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HELP Global Report

on Water and Disasters

HELP Water & Disasters
GRIPS
ADB ASIAN DEVELOPMENT BANK
ZURICH
Global Water Partnership

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Major Water-related Disasters under COVID-19 Pandemic in 2020-2021 and Lessons, Good Practices and Ways Forward

Dear Readers,

It is my great honor to share with you this HELP Global Report on Water and Disasters 2021, the third volume of the annual series that compiles experiences, lessons, and good practices that address the latest large-scale disasters related to water on Earth.

Of course, we all have been deeply enmeshed in the COVID-19 crisis during this period. The pandemic, defined as a biological disaster by the UN, has impacted every aspect of human society. Since the previous volume of this report was published in December 2020, the number of people infected worldwide increased from 70 million to 180 million (as of June 2021), and the death toll soared from 1.5 million to 4 million in just 6 months. Although the roll-out of vaccines in some countries has started to abate the catastrophe, the mutating virus has fanned out a flare of infections more fiercely in other countries. This serves as a stark lesson as to why international solidarity and cooperation is vital in order to counter global disturbances, such as mega disasters and climate change.

The risk of co-occurring disasters under the pandemic was the focus of attention and concern for many disaster managers. It was feared that large-scale disasters occurring in the middle of a pandemic may aggravate disaster impacts, spiraling them to an uncontrollable level. The HELP Principles to Address Water-related Disaster Risk Reduction under COVID-19 Pandemic, launched in May 2020, have been translated into 13 languages including the 6 official ones of the UN. They have been widely used in countries and in the field to help medical, DRR, and other stakeholders to prevent an explosion of the pandemic under co-occurring disasters. So far, the worst case scenario of a double impact wrought by disasters and the pandemic have been avoided.

This volume is dedicated to experiences and lessons of water-related disaster risk reduction under COVID-19. There were a number of large-scale disasters hitting many parts of the world from mid-2020 through to mid-2021: Cyclone Amphan in the Indian Sub-continent, Hurricanes in Northern and Central America, heavy rain and flooding in China, Japan, Kenya, Nepal, Pakistan, etc., to name a few. Countries and international organizations have addressed co-occurring disasters under the pandemic with all of their might. The valuable lessons learnt and good practices implemented during this unusual period of fierce biological disaster will yield invaluable lessons and pathways to enhance our preparedness in the future, for all kinds of disasters, particularly for co-occurring ones.

I hope this volume will help decision makers, administrators, practitioners, people of academia, NGOs, the private sector, and citizens from all walks of life to be better prepared for the next pandemics and disasters, and to build back the resilient post-corona world better.

Dr. Han Seung-soo

Chair, High-level Experts and Leaders Panel on Water and Disasters (HELP)
Former Prime Minister of the Republic of Korea

Water related disaster may complicate COVID-19 pandemic responses, including health risk for the first responders and for the evacuees. Both for water disasters and pandemic, we can state that those cannot be prevented at once, but certainly we can, and must, reduce the likelihood and the impact.

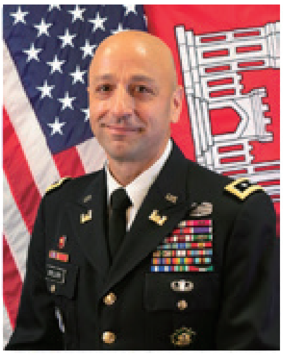
Reports and lesson learned from series countries still dominate this publication. Impacts of COVID -19 pandemic to country and regional development and COVID -19 from risk management perspective are also presented. Study on changes of water consumption pattern during COVID -19 pandemic has been carried out and reported for case in Indonesia. The results showed that the government is required to be more innovative and aggressive to pursue investment on clean water for community.

The current vaccine development effort will certainly reduce the uncertainty and bring more expectation to better situation after COVID-19 pandemic. However, over confidence may results in a worse condition. The COVID-19 prevention protocol is still need to be implemented: washing hands, wearing masks and implementing physical and social distancing. Disaster emergency responses ensure mobilization of workers, materials and tools must be implemented by complying the COVID-19 prevention protocol. Otherwise the COVID-19 pandemic will amplify and the field condition become more complicated.

During this difficult situation, I believe it is time to strengthen our close partnerships and cooperation to reduce water-related disaster risk while at the same time to overcome the COVID-19 pandemic. As the Vice Chair of HELP, I would be greatly supportive to strategic efforts taking into account preparedness and response to cope with these co-occurring disasters and mitigate its impacts.

Basuki Hadimuljono

Vice Chair of HELP
Minister of Public Works and Housing, the Republic of Indonesia



Over the past year, the COVID-19 pandemic threatened global health and livelihood, challenged our understanding of science, and changed the way businesses, society and families interacted. The pandemic continues to be a challenging threat with widely varying progress, in reducing infections and increasing vaccinations, around the globe. However, the outlook for a positive, sustainable "new normal" looks bright for all.

The U.S. Army Corps of Engineers' (USACE) response to the pandemic proved an unprecedented event with the USACE quickly expanding the United States' capacity to administer life-saving care through the construction of Alternate Care Facilities (ACFs) and providing engineering support for the design and development of Federal Vaccination Centers that assisted with the U.S. effort to provide 200 million vaccinations in 100 days in early 2021.

However, the presence of a pandemic did not prevent the normal occurrence of floods, wildfires, on-going construction of water resources infrastructure, and operation of facilities that support U.S. flood risk management, navigation, and hydropower production activities. People are our greatest resource, therefore, in meeting the nation's disaster response needs we were diligent in monitoring the health of our employees, providing personal protective equipment, and establishing standard procedures for travel, social distancing, and business operations during the pandemic. In addition, nearly 80 percent of our 36,000-person workforce were able to effectively operate under "maximum telework" to minimize COVID exposure. The results from the virtual work environment were successful and many practices will be carried into the USACE post-pandemic workplace transformation plan.

Through the COVID experience we validated the skill, perseverance, and dedication of the USACE workforce, while learning how to operate successfully in a pandemic environment. The process was not easy, but our leaders and employees rose to the challenges. The USACE article included in this report provides details of USACE solutions to this year's unique challenges.

We are most pleased to have an opportunity to further initiatives and discussions that improve Disaster Risk Reduction (DRR) concepts and approaches. Such contributions demonstrate our commitment to strengthening relationships as well as our responsibilities as water resources professionals.

Essayons,

Scott Spellmon
Lieutenant General, US Army
Chief of Engineers
U.S. Army Corps of Engineers

1 1.Overview of Water-related Disasters and Challenges of Disaster Risk Reduction under COVID-19 in 2020

Kenzo Hiroki

Professor, National Graduate Institute for Policy Studies (GRIPS) and Coordinator of High-level Experts and Leaders Panel on Water (HELP)

Water-related disasters in 2020 resulted in death toll of 8,400, over 97 million affected people, and economic loss of 152 billion US Dollars worldwide.

Challenges by cooccurrence of COVID-19 and water-related disasters continue despite vaccination throughout the year and beyond. Post-corona society should be more resilient to sudden and slow onset disturbances and changes. Integrated management of water-related disasters should be a core piece in holistic risk management policies and practices.

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

The year 2020 was characterized by recurrent water-related disasters under the pandemic of COVID-19, an unprecedented biological disaster. 8,425 people lost their lives by 356 water-related disasters (e.g. floods, tsunamis, slides and debris flow, storms, and droughts) out of total yearly death of 15,080, meaning that 56% of deaths were caused by water-related disasters. Despite 2020 was the world's hottest year, the year's number and impact of water-related disasters increased. According to EM-DAT (International Disaster Database) of Centre for Research on the Epidemiology of Disasters (CRED), 97.1 million people were affected by water-related disasters out of 98.4 million of people affected by all disasters, meaning 98.7% of disaster-affected people were caused by water-related disasters. Share of death by water-related death (56%) is much higher than the average of the recent ten years (24%). Top 10 Countries by occurrence of disaster sub-groups (2000-2019) with focus on water-related disasters are shown in Figure 1.1.

The increasing trend of number of affected people by water-related disasters continue due to, inter alias, climate change, population growth, and urbanization. In the recent twenty years (2000-2019) number of people affected by water-related disasters is 3.87 billion and accounts for 94% of total (4.03 billion). Climate change is a major factor to exacerbate nember, severity and impact of water-related disasters as shown in Figure 1.2.

Table 1.1 Death Toll by Disaster Type (2020 vs. average 2010-2019)

Event	2020	Average (2000-2019)
Drought	0	1,063
Earthquake	196	8,296
Extreme temperature	6,388	8,296
Flood	6,171	5,233
Land slide	512	892
Mass movement (dry)	0	19
Storm	1,742	9,985
Volcanic activity	1	80
Wildfire	1	80
Total	15,080	61,709

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

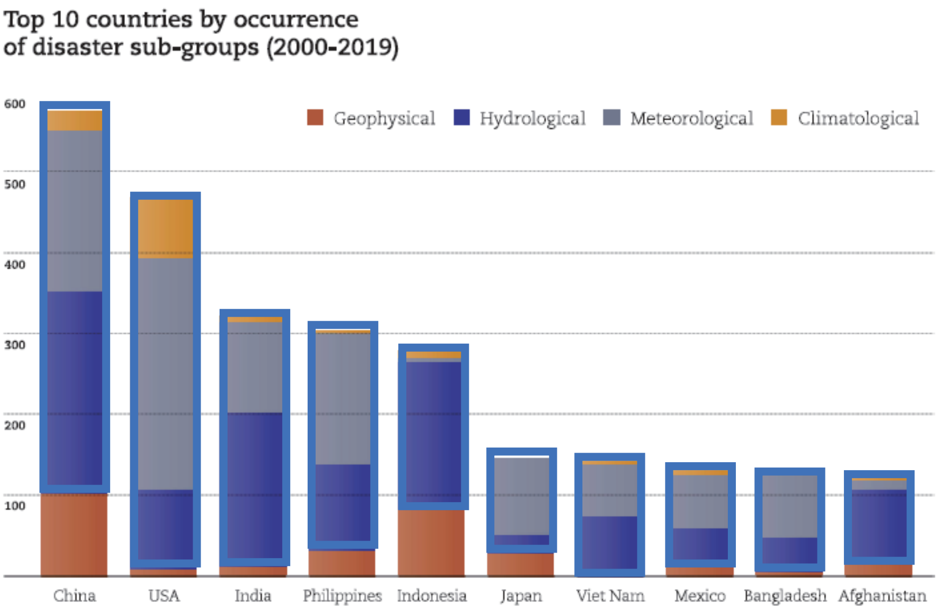
Table 1.2 Top 10 severest disaster events by death toll in 2020

Country	Name of event	Death toll
UK	Heat Wave	2,556
France	Heat Wave	1,924
India	Flood	1,922
Belgium	Heat Wave	1,460
Nepal	Flood	448
Pakistan	Flood	410
The Netherlands	Heat Wave	400
Kenya	Flood	285
China	Flood	280
Bangladesh	Flood	257

Source: 2020 The Non-COVID Year in Disasters

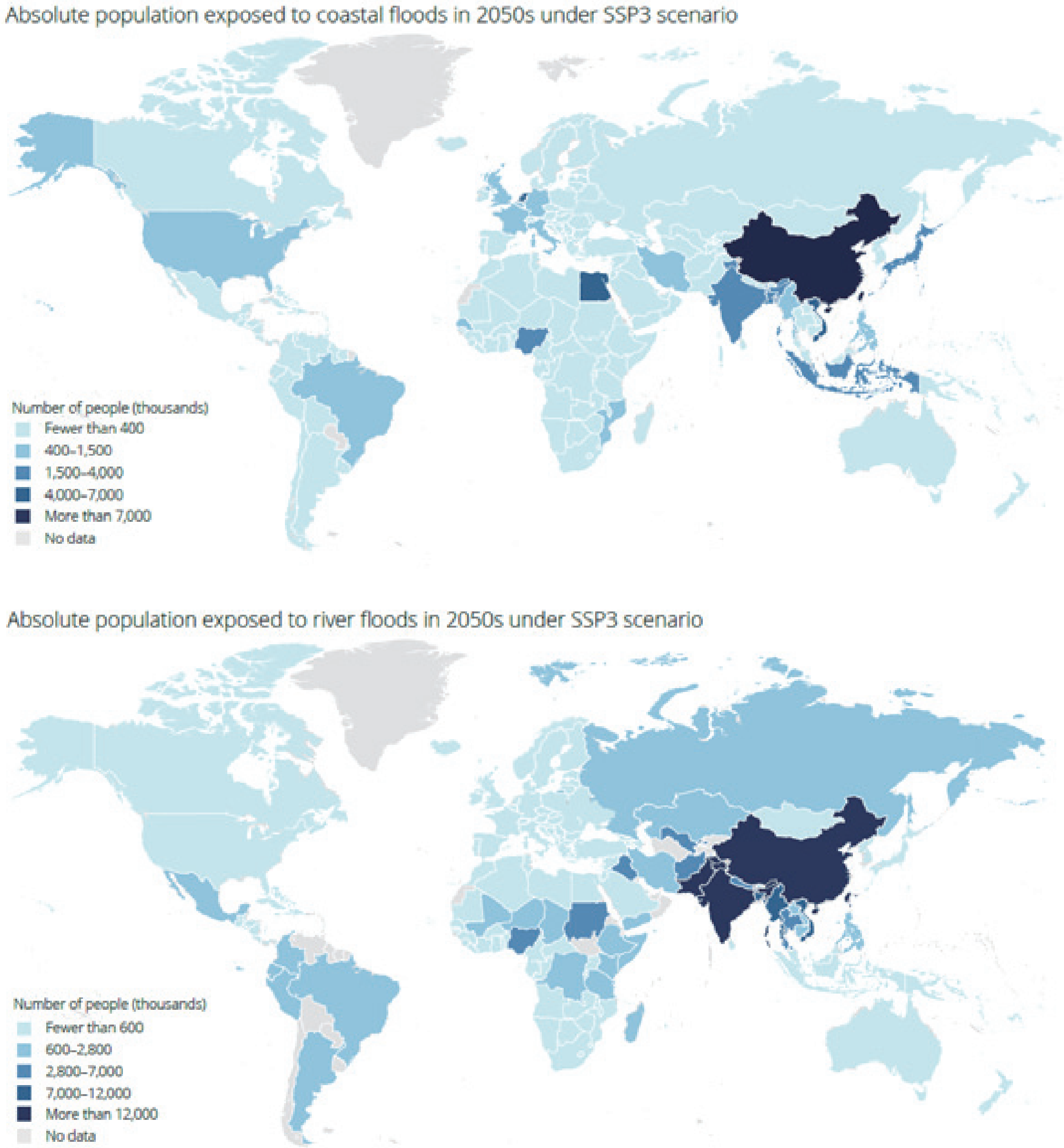
Figure 1.1 Top 10 Countries by occurrence of disaster sub-groups (2000-2019)

Water-related disasters (Hydrological, meteorological and climatological disasters)



Source: Human cost of disasters 2000-2019 (CRED and USAID)

Figure 1.2 Maps of absolute population exposed to coastal and river floods in 2050s by climate change under SSP3 scenario



Source: INFORM; Marzi et al, 2020.
Notes: INFORM risk projections are based on GAR2015 exposed population, expected annual exposed population based on GLOFAS hazard maps (Dottori et al, 2018, 2016), probabilistic coastal flood simulations of extreme sea level and Standardized Precipitation Evapotranspiration Index from CMIP5 simulations. See also Alfieri et al, 2017; Vousdoukas et al, 2018
SSPs are "Shared Socioeconomic Pathways" which are used by the IPCC to model different future scenarios based on demographic and economic trends. SSP3 is a scenario with high challenges for mitigation and adaptation, meaning slow development, persisting high inequalities and continued competitive and regionalized land and energy policies.

2 Economic loss by water-related-disasters

According to statistics of Munich Re., the overall economic impact by disasters in 2020 was US$ 210 billion, of which US$ 82 billion was insured.” Tropical cyclones, hurricanes, and typhoons hit and caused severe damage in various parts of the world. The annual loss of 210 billion USD was much higher than 166 billion in 2019 and average of 149 billion in the recent twenty years of 2000-2019. Four out of top five

Water-related disasters accounts for 74% (2.169 trillion USD) of total. The economic loss by disasters are in increasing trend as shown in the figure 1.1.

Table 1.4 Global economic loss by disasters in 2020 and 2019

	2020	2019
Number of events	980	860
Total loss n USD	210 billion	166 billion
Total insured loss n USD	82 billion	57 billion

Source: © 2021 Munich Re, NatCatSERVICE. As of January 2021.

Table 1.5 Top 5 disasters with highest economic loss

Date	Country	Event	Fatalities	Total loss in million USD	Insured loss in million USD
May 21 - May30	China	Flood	158	17,000	350
May 16.- May 20.	Thailand, Sri Lanka Bangladesh, India,	Cyclone Amphan	135	14,000	minor
Aug. 26- Aug.28	U.S.A.	Hurricane Laura	33	13,000	10,000
Aug.- Nov.	U.S.A.	Wildfire in California	32	11,000	7,500
Aug.8- Aug.12	U.S.A.	Convective Storm	4	8,800	5,000

From “Facts + Statistics: Global catastrophes” by Insurance Information Institute using Source: © 2021 Munich Re, Geo Risks Research, NatCatSERVICE. As of January 2021.

