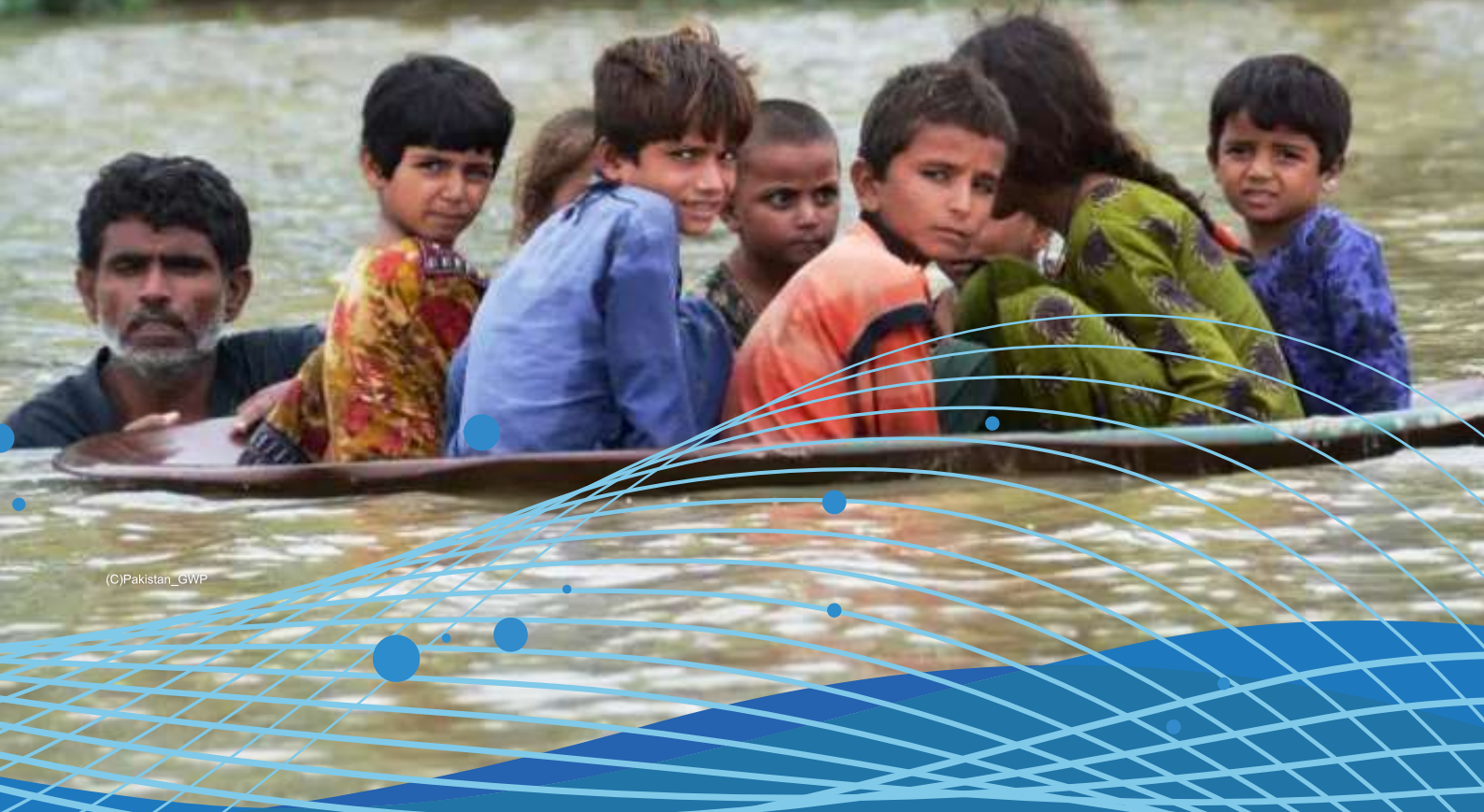


2023

HELP Global Report on Water and Disasters



(C)Pakistan_GWP



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Dear Readers,

I am pleased to share with you this HELP Global Report on Water and Disasters 2023, the fifth volume of this annual series. It compiles valuable experiences, lessons, and best practices for addressing large scale disasters that have occurred around the world in recent months.

While COVID-19 pursued its severe impact not only on human health but also on the global economy and politics, natural disasters continued unrelenting. In Pakistan, 40% of the national territory was submerged under water. Globally, the death toll from water-related disasters doubled compared to the previous year. Floods wreaked havoc in various parts of the world, including India, Nigeria, South Africa, Brazil, Australia, and in many other countries on every continent. Simultaneously, droughts affected millions of people across the Sub-Saharan region, including the Horn of Africa, as well as in parts of Asia (including China), Europe, the Americas (including the U.S.A.), and Oceania.

While the spread of COVID-19 may be abated soon, the same cannot be said for disasters. There is a growing fear that extreme hydrological events will increase rapidly in both frequency and severity due to the effects of climate change.

Against this backdrop, it is important to note the occurrence of the first United Nations Water Conference in March 2023. This event marked a significant milestone as the first such conference since 1977. Notably, the conference squarely addressed the pressing issue of water and disasters during the 3rd Interactive Dialogue (ID3) on the theme of “Climate Change, Resilience, and Environment”.

As the Chair of HELP, I had the honor of putting forth the following proposals within the framework of ID3:

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1. Enhance awareness, integrated preparedness, and timely information-sharing by both governments and citizens to detect and prevent future disasters, including pandemics, and all sorts of disturbances.
2. Water can and should play a critical role to build a post-COVID-19 society that is more resilient and adaptive to both sudden and slow onset disturbances.
3. A Scientific Panel on Water, a water version of IPCC, should be established within the UN system.

4. Water, DRR, and climate change issues should be firmly connected to discussions and actions. Dedicated discussion processes should be established by regularizing the Special Thematic Sessions on Water and Disasters.
5. Position science and technology as a game changer. All stakeholders should promote water cycle consilience by accelerating the Open Science Policy; foster “Facilitators”; and work together by adopting an end-to-end approach.
6. A UN Water Platform should be created to periodically discuss water in a dedicated manner.
7. A special discussion to connect water, DRR, and climate change should be held at the Mid-term Review Conference of the Sendai Framework for Action.
8. Create an international platform connecting culture and heritage to water, climate change and disasters.
9. Member States should establish symbolic days to harness the global will and commitments for action, namely International Day for Glacier Conservation and the World Lake Day.

The inclusion of all these recommendations without exception, in the final outcomes of the UN Conference carries significant importance. I extend my gratitude to the readers of the Global Report and all stakeholders in the realm of water and disasters for your interest and support for the issue of water and disasters. It is your collective dedication that created the momentum toward this landmark achievement.

With the conference now concluded, it is imperative that we remain committed to fulfilling our commitments and diligently follow-up on the outcomes.

I wish to express my gratitude to the thousands of people that helped galvanize global actions on water and disasters. I also wish to pay tribute to the memory of our deeply esteemed advisor to HELP and a regular contributor to this Report, the late Mr. Cees van de Guchte, who regrettably passed away last year. We will never forget his tall figure and gentle smile, only matched by his remarkable contributions to the global water cause. May his soul rest in peace.

Global challenges related to water and disasters persist within an ever-changing social, environmental, and political landscape. It is my aspiration that this volume will assist you in addressing these challenges by sharing the knowledge, lessons, and best practices imparted from the latest global disasters.



Dr. Han Seung-soo
Chair, High-level Experts and Leaders Panel on Water and Disasters (HELP)
Former Prime Minister of Republic of Korea



In the 2023, the world finds itself at a critical juncture, with water-related challenges taking centre stage in global discussions. This year marks a special milestone, as the United Nations Water Conference convened for the first time since 1977, signalling the urgency and gravity of the water-related issues that have unfolded in recent decades due to global change. It is a reminder that the world's future is intrinsically linked to the sustainable management of our most precious resource: water.

One of the predominant themes of the 2023 UN Water Conference was water-related disasters, a topic that affects almost all regions of the world. The HELP meeting, which was organized along-side the UN Water conference, provided an invaluable platform for various partners to come together and address these pressing concerns. This collaborative effort allowed us to raise awareness on the growing challenges posed by water-related disasters at this special occasion. Global Water Partnership (GWP) plays an instrumental role in this global conversation on water and is contributing its expertise and experience on water-related disasters. The urgent need for coordinated and comprehensive strategies to build resilience to such disasters is more apparent than ever. GWP stands dedicated and well-prepared to support this critical process in the years to come.

At the same time, as we see these positive developments and momentum towards more awareness for the importance of water for adaptation and development, the world continues to experience water-related disasters in increasing frequency and magnitude: The early months of 2023 witnessed the end of a protracted La Niña phenomenon, which had unleashed prolonged droughts in several parts of the world, including Southern South America and the Horn of Africa, leading to famine. As La Niña subsides, another challenge looms on the horizon, as we face an intensifying El Niño. The year 2023 is on track to become one of if not the warmest year on record, with temperatures projected to reach 1.4°C above preindustrial averages. This climatic shift may have already contributed to a series of devastating water-related disasters this year, from floods in Libya and China to hurricanes and wildfires across the globe. And there are many more examples in this report.

Yet, these challenges are not new to us. The growing frequency and severity of water-related disasters are inextricably linked to climate change. So limiting climate change is very important to reduce the future risk. Simultaneously, we must provide effective solutions now to mitigate the increasing risks faced by vulnerable societies.

In this context, initiatives like the UN Early Warning for All (EW4All), aiming to provide Early Warning Systems to every person on the planet by 2027, are paramount. GWP is actively contributing to this endeavour, partnering with the World Meteorological Organization (WMO) through the Integrated Drought Management Programme (IDMP) and the Associated Programme on Flood Management (APFM). We are committed to assisting countries and stakeholders at all levels by providing policy, technical guidance, management expertise, and by sharing scientific knowledge and best practices.

However, strengthening national policies to tackle water-related disasters is not limited to one approach. GWP envisions a multi-faceted strategy and HELP and its members have an important role to play. HELP serves as a conduit for dialogues between countries, ensuring that no one is left behind in our collective efforts to enhance resilience to water-related disasters. We believe that a united front is the path forward to confront these challenges effectively.

As we present this report, we hope that it will further the mission of HELP, accelerating the building of resilience against water-related disasters. GWP reaffirms its unwavering commitment to this cause and its continued and strengthened partnership with HELP. Together, we can forge a future, where water is no longer a source of adversity but a beacon of hope and sustenance for all.

A handwritten signature in black ink, appearing to read 'P. Bereciartua', with a stylized flourish at the end.

Mr. Pablo Bereciartua

Chair of Global Water Partnership

Water-related disasters in 2022 resulted in death toll of 12,569 (of which 9,565 by flood and storm and 2,601 by drought), affected people of over 180.9 million (of which 73.9 million by flood and storm, and 106.9 million by drought), and economic loss of 210.1 billion US Dollars (of which 175.9 billion USD by flood and storm and 34.2 billion USD by drought) worldwide. Share of water-related disasters are 40.9 % for deaths, 97.8% for number of affected people, and 92.6 % for economic loss. Addressing water-related disasters remains one of major challenges in building post-COVID19 world back better towards quality-oriented society that is more resilient, sustainable, and inclusive.

1.1 Human loss and number of affected people by water-related disasters in 2020

The year 2022 was characterized by recurrent water-related disasters under the continuous infection waves of COVID-19, which was threatening billions of people worldwide. In 2022, 12,569 people lost their lives by 323 water-related disasters (e.g., floods, tsunamis, slides and debris flow, storms, and droughts) out of total yearly death of 30,704, meaning that 40.9% of deaths were caused by water-related disasters. The death toll is 1.93 times higher than 6,500 in 2021.

According to EM-DAT (International Disaster Database) of Centre for Research on the Epidemiology of Disasters (CRED), 180.9 million people were affected by water-related disasters out of 185 million of people affected by all disasters, meaning 97.8 % of disaster-affected people were caused by water-related disasters. The number of people affected by water-related disasters in 2022 increased by 83 % from 99 million in 2021. Share of deaths by water-related death (40.9 %) is much higher than the average of the recent 20 years (28% in 2002-2021). Death Toll by Disaster Type (2022 vs. average 2002-2021) are shown in Figure 1.1. Top 10 severest disaster events by number of affected people in 2022 are shown in Table 1.2. The increasing trend of number of affected people by water-related disasters continue due to, inter alia, climate change, population growth, and urbanization. In the recent twenty years (2002-2021), number of people affected by water-related disasters is 3.75 billion and accounts for 94% of total (3.98 billion). Heavy rain and flooding in Pakistan immersed around 40% of the national territory, resulting in deaths of over 1,700 people. The year 2022 was also marked by series of droughts, resulting in death toll of 2,601 and affected people numbering 206.9 million.

Table 1.1 Death Toll by Disaster Type (2021 vs. average 2002-2021)

Event	2022	Average (2002-2021)
Drought	2,601	1,057
Earthquake	1,626	35,124
Extreme temperature	16,416	8,538
Flood	7,954	5,195
Land slide	403	838
Mass movement (dry)	0	37
Storm	1,611	10,006
Volcanic activity	6	90
Wildfire	76	82
Total	30,704	60,955

Source: UNDRR using EM-DAT (International Disaster Database)

Table 1.2 Top 10 severest disaster events by number of deaths in 2021

(Bold letter by water-related disasters)

Country	Name of event	Death toll
Europe	Heat Wave	16,305
Uganda	Drought	2,465
India	Flood	2,035
Pakistan	Flood	1,739
Afghanistan	Earthquake	1,036
Nigeria	Flood	603
South Africa	Flood	544
Philippines	Storm (Megi)	346
Indonesia	Earthquake	229
Brasil	Flood	272

Source: 2022 EMDAT Report

Table 1.3 Top 10 severest disaster events by number of affected people in 2021

(Bold letter by water-related disasters)

Country	Name of event	Number of affected people
Pakistan	Flood	33.0 million
Congo (D.R.)	Drought	26.0 million
Ethiopia	Drought	24.1 million
Nigeria	Drought	19.1 million
Sudan	Drought	11.8 million
Bangladesh	Flood	7.2 million
China	Drought	6.1 million
Niger	Drought	4.4 million
Burkina Faso	Drought	3.5 million
Philippines	Storm (Megi)	3.3 million

Source: 2022 EMDAT Report

1.2 Economic loss by water-related-disasters

The overall economic loss by water-related disasters in 2022 was US\$ 210.1 billion, or 93.8 % of total loss of US\$ 223.8 billion by all disasters. Tropical cyclones, hurricanes, and typhoons hit and caused severe damage in various parts of the world. Economic loss by drought increased to 34.2 billion USD whereas those by floods and storm remain kept the largest share at 175.9 billion USD. The annual loss of 210.1 billion USD was 149 % of the average of US\$ 140.6 billion in the recent twenty years of 2002-2021. 9 out of ten top economic loss disasters were water-related.

Table 1.4 Top 10 severest disaster events by economic loss in 2022

(Bold letter by water-related disasters)

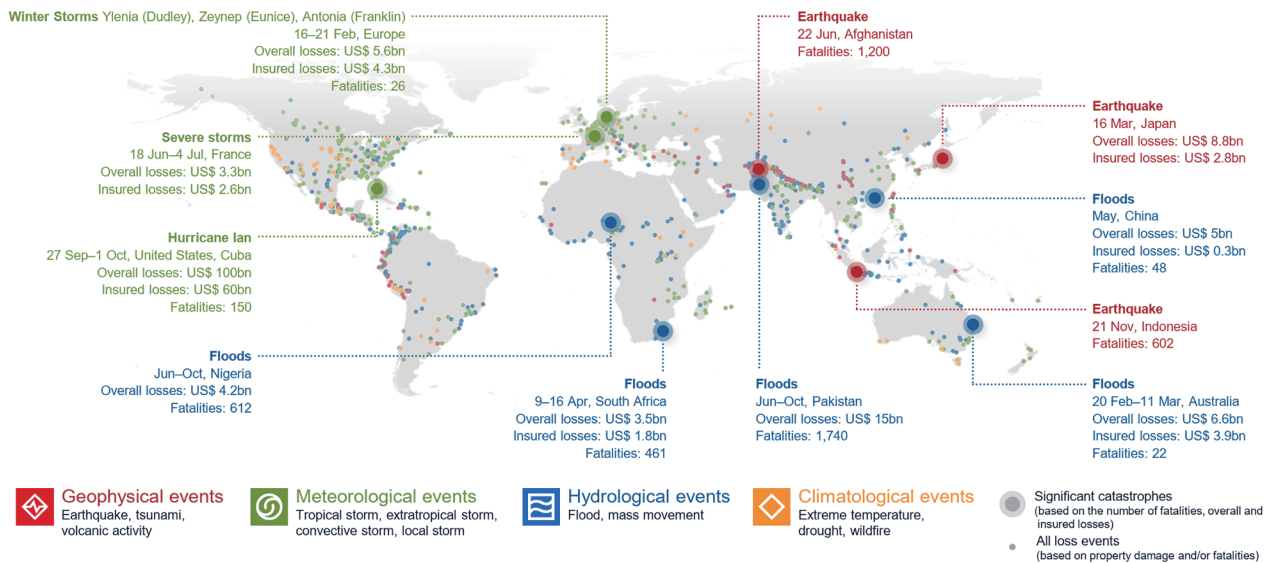
Country	Name of event	Economic Loss
USA	Hurricane (Ian)	100.0 billion
USA	Drought	22.0 billion
Pakistan	Flood	15.0 billion
Japan	Earthquake	8.8 billion
China	Drought	7.6 billion
Australia	Flood	6.6 billion
China	Flood	5.0 billion
Nigeria	Flood	4.2 billion
India	Flood	4.2 billion
Brazil	Drought	4.0 billion

Source: 2022 EMDAT Report

Fig. 1.2 Map of natural catastrophe loss events 2022

Nat cat loss events 2022

Natural catastrophes caused overall losses of US\$ 270bn worldwide



Source: Munich Re, NatCatSERVICE, 2023

Source: 2022 EMDAT Report

22/10/2022: https://www.munichre.com/content/dam/munichre/mrwebsitespressreleases/nat-cat-2022-world-map.pdf/_jcr_content/renditions/original./nat-cat-2022-world-map.pdf

1.3 Major water-related disasters in 2022

Disasters continued to occur in all continents of the world. Major water-related disaster events include Hurricane Ian in the U.S.A., Floods in India and Pakistan, Typhoon Megi in the Philippines, heavy rain and floods in Brazil, and droughts in Sub-Sahara Africa, China, U.S.A., and Brazil.

Heavy rain and floods in Pakistan submerged large parts of the national territory. The human and economic loss was comparable to that in 2010 although affected areas were not fully overlapped due to difference of rainfall patterns. South west part of the country which are usually dry zones were severely affected by heavy rain. Climate change is alleged to be main cause of the extreme hydrological event although thorough climatic analysis is expected.

Sardar Muhammad Tariq

*Member Regional Council South Asia GWP
Former Chairman Technical Committee (SASTAC) GWP*

Former Member and Managing Director

Water and Power Development Authority (WAPDA)

Former Member Presidents Technical Committee on Water Resources

Author of Technical Paper on Flood and Drought Management together with WMO

Introduction

Pakistan has been classified as 7th most affected country resulting from climate change. Pakistan receives 70% of its water resources from snow and ice melting. With rising temperatures in the Himalayan region where the largest number of glaciers are located, their melting has accelerated. It is estimated that by 2050 Pakistan water sources will face a 40% decline due to receding glaciers. The second most damaging effect of climate change is the monsoon pattern change, resulting in prolong droughts and more violent rainfalls. Climate change is apparent across the region and its impacts are visible in the form of increased heat waves, heavy down pours, shifting seasons, droughts and floods. Water resources is the most vulnerable sector to global warming the signs of which are visible posing serious threat to food, water and energy security efforts nationwide. Climate change trends are projected to continue with larger amplitude resulting from higher amount of heat trapping gas emissions. With recent history of 27 years, Pakistan has experienced the major earthquake in 2005, floods in 2010, 2014 and the super floods in 2022. The recent events are briefly described in order to understand the country's response to major disasters.

[Similarly Glacier Lake Outburst Flood \(GLOF\) Further Aggravate the Situation](#) the Himalayan region of Indus Basin has some of the world largest glaciers numbering 5218 and an area of 1040 km sq. The Basin has 3000 numbers of glacier lakes with an area of 156.65 km sq. Out of 3000 glacier lakes the potential GLOF are 52. These potential lake often burst during monsoon reason. During current flooding quite a number of glacier lakes breached and resulted in colossal damages to agriculture land, roads, houses and livestock. The GLOF release millions of cubic meters of water, and debris leading to the loss of lives, property and livelihoods amongst the remote and impoverished mountain communities. Over 7.1 million people in GB and KP are vulnerable to GLOF events. With rising temperatures due to climate change the GLOF events have been releasing increasing water.

[In addition Earthquake – Induced Land Slides Floods](#) have been known from early expeditions in the mountainous terrain of upper Indus valley that flooding caused by landslides and jokulhlaups (draining of glacial pounded reservoirs) occurs with considerable frequencies. A land slide dam which was over 200 meters high occurred in 1840-41 and blocked the Indus River. The Indus River valley impounded a reservoir which eventually overtopped the dam, resulting in a catastrophic flooding of downstream communities with massive loss of life. This is a frequent phenomenon and Hewitt (1968, 1982) has cataloged the landslides dams and jokulhlaups on the upper Indus basin for which there is a record, back to the year 1533.

1. Floods of 2010

During month of July and August Pakistan faced a major disaster as a result of heavy monsoon rains and glacier melting. The assessment carried out by United Nations Office for the Coordination of Humanitarian Affairs (OCHA), September 14, 2010 indicated total number of deaths were 1767, and 2701 were injured. 1.85 million Houses were destroyed and a population of 20.56 million was affected. The approach was response-centric and detailed inventory of damages along with sector wise cost as shown in Table 1 below were assessed and formed part of government's detailed and exhaustive post flood 2010 reconstruction plan (Table 2).

