GUIDANCE NOTE 1

Climate Change Adaptations for WASH

Guidance for Humanitarian Practitioners

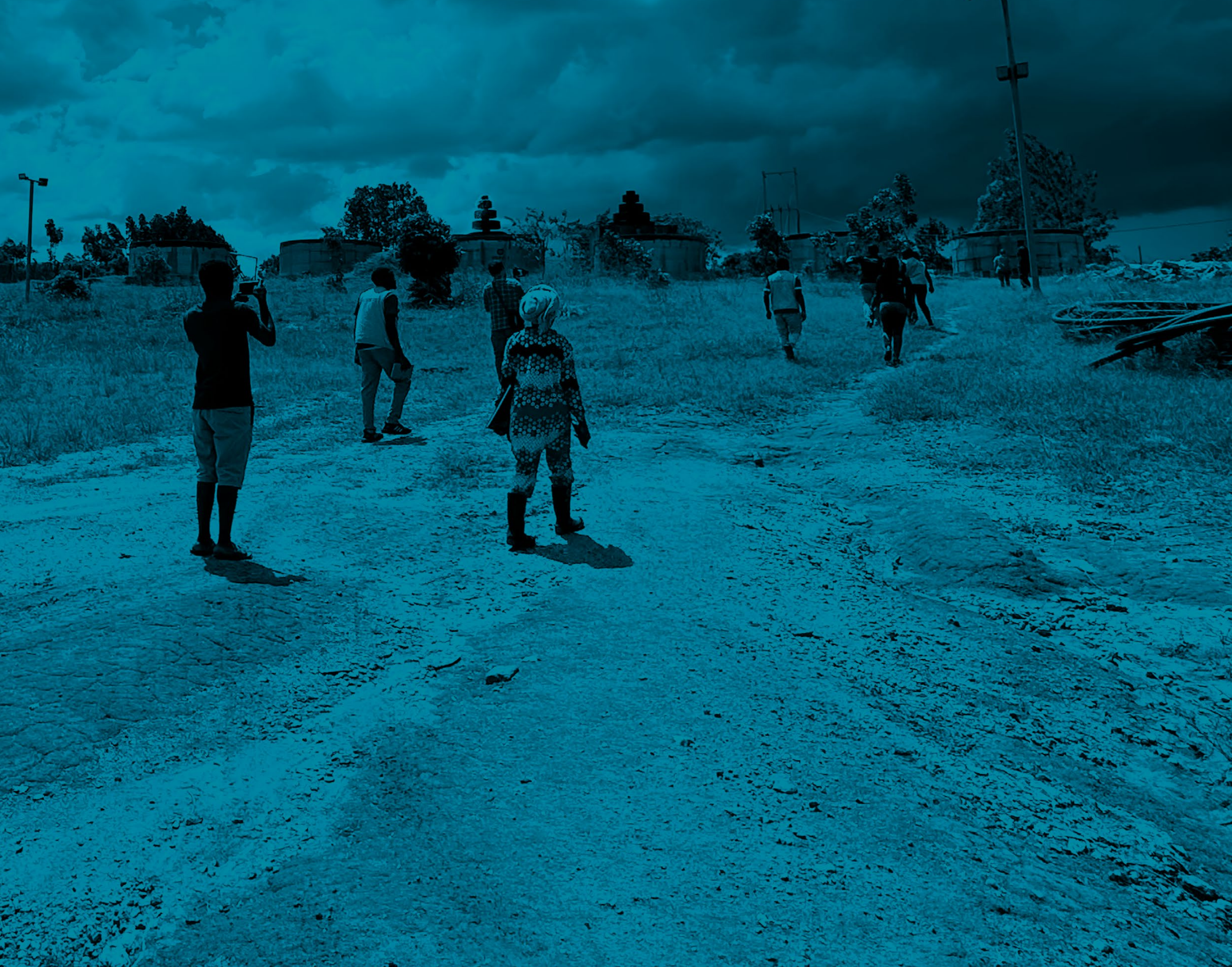
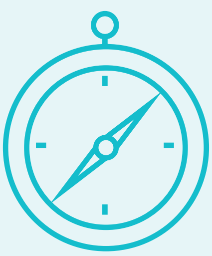


Table of Contents



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 Boxes

List of Figures

List of Tables

Abbreviations

CBWRM	Community-based water resources management
IWRM	Integrated Water Resources Management
NAP	National Adaptation Plan
O&M	Operation and Maintenance
ORS	Oral Rehydration Salts
RCCE	Risk Communication and Community Engagement
UDDT	Urine Diversion Dry Toilets
UV	Ultraviolet
WASH	Water, Sanitation and Hygiene

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Cover Image: Oxfam's WASH team and partners reviewing facilities in Kyaka II Refugee Settlement, Uganda (2023) | © Ibex Ideas

Introduction

Climate change is already having significant negative effects on the lives and livelihoods of people living in countries affected by conflicts and disasters. It is also making the provision of humanitarian support more difficult. This situation can be expected to get worse in the coming years. The humanitarian Water, Sanitation and Hygiene (WASH) sector faces particular risks and challenges. The increased temperatures resulting from global heating disrupt the water cycle: increasing evaporation, accelerating the melting of ice and snow and allowing more water to be stored in the atmosphere. This, in turn, leads to more erratic and intense precipitation and changes the availability of water in many places. At the same time, climate change affects the activity, seasonality and range of many of the pathogens that cause waterborne diseases. It also increases the frequency and scale of events such as floods and droughts, damaging WASH infrastructure while simultaneously increasing the need for humanitarian WASH services.

Humanitarian WASH programmes need to adapt to these threats. This Guidance Note (GN) introduces a wide range of climate change adaptations relevant to the WASH sector in humanitarian settings. It supports WASH implementing agencies to consider climate risks and how they might adapt WASH programming in response to those risks. It outlines how specific programming adaptations can be identified based on an analysis of climate change-linked hazards and their impacts.

The adaptations are geared towards programming by humanitarian practitioners, especially those establishing and delivering water, sanitation, hygiene and public health services in humanitarian settings. It is intended for international, national, and local NGOs, government agencies, service providers, and those involved in WASH sector coordination. The programming adaptations are drawn from existing literature and from Oxfam's programming experience.

Additional Guidance

At the end of each section, a hyperlink leads to a list of sources and references in the References and Resources section.

Guidance Note 1 introduces several of the other GNs in this 12-part series prepared by Oxfam and the ADAPT initiative on the following topics:

GN 1	**Climate Change Adaptations for WASH.** Guidance for Humanitarian Practitioners
GN 2	**Integrated Water Resource Management.** Guidance for Humanitarian Practitioners
GN 3	**Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH in Health Facilities.** Guidance for Humanitarian Practitioners
GN 4	**Passive Cooling for Public Buildings.** Guidance for Humanitarian Practitioners
GN 5	**Improving the Resilience of Groundwater Infrastructure to Climate Change.** Guidance for Humanitarian Practitioners
GN 6	**Risk Communication and Community Engagement Strategies for Climate Change Adaptation in WASH Programming:** Guidance for Humanitarian Practitioners
GN 7	**Climate Data for WASH Programming.** Guidance for Humanitarian Practitioners
GN 8	**Anticipatory Action in the WASH Sector.** Guidance for Humanitarian Practitioners
GN 9	**Nature-Based Solutions to Address Climate Change in WASH.** Guidance for Humanitarian Practitioners
GN 10	**Climate Change and Community-Based Water Resources Management (CBWRM).** Guidance for Humanitarian Practitioners
GN 11	**Climate-Resilient Faecal Sludge Management.** Guidance for Humanitarian Practitioners
GN 12	**Programmatic response to Extreme Heat.** Guidance for Humanitarian Practitioners

For further reading, refer to the above GNs, the additional resources referenced in the relevant sections below, and the Global WASH Cluster's Climate Change and WASH Toolbox for Humanitarian Practitioners.[1]

Format and Structure

This Guidance Note describes a four-stage process.

- **Stage 1: Preparation for climate change adaptation analysis**

  Collating information and convening or consulting with communities and stakeholders before an analysis of the hazards and risks relevant to the WASH sector.

- **Stage 2: Risk analysis**

  Analysing climate change and WASH risks, hazards and impacts.

- **Stage 3: Identifying WASH adaptations**

  Identifying priority actions which are the most relevant WASH adaptations based on the type of climate change hazards and the type of WASH intervention.

- **Stage 4: Implementing climate change adaptations**

  Outlining steps to action the agreed WASH adaptations and embed cyclical improvements in the process.

1 Stage 1: Preparation for Climate Change Adaptation Analysis

Climate change is significantly increasing the scale and frequency of both rapid-onset hazards (such as flooding, tropical storms and heatwaves) and longer-term threats (such as decreased water availability and increased salination). Acute hazards and long-term impacts both pose significant challenges to the provision of WASH services in humanitarian settings. Water supply, sanitation, and public health services are disrupted during climate shocks. WASH infrastructure is vulnerable to damage, and its capacity to meet changes in demand becomes stretched. Without adaptation, these changes can lead to insufficient water supply, worsening water quality, and inadequate sanitation and hygiene services. Public health is at risk due to the impacts on WASH infrastructure and services, and increasing disease outbreaks.

In response to these challenges, a wide range of climate change adaptations are possible in humanitarian WASH programming. But, as climate-related hazards differ widely from one place to another, selecting the most relevant adaptations requires a review of climate change-linked hazards, an analysis of the extent to which these hazards affect WASH services, and the ability of WASH actors to meet people's needs.

Before the analysis of climate hazards and their impacts on WASH, consider how it will be done and what information will be needed by:

1. Defining a **scope of analysis**
2. Deciding **who will be involved** in the exercise
3. Agreeing on **how the analysis will be done**
4. Setting out the **information needed**

The extent of this preparation will depend on the resources available, the geographical scope of the analysis, and the range of WASH elements impacted by climate change, which therefore require adaptation.

1.1 What is the scope of analysis?

At the outset, write a single sentence that describes the geographic scope being considered and the intended output of the exercise. A hazard analysis involves identifying, evaluating, and considering the vulnerabilities and impacts related to a set of climate change hazards. Choose either the national or sub-national level for conducting a hazard analysis. Different hazards may exist, and therefore different climate change adaptations may be needed, in different regions within a country or within a single region in a country. In defining a geographic area of analysis at the sub-national level, consider:

- Administrative divisions
- Climatic zones
- Watersheds and basins
- Mapping of historical and projected floods and areas affected by water scarcity, and other hazards and climate change impacts

1.2 Who will be involved?

Define who will be involved at the beginning. The process of analysing hazards and identifying adaptations can be done within an organisation, or by a number of WASH organisations working together, or as part of a broader, multisectoral analysis.

