'Hydrological'
3. Select 'Flood summary for days 1-15'
4. The predicted extent of the flood is shown under Map Viewer/'Flood Risk'/'Rapid Flood Mapping'.

* *The site requires sign up and some practice to use it effectively.*

- **Google Floodhub** also provides early warning of riverine floods, using a different methodology from GLOFAS. It gives projections of river flow rates for the next five days and of the probability of inundation in areas around the river. For many humanitarian contexts where working river gauges are not available, the user may need to access the 'lower confidence gauges only' option in the box on the right-hand side.
- **The Global Disaster Awareness and Coordination System (GDACS)** is a (mapped) compendium of current and recent disaster alerts (including alerts for flooding). Its focus on identifying ongoing flood events means that it is less useful for predicting short-term flood events.

4.4.2 Early Warning Information for Flash Flooding

Because of the short time between precipitation and flooding, providing effective early warning for flash flooding has historically been very difficult.

Communities living in locations at risk of flash floods have often developed their own early warning systems, with 'flood watchers' upstream who relay information to communities below. Communities are also often highly aware of the signs that precede a flash flood – changes in water flow, debris, and sounds which precede the arrival of a flash flood.

National meteorological agencies are increasingly able to issue early warnings, based on a combination of expected rainfall intensity and soil moisture.

The WMO's **Global Hydromet Weekly Scan** issues warnings of flash floods, but at a very low level of geographical specificity.

5 Data and Information about Tropical Cyclones

Tropical cyclones are rapidly rotating storms that begin over tropical oceans. Depending on where they occur, they are known as typhoons, hurricanes, cyclones, or tropical cyclones [13]. There are several different scales to measure their intensity. Tropical cyclones form under specific atmospheric conditions, where warm water evaporates and rises into the atmosphere, causing a low-pressure area that sucks in air. As this air moves towards the low-pressure area, it spins because of the Earth's rotation [22].

When cyclones reach land, they can have severe impacts through a combination of high winds, rainfall and storm surges. These in turn cause flooding - highly destructive saltwater flooding from storm surges, flash flooding from rainfall, and estuary/river flooding as increased river flow meets storm surges [13].

Climate change is not necessarily leading to more tropical cyclones, but it is making the ones that occur more destructive. There are several reasons for this. Cyclones are projected to become 'wetter', producing significantly more rain [19], which will, in turn, increase flash flooding. Cyclones are becoming more intense, with higher wind speeds, leading to increased damage [23]. They are expected to form and intensify more rapidly, giving communities less time to prepare (a tendency that is already visible in some parts of the world) [13]. They may also move more slowly (although there is no consensus about this among climate models), increasing the time that they remain over inhabited areas [13].

5.1 Hazard Information for Tropical Cyclones

In general, areas that have historically been at risk of tropical cyclones will continue to be at risk. However, the damage these cyclones will cause is likely to increase. Although communities, governments and other actors in these areas are aware of the existing risk of tropical cyclones, they may not be aware of the increased risk.

The area affected by tropical cyclones is expanding into higher and lower latitudes, putting newly affected communities at risk. Most of these communities are in higher-income countries (the USA, Western Europe, Australia) and are unlikely to be of concern to humanitarian agencies. National meteorological agencies should have information about projected (increased and new) risks.

Information is also available in **global tools**, including:

- ThinkHazard! gives the current risk of cyclones (Low /Medium / High), but not future, climate change-affected risks.
- **The** GRI Risk Viewer gives current risk and projected risk (for 2050) of tropical cyclones with two different climate models – Storm and IRIS. The user selects the climate model and the return period (50-year storm, 100-year storm) and the results are mapped by location and windspeed.

To use:

1. Select hazard
2. Click tropical cyclone
3. Select return period
4. Select now or 2050

- **The** World Bank Climate Change Knowledge Portal gives mapped projections of cyclone risk, using a scale based on wind speed, for the period 2035-60. The same page gives information on the change in incidence of cyclones of that category.

To use:

1. Access World Bank Climate Change Knowledge Portal
2. Select country and sub-national data
3. Select climate change deep dives
4. Select tropical cyclones
5. Select projections
6. Select category from tropical storm to category 5

5.2 Potential Impact of Tropical Cyclones - Information

The main cyclone risks are severe rainfall leading to flooding, land and mudslides, and extremely high winds. In coastal areas, cyclones are associated with tidal surges and land erosion.