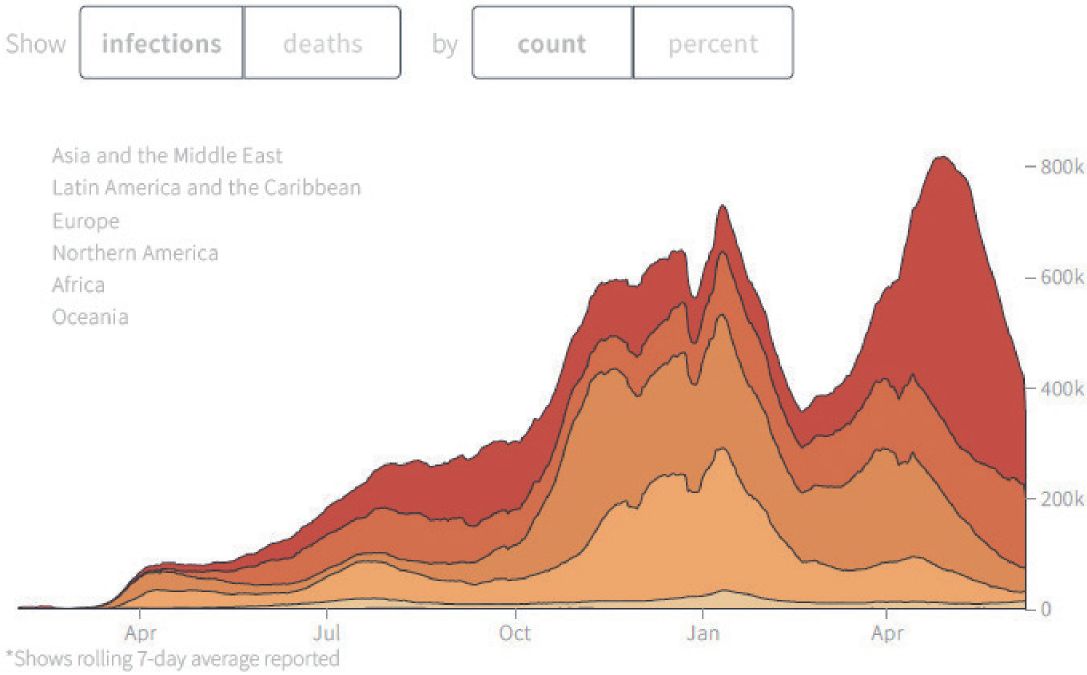
3 Major water-related disasters in 2019

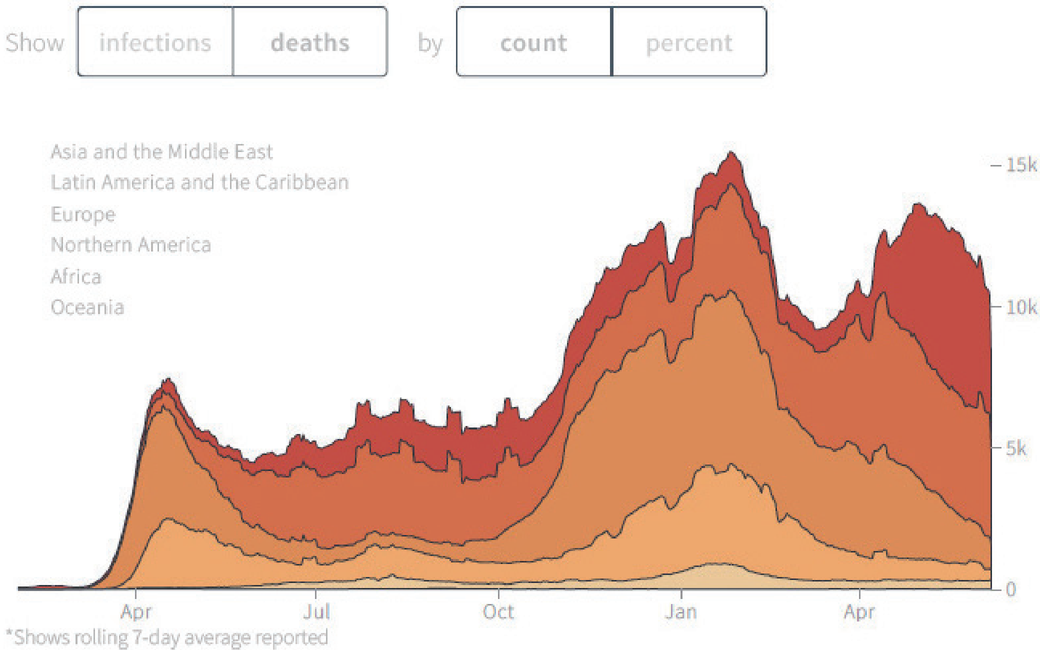
Severe water-related disasters happened in all continents and many islands. Major water-related disaster events include Cyclone Amphan in India, Bangladesh, Thailand and Sri Lanka in May, Floods In Assam, India in May-August, Heavy rain and Floods in West Japan in July, Floods in Southern China in June-July, Floods In Jakarta, Indonesia in January, and Hurricane Eta and Iota in United States and Central America in November.

4 Breakout of COVID-19 in 2020 and creation of HELP Principles to Address Water-related Disaster Risk Reduction under the COVID-19 Pandemic

The year 2020 was marked by outbreak and continuation of COVID-19, which is in itself a major health disaster and in many senses related to water. COVID-19 that broke out first in China in late 2019 or early 2020 spread rapidly across borders literally to all continents and islands on earth. It became one of the worst pandemics through history. The number of infected increased exponentially in all regions as shown in Figure 1.2. As of June, 2021 global total number of infected cases is 175 million and of death over 3.7 million.

Figure 1.3 Number of Infected and dead by COVID-19 (Jan. 2020- June 2021)





Source: Reuters, COVID-19 Global Tracker

https://graphics.reuters.com/world-coronavirus-tracker-and-maps/

High-level Experts and Leaders panel on Water and Disasters (HELP) took immediate action to help countries and stakeholders to address the unprecedented “twin pandemics”. It convened experts from 23 experienced organizations comprising governments, international organizations, academic institutes, private sector and civil society organizations to create a set of principles to properly and safely manage address disaster risk reduction under COVID-19. The Principles called “HELP Principles to Address Water-related Disaster Risk Reduction under COVID-19” were launched on May 31st, 2020. They have been currently translated into 13 languages including 6 UN official languages. 5 regional workshops were held in countries to discuss and promote use of the Principles in regions and countries. The Principles have been widely used in fields to help practitioners and stakeholders to address co-occurring disasters and COVID-19.

2

1.Overview of Major Water-Related Disaster in Japan in 2020 and a new policy, "River Basin Disaster Resilience and Sustainability by all"

Akihiro Shimasaki

Director for International Coordination of River Engineering, Water and Disaster Management Bureau,

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

1 Overview of the Water-related disaster and risk reduction policy in Japan

Water-related disasters hit Japan every year. Disasters struck Izu-Oshima island in 2013, Hiroshima city in 2014, Kanto-Tohoku region in 2015, 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 and Kumamoto Prefecture in Kyusyu region in 2020.

Heavy disasters are annual events in Japan, therefore the central and local governments are most often in a cycle of preparedness, disaster, response and recovery. In the cycle, Japanese society has been urging policy-makers and infrastructure managers to reduce disaster risks and damages and to prevent disasters from events of similar scales in the future. Post-disaster work is preparation in view of the next one. This is the basic concept of “Build Back Better”. However, disasters vary in magnitude and frequency, and people living in disaster-prone areas have to face unprecedented events.

This chapter describes the overview of the flood disaster by torrential rain in 2020, and the policy-making process by MLIT based on the changes in the climate and social environment.

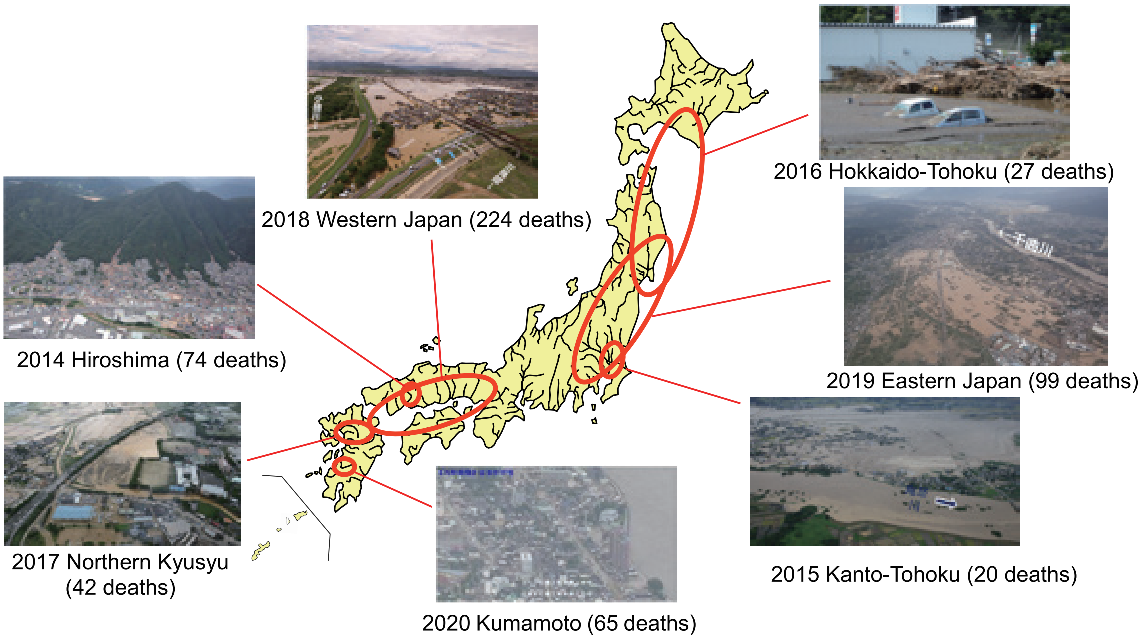


Fig.1 Successive water-related disasters hitting Japan

2 Total Damage from Water-Related Disasters in 2019 (preliminary estimate)

According to the preliminary estimate by the floods damage statistic survey, the total direct damage from water-related disasters in 2019 amounts to 2.15 trillion yen, which is the largest annual damage from water-related disasters except for tsunamis in the record since 1961.

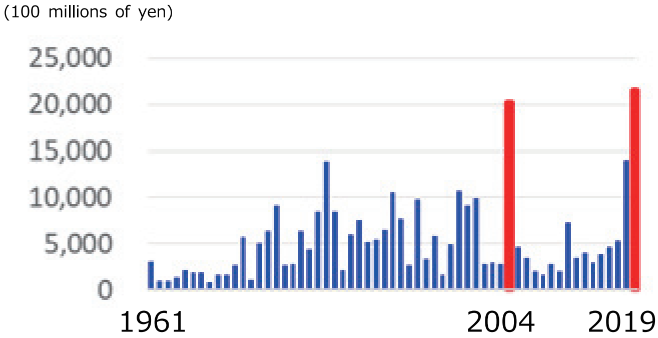


Fig 2 Annual Flood Damage (Nominal Amount)

(Break down of flood damage in 2019)

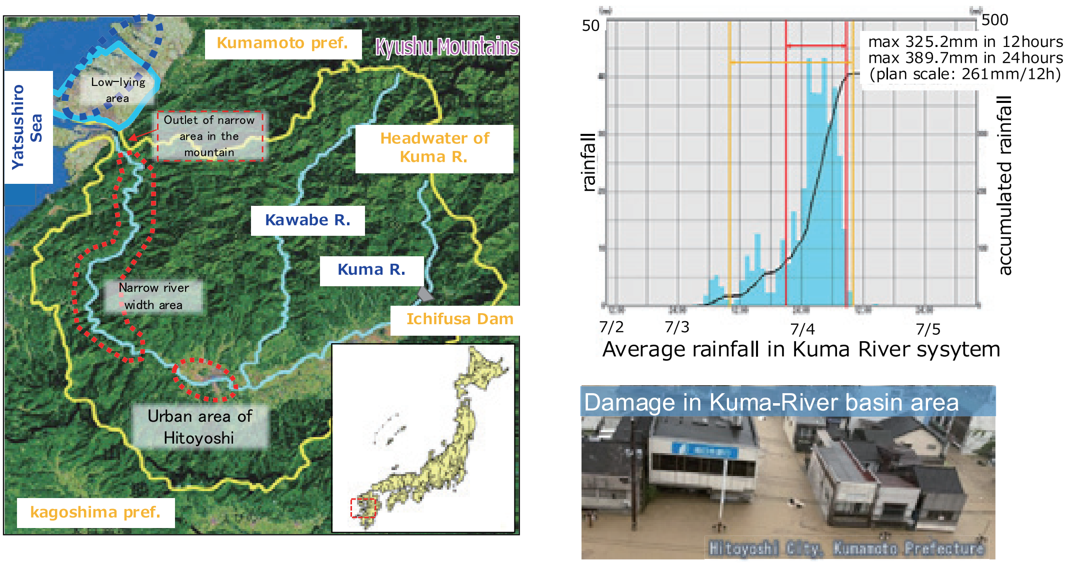
General Asset	¥1,593.9 billion (74.2%)
Public Infrastructure	¥523.3 billion (24.4%)
Public Services	¥30.4 billion (1.4%)
Total	¥2,147.6 billion

3 Overview of the Torrential Rain in July 2020

3.1 Hydrological Assessment

Unprecedented rainfall from July 3rd to 31st in Japan's Kumamoto Prefecture and elsewhere caused extensive flooding and levee breaches. At least 80 people died or remained unaccounted for, and around 14,000 houses were inundated.

The prefecture's flood-prone Kuma River has a geographical formation in which water flows downstream quickly into a bottleneck area, and the torrential rain exceeded its capacity.



Note: The information above is based on the initial reports and is subject to change according to the future investigations.

Fig.3 July 2020 Torrential Rainfall outline

The highest water level in the record was observed at several gauge stations in Kuma River and its biggest tributary, Kawabe River.

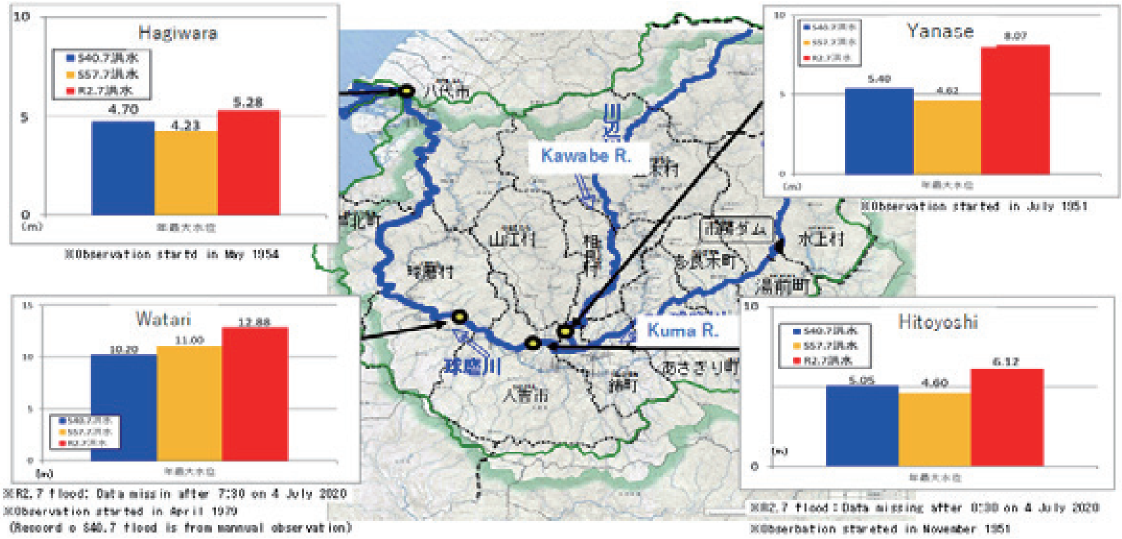


Fig.4 Annual Highest Water Level in kuma River and Kawabe River (Preliminary data for R2.7 flood)

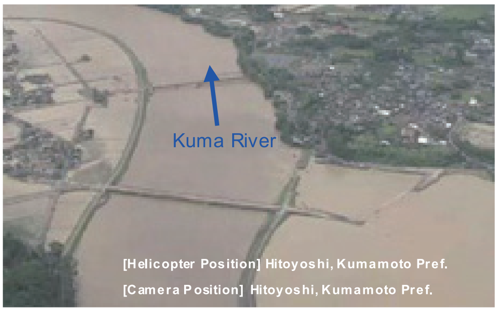
3.2 Summary of the damages

Flood disasters occurred due to collapsed embankment etc. in 10 rivers in 7 MLIT managed river systems and 193 rivers in 58 prefecture managed river systems (Embankments collapsed at 2 locations on 1 MLIT managed river and at 3 locations on 3 prefecture managed rivers, MLIT report in October 2020).

Sediment related disasters observed at 961 sites (Debris flows etc.: 178 cases; Landslides: 74 cases; Slope failures: 709 cases), which caused 16 fatalities and 225 damaged houses, including 37 totally destroyed and 27 half destroyed houses.

Damages were observed in 25 sections on 16 Expressway routes, 29 sections on 10 MLIT managed National Highways, and 725 sections of prefecture managed roads.

Regarding railways, 20 routes of 13 companies were damaged duet to floods or sediment-inflow etc. Bridges were washed away on the JR Kyushu Kyudai/Hisatsu Line and the Kumagawa Railway in 4 places.



Kuma River, Kuma River System
(Hitoyoshi, Kumamoto Pref.)

Kuma River, Collapsed Fukami Bridge
(Yatsushiro, Kumamoto Pref.)

Kuma River,Collapsed Kuma River Bridge No. 4 (Sagara-Nishiki-cho, Kuma-gun, Kumamoto Pref.)

Damage due to debris flow
(Tsunagi-cho Fukuhama, Ashikita-gun, Kumamoto)

Fig.5 Examples of Damages by Torrential Rain in July 2020

3.3 Technical Emergency Control Force (TEC-Force)

TEC-FORCE (Technical Emergency Control Force) is a specialist group, established in MLIT, which provides fast technical assistance for the affected municipalities to help make fast damage assessment, prevent the occurrence or escalation of disaster, and implement faster restoration and any other temporary disaster responses against large-scale natural disasters, such as earthquakes, flood or landslide disasters, etc.

Just after damages reported, MLIT dispatched TEC-FORCE to affected municipalities, 22 prefectures and 67 municipalities. The number of MLIT members mobilized amounted to 8,511 man-days in total (from 4 to 31 July 2020) from regional branch offices of MLIT.

Fig.6. TEC-FORCE activities

3.4 Preliminary water discharge to efficiently use reservoir volume for flood control

In Kiso River in Gifu Prefecture, preliminary water discharge was conducted in 8 reservoirs for water supply and hydraulic power generation to temporarily secure flood control capacity during the July 2020 Heavy Rain event. It is estimated that at Momoyama Gauging Station, the preliminary discharge by 5 upper-stream reservoirs contributed to reduce maximum water flow by about 20 %.

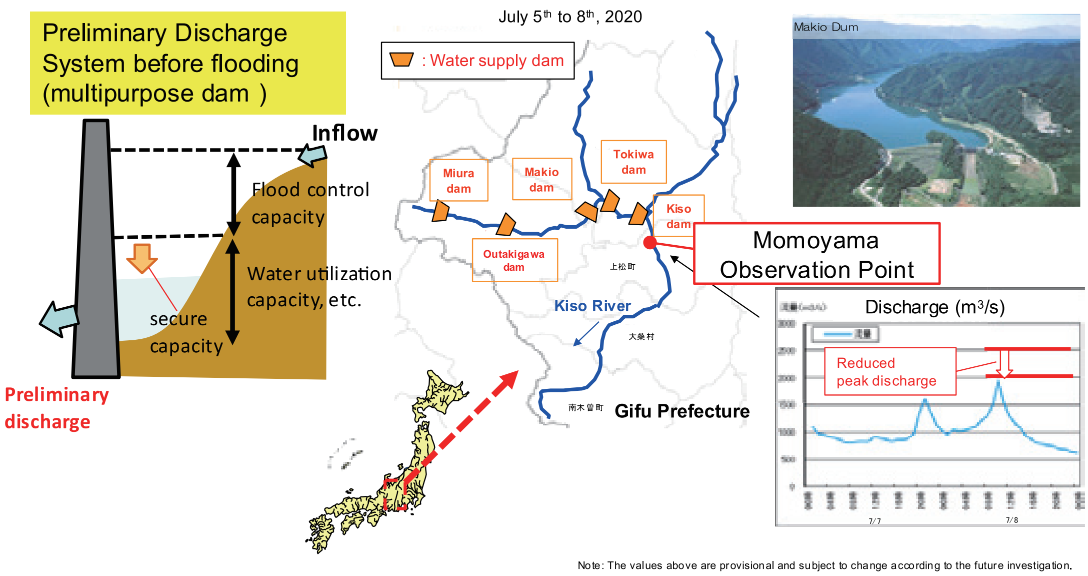


Fig.7. Effects of preliminary discharge

4 A new policy, "River Basin Disaster Resilience and Sustainability by all"

4.1 Background

The Panel on Infrastructure development issued a report on water-related disaster risk reduction (DRR) considering climate change in July 2020. The report has recognized the enormous damages by recent water-related disasters, advanced reconstructive actions based on the former “water-related DRR conscious society”, and advocated the water-related DRR with the concept of the “River Basin Disaster Resilience and Sustainability by All”, which calls for all stakeholders to consider DRR as natural, mainstream DRR, and take collaborative actions in each river basin including watershed and flood plain area.

MLIT has been developing and implementing DRR measures based on the report to achieve resilient and sustainable society against water-related disasters under the impact of climate change. Following paragraphs overview the new policy and ongoing efforts for water-related disaster risk reduction in Japan.

4.2 Climate change impact on precipitation in Japan.

The future forecast by climate change assumed the intense rain in short duration, more frequent and intensified rainfall, more total rainfall, rise of the average sea level, more sea level deviation from normal. There is fear of occurrence of severe and frequent water-related disasters and another mega disaster combined landslide, flood, storm surge and inundation.