Table 1 Flood 2010: Major Damages

Sector	Description
Housing	<ul style="list-style-type: none"> 1.61 million Units
Agriculture, livestock and fisheries	<ul style="list-style-type: none"> 2 million ha of standing crops Substantial stock of food, seed, fodders, tube wells, water courses (30k) and fish farms destroyed
Transportation	<ul style="list-style-type: none"> 25K km roads (793 NHA, 3,125 km PH, 21,170 P&M Roads) % Of flood affected areas 12% roads & 16% railways 80%
Roads and railway District and municipal roads	
Education	<ul style="list-style-type: none"> 10,404 (6.1% of total institutions in the country) 10,363 sch; 20 collages, 21 VTIs
Health	<ul style="list-style-type: none"> 496 BHUs, 1 DHQ and 6 THQs
Water and Sanitation	<ul style="list-style-type: none"> 7K Watsan schemes (WS 4,246, Sanitation 2,872)

Table 2 Reconstruction Plan Sectoral Damages and Reconstruction Cost

Rs Billion		
	Damages	Reconstruction Cost
Agriculture	428.8	21.8
Private Sector	23.9	8.6
Transport and Communication	112.9	200.3
Energy	26.3	9.0
Banking and Finance	57.2	39.4
Housing	135.0	126.1
Irrigation	23.6	36.3
Education	26.5	42.9
Health	4.2	4.1
WatSan	9.3	6.3
Governance	6.0	4.9
Environment	1.0	17.7
DRM	0	2.3
Livelihood	0	58.1
Total	854.8	577.9
Source: World Bank, 2010		

1.1. Reconstruction Plan:

Based on the detailed assessment of floods of 2010, an exhaustive post flood reconstruction plan was prepared by the government. The broader parameters and focus of this plan included:

- Transparency & Effective Spending
- Capacity Enhancement for Quality Delivery
- Community Involvement at all stages of project delivery
- Institutional Restructure
- Adoption of international best practices and assessment of ground situations to guide reconstruction plan
- Reconstruction plan to include a fast-track approval processes
- Robust system of procurement, accounting and oversight was included in the reconstruction plan
- Multidisciplinary and interministerial teams were formed to monitor and evaluate the reconstruction plan
- Flood specific strategy was adopted to prepare guidelines and hazard resistant standards
- Reconstruction plan included rehabilitation of damage irrigation infrastructure, houses, agricultural land, transport and communication, energy, industries including small and medium enterprises (SME's), education and health facilities, livelihoods etc.
- Disaster risk management needs including mapping of disaster-prone areas, improved disaster preparedness including early warning system and community involvement were made part of reconstruction plan
- A National oversight Disaster Management Council (NODMC) was formed to monitor inflows of funds for various phases of post flood recovery and reconstruction

1.2. Establishment of National Disaster Management Authority (NDMA)

Post 2010 Floods, Government realized to form an Independent Disaster Management Authority with the Following Functions and Responsibilities:

- Coordinate complete spectrum of disaster risk management.
- Secretariat of National Disaster Management Commission (NDMC) to facilitate implementation of DRM strategies.
- Map all hazards in the Country and conduct risk analysis.
- Develop guidelines and standards for stakeholders regarding their role in DRM.
- Establish Emergency Operations Centers in hazard-prone areas.
- Provide technical assistance to Government agencies for DRM initiatives.
- Organize training for capacity building and awareness programs.
- Collect, analyze, process, and disseminate information required for DRM.
- Ensure appropriate regulations framed to develop disaster response.
- Create requisite environment for participation of media in DRM activities.
- Liaison and cooperation with local and international NGOs.

2. Super Floods of 2022

2.1. Glacial Lake Outburst Flood

The glacial lake outburst flood (GLOF) caused major disasters in upper reaches of Pakistan particularly in Gilgit Baltistan and Khyber Pakhtunkhwa. In March 2022, the temperatures were exceptionally high in Pakistan killing at least 90 people. On May 1, the heat wave resurged, the city of Nawabshah recorded 49.5°C the hottest temperature recorded so far on earth in 2022 (All meteorological data is provided by the Climate Data Processing Centre of the Pakistan Meteorological Department) High in mountains, the heat accelerated ice melt, causing glacial lake at Shisper glacier in Hassanabad Hunza to burst. In the northern area maximum temperature reached around 40°C in Chitral and Gilgit Baltistan in summer but this year, maximum temperature of 43°C was recorded for several days in the month prior to the start of monsoon season. This led to the speedy melting of snow and ice in the mountains, and coupled with recent rains, many of the glacial lakes burst suddenly causing floods which damaged bridges, roads, houses and other infrastructure Pakistan Meteorological Department.

According to Ministry of Climate Change, around 3044 glacial lakes currently exist in Gilgit Baltistan and Khyber Pakhtunkhwa due to rapid melting of glaciers in Pakistan's northern mountain ranges (Hindukush, Himalayas and Karakoram) because of rising temperatures as a result of global warming. Around 52 are considered at risk of bursting putting some 7.1 million people at risk of GLOF. These sudden events unleash millions of cubic meters of water and debris leading to loss of life, property, livestock and livelihood of remote mountain communities. According to World Bank report Pakistan has faced 152 extreme climate events over the last 20 years in the form of extreme droughts, monsoon, forest fires, extreme events etc. The glacier melted three times. Pakistan faced overall loss of US dollar 40 million due to extreme climate events. The phenomenon of GLOF added to the floods of 2020 in the upper mountainous parts of zone 1 causing large damages (see map in Figure 1).

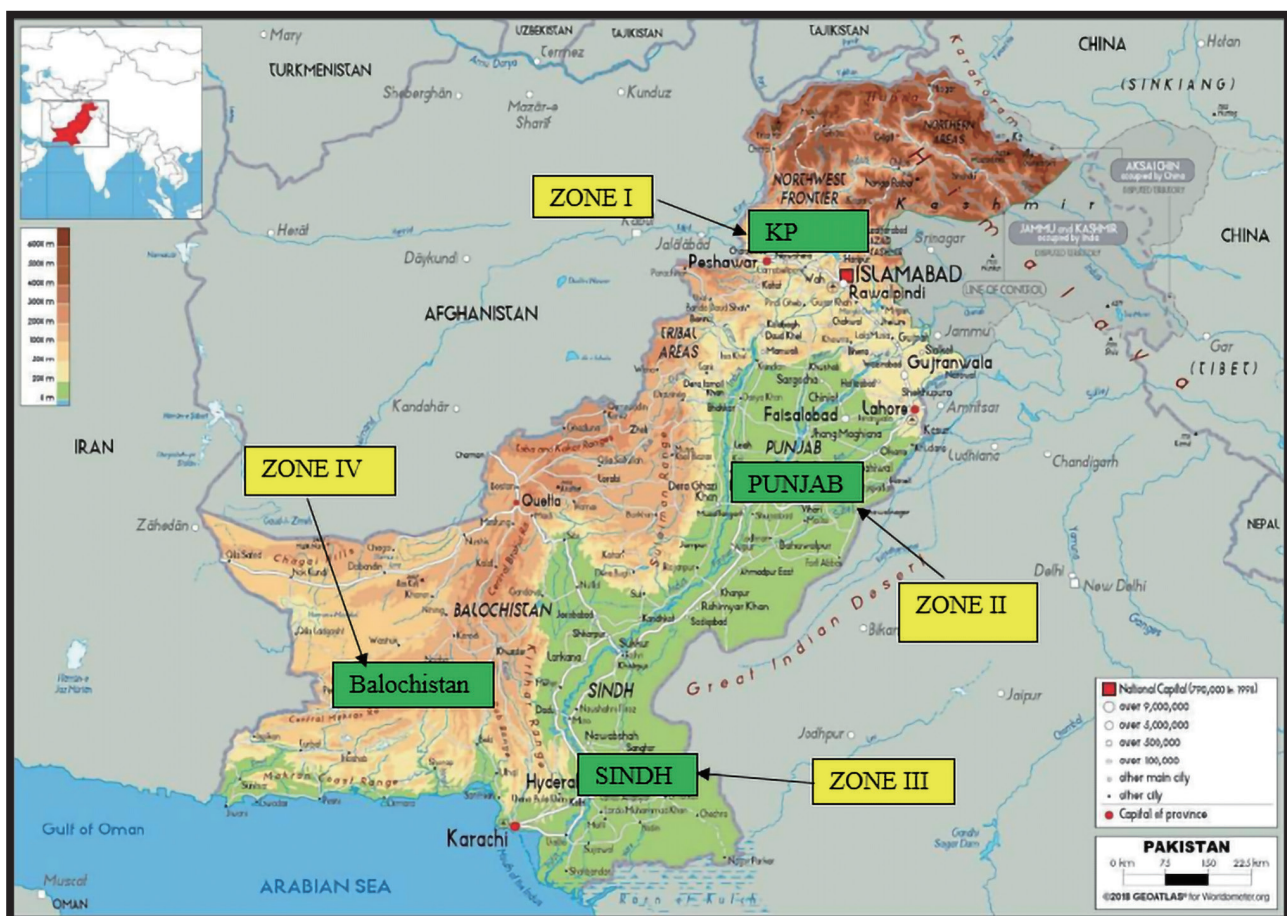


Figure 1 map of Pakistan including flood zones

2.2. Monsoon rains 1st July to 5th September 2022.

The monsoon season in 2022 started on 30th June. Significant continuous rainfall occurred from 4th July onwards. The rainfall in the country during the period remained excessively above average. In the following chapters we describe the rainfall situations for July and August 2022:

Natural rainfall in July was excessively above average as a whole with excessively above average over Sindh and Balochistan, largely above average over Punjab, above average over Khyber Pakhtunkhwa and Gilgit Baltistan and near average in Azad Jammu Kashmir (AJK). Normal area weighted rainfall for July in Pakistan is 63.3 mm. For Azad Jammu & Kashmir is 173.9 mm, Balochistan 29.7 mm, Gilgit Baltistan 13.3 mm, Khyber Pakhtunkhwa 106.7 mm, Punjab 104 mm and Sindh 60.2 mm. In July 2022 area weighted rainfall of the country remained above normal 180 %. On regional basis rainfall also remained above normal in Balochistan 450%, Sindh 307%, Punjab 116%, Gilgit Baltistan 32% and Khyber Pakhtunkhwa 30%. While in Azad Jammu and Kashmir area weighted rainfall remained below normal -7% (Table 1). In this month highest maximum temperature of 48°C was recorded in Nokkundi on 2nd July. Highest accumulated precipitation during the whole month was recorded at Islamabad A/P 573.34 mm. While the highest amount of rainfall during 24 hours was also recorded in Badin 219 mm on 25th of the month.

Table 3 July 2022 Precipitation in Pakistan

Region	July, 2022 Rainfall		
	normal (mm)	actual (mm)	Dev (%)
Pakistan	63.3	177.5	180
Azad J&K	173.9	161.2	-7
Balochistan	29.7	163.2	450
Gilgit-B	13.3	17.6	32
Khyber-PK	106.7	138.7	30
Punjab	104.0	224.3	116
Sindh	60.2	244.9	307

In July 2022 whole country received rainfall. Figure 2 represents the spatial distribution of rainfall during the month of July. The country received moderate to heavy, with exceptionally heavy rainfall in some parts. The centre of exceptionally heavy rainfall remained in upper Punjab, central/lower Sindh and upper Khyber Pakhtunkhwa. While the rest of the country received moderate to heavy rainfall. Details of rainfall patterns are shown in figures 2, 3, 4 and 5.

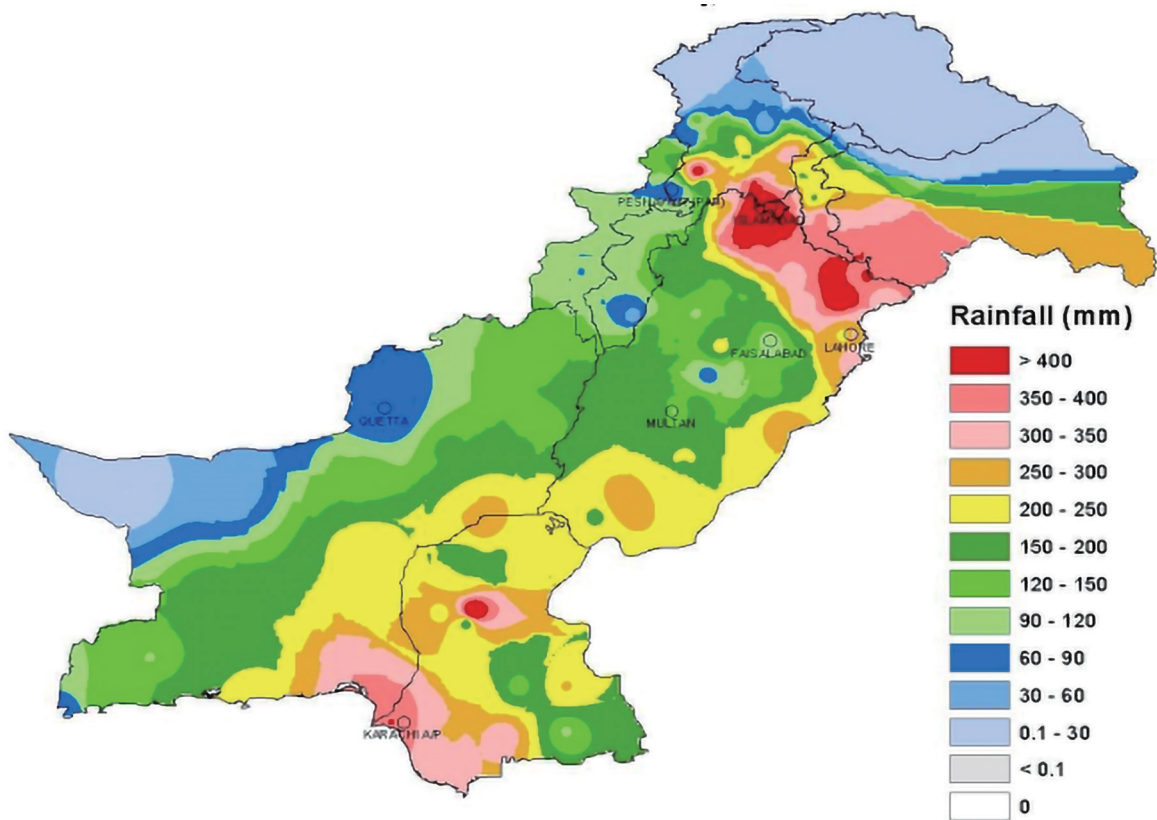


Figure 2 Rainfall (mm) distribution during July 2022

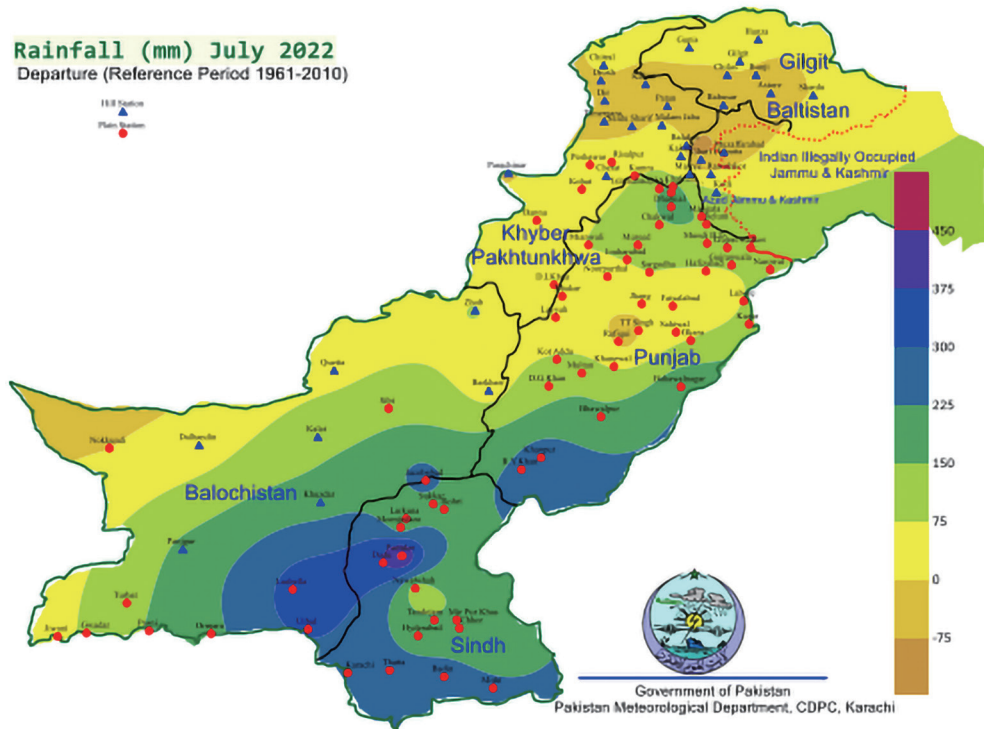


Figure 3 Spatial distribution of rainfall (mm) departure in July 2022


2.3. Rainfall in August:

The rainfall in August in Pakistan was more vigorous than July. In all areas of the country, it was significantly above average with peaks in Azad Jammu and Kashmir, Khyber Pakhtunkhwa, Punjab and most extreme in Sindh, Balochistan and Gilgit Baltistan,

Normal area weighted rainfall in August for Pakistan is 56.2 mm. For Azad Jammu and Kashmir, it is 150.7 mm, Balochistan 22.4 mm, Gilgit Baltistan 16.7 mm, Khyber Pakhtunkhwa 103.6 mm, Punjab 93.3 mm and Sindh 53.6 mm. In August 2022 area weighted rainfall of Pakistan remained above normal by 243%. On regional basis rainfall remained above normal in Sindh 726%, Balochistan 590%, Gilgit Baltistan 233%, Khyber Pakhtunkhwa 58% and Punjab 52%. While in Azad Jammu and Kashmir below normal rainfall recorded -3% (Table 4).

In this month the highest temperature of 46°C was recorded in Nokkundi. The highest accumulated precipitation during the whole month was recorded in Padidan 1228.5 mm. The highest amount of rainfall during 24 hours was also recorded in Padidan on 19th August with 355 mm.

Table 4 August 2022 Precipitation in Pakistan Exceptionally heavy rainfall observed in Sindh, Balochistan and upper Khyber Pakhtunkhwa.

	August, 2022 Rainfall		
	normal (mm)	actual (mm)	Deviation (%)
Pakistan	56.2	192.7	243
Azad J&K	150.7	146.1	-3
Balochistan	22.4	154.9	590
Gilgit-B	16.7	55.7	233
Khyber-PK	103.6	163.9	58
Punjab	93.3	141.7	52
Sindh	53.6	442.8	726

Details of rainfall are shown in Figure 4.

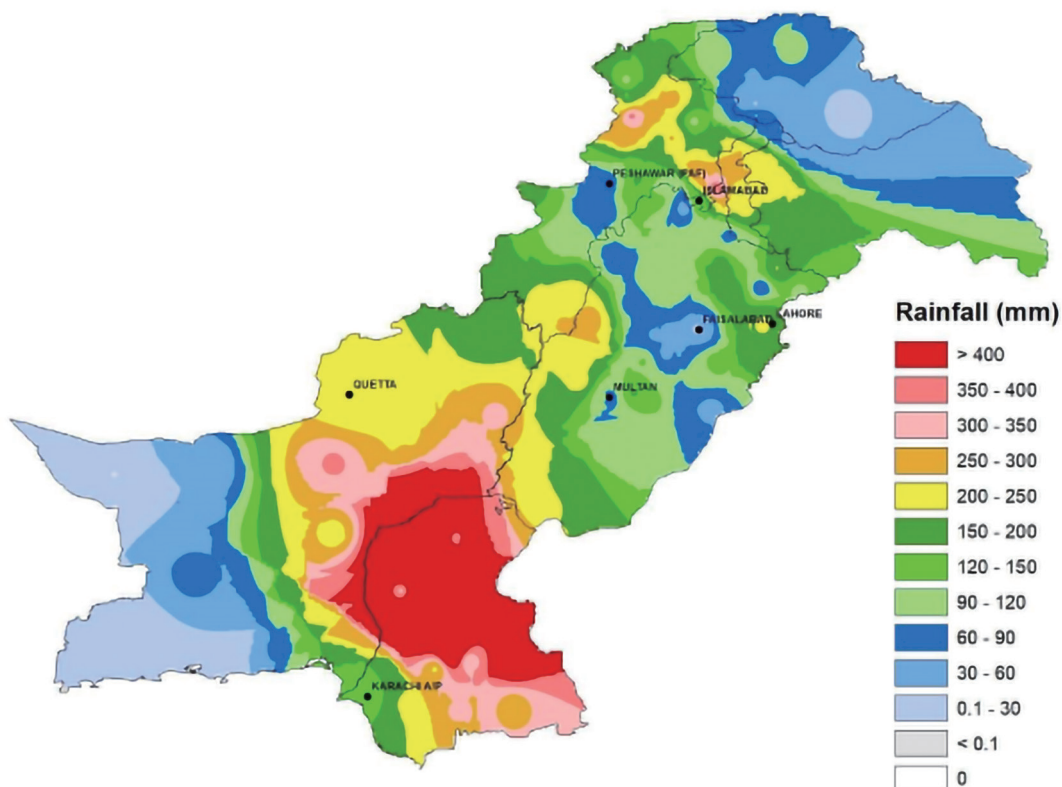


Figure 4 Rainfall (mm) distribution during August 2022

In August 2022 area weighted rainfall of Pakistan remained above normal by 243%. On regional basis rainfall remained above normal in Sindh 726%, Balochistan 590%, Gilgit Baltistan 233%, Khyber Pakhtunkhwa 58% and Punjab 52%. While in Azad Jammu and Kashmir below normal rainfall was recorded -3%. The spatial distribution of rainfall departure in the month of August with respect to the base period of 1961-2010 is shown in Figure 4.

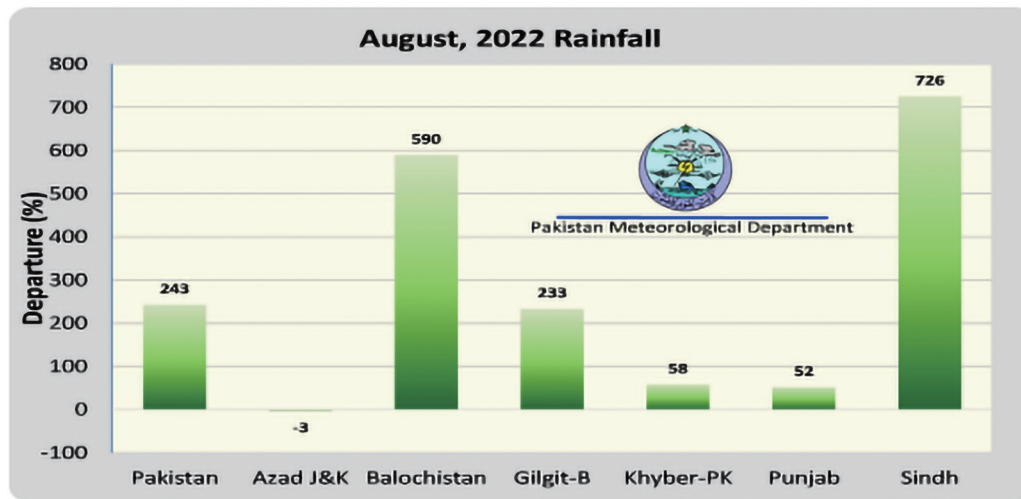


Figure 5 Rainfall Departure in August 2022

3. Situation Analysis:

Looking into the colossal damages caused by the super floods of 2022, it becomes evident that Pakistan can be divided into four (4) distinct zones where causes of damages and issues faced in each zone are quite different from one another requiring different solutions to reduce risk and damages (see map in figure 1).

3.1. Zone I:

Zone I encompasses the whole province of Khyber Pakhtunkhwa (KP) including the mountainous territory of Gilgit Baltistan (GB). In the upper northernmost region of zone I, 7.1 million people are vulnerable to GLOF events. The major rivers forming the tributaries of Indus are Shyoke, Gilgit, Hunza etc. In the North and further South, the Indus is joined by Swat and Kabul Rivers just upstream of the Attock gorge. Because of the Attock gorge which is a serious constraint to Indus River flows, the Indus starts ponding up which can in turn block the flow of Kabul River which in turn starts ponding up and overflows its banks. This whole network of rivers upstream of the Attock gorge can flood the very productive agricultural land, damaging cash crops in addition to flooding a large number of villages. As the Indus passes through the Attock gorge, it is joined by smaller hill torrents from the mountain ranges of Koh-e-Suleman. These hill torrents themselves also devastate built-up properties and can damage channels and other structures.