Table 4: Risk information for Cyclones

Risk	Primary Data	Secondary Data
Building collapse	Observation of obvious weaknesses	Any records of past impacts with local authorities UN and NGOs
Bridge failures	Local Knowledge	Local authority
Road blockages/ mudslides/ erosion **Blockages to access**	Observation and local consultations on past events Use of topographical maps to identify roads likely to flood	
Water and sewage pipe destruction	Observation	Pipe maps from local water provider
Wind damage to latrines	Observation and local consultation	
Coastal and land erosion	Observation	Local authorities may have records of the scale of past cyclone erosion
Electrical and communications blackout, especially those that could affect water distribution/ pumping stations	Observation and consultation with service providers – are they protected? Do they have back-up generators?	

See also Table 3: Risk Information for Flooding

5.3 Early Warning Information for Tropical Cyclones

Many communities have developed early warning systems for cyclones. These often relate to the behaviour of birds and marine life, or to visual and auditory indicators from the sky and the sea. In some countries, such as Vanuatu, these indicators have been incorporated into national early warning systems [24].

There has been significant work on early warning for tropical cyclones in recent years. A network of specialised regional meteorological centres (regional early warning centres that monitor ocean buoys and satellite information). If they detect a low pressure system that meets the criteria for a tropical cyclone, they send a specialised advisory to the National Meteorological and Hydrological Services of countries likely to be affected. These national services then issue public warnings.

These national warnings (issued before cyclones make landfall) are collated on:

GDACS website, where tropical cyclone warnings are displayed on a global map. The warnings provide the current and forecast position and wind speeds of active tropical cyclones from the moment they are formed until they are dissolved. They can forecast up to 5 days ahead. Warnings also have a severity level (low/medium/high) determined by combined information on wind speed, precipitation and storm surge.

To use, click on icons on the right-hand side to turn off alerts for other types of event. Click on the typhoon logo on the map to get information on the specific typhoon.

The Severe Weather Information Centre, a WMO site that displays current tropical cyclone alerts.

6 Data and Information about Drought

Drought is described as a situation where conditions are significantly drier than normal. This fairly broad definition covers several different types of drought:

Meteorological drought: where precipitation (how much it rains or snows) is below the historical average for the area. The common indicator for a meteorological drought is the Standard Precipitation Index (SPI), which compares precipitation with the area's long-term average. Meteorological drought refers only to precipitation - it does not take into account factors such as groundwater availability.

Agricultural drought: where the amount of moisture in the soil is insufficient to meet the water requirements of crops. Many of the different indicators for agricultural drought are measurements of soil moisture, not the amount of water available for human consumption. Some more advanced modelling techniques account for the actual or implied presence of aquifers, but in general, measures of agricultural drought are of limited interest to WASH practitioners.

Hydrological drought: where there is a low water supply (accounting for all sources - river flow, lakes and reservoirs, and groundwater). In most cases, this is the most relevant drought 'type' for WASH actors, because it relates to the supply of water. It is an important element in understanding water stress, which looks at both water supply and water demand. Hydrological droughts do not always occur at the same time as meteorological droughts - there are often 'time lags' between when groundwater supplies are depleted and when they recharge.

It is important for WASH actors to understand the differences between these different forms of drought, so that they can identify projections and early warning information that are relevant to WASH activities.

Climate change is expected to have significant effects on the frequency and duration of meteorological drought. The incidence of drought will increase in some regions and decrease in others, with an overall (global) increase. Climate change will also lead to increases in the frequency and intensity of hydrological droughts with increasing global warming in some regions (medium confidence) [23]. Sections 6.1 and 6.2 focus on information related to hydrological drought.

'By 2050, environmentally critical streamflow is projected to be affected in **42% to 79%** of the world's watersheds' [23].

These climate factors, when combined with population growth and poor water management, are projected to contribute to a significant increase in water scarcity [16].

6.1 Hazard Information for Hydrological Drought and Water Stress

WASH actors can look for information on the future possibility of hydrological drought (lack of water) and water stress (lack of water combined with high demand).

In general, areas that currently experience water stress can be expected to do so in the future. Communities in these areas can give information on current and past frequency of water stress, as well as their coping mechanisms to address it.

National Hydrological authorities may also have information on projected water stress, considering both future water availability and planned water use and water management measures.

The **Aqueduct Water Risk Atlas** maps current and projected future (2030/2050/2080) water stress at a river sub-basin level, along with a number of other variables such as water supply, water demand, and seasonal and interannual variability. Future projections take climate change models into account.