The information used in the analysis can come from literature, key informants, and community consultation. Start with a review of the available written information, followed by a plan for how to engage experts and people in communities. Findings from key informant interviews and community consultation will validate the information from secondary sources and fill information gaps. Consult further as necessary if additional gaps emerge.

It is helpful to bring in a range of perspectives from within and outside the WASH sector. Consider engaging colleagues in the WASH sector, DRR and climate change adaptation fields, humanitarian coordination, and in other sectors related to WASH, such as health, food security, livelihoods, gender, and protection. Climatologists and water resources specialists should also be engaged.

Establish a process through which people in communities can provide input, for example, by planning a series of focus group discussions, ensuring views from a diversity of participants are sought and that vulnerable and marginalised groups are represented. Depending on the context, if there is variation within the area of analysis, community consultations may be needed in multiple locations which experience different climate change hazards and impacts.

1.3 How will the analysis be done?

There is no 'right way' to analyse hazards and identify adaptations. The process can be through discussions in the office and at field sites, or through multi-day, multi-stakeholder workshops. It can be done at either the individual agency level or as a sector-wide exercise. However, a national-level process is best done collectively, in coordination with the relevant government ministry or, if this is not possible, with the WASH coordination platform.

The steps of this analysis can be aligned with an existing governmental or sectoral process. Elements of the analysis may have been, or are currently being, conducted by the relevant ministry as part of its climate change adaptation planning, particularly to produce a Nationally Determined Contribution document, National Adaptation Plan or sector-specific policies. The approach described in this document could be done together with these national processes; doing so may increase the acceptance and uptake of prioritised WASH sector adaptations within national systems.

1.4 What information will be needed?

There may be existing information available on climate change hazards and impacts in the selected area. This information should form the foundation of the analysis; it includes data and literature available in-country and from global data sets. It may also include information from key informants and communities.

See *GN 7: Climate Data for WASH Programming. Guidance for Humanitarian Practitioners*

At the country level, aim to compile information from a wide range of sources, including government ministries and line departments; the humanitarian WASH coordination platform (e.g., WASH Cluster) and other WASH sector networks in the country; other sectoral and intersectoral platforms; and academia.

Attempt to source information that can answer the following questions within the area being considered:

- What is the current status of WASH coverage, services, and water resources that form the baseline before climate change adaptations are made?
- What changes do climate change models project for precipitation, water resources and hydrology?

- How do climate change models project changes in the frequency and severity of specific weather hazards, such as floods, tropical storms, heatwaves and droughts?
- What are the current and future impacts of climate change (both rapid onset hazards and longer-term effects) on:
  - People's changing WASH and public health needs, and the specific needs of women and vulnerable groups?
  - WASH infrastructure?
  - People's access to WASH services?
- What adaptations and activities are already in progress to respond to these impacts, and who are the key stakeholders involved?

The resulting data and information will be the foundation for a meaningful risk analysis of climate change-related risks, hazards, and impacts on the WASH sector in Stage 2 below. Review the data and identify any key information gaps to be filled. Typically, the preparation stage is not linear, but a cyclical process of identifying, filling gaps and reassessing until the key questions listed above are adequately answered.

2 Stage 2: Risk Analysis

The risk analysis stage involves four steps:

1. **Identifying**
   hazards and longer-term impacts linked to climate change
2. **Prioritising**
   the hazards impacting WASH services
3. **Assessing**
   the WASH vulnerabilities and impacts on WASH needs and services
4. **Reviewing**
   the risk analysis

2.1 Step 1: Identify hazards

A wide range of hazards are linked to climate change, including both rapid onset disasters and hazards that manifest over a longer timeframe. Identify the hazards for the area as well as the longer-term impacts:

- **Identify the climate change-linked hazards**
  Using Stage 1 information, identify the current and projected hazards affecting the selected geography, for example:
  - Floods and storm surge
  - Cyclones/tropical storms
  - Wildfires and dust storms
  - Drought
  - Heatwaves/extreme heat
  - Landslides/mudslides

- **Identify longer-term climate change impacts**

  Now identify any important longer-term impacts of climate change, such as:

  - Decreased surface water
  - Decreased groundwater
  - Increased heat (long term)
  - Increased pathogen activity in water
  - Changes in disease vector activity
  - Salination and saltwater intrusion
  - Desertification
  - Riverine/coastal erosion
  - Siltation
  - Sea level rise
  - Subsidence
  - Ecosystem changes

2.2 Step 2: Prioritise hazards

Prioritise the hazards and longer-term impacts identified in Step 1. The prioritised list will form the basis for identifying adaptations to WASH infrastructure, services and programming. Use both climate change predictions and key criteria to prioritise:

- **Refer to climate change projections to identify priority hazards**

  Consider the future as well as the history of past disasters. For example, an area may never have experienced a heatwave but may be projected to experience them periodically in the future. Climate change projections can provide data and insights on which hazards are likely to be prominent in specific regions.

For more information, see *GN 7: Climate Data for WASH Programming*

- **Identify priority hazards based on key criteria**

  Start with the most important criteria when assessing if a particular hazard is a priority for adaptation:

  1. What is the severity of the hazard in relation to the scale of its impact (which can be measured by the number of people likely to be severely affected)?
  2. What future frequency of the hazard is indicated by climate projections and current trends?

  In some areas, the priority hazards may be obvious, but if different hazards are difficult to compare, a simple scoring matrix will show how each hazard relates to the key criteria. Hazards can be 'scored' numerically - if, for example, information is available on the number of people likely to be affected by each of the various hazards, these numbers can be included in the matrix. Alternatively, they can be ranked as low, medium, or high.

Assign more weight to the key criteria of severity and frequency. Consider first the number of people severely affected by the hazard and the projected frequency of the hazard. Consider additional criteria, if necessary: if the duration or geographic extent contributes to greater severity of the hazard, take this into account. Include Step 1's identification of both disaster hazards and long-term impacts in the prioritisation.

Figure 1: Example scoring matrix

	Hazard #1		Hazard #2	
	Information	**Scoring**	**Information**	**Scoring**
Number of people potentially severely affected (death, disease/malnutrition, loss of livelihood)	High	8/10	Medium	6/10
Potential frequency	Low	4/10	High	8/10
Potential duration (of event and of immediate effects)	High	5/5	Low	1/5
Potential impacted area	Large	5/5	Small	2/5
Total		22/30		17/30

If 'hard' information for all hazards and all criteria is unavailable, use expert judgement (informed by climate projections) in the prioritisation exercise. This judgement may come from professional key informants, community members, or both.

- **Review the list of priority hazards**

  Narrow down the list by selecting only the higher priority hazards and longer-term impacts. A reduced list of hazards supports the targeting of adaptations. Conversely, avoid an overly narrow selection: a risk analysis is likely to be incomplete if it only considers a single hazard. At this stage, review some of the additional hazards and consider which are likely to be significant in the future, based on climate change projections, even if they have not been historically important or there is less recent experience of responding to the hazard.

By the end of this step, a small number of high-priority hazards should have been identified for further analysis. In most contexts, this will be between two and four hazards.

2.3 Step 3: Assess the impacts on WASH needs and services

For each hazard, assess its impact. To do so, consider how the hazard impacts people's needs for services, their access to services, and the functioning of WASH infrastructure and service provision.

For every prioritised hazard, look at each of the primary areas of WASH programming:

Water supply

- Water resources and abstraction
- Water quality and treatment
- Water storage and distribution

For water supply, consider how the hazard impacts:

- People's water needs?
- Water abstraction, treatment, storage, and distribution infrastructure?
- Water supply services and people's ability to access those services?

Sanitation

- Excreta disposal
- Faecal sludge and wastewater treatment
- Solid waste and drainage, and surface water management

For sanitation, consider how the hazard impacts:

- People's sanitation needs?
- Faecal sludge emptying and transport, wastewater conveyance, treatment facilities, drainage, and solid waste processing infrastructure?
- Sanitation and solid waste services and people's ability to access those services?

Hygiene and health

- Hygiene promotion
- Vector control
- Disease outbreaks and healthcare settings

For hygiene and health, consider how the hazard impacts:

- People's vulnerability to the spread of disease and their need for health services?
- People's hygiene and vector control needs?
- Health services infrastructure?
- Delivery of health, hygiene and vector control services and people's ability to access those services?

For each of the above areas of programming, consider the needs of vulnerable groups within the community – this may include women and girls, people with disabilities, elderly people, displaced people, or people from marginalised ethnicities, castes, and other identities.

2.4 Step 4: Review the risk analysis

Review and summarise the priority areas of concern. Check that the list of hazards represents the most critical hazards with the most severe impacts. Ensure that climate change projections of future hazards, increasing severity, frequency, duration, and geographic extent are considered. Review whether the listed impacts on WASH services and people's needs accurately reflect the context. Add any additional hazards or impacts that may be missing.

The following short template (filled out with an example) can be used to summarise the risk analysis review.

Figure 2: Risk Analysis Review Template.

Hazard	Impact on the needs of the affected population	Impact on infrastructure	Impact on access to services
Flooding	• Increased need for treated water that meets water quality standards. • Increased need for latrine pit-emptying services. • Increased need to access health services for acute watery diarrhoea.	• Contamination of wells. • Overflowing pit latrines. • Overloaded wastewater treatment plants. • Failed drainage systems. • Spread of waterborne diseases.	• People are no longer physically able to access water points. • Latrine pit-emptying services are disrupted. • Mosquito net distribution is disrupted. • Access to health facilities is limited, particularly for the sick and for people with mobility difficulties.

The final reviewed list of high priority hazards and their associated impacts is used in Stage 3 to identify the most appropriate adaptations to WASH services.

3 Stage 3: Identifying WASH adaptations

Which WASH adaptations can address the identified risks?

The following sections introduce a wide range of climate change adaptations across the water supply, sanitation, hygiene and health components of WASH programming in humanitarian settings.