The records of precipitation show the increase of frequency is about 1.4 times for hourly precipitation above 50mm, and about 1.7 times for hourly precipitation above 80mm, compared with about 30 years before

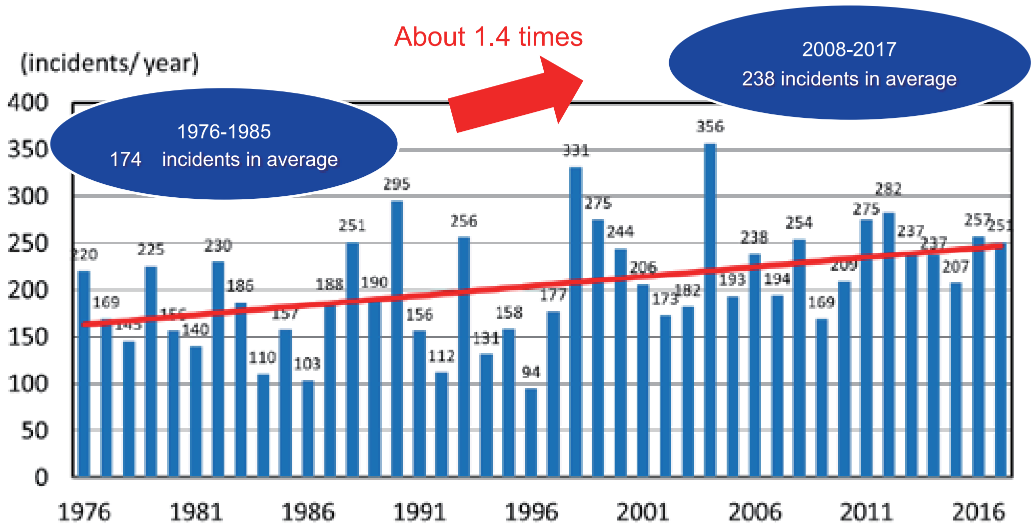


Fig. 8 The trend of the frequency of rainfall (50mm / hr or more) in last 30 years in Japan

MLIT established the Expert Group meeting for flood control plan under climate change to estimate the rainfall increase in the future, which provides the assumed information on facility design based on flood control plan.

It is estimated that about 1.3 times increase on the target rainfall, about 1.4 times increase on the flood flow, and about 4 times on the average frequency of flood, for flood control plan in the major rivers from the end of 20th century to 21st century in the case of 4 degree rise of world average temperature compare to before the Industrial Revolution. Even in the case of 2 degree rise (target scenario for the Paris Agreement), the result estimated about 1.1 times increase on the target rainfall, about 1.2 times increase on the flood flow, and about 2 times on the average frequency of flood, for flood control plan in the major rivers from the end of 20th century to 2040 in the major rivers.

<The expected changes in the precipitation by region>

Region	2℃ increase	4℃ increase	
			short time
Northern and Southern Hokkaido	1.15	1.4	1.5
Northwest Kyushu	1.1	1.4	1.5
Others including Okinawa	1.1	1.2	1.3

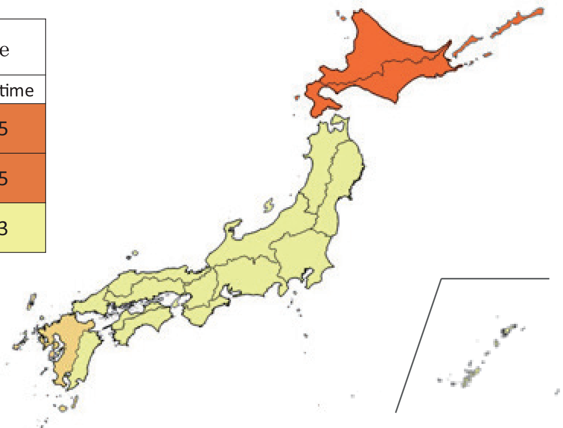


Fig. 9 The expected change in precipitation by temperature increase

4.3 Future direction of water-related disaster risk reduction

The river improvement works and urban works take long duration of time, therefore these planning should consider the climate change despite of the uncertainty on the forecast. Without the consideration, frequent change and additional works may happen so it should take longer period to complete necessary works.

It is difficult to maintain safety for water-related disasters only by traditional structural measures by river administrators considering the increasing external force by climate change as structural measures take time. Therefore, it's necessary not only to accelerate traditional disaster risk reduction projects by administrators, but also to consider the river basin as one comprehensive system from its catchment to river area including the floodplain, and involve all stakeholders there even who did not join before for the disaster risk reduction.

Population decreases, the declining birthrate and growing proportion of elderly people, and rise of vacant land use and abandoning cultivation farmlands appear in river basins. The land use in the basins needs to be changed dramatically to "compact plus network". Such changes require the water-related disaster risk sharing in the basins by reconsidering land use planning and water-related disaster risk reduction by new land use. The risk sharing needs the knowledge sharing among stakeholders, and combination of water-related disaster risk reduction and land use/urban planning. It's also necessary to use effectively the existence stock in the basin such as retarding securement of new place and utilization of the multilateral function for overflow.

Remarkable development has been observed in information: acquisition of information by new tools such as the IT utilization like 5G, IoT, artificial satellite and drone, processing of information by AI technology and these big data. The digitalization in society like contactless and remote-typed measures has developed under the new coronavirus infection. The platform where all stakeholders in the basin can work for water-related disaster risk reduction, should be built to utilize these technologies, share information and knowledge on water-related disasters, accumulate them sustainably and use the information effectively. Interdisciplinary innovation for water-related disaster may happen in the fields of the assessment of current conditions and the forecast of water-related hazard risk, the information sharing, and risk reduction methods. Such technologies should be introduced early and advanced for application in fields.

These climate, demographic, and social changes, and the technological innovation will provide the various impacts in wide fields. The protection of people's lives and assets from water-related disasters needs inclusive risk communication on knowledge and information on water-related disasters, land use planning, community vitalization and more productivity for population decrease and ageing society, resilience, and sustainability under positive participation of all stakeholders.

Resilience: Tough and flexible society with minimizing the loss of human lives and the economic damages even under the worst situation under maximum water-related disasters, responding and recovering early and avoiding falling malfunction on economic activity.

Sustainability: Even if a catastrophe occurs, community can be restored promptly, moreover improve the international competitiveness and also contribute to national growth strategy.

Inclusiveness: All stakeholders in the basin interdisciplinary from various fields always pay attention to water-related disaster risk reduction collaboratively, and advance countermeasures on water-related disaster risk reduction on a viewpoint jointly from various technological innovation.

Japan aims to build a more disaster-resilient society with the cooperation of all stakeholders around basins by preventing the loss of human life and catastrophic damages, and proceeding to prompt response and recovery

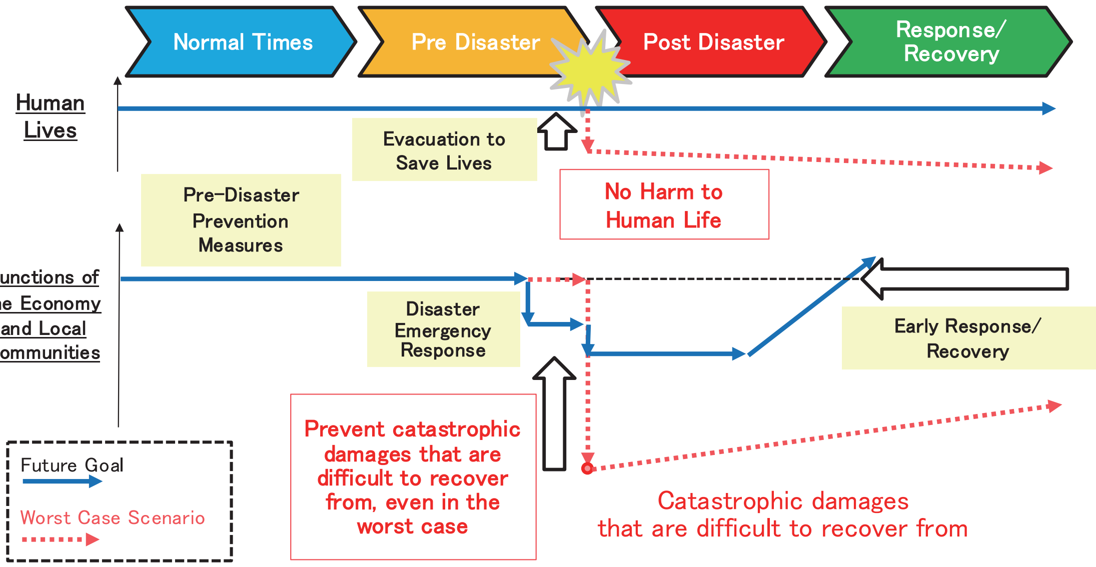


Fig. 10 Concept of Water-related Disaster Risk Reduction in Japan

4.4 Water-related disaster risk reduction to be conducted promptly

4.4.1 Reconsideration of the plans and the standards

The flood control facilities for rivers, sewage and coasts have been planned, designed and arranged based on precipitation and tide level records in the past or their statistical analysis.

The long-term river management plan sets a target flood which shows the basis of a flood protection plan, the annual probability of exceedance 1/100-1/200 in case of major rivers administrated by MLIT. The mid-term river improvement plan set the lists of the improvement works in 20-30 years based on the basic management policy. However, these plans may not be able to secure safety considering impacts of climate change such as rainfall increase and sea level rise. MLIT has commenced the revision of these plans considering impacts of climate change such as 1.1 times precipitation in case of the scenario below 2 degrees Celsius of global temperature rise, target scenario of Paris Agreement of climate change.

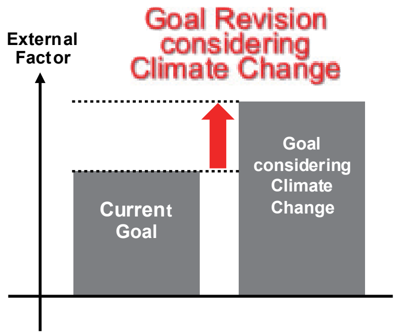


Fig. 11 Image of revisions of plans

4.4.2 Conversion to "River Basin Disaster Resilience and Sustainability by All "

(1) Enhancement of flood prevention measures

It is necessary to enhance and effectively combine flood prevention measures such as storing rainwater and running water, increasing discharge capacity of rivers, controlling flooding water for improving safety against water-related disasters at the whole basin.

It is first necessary to further accelerate ongoing structural measures such as embankment improvement, channel dredge, dam and retarding basin construction by river administrators, the improvement of rainwater line and underground storage by sewage administrators.

It is important to ask for the cooperation to the stakeholders who have not been consulted with previously. The platform where such stakeholders can cooperate for the basin management should be set and flood prevention measures such as the implementation of preliminary discharge by water users' dams, installation of rainwater storage/penetration facilities around urbanized / populated areas by local governments or private sectors, and conservation of forests and agriculture lands to maintain water holding and retarding function, considering the characteristics of the river basin.

Further, the technological research and development about embankment reinforcement should be advanced for "persevering embankment" difficult to be burst even if flooding occurs. This can reduce the flood amount during flooding, at higher risks in particular.

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(2) The measure to reduce a damage target - exposure reduction

The flood prevention measures are primarily taken to reduce water-related disaster risks, but it is also desirable to take the measure for damage minimization as well in case that flood may occur. Specifically, following measures are effective for reducing flood damages: regulation for land use and way of living in water-related high-risk areas, leading resident and urban function to the lower risk areas, limiting the flooded area, the augmentation in land for housing in an area with flooding risk, and the device of building structure.

Land use and the building structure have been regulated by designating the high-risk area as a hazard area, but these were performed with river works. There is still new development even in the area with high water-related hazard risk, and flood damage occurs there. Therefore, it is important to collaborate with urban planning sectors, connecting water-related disaster risk reduction with "compact plus network", lead to the low-risk zones and give devices of how to live. For local revitalization, the community should take the leading measures for urban planning resilient to water-related disasters according to each characteristic.

It is necessary that all kinds' information about water-related hazard risk is being estimated appropriately and is being reflected in actual measures. Risk information about water-related disasters has been published mainly for smooth evacuation by residents to protect their lives, but these should be improved for urban planning. Water-related hazard risk evaluation should apply to the risk reduction around a whole basin.

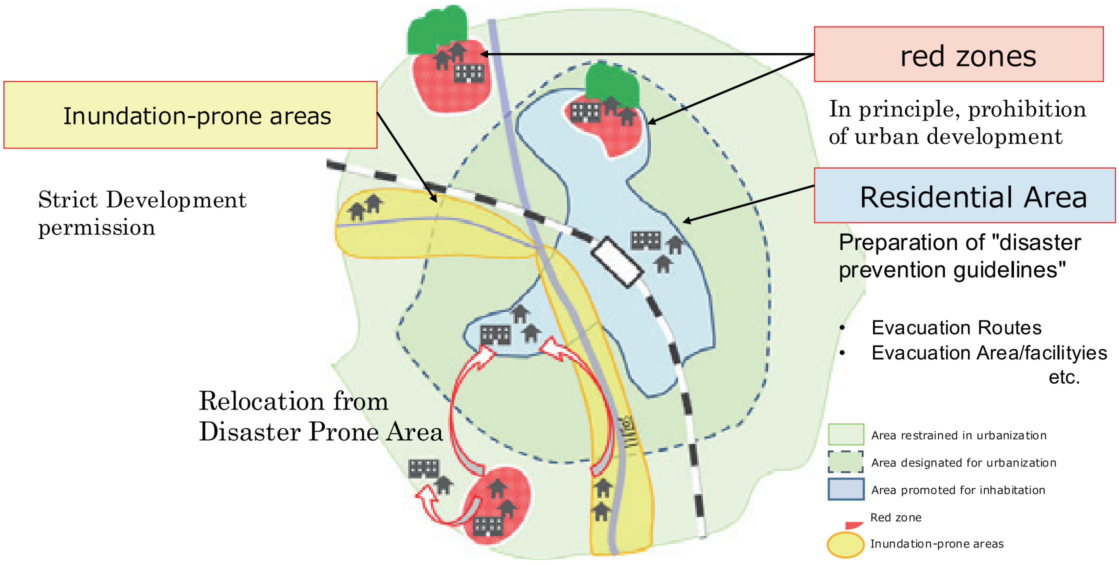

Fig. 12 Image of land use management

(3) Damage reduction, early response and recovery - Disaster resilience

The damage to people's live and social economic assets should be minimized even when floods and sediment disasters become inevitable. Public sectors should provide the information on water-related hazard risks appropriately. It is important that every stakeholder in the basin have information and attitude on water-related disasters, prepare beforehand, and take appropriate actions during the disasters.

Various measures for more effective evacuation have been taken place, such as designating flood forecast and flood alert rivers for flood suffered rivers, preparation of flood hazard area maps, flow observation, and providing those information to the resident.

Besides, the flood fighting act was amended to oblige facility managers to prepare a flood prevention plan and to conduct evacuation drill for underground facilities with high flood risk, and to prepare a plan to secure evacuation for welfare facilities for people who need special assistance. The national and local governments have been cooperating to support the facility managers to implement the obligations.

The evacuation drill and disaster risk reduction education have been implemented all over the country for awareness raising and effective evacuation. "My timeline" has been developed as an individual action plan for emergency situations.

The 2019 Typhoon Hagibis shows the damage to people's lives in the water-related risk information blank areas as well as in the estimated flood inundation areas because of escape delay. Evacuation system should be further improved by reinforcing existing activities.

National support including TEC-FORCE has worked for assistance to affected areas as measures of early response and recovery. Such support mechanism by national government should be reinforced and strengthened by the cooperation among all stakeholders in a whole river basin.

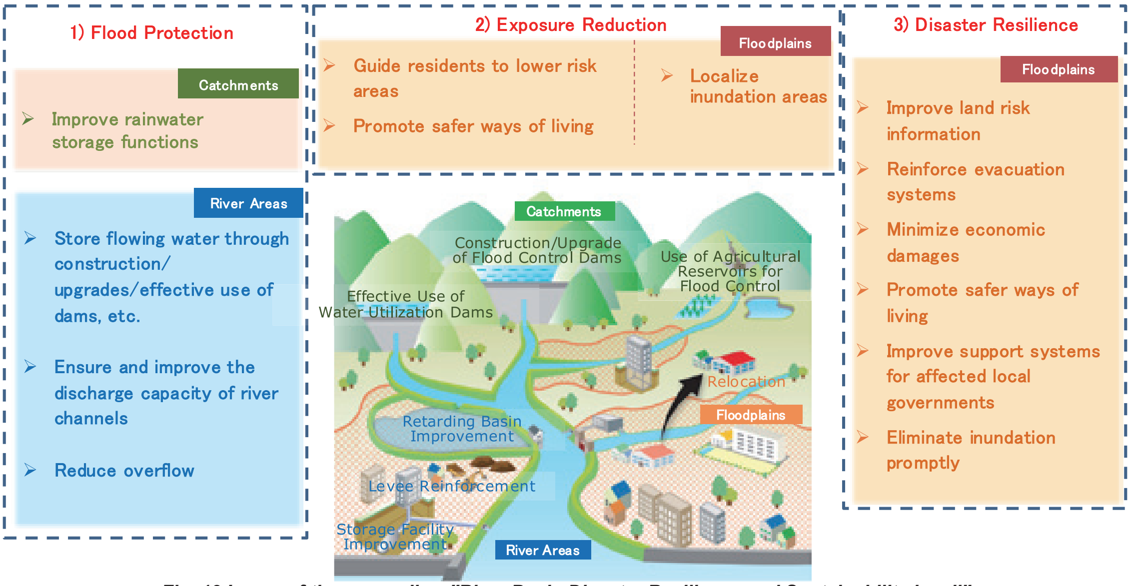

Fig. 13 Image of the new policy, "River Basin Disaster Resilience and Sustainability by all"

4.4.3 Acceleration of ex-ante measures for DRR

It is necessary that the preparation for disasters should be further accelerated with sufficient budget allocation.

In case the preparation for disasters has not taken place and a disaster occurs, comprehensive measures combining structural and nonstructural measures should be promoted by building back better beyond simple recovery, building resilient society and updating the land use at affected areas.

There is fear of increasing water-related disaster risks through more severe and frequent torrential rainfall and higher tide by future climate change. The planned safety level cannot be secured only by constructing the flood prevention facilities based on the current plan. The improvement plans should be updated considering climate change impacts, and further accelerated.

4.4.4 Social mechanism mainstreaming disaster risk prevention and reduction

(1) Daily life considering disaster prevention and reduction

National government, local governments, private sectors and individual resident should consider disaster prevention and reduction in their daily lives for the implementation of the "River Basin Disaster Resilience and Sustainability by All" with cooperation by all stakeholders. It is important to include the aspect of disaster prevention and reduction into their daily knowledge and actions.

Therefore, the whole society's preparation for disasters (disaster prevention and reduction capacity) should be enhanced through their daily life considering disaster prevention and reduction, and through reorganization of administrative processes, economic activities and various works considering the aspects of disaster prevention and reduction.

It is important to make the individual more prepared by providing disaster prevention education at schools and encouraging participation in disaster prevention activities, so the residents can collect necessary information and take appropriate preventive actions by themselves.

(2) Visualization of the effect of the various stakeholders’cooperation in the basin

For the measures by various stakeholders in the basin, it is desirable that each stakeholder has common understanding on the water-related hazard risks and their reduction target as well as each action and its effect.