To use:

1. Launch Water Risk Atlas
2. Select future
3. Choose timeframe and scenario
4. Click water stress.

* *Note that many other tools that project drought (such as the GRI Risk Viewer) refer to agricultural, rather than hydrological drought.*

6.2 Potential Impact of Hydrological Drought/ Water Stress

Table 5: Risk Information for Drought

Risk	Primary Data	Secondary Data
Surface water – rivers/ reservoirs **Water scarcity**	Local information on past drought history - what surface water dries up first - what are people's coping mechanisms and alternative sources?	Any records of past impact on surface water held by local authorities, UN and NGOs?
Groundwater levels: decrease or dry up **Water scarcity**	Local knowledge about which boreholes and wells traditionally last the longest. Borehole data such as logger/ dipper information from the authorities and NGOs or the UN on groundwater levels	Local authorities, NGOs or National Government records Hydrogeological maps and previous aquifer assessments (see *Guidance Note 5: Improving the Resilience of Groundwater Infrastructure*)
Lack of water for latrine flushing and/or the conveyance of sludge	Observation of existing types of latrines and consultation about coping mechanisms	Local authorities and NGOs
Increased disease due to a decrease in nutritional status; water for drinking and washing is insufficient and/or contaminated; water and heat stress/dehydration	Key informant interviews with local clinics and health actors about current and emerging health trends	National health data from Health Ministries

Economic loss and poverty due to fewer crops and reduced livestock revenue	Observation, local consultation on people's ability to continue accessing WASH facilities, especially in areas where people have to pay for water	Historical reports on previous droughts and coping mechanisms from local authorities and responding actors such as the UN or NGOs
Displacement/conflict and social instability	Observation and local consultation - when will people leave and where will they go?	Local authorities and news outlets; past damage information

6.3 Early Warning Information for Hydrological Drought/Water Stress

Communities may have their own early warning indicators for hydrological drought - for example, 'when water in a stream dries up, and it doesn't rain, water in wells will dry up within two weeks'. National hydrological agencies may also have early warning systems in place for hydrological drought.

If this information is not available, some idea of future hydrological drought/water stress can be generated by combining current levels of water stress with forecasts of precipitation.

The **Global Drought Observatory** has a display (for areas of 100km^2) that shows the total amount of water (surface, soil and groundwater) in a given area compared to the historical average.

To use:

1. Access Global Drought Observatory
2. Select Map
3. Select Hydrology
4. Select GRACE TWS anomaly

This will show whether levels of water are low compared to historical averages - information that can be combined with forecasts of precipitation to get a sense of drought risk.

An alternative approach is to consider projected streamflow in rivers. **Global Flood Awareness System** (GLOFAS) gives projections of streamflow for 7 months in advance:

To use:

1. Access Global Flood Awareness System
2. Click Data Access
3. Click Map Viewer
4. Log in or create an account

* Rivers coloured yellow are projected to have extremely low streamflow compared to the historical average

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Annexe A: Tools for Data Analysis and Mapping

The following tools can help humanitarian field teams transform raw climate and environmental data into actionable insights for WASH decision making. They are especially useful for mapping, risk assessment, and scenario planning in data-scarce or dynamic contexts.

GIS Tools

- **QGIS – Quantum Geographic Information System**

User-friendly, open-source GIS software for spatial data analysis, risk mapping, and overlaying infrastructure and hazard data.

- **GRASS GIS – Geographic Resources Analysis Support System**

Advanced GIS software with powerful geospatial modelling, time-series analysis, and remote sensing tools.

Hydrological Models

- **WEAP – Water Evaluation and Adaptation Planning System**

Scenario-based modelling tool for water resource planning under climate variability and population growth.

- **SWAT – Soil and Water Assessment Tool**

Open-source model for watershed-scale simulation of hydrology, water availability, land use impacts, and pollution.

- **MIKE+ (formerly MIKE FLOOD)**

Comprehensive hydrological and hydraulic modelling platform for river, coastal, and urban flood systems. Useful for detailed scenario analysis and design in flood-prone areas (commercial).

Risk Mapping Tools

- **Kalypso – Open-Source Flood and Risk Mapping Platform**

Open-source modelling system for hydrological and hydraulic simulation, flood mapping, and evacuation planning.

- **ZeroFlood – A Geospatial Foundation Model for Data-Efficient Flood Susceptibility Mapping**

Research-based open AI model designed for flood-susceptibility mapping in data-scarce regions, supporting climate risk assessment and preparedness analysis.

Annexe B: Secondary Data Sources and Portals

This Annexe provides a non-exhaustive list of freely available portals that humanitarian WASH actors can use to access climate, disaster risk, hydrology, and demographic datasets. These sources should be used alongside national meteorological and hydrology services, local government data, and community-based knowledge to ensure relevance and accuracy.