A single WASH implementing agency, or even an entire sector, cannot implement all the possible adaptations. The most appropriate, relevant, and impactful adaptations will be different in every context. The preceding risk analysis is therefore essential for the selection of the highest priority adaptations that meet the needs of affected people, address impacts on infrastructure, and enable access to essential WASH services.

The menus of possible adaptations in the sections below represent a starting point. Use the hazards listed for each adaptation to filter out adaptations that are not relevant. Then identify suitable options for the context from the remaining adaptations. The options listed can be used to support further brainstorming on possible solutions. Additional unlisted adaptations can be identified by addressing specific contextual needs and the completed risk analysis.

Box 1: Identifying adaptation options

1. Refer to the summarised hazards and impacts identified in the risk analysis (Stage 2).
2. Select the components of WASH programming (e.g., Sanitation Adaptations ▶ Excreta Disposal ▶ Latrine Design) which require adaptations based on the impacts identified.
3. Filter out adaptations that are not relevant for each set of hazards and programming components.
4. Review the remaining possible adaptation options.
5. Select the adaptations, and, if necessary, identify new ones that are relevant to the context and will address the identified impacts.

Prioritising WASH adaptation activities

Following the steps outlined above is likely to result in a long list of adaptations for a broad range of WASH activities. At this stage, it is helpful to prioritise the adaptations to determine which will be most effective and should be selected. Consider:

- Which adaptations will meet people's WASH and public health needs?
- Which adaptations will result in durable WASH infrastructure affected by hazards?
- Which adaptations will enable people's access to WASH services?

Types of humanitarian WASH programming adaptations are listed below under three main WASH interventions: water supply, sanitation, hygiene and public health. An introduction to WASH preparedness follows the adaptations. Each adaptation is hyperlinked to the relevant sections that follow:

3.1 Water supply adaptations

3.1.1 Water resources and abstraction in floods, heavy rainfall events, and storm surges

For floods, heavy rainfall events, and storm surge hazards, technical adaptations for water resources and abstraction are primarily those that protect water abstraction infrastructure. Floodwater poses a major risk of contamination to the water supply. A range of adaptations is introduced in this section to protect water sources at the point of abstraction.

These adaptations can be complemented by others, including adaptations to drainage and surface water management, which protect both affected populations and water supply infrastructure from floodwaters. There is a close link between the implementation of these adaptations and Integrated Water Resource Management (IWRM).

See *GN 2: Integrated Water Resource Management*

An overview with links to the adaptations to protect water abstraction infrastructure is described below.

Table 1: Adaptations to protect water abstraction infrastructure

Hazard	Adaptations
Floods, heavy rainfall events, and storm surges	Use flood hazard maps and climate projections to identify low-risk zones for new boreholes
	Construction of raised platforms for boreholes and wells
	Borehole and well flood protection by installation of aprons and sanitary seals
	Construction of diversion drains around water points
	Establishment of temporary barriers, such as sandbag walls, to protect wells and reservoirs
	Installation of sealed well caps on production boreholes
	Deeper intake depth in new boreholes

	Construction of spring boxes to protect springs
	Cap the intake area of springs with an impermeable layer
	Relocation or modification of surface water intake to accommodate higher flows
	Installation of alternative on-site power supply for pumping and treatment stations dependent on grid electricity (floods)

Adaptations to protect water abstraction infrastructure

For more information on all aspects of groundwater and climate change see *GN 5: Improving the Resilience of Groundwater Infrastructure to Climate Change*.

Use flood hazard maps and climate projections to identify low-risk zones for new boreholes
For new boreholes or wells, avoid locating water points in areas within historical or projected flood boundaries.

Construction of raised platforms for boreholes and wells
Borehole casings, or linings of dug wells and platforms, should be elevated at least 0.4 m above the 1%-annual-chance (100-year) flood level, or the highest recorded flood level.

Borehole and well flood protection by installation of aprons and sanitary seals
A sanitary seal should be installed in the annular space between a borehole casing, or well lining, and the well wall to prevent the seepage of floodwater from contaminating the well. Proper installation of the sanitary seal should be complemented by the construction of a well apron that diverts surface spillage and runoff.

Construction of diversion drains around water points
A diversion or 'cut-off' drain can intercept and channel surface runoff from the wider catchment area safely around and away from the borehole site. For springs, a ditch can be excavated on the slope above the spring to intercept surface runoff and divert it safely away from the collection area.

Establishment of temporary barriers, such as sandbag walls, to protect wells and reservoirs
An emergency adaptation, temporary structures such as sandbag walls, can protect infrastructure from floodwaters. Where floods are likely, and more permanent adaptations have not yet been undertaken, a regular review of water points and their needs for flood protection can be undertaken, for example in advance of the rainy season. Materials, such as sandbags, can be prepositioned in communities for use prior to the onset of flooding.

Installation of sealed well caps on production boreholes
Production boreholes are outfitted with submersible pumps and pipes to an overhead tank or booster pumping station; they may be vulnerable to flooding. Production boreholes can be sealed with well caps to prevent floodwater from entering the borehole casing.

Deeper intake depth in new boreholes
Deeper intake depths in boreholes allow for greater filtration of contaminated floodwater. It is not feasible to lower an existing borehole's screen intake, but installation of the well screen can be placed at a lower depth for new or relocated boreholes.

Construction of spring boxes to protect springs
A spring box is a covered, watertight collection chamber that protects the water collected from a spring from direct contamination. Spring box construction can be adapted for floods by ensuring the access hatch is raised above the expected flood level.

Cap the intake area of springs with an impermeable layer
The intake area of springs can be protected by an impermeable layer of clay to prevent surface water from seeping down into the clean water source.

Relocation or modification of surface water intake to accommodate higher flows
An 'elevate or relocate' approach can be taken for protecting pumps and infrastructure for surface water abstraction, such as when river water levels rise. For surface water intakes, pumps can be relocated or elevated to 0.4 m above the 100-year flood level, or alternatively at the 500-year flood level.

Installation of alternative on-site power supply for pumping and treatment stations dependent on grid electricity (floods)
Pumping stations reliant on grid electricity need back-up power options during climate shocks. Emergency generators and fuel, appropriately sited above potential flood levels, can provide alternative power. Solar power systems

provide an alternative that reduces reliance on grid systems but may still require generator back-up systems during emergencies.

Resources for Adaptations to protect water abstraction infrastructure are listed under References and Resources

3.1.2 Water resources and abstraction in drought and decreased water availability

Adaptations for water resources and abstraction for drought and decreased long-term water availability include three types:

1. Diversification of water resource utilisation
2. Water conservation and water resource management
3. Adaptations to water abstraction infrastructure

These three strategies will often be combined to make adaptations to water availability in drought contexts. In many contexts, climate change creates both drought conditions and flooding in the same locations. In such contexts, consider which adaptations in this section can be undertaken alongside adaptations in the previous section for water abstraction and resources for floods, heavy rainfall events, and storm surges. The following overview provides links to descriptions of potential adaptations for each of the three strategies below:

Table 2: Diversification of water resource utilisation

Hazard	Adaptation
Drought and decreased water availability	Practise conjunctive use of water supply
	Increase rainwater harvesting
	Capture surface water runoff in wells with sloped surfaces
	Selecting only high-yielding springs for development and protection

	Construction of sand dams
	Construction of infiltration galleries
	Desalination of saline water
	Piping non-saline water to areas where groundwater is saline
	Fog harvesting

Table 3: Water conservation and water resource management

Hazard	Adaptation
Drought and decreased water availability	Development of community-based water management plans
	Promote water conservation and utilisation techniques
	Increase rainwater harvesting
	Implementation of water rationing seasonally or during severe droughts
	Water re-allocation from one use to another
	Demarcation of water sources used during droughts
	Reduction of water abstraction from shallow aquifers to mitigate salinisation
	Managed aquifer recharge (MAR)
	Monitor and model changes to groundwater quantity and quality
	Hydrogeologic assessments and analysis
	Soil moisture conservation
	Wetland restoration
	Construction of saltwater intrusion barriers

Table 4: Adaptations to water abstraction infrastructure

Hazard	Adaptation
Drought and decreased water availability	Well redevelopment of boreholes
	Deepening of wells and pumps
	Installation in boreholes of low-level sensor cut off
	Optimise pump sizing based on aquifer capacity assessment

Diversification of water resource utilisation

Practise conjunctive use of water supply[2]
Diversifying water sources may already be practised in communities facing recurring droughts. One form of diversification is known as 'conjunctive use', which combines the use of surface and groundwater. Groundwater can serve as a buffer capacity for when surface water sources are more affected by drought and/or have high flow variability.

Increase rainwater harvesting
Water supply can be augmented through harvesting rainwater. While it is not typically possible to rely on rainwater harvesting for 100% of water needs year-round, rainwater harvesting can reduce dependence on other water sources. Harvesting and using rainwater may be appropriate in settings with periodic rains interspersed with long dry periods.

Capture surface water runoff in wells with sloped surfaces
To reduce the utilisation of primary clean water sources, surface water runoff can be used for some purposes, such as for livestock and irrigation. Ground surfaces can be sloped and reservoirs constructed to capture surface water runoff.

Selecting only high-yielding springs for development and protection[3]
Higher-yielding sources are less likely to dry up seasonally and during drought. Gather data on dry season spring yield and triangulate through community consultation to inform selection.

Construction of sand dams
Sand dams are an alternative and complementary water harvesting and storage technology option suitable for drought-impacted regions. Sand dams are reinforced concrete walls built across seasonal sandy riverbeds. Their purpose is to trap sand and gravel carried by floods, creating an artificial aquifer upstream of the dam. Water is stored in the pore spaces of this accumulated sand. For more information on this topic, including a design schematic and example photos, see *GN 5: Improving the Resilience of Groundwater Infrastructure to Climate Change.*

Construction of infiltration galleries
An infiltration gallery collects naturally filtered subsurface water from permeable sands/gravels near rivers or lakes. It consists of a horizontal perforated pipe (gallery) buried in these sediments, connected to a vertical, lined well (stilling well) on the bank.

For more information on this topic, including design schematics, see *GN 5: Improving the Resilience of Groundwater Infrastructure to Climate Change*

Desalination of saline water
Saline water may be a viable water source through desalination at either the community-level, through desalination plants, or at the household level through solar water distillation. For more information on this topic, see Establishment of community level desalination plants below.