In this particular zone the major problem is the failure of governance. Water ways have been encroached with the result that many tourist resorts got washed away including a 4 stars 60 beds hotel constructed against the law within the flood plain. Due to the steep terrain in this region, the velocity and force of water is tremendous, capable of eroding even the underlying rock on which the structures are erected. The Tarbela dam located on River Indus if intelligently operated, would be able to absorb flood peaks, the Indus tributaries would flow within their banks, thus avoiding flooding of areas in Zone I.

3.2. Zone II:

This zone encompasses the whole of the Punjab province which is a food basket for Pakistan and some of the major agriculture based industries are located here.

Within this province all other major Rivers such as Jhelum, Chenab, Ravi and Sutlej join the main Indus. This zone therefore carries the maximum volume of water and has major part of Pakistan's world largest contiguous network of irrigation system. In this zone large volume of rivers flow together with torrential monsoon rains resulted in flooding of agriculture land and a large number of villages.

In order to reduce the volume of river flows and avoid flooding in this zone, additional dams need to be constructed in Zone I which is the upper riparian within the country. Since Zone I is mountainous, a large number of storage sites are available and have already been identified. Presently two large multipurpose sites are under construction. One at Diamer Bashawich will be the world highest Roller Compacted Concrete (RCC) Dam with a height of 272 meters. The other storage site under construction is on Swat River, the tributary of Indus. This is also a RCC structure when completed will be the fifth largest dam in the world. In addition, some sites on Chenab River in Zone II have also been identified. The dams currently under construction and the identified storages sites when completed would be able to mitigate to a great extent flooding in Zone I and II and would reduce enormously the volume of water entering Zone III. In addition the Zone II also contains a large area of the Cholistan desert to which the flood excess water could be diverted for groundwater recharge and supply communities living in that desert.

3.3. Zone III:

This zone is located in the Southern part of Pakistan, covering the province Sind. Here the Indus flows into the Arabian Sea. Being a coastal zone, the topography of this zone is generally flat, lacking proper drainage with the result that flooded areas remain under water for months. The uncontrolled large volume of water enters this zone from Zone II and some hill torrents also enter from Zone IV. During the 2022 flooding, the combination of torrential rains and inflow from Zone II led to an unprecedented flood situation which resulting in massive damages.

To tackle issues in Zone III, a well detailed plan of a drainage network has to be constructed along with controlling the River flows from Zone II and channelization of hill torrents from the western hill ranges.

In this zone multi-pronged solutions to mitigate flood risk are necessary. The first step required is to reduce the flow of flood waters entering from Zone II by constructing storages in Zone I and II, diverting part of flood waters to the Cholistan and Tharparkar deserts and establishing a plan of the drainage network.

3.4. Zone IV:

This zone encompasses the province Balochistan and is the largest province by area but smallest by population. The province has vast desert areas and is mostly unpopulated. The flooding of cities and town is caused by rivers overflowing their banks. This issue can be tackled by diverting part of flood waters to the desert through a well-planned network of inundation canals. This would not only recharge the groundwater aquifers but at the same time allow the planting of trees and shrubs and establishing grazing grounds for livestock to boost its economy. This would also support the large percentage of nomadic tribes of the province whose main source of income is livestock. In addition, cities and towns would also need to have effective drainage system.

4. Impact of the 2022 floods on agriculture in Pakistan's Sindh Province:

- In the summer (kharif) season, most of the area in Sindh is cultivated under three commercial crops: rice, cotton, and sugarcane. The flood was highest in the rice crop zone, which has resulted in an overall estimated loss of 1.8 million tons of rice, or an 80% loss of the expected total rice production in Sindh.
- Sugarcane and cotton zones were relatively lesser affected by the inundation during the flood. However, both zones received several exceptionally high daily rainfalls, which almost completely devastated the cotton crops at maturity (with cracked cotton balls).
- A loss of about 88% of the total expected cotton production is expected (3.5 million bales) because of the exceptionally high rainfall and inundation in the cotton-growing areas of Sindh. Damage to sugarcane crops amounts to a loss of USD 273 million.
- In economic terms, rice, cotton, and sugarcane together faced a direct loss of USD 1.30 billion (rice: USD 543 million, cotton: USD 485 million, and sugarcane: USD 273 million).
- Overall, the province faced a combined loss of USD 1.7 billion in rice, cotton, sugarcane, tomato, onion, chilli, and livestock.

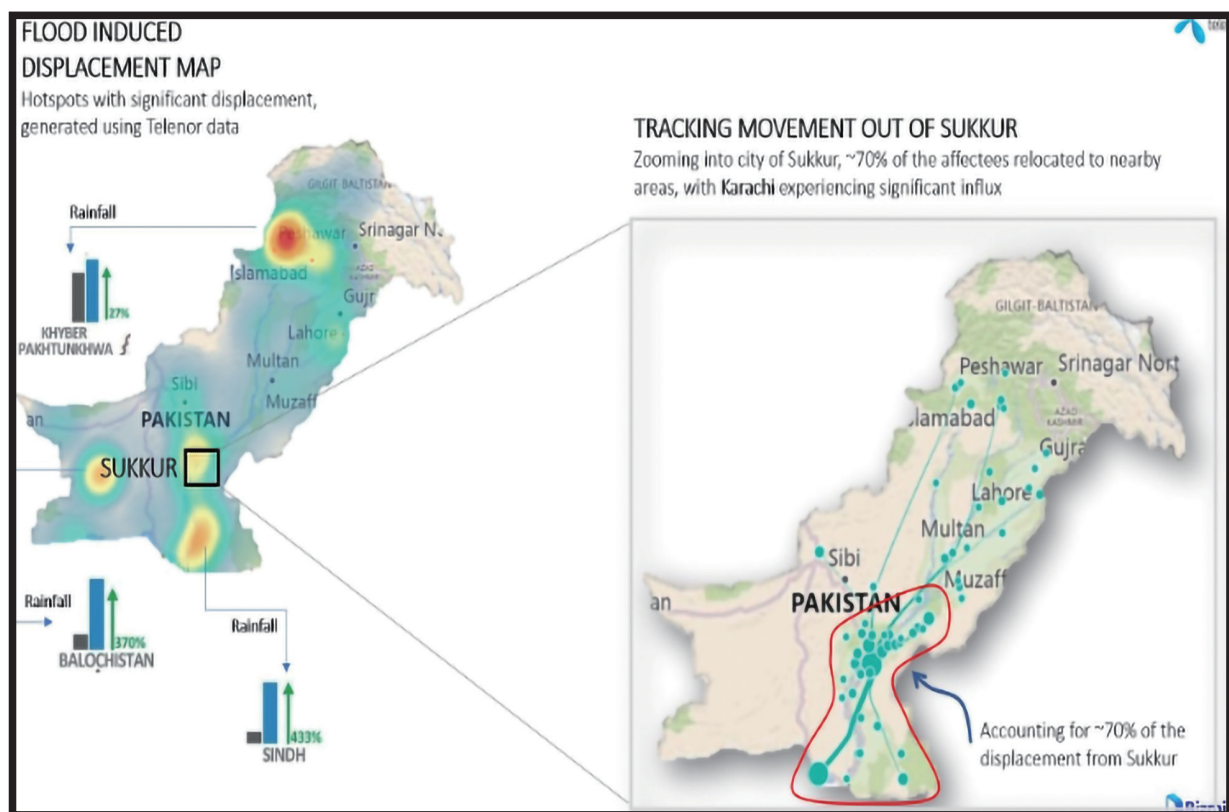


Figure 6 Flood Induced Displacement Map

The flood damages of 2022 as summarized by National Disaster Management Authority in Tabular form are shown below in Table 5 to 6:

Table 5 Damages of Infrastructures to date (PD – Partially Damage FD – Fully Damaged)

Province/Region	Roads (km)	Bridges	<u>HOUSES</u>			Livestock
			PD	FD	Total	
AJ&K	19	33	228	327	555	792
Balochistan	2,222	58	125,837	115,822	241,659	434,425
GB	33	61	1,126	667	1,793	609
KP	1,575	107	53,939	37,525	91,464	21,328
Punjab	877	15	42,127	25,854	67,981	205,106
Sindh	8389	165	1,168,210	716,819	1,885,029	436,435
TOTAL	13,115	439	1,391,467	897,014	2,288,481	1,164,270

Table 6 Calamity Hit Districts & Affected Population

Provinces/State	Calamity Hit Notified Districts	Affected Population
AJ&K	0	53,700
Balochistan	32	9,182,616
GB	9	51,500
KP	17	4,350,490
Punjab	3	4,844,253
Sindh	24	14,563,770
Total	85	33,046,329

Table 7 Deaths and Injuries (M:Male; F:Female; C:Children; T: Total)

Province /Region	Deaths				Injured			
	M	F	C	T	M	F	C	T
AJ&K	31	17	0	48	15	9	0	24
Balochistan	149	80	107	336	97	40	50	187
GB	5	12	6	23	3	0	3	6
ICT	1	0	0	1	0	0	0	0
KP	151	42	116	309	157	79	134	370
Punjab	92	51	80	223	2173	1113	572	3858
Sindh	310	151	338	799	2964	2211	3247	8422
Total	739	353	647	1739	5409	3452	4006	12867

Table 8 Flood Relief Assistance BISP

Province	Total Beneficiaries	Total Cash Disbursement Planned	Disbursement Completed		Disbursement Balance	
			Beneficiaries	Cash	Beneficiaries	%age
Balochistan	241,063	6,026,575,000	220,933	5,523,325,000	20,130	91.6%
Sindh	1,862,041	46,551,025,000	1,828,582	45,714,550,000	33,459	98.2%
KP	315,773	7,894,325,000	305,799	7,644,975,000	9,974	96.8%
Punjab	340,252	8,506,300,000	330,670	8,266,750,000	9,582	97.2%
GB	472	11,800,000	470	11,750,000	2	99.6%
Total	2,759,601	68,990,025,000	2,686,454	67,161,350,000	73,147	97.3%

4.1. Loss of Livestock during the 2022 Flood:

An event was held on 1st December 2022 on “Flood 2022 and Animals” jointly organized by the provincial livestock and fisheries department of government of Sind province and Brook Pakistan an international non-profit organization working since 1991 for the welfare of equine animals belonging to the poor’s. Based on official and international data it has been estimated that over 1.1 million livestock was lost in the provinces Balochistan, Khyber Pakhtunkhwa and Sind. Most of the animals lost their lives just because they could not be evacuated at the right time. Some of the animal rescued are frail, inflicted with sorts of diseases due to starvation, thirst, malnutrition as their bodies remained exposed to stagnant flood waters for a long time. It is important that animal welfare is considered important in order to ensure their rescue and welfare during floods sinceas livestock is a precious source of income to the poor’s and a sizable part of the agriculture economy of Pakistan.



Figure 7 Dead livestock after the 2022 Flood

4.2. Climate and Health

In the aftermath of the 2022 Flood, hundreds of thousands of displaced people lived in makeshift camps next to stagnant water. Outbreaks of diarrheal diseases, skin infections, respiratory tract infections, malaria and dengue were compounding existing health threats, including cholera, typhoid, measles, HIV and polio. Critical health infrastructure such as basic health units have been destroyed by floods limiting the access of flood affected communities to primary health care.

The United Nations International Children’s Fund (UNICEF) representative in Pakistan stated: “The Super Floods of 2022 have impacted 16 million children in Pakistan. 3.4 million girls and boys remain in need of immediate life saving support. The situation is extremely grim in flood affected areas with malnourished children battling diarrhea, dengue fever and several painful skin diseases. Floods have so far claimed the lives of 528 children and each and every one of these deaths was a tragedy which could have been saved. A lot of mothers are anemic and malnourished themselves and have very low weight babies. Mothers are exhausted or ill and they are unable to breast feed. Flooded areas have become infested with diseases including malaria, dengue fever, diarrhea and skin problems.”

Besieged by weak macroeconomic indicators, and as the world’s sixth most populous country, Pakistan is particularly vulnerable to climate-related reversals in development gains. The rate of stunting is around 40 per cent (the highest among regional peers) and there has been resurgence in polio cases. Pakistan slipped down seven places on the Human Development Index 2021-22 and currently ranks 161 out of 192 countries.

The 2021 Report of The Lancet Countdown on Health and Climate Change confirms climate change as the greatest global health threat facing the world this century. Its burden on human health and consequently health systems is increasing rapidly. Ironically, those who have contributed the least to the climate crisis and were already living below the poverty line are bearing the brunt.

The WHO estimates an additional 250,000 annual climate-associated deaths between 2030 and 2050 from preventable causes such as malnutrition, malaria, diarrhoea and heat stress.

4.3. Climate and Food Security

Pakistan mean annual temperature and precipitation have increased across the country. By 2100, the average rise in Pakistan's temperature is expected to be between three degrees Celsius and 5°C higher than the global average (World Bank 2021).

In order to ensure the physical, mental and social well-being of Pakistan's citizens, there is an urgent need to invest in climate-resilient health systems. This includes climate-proofing healthcare facilities and infrastructure in vulnerable areas, increasing awareness about the health risks of climate change, promoting community-based health adaptation, building the capacity of the healthcare workforce to respond to climate-specific health issues and ensuring access to life-saving medicines in climate-related emergencies.

Although a joint inter-ministerial taskforce was set up by the ministries of health and climate change to develop a National Health Adaptation Plan (NHAP), the process stalled due to the Covid-19 pandemic. Authorities should reprioritize the strengthening of essential public health services and emphasize coordination among government agencies.

The Food and Agriculture Organisation (FAO) of the United Nations has warned that acute food insecurity is likely to worsen in parts of Pakistan due to the negative impact of floods and extremely high prices of basic food items, energy and fuel.

International food and agricultural assistance is urgently needed to avoid deterioration of the local food security situation, according to a Special Alert of Global Information and Early Warning System on Food and Agriculture report issued by the FAO (Mushtaq et al. 2022).

The report released recently says about six million people, 30 % of the rural population, were estimated to be facing high levels of acute food insecurity between July and November 2022 in 28 vulnerable districts analyzed in Balochistan, Sindh and Khyber-Pakhtunkhwa provinces as per the food security phase classification analysis carried out prior to floods in the first week of July.

However, acute food insecurity is expected to go up considerably as livelihood of a large number of people has been disrupted and vulnerable households have been forced to deplete their productive assets to secure their basic needs. In addition, early information indicates severe losses of food stocks at household and warehouse levels, including wheat and wheat flour, which provides about 35 per cent of the average per capita energy requirements.

The report says access to food has been worsening as soaring inflation has reduced households' purchasing power, with additional support to prices exerted by market supply disruptions due to blocked roads and damage to infrastructures. Given the extensive damage caused by the floods to road infrastructure, physical access to food in some areas has become very difficult.

Latest official estimates show that the area affected by floods represents about 35 % of the total area where cereal, sugarcane and cotton were sown for the 2022 Kharif season. Severe losses to the Kharif crop of cotton and rice have been reported which, together with sugarcane, are important crops and account for a large portion of the country's export earnings.

4.4. Flood waters inundate 13 districts of Sindh, Balochistan for long time after the flood waters have receded

As the satellite imagery indicates an estimated eight million people still potentially exposed to floodwaters or living close to flooded areas even when the flood is gone. The floodwaters were still present in 11 districts of Sindh and two districts of Balochistan by early 2023.

The UN Office for the Coordination of Humanitarian Assistance's report said floodwaters continued to recede in many flood-affected areas of the country, but standing floodwaters continue to be present in Dadu, Kambar-Shahdada, Khairpur, Mirpurkhas, Jamshoro, Sanghar, Umerkot, Badin, Shaheed Benazirabad and Naushahro Feroze districts in Sindh, and Sohbatpur and Jafferabad districts in Balochistan.

The report says the floods have had a significant impact on health, particularly for children. Poor sanitation and contaminated water resources are adversely affecting the health and wellbeing of children as cases of diarrhea and other waterborne diseases are still prevalent.

Moreover, overcrowded, makeshift shelters, damaged health infrastructure and inadequate water and sanitation have compounded the risk of measles and rubella, along with waterborne skin and respiratory illnesses.

The floods have exacerbated underlying vulnerabilities that existed in flood-affected areas prior to recent flooding. According to WHO, Pakistan is among the top 10 countries in the world with a large pool of unvaccinated or under-vaccinated children and is home to more than 600,000 children who have not received a single vaccine dose.

The recent floods have compounded the problem, further reducing access to routine immunization services, especially in flood-affected districts.

Major immunization service delivery interruptions have been reported in Balochistan and Sindh. A recent need and gaps analysis by partners in the food security sector indicates a persistent and increasing need for emergency food assistance moving into the first quarter of 2023.

The report says a failure to address this need would worsen the already frail food security situation and drive more people into crisis and emergency levels. The food security situation of an estimated additional 1.1 million people is deteriorating and is forecast to fall into the emergency food security phase between January and March 2023.

Evidence from available data indicates that relief response to date has fallen well short of the need, with over 5.1 million people now experiencing class four of five of the Integrated Food Security Phase Classification conditions in flood-affected areas.

According to the Provincial Disaster Management Authority of Sindh, over 240,000 people remained displaced in the province as of December 3, down from 6.5 million in early September. Nearly 90 per cent of flood-displaced people are reportedly with host communities, while the remaining are in tent cities and relief camps.

While receding flood waters have allowed millions of people to return to their homes, there are reports of significant service gaps in areas of return, in addition to extensive impacts to homes, agriculture and livelihood.

According to WHO, cases of malaria, cholera, acute watery diarrheal diseases, and dengue fever have been declining in most of the flood-affected districts by the end of 2022. Overall, malaria cases have reduced to around 50,000 from over 100,000 confirmed cases in early October. Malaria cases have declined by 25% in Balochistan, 58pc in Khyber Pakhtunkhwa and 67% in Sindh.

However, high malaria and cholera cases are still being reported in some districts of Sindh and Balochistan where standing water is the main cause of this problem. In November 2022, around 70 suspected cases of diphtheria were reported from the flood-affected provinces of Khyber Pakhtunkhwa, Sindh and Punjab.

5. Reasons for the enormous impacts of the flooding

The government and disaster management agencies at both the national and provincial level have been severely criticized as Pakistan experiences one of the most devastating floods in recent years.

This year's floods, which have reportedly killed 1,500 people and directly affected over 33 million, are among the worst disasters to have hit the country (see table 7).

From governmental side, the sheer magnitude of the flood hazard has been given as reason for the unprecedented impact of the 2022 flood. Several politicians have pushed forward narratives of 'unprecedented rains', 'act of God' and 'climate change'. However, there are indications that this was done to distract from their and their institution's responsibility to protect citizens from the disaster.

These narratives seem to reinforce an archaic, response-centric approach to disaster management, whereby the government springs into action after a disaster, providing rescue, relief and rehabilitation support. This approach has contributed to the unfolding of a monumental humanitarian crisis and has led to extensive losses to the economy and infrastructure, disproportionately affecting the poor.

This situation raises questions about the role and responsibilities of the government in protecting its citizens against the impact of a disaster and the reasons for the disconnect between its expected role and the status quo.

Until the middle of the 20th century, disaster risk management approaches were based on the 'naturalness' of disasters and narrowly conceptualized as the provision of relief and assistance in their aftermath. Several decades later, the concepts of 'hazard' and 'vulnerability', the two distinct components of disaster risk, allowed for deeper insight into the processes of vulnerability; eg, how unequal access to resources and power contributed to 'who' is impacted.

The disaster risk management cycle approach conceptualized disaster management as sequential steps — from risk assessment, mitigation, and preparedness before a disaster, to response, humanitarian assistance, and reconstruction in its wake. This marked a shift away from the response-centric approach, acknowledging that essential steps undertaken before disasters could reduce the impact. Over the past two decades, however, the link between disaster risk and development has been much better understood. It is based on evidence-based understanding of how disasters result not from natural biophysical phenomena, but conditions of vulnerability unaddressed or perpetuated by the development process.

5.1. A response-centric approach to disaster management is not the answer

Pakistan's approach to dealing with disasters was first formalised under the 1958 National Calamities Act, which made the relief commissioner responsible for relief in calamity-hit areas. The shortcomings were exposed after the 2005 Kashmir earthquake struck.

It became evident that the enormous loss of life could not have been prevented by rescue and relief alone. In the wake of this tragedy, a push was made for better legislation to strengthen the state's role in protecting its citizens against disasters.

The National Disaster Management Act, (NDMA) 2010, stipulated the formation of a National Disaster Management Commission, chaired by the prime minister, with the National Disaster Management Authority (NDMA) as its federal executive arm, along with the Provincial Disaster Management Authorities (PDMA), District Disaster Management Authorities (DDMA), and local authorities at the provincial, district and local levels respectively. These institutions, to be formed at various government tiers, were given the mandate to work in all phases of the disaster risk management cycle, besides influencing cross-sectoral development plans.

More than 12 years later, the institutions set up under the National Disaster Management Act appear to cling to a response-centric approach to disaster management and are confined to the coordination of external humanitarian assistance. A limited number of disaster risk reduction (DRR) initiatives are unable to influence routine national economic, social and infrastructural planning — resulting in the failure to integrate DRR in the development process.

This failure stems from deep-rooted problems. First, there's a lack of political will to shift from a response-focused approach, where political leaders benefit from being seen as saviors championing relief initiatives and handing out rations to the affected. Political will to empower local governments and local level implementation of DRR initiatives is also lacking.

Second is the perceived budgeting conflict between 'development' and DRR; this is the result of the silo mentality of government sectors and fails to fully account for the benefits of DRR in terms of loss prevention. Abundant evidence from South Asia and the Asian countries indicates that DRR measures pay off remarkably well, particularly in countries like Pakistan where human development indices are poor.

Third is the dependence on foreign aid during the disaster relief and reconstruction phase. While the urgency of humanitarian response takes precedence, little is set aside for long-term risk reduction and the integration of 'build back better' in the recovery process. A donor-driven agenda in the recovery and reconstruction phase can also distort priorities, leaving many urgent needs unmet.

Lastly, the legacy of a response-oriented approach, a part of which has been delegated to the military, has shaped societal attitudes. This approach has also contributed to a lack of focus on the technical and institutional capacity development of disaster management departments beyond response and relief coordination.

The current approach is also untenable in the context of climate change. Without DRR, even a rise of 1.5 °C in average global temperatures may require a nearly three-fold increase in global disaster response spending. This increase appears untenable, particularly for developing countries such as Pakistan, making it likely that an increasing number of people will be left without humanitarian assistance.

The social contract between citizens and the state must shift from one of responsibility to minimize human suffering after a disaster to one preventing calamities or minimizing their impacts. This underscores the importance of integrating DRR in sectoral policies and local development plans, based on a thorough understanding of local risks and the socioeconomic and technical capacity of the concerned communities.

5.2. 'Data not showing true extent of flood catastrophe'

There is strong evidence that the number of people in need of help in flood-hit areas is much higher than what has been reported officially.

The rapid needs assessment carried out by the government, the UN and humanitarian partners revealed that many more people have been in need of life-saving support services in the aftermath of the catastrophic floods.

The revised 'Pakistan Floods Response Plan 2022' has been launched in Geneva in early 2023. The assessment, ranging from \$600m to \$800m, will focus on life-saving support for immediate and urgent needs. This was revealed by UN Resident Coordinator in Pakistan, together with representatives from the World Health Organisation (WHO) and Unicef.