In most of the cases, the effect of each measures varies and spreads widely in a multiple way, but its degree is not always elucidated. For example, the effect of water-related disaster prevention and reduction is not only in the reduction on the loss of people’s lives and assets, but also in the support of community’s function and economy. However, such indirect effects have not been elucidated enough. It is also difficult to estimate the effect of various outflow restraint measures in the basin uniformly as the size and location of such measures vary and their effects change depending on the actual rainfall and basin characteristics. The effect of various non-structural measures has not be estimated numerically one by one.

It is necessary to advance quantitative qualitative evaluation about the effect of the measure by each stakeholder, so various stakeholders can consider the effective operation and additional measures with enhanced each motivation toward water-related hazards around the whole basin.

4.5 The Way forward

MLIT commenced to review flood control plans of main rivers by reflecting the estimation of increases in heavy rain by 2100 based on the latest scientific knowledge. The National Diet approved the amendment of related laws in April 2021 to take all possible actions throughout river basins towards water-related disaster risk reduction, by utilizing existing storage facilities and strengthening the functions of forests and agricultural lands to suppress outflow.

A basin can be a family. It is desirable that all stakeholders in the basin can cooperate than before, and think what they can do for the total damage reduction, under the recognition of each resident membership.

MLIT will strengthen its efforts to implement the new policy and accelerate structural and non-structural measures with close cooperation with all stakeholders in a basin.

3 U.S. Army Corps of Engineers Emergency Response Operations within the COVID-19 Environment

By Mr. Steve Hill[1], Dr. Nadia Mohandessi[2], Mr. Eric Conrad[3], and Mr. Kent Simon[4]

1. Summary

The U.S. Army Corps of Engineers' (USACE) response to COVID-19 proved to be an unprecedented event, engaging the entire enterprise nearly simultaneously, impacting every single district, division, center, business line, and employee within the Corps of Engineers.

The unique circumstances of the pandemic introduced a new subset of challenges in its emergency response operations throughout most of 2020 and into 2021. USACE, like all other federal agencies, was required to adapt to the new operating environment and make risk-informed decisions based on objective assessments of COVID-19-related risks to the force and impacts on USACE program delivery. Workforce safety was, and is, the top priority for the USACE commanding general and the broader USACE enterprise.

In direct emergency response to the pandemic, USACE rapidly expanded the nation's capacity to administer life-saving care to those infected through the construction of Alternate Care Facilities (ACFs). Beginning in late January 2021, the agency also provided engineering support with the design and development of Federal Vaccination Centers to assist with national vaccination delivery efforts targeting 100 million vaccinations in 100 days.

Against the backdrop of providing nationwide support in direct response to the COVID-19 pandemic, USACE maintained and executed full program delivery, including executing emergency operations under its own authorities through Public Law 84-99, in support of FEMA under the National Response Framework, and in support to the Department of Defense as requested. This required adapting to the persistent COVID-19 environment to ensure emergency responders executed their missions with appropriate risk reduction measures in place to ensure a safe environment for civilian employees, service members, dependents, and contractors.

USACE personnel continued to abide by state and local government movement restrictions and interstate travel quarantine requirements, as stipulated in state and local orders. Applicability, exemptions, and requirements varied in each state, particularly for emergency response operations and emergency response personnel.

Finally, USACE continues to focus on the integration of new technology to increase efficiencies in mission execution and facilitate the use of increased virtual support. Though many of these efforts began prior to the COVID-19 pandemic, this focus emerged as one of USACE's key

takeaways and best practices during emergency response operations in a COVID-19 environment.

2. USACE Response to COVID-19: Alternate Care Facilities

In direct emergency response to the pandemic, USACE rapidly expanded the nation's capacity to administer life-saving care to those infected through the construction of ACFs. USACE developed four separate standard designs, conducted 1,155 facility assessments, constructed 38 different facilities, and expanded the capacity by 15,074 beds.

New York would set the stage for how the national USACE response to COVID-19 unfolded. In the March 15, 2020, op-ed article "Andrew Cuomo to President Trump: Mobilize the Military to Help Fight Coronavirus" published in the Sunday New York Times, New York Governor Andrew Cuomo wrote:

> *States cannot build more hospitals, acquire ventilators, or modify facilities quickly enough. At this point, our best hope is to utilize the Army Corps of Engineers to leverage its expertise, equipment and people power to retrofit and equip existing facilities — like military bases or college dormitories — to serve as temporary medical centers. Then we can designate existing hospital beds for the acutely ill.*
>
> *We believe the use of active duty Army Corps personnel would not violate federal law because this is a national disaster. Doing so still won't provide enough intensive care beds, but it is our best hope.*

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3 Mr. Eric Conrad is the USACE Emergency Support Function #3 Permanent Cadre Lead.
4 Mr. Kent Simon is the USACE Readiness Support Center Director.

In short: Localize testing, federalize shutdowns, and task the Army Corps of Engineers to expand hospital capacity.

The publication of that article led to the rapid engagement of USACE, first in New York and near-simultaneously nationwide, as a support agency to FEMA and the U.S. Department of Health and Human Services (HHS) during the unfolding pandemic.

On March 18, 2020, USACE received a FEMA Mission Assignment (MA) to provide initial planning and engineering support to address possible medical facility shortages in communities across the country that may be overwhelmed with COVID-19 cases. This MA marked the beginning of the ACF mission.

Figure 1. USACE Memphis District Commander Col. Zachary Miller visited the former Commercial Appeal building April 29, 2020, for a progress update tour of what became Memphis' only USACE-built Alternate Care Facility. (USACE photo by Vance Harris)

In support of this mission, and at the direction of the USACE commanding general, all USACE division commanders began conducting key leader engagements with state governors and senior state leaders, briefing them on USACE assessment and planning capabilities. By March 19, 2020, USACE published the first two standard designs for Alternate Care Facilities[5] utilizing a Hotels to Healthcare Concept (H2HC) and Arena to Healthcare Concept (A2HC) to retrofit existing facilities. Two additional standard designs, approved by both FEMA and HHS, would follow.

USACE senior leaders leaned forward to provide states “a simple solution to a complex problem” before infection numbers were predicted to peak in each state. Regarding this mission, then-USACE Commanding General Lt. Gen. Todd Semonite stated that

“The Corps is working to take the site aspect out of the equation. We don’t want to have an ambulance pull up with patients who have to be turned away because we don’t have the bed ready to treat them. …

5 An Alternate Care Facility or Alternate Care Site (ACF or ACS) is a facility that’s temporarily converted for health care use during a public health emergency to reduce the burden on hospitals and established medical facilities.

USACE, through its ACF designs and construction, has provided additional hospital-like capacity giving our stakeholders the capability to stay ahead of the need for patient beds. States/territories/ Tribal nations determine if converted sites will either continue to be maintained as ACFs for possible future COVID-19 use or will be used for some other purpose."

3. USACE Response to COVID-19: Federal Vaccine Centers

On Jan. 21, 2021, the White House released the National Strategy for the COVID-19 Response and Pandemic Preparedness, which outlined "an actionable plan across the federal government to address the COVID-19 pandemic, including twelve initial executive actions issued by President Joe Biden on his first two days in office." The National Strategy is organized around seven goals:

1. Restore trust with the American people.
2. Mount a safe, effective, and comprehensive vaccination campaign.
3. Mitigate spread through expanding masking, testing, data, treatments, health care workforce, and clear public health standards.
4. Immediately expand emergency relief and exercise the Defense Production Act.
5. Safely reopen schools, businesses, and travel while protecting workers.
6. Protect those most at risk and advance equity, including across racial, ethnic and rural/urban lines.
7. Restore U.S. leadership globally and build better preparedness for future threats.

The publication directed that "the federal government will execute an aggressive vaccination strategy, focusing on the immediate actions necessary to convert vaccines into vaccinations, including improving allocation, distribution, administration, and tracking."

Of note, under Goal 2 in the National Strategy was the following objective:

> **Create as many venues as needed for people to be vaccinated.** The federal government — in partnership with state and local governments — will create as many venues for vaccination as needed in communities and settings that people trust. This includes, but is not limited to federally run community vaccination centers, in places like stadiums and conference centers, federally-supported state and locally operated vaccination sites in all 50 states and 14 territories, pharmacies and retail stores, federal facilities like Veterans Affairs hospitals, community health centers, rural health clinics, critical access hospitals, physician offices, health systems, urgent care centers, and mobile and on-site occupational clinics.

In response, FEMA was directed to provide federal support to existing or new community vaccination centers and mobile clinics across the country leveraging close coordination between the federal government and all vaccination jurisdictions to ensure that COVID-19 vaccines are distributed equitably.

To support this effort, FEMA mission assigned USACE to provide engineering support with the design and development of Federal Vaccination Centers to assist with national vaccination delivery efforts targeting 100 million vaccinations in 100 days. USACE provided technical/engineering concepts, sketches, and Project Work Statements (PWS) for three Mass Community Vaccination Site (MCVS) options: 1) Walk-through Sites, 2) Drive-through Sites, and 3) Mobile Sites. As of April 2021, coordination with HHS and FEMA remained ongoing to incorporate partner input for concept refinements and improvements.

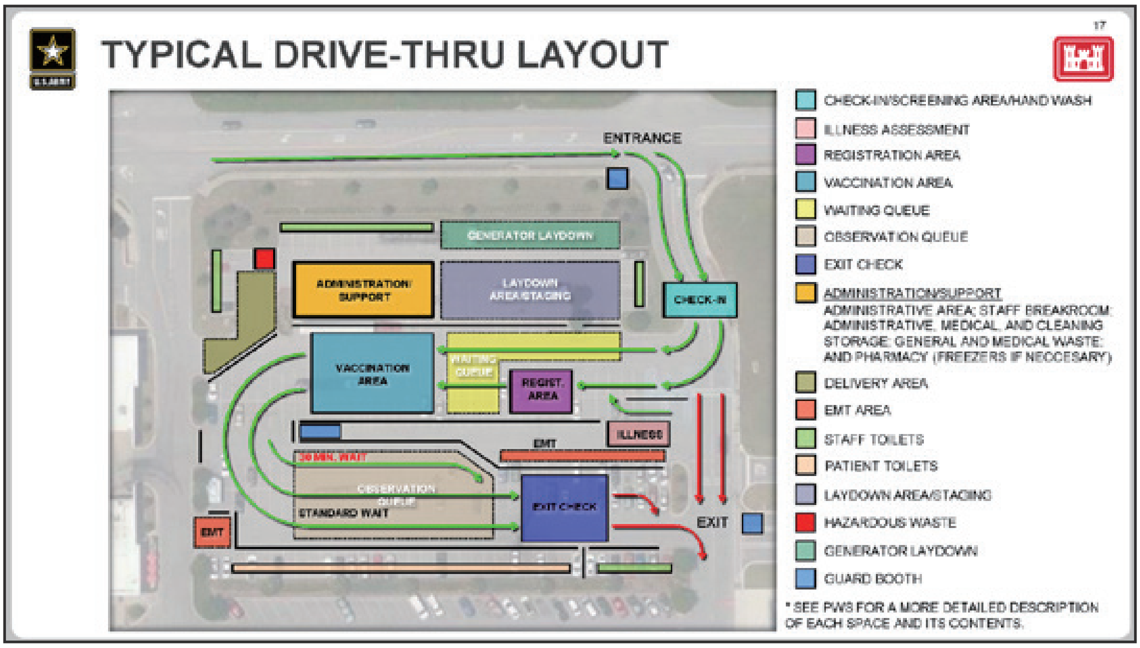

Figure 2. A USACE-designed immunization facility concept for a drive-through vaccination center. This concept design, along with additional designs for walk-up and mobile vaccination centers, was developed in coordination with the U.S. Department of Homeland Security and the U.S. Centers for Disease Control and Prevention and made publicly available in early February 2021.

4. Individual Health Protection Measures and Organizational Requirements

Against the backdrop of providing nationwide support in direct response to the COVID-19 pandemic, USACE maintained and executed full program delivery, including executing emergency operations under its own authorities through Public Law 84-99, in support of FEMA under the National Response Framework, and in support to the Department of Defense as requested. This required adapting to the persistent COVID-19 environment to ensure emergency responders executed their missions with appropriate risk reduction measures in place to ensure a safe environment for civilian employees, service members, dependents, and contractors.

In order to adapt to the new environment, USACE monitored directives from Headquarters, Department of the Army (HQDA), the U.S. Office of Personnel Management, and other relevant agencies to inform changes to policy, including travel restrictions and administrative policy and disseminated COVID-19-related health protection guidance to the enterprise, in accordance with HQDA and Centers for Disease Control and Prevention (CDC) best practices.

Supporting elements were required to provide personnel deploying in support of USACE emergency response operations missions a 30-day of supply of health protection equipment, for example masks and hand sanitizer, with additional supplies beyond 30 days when required.

Figure 3. A USACE contractor undergoing a temperature check prior to entering the building during emergency response operations on April 30, 2020. (USACE photo by Vance Harris)

Emergency Response Operations Checklists and Standard Operating Procedures

Responders were notified at the time they volunteered for deployment that as a condition of deployment, they agreed to follow COVID-19 health protection measures implemented in the deployed environment, such as wearing face coverings and maintaining social distance, as well as undergoing temperature checks and health questionnaire screenings required for entry to the work site. Subsequent failure to follow the health protection measures resulted in responder redeployment at the manager's discretion.

Additionally, USACE developed new standard operating procedures (SOP) for deploying to support emergency response operations during the ongoing pandemic. The SOP included several checklists for both managers and personnel deploying to support emergency response operations detailing pre-deployment actions, alerted to deploy actions, and deployment actions to mitigate the risks of contracting or spreading COVID-19 while responding to emergencies. The checklists and SOP provided guidance regarding the appropriate use of cloth face coverings, hand sanitizer, nitrile gloves, sanitizing wipes, and the need for daily temperature checks and the general monitoring of responders' well-being. The checklists and SOP also included instructions for instances in which a responder may feel sick and instances in which a responder tests positive for COVID-19.

USACE developed a Travel Guidance Checklist as well, tailored specifically for responders deploying to emergency response operations. The Travel Guidance Checklist provided clarification concerning driving options (travel using a government-owned vehicle, rental vehicle, or personal vehicle) for traveling in lieu of air travel when deploying as a first responder to support a disaster mission during the ongoing COVID-19 pandemic. The Travel Guidance Checklist also provided additional health protection measures responders should take while in transit to an emergency response operation.

Text Illness Monitoring (TIM) System

USACE directed all responders to enroll in the TIM system prior to their deployment and continue to use the system until at least 14 days after their deployment. Once enrolled, the text-based system began pushing daily notifications to the recipient detailing COVID-19 symptoms.

Personnel were instructed to respond “yes” or “no” daily to the text message after performing a daily self-check for COVID-19 symptoms, including fever/chills, cough, shortness of breath, fatigue, body aches, headache, new loss of taste or smell, sore throat, congestion, nausea/vomiting, or diarrhea.

If a recipient responded “yes” to the text message, or failed to reply after two consecutive text messages, a USACE Occupational Health Professional contacted the recipient to provide further instructions. Responders were able to opt-out at any time.

If a Responder Tested Positive for COVID-19

If a DOD employee (military member or civilian) tested positive for COVID-19, he or she was directed to inform his or her supervisor immediately. The supervisor then notified the appropriate persons within the chain of command designated as need-to-know for COVID-19. This information along with any other related details, such as quarantine date(s), exposure date(s), duty status date(s), etc., were provided only to persons with an authorized need to know. USACE commanders were authorized to utilize the USACE Safety and Occupational Health Office to conduct limited contact tracing at the local level to determine employees who may have been in close contact[6] to that employee. Any close contacts identified during a

COVID-19 positive employee interview is contacted for notification of potential exposure. Close contact supervisors need to also be informed of this potential exposure to their employee.

Contact tracing was limited in scope to USACE employees and contractors physically working at USACE projects and did not include family members or general public. While the DOD authorized USACE to conduct limited contact tracing inhouse in tandem with local public health officials, USACE could not require a USACE employee or contractor to provide contact tracing information.

Returning from Deployment

Responders were allowed to return to normal duties (telework, worksite, etc.) as determined between them and their supervisor immediately upon return from a domestic deployment. Employees were not tested or requested to self-quarantine upon redeployment if they had no COVID-19 symptoms and were not assessed by a health professional to have been at a high risk for exposure (direct and sustained contact with someone diagnosed with COVID-19).

If a responder developed COVID-19 symptoms after returning to their permanent duty station, it was suggested that the responder undergo testing and self-isolate if directed by a medical professional. The responder may then be placed in a sick leave status and self-isolate in his or her home. If the responder chose to self-isolate outside their home due to concerns of exposure for other members of the household, USACE did not reimburse any incurred costs. Per diem (including housing allowance) is not authorized when an employee has returned to their permanent duty station according to the Joint Travel Regulations (JTR)[7] .

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6 The Army Public Health Center (APHC) defined close contact as an individual who was within 6 feet of other employees for at least 10 minutes starting from 48 hours before illness onset until the time the individual is isolated.

7 The Joint Travel Regulations (JTR) implements policy and law to establish travel and transportation allowances for Uniformed Service members (i.e., Army, Navy, Air Force, Marine Corps, Coast Guard, National Oceanic and Atmospheric Administration Commissioned Corps, and Public Health Service Commissioned Corps), Department of Defense (DOD) civilian employees, and others traveling at the DOD’s expense.

Figure 4. Memphis District Corps of Engineers Commander Col. Zachary Miller joined Maj. Gen. Diana Holland, Mississippi Valley Division (US Army Corps of Engineers) Commanding General, and other USACE emergency responders at Louisiana Governor's Office of Homeland Security and Emergency Preparedness (GOHSEP) for federal response coordination to Hurricane Laura, Aug. 28, 2020. (USACE photo)

5. Adjusting to State and Local Requirements

USACE personnel continued to abide by state and local government movement restrictions and interstate travel quarantine requirements, as stipulated in state and local orders. Applicability, exemptions, and requirements varied in each state, particularly for emergency response operations and emergency response personnel.

Some U.S. states and territories, for example Florida and the U.S. Virgin Islands, enforced additional requirements, i.e., a negative COVID-19 test within a specified number of days prior to their deployment, for emergency responders who would be entering specific facilities such as state/territory emergency operations centers (EOCs). These requirements were specifically for those responders who may have flown commercial airlines to travel to the disaster site.

These state-by-state, and territory-by-territory requirements impacted the deployment timelines and potentially, the mission execution timelines, for USACE responders. As such, USACE adopted a more regional approach to sourcing volunteers for deployment rather than its traditional rotational order of deployment. Identifying volunteers who lived within an eight-hour drive of a deployment location enabled the use of ground transportation rather than air travel, which mitigated the potential time delays and other impacts to emergency response mission execution.

Figure 5. U.S. Army Corps of Engineers Emergency Operations personnel meet with FEMA representatives in Cedar Rapids, Iowa, to discuss derecho recovery efforts across the state, Aug. 27, 2020. (Photo by James Finn, USACE Rock Island District)

6. Integration of New Technology and Virtual Support

Operation Blue Roof

Since August 2017, USACE has focused on the integration of new technology to increase efficiencies in mission execution and facilitate the use of increased virtual support. Though many of these efforts began prior to the COVID-19 pandemic, this focus emerged as one of USACE's key takeaways and best practices during emergency response operations in a COVID-19 environment. USACE is the lead agency for several missions under the Emergency Support Function #3 (ESF #3) and the National Response Framework in support of FEMA, including debris removal and clearance, temporary roofing, temporary housing and critical public facilities, temporary emergency power, and infrastructure assessment. The integration of new technology was particularly well planned and executed within temporary roofing emergency response operations, also known as Operation Blue Roof, during calendar year 2020.

Figure 6. An aerial photo shows some of the more than 8,000 blue roofs that were installed after Hurricane Laura that survived Hurricane Delta just a few weeks later – approximately 87% of all USACE-installed roofs survived the second storm.