Piping non-saline water to areas where groundwater is saline[4]
In areas with high salinity, an alternative adaptation to desalination is to supply water from other sources with low salinity. Choosing this adaptation strategy will be dependent on the water resource availability and the risk of increased salination of the chosen new source. Localised piping differs from larger-scale inter-basin transfers, which require more comprehensive analysis and regulatory scrutiny.

Fog harvesting[5]
In places where the presence of fog is naturally high, fog can be harvested as an alternative water source. Fog harvesting can be implemented by installing a net between two posts with a gutter underneath and capturing the wind as it passes through the net, capturing drops of water which are then stored on site.

Water conservation and water resource management

Development of community-based water management plans
In its simplest form, water resource management requires a balance between water supply and demand. Community-based water resources management (CBWRM) emphasises the assessment and monitoring of available water resources by communities themselves and taking steps towards managing these resources. Initiating CBWRM involves training and equipping communities and providing sustained support to communities in their water resource management efforts.

Climate change is increasing the need for environmentally sustainable and equitable resource management. Integrated Water Resources Management (IWRM) is 'a process which promotes the coordinated development and management of water, land, and related resources to maximise economic and social welfare equitably without compromising the sustainability of vital ecosystems and the environment.'[6] Given the predicted increase in severe weather events it is essential that humanitarians understand both the groundwater and surface water dynamics and recharge issues, before taking any action. See *GN 2: Integrated Water Resources Management.*

For more information on Community-Based Water Resources Management, see *GN 10: Climate Change and Community-Based Water Resources Management (CBWRM).*

Promote water conservation and utilisation techniques
Community-Based WRM processes can identify local options for water conservation and utilisation, including identifying points where water is wasted and addressing the losses. Water conservation practices at the household level can also be promoted, such as greywater reuse and reducing evaporation losses in irrigation.

Increase greywater treatment and reuse
Making use of greywater, especially water from taps, sinks, showers, and laundry facilities that would otherwise be wasted, is a practical method of conservation and reuse. Greywater should be treated before reuse. Reuse applications can include toilet flushing, irrigation, and cleaning.

Implementation of water rationing seasonally or during severe droughts
Development of community-based water management plans can be undertaken to allow for equitable distribution of water during droughts. At the community or basin level, water rationing policies may be put in place. Water rationing would typically be selected alongside other conservation and mitigation measures.

Water re-allocation from one use to another
During droughts or periods of prolonged water scarcity, previously agreed water allocations may be revisited and changed. For example, water may be re-allocated from irrigation to domestic use, or irrigation of crops with high water demand may be suspended.

Demarcation of water sources used during droughts
Through CBWRM planning, water sources can be mapped and allocated for specific purposes and times of use.

Reduction of water abstraction from shallow aquifers to mitigate salinisation
Salinisation can be reduced by reducing abstraction, especially from boreholes and wells drawing water from shallow aquifers in coastal regions or other areas with high salinity. This strategy can be coupled with approaches to abstracting water from alternative sources, such as from deeper aquifers or surface water.

Managed aquifer recharge (MAR)[7]
Through MAR, aquifers are intentionally recharged to recover water, increasing water availability while reducing losses due to evaporation. A variety of recovery techniques are possible through MAR, including use of injection recharge wells and other surface and sub-surface infiltration structures.

Monitor and model changes to groundwater quantity and quality
Groundwater monitoring is important for understanding changes in groundwater resources, and therefore of groundwater utilisation. Taking measurements of groundwater levels in either observation or water supply boreholes or wells provides information on how water levels fluctuate within the aquifer.

Hydrogeologic assessments and analysis
A hydrogeological assessment is essential for planning and designing sustainable groundwater utilisation. The assessment's primary goal is to develop a conceptual model of the local groundwater system. This model combines all available data to illustrate the understanding of groundwater conditions, which can be used for planning future adaptations.

Soil moisture conservation[8]
Soil moisture conservation aims to minimise water loss from evaporation and transpiration. Several techniques, such as mulching and conservation tillage, can be applied to preserve soil moisture for both agricultural use and groundwater recharge.

Wetland restoration[9]
Wetlands provide a natural source of storage and treatment of water. Wetland restoration is the re-establishment of a degraded wetland. Restoration interventions aim to restore the original hydrology and topography of the wetland to provide water storage and natural treatment, while also providing ecosystem benefits.

Construction of saltwater intrusion barriers[10]
Physical barriers can be constructed to stop saltwater intrusion. Subsurface cut-off walls, such as bentonite-cement slurry walls, are constructed below ground to block the lateral movement of saline water. Subsurface dams, another form of physical barrier, are embedded in the impervious bottom layer of the aquifer to create a hydraulic block.

Adaptations to water abstraction infrastructure

Well redevelopment of boreholes
Borehole redevelopment helps to remove fine material from the aquifer to improve permeability in the immediate vicinity of the well screen. There are both mechanical techniques, such as airlifting and jetting, and chemical methods to break down clogging agents and clean boreholes.

Deepening of wells and pumps
When an existing borehole fails in a drought-prone area due to declining water levels, deepening it can be a viable resilience measure. However, this approach has risks and requires a thorough technical and financial assessment. It is also more complex for typical cased and screened boreholes than for hand-dug wells. Pumps can be lowered, but with the installation depth dependent on the depth of the well screen in boreholes.

Installation in boreholes of low-level sensor cut off
Install a low-level probe within boreholes to protect the pump from declining

groundwater levels during a drought. When the water level in the well drops below the level of the well probe, the probe will stop the pump, protecting it from dry running.

Optimise pump sizing based on aquifer capacity assessment
Perform pumping tests to determine the aquifer properties and specific capacity of the borehole. This data should be used to optimise pump sizing and selection of a pump which will not over-extract water beyond the safe yield of the borehole.

Resources for Water resources and abstraction in drought and decreased water availability

3.1.3 Water quality and treatment

Water quality and treatment are critical areas of WASH programming in which climate change adaptations may be needed. Climate change introduces new risks to water safety, including increased contamination from flooding, salination, and algal blooms driven by rising temperatures. Adaptations to protect water quality are most relevant where the risk analysis has identified that water quality is vulnerable to contamination. This section outlines key adaptations to water treatment and the management of water quality.

Table 5: Water treatment

Hazard	Adaptation
All	Establish central or community-level water treatment
	Promote household water treatment and safe storage
	Modify water treatment plant capacity
	Utilise low maintenance treatment methods
Floods and storm surges	Elevate or relocate water treatment infrastructure

Salination and saltwater intrusion	Establish community-level desalination plants
	Install solar water stills at the household level

Table 6: Managing water quality

Hazard	Adaptation
All	Initiate water safety planning
	Modify water safety plans for climate change linked hazards
	Identify trigger thresholds of degraded water quality for taking remedial action
	Protect water quality at the source
	Manage water quality in pipelines
Flooding and heavy rainfall	Carry out water quality testing after heavy rainfall or flooding events

Water treatment

Establish central or community-level water treatment
Increased contamination of water quality can occur after climate shocks. Prolonged degradation of water quality can also occur as a long-term impact of climate change. This is because extreme weather events, such as floods and droughts, can mobilise pollutants, damage water infrastructure, and alter the natural purification processes of aquatic ecosystems. Moreover, in water-scarce settings, people are likely to use alternative, low quality water sources. In these contexts, central or community-level water treatment can be established to supply the population with piped water.

Promote household water treatment and safe storage
An alternative adaptation to central treatment, including after climate shocks, is household water treatment, especially if this form of water treatment is familiar to users. The materials can be prepositioned before the onset of floods and the arrival of major storms.

Modify water treatment plant capacity
Water treatment plant capacity should be modified to accommodate either higher flows or degraded influent water quality. For higher inflows, such as after heavy rainfall events, the number and size of treatment units can be increased. Some extreme heat contexts are expected to experience an increase in algal blooms, resulting in an increase in fine organic material in the water. Treatment processes should be modified to eliminate this organic matter; otherwise it can combine with chlorine to form potentially carcinogenic disinfection byproducts.

Utilise low maintenance treatment methods
Treatment methods with low energy inputs and low maintenance requirements are more resilient to climate shocks and offer greater continuity in treatment operations. Slow sand filters and constructed wetlands are two treatment options that can also handle flow variability. Gravity flow should be designed in treatment processes where possible.

Elevate or relocate water treatment infrastructure
Water treatment systems should be sited at elevations above historical and projected flood levels. Treatment components should be relocated or elevated to 0.4 m above the 100-year flood level, or alternatively at the 500-year flood level. Additionally, flood barriers should be constructed to protect infrastructure where flood risks are present.

Establish community-level desalination plants
Where water is saline, desalination, typically through reverse osmosis technology, may be increasingly deployed and at a greater scale. The viability of desalination greatly depends on the technical, financial, and operational capacity for professionalised management of water services, in addition to the availability of equipment and skilled personnel in local markets.

Install solar water stills at the household level
Solar stills are the simplest technology option for desalination but are the most expensive on a price per litre basis. They may be appropriate in certain contexts through local fabrication.

Managing water quality

Initiate water safety planning[11]
Water safety plans are a form of preparing adaptations to manage water quality in response to risks. Water safety planning assesses and manages risks at all stages of the safe water supply chain to protect public health and identify climate-resilient actions that can be taken incrementally.

Water safety planning is linked to community-based WRM. See *GN 2* and *GN 10* and, for a community-based WRM framework based on water safety planning, see also Managing Water Locally: An essential dimension of community water development (2011).[12]

Modify water safety plans for climate change linked hazards[13]
Existing water safety plans can be adapted in response to climate change impacts. The modifications entail identifying and assessing the risks from environmental and climate hazards (as described in the Risk Analysis section of this guidance) and developing and implementing interventions to address these hazards.

Identify trigger thresholds of degraded water quality for taking remedial action
Degraded water quality, whether a long term trend or an acute incident, requires a response. Water quality monitoring parameters, for both biological and chemical contamination and, where relevant, for salinity, should be identified with threshold values that trigger a remedial response.

Protect water quality at the source
Water quality should be protected at the source. It can include physical adaptations, such as improved sanitary seals on wells, but also regulation, water safety planning, engagement with water resources stakeholders, incentivisation, and community engagement to prevent community members and agricultural users from contaminating water at the source.

Manage water quality in pipelines
To mitigate the water quality impacts of extreme heat on pipeline systems, extra monitoring is required to maintain adequate disinfectant residuals.