"Food is being delivered to the vulnerable families but it is still not enough to meet the nutrition needs of people,". According to the data, the number of damaged and destroyed houses has exceeded 2m as of Sept 23, 2022. More than 5,000 schools are currently being used to host displaced populations, while an estimated 23,900 schools have been damaged, data reveals. More than 2,000 health facilities have been damaged or destroyed, causing a public health emergency. 2.3m people have no access to safe drinking water and almost 3m are using polluted water for drinking. The data collected so far showed that at least 25,993 schools have been damaged or destroyed in the four provinces.

5.3. Initiative to Streamline Disaster Response in the Khyber Pakhtunkhwa Province

The Provincial Disaster Management Authority (PDMA), Khyber Pakhtunkhwa, one of the four provinces has initiated drawing up a contingency plan to streamline response to natural calamities at provincial and district levels.

"The province is preparing a Winter Contingency Plan 2022-23 in consultation with all the stakeholders in order to minimize disaster risks, identify hazards, risks and resource mapping for reducing disaster risks and ensuring timely coordinated response. It will be ready shortly."

The province suffered from torrential rains and heavy floods during the recent monsoon season but the early warning system helped the PDMA, district administrations and other relevant departments evacuate 406,568 people to safe places in different districts ahead of the monsoon disaster, while 69,775 people were rescued. PDMA has started the vulnerability, risk assessment for districts.

The PDMA had developed the Monsoon Contingency Plan, 2022, with the consultation of district administrations. The tools had been shared with all stakeholders for collecting information regarding district- and sector-wise specific hazards and vulnerability profile, hazard impact, damages, compensation paid, resource mapping, need assessment, and coordination.

"Under the contingency plan, the [PDMA] will make efforts to minimize the losses likely to be caused by natural disasters, including extreme low temperature, fog and smog, snowfall, rains, landslides, flash floods, and seismic activity along the mountainous northern and western regions,".

The PDMA would categorize the district wise vulnerability and risk assessment into very high, medium and low categories.

The peculiar geography, terrain and natural resources make the province prone to a number of climate contingencies during both summers and winters. Some regions of Khyber Pakhtunkhwa such as Malakand and Hazara divisions, by virtue of their high altitudes, are exposed to weather extremes in the winter season spreading around four months from December to March. The low temperature, fog and smog, snowfall, rains, landslides, avalanches and the consequent blockade of roads and pathways resulting in inaccessibility of the areas are some of the common features.

The PDMA has initiated the process of introducing proactive preparedness regime under guidelines by the National Disaster Management Authority for streamlining response to natural calamities at provincial and district levels in coordination with all the stakeholders. The process of contingency planning for major hazards will enable initiation of requisite mitigation measures and to undertake a coordinated response to minimize the loss of life and property in the events of disasters. It is anticipated that other provincial authorities would also initiate planning for Disaster Risk Reduction as essential part of their development agenda.

6. Lessons learned and suggestions to improve flood resilience in Pakistan

- I. Floods and poverty are linked in a self-amplifying cycle that can be halted by strategically shifting from a crisis management approach to a more comprehensive approach of integrated flood management that aims at a flood risk management encompassing preventive and mitigative measures appropriately with the preparedness response activities.
- II. Traditional approach to flood management has been reactive, relying largely on crisis management. This approach has been ineffective because response is untimely, poorly coordinated and poorly targeted to flood stricken groups or areas.
- III. With the exponential population growth, haphazard development of both urban and rural areas, interfering with natural drainage system added to the severity of flooding. This aspect requires a serious development planning to preserve the natural draining contours. Additional drainage network where required, should be made part of development initiatives.
- IV. Earlier identification of country risks and vulnerabilities is essential in crisis response preparedness and management. A detailed mapping and identification of risks for three recent major disasters of earthquake of 2005, floods of 2010 and super floods of 2022 needs to be carried out urgently in preparation of disaster risk reduction planning. Lessons learnt must form basis of development plan.
- V. The important aspect of land use in reducing flooding must be made part of mitigatory measures ensuring natural drainage network is not encroached upon. The deserts of Punjab, Sindh and Balochistan provinces provide vast areas where flood waters can be diverted to provide development opportunities to the impoverished desert communities.
- VI. Flood hazard area maps should be prepared for existing population centers and all future development plans be made available to line departments and general public.
- VII. With the involvement of the community, effective evacuation plan should be prepared. Evacuation drill prior to impending floods should be made part of DRR plan.
- VIII. Important Infrastructure including hospitals, education institutions, public health centers and general public centers should be located out of flood hazard areas.

- IX. WASH needs to be placed at the highest priority and proper provision be made to included in DRR initiatives along with food, fodder and clean drinking water. In reviewing the three major disasters it has become quite clear that the government is required to be more innovative and aggressive to pursue investment on clean water and sanitation.
- X. The country has been divided into four geographic zones. The risk and vulnerabilities in each zone has been identified which differ from one another. The government needs to look into this seriously prior to undertaking structural and non-structural DRR measures.
- XI. Large number of casualties in the rural areas of Pakistan took place due to falling walls and roofs of village houses mostly constructed of mud and stone. Government needs to take a leading role in properly rebuilding the houses under strict regulations to withstand torrential rains and flooding.
- XII. In view of large damages to infrastructure, loss of precious lives including children, livestock and a big blow to country's economy, the policy makers need to adopt disaster risk reduction (DRR) as a high level priority in their development agenda. Policy makers must understand that under climate change, the country is going to face more frequent violent hydrological events.

Annex-I

References:

- Engineering Implications of Impoundment of the Indus River by an Earthquake-induced Landslide presented at ASCE Spring Convention Seattle April 1986 by James A. Code, Chief GeoTechnical Engineer Monenco Consultants Limited, Montreal, Quebec, Canada and Sadiq Sirhindi, Deputy Director Geology Water and Power Development Authority Lahore, Pakistan)
- The World Bank Group and the Asian Development Bank, 2010: Pakistan floods 2010 : preliminary damage and needs assessment project (English). Washington, D.C, US.
<https://documents.worldbank.org/en/publication/documents-reports/documentdetail/676321468057882381/pakistan-floods-2010-preliminary-damage-and-needs-assessment-project>
- The World Bank Group and the Asian Development Bank, 2021: Climate Risk Country Profile: Pakistan. Washington, D.C, US.
https://climateknowledgeportal.worldbank.org/sites/default/files/2021-05/15078-WB_Pakistan%20Country%20Profile-WEB.pdf
- Mushtaq, F., Ali, M., Ghosh, A., Jalal, R., Asghar, A., Dadhich, G., Chiozza, F., Franceschini, G., Muchoney, D., Toirov, F., Rolle, F. and Henry, M. 2022. A rapid geospatial flood impact assessment in Pakistan, 2022. Rome, FAO. <https://doi.org/10.4060/cc2873en>
- Data derived from:
 - Pakistan Meteorological Department (PMD) (<https://www.pmd.gov.pk/en/>)
 - National Disaster Management Authority (NDMA) (<https://cms.ndma.gov.pk/>)
 - Planning Commission of Pakistan (PCP) (<https://www.pc.gov.pk/>)
 - Office of Federal Flood Commission of Pakistan (<https://ffc.gov.pk/>)
 - Indus River System Authority (IRSA) (<https://pakirsa.gov.pk/>)
 - Climate Data Processing Centre of the Pakistan Meteorological Department (2023) <http://www.pmd.gov.pk/cdpc/home.htm>. Last accesses June 2023.

Annex-II

Selective Photograph of Flood Damages



Destroyed Village



Submerged Town



Main Bridge in the process of Collapse



Self Help Recovery of Households



Cotton Crop Severely Damaged



Moving Away from Flood Areas



Family to be Rescued



Children Being Rescued



Self Help Evacuation



Result of Water way Encroachment



High Velocity flows Northern areas flows. 60 Bed 4 Star Hotel constructed within water way being washed away



Railway Line Submerged and Damaged



Damaged Railway Line – Embankment Washed away under the Railway Track

3

Overview of Major Water-Related Disaster in Japan in 2023 and Contribution of the Japanese Government to the UN 2023 Water Conference

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Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan

1.1 Overview of water-related disaster in Japan and contribution to the formulation of world opinion

The increase in the occurrence of torrential rains and larger typhoons has caused frequent flood damage recently in Japan. The effects of global warming are becoming obvious, and water-related disasters are expected to become severer and more frequent in the future due to climate change.

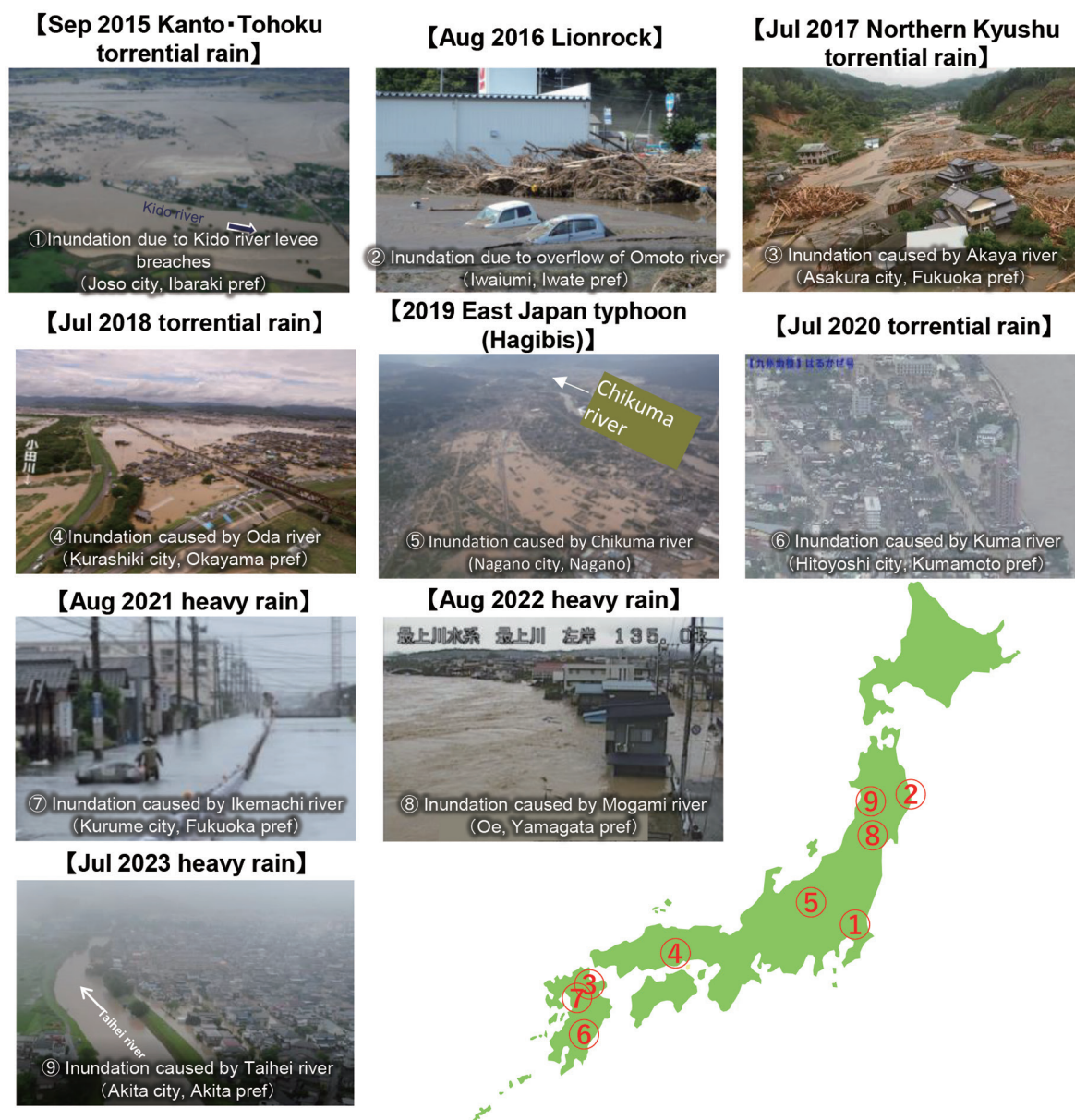


Fig.1 Successive water-related disasters hitting Japan

Disasters struck the Kanto-Tohoku region in 2015, the Hokkaido-Tohoku region in 2016, Northern Kyushu region in 2017, a widespread area in Western Japan in 2018, Northern Kyushu region and a widespread area in Eastern Japan in 2019, Kumamoto Prefecture in Kyusyu region in 2020, Northern Kyushu region in 2021, Tohoku region in 2022 and 2023.

This chapter describes the overview of the flood disaster by torrential rain in 2023, and the contribution of the Japanese Government to the UN 2023Water Conference based on the historical experiences in Japan.

1.2 Overview of Heavy Rain Events in 2023

1.2.1 Heavy rainfall due to Typhoon MAWAR and associated frontal activation in 2023 (as of 19 June 2023)

From May 31 to June 3 in 2023, Typhoon MAWAR and the accompanying active rainy front brought heavy rainfall mainly to the Pacific Ocean side of western and eastern Japan, causing a linear precipitation zone in 6 prefectures (Kochi, Wakayama, Nara, Mie, Aichi and Shizuoka). 23 rainfall stations recorded the highest 24-hour rainfall in observation history.

Inundation damage by a total of 44 rivers, including 3 rivers in 3 river systems administered by the national government and 41 rivers in 27 river systems administered by prefectures, as well as by inland floodings. Flood control operation was carried out at 158 dams (including 55 dams with pre-discharge).

308 landslides occurred throughout Japan especially damaged at Wakayama prefecture and Shizuoka prefecture.

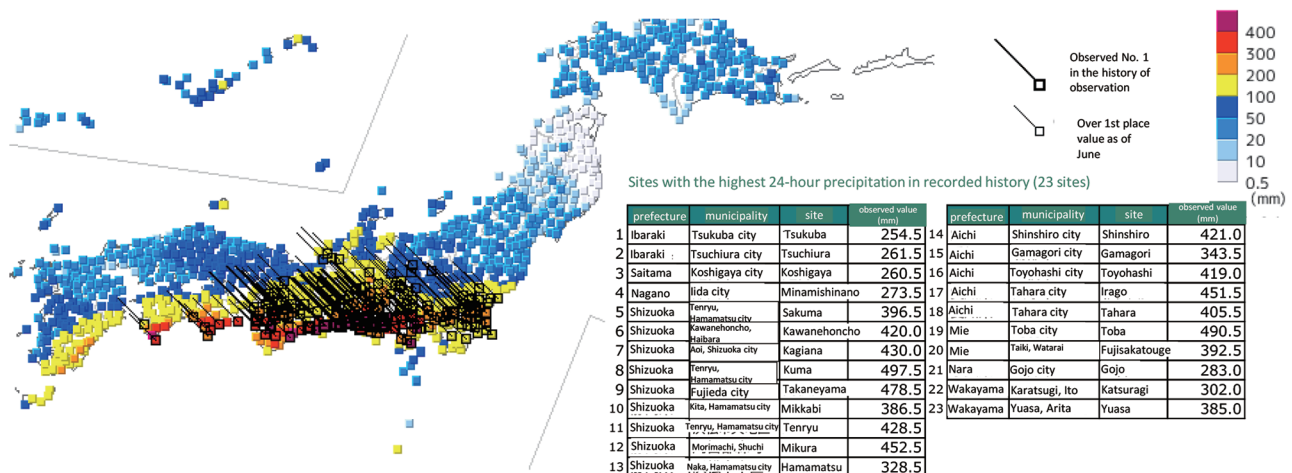


Fig.2 Maximum 24-hour rainfall for the period (Period: June 1, 2023 - June 3, 2023)



Fig.3 Photos of damage by Typhoon MAWAR

1.2.2 Heavy rains from June 29, 2023 (as of 28 July 2023)

Active activity of the rainy season front and cold air in the sky caused heavy rainfall from June 28, and a linear precipitation zone occurred in 9 prefectures (Yamaguchi, Kagoshima (Amami area), Kumamoto, Shimane, Fukuoka, Saga, Oita, Ishikawa, Toyama) from July 1 to 13 (16 announcements of occurrence of linear precipitation zone). the rainfall was comparable to the torrential rains that have caused extensive damage in the Kyushu region in the past.

A total of 118 rivers flooded, including 9 rivers in 6 river systems administered by the national government and 112 rivers in 38 river systems administered by prefectural governments. 321 landslides occurred in various locations.

Flood control operation was implemented at 164 dams (including 22 dams with pre-discharge), of which 2 dams were shifted to emergency flood control operations (emergency discharge) when the dams approached full capacity due to prolonged heavy rainfall (no damage or reduced damage).

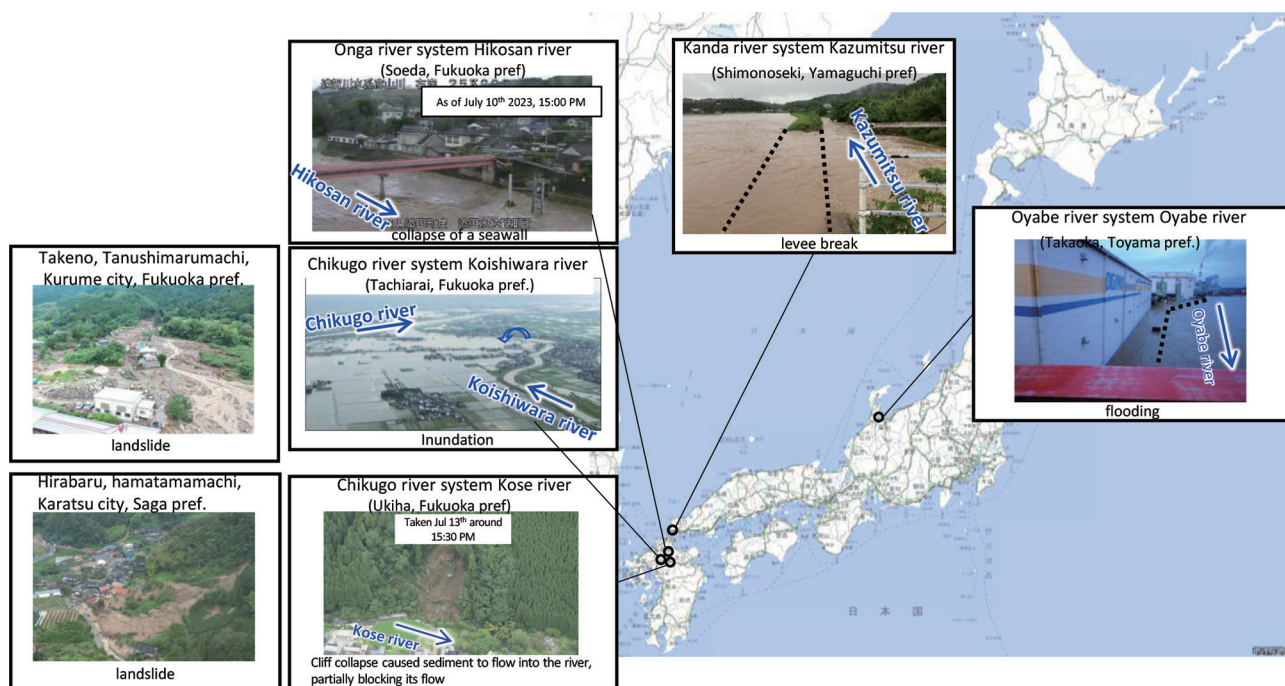


Fig.4 Damage caused by heavy rains from June 29, 2023

1.2.3 Torrential rains from July 15, 2023 (as of 2 August 2023)

An active seasonal rain front caused record-breaking heavy rainfall mainly in Akita Pref, comparable to the heavy rainfall in July 2017, which in the past caused extensive damage in the Yubutsu River basin from July 14 to 16.

16 rivers in 6 river systems administered by Akita Prefecture overflowed, and 2 rivers in 2 river systems administered by the national government were flooded in areas without levees, including widespread flooding around Akita Station due to overflowing of the Taihei-gawa River in the Yubutsu River system. 8 landslides occurred in Akita and Niigata prefectures.

Flood control operation was implemented at 22 dams (including 2 dams with pre-flood discharge), of which 3 dams shifted to emergency flood control operations (emergency discharge) as the dams approached full capacity due to prolonged heavy rainfall (no damage or reduced damage).

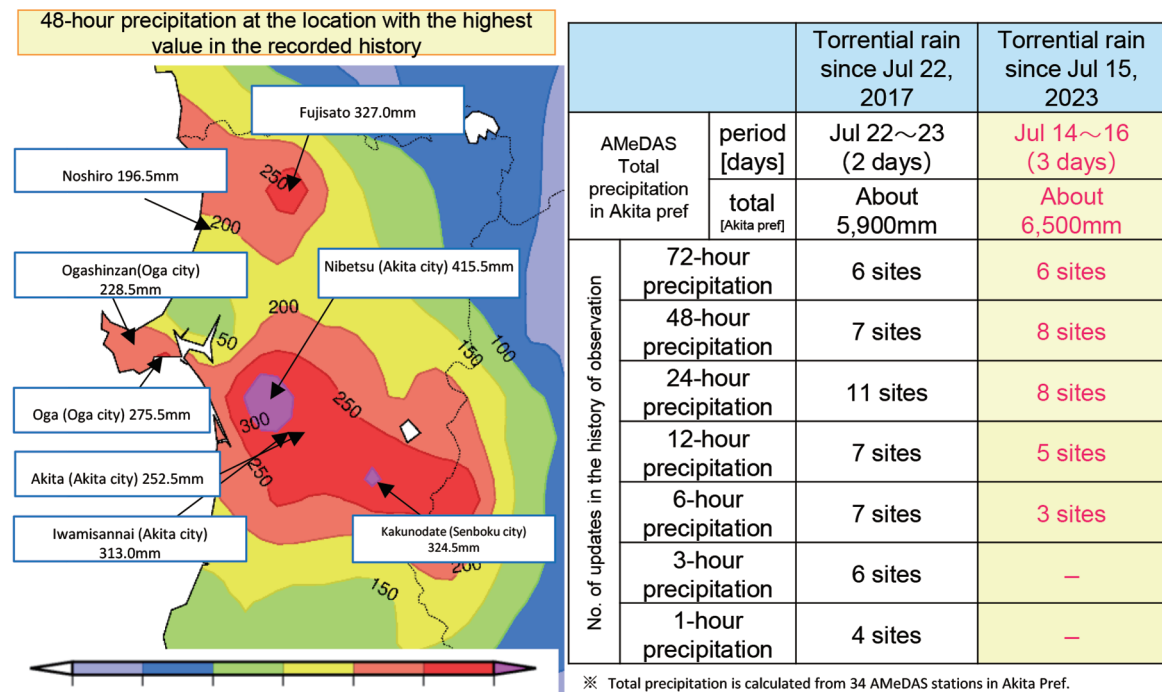


Fig.5 Comparison of recent heavy rains in Akita Prefecture with those since July 15, 2023

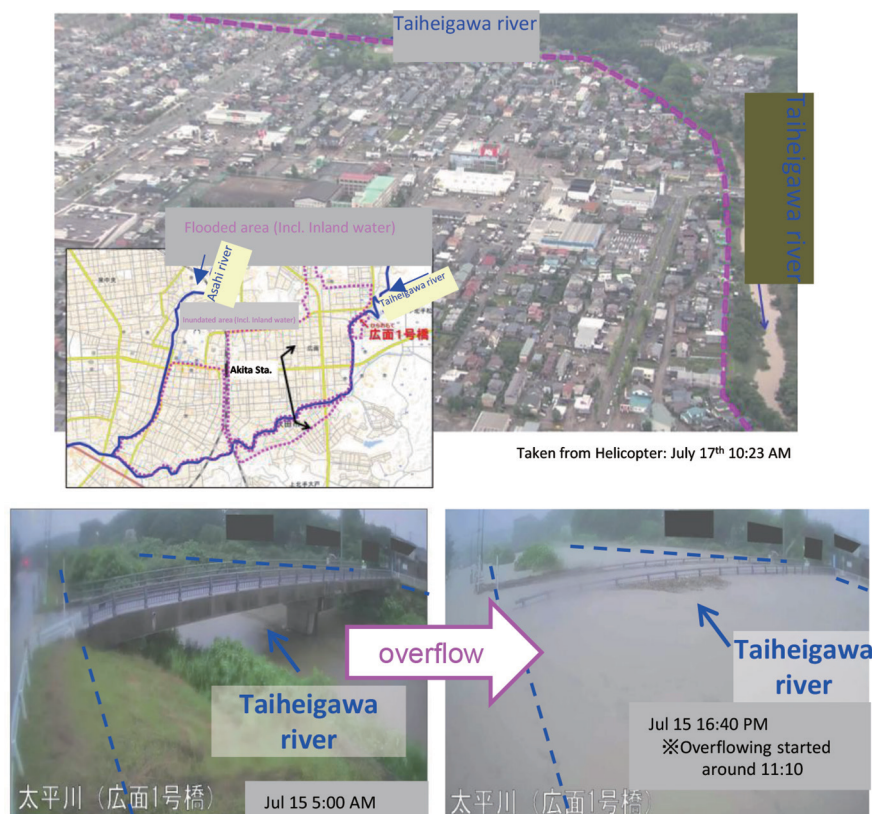


Fig.6 Inundation around Akita station (Taiheigawa River, Yubutsu River system)

1.3 Contribution of the Japanese Government to the UN 2023 Water Conference

1.3.1 Introduction

The United Nations 2023 Water Conference, held at the United Nations Headquarters from March 22 to 24, 2023, was attended by more than 6,700 people, including 20 leaders and 120 ministers from approximately 200 countries, regions and organizations. It was an international conference that marked a major turning point in the world's water sector.