The purpose of Operation Blue Roof is to provide homeowners in disaster areas with fiber-reinforced sheeting to cover their damaged roofs until arrangements can be made for permanent repairs. This is a free service to homeowners. Operation Blue Roof protects property, reduces temporary housing costs, and allows residents to remain in their homes while recovering from the storm. Residents sign up for Blue Roof assistance using a Right of Entry (ROE) form. The ROE is a legal document that allows USACE workers to access the resident's property and assess damage to their home. The ROE also allows contracted crews to work on the resident's roof. Traditionally, residents were required to visit an ROE Collection Site in person to complete the form. The ROEs are the first step in processing a Quality Assurance (QA) Assessment and work order before the USACE contractor can begin blue roof installation.

The persistent COVID-19 environment required a significant sea change in this process to mitigate the risks of face-to-face interaction where appropriate. USACE made significant advances in both online ROE collection and telephonic ROE collection through a call center to minimize the use of in-person collection centers. During Hurricane Laura, and subsequently Hurricane Delta, emergency response operations, online sign-up was available immediately at the start of the mission. This allowed for QA personnel to focus on assessments, rather than ROE collection. Online sign-up became the primary means for the public to request assistance during these two events.

Figure 7. A U.S. Army Corps of Engineers' Blue Roof Mission Assessor observes contractors as they install temporary roofing for the 5,000th homeowner to receive a 'blue roof' during Hurricane Laura recovery efforts. Using satellite and fixed-wing imagery allow USACE assessors anywhere in the world to conduct assessments, but if for some reason imagery is unclear, an evaluator will conduct a physical review of the roof to ensure an accurate assessment is conducted. (Photo by George Stringham, USACE St. Paul District)

Hurricane Laura was also the first event with widescale call center sign-up use at the start of Operation Blue Roof. The integration of both online and call center sign-up was validated during the response, as the in-person collection centers were vastly underutilized this year compared to historical Blue Roof missions in which in-person collection was the only method available.

Additionally, USACE awarded a contract prior to the 2020 Atlantic Hurricane Season to a company that acquires post-storm aerial imagery to prepare roof reports at the request of USACE. These roof reports include pre- and post-storm aerial imagery and measurement of individual roofs. In all past missions, QA personnel were required to measure each individual roof and estimate damages while onsite on the ground. For 2020, the team developed procedures to utilize the aerial roof reports for in-person assessments. Accurate roof measurements within the reports proved far more efficient for QA personnel and reduced disputes with contractors. The aerial roof reports also enabled a remote assessment team to create work orders for greater installation efficiencies, increased QA productivity for field assessments, and increased both the expediency and accuracy of USACE's assistance.

Increased Virtual Support

Finally, USACE increased and embraced virtual support as an agency. The use of virtual support proved to be a best practice, enabling USACE subject matter experts to provide expertise to multiple response nodes during concurrent emergency response events without negatively impacting mission execution throughout the storm season while reducing the in-person responder footprint. The agency's use of virtual support will be sustained in future events well after the COVID-19 pandemic subsides, increasing efficiency and decreasing operational costs during emergency response mission execution.

7. Conclusion

The USACE response to COVID-19 proved to be an unprecedented event, engaging the entire enterprise nearly simultaneously, impacting every single district, division, center, business line, and employee within the Corps of Engineers. Nevertheless, USACE, as an agency within the DOD, is committed to the Secretary of Defense's three priorities – protecting our force, DOD civilians and their families; safeguarding our national security capabilities; and supporting the whole-of-nation response. As such, the agency successfully continued to execute its civil works and military programs missions during the COVID-19 Pandemic in support of these priorities.

The unique circumstances of the pandemic and the resultant response within USACE validated the resiliency, flexibility, and adaptability of the leadership, the agency as a whole, and of each of the agency's 35,000 employees. The ongoing pandemic and the agency's response demonstrated USACE's collective ability to rise to and overcome any challenge, delivering both support to FEMA and engineering solutions to the nation while maintaining its number one priority: the life, health, and safety of USACE employees and the public.

4 CHALLENGES ON MAJOR WATER RELATED DISASTER AND COVID-19 PANDEMIC IN INDONESIA IN 2020 – 2021

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INTRODUCTION

The weather in Indonesia is very diversed, the pattern of rainfall is based on the distribution of the average monthly rainfall data. In October 2020 to February 2021, the increase in monthly rainfall due to La Nina occured in almost all parts of Indonesia. In April 2021, The Seroja tropical cyclone was the strongest tropical cyclone ever occurred in Indonesia. Flood disasters, landslide, and droughts are natural disasters that are closely related in Indonesia. These phenomenons lead up to Indonesia's state of water crisis. The clean water crisis in Indonesia happened because of the lack of capability in water management, hence causing natural disasters such as floods and landslides when water is abundant in rainy season and on the other hand causing droughts during summer. Even though Indonesia has high intensity of rainfall and abundant water sources, the clean water challenge continues to occur due to many factors, including limited assistance and facilities for residents in rural areas to access clean water, population density and water privatization.

In conjuction with the condition of the COVID-19 pandemic which requires maintaining cleanliness in the house, people today tend to switch the water consumption pattern. A stable supply of drinking water plays an important role in ensuring the health of population, especially during epidemic disease outbreaks, where water-requiring behavior, such as washing hands is required to prevent the spread of the virus.

Keywords: Disaster Management, Indonesian Water Related Disaster, Clean Water Requirement

1. GENERAL WEATHER CONDITION IN INDONESIA IN 2020 AND 2021

The weather in Indonesia is very diversed, the pattern of rainfall is based on the distribution of the average monthly rainfall data. In October 2020 to February 2021, the increase in monthly rainfall due to La Nina occured in almost all parts of Indonesia. In April 2021, The Seroja tropical cyclone was the strongest tropical cyclone ever occurred in Indonesia. Flood disasters, landslide, and droughts are natural disasters that are closely related in Indonesia. These phenomenons lead up to Indonesia's state of water crisis. The clean water crisis in Indonesia happened because of the lack of capability in water management, hence causing natural disasters such as floods and landslides when water is abundant in rainy season and on the other hand causing droughts during summer. Even though Indonesia has high intensity of rainfall and abundant water sources, the clean water challenge continues to occur due to many factors, including limited assistance and facilities for residents in rural areas to access clean water, population density and water privatization.

In conjuction with the condition of the COVID-19 pandemic which requires maintaining cleanliness in the house, people today tend to switch the water consumption pattern. A stable supply of drinking water plays an important role in ensuring the health of population, especially during epidemic disease outbreaks, where water-requiring behavior, such as washing hands is required to prevent the spread of the virus.

1. The monsoon rainfall pattern, has a clear area of difference between the rainy season period and the dry season period, then categorized as the Season Zone (ZOM), a type of rainfall that is unimodial (one peak of the rainy season, December-January-February (DJF) the rainy season, June-July-August (JJA) dry season). The monsoon rain plaques are located in the eastern and southern parts of Sumatera, Java, Bali and Nusa Tenggara, southern Kalimantan, west coast of South Sulawesi, western Southeast Sulawesi and Buton / muna islands, North Sulawesi, southern Maluku and coastal Papua. north and Merauke.

2. Equatorial rainfall pattern, characterized by a bimodal monthly rainfall distribution with two maximum rainy season peaks and most of the year it is included in the wet season criteria. The peak of rain which usually occurs around March and October or when there is an equinox. The equatorial rain pattern occurs in the western part of Sumatra, northern Kalimantan, parts of Central Sulawesi and South Sulawesi (Luwu Raya and Toraja areas) and central Papua.
3. Local rainfall pattern, defined as having the opposite monthly rainfall distribution to the monsoon pattern. The local pattern is characterized by the form of a unimodial rain pattern (one rain peak), but the shape is opposite to the monsoon type. Such as in the areas of Parigi Moutong, Palu, Luwuk Banggai, Banggai Islands, Taliabu, Sula, southern Buru, southern Seram, Ambon, Sorong, Raja Ampat, Bintuni Bay, Fak-fak and South Sulawesi on the east coast.
4. Multi Pattern Rainfall, characterized by an almost even distribution of monthly rainfall every month, with no significant rain and dry peaks. For example, in the cities of Palu, North Morowali, Asmat, Mimika and Kerinci.

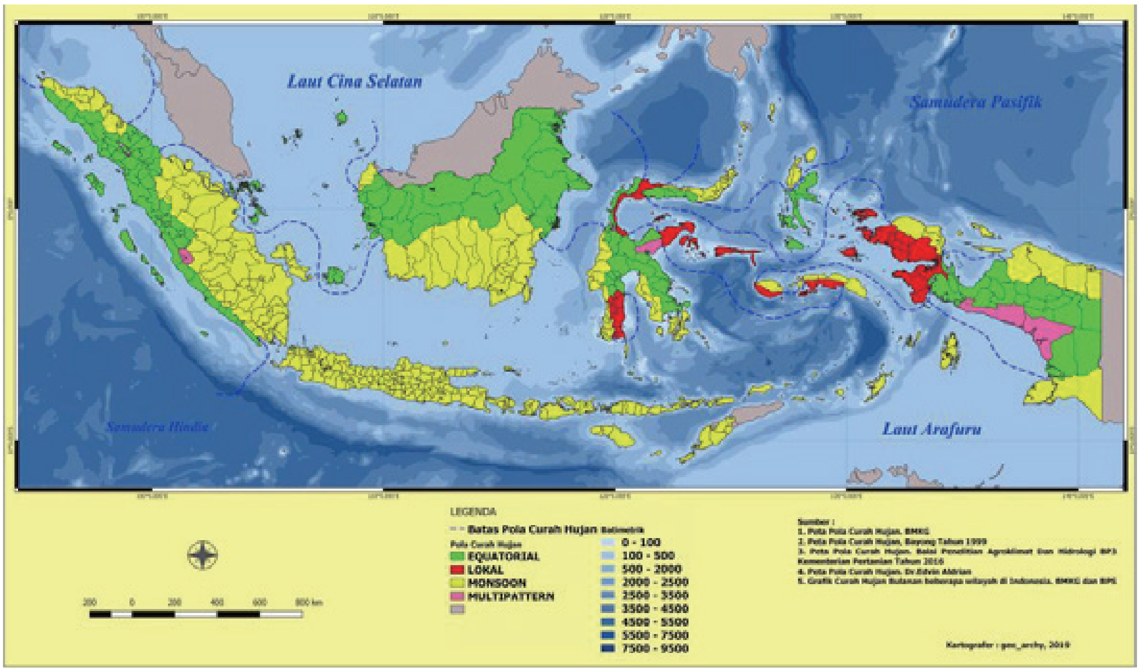

FIGURE 1. INDONESIAN RAINFALL PATTERN MAP

According to BMKG, the peak phase of the rainy season was identified in early 2021. Most of Indonesia was predicted to experience a peak rainy season in January and February 2021, which is 248 ZOM of the total 342 ZOM or 72.5 percent.

34.8 percent of the total 342 ZOM in Indonesia were predicted to start the rainy season in October 2020. These areas are spread across Sumatra, Java, Kalimantan and Sulawesi. While 38.3 percent of the other ZOM areas will enter the rainy season in November 2020. Areas included in this category are in parts of Sumatra, Java, Nusa Tenggara, Kalimantan, Sulawesi, Maluku and Papua. The remaining 16.4 percent of the ZOM area, which is spread over Java, Kalimantan, Sulawesi, Maluku, West Nusa Tenggara (NTB), East Nusa Tenggara (NTT) and Papua, was predicted to enter the beginning of the rainy season in December 2020.

Observation results, during November 2020 - March 2021, ENSO was in a La Nina condition indicated by the index value (SST anomaly in the central and eastern Pacific Ocean) which was below the value of 0.5. Meanwhile, IOD was observed to be in the Neutral phase during November 2020 - March 2021 with index values ranging between 0 - 0.2. Monthly rainfall is generally in the medium to high category with rainfall in most areas of more than 200 mm/month.

In October-November 2020, the increase in monthly rainfall due to La Nina occured in almost all parts of Indonesia except Sumatra. In December 2020 to February 2021, the increased rainfall due to La Nina can occur in eastern Kalimantan, Sulawesi, Maluku-North Maluku and Papua.

HYDRO-METEORIGICAL IN INDONESIA

According to BMKG, tropical cyclones in Indonesia can be formed if they meet the following criteria:

- Sea surface temperature should be at least 26.5o C to a depth of 60 meters.
- Atmospheric conditions are unstable, allowing the formation of Cumulonimbus clouds.
- The atmosphere is relatively humid at an altitude of about 5 km (≈15 thousand feet).
- Atmospheric disturbances near the earth's surface in the form of swirling winds accompanied by winds (convergence).
- Changes in wind conditions with respect to altitude are not too large. Changes in wind conditions will disrupt the progression of a thunderstorm

Indonesia's territory which is located around the equator, hence by nature is one of the areas that are most likely not traversed by tropical cyclone trajectories. However, nowadays there are many tropical cyclones that occurred, and have an indirect impact on weather conditions in Indonesia. The first cyclone is Durga, which appeared in the waters southwest of Bengkulu, then appeared afterwards, namely Anggrek (2010), Bakung (2014), Cempaka (2017), and Dahlia (2017).

Seroja Tropical Cylone

In April 2021, The Seroja tropical cyclone was the strongest tropical cyclone ever occurred in Indonesia and the closest reached the mainland region of NTT. Seroja Cylone begins on April 3, 2021. The Joint Typhoon Warning Center (JTWC) issued the first warning against the Tropical Cyclone 26S on April 4 at 23.00 WITA. The low-pressure system slowly evolved into Category 1 Tropical Cyclone and was named Seroja by TCWC Jakarta on April 5 at 04.00 WITA when the cyclone was 95 km north of Rote Island. On April 6, 2021, Seroja Tropical Cyclone reached its peak where the wind speed reached 100 km / hour triggered wind currents, landslide, flood, flash floods in several areas in NTT.

National Disaster Management Agency (BNPB) reported that as many as 509,604 persons were affected with 11,406 people displaced, 181 deaths, 271 injuries, 45 missing persons while 66,036 houses were reportedly damaged in NTT and NTB (as of 12 April, 23.30 WIB), with the following details:

NTT - 472,765 people affected, 11,406 displaced, 179 dead, 271 injured, 45 missing, and 60,703 houses damaged;

NTB - 36,839 people affected, 2 dead, and 5,333 houses damaged.

2. SPECIFIC CHARACTERISTIC OF WATER DISASTER

Indonesia is a tropical country surrounded by 17,000 islands. With a total population of around 237 million people, it is the fourth most populous country in the world. Indonesia is often hit by natural disasters. Almost on a regular basis, Indonesia experiences floods, landslides, earthquakes, hurricanes, hurricanes, tides, and drought. In the last decade, recurrent floods happened every year in many parts of the country. Compared to other countries, Indonesia is much more vulnerable to flood disasters

Generally, water related disasters are influenced by the seasons that occur in Indonesia. Water disasters that occur in Indonesia can be grouped as follows:

a. Typhoon and strong wind
Windstorms that occur in Indonesia can generally be caused by tropical cyclones. Wind is the main cause of openness of buildings above the ground. The risk of damage is directly related to the height of the building structure and the exposed surface

b. Floods
Floods are generated from high and long intensity rainfall, rising sea levels, and a combination of these two phenomena. According to WHO, the occurrence of flooding can be influenced by factor, including:

Climate Factors

- Precipitation: rain, intensity, duration, distribution over time, distribution over a region, previous precipitation and moisture level in soil.
- Interception: vegetation type: composition, age and density of strata, season of the year, and size of storm.
- Evaporation: temperature, wind atmospheric pressure, nature and relief of the evaporation surface.
- Transpiration: temperature, solar radiation, wind, humidity and vegetation cover.

Physiography factors

- Characteristics of the catchment area, size, shape, slope and orientation.
- Physical features: ground use and coverage: infiltration condition such as type of soil, and geologic features such as permeability and capacity for formation of ground water. Topography, including the presence of lakes, marshes, and artificial drainage.
- Characteristic and transport capacity of the channel, size, shape, slope, roughness, length and tributaries.
- Storage capacity: backwater curves.

c. Landslides

Landslides are difficult to be estimated as an independent phenomenon. It seems appropriate, therefore, to associate landslides with other hazards such as tropical cyclones, severe local storms and river floods. The term landslide is used in its broad sense to include downward and outward movement of slope forming materials (natural rock and soil). It is caused by heavy rain, soil erosion and earth tremors.

d. Drought

Droughts, unlike other natural disasters, do not occur suddenly, but are slow-onset disasters resulting from insufficient rain over a period of months. The impact of drought can cause water supply to agricultural land and the environmental sector which can increase the potential for forest and land fires. In addition, the impact of drought has caused a reduction in water sources for household needs.

Apart from being affected by the season, water disasters are also affected by the catchment area. The poor managed condition of the catchment area causes an increase in the potential for disaster during the coming rainy season. Other impacts include a very low flow of river water in the dry season, accelerated sedimentation in lakes and irrigation networks, and a decrease in water quality, which threatens the sustainability of development, especially agricultural development.

Indonesia has more than 17,000 catchment areas, those are scattered throughout the country. According to the Ministry of Environment and Forestry (2020), Indonesia has 17,076 catchment areas covering an area of 189 and more hectares and 14.3 million hectares of which are critical land that must be handled and replanted. In the 2015-2019 Midterm Development Plan, the Government of Indonesia is targeting 5.5 million hectares of forest and land rehabilitation within the forest and catchments area, but this target has only been achieved by 1.9 million hectares.

Degradation of catchment areas can be caused by a number of reasons, the most affected which is due to land use change which prevents the environmental buffer from functioning optimally.

3. MAJOR DISASTER (WATER RELATED)

3.1 HYDRO-METEORIGICAL IN INDONESIA

The data from National Board for Disaster Management Agency (BNPB) showed there has been a total of 2.952 natural disasters that happened in Indonesia within the period of 1st of January until 31st December 2020, in which 99% (2.928 Natural disasters) of the natural disasters are Hydro-meteorological disaster or water-related disasters such as floods, flash floods, tornadoes, landslides, forest & land fires, and droughts. Floods are the most occurring natural disaster in 2020 (1.080 disasters), followed by tornadoes or extreme winds (880 disasters) and landslides (577 disasters). These three disasters caused great number of deaths and missing people in 2020. Based on the data stated on BNPB in 2021, out of the 409 victims (deaths and missing persons) of natural disasters in 2020, it is written that 259 were flooding victims, 124 were victims of landslide disasters, and 24 were victims of tornadoes and strong wind currents.

Meanwhile, from 1st January 2021 to 11th April 2021, 1.089 natural disasters happened, in which 98% (1.072 natural disasters) out of the natural disasters are Hydro-meteorological disasters. Floods was the most occurring natural disasters (468 natural disasters), followed by tornadoes & strong wind currents (288 natural disasters) and landslides (210 natural disasters). A quick reminder that we have only just entered the fourth month of 2021 and the natural disasters that has occurred until then has reached 37% of the total of natural disasters happening in 2020. Table 1 summarizes the Hydro-meteorological natural disasters recorded that has happened throughout 2020 until the early 2021 (please refer to the Appendix

1)

TABLE 2. INDONESIA'S HYDRO-METEOROLOGICAL NATURAL DISASTERS IN 2020 & EARLY 2021

Hydro-Meteorological Natural Disasters	Year	
	2020[a]	**2021**[b] (Until the 11th of April 2021)
Forest & Land Fires	326	90
Drought	29	1
Floods	1.080	468
Landslides	577	210
Tornadoes & Strong wind currents	880	288
Global tides	36	15
Total	**2.928**	**1.072**

Sources:
[a] Indonesia Disaster Infographic, 2020, BNPB
[b] Indonesia Disaster Infographic, 2021, BNPB

Flood disasters, landslide, and droughts are natural disasters that are closely related in Indonesia. These phenomenons lead up to Indonesia's state of water crisis. The water crisis happening in Indonesia happened because of the lack of capability in water management, hence causing natural disasters such as floods and landslides when water is abundant in rainy season and on the other hand causing droughts during summer. Figure 2 shows a big portion of the natural disasters that happened through the period of 2020 until early 2021 was Floods, covering about 38.7% of the total Hydro-meteorological disaster. Meanwhile, 19.7% of the total Hydro-meteorological disasters are landslides. While, 0.8% of it is drought in places in Indonesia that has been predicted would start their rainy season late, especially foodshed areas like Java, Bali, Nusa Tenggara Barat, and Sulawesi (BMKG, 2020).