Water stagnation in the pipes must be reduced; conducting regular flushing of pipelines is essential to control microbial growth and prevent the proliferation of pathogens such as *Legionella*. Additionally, establishing real-time water quality sensors, adaptive treatment adjustments during heatwaves, and emergency response protocols can ensure the safety and resilience of water supplies under extreme heat conditions.

Carry out water quality testing after heavy rainfall or flooding events
Further adaptations and/or emergency measures may be needed to protect water quality after heavy rainfall or flooding events. Carry out water quality testing to inform the approaches needed.

Resources for Water quality and treatment

3.1.4 Water storage and distribution

Adaptations to water storage and distribution prepare physical infrastructure to withstand climate change-linked hazards to ensure a continuity of water supply. Three types of adaptations are introduced in this section:

1. Adaptations to water storage
2. Adaptations to pipe networks
3. Reduction of evaporation and overheating

Water supply infrastructure requires regular assessment for vulnerabilities, damage, and water loss. It is recommended to regularly revisit the water storage and distribution component of the risk analysis, in addition to establishing systems for a physical assessment of the infrastructure to make the necessary modifications. The following overview provides links to the adaptations described in this section:

Table 7: Water storage

Hazard	Adaptation
Droughts and floods	Increase water storage capacity

Floods and storm surges	Elevate or relocate taps, tanks, and water distribution points
High winds, storm surges	Anchor elevated tanks
Floods and heavy rainfall events	Reinforce tank foundations
	Design drainage and overflow systems for tanks and taps

Table 8: Piped water networks

Hazard	Adaptation
Drought, water scarcity	Extension of water pipelines to water scarce areas
Extreme heat, extreme cold	Increase pipe laying depth
Extreme heat, floods, storm surges, landslides	Use of flexible and high pressure-rated pipes
Extreme heat	Utilise standby pumps and generators
Flooding, storm surges	Install backflow prevention devices on pipelines
Drought, water scarcity	Reduce water wastage through metering (and tariffs where appropriate)
	Periodic assessment of water distribution infrastructure for leakages
	Installation of quality taps that reduce water wastage
	Establish or strengthen systems for operation and maintenance

Table 9: Reduction of evaporation and overheating

Hazard	Adaptation
Extreme heat, drought	Shading of reservoirs and tanks
	Material selection for tanks and pipes
	Thermal insulation for exposed pipelines and tanks
	Covering of irrigation channels
	Installation of shading for pumps

Water storage

Increase water storage capacity
Due to the future unpredictability of rainfall, river flow or aquifer recharge, it is essential to increase storage at both the community and household level to reduce water stress during intermittent drought periods. Capacity can be increased by enlarging existing water reservoirs or by adding storage tanks before distribution. Increased storage of treated water is also important for emergency capacity during floods.

Elevate or relocate taps, tanks, and water distribution points
Distribution tanks, taps, and water points can be relocated or raised above anticipated flood levels. The need to relocate waterpoints must be balanced with ease of access for water users. Elevating water tanks may introduce vulnerability to heavy winds; structural requirements should be reviewed accordingly. Evaluate whether elevation or relocation is more cost effective when deciding between these adaptation approaches.

Anchor elevated tanks
Elevated water storage tanks should be anchored in place to withstand high winds and storm surges. This will require structural and site geotechnical assessment; the level of analysis required will depend on the size of the tank and the height of elevation.

Reinforce tank foundations
Heavy rainfall events can lead to soil erosion around tank foundation structures. Foundations can be reinforced, or made wider and deeper, in areas vulnerable to erosion to prevent structural damage.

Design drainage and overflow systems for tanks and taps
To divert floodwater, design and construct drainage around tanks and taps. Additionally, include overflow systems in the tank design to allow overflow water to be drained away from tank platform sites.

Piped water networks

Extension of water pipelines to water scarce areas
A piped water supply can be extended from areas with sufficient water resources to areas experiencing water scarcity and/or which are more vulnerable to droughts.

Increase pipe laying depth
Pipe laying depth can be adapted, increasing the depth to accommodate water distribution in extreme temperatures.

Use of flexible and high pressure-rated pipes
Water distribution networks can be adapted by installing flexible and high pressure-rated pipes. Floods, landslides, and other causes of soil movement can shift pipes; flexible HDPE pipes are able to bend without rupturing.

Utilise standby pumps and generators
In extreme heat, the efficiency of solar energy systems decreases under thermal stress; at the same time, water demand increases. To meet demand at peak times, standby pumping and energy systems, including generators and fuel, can complement primary solar energy and pumping systems.

Install backflow prevention devices on pipelines
To avoid contamination during floods, non-return valves should be installed on pipelines to prevent backflow, especially in areas where water distribution infrastructure is vulnerable to flooding. Check valves provide a dual purpose; they both protect pumps from damage from floodwaters and prevent contamination of the water supply.

Reduce water wastage through metering (and tariffs where appropriate)
Metering in the water distribution system can be used to determine the points at which water is wasted. This can include 'smart metering' for enhanced leak detection. Consumption-based water tariffs using metering is one way to incentivise better utilisation of water resources by the public. In humanitarian settings, tariffs must be based on the ability of water users to pay, while still meeting their basic needs.

Periodic assessment of water distribution infrastructure for leakages
As either a complement or alternative to metering, periodic assessments of water distribution infrastructure can be carried out to detect leaks. A leak assessment by technicians should be done to allow for quick fixes and remedial actions at tapstands and distribution lines.

Installation of quality taps that reduce water wastage
Leaky taps are a common source of water wastage and one that is easy to detect. Low quality taps that require regular replacement can lead to significant water losses. Adaptations can be made to tapstands by installing higher quality, longer-lasting taps.

Establish or strengthen systems for operation and maintenance
Ineffective systems for Operation and Maintenance (O&M) of waterpoints and water distribution infrastructure can lead to non-functional systems, water wastage and/or a failure to meet the water needs of people. The lack of reliable O&M also leads to significant system downtime after climate shocks. O&M service provision must have a reliable source of financing (either through tariffs or subsidies), be carried out by technicians with sufficient skill capacity, and be supported by effective service oversight, governance, and accountability arrangements.

Reduction in evaporation and overheating

Shading of reservoirs and tanks
Water reservoirs can incur significant evaporation losses. Use floating covers or shade nets to reduce evaporation in reservoirs, especially in areas with high solar radiation. Water tanks can be placed in shaded areas or under trees where possible. Consider possible wind conditions when selecting the type of shading being used.

Material selection for tanks and pipes
Prevent overheating of both water and materials, and potential degradation of materials under extreme heat, through appropriate material selection of tanks and pipes. Use materials with high thermal tolerance, such as HDPE. Consider black or dark-coloured polymers, which often have better Ultraviolet (UV) resistance than lighter alternatives. Ferrocement and reinforced concrete tanks absorb heat more slowly than plastic tanks and can be more effective than HDPE at preventing overheating.

Thermal insulation for exposed pipelines and tanks
To reduce water heating, incorporate thermal insulation in pipes and tanks. For tanks, consider double-walled tank designs. For pipes, also consider expansion joints or flexible connectors to accommodate thermal expansion.

Covering of irrigation channels
Covering of irrigation channels can reduce evaporation losses. Consider using local materials for covering channels or, where feasible, enclosing channels into closed conduits.

Installation of shading for pumps
Exposure of pumps and other electro-mechanical equipment can lead to the overheating of electrical components or UV damage to plastic and rubber components. Install shading for pumps to limit the negative effects of exposure to high solar radiation.

Resources for Water storage and distribution

3.2 Sanitation adaptations

Sanitation adaptations are described for three main areas of humanitarian sanitation programming: Excreta Disposal, Faecal sludge and wastewater treatment and conveyance and Solid waste management and drainage.

3.2.1 Excreta disposal

Excreta disposal systems must be adapted to withstand the increasing risks posed by climate change. Flooding, drought, and extreme weather events can compromise latrine infrastructure, contaminate water sources, and heighten public health risks. This section presents practical adaptations to latrine design, sanitation planning, pit emptying and in-situ treatment that improve resilience in humanitarian settings.

For more information, see *GN 11: Climate-Resilient Faecal Sludge Management*

An overview with links to descriptions below of adaptations to excreta disposal:

Table 10: Latrine design

Hazard	Adaptation
Floods, storm surges, heavy rainfall events	Siting of latrines away from water sources
	Establishing diversion channels around latrines
Floods, storm surges	Relocation of latrines to higher ground and away from flood-prone areas
	Construction of raised latrines
	Lining and sealing of latrine pits
	Including a sand envelope around latrine pits
	Use of plastic drums and tanks for excreta containment
Floods, heavy rainfall events, drought	Use of container-based sanitation
	Construction of urine diversion dry toilets (UDDTs) and composting toilets

Droughts and water scarcity	Use of container-based sanitation
Extreme heat	Heat proofing of latrines
Storms	Building wind resistant latrines

Table 11: Sanitation planning, pit emptying, and in-situ treatment

Hazard	Adaptation
All	Carrying out sanitation safety planning
Floods, storm surges, heavy rainfall events	Raised septic tanks
	Modified septic tank design
	Adding secondary treatment in sand filters
	Adding secondary treatment in constructed wetlands
	Using floating sanitation systems
	Emptying latrine pits before the rainy season
Drought, water scarcity	Pit emptying by auger

Latrine design

Siting of latrines away from water sources
Increase the distances between latrines and water sources, taking account of flood risks and soil saturation conditions.

Establishing diversion channels around latrines
To divert floodwater, construct drainage channels around latrine sites. Drainage channels should be connected to other drainage infrastructure for managing outflows.

Relocation of latrines to higher ground and away from flood-prone areas
Latrines should be sited above potential flood levels. This may require relocating latrine sites to higher ground. Previously used latrines that remain in flood-prone areas must be decommissioned (see Emptying latrine pits before the rainy season below).

Construction of raised latrines
To prevent contamination of floodwater from latrine pits, latrines should be constructed with the latrine plinth elevated above potential flood levels. Raised latrines can be constructed using cement blocks, bricks, or other materials or may be constructed on earth mounds.

Lining and sealing of latrine pits
If there is a risk of latrine effluent contaminating groundwater due to flooding or saturated soils, latrine pits should be lined and sealed. Lining of latrine pits also prevents the collapse of latrine pits due to saturated soils.
The complete sealing of latrine pits requires a strategy for dealing with liquid effluent, either through a treatment system or through methods such as the sand envelope design described below.