Japan has unique natural and social conditions such as a large population and assets concentrated on alluvial plains, and frequent torrential rains caused by typhoons. The water-related disaster countermeasures that Japan has taken for many years and its achievement have been highly evaluated in the international community. For this reason, the United Nations, which is the organizer of the UN 2023 Water Conference, and the governments of the Netherlands and Tajikistan, which are co-chairs, requested a special contribution from Japan to the UN 2023 Water Conference.

Japan made many contributions to the UN 2023 Water Conference. In this report, contributions by the Japanese government to the UN 2023 Water Conference, especially the statement at the Plenary Meeting and the Interactive Dialogue 3 (ID3) "Water for Climate, Resilience and Environment" are reported.

1.3.2 Overall program of the UN 2023 Water Conference

The main programs of the United Nations Water Conference are shown in Table 1.

The "Plenary Meetings," in which representatives of the countries, regions, and organizations participating in the conference gave speeches, and the "Interactive Dialogue," in which discussions were focused on five individual themes related to water, were held in parallel. In addition, many side events and special events were held in and around the United Nations Headquarters building.

H.E. Yoko Kamikawa, a member of the House of Representatives, participated in the UN 2023 Water Conference as a special envoy of the Prime Minister of Japan.

Table.1 Overall program of the United Nations Water Council

March 22nd	Morning	Opening Ceremony, Plenary Meeting 1, Interactive Dialogue 1
	Afternoon	Plenary Meeting 2, Interactive Dialogue 2
March 23rd	Morning	Plenary Meeting 3, <u>Interactive Dialogue 3</u>
	Afternoon	<u>Plenary Meeting 4</u> , Interactive Dialogue 4
March 24th	Morning	Plenary Meeting 5, Interactive Dialogue 5
	afternoon	<u>Plenary Meeting 6</u> , Closing session

Note: **Bold underline** were presented by representatives of the Japanese government

1.3.3 Plenary Meetings

At the plenary meeting held at the United Nations General Assembly Hall, representatives of countries, regions, and organizations stated their own efforts to address various water problems in their respective countries and the world, as well as their commitments to the world.

From Japan, H.E. Ms. Yoko Kamikawa took the podium at Plenary Meeting 4 held on the afternoon of March 23, and introduced the “Kumamoto Initiative of Water “ announced by the Japanese government at the 4th Asia-Pacific Water Summit in April 2022. While reconfirming the importance of this, she also introduced Japan’s efforts to “River Basin Disaster Resilience and Sustainability by All” and restoring and keeping a sound water cycle.



Photo.1 Speech by H.E. Ms. Yoko Kamikawa at the Plenary Meeting

1.3.4 Interactive Dialogues

Since water issues need to cover a wide range of themes, five Interactive Dialogues were set as important themes, and two co-chair countries were selected for each dialogue. Co-chairs were selected from developed and developing countries respectively.

The five Interactive Dialogues and their respective co-chairs are shown below.

(1) Water for Health (Co-Chairs: United Kingdom & Dominican Republic)

Discussed how to deal with issues such as access to safe drinking water, outdoor defecation, and hygienic hand washing.

(2) Water for Sustainable Development (Co-chair: EU & China)

Discussed the role of water management for economic activities such as agriculture and urban development.

(3) Water for Climate, Resilience and Environment (Co-Chairs: Japan & Egypt)

Discussed how to respond to the increase in water-related disasters and the loss of aquatic ecosystems due to climate change.

(4) Water for Cooperation (Co-Chairs: Switzerland & Senegal)

Discussed water resources management in transboundary rivers (rivers that flow through multiple countries and regions).

(5) Water Action Decade (Co-Chairs: USA & Singapore)

In order to accelerate efforts to achieve the SDGs related to water, we discussed the follow-up of each goal of the “Decade for International Action on Water” established by the United Nations in 2018.

1.3.5 Outline of Interactive Dialogue 3 (ID3)

The outline of the ID3 is as follows;

- Co-chairs
 - H.E. Ms. Yoko Kamikawa, Special Envoy of the Prime Minister of Japan
 - H.E. Mr. Hani Sewilam, Minister for Water Resources and Irrigation of Egypt
- Panelists
 - H.E. Mr. Janos Áder, former President of Hungary
 - H.E. Mr. Senzo Mchun, Minister for Water and Sanitation of South Africa
 - H.E. Mrs. Mariam Almheiri, Minister for Climate Change and Environment of the United Arab Emirates
 - H.E. Mr. Christophe Béchu, Minister for Ecological Transition and Territorial Cohesion of France
 - Ms. Mami Mizutori, Head of the UN Office for Disaster Risk Reduction (UNDRR)
 - Mr. Bruno Oberle, Director-General of the International Union for Conservation of Nature (IUCN)
 - Mr. Petteri Taalas, Secretary-General of the International Meteorological Organization (WMO)
 - Ms. Leticia Tituana, youth representative from Future Rising Fellows
- Moderator
 - Mr. David Cooper, Acting Executive Secretary of the Secretariat of the Convention on Biological Diversity (CBD)

The discussion for three hours was divided into three sub-themes: 1) Changing Climate: Water scarcity, droughts, and the melting cryosphere, 2) Resilience to water disasters: decreasing risk and conserving biodiversity, and 3) Working for the future: Early warning from source to sea. After the co-chairs, panelists, and moderators gave their opinions for about five minutes respectively, 30 people from the floor (representatives of each country, international organizations, etc.) who participated in the discussion gave their opinions.

The various opinions expressed during the ID3 were compiled by the co-chair's Japan and Egypt and submitted to the United Nations Secretariat as the Co-Chair's Key Messages.



Photo.2 Discussion in the Interactive Dialogue 3



Photo.3 Co-chair H.E. Ms. Yoko Kamikawa (Japan)

1.3.6 Co-Chair's Key Messages

In the field of ID3 “Water for Climate, Resilience, and Environment”, the items that should be prioritized in the future are summarized in 4 pages of A4 size as the Co-Chair's Key Messages.

The summary of the messages by the author of this chapter are as follows;

- Water is interconnected with food, energy and ecosystems, and addressing water issues will help solve these social problems.
- In order to reduce the risk of water-related disasters, it is necessary to coordinate and cooperate with various stakeholders. It is also important to build a national mechanism (legislation, etc.) for this purpose.
- It should be focused on measures that contribute to both climate change adaptation and mitigation.
- Promote investment in infrastructure with the trust of financial markets. By enhancing the capacity of existing infrastructure, it is possible to obtain a large effect with a small investment.

- It is important to combine resilience and biodiversity conservation and take measures as a whole.
- Enhance awareness, integrated preparedness, and timely information-sharing by both government and citizens.
- In order to build resilience, it is essential to mainstream integrated policy frameworks that combine integrated water resources management (IWRM) with other holistic water-related approaches that link the interconnected ecosystems of the hydrological cycle with the associated socioeconomic processes (source to sea, inclusive transboundary governance, integrated coastal zone management, and disaster-risk management).
- Decision-making on disaster prevention should be based on science and technology.
- Adopting an “Inter-COP” to connect, integrate, and fully implement water-related decisions made at the global assemblies, conventions, and frameworks.
- Utilize “Kumamoto Initiative of Water”, etc. in order to facilitate finance allocation and cost-effective implementation.
- A Global Water Information System be among the top priorities of water-related climate action.
- In order to achieve resilience, it is necessary to finally solve problems in the field. To that end, the co-chairs proposed an “action workflow,” linking the process for problem-solving on the ground with contributions proposed by each country.

A supplementary explanation about the “Action Workflow” proposed at ID3 is as follows;

Discussions at the United Nations are basically held among diplomats, and tend to emphasize political, diplomatic, and conceptual aspects rather than practical aspects. In addition, countries and international organizations often disseminate information with an eye toward supporting their own efforts and securing future funding. The report may focus solely on individual activities, such as collecting and managing data, securing a budget, or collaborating with stakeholders, and simply enumerates those activities.

However, in the field of water, especially in the field of water-related disaster risk reduction, such conceptual discussions do not solve the problem. For example, the acquisition and management of data is meaningless unless the risk assessment and its assessment method are clarified. Efforts such as demonstrating the effects of the project in an easy-to-understand manner through risk assessment, etc., will be necessary to ensure this. Then, after going through those procedures, the issues will be solved only after the project is completed on site.

With the awareness of such issues, the co-chairs proposed the action workflow shown in Fig. 7. By sorting out the various individual initiatives expressed by the participants in the ID3 as part of an action workflow that will help their implementation, the discussion will ultimately lead to the implementation of countermeasures on the ground.

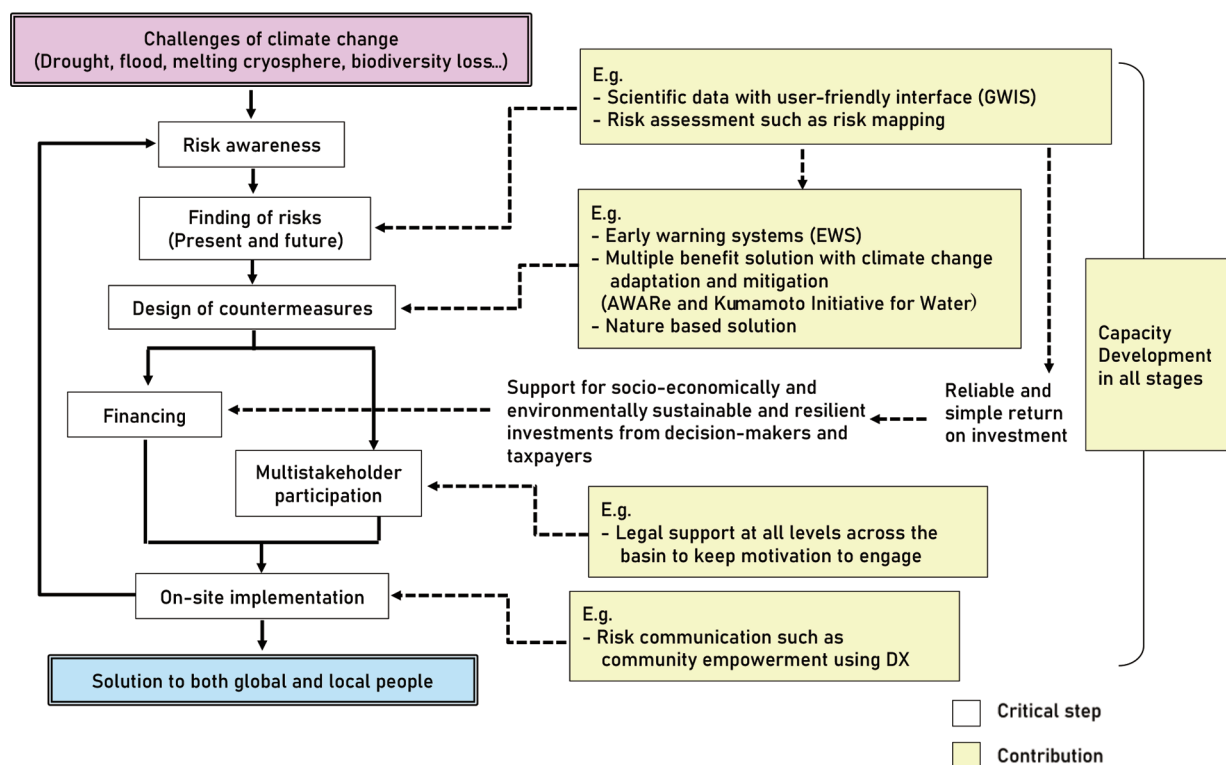


Fig.7 'Action Workflow' proposed in the ID3

1.3.7 Conclusions

Many countries with different climatic, natural, and social conditions participated in the UN 2023 Water Conference, and each country faced a wide variety of problems.

However, all countries seemed to have great concerns about the impact that future changes in temperature and rainfall due to climate change would have on their own water environment. Also, even if they wanted to deal with that anxiety, most of the countries did not know how to plan for an uncertain future and how to secure funds for countermeasures, or were in the process of trial and error.

Japan is in the midst of a similar trial and error, and we have once again recognized the importance of disseminating Japan's efforts to the world and learning about the world's efforts.

4

The 2022 Hurricane Hat Trick for U.S. Army Corps of Engineers-Jacksonville, Florida District

Ms. Michelle Roberts, Mr. Edwin Baltzley, and Ms. Savannah Lacy

Ms. Michelle L. Roberts is the USACE Jacksonville (Florida) District Corporate Communications Chief

Mr. Edwin Baltzley is the USACE Jacksonville District Natural Disaster Program Manager

Ms. Savannah Lacy is the USACE Jacksonville District Operations Unit Chief for the Water Management Division

Summary

U.S. Army Corps of Engineers (USACE) has an important role in the unified Federal interagency response to natural disasters and emergencies such as hurricanes. Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), USACE and other agencies work under the direction of the Federal Emergency Management Agency (FEMA), with USACE as the primary agency for FEMA's Emergency Support Function #3, Public Works and Engineering. USACE can also act under its own authorities in Public Law 84-99 (Flood Control and Coastal Emergencies) to provide emergency technical and direct assistance to state and local governments before, during and after flood events and coastal storms.

The 2022 hurricane season brought three hurricanes—Fiona, Ian and Nicole—into USACE Jacksonville (Florida) District's area of operations over a two-month period – one in southwest Puerto Rico and two in Florida, one hitting the southwest coast and one hitting the northeast coast of the state. In responding to natural disasters, USACE relies not only on the affected district for its response, but other districts as well. USACE leverages a combination of individuals, teams, units, and remote on-call personnel to ensure it provides the right subject matter expertise and assistance for the situation. This whole-of-USACE approach allows for an immediate response with the right resources. Relationships Jacksonville District built during its everyday work allowed for critical coordination with local stakeholders before, during and after the hurricanes to provide a smooth response effort.

Introduction

The southeastern United States, like many of the world's tropical to subtropical regions, experiences cyclones or hurricanes. On May 24, 2022, the National Oceanic and Atmospheric Administration (NOAA) predicted a 65% chance of above-average hurricane activity for the 2022 Hurricane Season, considered to be June 1 to November 30 (Figure 1). They based their prediction on several factors, including ongoing La Niña conditions, above-average surface temperatures in the Atlantic Ocean and Caribbean Sea, weaker Atlantic trade winds, and stronger African Easterly Waves from an enhanced west African monsoon.¹

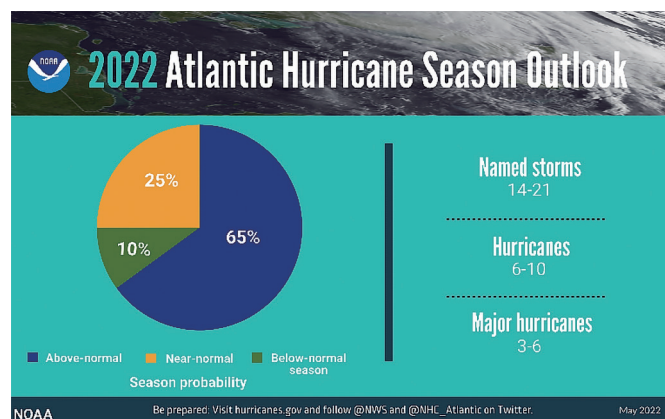


Figure 1. A summary infographic showing hurricane season probability and numbers of named storms predicted from the National Oceanic and Atmospheric Administration (NOAA) for the 2022 Atlantic Hurricane Season Outlook. Source: <https://www.noaa.gov/news-release/noaa-predicts-above-normal-2022-atlantic-hurricane-season>.

¹ <https://www.noaa.gov/news-release/noaa-predicts-above-normal-2022-atlantic-hurricane-season>

Predictions do not always match reality though. The 2022 hurricane season started rather quietly, but it ended with a vengeance (Figure 2). It was the first season since 2014 not to have a pre-season named storm. It was also the first season since 1997, and first on record during a La Niña year, in which no tropical cyclones formed in August. Despite the quiet start and average number of named storms, it became the third costliest hurricane season on record, mostly due to Hurricane Ian.²

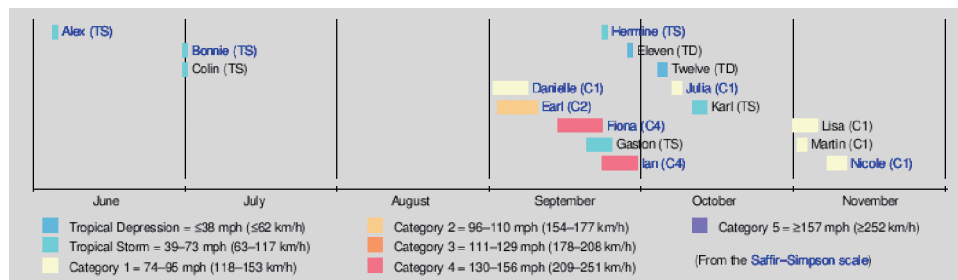


Figure 2. Summary of the 2022 hurricane season activity by month and storm strength. Source: https://en.wikipedia.org/wiki/2022_Atlantic_hurricane_season.

U.S. Army Corps of Engineers (USACE) is always prepared to respond to natural and man-made disasters as part of the federal government's unified national response to disasters and emergencies. Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), USACE and other agencies work under the direction of the Federal Emergency Management Agency (FEMA), the agency responsible for coordinating the federal interagency response, with USACE as the primary agency for FEMA's Emergency Support Function #3, Public Works and Engineering. USACE can also act under its own authorities in Public Law 84-99 (Flood Control and Coastal Emergencies) to provide emergency technical and direct assistance to state and local governments before, during and after flood events and coastal storms.

² https://en.wikipedia.org/wiki/2022_Atlantic_hurricane_season

In any given hurricane season, the storms typically are spread out over the six-month timeframe and hit different locations. In 2022, USACE's Jacksonville (Florida) District had a hurricane "hat trick", dealing with three hurricanes in its area of responsibility within two months – Hurricane Fiona, Hurricane Ian, and Hurricane Nicole. Two of these were the strongest storms of the season, occurring within a week of each other, and the third went right over Jacksonville District's headquarters. Responding to these storms required leveraging assets across many USACE districts, and the Biden Administration expressed it was an example of extraordinary cooperation at every level of government that began before the storm hit.

Hurricane Fiona

The National Hurricane Center (NHC) began monitoring a tropical wave out of West Africa on September 12, 2022. In anticipation of potential impacts to Puerto Rico and the U.S. Virgin Islands (USVI), the Federal Emergency Management Agency (FEMA) activated the responsible region for Emergency Support Function (ESF) #3, Public Works and Engineering, on September 13, 2022. FEMA issued two Mission Assignments to USACE – a Regional Activation mission for Jacksonville District, which allowed for activation of the Emergency Operations Center (EOC) and prepositioning personnel, and a Temporary Power mission assigned to Pittsburgh (Pennsylvania) District. Jacksonville District activated its Emergency Operations Center (EOC) to support USACE personnel deploying for this mission - a civilian-led Temporary Emergency Power Planning and Response Team, soldiers from an Engineer Battalion specialized in power generation, team leaders and assistant team leaders, as well as subject matter experts in logistics, temporary power, infrastructure assessment and debris.

On September 14, 2022, as the storm was developing into a tropical depression, a Power Restoration Team (PRT) from Walla Walla (Washington State) District began travel to Puerto Rico and a PRT from Savannah (Georgia) began travel to USVI to preposition personnel in both locations ahead of potential landfall. The depression organized into a tropical storm with sustained winds of 80 km/hr on September 15, 2022, and was assigned the name Fiona, becoming the sixth named storm of the season. Advance party ESF3 personnel arrived at their locations and were staged to prepare for the impending storm - a team of 17 personnel in Puerto Rico, 13 personnel on St. Croix, and 5 personnel on St. Thomas.

The next day, PRT members conducted assessments of critical facilities, 20 on USVI and one on Puerto Rico, as directed by FEMA. One of the assessments was at the University Hospital in San Juan, PR (Figure 3). This assessment led FEMA to lease a generator to the hospital to mitigate risk of potential power disruption. The hospital was responsible for contracting the movement, installation, and maintenance of the generator. Assessments continued as long as it was safe to do so, while leadership planned out sheltering operations for all USACE personnel as the storm approached.



Figure 3. USACE Power teams assess generators at various locations in Puerto Rico. (Luis A. Deya - Antilles Area Office, USACE Jacksonville District)

After entering the eastern Caribbean, Fiona began to gain strength. Rainfall forecasts for Puerto Rico projected 30 to 45 cm, with potential local maximums of 75 cm in locations. Based on storm forecasting, FEMA directed USACE to increase its temporary power capability to be able to conduct more installations per day on September 17, 2022. The increase would allow for at least 10 generator installations per day, and additional Walla Walla PRT team members scheduled flights to pre-stage in Atlanta and cut down the time needed to arrive on-island as soon as flights resumed. President Biden approved an Emergency Declaration for emergency protective measures.