Category	Source and Description
Climate, Weather and Hydrological Hazard Data (*mentioned in this document)	**World Bank ThinkHazard!*** Information about a wide variety of current hazards at a sub-national level. Provides a general overview. Does not include future (climate change-influenced) projections of hazards
	Global Resilience Index GRI Risk Viewer* Mapped projections of various future hazards, including river and coastal flooding, tropical cyclones, extreme heat and landslides at a local level. Projections can be overlaid with other data, such as population and (some) infrastructure
	World Bank Climate Change Knowledge Portal (CCKP)* Mapped projections and additional data about future hazards including tropical cyclones, extreme heat and extreme precipitation (planned) at a local level. Also provides information on historical hazards (country by country) and future climate data
	Copernicus Interactive Climate Atlas* Wide range of projected climate data, including for extreme heat and precipitation
	WRI Aqueduct Water Risk Atlas* Mapped water risks - current situation and future projections (water supply demand, depletion and stress)

	National Adaptation Plans (NAPS) and Nationally Determined Contribution Documents (NDCS)* Documents produced by national governments outlining how they will adapt to climate change (NAPs) and/or contribute to the mitigation of climate change (NDCs). They often have information about future hazards, impact of climate change on water availability, and the current and future climate
	INFORM Climate Change Country-level current and projected risk of hazards including flood, coastal flood, cyclones and drought
Data on real-time hazards and hazard early warning data	**GDACS – Global Disaster Alert and Coordination System*** Mapped real-time alerts and maps for tropical cyclones, floods, and earthquakes. Cyclone alerts can also serve as early warning
	WHO Severe Weather Information Centre* Mapped real-time alerts for tropical cyclones, gales, heavy rain/snow
	EU Global Flood Awareness System (GLOFAS)* Mapped seasonal forecasts, flood early warning for riverine floods, current flood situation for riverine floods
	Google Flood Hub* Mapped River flood early warning
	Global Drought Observatory* Mapped forecasts of agricultural and meteorological drought, the current situation for soil moisture and total water in the water column
	WMO Global WCM HydroMet Weekly Scan for humanitarian organisations Risk information for the coming week on multiple weather and water risks; low level of detail

Other Global Climate & Weather Data	[World Bank Climate Change Knowledge Portal (CCKP)] Historical climate data, rainfall/temperature projections, climate risk profiles, and vulnerability indicators
	[Copernicus Climate Data Store (CDS)] Seasonal forecasts, long-term climate indicators, and global environmental datasets
	[NOAA Climate Data Online (CDO)] Historical and long-term temperature, rainfall, and extreme climate event datasets
	[WorldClim] High-resolution maps of precipitation and temperature for climate modelling and mapping
	[NASA Earthdata] Satellite-based remote sensing data on floods, fires, vegetation cover, and environmental change
	[CHIRPS - Climate Hazards Group InfraRed Precipitation with Station Data (CHIRPS)] Rainfall estimates for drought monitoring, early warning, and flood analysis
Other hazard/ disaster data	[EM-DAT. International Disaster Database] Centre for Research on the Epidemiology of Disasters (CRED) Data on the occurrence and impacts of over 27,000 mass disasters worldwide since 1900. Records of disaster events, human losses, and damages
	[ReliefWeb – Climate & Crisis Reports] Repository of humanitarian reports and situation updates, including climate-related crises

Water, WASH & Demographic Data	FAO AQUASTAT	FAO Global information system on water resources, usage, and availability
	Humanitarian Data Exchange (HDX)	Humanitarian datasets, including climate risks, displacement, population, and WASH infrastructure
	GRID3 – Geo-Referenced Infrastructure and Demographic Data	High-resolution geospatial data on settlements, health facilities, roads, and population density
	CREWS – Climate Risk & Early Warning Systems Initiative	Tools for early warning, disaster preparedness, and seasonal forecasting
Hydrology & Water Monitoring	Global Runoff Data Centre (GRDC)	Long-term river discharge data from global gauging stations. Useful for flood and drought analysis
	IWMI Water Data Portal	Datasets on surface water, groundwater, evapotranspiration, and agricultural water use
Health & Climate Links	WHO Climate and Health Country Profiles	Country-level data on climate-related health risks, linking WASH and disease outcomes
Population & Settlements	WorldPop	High-resolution global population datasets, disaggregated by age and sex, supporting exposure analysis, targeting and demographic modelling

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