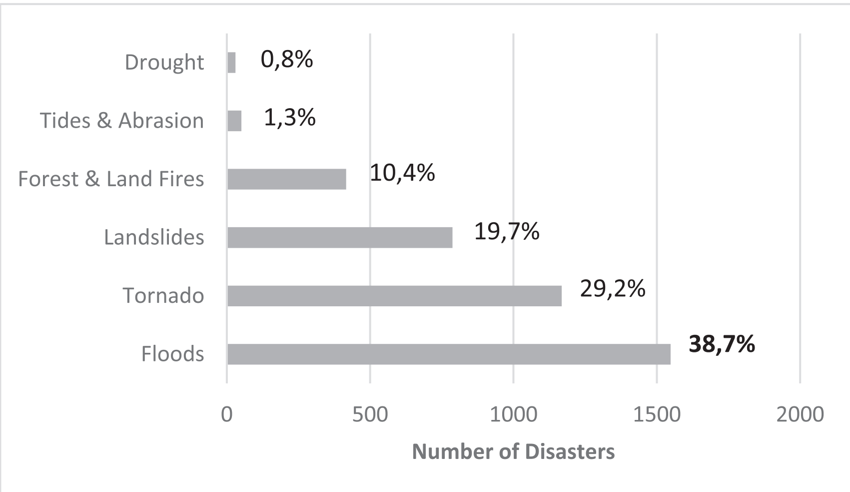

FIGURE 2. HYDRO-METEOROLOGY DISASTERS IN INDONESIA (2020 – EARLY 2021)
Source: Indonesia Disaster Infographic 2020-2021 – BNPB,
analyzed by Indonesia Water Institute

Flood disasters, landslide, and droughts are natural disasters that are closely related in Indonesia. These phenomenons lead up to Indonesia's state of water crisis. The water crisis happening in Indonesia happened because of the lack of capability in water management, hence causing natural disasters such as floods and landslides when water is abundant in rainy season and on the other hand causing droughts during summer.

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TABLE 3. INDONESIA MONTHLY RAINFALL INTENSITY AND MAXIMUM EXTREME DAILY RAINFALL INTENSITY

Month, Year	Monthly Rainfall Intensity	Daily Extreme Rainfall Intensity (Highest)
January 2020	Medium - High	DKI Jakarta: 377 mm/day Central Java: 345 mm/day
February 2020	Medium - High	Central Java: 460 mm/day
June 2020	Medium	Riau: 375 mm/hari
July 2020	Medium	Maluku: 386 mm/hari
September 2020	Medium	Central Sulawesi: 279 mm/day
Oktober 2020	Medium	West Java: 316 mm/day
November 2020	Medium	Central Java: 325 mm/day
December 2020	Medium	Papua: 330 mm/day
January 2021	High – Very High	Riau: 525 mm/day South Kalimantan: 492 mm/day
February 2021	Medium	West Nusa Tenggara: 337 mm/day

Note:
Monthly Rainfall Intensity: low (0-100 mm), medium (100-300 mm), high (300-500 mm), very high (>500 mm)
Daily Extreme Rainfall Intensity: heavy rain (50-100 mm/day), very heavy rain (>100 mm/day)
Source: BMKG Month Rainfall Analysis, 2020-2021

The floods that happened in early 2020 (1st of January 2020) was recorded as a big flood that innundated a part of Jabodetabek, specifically Jakarta as the capital city. The disaster caused the innundation of houses, power outage by State Electricity Company in a few flooded areas, cut off road access, along with landslides in the outskirts of Jakarta. On the record, about 62.000 people are evacuated from flooded areas, a number of people also spent their night on the roofs while waiting for the rescue team (BBC News, 2020). The highest rainfall intensity (377 mm/day recorded at Halim BMKG Station, East Jakarta) in the early 2020 flood was the highest rainfall intensity all throughout all the big floods that happened in Jakarta since the year 1996 (Refer to Figure 3). Based on DKI Jakarta's Disaster Management Board (BPBD) data, about 390 sub-sub districts in 151 Sub-districts from 35 districts are submerged by the floods with water receding period of 4 days, about 83.406 people affected, 36.445 people evacuated in 269 area points, and 19 deaths because of the flood.

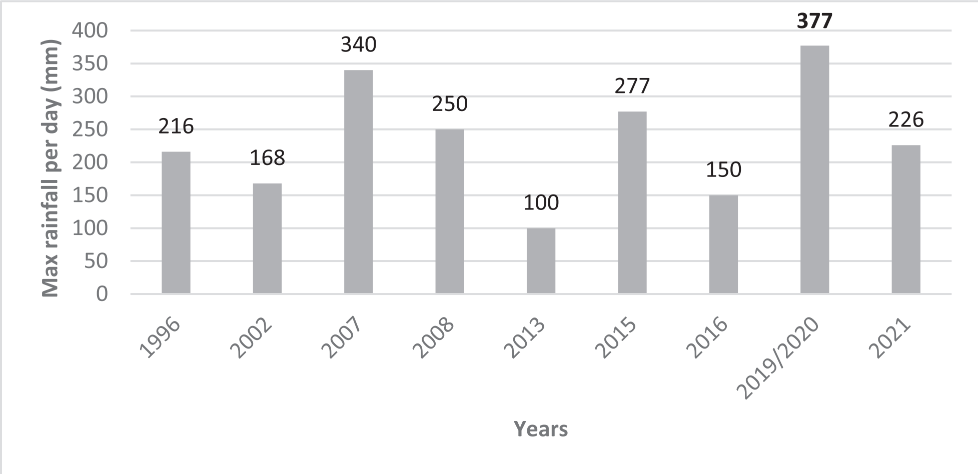

FIGURE 3. MAXIMUM RAINFALL INTENSITY DURING MAJOR JAKARTA FLOODS
Sources: BMKG (2020) & DKI Jakarta BPBD (2021)

Meanwhile, the flood and landslide disasters have happened in early 2021 in a number of regions in Indonesia. The increase in rainfall intensity since early January 2021 triggered the flood and landslide disasters. The disasters that occurred are flood in South Kalimantan; flood and landslide in Sumedang, West Java; flood and landslide in Manado, South Sulawesi; flood and landslide in Paniai, Papua; flood in Semarang, Pekalongan, and Jakarta (BBC News Indonesia, 2021). The flood that happened in South Kalimantan is categorized as the worst and was appointed the status of Flood Disaster Emergency Response by the South Kalimatan Governor per 14 January 2021 because of its high rainfall intensity (492 mm/day-Refer to Table 2) affected almost all of the region of South Kalimantan. Based on BNPB (2021), from a total of 13 administration areas, it is recorded that 10 regencies/cities in Kalimantan provinces affected by flood. Table 4 summarized the data of the South Kalimantan areas that are affected by the flood.

TABLE 4. SOUTH KALIMANTAN REGENCY /CITY AFFECTED BY FLOOD DATA

Regency/City	Houses Affected	Evacuated People	Affected People	Deaths
Tapin Regency	582	382	-	1
Banjar Regency	6.670	11.269	-	3
Banjar Baru City	2.156	3.690	-	1
Tanah Laut City	8.506	13.062	-	7
Banjarmasin City	-	-	716	-
Hulu Sungai Tengah Regency	4.000	11.200	64.400	3
Balangan Regency	1.154	17.501	-	-
Tabalong Regency	407	770	-	-
Hulu Sungai Selatan Regency	387	6.690	-	-
Barito Kuala Regency	517	-	28.400	-
Total	**24.379**	**64.564**	**93.516**	**15**

Source: Data of BNPB as of 17 January 2021

The flood and landslide disasters also happened recently in West Nusa Tenggara (NTB) on the 2nd of April 2021 and in NTT on the 4th of April 2021. The high rainfall intensity lasting 9 hours caused the flood to happen in Kabupaten Bima, NTB. Meanwhile, on the 4th of April 2021, it is known that the Seroja Tropical Cyclone caused the flash flood to happen in Kabupaten East Flores, Kabupaten East Sumba, Kabupaten Lembata in NTT. The Seroja cyclone in South NTT caused the strong wind currents, landslide, flood and flash flood that affected 11 districts & cities in the NTT province. In the 10th of April 2021, BNPB data stated that the disaster caused 174 deaths and 48 missing people case. Whilst, the deaths caused by the NTB flood is about 2 deaths. To this moment, the affected victim's data collection of the NTB and NTT flood is still being done and updated by BNPB.

In addition, the Ministry of Public Works and Housing through the environmental station for Hydrology and Water Environment reported that there were floods and landslides in several places. Flood and landslide reports are described in the attachment table.

3.2 CATCHMENT AREA RECOVERY POLICY

In the 2020-2024 Medium Term Plan, the Indonesian Government has designated the Restoration of Four Critical Catchment Area as a Major Project, namely in the North Sumatra (Asahan Catchment Area) and West Java (Cisadane, Ciliwung, and Citarum Catchment Area) regions. The Ministry of Public Works and Housing, through the Directorate General of Water Resources, has carried out several strategies in an effort to restore catchment areas, including:

1.Normalization and increase of river flow capacity;

2.Conservation of swamp and peat areas;

2.Controlling pollution in reservoirs and lakes with high pollution levels;

3.Coordination and cooperation with Ministry Environment and Forestry and local governments for conservation and restoration of upstream areas.

The focus of support for catchment area conservation is carried out with structural and non-structural efforts at priority catchment area locations that are prioritized for handling in the 2020-2024 RPJMN, including: Asahan Catchment Area, Cisadane Catchment Area, Ciliwung Catchment Area, and Citarum Catchment Area, in coordination with the Ministry of Environment and Forestry, and taking into account the spatial plan.

4. HANDLING OF VICTIMS OF NATURAL DISASTER

4.1 SPREADING OF COVID-19

Indonesia and the rest of the world have been facing COVID-19 pandemic for approximately one year. Based on data obtained from the COVID-19 Special Task Force as of 14 April 2021, it is known that there are 1,58 million positive cases in Indonesia. The COVID-19 pandemic has brought about many changes in human behavior which will indirectly have an impact on the environment, including water use.

Since the first COVID-19 case in Indonesia on 2nd March 2020, the spread of the virus has continued to increase without any signs of slowing down. The COVID-19 case in South Kalimantan, NTB dan NTT showed a sharp increase after the flood disasters.

4.2 WATER CONSUMPTION PATTERN DURING COVID-19 PANDEMIC

Health protocols that have been implemented in the past year, such as hand washing, routine disinfection and good sanitation, require that we use clean water in more than usual. A stable supply of drinking water plays an important role in ensuring the health of a population, especially during epidemic disease outbreaks, where water-requiring behavior, such as washing hands is required to prevent the spread of the virus (World Health Organization, 2015). Not only in Indonesia, but all countries in the world are also experiencing a similar pandemic condition which requires restrictions on outdoor activities to reduce the spread of the virus.

Since the first COVID-19 case in Indonesia on March 2, 2020, the spread of the virus has continued to increase without any signs of slowing down. Apart from implementing large-scale social distancing policies, the most effective way to prevent the spread of the virus is by washing hands and maintaining environmental sanitation around us. Washing your hands properly with soap or hand sanitizer can kill the SARS-Cov-2 virus before they can spread to other surfaces. Even so, not everyone has this luxury. The recommendation to wash hands for 20 seconds to prevent transmission of the COVID-19 at least contributes or becomes one of the wastes of 1.5-liters of water for one person per day If a family has 5 family members then at least disposing of 100 liters of water per day which is only for washing hands alone not to mention using water for other needs. Lack of clean water supplies and low levels of sanitation are huge problems, not only in Indonesia, but worldwide.

Without a clean water supply, hygienic activities such as cleaning the body, food and clothing cannot be carried out. Even though Indonesia has high intensity of rainfall and abundant water sources, the clean water crisis continues to occur due to many factors, including limited assistance and facilities for residents in rural areas to access clean water, population density and water privatization. The high price of clean water is a major issue for low-income groups. The government has made various efforts to overcome the clean water crisis, including through the community-based drinking water supply and sanitation program and by encouraging the development of water resource facilities. To anticipate the growing clean water crisis and to compensate for the water supply capacity that cannot change rapidly, it is necessary to carry out an analysis related to changes in water consumption during a pandemic at every level of the socio-economic strata of society. The results of this analysis can later be used as a way of anticipation that must be carried out by the government and other interested parties in meeting clean water needs.

This study used Random Sampling Survey method, in which the survey form was filled out online and distributed throughout Indonesia. The filling period starts from 15 October 2020 to 4 November 2020. Samples were taken as many as 1,331 from all over Indonesia. Random Sampling technique is a sampling technique from members of the population that is done randomly without paying attention to the strata (homogeneous) in the population due to the distribution of questionnaires and interviews conducted online.

4.3 WATER CONSUMPTION PATTERN

In conjuction with the condition of the COVID-19 pandemic which requires maintaining cleanliness in the area of the house, people today tend to be more routine in bathing after traveling. This can be seen from the results of the analysis on changes in bathing activity under normal conditions and during the COVID-19 pandemic, which shows that there is an increase in bathing activity 3 times more often than normal conditions. The graph below shows that 29% of respondents took more baths (more than 3 times a day) during the COVID-19 pandemic than during normal conditions. From the results of questionnaire distribution, it is found that the following table shows changes in bathing activity during the COVID-19 pandemic:

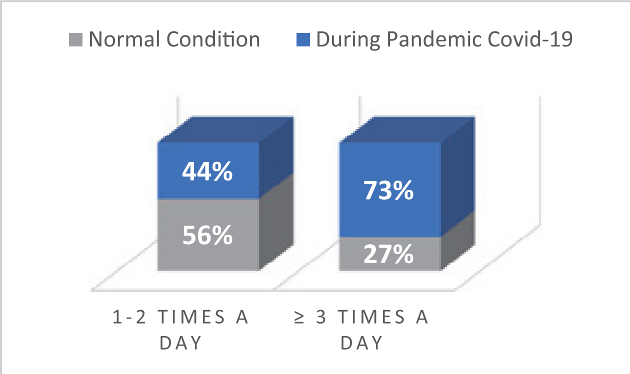

FIGURE 4 CHANGES IN FREQUENCY OF BATHING ACTIVITIES DURING COVID-19 PANDEMIC AND NORMAL CONDITIONS
SOURCE: INDONESIA WATER INSTITUTE ANALYSIS, 2021

Apart from bathing activities, other activities that support hygiene, such as washing hands, were also observed to determine changes in water consumption patterns that occur. From the results of the analysis, it can be seen that 67% of respondents wash their hands more often (more than 5 times a day) so that it has an impact on increasing the need for water to wash their hands up to 5 times from normal conditions.

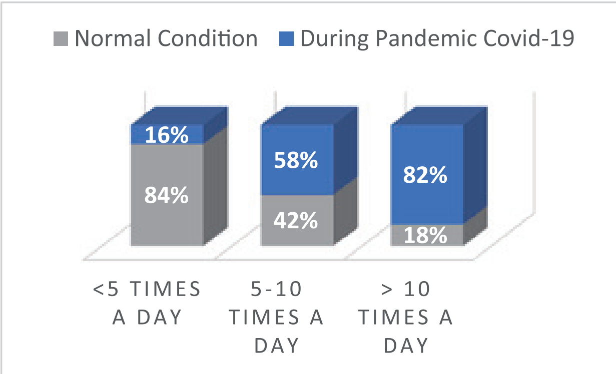

FIGURE 5 CHANGES IN FREQUENCY OF HAND WASHING ACTIVITIES DURING COVID-19 PANDEMIC AND NORMAL CONDITIONS
SOURCE: INDONESIA WATER INSTITUTE ANALYSIS, 2021

Interviews were also conducted regarding the habit of turning off the tap when washing hands, where the result was 69% of respondents had turned off the tap when rinsing their hands with soap. This can be used as a basic assumption that the community begins to understand efforts to conserve water use.

In regard to the existence of government policies, namely work from home and distance learning, this will indirectly have an impact on increasing the duration of activities carried out at home. The increase in household activities during a pandemic also needs to be further analyzed to determine any changes in consumption patterns at the household scale. Therefore, an initial analysis was carried out on the activities of cooking, washing dishes, cleaning houses, and washing vehicles. For cooking and washing dishes, 64% of respondents stated that there was an increase during the COVID-19 pandemic. This could be due to the demands for healthy dietary changes and reduced food consumption outside the home.

Similar to household cleaning activities, 76% of respondents stated that there was an increase in house cleaning activities during the COVID-19 pandemic, in connection with increasing activities carried out at home and prohibitions on traveling. As for vehicle washing activities, 69% of respondents stated that there was no increase in vehicle washing activities. This is supported by reduced mobility outside the home during the pandemic. The image below illustrates the changes in household activities that occurred during the COVID-19 pandemic.

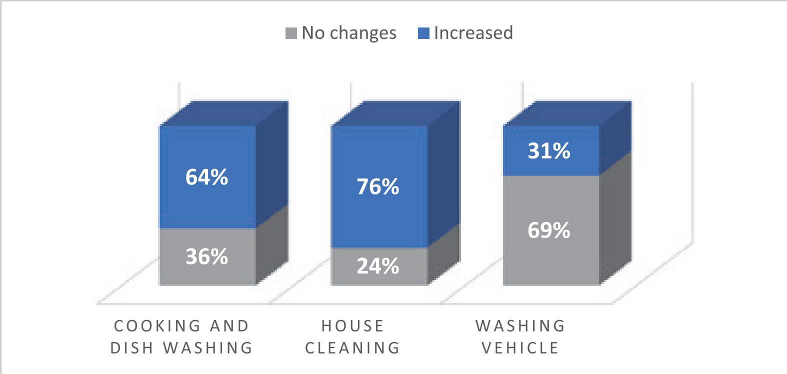

FIGURE 6 CHANGES IN FREQUENCY OF HOUSEHOLDS ACTIVITIES DURING COVID-19 PANDEMIC AND NORMAL CONDITIONS
SOURCE: INDONESIA WATER INSTITUTE ANALYSIS, 2021

From the analysis of water consumption patterns during the pandemic previously described, it can be further reviewed to determine changes in water consumption patterns that occur at the household scale. The table below describes changes in water consumption patterns during a pandemic compared to normal conditions. With the assumption of 5 family members per house, it can be seen that there is an increase in water consumption up to 2-3 times from normal conditions. Increasing the frequency of household sanitation activities during the COVID-19 Pandemic is a health protocol that must be adhered to. Healthy and clean-living habits require the availability of adequate water.