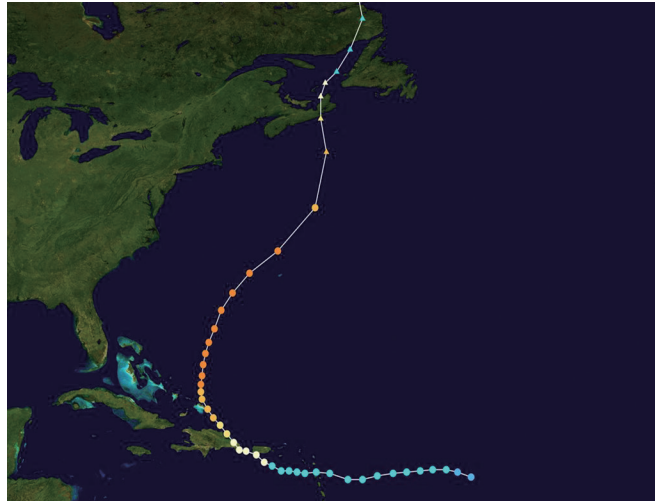


Figure 4. A NOAA graphic displays Hurricane Fiona’s path through Puerto Rico and north in the Atlantic Ocean (Source: <https://twitter.com/noaa>)

Hurricane Fiona continued to strengthen as it approached Puerto Rico, making landfall as a Category 1 hurricane with maximum sustained winds of 137 km/hr on September 18, 2022, at 3:20 PM local time, along the southwestern coast (Figure 4).³ It was two days before the five-year anniversary of Hurricane Maria, and many residents re-lived the memories of that catastrophic storm as the entire island lost power about an hour before landfall. Winds from the storm affected the entire island, knocking down power lines and tearing roofs off houses, as the storm brought torrential rainfall that flooded rivers, stripped roads of pavement, caused landslides, and washed away bridges (Figure 5).



Figure 5. Photos show the destruction in Puerto Rico from Hurricane Fiona (Luis A. Deya - Antilles Area Office, USACE Jacksonville District)

³ Pasch, Richard (September 18, 2022). *Hurricane Fiona Update Statement (Report)*. Miami, Florida: National Hurricane Center. Retrieved March 3, 2023

The National Weather Service registered wind gusts as high as 182 km/hr and multiple locations with more than 50 cm of rain. The highest rain measurement came from a gauge near Ponce, on the southern coast, that measured 80 cm of rain.⁴ Based on storm effects, FEMA requested that USACE deploy another power team to increase the capability for up to 20 installations per day. Based on a lack of need in USVI, the decision was made to move the Savannah PRT from its USVI locations to fill the requirement for a second PRT in Puerto Rico.

As the storm passed and it became safe to do so, USACE began doing initial assessments in Puerto Rico on September 19, 2022. Col. James Booth, Jacksonville District commander, arrived on island with FEMA personnel to coordinate with key territory leadership and oversee the district's response operations. Hydrologic assessments allowed the San Juan Port to open for daylight operations. Under the Stafford Act, Jacksonville District received its authorities to provide temporary emergency power to public facilities under the direction of FEMA. Due to the massive flooding and damages to the flood risk management systems on the island, Jacksonville District, under its Public Law 84-99 flood fighting authorities, prepared an additional 10 dam/levee engineers to deploy as soon as the airport opened to augment the two personnel in the Antilles Office and stand up an Interagency Flood Fight Taskforce for conducting assessments and providing technical support to local agencies. As Hurricane Fiona made landfall in the Dominican Republic and then moved back over the Atlantic Ocean to begin intensifying again, the NHC started tracking another tropical wave from Western Africa with a projected possible strike on Florida the next week.

⁴ Masters, Jeff (September 19, 2022). *"Puerto Rico crippled by flash flooding and power failures as Fiona heads toward Bermuda"*. Yale Climate Connections. Retrieved March 4, 2023.

Levee and Dam Inspection teams conducted their first inspections on September 20, 2022; over four days, the teams inspected 38 dams and levees and found no issues. In south-central Puerto Rico, the dams at Cerrillos, Portugués and Guajataca were all performing as expected (Figure 6). In the north-central part of the island, the Barceloneta levee sustained the currents of the Manati River during the storm's heavy rains—protecting the municipality of Barceloneta, mitigating the risk of flooding in the adjacent communities, and preventing millions of dollars in damage. And in the southwest, earlier dredging by USACE of a creek at the town of San German redirected floodwaters, as planned, to prevent flooding and damages.



Figure 6. The Portuguese and Cerrillos Dams were able to hold approximately 20 million cubic meters of water combined during Hurricane Fiona. This volume of water would have flooded almost the entire urban area downstream of the dams. Rough preliminary estimates for the prevention of flood damages from both dams and associated channels are over \$100 million. More importantly, thousands of priceless lives were saved, (Brigida Sanchez - USACE Jacksonville District)

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Hurricane Ian

In response to Hurricane Fiona, the power teams began conducting daily power assessments throughout Puerto Rico to determine generator needs. They installed the first generator at the Diagnostic Treatment Center of Guanica on September 21, 2022, and by the time Tropical Storm Ian was named on September 24, 2022, the power teams had conducted 20 power assessments and installed nine generators. That same date, the remnants of Hurricane Fiona, which had been moving North in the Atlantic Ocean and continued to strengthen, slammed into eastern Nova Scotia as a category 4 hurricane and Canada's all-time strongest storm as measured by pressure.

USACE named Louisville District commander Col. Eric Crispino to backfill Col. Booth in Puerto Rico overseeing emergency response and recovery efforts. Under his watch, the power teams went on to process a total of 266 power assessment requests and install a total of 71 generators. Response and recovery operations had reached a steady rhythm, and attention began to turn to the new threat. Ian was rapidly intensifying daily and appeared to be heading for the west coast of Florida. Jacksonville District now had two hurricanes to deal with simultaneously. Florida Governor Ron Desantis declared a state of emergency for the entire state, and Col. Booth made his way back to Florida to prepare for the second fight.

As FEMA issued the initial Mission Assignments for Regional Activation and Temporary Power in preparation for Ian, Jacksonville District split its EOC staff into two teams; one team remained focused on Fiona recovery operations while the other prepared for Ian. The daily Commander's Update Brief briefed response and recovery efforts for Hurricane Fiona first, followed by preparation efforts for Hurricane Ian. The district requested augmentation personnel through USACE headquarters to assist in manning two EOCs. Florida opened its State EOC in Tallahassee, and COL Booth met with key leadership there on September 25, 2022. The district conducted inspections of Herbert Hoover Dike surrounding Lake Okeechobee—the largest Lake in Florida, located in the south-central part of the state—and reached out to county sponsors of Federal Coastal Storm Risk Management Projects to initiate pre-storm surveys and document conditions, while Water Management personnel worked on inundation/storm surge mapping models to better understand potential impacts of the storm. FEMA designated the Initial Staging Base for incoming teams and units, and the assembly location for temporary power teams, in the state of Alabama, and the "Blue Roof" (see below) Call Center location as Portland, Oregon.

On September 26, 2022, Ian became a Category 1 hurricane, and within 24 hours, rapidly intensified to a Category 3 before making landfall at 4:30 local time on September 27, in Cuba, with sustained winds of 200 km/hr. Florida issued mandatory evacuations for 12 counties and voluntary evacuations for six others. Given the intensity of the storm, FEMA directed USACE to activate two additional Temporary Power Teams, for a total of four, keeping three at the staging base in Alabama and moving one to Florida, near the anticipated impact area.

Water assessments found the Kissimmee Chain of Lakes to all be above schedule and releasing water and Lake Okeechobee at 4.0 m feet. This made residents around the lake nervous because memories were still strong of the hurricanes in the 1920s that cause the lake to overflow and drown thousands of residents in neighboring areas. Fortunately the Herbert Hoover Dike Rehabilitation Project had recently completed more than 97 percent of the work - all the culvert replacements and removals were done, and the cutoff wall construction was 99 percent complete - so the district felt that Lake Okeechobee would likely be able to absorb the rainfall from the storm, as well as runoff from the north, without any issues. USACE extended operating hours for its navigation locks on the Okeechobee Waterway connecting the lake to both coasts to allow safe passage for boaters until it was no longer safe to do so (Figure 7).

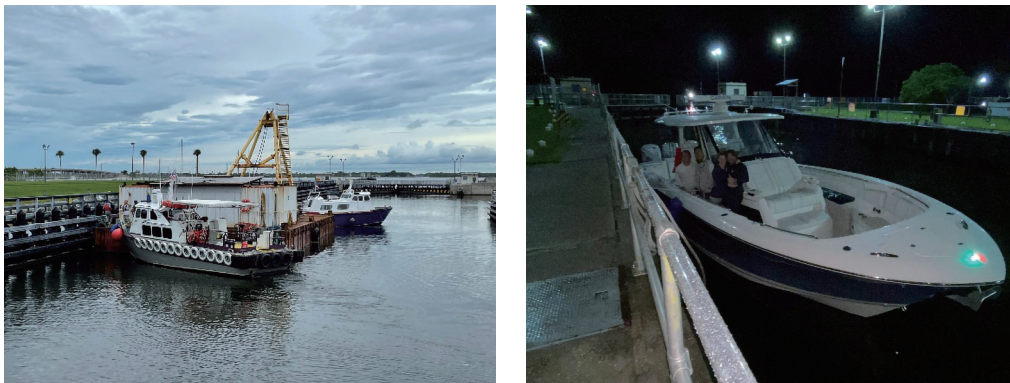


Figure 7. Lock Operators worked overtime to make sure everyone who needed to get to safe harbor could travel through the Okeechobee Waterway in advance of Hurricane Ian. (USACE Jacksonville District)

As Hurricane Ian continued to intensify to a Category 3 hurricane, Jacksonville District deployed liaison personnel to the State EOC in Tallahassee, the state capital, suspended navigation operations at all lock and dam structures on the Okeechobee Waterway and closed all Herbert Hoover Dike structures around Lake Okeechobee. The district's tribal liaison conducted critical coordination with the Miccosukee Tribe of Florida and the Seminole Tribe of Florida to provide updates, answer questions and offer assistance if needed. The district provided guidance to employees on remote work through the storm and EOC personnel prepared to stay at the USACE District office in Jacksonville through the storm and for up to three days if flooding occurred around the building. COL Booth and the mobile command post, and communications personnel, prepositioned in safe locations nearby to weather the storm.

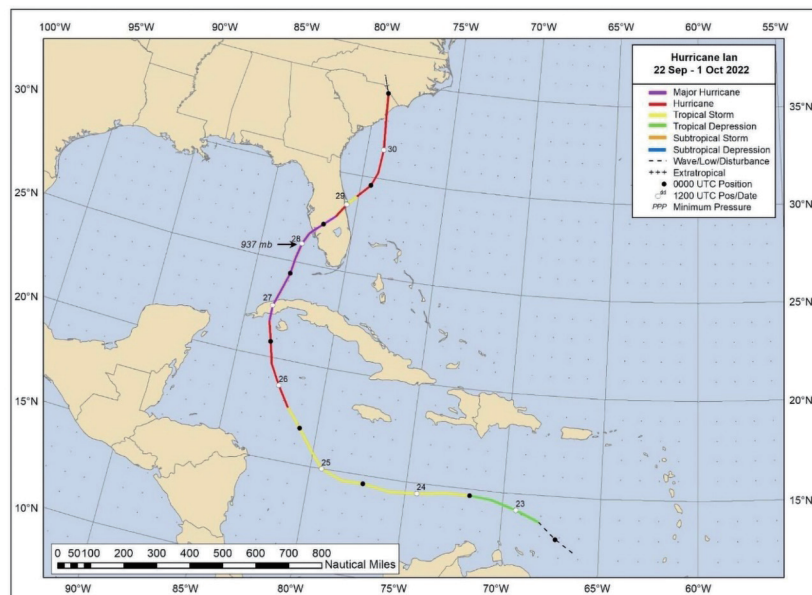


Figure 8. NOAA graphic depicts the path of Hurricane Ian as it made landfalls in Cuba, Florida and South Carolina Source: https://www.nhc.noaa.gov/data/tcr/AL092022_Ian.pdf

On September 28, 2022, Hurricane Ian intensified to a high-end Category 4 while over the southeastern Gulf of Mexico with sustained winds up to 250 km/hr. Ian made landfall south of Tampa (Figure 8) at 3:05pm local time with sustained winds of 240 km/hr. It was the first Category 4 hurricane to impact Southwest Florida since Charley in 2004 and was one of the five strongest hurricanes on record to make landfall in the contiguous United States. The storm spawned tornadoes in the Miami metropolitan area as it approached land. Upon landfall, the storm brought damaging winds, historic torrential rains, destructive storm surges, and widespread flooding. The strong winds damaged structures, tipped vehicles, and downed electrical lines, trees, signs and traffic signals (Figure 9). At one point, water gauges on Lake Okeechobee registered an eight-foot difference from north to south, meaning the lake water was literally at a diagonal angle due to the strong winds. This is not uncommon during strong storms which pass near or over Lake Okeechobee. Storm surges ranged from 3.0-5.5 m, submerging single story homes, filling elevated homes to their second level, and washing away portions of the Sanibel Causeway and the Matlacha Bridge, southwest of Fort Myers. Gauges 10 miles east of Fort Myers registered historic surges, over one meter higher than that seen during Hurricane Irma in 2017. Rainfall amounts varied widely, but one unofficial gauge registered more than 79 cm.⁵



Figure 9. Photos of Hurricane Ian destruction (Brigida Sanchez and Mark Rankin – USACE Jacksonville District)

⁵ Finch, Allison (September 30, 2022). "Southwest Florida in tatters 2 days after Hurricane Ian's rampage". Accuweather. Retrieved March 5, 2023.

As soon as the storm passed and it was safe to do so, Jacksonville District personnel headed to the hardest hit areas, stopping at each County EOC and talking with leadership and emergency personnel to get their assessments. FEMA issued additional Mission Assignments to USACE for Debris Technical Assistance/ Monitoring, Roofing, and Infrastructure Assessments. Jacksonville District established Generator Staging Bases (GSBs) at several locations and tasked the power teams to prepare for movement. Under its PL 84-99 authority, the district requested activation of an Unwatering Team to assist with flood fighting in Central Florida, which USACE tasked to the New Orleans District, and they started movement to Jacksonville. District engineers conducted post-storm inspections of Herbert Hoover Dike and all locks on the Okeechobee Waterway to reopen the waterway. As soon as water movement was possible, hydrologic survey teams began the process of assessing federal navigation channels to facilitate the reopening of ports (Figure 10). As Ian turned northward and accelerated toward the South Carolina coast, Jacksonville District's coastal engineers prepared for post-storm beach assessments of federal projects beginning October 2, 2022.

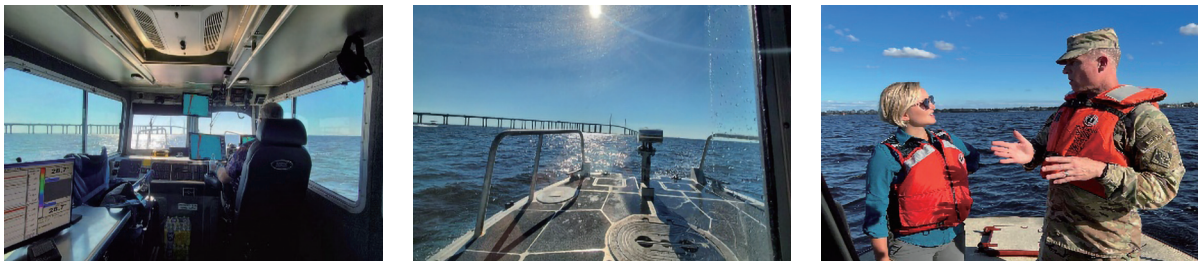


Figure 10. USACE Hydrographic Survey team members worked with the Tampa Port Survey Team, NOAA Coast Survey Team as well as the US Coast Guard, Sector St. Petersburg to assess port conditions for a safe port reopening (left and middle). Brig. Gen. Daniel Hibner, South Atlantic Division commander, interviewed with an NBC reporter aboard a hydrologic survey vessel near the Sanibel causeway (right).(USACE – Mark Rankin)

Lee County, which includes Fort Myers, was hardest hit by Ian, and the state's priorities were getting water treatment facilities running and facilitating the transport of emergency personnel to Sanibel Island. The county requested technical assistance with pressurizing the water treatment systems and hydro-surveys in the vicinity of the downed Sanibel Causeway to map a ferry route to the island. The district's mobile command post co-located with the Lee County EOC to facilitate coordination. Initial infrastructure assessments in support of FEMA and the State focused on seven requested Water/Wastewater Treatment Facilities and nine requested hospitals to determine condition, status, and possible operational needs. After the initial assessments were completed, district personnel moved on to conduct 334 infrastructure assessments at other requested facilities such as additional water/wastewater facilities/lift stations and hospitals, fire houses, public safety and government facilities, assisted living facilities, and schools/education facilities. Once those were complete, the infrastructure team conducted 10,070 rapid and detailed inspections of residential and non-residential structures in Fort Myers Beach and on Sanibel Island.

To assist with temporary power needs, two of the four PRTs, which now included teams from Tulsa, Oklahoma, Memphis, Tennessee and Honolulu, Hawaii, traveled to Southwest Florida. They performed over 300 power assessments at requested facilities, took delivery of generators from FEMA and installed them where needed. Unlike Hurricane Fiona in Puerto Rico, the power grid in South Florida was able to come back online rather rapidly, so the need for generators was not as high. By October 12, 2022, all but two of the temporary power teams had demobilized.

On October 3, 2022, FEMA tasked USACE to manage "Operation Blue Roof" to assist eligible homeowners in five counties with temporary roof repairs (Figure 11). The program provides a temporary blue covering with fiber-reinforced sheeting to help reduce further damage to property until permanent repairs can be made. The district established a Regional Field Office, activated the program website, and stood up the call center in Portland to begin receiving calls. The first Blue Roof was installed on October 8 and the last one was installed on November 6, 2022. In total, 36,916 applications were received, and after validation of eligibility, 20,250 temporary roofs were installed in less than a month. They used more than 360 hectares of reinforced plastic sheeting during the installations, which would cover approximately 680 football fields.



Figure 11. Contractors install blue reinforced plastic sheeting as temporary roofing as part of Operation Blue Roof until more permanent repairs can be made. (Brigida Sanchez and UAS Team - USACE Jacksonville District)

Catastrophic storms create large amounts of debris, and that was definitely the case with Ian. In support of its FEMA Mission Assignment for Debris Technical Assistance and Monitoring, the district initially tasked four debris subject matter experts (SMEs) to liaise with counties for the purpose of performing volume estimates and mission analysis for debris removal in affected areas. The SMEs then created three teams, broken out by regions, with a total of 12 personnel. District debris personnel were still in place as of February 8, 2023, and the total debris reported collected was over 24 million cubic meters.

While Lake Okeechobee and its surrounding Herbert Hoover Dike fared well during Ian, the Kissimmee Chain of Lakes to the north were struggling to contain the historic volume of rain that they received when they were already above schedule before the storm. Osceola County, just southeast of Orlando, was the focus of the flood fight, and the county requested USACE assistance with pumps and sandbags. The Unwatering Team from New Orleans, the South Florida Water Management District (SFWMD), Osceola County and others strategically placed 27 pumps along with sandbags to divert water away from residential areas. Overall, the joint efforts saved approximately 12,000 residential structures from flood water threats post-hurricane.

Though Hurricane Ian is just a memory to many, Jacksonville District is still involved in the recovery efforts. In addition to the ongoing debris mission, FEMA just tasked Jacksonville District with a Mission Assignment for Temporary Housing in March 2023.

Hurricane Nicole

The third threat to emerge in Jacksonville District's area of operations appeared late in the season, while the district was still immersed in recovery operations from Hurricane Ian and was projected to be a direct threat to the very city where the district is located. After watching a low-pressure system in the Caribbean for two days, the NHS named Subtropical Storm Nicole on November 7, 2022. For the third time in the 2022 season, FEMA issued USACE a Mission Assignment for Regional Activation.

The district activated its EOC that day to prepare yet again and initiated storm operations for Herbert Hoover Dike and the Okeechobee Waterway. There was significant concern about wind and rainfall from another storm in areas already battered by Hurricane Ian. Lake Okeechobee was well above the seasonal average already and the track for this new storm showed it going directly over the lake. Water Management ran inundation modeling and advised that overwash of the dike was not expected unless winds reached a Category 3 level over the lake. As during Hurricane Ian, the district extended operations at the navigation locks to allow safe passage of vessels away from the coastline. Inspections by Coastal Storm Risk Management personnel had assessed nine of the 28 beaches in the program as being in poor condition from Hurricane Ian. Seven of those nine were on the East Coast, so teams were placed on alert for post-storm inspections. The district placed most employees in telework status and had them shelter at home while EOC personnel sheltered again in the Jacksonville District office to ride out the storm.



Figure 12. Graphic depicts the path of Hurricane Nicole as it made landfall in Florida and moved north into Georgia.⁶

The next day, the storm strengthened into a tropical cyclone and made landfall on Great Abaco and Grand Bahama in the Bahamas where it quickly strengthened into a Category 1 hurricane (Figure 12). As the outer bands of the storm arrived, the coast experienced wave attack and storm inundation across the coastal highway (State Route A1A) just south of Jacksonville (Figure 13).

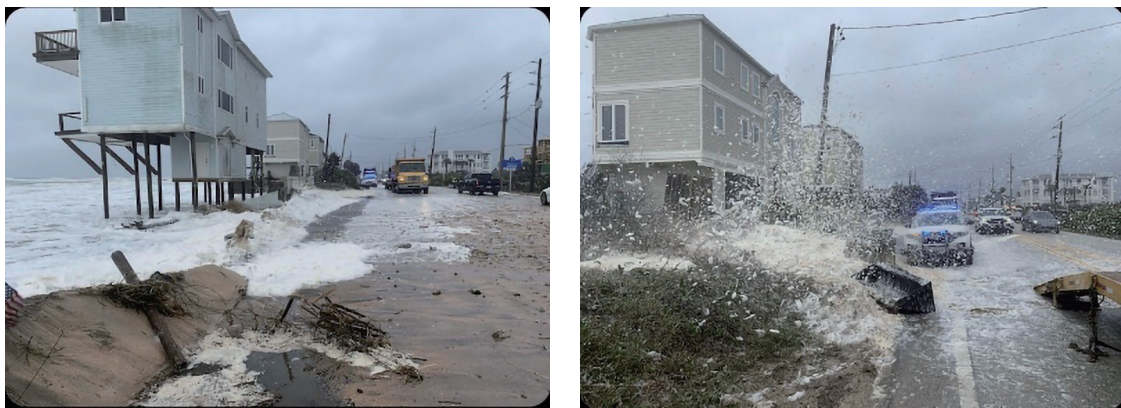


Figure 13. As Hurricane Nicole approached land, water breached onto State Route A1A south of Jacksonville, Fla. (Jason Engle – USACE Jacksonville District)

⁶ <https://www.wunderground.com/article/storms/hurricane/news/2022-11-11-hurricane-nicole-recap-florida-southeast>

Jacksonville District prepositioned hydrologic survey vessels near deep water locations to allow for inspections of federal navigation channels at the harbors immediately after the storm. The district ceased lock operations at 10:00pm November 9, 2022, as conditions worsened, but by then hundreds of vessels had passed through the locks and found safe harbor (Figure 14).