Including a sand envelope around latrine pits[14]
In the absence of a treatment system, the contamination of water can be prevented by including a sand envelope around latrine pits. Construct the latrine pit with a 0.5 m thick sand envelope to provide sand filtration of the liquid effluent in the ground.

Use of plastic drums and tanks for excreta containment
Toilet design can use drums or plastic tanks to contain excreta in flood-prone areas. Excreta containment in containers is a temporary solution, requiring systems in place to empty or remove tanks and transporting of faecal sludge for treatment.

Use of container-based sanitation[15]
Container-based sanitation is a more formalised form of sanitation in which excreta is contained in drums or other containment units. In container-based sanitation, the design of the latrine, containment unit, and collection system is part of an established faecal sludge management service. Container-based sanitation is used in flood-prone settings to safely contain excreta.
Some container-based sanitation systems are waterless, also making them relevant in contexts of drought and water scarcity.

Construction of urine diversion dry toilets (UDDTs) and composting toilets
Various dry toilet options are suitable both in the context of flooding and saturated soils and in contexts experiencing drought. Variations in UDDT design with above-ground vaults are relevant in flood-prone areas. Dry toilets can also be suitable in contexts of drought and water scarcity, as water is not used for flushing.

Use of water-efficient toilets
As an alternative to dry toilets, water-efficient toilets can be used where water is used for flushing. Water-efficient designs such as the *Sato Pan* can be used to save water.

For more information on latrine design for high water table and flood-prone areas, see *GN 11: Climate-Resilient Faecal Sludge Management*.

Heat proofing of latrines
Extreme heat can negatively affect latrine users, especially when latrines are constructed without ventilation or with metallic superstructures that easily transmit heat. Add ventilation to latrine designs, utilise shading and use building construction and materials which provide passive cooling.

For more information on building construction under extreme heat, see *GN 4: Passive Cooling for Public Buildings*.

Building wind resistant latrines
Latrine superstructures, especially when built with lightweight materials or with sheet metal, are prone to being blown away in storms and heavy winds. Position latrines away from windy areas where possible. Latrine superstructures should be built using robust construction materials. Guy ropes can also be used to anchor a latrine superstructure in place.

Sanitation planning, pit emptying, and in-situ treatment

Carrying out sanitation safety planning[16]
Climate-resilient sanitation safety planning consists of assessing and managing risks at all stages of the safe water supply chain to protect public health. The sanitation system and potential hazards are assessed, identifying a range of climate-resilient actions that can be taken. An incremental approach to carrying out those actions is then planned, followed by monitoring progress, reviewing and periodic improvement of the sanitation safety plan.

Raised septic tanks
Septic tanks are sealed and effectively contain septage from contaminating their surroundings. They can be a suitable option in flood-prone areas. Septic tanks can be raised, such that influent and effluent pipes are elevated above potential floodwater levels.

Modified septic tank design
When soils are saturated and septic tanks are empty, the tanks are vulnerable to floating and cracking. Construction standards on septic tank construction need to be adapted, such as with increased wall thickness.

Adding secondary treatment in sand filters
Secondary treatment in sand filters can be added to systems such as septic tanks and for latrine pit liquid effluent. Latrine pits must be lined and sealed to provide significantly improved effluent quality before discharge. Adding secondary treatment is important when floodwaters are present and will become contaminated with septage from septic tanks.

Adding secondary treatment in constructed wetlands
Using constructed wetlands can offer improved performance and be an alternative to secondary treatment in sand filters. Vertical flow constructed wetlands, when used in conjunction with septic tanks, have the advantage of combining aerobic treatment with anaerobic treatment, further improving performance.

Using floating sanitation systems[17]
For communities located in areas that experience extended seasonal flooding or that are permanently on water, adaptations to create floating sanitation systems are appropriate. Floating designs, such as the HandyPod, consist of primary containment and digestion in drums, followed by secondary treatment in floating containers with filter media before discharge.

Emptying latrine pits before the rainy season
Pit latrines in flood prone areas are major sources of contamination during flood events. If latrine decommissioning is not possible, pit latrines can be emptied as a mitigation activity prior to the rainy season when flooding is more likely to occur. Pit emptying is only an acceptable adaptation if the emptied sludge is safely treated. Treatment of flood-prone pits with hydrated lime can also be done before the expected onset of flooding.

Pit emptying by auger
In environments where water is scarce, faecal sludge at the bottom of pit latrines can become compacted and difficult to desludge without adding water to the pit. To avoid this, pits can be emptied using either a manual or motorised auger.

Resources for Excreta disposal

3.2.2 Faecal sludge and wastewater treatment and conveyance

Climate change-linked flooding, drought, and extreme temperatures can disrupt treatment systems, damage infrastructure, and increase the risk of environmental contamination. This section outlines key adaptations to treatment plants and conveyance systems that enhance resilience and ensure the continuity of sanitation services in humanitarian settings.

The following overview provides links to each of the adaptations below:

Table 12: Faecal sludge and wastewater treatment plants

Hazard	Adaptation
Floods, storm surges, heavy rainfall events	Establish wastewater or faecal sludge treatment plants
Floods, storm surges, heavy rainfall events, droughts, water scarcity, extreme heat	Modify treatment plant capacity to accommodate changing flows and temperatures
	Modify design parameters in treatment plant design

All	Utilise low maintenance treatment methods
Extreme heat	Conduct stress testing on wastewater treatment biological systems to assess tolerance to heat
Floods, storm surges, heavy rainfall events	Elevate or relocate treatment plants
	Addition of backflow protection to wastewater treatment plants

Table 13: Wastewater conveyance

Hazard	Adaptation
Floods, storm surges, heavy rainfall events	Installation of separate sewer systems for wastewater and stormwater
	Stormwater intrusion prevention
	Relocation of wastewater lift stations
	Increased pumping capacity
	Installation of alternative on-site power supply
Drought	Installation of low-water and vacuum sewer systems

Faecal sludge and wastewater treatment plants

Establish wastewater or faecal sludge treatment plants
Without treatment plants, sewage will contaminate surface water sources. This increases the risks to people during floods, heavy rainfall events, and storm surges. Wastewater or faecal sludge treatment plants can be established through either centralised or decentralised systems.

Modify treatment plant capacity to accommodate changing flows and temperatures
Wastewater and faecal sludge treatment plant capacity should be modified to accommodate either higher or lower flows, but with degraded influent water quality. Process modifications may be required to handle inflows at increased temperatures.

Modify design parameters in treatment plant design
Treatment units may require different sizing parameters to manage increased loads. Additionally, freeboard requirements may be higher during inflows after heavy rainfall events.

Utilise low maintenance treatment methods
Treatment methods with low energy inputs and low maintenance requirements are more resilient to climate shocks and offer greater continuity in treatment operations. Slow sand filters and constructed wetlands are two treatment options that are also able to handle flow variability.

Conduct stress testing on wastewater treatment biological systems to assess tolerance to heat[18]
Increased surface water temperature may require changes to wastewater treatment systems. Stress testing involves subjecting biological systems to elevated temperatures and monitoring the impacts on treatment processes.

Elevate or relocate treatment plants
Faecal sludge and wastewater treatment systems should be sited or elevated to 0.4 m above the 100-year flood level, or alternatively at the 500-year flood level. For relocation and elevation siting, make use of flood maps and historical records and triangulate through community consultation. Additionally, flood barriers should be constructed to protect infrastructure where flood risks are present. Wastewater and faecal sludge treatment plant sites should have drainage to effectively divert stormwater away from the treatment site and should have slope stabilisation or retaining walls.

Addition of backflow protection to wastewater treatment plants
Wastewater treatment plants typically discharge to rivers or other water bodies. If water levels and rivers rise, due to flooding or storm surge, it risks backing up and flooding the wastewater treatment plant. Add non-return valves at discharge and for any pumps that are potentially vulnerable to flooding or flow reversal.

Wastewater conveyance

Installation of separate sewer systems for wastewater and stormwater
Combined wastewater systems increase the risk that wastewater treatment plants will be overloaded after heavy rainfall events. Separate systems for stormwater and domestic wastewater reduce this risk.

Stormwater intrusion prevention
Wastewater conveyance infrastructure, including pipes and tanks, should prevent the intrusion of stormwater, which would increase the volume of wastewater requiring treatment.

Relocation of wastewater lift stations
Wastewater lift stations should be located where they will remain functional and accessible for operation and maintenance in the event of flooding.

Increased pumping capacity
Increased pump capacity may be required at wastewater lift stations during flooding and after heavy rainfall events, especially at wastewater treatment plants treating combined wastewater.

Installation of alternative on-site power supply
Pumping stations reliant on grid electricity need back-up power options during climate shocks. Emergency generators and fuel, appropriately sited above potential flood levels, can provide alternative power.

Installation of low-water and vacuum sewer systems
Low-water sewerage systems use smaller diameter, shallow-buried pipes laid at flatter gradients. In vacuum sewer systems, faecal sludge or wastewater is transported using air pressure rather than water. Toilets are connected to a vacuum station via sealed pipes.

For more information on low-water and vacuum sewer systems, see *GN 11: Climate-Resilient Faecal Sludge Management*.

Resources for Faecal sludge and wastewater treatment and conveyance

3.2.3 Solid waste management and drainage

Climate change-linked hazards, particularly flooding and heavy rainfall, can overwhelm waste disposal sites and drainage infrastructure, leading to contamination, disease outbreaks, and disruption of WASH services. This section outlines practical adaptations to improve waste collection, protect disposal facilities, and manage stormwater in humanitarian settings.

Natural water storage and treatment capacity can be utilised for managing stormwater. This includes the use of ponds, wetlands, green corridors and natural drainage. For more information, see *GN 9: Nature-Based Solutions to Address Climate Change in WASH*.

Stormwater management should be linked with broader water resource management efforts, as outlined in *GN 2: Integrated Water Resources Management* and *GN 10: Climate Change and Community-Based Water Resources Management*.