TABLE 4. SOUTH KALIMANTAN REGENCY /CITY AFFECTED BY FLOOD DATA

No	Activity	Unit	Normal Conditions*	COVID-19 Pandemic
1	Bathing	Liter/person.day	50-70	150-210
2	Hand Washing	Liter/person.day	4-5	20-25
3	Cooking	Liter/day.house	45-90	45-90
4	Cloth Washing	Liter/day.house	100-150	100-150
	Total of Water Consumption	Liter/day.house	415-615	995-1.415

SOURCE: INDONESIA WATER INSTITUTE ANALYSIS IN 2013 AND 2021*

4.4 FLOOD HANDLING DURING COVID-19 PANDEMIC

In regard to water related disasters in Indonesia, the President has given direct instructions to maximize flood handling. The instructions given are as follows:

a. Faster/speed-up the process of evacuation, search and rescue of victims who still have not been found.

b. Ensure the presence of health services and medical assistance which are urgently needed by the victims. The Minister of Health will direct the medical aid team to arrive immediately at the disaster location.

c. Fulfill the logistical, sanitation and other needs for refugees to be well-cared and to immediately received by them. The Minister of Public Works and Housing has to accelerate the repairment of supporting infrastructure that was damaged by the disaster, such as collapsed bridges and cut off road accesses.

d. Early anticipation of the potential impact of extreme weather that occurs in various regions in Indonesia. Information and warnings from BMKG regarding this matter are very crucial and the publication of them must be intensified.

In order to recover the field conditions, the Ministry of Public Works and Housing remains committed to support emergency response towards disasters in South Kalimantan, NTB and NTT. The Ministry of Public Works and Housing deployed heavy equipment from various locations, evacuated flood-affected residents and prepared emergency response management. The Ministry of Public Works and Housing also conducted covers damages inventory, installing danger signs at landslide locations, and cleaning-up mud on the national road in order to control the possibility of upcoming disasters.

Meanwhile, the follow-up responses include placing the Disaster Relief Unit Team on Adonara Island and Lembata Island, and installing emergency bridges on Adonara Island and Lembata Island with a minimum span of 40 meters. Emergency response efforts related to other damaged bridges include cleaning-up sedimentation and flood-borne materials on roads and bridges as well as inventory of damages. The follow-up handling is by normalizing and strengthening the damaged riverbanks.

CONCLUSION

Almost on a regular basis, Indonesia experiences floods, landslides, earthquakes, hurricanes, hurricanes, tides, and drought. The water crisis happening in Indonesia happened because of the inability in water management, hence causing natural disasters such as floods and landslides when water is abundant in rainy season and on the other hand causing droughts during summer. These disasters caused great number of deaths and missing people in 2020 and 2021.

Apart from being affected by the season, water disasters are also affected by the catchment area. The Ministry of PUPR carried out several strategies to restore catchment areas, including: 1) Normalization and increase of river flow capacity; 2) Conservation of swamp and peat areas; 3) Controlling pollution in reservoirs and lakes with high pollution levels; 4) Coordination and cooperation with Ministry of Environment and Forestry and local governments for conservation and restoration of upstream areas.

Health protocols that have been implemented since the first COVID-19 case in Indonesia equipped with a clean water supply. The increase in household activities during a pandemic has been carried out on the activities of cooking, washing dishes, cleaning houses, and washing vehicles. Increasing the frequency of household sanitation activities during the COVID-19 pandemic is a health protocol that must be adhered to, and it requires the availability of adequate water.

The flood handling during COVID-19 pandemic includes speeding-up the process of evacuation, ensuring the presence of health services, accelerating the repairment of supporting infrastructure, early anticipation of the potential impact of extreme weather.

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APPENDIX I

TABLE 1. FLOOD AND LANDSLIDE REPORT IN SOME REGIONS IN INDONESIA

No.	Date of Events	Type of Disaster	Location	Information
1	8 January 2021	Flood	South Pesisir Regency, West Sumatra Province	• Caused by heavy rainfall (150 mm) • Flash flood from Batang Lengayang River. • Overflow affected 100 houses submerged with 50 cm height.
2	9 January 2021	Flood and landslid e	Sumedang and Bandung Regency, West Java Province	*Flood* • Due to high intensity rainfall causes drainage channels to be full and water overflows the roads around PT. Kahatex • High intensity rainfall and the shallow Cikeruh River causes water to overflow from the Cikeruh River onto the main road and into the residents' housing. • The Cimande River overflows causing a flood inundation in the public house to be 30-60 cm deep, and flood inundation in the green charm housing 40-60 cm *Landslide* Cliffs as high as 20 m and a length of 40 m landslides, resulting in the death of 22 people, and 6 people are still in search.
3	12 January 2021	Flood	Sarolangun and Bungo Regency	The flood was caused by low - moderate intensity rain with a long duration of 1.5 days, starting from 11 January 2021 to 12 January 2021, thereby increasing the discharge in the Batanghari river. There were no casualties.
4	12-14 January 2021	Flood	Banjar Regency, Tanah Laut Regency, Regency Balangan and the City of Banjarmasin South Kalimantan Province	Banjar Regency: The high intensity of rainfall (± 100 mm) causes the overflow of the Riam Kiwa River. Tanah Laut District: High intensity rains caused high water volume in Embung Takisung I, so that the spillway was unable to discharge flood discharge which resulted in the breach of the embankment in Embung Takisung I. Balangan Regency: High rainfall in mountainous areas, causing the river to overflow in the mountainous area of Tebing Tinggi District. Meanwhile, the flood that occurred in Awayan District was flood water sent from Tebing Tinggi District. (Forecast CH = 150 mm) Banjarmasin City: Rain with high intensity and long duration from January 13, 2021 to January 14, 2021 does not stop. The tributaries around Central Banjarmasin overflowed and inundated houses and roads. Banjar District: High rainfall in the vicinity of the disaster area (around 100 mm) resulted in overflow of water inundating the bridge on the Martapura River. Impact:

No.	Date of Events	Type of Disaster	Location	Information
				Submerging hundreds of houses and intersections on the Martapura River broke up
5	15 January 2021	Flood	Penukal Abab Lematang Ilir Regency (PALI), South Sumatra Province	On the day of January 14, 2021, the flood due to high rainfall in the upper reaches of the river, causing the Lematang River to overflow. The rainfall recorded in the upstream area of Tanah Abang District on January 14, 2021 is 28.1 mm. Impact: Around 250 houses were flooded with water levels of about + 0.9 meters + 1.0 meter.
6	15 January 2021	Flood	Luwu Regency, South Sulawesi Province	Caused by High intensity rain (80.5 mm) throughout the day of January 15, 2021 at upstream area.
7	16 January 2021	Flood and landslid e	Bitung City and Manado City, North Sulawesi Province	Bitung City Rain with high intensity that causes the Girian River to overflow. The impact: Houses are submerged in several sub-districts including: Manembo-nembo Village, Philipin Village, Girian Weru Satu Village and Girian Bawah Village. Manado City • Flood Rain with high intensity that causes the discharge of water to overflow in several rivers, including: Tondano River, Mahawu River, Sario River and Tikala River. • Landslide Due to high intensity rain and unstable soil structure Damage There were 5 people who died due to landslides (3 people in Perkamil Village and 2 people in Malalayang Village)
8	18 January 2021	Flood	Sayung District, Demak Regency Central Java Province	Heavy rain since the afternoon of Sunday 17 January 2021 in the upstream area and evenly rains in Demak Regency until evening. The intensity of this rain caused the Dolok River water to overflow the embankment and caused the left embankment to burst on 18 January 2021 in the morning along 12 m, the height of the embankment was 4 m.
9	19 January 2021	Flood	Bogor Regency, West Java Province	Heavy rain was starting in the early morning, the Bogor Peak area in the Gunung Mas Complex, Tugu Selatan Village, Cisarua District, Bogor Regency. The existence of continuous rain causes flash floods. Damage 134 families or 474 people must be evacuated
10	17 February 2021	Flood	Subang Regency, West Java Province	Flood occurred due to High intensity rainfall.

No.	Date of Events	Type of Disaster	Location	Information
11	12 March 2021	Flood	Takalar Regency, Jeneponto Regency, and Maros Regency - South Sulawesi Province	• Regency Takalar: Heavy rain on March 9, 2021 at 15.00 WITA, causing the Pappa River and Je'nemarrung River to overflow. • Regency. Jeneponto: Heavy rain from 19.00 WITA on March 9, 2021, causing the Allu River to overflow. • Regency. Maros: heavy rain from Tuesday, March 9, 2021 at 11.00 WITA, causing the Maros River to overflow
12	27 March 2021	Flood	Tasikmaya City, West Java Province	Heavy rain from 17.00-21.00 WIB with extreme rain intensity of 215 mm, causing the Citanduy river discharge to overflow. Damage: The Citanduy river overflowed several places in the Panyingkiran area As a result, the irrigation of Bobojong Village, Panyingkiran Village was flooded.
13	3 April 2021	Flood	Bima Regency West Nusa Tenggara Province	Rain started on Friday April 2 with moderate and high intensity for 9 hours, flushing the entire Bima Regency area until around 15:00 WITA resulting in flooding that inundated rice fields, settlements, public facilities and social facilities. Rainfall data recorded in ARR Paradowane was 131 mm.
14	1-6 April 2021	Flood	Kupang City, Alak District, Kelurahan / Desa Nunbaun Sabu East Nusa Tenggara Province	Strong winds from April 1, causing high waves of about 3 m, which then hit the coast of Namosain Beach
15	1-6 April 2021	Flood	Kupang Regency, Sulamu District, Sulamu Village / Village East Nusa Tenggara Province	Strong winds from April 1, causing high waves of about 3 m which then hit the coast.
16	1-6 April 2021	Flood	Kupang Regency, Taebenu District, Kuaklalo Sub-district / Village East Nusa Tenggara Province	Due to rain and strong winds, it caused landslides and damage part of the construction
17	1-6 April 2021	Flood	Timor Tengah Selatan District,	The rain that has occurred since Tuesday, March 30, 2021 has continuously caused the concentration of

No.	Date of Events	Type of Disaster	Location	Information
			Kualin District, Toineke Village East Nusa Tenggara Province	surface runoff in the Noel Muke catchment area and finally overflowed inundate the plains of Toineke village and its surroundings. Damage: Floods inundated 803 houses, 6 places of worship, 2 schools, roads, markets, village offices and about 420 H of agricultural land, with inundation heights ranging from 30 cm to 100 cm. Flood inundation has also disturbed the southern passage of Timor Island (Batu Putih-Malacca). The flood started at 21.00 WITA on April 1 and has gradually subsided.
18	1-6 April 2021	Flood	South Central Timor Regency, Polen District, Konbaki Village East Nusa Tenggara Province	Due to heavy rain there was a large flood which was not proportional to the conduit capacity Damage: landslide in around the conduit embankment
19	1-6 April 2021	Flood	Belu Regency, Lamaknen District, Lamak Senulu Village / Village East Nusa Tenggara Province	High intensity rain caused river overflow and damages the dike Damage: Dike damage of 80 m long
20	1-6 April 2021	Flood	Belu Regency, Kakuluk Mesak District, Fatuketi Village / Village East Nusa Tenggara Province	Due to rain and strong winds causing landslides Damage: Landslide on the left side of the dam 30 m long
21	1-6 April 2021	Flood	Malacca Regency, West Malaka Subdistrict, Motaulun and Kakaniuk Sub-District / Village East Nusa Tenggara Province	High flow of river water causes discharge in the river Benanain was getting higher and destroying trashrack and grinding river cliffs around the primary and siphon channels Damage: Damage to the trashrack weir, scour around the primary channel, dike damage around the sipon are about 50 m
22	1-6 April 2021	Flood	East Sumba Regency, Waingapu City District, Kambaniru Sub-District / Village	High flow of river water causes discharge in the river Kambaniru was getting higher and damaging the pedestrian bridge above dike Damage: The Pedestrian Bridge over the weir was damaged by the flood

No.	Date of Events	Type of Disaster	Location	Information
			East Nusa Tenggara Province	
23	1-6 April 2021	Flood	East Flores District, Ile Boleng and East Adonara Districts, Kelurahan / Desa Lamanele and Waiburak East Nusa Tenggara Province	Due to high intensity rain and flash flood on Sunday, 04 April 2021, at 01.00 PM Damage: 49 Affected Settlements, bridges, roads and public facilities have been damaged.

5 Water-Related Disasters and COVID-19: Exploring the relevance of the HELP Principles in Caribbean Small Island Developing States.

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The Caribbean Context

Caribbean, Small Island Developing States (SIDS) are among the most vulnerable in the world regarding natural hazards. According to CDEMA (2014), the Caribbean is the World`s second most hazard prone region. This heightened vulnerability emanates from a myriad of factors that range from inherent geographic factors to socio-economic complications, which have been intricately influenced by decades of colonial hegemony. Specific factors of relevance include small geographic size (smallness), steep terrain, geographic location (exposure to natural hazards), sensitive biophysical ecosystems, and financial and human resource limitations. Furthermore, 60% of the region`s population reside and 70% of the economic activity occurs within two miles of region`s coastlines (CDEMA 2014). Scandurra et al. (2018) examined the vulnerability of (SIDS) in relation to climate change and environmental challenges and noted some of the factors mentioned above, while emphasizing the disparity between the collective contributions of SIDS to Climate Change, and its potential for devastating impacts on local economies and societies.

Over the last decade there has been a notable increase in both the frequency and intensity of hydro-climatic extreme events resulting in catastrophic outcomes for affected islands. Throughout the Caribbean, floods are one of the most prominent hazards (Roopnarine et al. 2018), while seasonal climatic variations also subject some islands to water scarce conditions and, in some cases, droughts. The Caribbean Drought and Precipitation Monitoring Network (CDPMN) operated and managed by the Caribbean Institute for Meteorology and Hydrology (CIMH) has expressed concerns relating to the reduction in rainfall associated with climatic anomalies in recent years. Further to this, some islands lack sufficient surface water sources and are heavily reliant on groundwater reservoirs and desalination plants. Additionally, many vulnerable communities in rural districts do not have access to a consistent and reliable supply of pipe-borne water and, in some cases, the supply is not incorporated into national distribution networks.

These circumstances underpin the critical need for intervention as it relates to water and water-related disaster management which are core aspects of Agenda 2030 and the associated Sustainable Development Goals (SDGs). Notwithstanding the interrelations and relevance of all SDGs, SDG 6 and SDG 11 are both worthy of special mention as they have specific indicators aligned to the elements of DRM and Sustainable Water Use **(BOX 1)**.

BOX 1: Sustainable Development Goals (SDGs) 6 and 11.

SDG 6: Ensure availability and sustainable management of water and sanitation for all, and its interconnected target 6.4; which states to, "substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity".

SDG 11: Make cities and human settlements inclusive, safe, resilient, and sustainable, and its interconnected target 11.5; which states to, "significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations".

Mechanisms aimed at achieving these goals and their corresponding targets are crucial, as currently only 74% of the Latin America and Caribbean (LAC) population use a safely managed drinking water service. With respect to safely managed sanitation services, coverage is an alarmingly low 31% and the average percentage of implementation of Integrated Water Resources Management (IWRM) in Latin America and the Caribbean (LAC) is 35%. Data on Hygiene, Wastewater, Water quality, Efficiency, Cooperation and Participation among other variables, remain absent (Region | SDG 6 Data 2020). Considering that the UN data portals combine statistics for the Caribbean and Latin America (LAC), some level of masking and distortion is expected as opposed to when each region is considered on an individual basis. The underlying premise of limited data availability and the notably low % achievement of the respective targets, however, holds for many Caribbean SIDS. The emergence of the COVID-19 pandemic added another layer to the myriad of challenges faced by these islands. Fighting a pandemic in the context of this very high vulnerability with such unique circumstances exposed the urgent need for a holistic and integrated approach to Disaster Risk Management (DRM).

COVID-19 Pandemic and Caribbean SIDS

COVID-19 has triggered a chain reaction of unprecedented proportions, with socio-economic and health concerns apparent throughout the region. For tourism-based economies, travel restrictions and border closures continue to stifle economies, while the international decline in oil prices and widespread occurrence of curfews across the region, brought similar, though less severe outcomes for the few industrialized countries like Trinidad and Tobago (Garavito, Beuermann, and Álvarez 2020). Figure 1 illustrates the trend in occurrence of new COVID-19 cases for six randomly selected Caribbean SIDS territories. Of the territories included, Jamaica had the most pronounced increase in the number of new cases, with a notable spike in the first quarter of 2021. The trend for all other territories were relatively similar with peaks in and around September to November 2020, followed by intermittent spikes in early 2021. It should also be noted that case numbers associated with the "second wave" in these territories did not exceed those of the first wave except in the case of Jamaica.

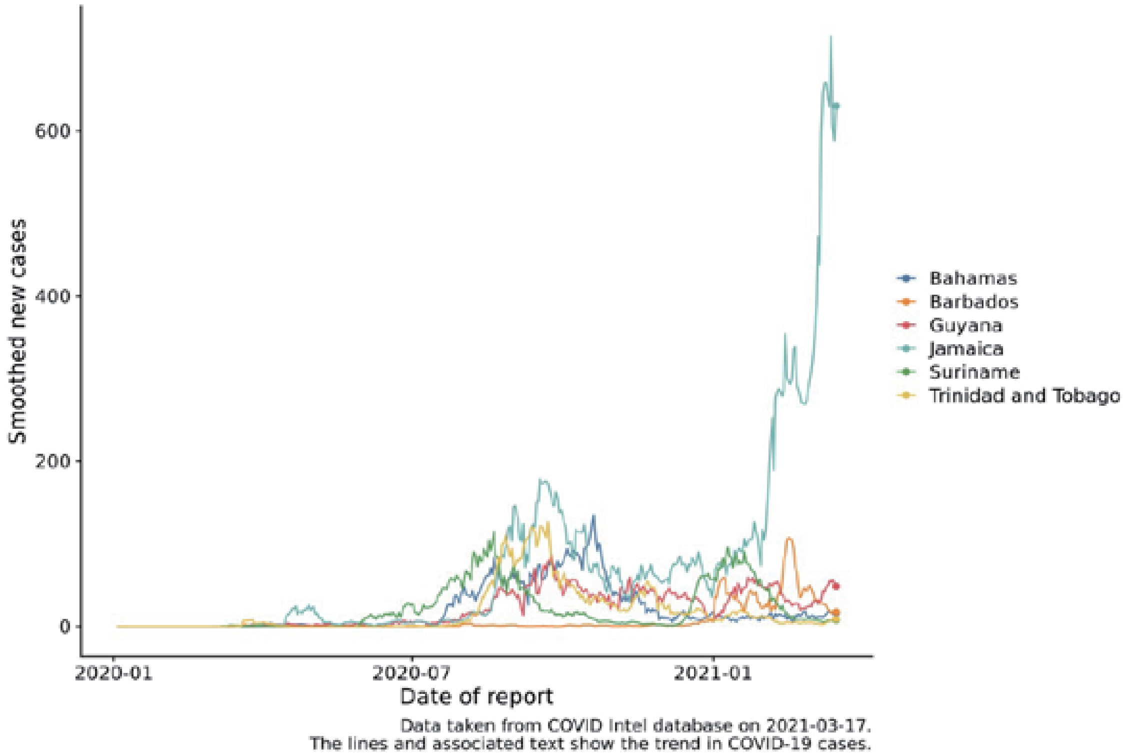

Figure 1. Showing the number of new COVID-19 cases per day in six (6) Caribbean SIDS
Source: World Health Organization (WHO); COVID-19 Explorer (2021).

Despite the global uncertainty regarding the best management strategies, experts strongly recommended that minimizing the spread of the virus, was and continues to be paramount. Figure 2. illustrates the "flattening the curve" concept and its relevance in relation to the carrying capacity of health care systems with and without the introduction of protective measures. For the Caribbean SIDS it was priority to "flatten the curve", due to the limited capacities of health care systems throughout the region. Most regional governments integrated this concept into their respective COVID- 19 management strategies and despite the significant initial increases in cases and societal anxiety, health care facilities, thus far, have been able to adequately cope. The challenge now, is for regional authorities to find an equilibrium between minimizing spread while simultaneously ensuring economic stability.