Figure 14. Space X Vessel Megan (L) approaches Canaveral Lock, 130 km south of Vero Beach, to find safe harbor at the Kennedy Space Center in advance of the arrival of Nicole. Other vessels also sought safe harbor through the Okeechobee Waterway. (USACE Jacksonville District)

At 4:00am local time on November 10, 2022, Nicole made landfall just south of Vero Beach, Florida (Figure 12), with sustained wind of 121 km/hr. It was just the third November hurricane on record to make landfall in Florida, along with the 1935 Yankee hurricane and Hurricane Kate in 1985.⁷ Much of Florida experienced heavy rains, gusty winds, and power outages as Nicole, weakened to a tropical storm, moved across the state and then through the panhandle.

Most of the damage in Nicole came from storm surge, as days of strong on-shore wind flow produced severe beach erosion, especially in the counties south of Jacksonville (Figure 15). At least 24 hotels and condos, and 25 single-family homes, in those counties were declared structurally unsafe by building inspectors and evacuated.⁸

⁷ Frisaro, Freida; Coto, Dánica (November 10, 2022). "Hurricane Nicole forms; Florida awaits rare November storm". ABC News. Associated Press. Retrieved March 7, 2023.

⁸ Schneider, Mike; Frisaro, Freida (November 10, 2022). "Tropical Storm Nicole sends beachfront homes into ocean". ABC News. Retrieved March 10, 2023.

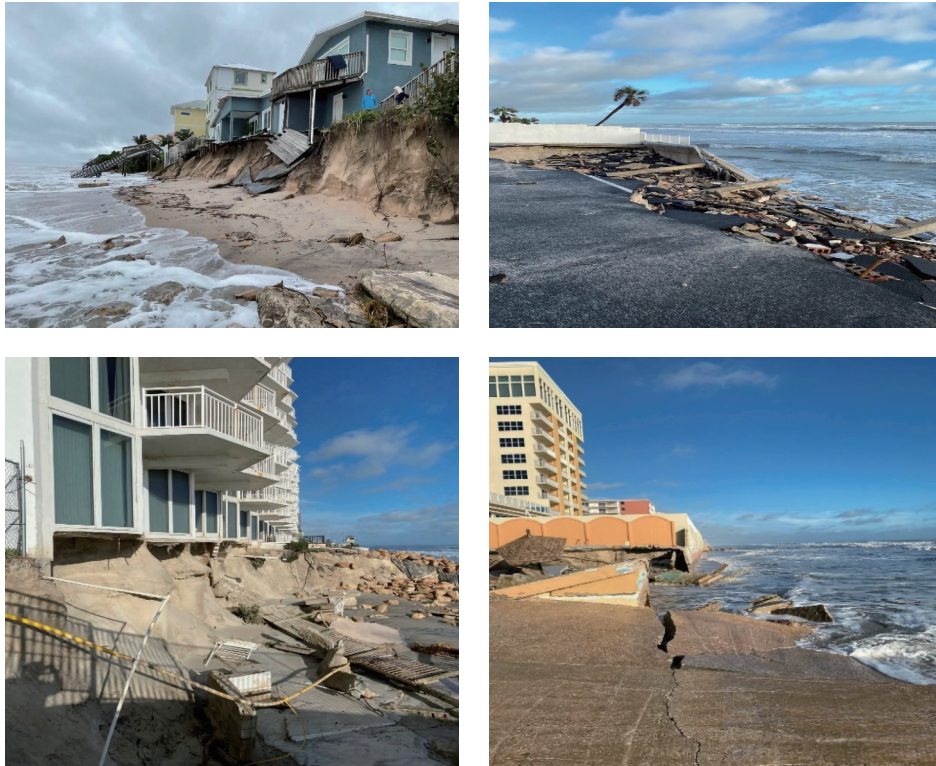


Figure 15. Extensive erosion occurred around buildings south of Jacksonville, Florida during Hurricane Nicole. (Col. James Booth – Jacksonville District commander)

As soon as it was safe to do so, district personnel conducted post-storm inspections of Herbert Hoover Dike and all locks and dams on the Okeechobee Waterway. They deemed everything was working properly and resumed normal operations. District hydrologic survey vessels completed their surveys, allowing all but one port to reopen within 24 hours of the storm passing.

At the direction of Congress, the U.S. Army Corps of Engineers (USACE) in the Department of Defense (DOD) undertakes water resource development activities. USACE develops civil works projects principally to improve navigable channels, reduce flood and storm damage, and restore aquatic ecosystems. On November 14, 2022, 17 district personnel arrayed into six teams and began conducting inspections of Federal Beach projects. A “Federal Beach” is a segment of Federally constructed beach, authorized by Congress, as a Shore Protection Project or Coastal Storm Risk Management Project for the purpose of reducing flood and storm damages to

coastal infrastructure for the national economic development benefit of the nation. The Federal Government will cost share up to 65% of the construction costs of a Coastal Storm Risk Management Project and share up to 50% of renourishment costs over a 50-year period. When a project is damaged by a storm of extraordinary nature the non-Federal sponsor of the project submits a letter to the district requesting rehabilitation assistance as authorized by Public Law 84-99. In response, the district prepares a Project Information Report (PIR) to document damages to the project and determine if it qualifies for rehabilitation assistance (repair at 100% Federal expense). Additionally, FEMA issued USACE a Mission Assignment for technical assistance with non-federal beach inspections. A non-federal beach is a segment of beach that does not have congressional authorization, and thus, where the federal government shares no cost. Two district personnel joined FEMA teams to conduct inspections at non-federal beaches in Flagler and Volusia counties. The teams completed inspections of 22 federal beaches and 21 non-federal beaches. The district anticipated six addendums to PIRs issued after Hurricane Ian due to Nicole impacts and nine new PIRs from Hurricane Nicole.

⁹ <https://www.ncei.noaa.gov/access/billions/events>

Conclusion

While the 2022 hurricane season seemed like an average season in terms of the number of named storms and hurricanes, it proved that one cannot always rely on predictions. Quiet seasons can become active, and the track of a storm matters. Hurricane Fiona caused 25 deaths and did an estimated \$2.5 billion in damage. Hurricane Ian caused 152 deaths, mainly from storm surge and flooding, and caused an estimated \$112.9 billion in damage. Hurricane Nicole caused 5 deaths and an estimated \$1 billion in damage.⁹

Though these three hurricanes impacted the Jacksonville District area of operations, the responses to the storms highlighted both the “whole-of-government” and, especially, the whole-of-USACE approaches to emergency management. For the former, the unified Federal interagency response to hurricanes under the Stafford Act established the roles of FEMA (overall direction), USACE (primary agency for Public Works and Engineering) and other agencies so that every agency knew what they were being asked to do.

Within USACE, from individuals, to teams, to units, to reach-back capability, USACE was organized to provide the right resources, at the right time, to the right location. Personnel appropriate to the tasks were drawn from districts around the country, rather than just the Jacksonville District. At the height of emergency response operations, Jacksonville District had 182 personnel (military, civilian, contractor, and reach back) on tasking orders for Hurricane Fiona, 692 personnel on tasking orders for Hurricane Ian, and 46 personnel on tasking orders for Hurricane Nicole. These totals are just the orders at the district and do not include tasking orders for personnel issued at the Division and USACE levels.

Key to the success of these responses was USACE’s preparation and established relationships. USACE conducts annual hurricane exercises at the division and district levels to ensure personnel are prepared for hurricane season. Exercising various scenarios annually defines the tasks and creates the communication flows that allow for seamless coordination when a real emergency hits. Relationships built with local stakeholders as part of routine daily work become invaluable during an emergency. Jacksonville District personnel in South Florida knew the leaders impacted by Hurricane Ian, had their phone numbers, and were able to gather assessments from the local perspective very quickly. Prepositioning of personnel allowed USACE to go to their locations immediately after the storm passed to begin assessing what support would be needed. This allowed for a seamless response with the appropriate resources in their time of need.

Introduction

In February-April 2022, flood events in the Australian states of New South Wales and south-east Queensland experienced flood events that were the costliest in Australian history. Over 5,300 homes were made uninhabitable and \$2.7 billion in infrastructure destroyed. Nine people lost their lives.

Following public criticism of the preparedness for and response to these floods, the New South Wales government commissioned the NSW Flood Inquiry “to examine and report on the causes of, planning and preparedness for, response to and recovery from the 2022 catastrophic flood events”.

The [inquiry report](#) describes that following two years of well above average rainfall and intermittent flooding, an exceptional weather event in late February and early March 2022 delivered extreme multi-day rainfall and flooding to eastern NSW. Multi-day rainfall records were broken across north-east NSW, with multiple sites recording more than one metre of rainfall.

The report described the causes of the disaster as follows:

“NSW is flood prone and has a lot of people living in the floodplain. Floods will continue to be a major risk for NSW.

“It is incredibly challenging to identify trends and patterns in flood events due to complexities in pinpointing the causes of, and interplay between, the various factors that lead to flood. Based on the current science, it is difficult to state confidently that, overall, extreme flood events in NSW and across Australia will increase in intensity or frequency as a result of climate change. Springs and summers as wet as 2021–2022 are rare and are likely to remain so in the future.

“However, there is clear evidence of the tropics expanding towards the poles, in addition to rain intensifying at daily and sub-daily scales. Observations show that the intensity of short duration, or hourly, extreme rainfall events has increased. As the climate warms, heavy rainfall events are expected to continue to become more intense with consequent increased chances of flash flooding. There will also be increased coastal inundation from sea-level rise.”

This chapter summarises the outcomes the [2022 NSW Flood Inquiry](#) with a focus on its findings and recommendations relevant to the following relevant [guiding principles of the Sendai Framework for Disaster Risk Reduction 2015-2030](#).

Sendai principle: Shared responsibility between central Government and national authorities, sectors and stakeholders as appropriate to national circumstances

The inquiry found weaknesses with cooperation between levels of government on the ‘knowledge resources’ to support flood management:

“The design of the current rain and river gauge network is not fit for purpose. There are issues around gauge location, ownership and maintenance, and there is a lack of leadership and coordination of the gauge network. The river gauge network covering NSW needs to be significantly enhanced and appropriately maintained, preferably under leadership from the Bureau of Meteorology”.

In response to these findings the inquiry recommended improving river and rain gauging and research and technology development to improve rainfall forecasting accuracy and to provide more accurate and complete data for flood threat identification, warning and modelling systems. The report recommended the State and Commonwealth governments work together to:

- transfer ownership and maintenance responsibility for as many of the river and rain gauges as possible from the state to the federal in NSW to the Commonwealth Bureau of Meteorology;
- upgrade and ensure a maintenance program for those gauges that remain in state and local government ownership;
- upgrade radar capability to ensure overlapping coverage and some redundancy; and
- ensure that all relevant state entities and local councils implement the (national) flash flooding guidelines for all watercourses for which they have flood warning responsibility, drawing on the state’s significant expertise in remote sensing to implement effective monitoring and warning systems that send warnings to all residents and businesses in affected areas.

In response to findings of gaps in radar coverage and to ensure reliability of forecast and warning services available for at-risk catchments, the report recommended a long-term research funding network/partnership with the state’s universities for further research and technology development to increase rainfall forecasting accuracy in time and location.

Sendai principle: ‘Protection of persons and their assets while promoting and protecting all human rights including the right to development’

In its coverage of ‘operational response preparedness’, the inquiry found the lack of appropriate training and exercising across all combat and relevant government agencies meant some did not understand their roles and responsibilities under the emergency management arrangements, and this affected the protection of life and property in the flood response.

The report recommended a range of governance reforms to improve NSW’s ability to prepare for and respond to floods and other disasters, including changes to command and reporting arrangements. This would include:

- facilitating collaborative risk management and compliance activities working with local and regional emergency management committees, communities, local government, state government agencies and the Australian Government and working with relevant state government agencies.
- improving operational readiness and preparedness for emergencies including training, education and ensuring proactive understanding of the location and condition of assets available to the combat agency in the event of an emergency, rather than this information being sought during an emergency.

The inquiry also found that the loss of power during the flood events was significant in terms of scale, duration and its compounding effect on other services including telecommunication, sewerage system plants and water supply systems. “Loss of telecommunications services caused the most distress to communities because it affected their ability to request flood rescues, communicate with family and friends, provide warnings and access post-emergency information”.

The report recommended that, to minimise disruption to essential services, including outages which compromise basic communication coverage, and to ensure access to safe water supply and power during flood events, Government work directly or together and/or with their relevant power and telecommunications regulatory, policy and market bodies to

- ensure there are sufficient redundancy options known and made available (for example, backup diesel generators, deployed temporary telecommunications facilities, etc.) to supply power to essential telecommunication infrastructure, alternative telecommunications infrastructure and water treatment facilities;
- ensure that the telecommunication entities, electricity network providers and water treatment managers are using up to the minute, whole of catchment models to inform business continuity planning in the event of flooding; and
- facilitate cross carrier roaming arrangements between carriers and the public for basic text, voice and data during the period of emergency in areas directly affected by floods.

Flood rescue capability preparedness

The Inquiry found:

- Weaknesses in operational ability to coordinate multiple flood rescues.
- No redundancy built into emergency service calls systems.
- Insufficient people trained in flood rescue.

In response to these findings, the report recommended that to help improve the protection of life across NSW in flood events, current flood rescue arrangements be audited and reconsidered and training facilities be improved.

Preparedness for handling of evacuations and community support in the recovery phase

The Inquiry found weaknesses in the actions of the relevant government agencies, with uncertain roles and accountability causing confusion and stress for affected communities.

In response to these findings the report recommended that to “enhance NSW disaster preparedness, response and recovery, and meet the needs of the people of NSW prior to, during and after a disaster”, the government should provide clarity on agency roles and responsibilities and renew focus on agency, local and state government training. The report also “notes the importance of a police or security presence in evacuation centres, particularly in the early days of the establishment of the evacuation centres.

Sendai principle: ‘Full engagement of all State institutions of an executive and legislative nature at national and local levels’

The inquiry found that NSW needs improved governance arrangements to drive a cohesive, whole of government approach to disaster preparedness, planning and emergency management and commended the model of the Civil Contingencies Committee (COBRA) in the United Kingdom.

The report recommended the State Government establish a high-level Government standing committee, comprising key Cabinet Ministers, Secretaries and Commissioners that meets, trains and exercises to ensure Government is prepared to respond to any emergency and to ensure the emergency management systems and plans are fit for purpose, effective and appropriate.

Sendai principle: ‘Empowerment of local authorities and communities through resources, incentives and decision-making responsibilities as appropriate’

The inquiry found that “during disasters, particularly when Government capability is exceeded, community was often more effective at saving community than Government... During the 2022 flood events, multiple communities, ... felt abandoned by Government... Communities want to feel supported by Government, but do not want government to run or interfere in community led initiatives that work well. “... if properly supported through grant initiatives by Government, community can be an effective ‘first responder’ in disasters. This grant funding could support the establishment and management of evacuation and recovery centres, delivery of psychological first aid and other initiatives to help protect life and property. Ongoing training opportunities must be part of this initiative”. “While Government has a role in sustaining a community response to a disaster, it should also aim for, wherever possible, transitioning from a community to an agency response.”

Supporting local responsibility

The report recommended the government fund a program to better coordinate community efforts to save life and property during a disaster which could support and empower community led initiatives such as disaster response, evacuation centres and the provision of services such as psychological first aid.

The report also found that effective messaging will empower the community to make better decisions in a disaster, particularly around early evacuation, and recommended administrative reforms to centralise responsibility for warnings flood, storm and tsunami threats, including to:

- proactively assess community sentiment and work with agencies to effectively disseminate key disaster information to all communities including vulnerable, culturally, linguistically, and religiously diverse communities
- coordinating clear, consistent, reliable messaging from all government agencies, especially during a disaster providing public statements evaluating the likely risk of flooding and the effectiveness of planning and preparation for the upcoming season.

The report says this should be “based on sophisticated monitoring of key risk factors and signals for extreme flood events” and “form the basis for clear public communication about these risks on a regional basis and the actions that the Government proposes in preparation”, and should be “available to communities and individuals in real-time, on live warning signs in town centres (using satellite connections so they are not reliant on local telecommunications infrastructure)”.

The report also recommended a single ‘NSW disaster app’ to consolidate individual agencies warning apps and have a simple interface that is accessible via mobile devices and provide real time flood warnings and information, both raw information from gauges and processed information from publicly available models and allow citizens to provide information during a flood to help authorities and community, including flood imagery and local knowledge observations in the lead into, during and immediately after flood events.

Flood risk education

The Inquiry found that “broad community memory of disasters is negligible, though sympathy at the time of the event is significant. Collective amnesia in the long tail following a disaster event promotes inertia and inhibits decisive and necessary action in preparing for, responding to, recovering from and building resilience against future events”.

The report recommended a new disaster curriculum to build disaster resilience in future generations “as floods and other natural disasters are a fact of Australian life”.

Landholder awareness

The inquiry found most landholders have “little idea if their property is at risk of disaster or has ever been affected previously by disaster” and recommended to “provide a single source of ground truth to prepare for and respond to emergencies, and to provide people with a better understanding of their individual property and community risk exposure, an online visualisation tool be developed to display ..., the extent of known disasters that have affected each piece of land in NSW in the past. This information should be made available through the Planning Portal and, particularly in light of climate change, the data involved should be revised and updated at least every two years and after each major natural disaster”.

Sendai principle: ‘Decision-making to be inclusive and risk-informed while using a multi-hazard approach’

The Inquiry found that “the new disaster adaptation plans and risk-based approaches to calculating flood planning levels will need to have a clear connection to the development assessment and infrastructure delivery process and it will be critical for new controls to create more resilient buildings to be enforced through development decisions”.

The report recommended planning authorities include disaster response and resilient settlement outcomes in long term strategic plans and have the necessary tools and advice to enable planning authorities to incorporate cumulative impacts of potential natural disasters into strategic plans. These tools should ensure the disaster adaptation plans can be given real effect in strategic plans for settlement and local planning controls.

The report also recommended a more systematic prioritisation of investment options in risk mitigation before, during and immediately following a natural disaster event, through a Disaster Cost Benefit Framework. “This Framework will enable the Government to estimate the investment required for any given disaster, starting with flood events, and will enable the fast allocation of funding based on detailed and rapid analysis of flood and property modification, mitigation, preparation, response and finance related options including:

- flood modification measures/flood defence (including dams/ water management; levees; waterway or floodplain modifications; etc)
- property modification measures/flood risk mitigation (including land filling; flood proofing; house raising; optimum zoning; buy back schemes/relocation;
- response modification measures/flood preparation (including flood warnings; upgrading evacuation routes; evacuation planning; emergency response and education programs; flood data collection and sharing; etc)
- finance related options (including building standard reforms; restructure and reduction of stamp duty; direct subsidies; government reinsurance pools; etc)”.

Sendai principles: ‘Coherence of disaster risk reduction and sustainable development policies, plans, practices and mechanisms, across different sectors’ ‘Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk’ and “Build Back Better’ for preventing the creation of, and reducing existing, disaster risk’

Floodplain management principles

The report recommended ‘guiding principles’ for floodplain management:

- treat floodplains as an asset, specialising in uses that are productive and minimise risk to life during major weather events. Such uses would include sporting and recreational activities, garden plots and community gardens, agriculture and forestry, renewable energy production, biodiversity offsets, parks and outdoor education activities.
- treat development of the floodplain in parallel with development of urban structures (houses, businesses and industry) that are built near to the edge of the floodplain. Examples of connection could include high rise housing developments where apartment owners are granted automatic rights and access to community garden and community recreation facilities
- favour letting watercourses largely flow naturally rather than implementing engineering barriers such as flood levees and mitigation schemes to stop floods
- communicate the intention to use planning arrangements that will lead to greater safety and community amenity as well as realising a significant state asset. This needs to be communicated in general to the people of NSW, but also to those particularly affected communities at the time of planning, rebuilding and construction.

Local adaptation planning

The Inquiry found “Natural disasters will recur in NSW as we see more extreme climate. NSW will experience more extreme bushfires and larger and more dangerous floods. This means that certain regions and certain areas of cities and towns (notably floodplains associated with major rivers and the parts of cities that are bushfire prone) are increasingly dangerous places to live and will increasingly be a drain on the public purse as people who live there have to be evacuated repeatedly and then re-housed”.

The inquiry also found that “the floods made uninhabitable or significantly damaged thousands of homes and forced thousands into emergency accommodation”, that “this is driving more demand for social, affordable and market rental housing and has worsened homelessness”, and that “urgent action is needed to provide fit for purpose, resilient homes for the displaced or those who continue to reside on high-risk floodplains”.

The Report recommended the State Government work with local government to prepare a disaster adaptation plan for each city and town, with planning instruments discouraging (and in many cases forbidding) development in disaster-likely areas.

The Report also recommended relocating communities most at risk with good homes and amenities by empowering vulnerable people and communities to relocate. This requires identifying and prioritising those communities most at risk from future disasters, and for whom relocation may be appropriate or necessary and should also include considering how to repurpose floodplains for community use and benefit, i.e. recreation, sports and energy production as part of the process of returning land below the flood planning level to Government ownership.

Updating flood planning tools

In response to findings that the current calculation method of the flood planning level for planning purposes in NSW is not adequate, especially in the light of changing rainfall patterns including the intensification of intraday rainfall, with the consequent risk of greater flash flooding, and that to understand risk, especially for major flooding events, knowledge of floods at a catchment-wide scale is needed, the report recommended the Government reinforce its adoption of a risk-based approach to calculating the flood planning level for planning purposes and immediately start a process of revising all flood planning level calculations in the state's high-risk catchments.

Sendai principle: 'Addressing underlying risk factors cost-effectively through investment versus relying primarily on post disaster response and recovery'

Road access

The Inquiry found that roads are critical in flood evacuations, but are themselves vulnerable to flood damage and to being cut off by floodwaters and landslips, preventing entry and egress, and isolating communities from essential services, and that the cost of critical road maintenance and flood-damage repairs, particularly for key evacuation routes, is beyond the capacity of local government and private road owners.

The Report recommended that future development must be informed by sound road evacuation modelling to ensure road capacity for population increases and that future road design must be more resilient to flood impacts.

Power, communications, water, sewerage services

The Inquiry found that essential services disruption was exacerbated by critical infrastructure being situated in low-lying areas and consequently being flooded. Several hospitals, medical centres, nursing homes, aged care facilities and police stations situated below the flood planning level were affected in the floods.

Some detrimental impacts of floods come from built structures which are supposed to provide flood mitigation not being maintained and consequently malfunctioning after heavy rain, making floods worse at a local level."

The Report recommended that to minimise disruption to essential services (power, communications, water, sewerage) and to ensure flood infrastructure is fully serviceable before flooding

- essential services infrastructure (communications, water, power and sewerage) should be situated as much as possible above the flood planning level
- hospitals, medical centres, nursing homes, aged care facilities and police stations should be situated above the probable maximum flood level and
- floodplain infrastructure (drains, levees, flood gates) should be fully maintained and functioning especially when floods are likely.

Conclusion

The 2022 NSW Floods Inquiry comprehensively reviewed the issues faced by the communities and government in the response to these floods and recommended many risk reduction measures in considerable detail. Generally the Inquiry recommendations align with the Sendai Framework principles and approaches. As such many should have potential application in other locations and for other types of disasters, as acknowledged in the [NSW Government's response](#) .

The report describes in some detail many practical disaster risk reduction actions which are not often exposed and discussed. As such readers interested in knowing more of these actions are encouraged to refer to the report itself rather than to this simple summary of its findings and recommendations.