The following overview provides links to the descriptions of each adaptation below:

Table 14: Solid waste management

Hazard	Adaptation
Floods and heavy rainfall events	Design disposal facilities for extreme rainfall
	Increase solid waste collection frequency
	Select appropriate solid waste collection methods
	Protect hazardous waste from floodwater
Floods and droughts	Introduce composting of solid waste
All	Use biodegradable materials

Table 15: Drainage and surface water management

Hazard	Adaptation
Floods and heavy rainfall events	Construction of drainage channels to divert stormwater
	Enlarge and expand storm water drainage systems
	Clean stormwater drainage systems
	Use sloped surfaces at waterpoints to collect drainage water and avoid stagnant water
	Excavation of dry basins

	Diversion of floodwater to ponds and wetlands
	Remove, reduce, divert, or treat contaminated surface water
	Utilise green corridors and natural drainage
	Structural barriers to flooding
	Reconnection of rivers with flood plains
	Construction of check dams
	Clean and de-silt water sources
Flooding and landslides	Protect drainage systems and surrounding soils from erosion
	Riverbank and soil stabilisation and retention walls

Solid waste management

Design disposal facilities for extreme rainfall
Landfills or controlled disposal sites are vulnerable to flooding after heavy rainfall events. A range of design adaptations can be made to disposal sites to deal with flooding risks: establishing stormwater diversion on the periphery of disposal sites, designing leachate ponds sized according to heavy rainfall projections, and installing impermeable liners to prevent infiltration into groundwater sources.

At the household or neighbourhood level, new disposal pits should be sited (or existing ones relocated) away from water sources and above the groundwater table, to avoid contamination during flood or heavy rainfall events.

Increase solid waste collection frequency
Solid waste that has not been collected before a storm is likely to be washed away with the stormwater. Collection frequency can be increased during rainy seasons and prior to the landfall of storms.

Select appropriate solid waste collection methods
During flooding and heavy rainfall, some collection transport options, such as those by large trucks, may be unable to access collection points. Introduce smaller vehicles, tractors, or manual transport capable of providing collection services, even when floods or muddy conditions limit access.

Protect hazardous waste from floodwater
A number of hazardous waste products, such as oil and fuel, electric and electronic equipment, and medical waste, can pose a risk to people coming into contact with them, including through floodwaters. Hazardous waste, and locations where it has accumulated, can be elevated or relocated to higher locations, where it is protected from floodwaters.

Introduce composting of solid waste
Composting methods can reduce the volume of solid waste, which can otherwise be an attractive source of food for vermin and other disease-carrying pests. Solid waste disposal sites may also be vulnerable to flooding or severe weather events. Composting also supports crops during times of drought or erratic rainfall. Existing composting facilities can be improved by introducing enhanced aeration.

Use biodegradable materials
Eliminating or reducing the use of non-biodegradable materials in humanitarian programming is a straightforward adaptation to address risks associated with solid waste.

Drainage for stormwater management

Construction of drainage channels to divert stormwater
Effective systems for drainage are important for the management of stormwater during flooding events and for preventing the spread of waterborne diseases. Where increased heavy rainfall or flooding events are anticipated, or where there is increased risk of the spread of mosquito-borne diseases, drainage systems can be adapted.

Drainage channels can be used to move stormwater, which may otherwise lead to flooding conditions, away from people to downhill locations. Construction of drainage channels requires a downhill discharge location that must be identified. Additional measures for flow control may be required, such as check dams.

Enlarge and expand storm water drainage systems
Drainage systems can be expanded. This may include widening and deepening existing drainage channels, constructing secondary branches to convey stormwater to primary drainage channels, and adding culverts. If existing drainage systems are not managing surface waters adequately, resulting in flooding, perform a network check to determine where and how the system is flooding to make the most impactful adaptations.

Clean stormwater drainage systems
Existing drainage systems can easily become clogged with silt, debris, and solid waste. Clogged drainage channels, culverts, and junction points can quickly lead to poorly functioning drainage systems and contribute to flooding. Cleaning existing systems and performing regular checks is an important low-cost adaptation to improve stormwater management.

Use sloped surfaces at waterpoints to collect drainage water and avoid stagnant water
Stagnant water at community water points is a common problem. Address it through sloped surfaces of waterpoint platforms and/or drainage channels.

Excavation of dry basins[19]
Dry basins can be utilised to temporarily store stormwater after heavy rainfall events. Basins allow for infiltration and evaporation and eventual controlled outflow when their capacity has been reached. Dry basins can be used in areas without shelters/critical infrastructure, where space is available, and where levels are suitable to allow in and outflow.

Diversion of floodwater to ponds and wetlands[20]
Existing ponds and wetlands can be used to store water from extreme rainfall events and floodwaters diverted from communities. The capacity of ponds and wetlands should be assessed to determine their suitability for potential stormwater inflows. New ponds require careful design.

Remove, reduce, divert, or treat contaminated surface water
During major flooding events, stormwater is more likely to be contaminated, especially if there are vulnerabilities in the sanitation systems. It is recommended to identify potential sources of contamination, where in the drainage networks the contamination is present, and if and how it is causing harm. Adaptations can include removing or reducing contamination at the source, diverting harmful surface water away from vulnerable areas, and treating the water.

Utilise green corridors and natural drainage[21]
Green corridors are a type of nature-based solution for flood risk reduction. They are linear green spaces or vegetated pathways, such as riverbanks, riparian buffers, wetlands, or urban green belts, designed to absorb, slow, and redirect floodwaters.

Creating natural drainage corridors normally involves converting a ditch or storm drain into a natural waterway flowing within a multipurpose corridor. They can also be created by rehabilitating and enhancing natural water channels and streams. They greatly reduce the number of drainpipes and other costly technologies required to manage stormwater runoff and reduce overall flood management costs.

For more information see *GN 9: Nature-Based Solutions to Address Climate Change in WASH*

Structural barriers to flooding[22]
Dams, dykes, and levees are engineered structures with an impervious core that support flood control. Dams contain water and then control discharge, while dykes, locks and levees act as barriers for diverting, redirecting, or confining floodwaters. These structures can themselves be vulnerable to the effects of a changing climate: more rain and increased volumes of floodwater beyond their design capacity can result in the failure of dams, dykes, and levees. The building of these structures may itself lead to either upstream or downstream flooding. Adaptations to existing infrastructure may be needed following an assessment.

Reconnection of rivers with flood plains[23] [24]
Rivers can be disconnected from their floodplains because of built infrastructure (including dams and levees). By reconnecting rivers with their floodplains, upstream flooding can be prevented or mitigated.

Construction of check dams
Check dams are small, low barriers (typically under 1.5-2 metres high) constructed across gullies, or minor ephemeral streams, using local materials like stone, gabions, earth, or concrete. Their main purpose is erosion control, achieved by slowing runoff velocity and trapping sediment. Check dams can be constructed to manage runoff after heavy rainfall events.

For more information on structural barriers to flooding, see *GN 5: Improving the Resilience of Groundwater Infrastructure to Climate Change*.

Clean and de-silt water sources
Over time, reservoirs, ponds, and tanks accumulate silt, reducing their ability to store water. De-silting restores this capacity, allowing these structures to capture and hold more floodwater during heavy rains, acting as a buffer and reducing flood intensity.

Protect drainage systems and surrounding soils from erosion
The drainage system and surrounding soils can be adapted to protect them from erosion, such as by planting trees and grasses and using rocks or gravel in flow pathways. Providing gradients that are not too steep and constructing aprons at drainage system inlets can help prevent erosion.

Riverbank and soil stabilisation and retention walls[25]
Riverbank protection reduces erosion and prevents localised hazards during floods and heavy rains. Stabilising riverbank slopes through the placement of rocks or other materials is often called 'riprap'. In other cases, retention walls, including gabion walls, are needed to stabilise soils and prevent localised landslides and limit flooding.

Resources for Solid waste management and drainage

3.3 Hygiene and public health promotion adaptations

This section describes adaptations to three critical areas of hygiene and public health promotion programming: Hygiene Promotion, Vector Control and Disease outbreaks and healthcare settings. As several of the adaptations for vector control and disease outbreaks are the same as for hygiene promotion, links and cross-referencing are used throughout this section to avoid duplication.

3.3.1 Hygiene promotion

Hygiene promotion plays a vital role in protecting public health from climate-related hazards. This section introduces key adaptations to three key hygiene promotion strategies: community engagement, provision of hygiene materials, and using public health data.

For more information on all the adaptations below, see *GN 3: Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH in Health Facilities*.

Community engagement

Hazard	Adaptation
Floods	✔ ***Discussion of flood-specific hygiene information*** Discuss flood-specific hygiene information with people in communities and the coping mechanisms and barriers and enablers to positive practices.
Floods, ecosystem changes	✔ ***Discussion of waterborne disease information*** Discuss specific information about waterborne diseases, during both preparedness and response phases, with people in communities. Discuss the key actions to take and the barriers and enablers to taking these actions.

Drought	✓	***Discussion of water-washed disease information*** Discuss water-washed disease-specific information, during both preparedness and response phases, with people in communities. Discuss the key actions to take and the barriers and enablers to taking these actions.
Extreme heat	✓	***Discussion of food hygiene information*** Discuss food hygiene-specific information with people in communities and the barriers and enablers to safe food preparation and storage practices.
	✓	***Discussion with high-risk groups on health-seeking behaviour*** Discuss signs and symptoms, coping mechanisms and health-seeking behaviour with high-risk groups in communities, and the barriers and enablers to taking these actions.
	✓	***Discussion of pre- and post-disaster/movement practices*** Discuss pre- and post-disaster/movement practices with people in communities, and the barriers and enablers to regaining positive hygiene behaviours.
Floods, drought, heat, ecosystem changes	✓	***Engagement with communities on reducing risks with longer-term strategies*** Longer-term participatory Risk Communication and Community Engagement (RCCE) strategies can be developed to address the WASH-related public health impacts of climate change. See *GN 6: Risk Communication and Community Engagement Strategies for Climate Change Adaptation in WASH Programming*.

Materials for hygiene and health

Hazard		Adaptation
Floods, ecosystem changes	✓	***Providing access to hygiene related materials*** Hygiene materials can be provided to communities. Products can be given to replace items lost during climate shocks.

Drought	***Use of water-conserving designs for hygiene*** Water for handwashing, body hygiene, Menstrual Hygiene Management and incontinence can be conserved using water-efficient and water-conserving designs of taps, faucets, and handwashing devices. ***Provision of materials and activities to minimise water-washed disease transmission*** To reduce the spread of water-washed disease, materials for handwashing should be provided and increased handwashing practice promoted.
Extreme heat	***Provision of items to facilitate household cooling*** Materials and equipment can be provided to people in communities to improve cooling in the household.