ENDS

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Acronyms and abbreviations

1. **CIAT** - Flood Hazard Map published in the Atlas of Natural Hazards in Haiti.
2. **DGPC** - General Directorate of Civil Protection.
3. **OCHA** - United Nations Office for the Coordination of Humanitarian Affairs.
4. **FAES** - Economic and Social Assistance Fund.
5. **CRS** - Catholic Relief Service.
6. **USD** - United States Dollar.
7. **GWPC** - Working Group for Civil Protection.
8. **NGO** - Non-Governmental Organization.
9. **PETRI** - Plan for the Evacuation and Transportation of Internal Refugees.

1) Introduction

The Republic of Haiti is confronted with severe climatic crises, including droughts, floods, cyclones, and storms. Haiti experiences recurring issues with flooding due to its mountainous topography, heavy rainfall, and insufficient infrastructure to manage rainwater. In recent years, the country has been adversely affected by floods, leading to serious consequences for communities situated downstream of watersheds or near areas with temporary or permanent surface water runoff. According to the flood threat map published in the Natural Threats Atlas of Haiti (CIAT), certain regions of the country are more severely impacted than others. These regions encompass the coastal areas of the Sud, Sud Est, Nippes, and Grand Anse departments. The plains of the West, Artibonite, and North-West departments are also highly vulnerable to flooding. However, other regions in the North and Central Plateau are less exposed to such risks. During the cyclone season, which lasts from June to November, the risks are heightened due to the probable passage of cyclones. It is worth mentioning that floods pose a major threat as the main densely populated cities are located in flood-prone plains, coastal areas, and steep zones. The World Risk Index places Haiti among the countries with the highest predisposition index, meaning it has a high probability of being affected by natural disasters (cf. Threats Atlas).

This year, on June 3, 2023, just two days after the opening of the cyclone season, a cold front aloft passed over Haiti, resulting in heavy rainfall and flooding in the southern and some northern regions of the country. In light of the recorded damages and the recurring nature of this phenomenon, the Global Water Protection Council (GWPC) presents an analysis of Haiti's situation concerning this major risk, with a particular focus on the most recent floods of June 3, 2023. The report begins by providing a historical account of devastating floods and their impacts over the past two decades. It then delves into the June 2023 event and its consequences for key economic and social sectors. The report also discusses the humanitarian response that has been undertaken or planned to assist the affected communities. Finally, it concludes with recommendations for mitigation measures aimed at reducing the devastating effects of floods in the future.

2) Haiti's Physical, Socio-economic, and Political Landscape

Geographical Perspective: Haiti is a small Caribbean Island state with a tropical climate. Its geographical location makes it susceptible to cyclones, which often result in severe floods. Haiti shares the island with the Dominican Republic, located to the East. It is part of the "Greater Antilles" and covers an area of 27,750 km². Demographically, Haiti is the most populous country in the Caribbean. According to the Haitian Institute of Statistics and Informatics (IHSI)¹, a governmental organization, the estimated population of Haiti was 11,905,897 inhabitants in 2021.

Socio-economic and Political Perspective: Compared to other countries in the region, Haiti's situation is highly critical, with several underlying causes. Reports from international institutions consistently indicate that Haiti is the poorest country in the Northern Hemisphere. Whether it is the World Bank, IMF, UN agencies, or other organizations working on Haiti's situation, the data concerning its political, economic, and social conditions continue to worsen. Notably, on July 6th, the country marked the second anniversary of the assassination of its President, Jovenel Moïse, who was in the fourth year of his five-year term. Since then, no compromise has been reached, and the organization of new general elections in the country remains delayed.

An article published on the Ministry of Economy and Finance's website² states: "Haiti, the poorest country in the American continent, has plunged into a deep political, economic (with four consecutive years of GDP decline since 2022), security, and health crisis, from which it struggles to emerge. The slight recovery anticipated by the IMF in 2023 (+0.3%) will largely depend on the improvement of the security situation and is doubted by the World Bank, which predicts a fifth year of economic decline. The Fund is supporting Haiti with a Stand-by Arrangement (SMP) that involves the gradual implementation of structural reforms."

Consequently, with successive political crises, corruption, and mismanagement of public resources, Haiti is increasingly indebted and has become the most corrupt country in the region. Such situations have significant repercussions on the daily lives of the population. They are deprived of access to essential services, including education, healthcare, housing, employment, and infrastructure, which are their rights. As a result, they are highly vulnerable to not only epidemics but also natural disasters that strike the country every year.

3) History of flooding in Haiti

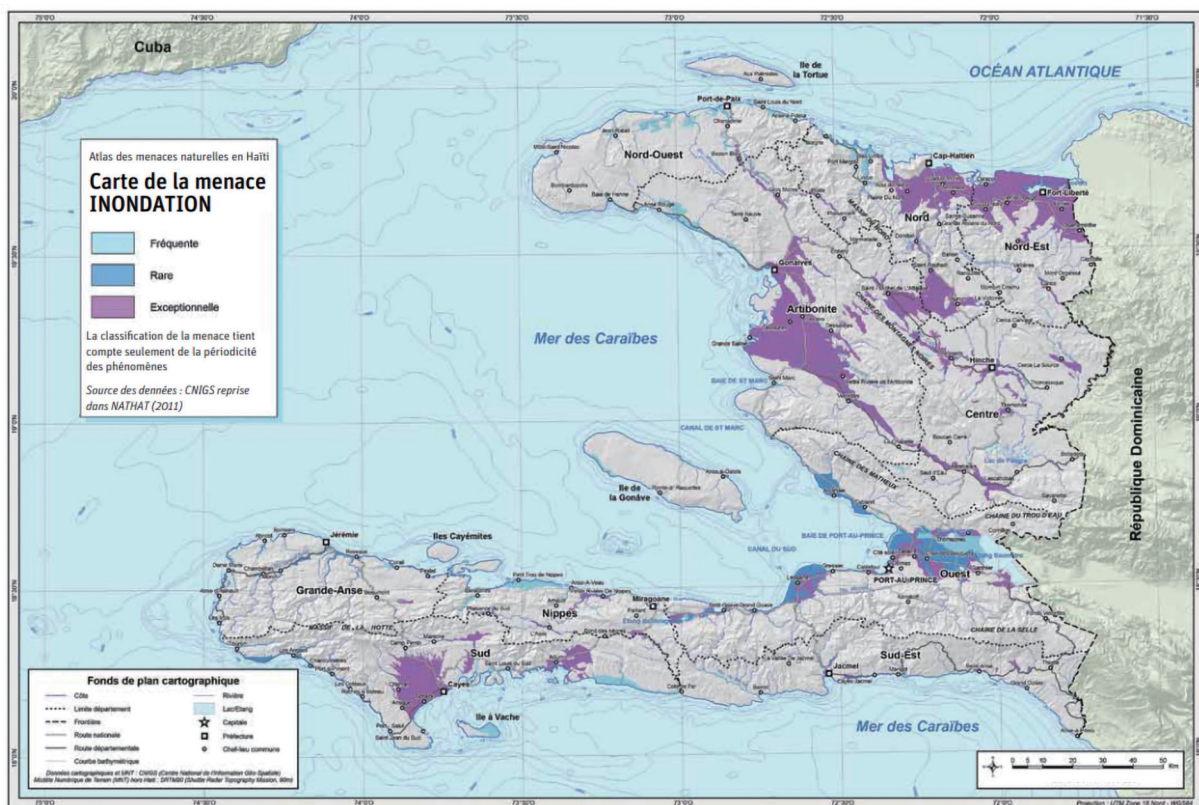


Figure i : Flood Map of Haiti (Atlas des menaces naturelles en Haïti p.14).

According to the Classical definition reported in the Natural Threats Atlas of Haiti, flooding is defined as the temporary submersion, whether natural or artificial, of a terrestrial space. It is caused by an excess of water falling during precipitation and not being able to infiltrate the ground. It can also result from the rupture of a dam, releasing a significant volume of water that affects the downstream areas of the dam.

There are several types of flooding distinguished in Haiti:

Flash floods are sudden, severe, and sometimes deadly. As the waters flow, they gain speed.

“Pluvial” floods generally occur in inhabited areas due to the impermeability of the ground caused by human activities (roads, parking lots, settlements, etc.). They are usually characterized by slow-moving waters (stagnation) or shallow water depths.

“Fluvial” floods are generated by the overflow of rivers, where the river escapes its regular channel and occupies its floodplain. These raging waters cause material and human damages.

Haiti has always been susceptible to floods, which are recurring and vary in their severity depending on the causes that lead to them. For example, the most devastating floods are often caused by torrential rains recorded during storms or tropical depressions. Based on reports from the Direction Générale de la Protection Civile (DGPC) or other sources as published by the DGPC, we present some of the floods recorded over the last 20 years.

Table 1: Impact of Natural Disasters by Period, Affected Area, and Recorded Damage.

Period	Area affected	Damage recorded
24 – 27 May 2002	Southern Peninsula. The town of Camp Perrin and the localities of Azile and Anse-à-Veau were the hardest hit.	31 dead, 14 missing and over 7,000 affected
23 – 24 May 2004	Southeast department: Mapou, Belle-Anse, Bodary West department: Fonds-Verrettes	1232 dead, 1443 missing and 100,000 people affected
17 – 18 Sept 2004	City of Cap-Haitien, City of Gonaïves City of Port de Paix	300,000 people affected and over 3,000 killed by the floods.
4 Oct 2005	Various regions of the country, including Pétion-Ville and Grand Goâve in the West department,	The floods caused considerable losses. However, no balance sheet had been drawn up for the disaster.
25 Oct 2005	Several regions in the North-West, including the communes of Port-de-Paix, Bassin-Bleu, Anse-à-Foleur and Saint-Louis du Nord	Cattle and gardens were swept away, and one person was reportedly killed.
22 – 23 Nov 2006	Department of Grande Anse, Department of Nippes North-West Department	Several public buildings were flooded and some road structures were damaged. damaged, including the collapse of the bridge at Ravine Sable (Commune de Bonbon).
17 March 2007	Grande Anse department: Jérémie, Abricots, Bonbon, Carcasse (Les Irois). South-East department: Jacmel. West Department: Cité Soleil, Delmas, Port-au-Prince (Carrefour-Feuilles, Canapé Vert). North-West Department: Port-de-Paix, Saint-Louis du Nord, Anse-à-Foleur. North Department: Cap-Haïtien Nord-Est department: Ferrier, Ouanaminthe.	Eight dead and some 36,000 families affected

Period	Area affected	Damage recorded
8 – 9 May 2007	Several regions of the country, including the North, North-East and South departments.	The town of Ouanaminthe was particularly hard hit, and the bridge linking Haiti (Ouanaminthe) to the Dominican Republic (Dajabón) was severely damaged.
1th Sept 2008	City of Gonaïves Western Department of Haiti	The town was completely flooded, and in some places the water was up to two meters high. Many inhabitants had taken refuge on the roofs of their houses to escape the rising waters." The official death toll was one
20 Oct 2009	Heavy rain in the Haitian capital and its suburbs. The commune of Carrefour was completely flooded.	Five dead, 3 of them in landslides, while the other two perished under the debris of their homes.
4 oct 2016	Heavy rains on the Southern Peninsula during Hurricane Matthew	Almost total crop loss occurred in the Grand'Anse and Sud departments, leaving the impoverished population without a source of food. Communication networks and the road system were also compromised. The raging waters washed away the Petit-Goâve bridge, temporarily cutting off the town's road network.

Based on the data presented in the table above, over the last 20 years, the southern region of the country has been the most affected by floods. It is also worth noting that in 2004, Haiti experienced two of the deadliest floods during this period. In May 2004, there were over 1,232 deaths and 1,443 missing persons. A few months later, during the passage of Tropical Storm Jeanne, the city of Gonaïves was completely flooded, along with two other cities in northern Haiti, resulting in over 3,000 deaths and 300,000 affected families. Besides the loss of human lives, floods also consistently impact agricultural production systems. The analysis of the table shows that the flood-prone period occurs between May and November, with September and October being the two months that recorded the highest number of floods.

4) Major Flood Event June 2023

4.1 Causes of the Flood:

The devastating flood that struck Haiti in June 2023 resulted from a combination of factors. A meteorological low-pressure system remained stationary over the country, unleashing torrential rains, gusty winds, and thunderstorms. With soils already saturated from previous rainfall, the new downpour could not be absorbed, causing rivers to overflow their banks and triggering landslides in riverside areas. The situation was compounded by the onset of the cyclone season, increasing the likelihood of more intense weather phenomena. Additionally, on June 6, a magnitude 5.5 earthquake further aggravated the emergency, exacerbating the flooding, displacing populations, and causing damage to infrastructure.

Torrential rains caused major flooding in the country's main rivers. Several towns in the departments of Grande Anse, Nippes, Nord-Ouest and Ouest were flooded.

- Grande Anse department: Les Irois, Pestel and Beaumont
- Nippes department: Anse a Veau, Miragoane and Plaisance du Sud
- Nord-Ouest department: Port de Paix
- Ouest department: Arcahaie, Carrefour, Ganthier, Cite Soleil, Gressier, Leogane, Petit-Goave

4.2 Impacts of the Flood:

The immediate consequences of the flood were severe. Human losses amounted to 51 fatalities, with 140 people injured, and 39,458 households affected, leading to the evacuation or sheltering of 3,586 individuals. The floodwaters inundated 31,591 homes and caused significant damage to 2,445 houses. Infrastructure damage was widespread, including landslides and impassable agricultural tracks that hindered the movement of goods and people. Educational and health facilities also suffered damage, with some health centers temporarily closing due to flooding.

The agricultural sector, a critical component of Haiti's economy, bore a heavy blow. Crops such as corn, bananas, manioc, peppers, and beans were severely affected, while irrigation canals were silted up, and farm tracks were damaged. The livelihoods of farmers were further impacted as over 2,890 head of cattle were washed away.

Table 2: Statistics by Category and Number

Category	Number
Numbers of households affected	39,458
Number of people evacuated or sheltered	3,586
Numbers of deaths	51
Injured	140
Numbers of houses flooded	31,591
Number of houses destroyed/damaged	2,445



In Petit Goave, the local people showed their solidarity.

Figure ii: local people showed their solidarity (credit: France 24)

On Route Nationale #2, Port-au-Prince, a determined family, braving the waters, struggles to get around.



Figure iii: a determined family, braving the waters (credit: RFI)

The hardest-hit department is the West, particularly the communes of Léogâne, Gressier, Cité Soleil and Tabarre. Other departments were also affected, including Sud-Est, Nippes, Grand'Anse, Nord-Ouest, Centre and Sud.

Figure v: Affected Department (source: DGPC)

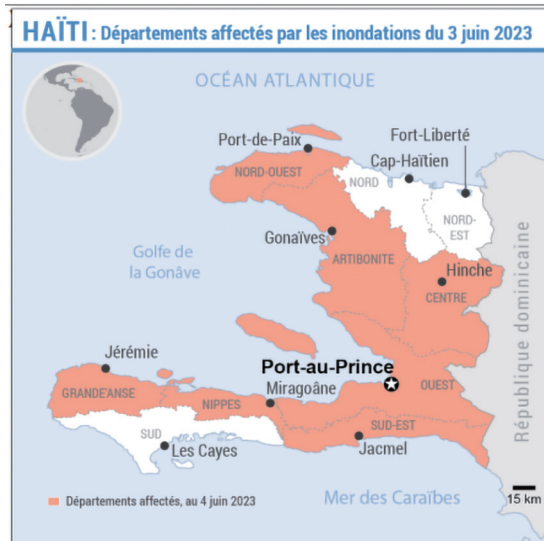
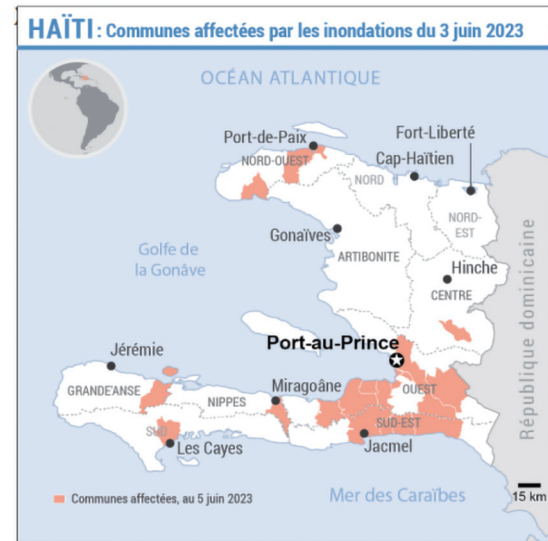


Figure iv: Affected Municipality (source DGPC)



According to the report published by the DGPC, the consequences were disastrous.

- Several communication infrastructures (roads and bridges) were damaged: landslides and landslides, impassable agricultural tracks. This has limited the free movement of goods and people and impacted initial response activities.
- Infrastructures such as schools and health centers were damaged, and some health facilities had to close temporarily due to flooding.
- In the agricultural sector, the latest floods are likely to worsen the country's food situation. The month of June coincides with the harvest period for the spring season, considered to be the main production period and responsible for over 50% of local food availability. Plantations of corn, bananas, manioc, peppers and beans were severely affected. As for hydro-agricultural infrastructures, assessments show that several kilometers of irrigation canals have been silted up and farm tracks damaged. Urgent action is required to avoid jeopardizing the summer and winter agricultural campaigns, especially on the wet plains. Livestock were also affected, with over 2,890 head of cattle washed away.

4.3 Preparedness and Response:

A humanitarian response has been launched, including the provision of shelters, food kits, hygiene kits and drinking water. Work is also needed to clear roads, pump out water and clean up flooded homes. Several state and non-governmental institutions have provided initial assistance. The Fonds d'Assistance Economique et Sociale (FAES) distributed food kits, Catholic Relief Service (CRS) provided the most affected communities with farming tools to facilitate clean-up, and the Red Cross installed a water purification system to improve access to drinking water in Léogane. A few days after the events, Start Network activated the alert to mobilize funds for a rapid response. Haiti Survie, in partnership with World Jewish Relief, received funds to develop response activities for a 45-day period from June 16 to July 31, 2023, in the commune of Petit Goâve. These activities involve transferring cash for basic needs to over 370 families, providing non-food products to meet hygiene and water treatment needs, and providing agricultural inputs (beans) to over 350 households to support the bean production campaign in the wet mountains of Petit Goâve. Other organizations such as HelpAge are also active in other affected regions. The mobilization of the private sector, humanitarian agencies and the international community is essential to support the emergency response. However, only 20% of the 720 million USD budget of the 2023 Humanitarian Response Plan for Haiti has been received to date, so it is crucial to replenish emergency stocks to meet the needs of the affected population.

In addition to the low rate of disbursements, there are other factors which can hamper humanitarian response activities: insecurity due to the activities of armed gangs, the blocking of certain roads controlled by these gangs, the fuel crisis, and the unavailability of stocks on the market.

4.4 Lessons Learned and Recommendations:

The bad weather in Haiti highlights several lessons to be learned and calls for concrete action to strengthen resilience and disaster preparedness. Here are some key points:

Strengthening prevention and preparedness: Extreme weather events are becoming increasingly frequent. It is essential to invest in effective early warning systems, resilient infrastructures, and robust emergency plans. Awareness of risk prevention and training in adaptation measures must be stepped up to reduce human and material losses in future disasters.

Enhanced international cooperation: Natural disasters transcend borders. It is crucial to step up international cooperation in emergency response and resource mobilization. Partnerships between national organizations, humanitarian agencies and the international community must be strengthened for a coordinated and effective response.

Investing in community resilience: Local communities are the first to be affected by natural disasters. It is important to strengthen their resilience by providing them with knowledge, resources and capabilities to cope with crises. Training programs, risk reduction initiatives and insurance mechanisms can help empower communities and reduce their vulnerability.

Priority to sustainable reconstruction: After a disaster, it is essential to rebuild with sustainability in mind. This means rebuilding disaster-resistant infrastructure, promoting sustainable agricultural practices, strengthening health and education systems, and adopting environmentally friendly approaches. Sustainable reconstruction helps to reduce future risks and create more resilient communities.

Mobilizing adequate resources: It is imperative to mobilize adequate resources to support emergency response and long-term reconstruction. International donors, national governments and philanthropic organizations must commit to providing sufficient funding to meet immediate needs and build national capacity to cope with disasters.

Integrating the climate dimension: Haiti's bad weather is linked to climate change. It is essential to integrate the climate dimension into development and disaster risk reduction policies. This includes mitigating greenhouse gas emissions, adapting to the effects of climate change and promoting sustainable practices.

By learning from these events and acting accordingly, Haiti and the international community can work together to strengthen the country's resilience to disasters and ensure a safer future for its people.

5) Conclusion

The bad weather in Haiti has caused loss of life, displacement of the population and significant material damage. National and international organizations such as OCHA, DGPC, the private sector, humanitarian agencies and the international community have mobilized to provide an emergency response. Essential infrastructure, such as schools and health centers, has been damaged, requiring reconstruction and repair efforts. The agricultural sector has also been affected, with plantations destroyed and livestock lost. The humanitarian response includes the provision of shelter, food kits, hygiene kits and drinking water, as well as work to clear roads and sanitize flooded areas. It is crucial to mobilize sufficient resources to support the emergency response and meet the needs of the affected population. It is also necessary to learn from these events and strengthen prevention, preparedness, and resilience in the face of natural disasters. An appeal for solidarity and international aid is launched to support Haiti in its period of reconstruction and recovery. By adopting a holistic and long-term approach, it is possible to reduce the devastating impact of natural disasters in the region and strengthen community resilience.

6) Bibliography

- 1) [Atlas des Menaces Naturelles en Haïti \(2017\).](#)
- 2) ihsi.gouv.ht/indicateur-population
- 3) [Indicateurs et conjoncture - HAÏTI | Direction générale du Trésor \(economie.gouv.fr\)](#)
- 4) <https://www.haiti-reference.info/pages/plan/geographie-et-tourisme/milieu-naturel/desastres-et-accidents/cyclones-et-ouragans>
- 5) <https://www.meteo-haiti.gouv.ht/cyclone.php><https://www.mediaterre.org/actu/20191112092227.8.html>
- 6) www.mediaterre.org/actu/20191112092227.8.html
- 7) <https://disasterscharter.org/fr/web/guest/activations/-/article/hurricane-sandy-in-haiti>
- 8) [L'agriculture en Haïti : terriblement exposée, et presque sans assurance \(banquemondiale.org\)](#)
- 9) [Gestion du risque de catastrophe \(banquemondiale.org\)](#)
- 10) [Résilience des infrastructures : Comment les solutions fondées sur la nature peuvent améliorer l'infrastructure de transport ? Leçons d'Haïti \(worldbank.org\)](#)
- 11) [La commune de Léogane sévèrement touchée par les inondations - METROPOLE](#)
- 12) [Haïti : Aperçu humanitaire : intempéries du 3 juin 2023, au 21 juin 2023 - Haiti | ReliefWeb](#)
- 13) [Plan national de gestion des risques de désastres](#)
- 14) [Système d'alerte précoce : une réponse à la sécheresse et à l'insécurité alimentaire en Haïti | COOP](#)
- 15) [Haïti : Renforcement de la résilience face aux catastrophes et au changement climatique | GFDRR](#)



(c) Pakistan_GWP



(c) U.S._USACE



(c) U.S._USACE



(c) Pakistan_GWP



(c) Haiti_GWP



(c) Pakistan_GWP



(c) Japan_MLIT



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