Public health data and information

Hazard	Adaptation
Floods, ecosystem changes	***Monitoring of epidemiological data and trends*** Monitor epidemiological data and trends to determine changes in risk, identify high risk groups and target preparedness and response resources.
Heat, ecosystem changes	***Collaboration with health system representatives*** Collaborate with formal and informal health system representatives to ensure the provision of clear and coordinated information.

Resources for Hygiene Promotion: for more information and a full list of resources see *GN 3: Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH in Health Facilities*.

3.3.2 Vector control

Rising temperatures, changing rainfall patterns, and ecosystem disruptions can increase the prevalence of vector-borne diseases. This section outlines key adaptations to community engagement about vector control, steps to reducing vector breeding grounds, support for vector-deterrent materials and health system coordination.

Some of the adaptations listed below are shared with hygiene promotion. Where relevant, adaptations are linked to the hygiene promotion section above.

The following overview provides summaries of key vector control adaptations in each main area:

Community engagement

Hazard	Adaptation
All	✔ ***Discussion of vector borne disease information*** Discuss specific vector borne disease information with people in communities, and the barriers and enablers to adopting protective measures.
	✔ ***Discussion of signs and symptoms of vector borne disease and health-seeking behaviour*** Discuss with people in communities the signs and symptoms of vector borne disease, their perceptions and health-seeking behaviour, and the barriers and enablers for prevention and early treatment, particularly in areas where there are new/increasing cases of vector borne disease.
	✔ ***Clearing standing water sources*** Carry out community engagement and mobilisation to clear standing water sources in communities.
	✔ ***Engagement with site planning for proper environmental control*** Engage with site planning representatives for proper environmental control through cleaning campaigns, solid and liquid waste management, fixing leaks in taps and clearing drainage channels.
	✔ ***Engagement with communities on reducing risks with longer-term strategies***

Materials for hygiene and health

Hazard	Adaptation
All	***Provision of vector deterrent materials*** Provide vector deterrent materials such as nets and sprays to people in areas affected by vector borne disease.

Public health data and information

Hazard	Adaptation
All	*Monitoring of epidemiological data and trends*
	Collaboration with health system representatives

Resources for Vector Control: for more information and a full list of resources, see *GN 3: Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH in Health Facilities*.

3.3.3 Disease outbreaks and healthcare settings

Climate change is intensifying the frequency and severity of disease outbreaks, placing additional strain on healthcare settings and WASH services. The key adaptations listed below can be applied in the context of healthcare settings and during disease outbreaks, including community engagement, provision of hygiene materials, and the use of public health data.

Many of the adaptations listed below are common to hygiene promotion and vector control. Where relevant, links are included to those sections above.

The following overview provides links to summaries of key adaptations in the three main areas:

Community engagement

Hazard	Adaptation
Floods, ecosystem changes	✔ *Discussion of waterborne disease information*
Drought	✔ *Discussion of water-washed disease information*
Extreme heat	✔ *Discussion of food hygiene information*
	✔ *Discussion with high-risk groups on health-seeking behaviour*
Floods, drought, heat, ecosystem changes	✔ *Engagement with communities on reducing risks with longer-term strategies*
All	✔ *Discussion of vector borne disease information*

Materials for hygiene and health

Hazard	Adaptation
Floods, ecosystem changes	✔ ***Provision of hygiene related materials and ORS*** Provide hygiene-related materials, including water treatment supplies, safe water storage containers and Oral Rehydration Salts (ORS) (if applicable), and accompanying information on safe use.
All	✔ *Provision of vector deterrent materials*
	✔ ***Promote the use of climate-adapted water and sanitation infrastructure in health facilities*** For adaptations to water and sanitation infrastructure in health facilities see the water supply and sanitation sections of this guidance note.

Public health data and information

Hazard	Adaptation
Floods, ecosystem changes	✓ *Monitoring of epidemiological data and trends*
Heat, ecosystem changes	✓ *Collaboration with health system representatives*

Resources for Disease outbreaks and healthcare settings: for more information and a full list of resources, see *GN 3: Climate Change Adaptation for Hygiene Promotion, Vector Control, Outbreak Preparedness and WASH in Health Facilities*.

3.4 Preparedness

Many climate change adaptations in the humanitarian WASH sector make WASH infrastructure more resilient or effective, so that it continues to function during climate-related disasters. But it is also important for WASH actors to prepare to respond in the event of a disaster. In practice, this means that humanitarians should adapt boreholes so that they are less likely to be contaminated during floods. They should also be prepared to provide clean water in situations where the boreholes have become contaminated.

Preparedness strategies enable WASH actors to anticipate and respond to climate-related hazards, ensuring continuity of services and protection of public health. Preparedness activities should be integrated across all components of WASH programming and coordinated with national systems, local institutions, and communities. This section briefly outlines key preparedness actions in four programme areas: early warning systems, contingency planning, system strengthening and capacity building, and monitoring.

3.4.1 Early warning systems

Early warning systems are essential tools for anticipating climate-related hazards. They help to provide timely information and forecasts to alert stakeholders, enabling action before the hazard unfolds. Early warning systems can be used to activate anticipatory action and are used to inform communities of imminent risks in a timely manner.

See also *GN 8: Anticipatory Action in the WASH Sector*

Early warning systems are important for preparedness before the onset of flooding, the intensification of heavy rainfall, and the arrival of storms. These systems should trigger the deployment of temporary protective infrastructure, such as sandbag barriers around wells and reservoirs, and the activation of flood-free access routes to water points, for example.

In drought and water scarcity contexts, where climate change impacts worsen during prolonged periods of insufficient rainfall, early warning systems can inform emergency measures at specified thresholds. These thresholds should be pre-defined, with actions triggered, such as those listed in the Water resources and abstraction in drought and decreased water availability section of this document.

Communities must be connected to early warning systems and water resource authorities with clear action plans to make effective use of early warning systems and the anticipatory action window.

3.4.2 Contingency planning

Contingency planning involves preparing for the operational and logistical needs of WASH services during climate shocks. Plans should be developed collaboratively with communities and service providers and include both infrastructure and supply chain considerations.

Contingency plans should include pre-positioning of supplies. Essential items should be prepositioned, such as water treatment products, safe storage containers, materials for pipeline fixes, soap, ORS, hydrated lime, and vector control materials (e.g., mosquito nets). These can be deployed at household or communal levels, depending on the hazard.

Contingency plan components specific to safe water and sanitation are a part of water safety planning and sanitation safety planning. These approaches are recommended for developing relevant water and sanitation measures. Plans should include routine inspection and testing of infrastructure for durability under stress conditions.

Community action plans or community water management plans may also be developed. They can feed into contingency plans and help define roles, responsibilities, and actions during climate shocks at the community level.

See *GN 10: Climate Change and Community-Based Water Resources Management*

Community engagement is a key aspect of preparedness, to both understand the community's perceptions of climate risks and hazards and to identify the most impactful actions that can be taken in advance.

See *GN 6: Risk Communication and Community Engagement Strategies in Climate Change on WASH/Public Health*.

3.4.3 System strengthening and capacity building

Effective preparedness strengthens the capacity of all actors involved in WASH service delivery, from government departments to community volunteers.

Institutional strengthening involves supporting national and local authorities, including sanitation service providers and water utilities, to integrate climate adaptation into their long-term planning and budgeting. This work can include improving systems of governance and management to allow adaptations to WASH service to be implemented by stakeholders with clear roles and responsibilities. A wide range of other potential areas of support and collaboration are possible. For more information on how the building blocks of the WASH system can be strengthened and integrated with climate resilience, see WaterAid (2021).[26]

Technical capacity building, including technical training on the adaptations introduced in this document, can be conducted for government, service providers, and NGO actors. Technical training plans should align with priorities defined at the sector level. Capacity building efforts should seek to bridge gaps between sectors through collaboration by, for example, including health sector actors in the context of the spread of disease linked to climate change.

3.4.4 Monitoring for Preparedness

Monitoring systems are vital for informing both preparedness and adaptation actions. In the water sub-sector, monitoring water quality and water resources is key. Monitoring data can be used for near-term actions, such as triggering anticipatory actions, and for long-term water resource management, such as managing appropriate thresholds for groundwater abstraction.

Monitoring is an important element of responding to disease outbreaks and requires coordination with health sector actors. Identifying locations that are regular hotspots for diarrheal cases after flooding events, for example, can be used to target additional preparedness activities in these locations.

4 Stage 4: Implementing climate change adaptations

Once the adaptations have been prioritised and selected (Stage 3), implementation follows. Before carrying out the adaptations, capacity strengthening may be necessary. For ongoing programmes, the climate change adaptations can be included in existing activities, after reviewing the context and consulting with communities and project stakeholders. During and following implementation, an iterative process of monitoring and reviewing progress can improve the effectiveness of climate change adaptations by further modifying the adaptation activities.

4.1 Capacity strengthening

Some climate change adaptation activities may require new capacities from the implementers. A capacity needs analysis should be carried out:

Identify gaps in capacity that will limit WASH actors' ability to implement adaptations and that need strengthening

Start with the **highest priority** adaptation activities requiring capacity strengthening

Consider the **existing capacity** of other actors or explore **dividing capacity building** between partners

Not all agencies need to be trained specialists on all adaptations. Focus on action points that are achievable with existing resources. Alongside technical training, identify overall WASH System Strengthening and Capacity Building opportunities.

4.2 Monitoring and reviewing

The WASH sector should periodically convene to self-evaluate its progress in making WASH climate change adaptations and to learn from implementation experience.

Tips for reviewing progress on WASH adaptation activities

- Use a traffic light system to review progress on adaptations
- Highlight achievements and easy-win adaptations
- Identify barriers to achieving the more difficult adaptations
- Identify what can be written into the sector response plan, funding proposals, and advocacy pieces to draw attention and resources to unmet adaptation needs
- Integrate the sector review into the Humanitarian Needs and Response Plan cycle (or similar, coordinated plan for the humanitarian sector)
- Revisit previous summaries of the prioritised hazards and adaptations. Identify if any new developments, hazards, or impacts have emerged that require further analysis. Determine if additional adaptations are required and decide which adaptations being implemented require modification

References and Resources

Further resources are listed below for each of the main WASH programme adaptation areas described in Stage 3.

Adaptations to protect water abstraction infrastructure

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