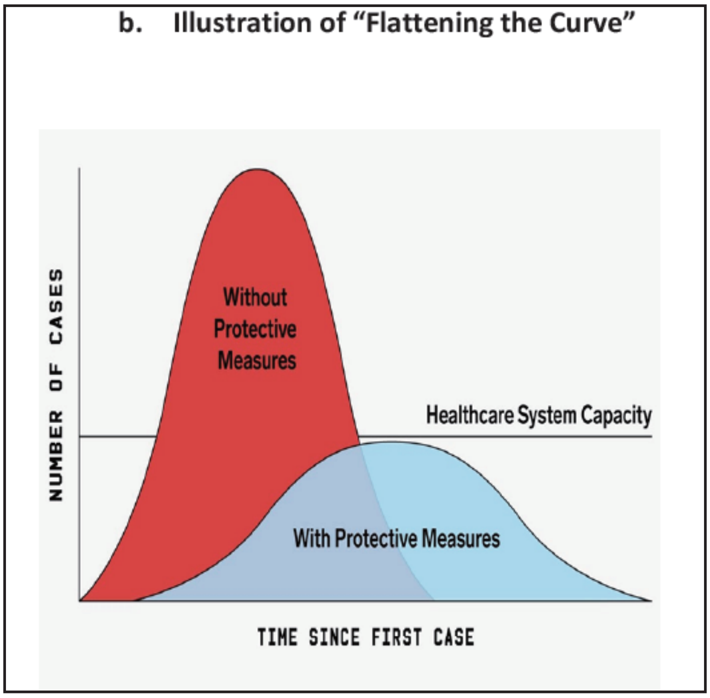

Figure 2. Showing the "flattening the Curve" concept.
Sources: Inter-American Development Bank 2020; Economist Intelligence Unit; Johns Hopkins Center for Health Security; Johns Hopkins University database; and IDB country office reports.

Considering the current hyper focus on COVID-19 management, it is critical that efforts to address water-related disasters are not paralyzed. Mandated sanitary measures have increased water usage. Handwashing, for instance, is considered as one of the most important strategies towards curbing the transmission of the virus. Many Caribbean SIDS are affected by drought, water pollution issues or simply lack of access to water for economic, social, or environmental reasons. The availability of water for the purpose of COVID – 19 management, and perhaps more seriously the additional operational constraints[1] faced by

water service providers is posing a challenge. This underscores the need for a comprehensive risk management that extends beyond COVID-19 management to be inclusive of integrated efforts to improve access and availability of water during co-occurring disasters.

1 Loss of income increases in overtime and travel costs, supply chain difficulties and constraints on working practices.

Water-Related Disasters in Caribbean SIDS

The COVID-19 Pandemic has certainly shifted the paradigm and has forced society to establish a “new normal”, while simultaneously releasing a Pandora’s box of new troubles and realities. Notwithstanding, water-related disasters remain a concern. Andrewin, Rodriguez-Llanes and Guha-Sapir (2015), underscore the phenomenon that floods and storms are climate-related hazards which pose high mortality risk to inhabitants of the Caribbean SIDS. Figure 3 depicts the total damage in US$ annually across Caribbean SIDS from 1991 to 2021 resulting from water-related disasters. In the last five years storms and floods resulted in three instances of damages in excess of two billion US$, with occurrences in 2017 accounting for a 30-year high of almost seven billion US$, in damages.

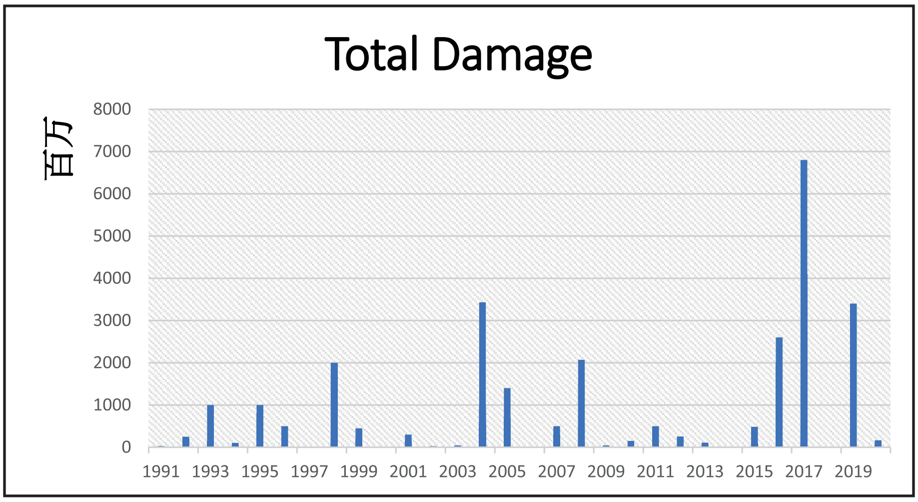

Figure 3. Showing the total damages in Millions in the Caribbean Region.
Source: EM-DAT, the International Disaster Database.

Fontes de Meira and Phillips (2019), noted the historical profile depicting Caribbean flood emergencies and emphasized the reality that flooding has become a widespread and commonplace occurrence, which goes further to threaten lives, citizen`s livelihood and the economies of the Caribbean Region. Caribbean SIDS must therefore be pragmatic in their approach, cognisant of the potential risk associated with water-related hazards. Fontes de Meira and Phillips (2019), also documented that there were over 350 occurrences of either storms or flooding events in Caribbean (SIDS) between 1990-2018 (Table 1). These events resulted in damages amounting to over US$ 114 million with over 35 million people affected from the less than 20% of the events being assessed. Figure 4 provides an example of the impacts of excessive rainfall associated with the Intertropical Convergence Zone (ITCZ) in Trinidad and Tobago in 2018. The author also noted the significant non-monetary effects of recurrent flooding events such as the yearly interruptions of educational activities, with attendant mental burdens on the affected local populations.

Table 1. Showing the summary of specific affected populations and damage cost for both flood and storm events in the Caribbean region (1990-2018)

Summary of affected population and damage in the Caribbean region (1990 – 2018)

Type of event	Occurrence	Percentage Assessed	Total affected population	Total damage ('000 US$)
Flood	119	20	6 077 603	1 460 082
Storm	237	44	29 770 071	112 803 519

Source: Fontes de Meira and Phillips 2019, An economic analysis of flooding in the Caribbean, The case of Jamaica and Trinidad and Tobago; EM-DAT: The Emergency Events Database - Universite catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be,Brussels, Belgium.

Figure 4 Showing images of a 2018 ITCZ induced flooding event in Trinidad.
Sources: CCRIF SPC, Event Briefing, Excess Rainfall 2018; Trinidad Express Newspapers, Loop, and Jamaica Observer.

In addition to flooding events associated with excess rainfall; tropical storms, and hurricanes pose major threats to the Caribbean Region (Figure 5). Michener et al. (1997) postulates that Climate Change is expected to cause alterations in meteorological factors such as temperature and precipitation patterns, oceanic and atmospheric circulation, increased rate of rising sea levels and the frequency, intensity, timing and distribution of hurricanes and tropical storms. This perception was reiterated by Knutson et al. (2010), indicating that based on future climate projections and high-resolution dynamical models, greenhouse warming is expected to cause tropical storms to increase its intensity by 2-11% by 2100. Fortunately, 2020 was only a fairly active hurricane season for most Caribbean countries in contrast to Central American, where countries experienced a very severe season. Therefore, impacts on Caribbean SIDS were limited with only the Cayman Islands suffering the direct effects of Tropical Storm Eta (Figure 6). It is also worth highlighting that some Caribbean SIDS exist in cycles of perpetual crisis management, as resources are often consumed in the significant task of financing recovery efforts after disasters. The fiscal demands attached to relief operations such as ensuring the availability of emergency assistance and sourcing funding for shelter, food and medical attention for displaced persons, often limits their ability to invest in the medium- to long-term recovery and reconstruction process. Consequently, the impacts of disasters extend well beyond the acute phase. To date, there are no studies published that show how disasters such as hurricanes, have impacted the spread of the COVID-19 virus. It seems plausible that virus could spread easier in the dense situation of emergency shelters or that the hazard may hinder logistical arrangements designed to curb transmission. These interactions still need to be investigated in order to understand the dynamic of the outbreak in 2020 and to be better prepared for a potentially worse hurricane season in 2021 and beyond. On the cusp of the 2021 Hurricane season and with many islands still struggling to cope with the plethora of socio-economic impacts of COVID-19 and the limited access to and distribution of vaccines, a robust strategy must be on hand to ensure catastrophic outcomes are minimized in the event of an active 2021 Hurricane Season. As seen in Figure 5 the region is at the heart of the hurricane belt.

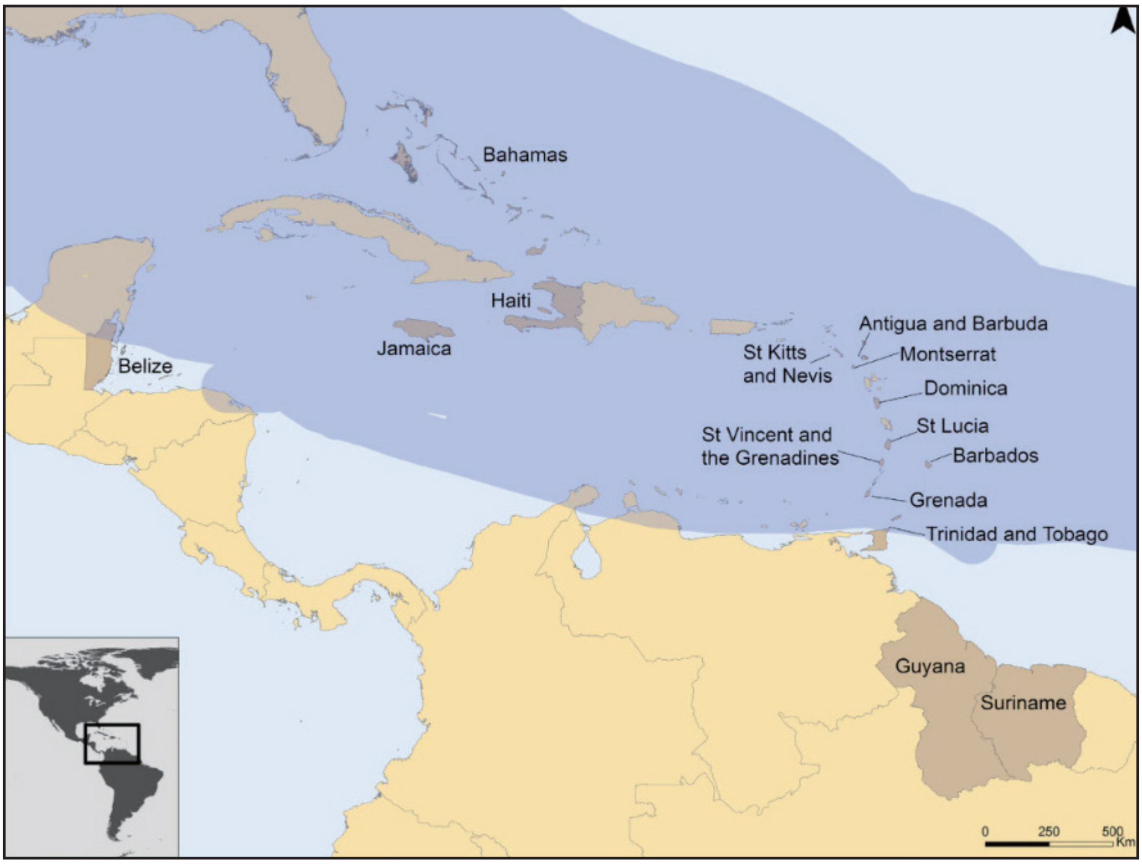

Figure 5. Showing the Caribbean (SIDS) in light brown, located within the Regional Belt of major Hurricanes highlighted in dark blue.
Source: Andrewin, Rodriguez-Llanes and Guha-Sapir 2015.

Figure 6. Showing the damages of Tropical Storm Eta in the Cayman Islands, November 2020.
Source: CCRIF SPC Event Briefing for Tropical Cyclone Eta, November 18, 2020.

According to Waithe (2019), since 2010 Caribbean SIDS incurred costs of up to US$ 3.2 billion in damages to crops, agriculture, housing, and infrastructure due to natural hazards. CDEMA (2014), also noted that regular annual disaster economic losses are estimated at US$3 billion. These estimates are likely to increase unless focus is placed on effective DRM. As it stands, the average disaster damage to GDP ratio is 4.5 times greater for small states when compared to larger ones, however, it is alarmingly six times higher for Caribbean (SIDS) with an accompanying higher frequency (Figure 8). This reality limits all aspects of development, as it catalyses political, economic, and social upheavals and results in cycles of crisis management as opposed to risk management.

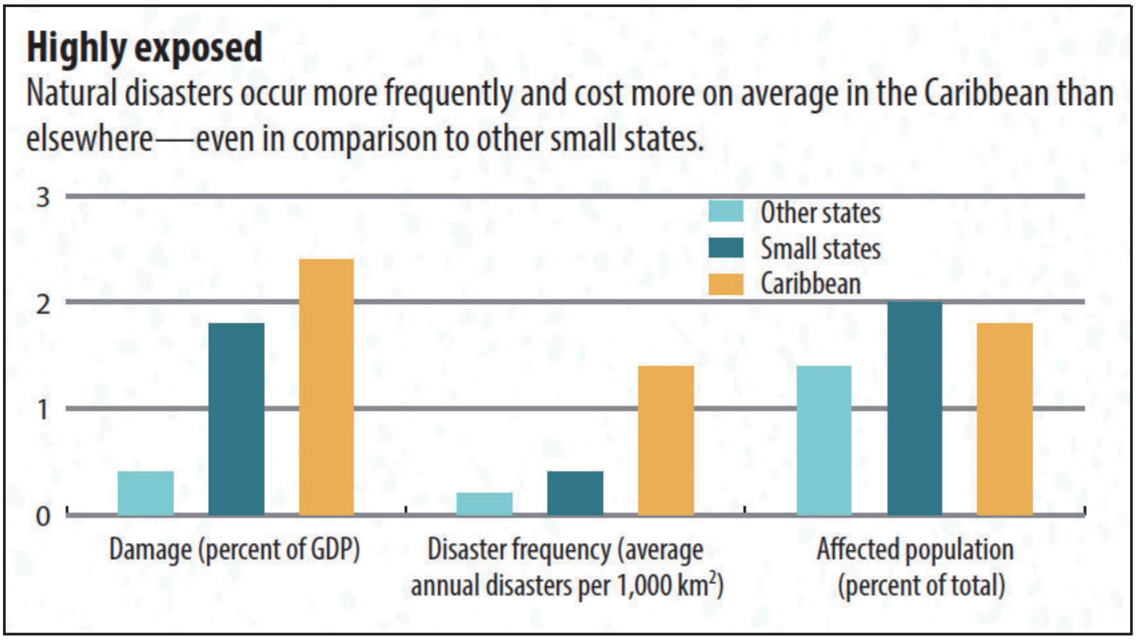

Figure 8. Showing the comparative cost of natural disasters in the Caribbean to small and other states.
Sources: Ötker and Srinivasan, 2018; EM-DAT; IMF.2016. "Small States' Resilience to Natural Disasters and Climate Change – Role of the IMF": IMF, World Economic Outlook; World Bank, Development Indicators; and authors` calculations.

These occurrences compound the vulnerabilities of low-income households and has the potential to reverse whatever minimal economic gains that were attained prior to exposure. The World Bank proposed key suggestions for the Caribbean SIDS regarding natural hazard risk management, these included:

1) Conducting detailed risk assessments, for the basis of developing efficient and cost-effective risk management strategies,
2) Developing and introducing financing strategies for approaching catastrophic events, which should also address the funding gap caused by the need to recover fiscal losses, and meeting social obligations, and other responsibilities post event,
3) Country specific mitigation measures that balance emergency preparedness, and investment in physical risk mitigation measures, strengthening institutional capacity to manage hazards, and
4) The introduction of risk financing strategies.

Additionally, the Sendai Framework for Disaster Risk Reduction (2015-2030) emphasizes the urgency for improved DRM and notes the importance in relation to vulnerable populations such as those in Caribbean SIDS. The Framework aimed to achieve a notable reduction of disaster risk and the subsequent loss of lives, accompanying loss of livelihoods and health, with a cross-cutting approach, that considers the economic, physical, social, cultural, and environmental assets of individuals, communities, businesses, and countries for the next fifteen (15) years (UNISDR 2015). Accordingly, there are four priorities for action within the framework, which include;

1) Understanding disaster risk,
2) Strengthening disaster risk governance to manage disaster risk,
3) Investing in disaster risk reduction for resilience, and
4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation, and reconstruction.

While there were aspects of other International Agreements and Frameworks (e.g. Millennium Development Goals (MDGs), SAMOA Pathway and Barbados Plan of Action (BPOA)) that address elements of DRM, the Sendai Framework focuses solely on DRM thus providing the impetus necessary to action protocols, plans, and policies, to address disaster risk. Caribbean SIDS Governments have recently started to increasingly prioritize Disaster Risk Reduction (DRR) efforts, geared towards increased institutional and social capacity, with the aim to better structure policies and strategies, that are better equipped to ensure their population`s resilience to water-related disasters (GWP-C 2021). Regional organizations such as the Caribbean Disaster Emergency Management Agency (CDEMA) have also placed focus on DRM. A Regional, Comprehensive Disaster Management (CDM) Strategy and Results Framework (2014-2024) was developed by CDEMA with the following objective:

"…To strengthen regional, national, and community level capacity for mitigation, management, and coordinated response to natural and technological hazards, and the effects of climate change".

While there were aspects of other International Agreements and Frameworks (e.g. Millennium Development Goals (MDGs), SAMOA Pathway and Barbados Plan of Action (BPOA)) that address elements of DRM, the Sendai Framework focuses solely on DRM thus providing the impetus necessary to action protocols, plans, and policies, to address disaster risk. Caribbean SIDS Governments have recently started to increasingly prioritize Disaster Risk Reduction (DRR) efforts, geared towards increased institutional and social capacity, with the aim to better structure policies and strategies, that are better equipped to ensure their population`s resilience to water-related disasters (GWP-C 2021). Regional organizations such as the Caribbean Disaster Emergency Management Agency (CDEMA) have also placed focus on DRM. A Regional, Comprehensive Disaster Management (CDM) Strategy and Results Framework (2014-2024) was developed by CDEMA with the following objective:

The CDM identifies four key priority areas:

1) Institutional arrangements for Comprehensive Disaster Management (CDM),

2) Knowledge management and learning for CDM,

3) Integration of CDM at sectoral levels, and

4) Strengthened and sustained community resilience through CDM (CDEMA 2014).

The HELP Principles and Caribbean SIDS

All things considered, it is increasingly important for the Caribbean SIDS to acknowledge and enhance DRM plans as it relates to water-related disasters despite the current emphasis on coping with the COVID-19 pandemic. This extreme focus has the potential to "distract" governments and inadvertently undermine efforts to manage threats posed by water-related disasters and disasters in general. Considering the foregoing, the ***"Principles to Address Water-related Disaster Risk Reduction (DRR) under the COVID-19 Pandemic"***, spearheaded by the ***High-level Experts and Leaders Panel on Water and Disasters (HELP)*** was birthed.

Given the urgency of the matter and the relevance to Caribbean SIDS, the Global Water Partnership- Caribbean (GWP-C) and the Global Water Partnership (GWP), partnered with the High-level Experts and Leaders Panel on Water and Disasters (HELP) to conduct an online ground-truthing consultation focused on Caribbean (SIDS). The consultation attracted a total of 83 participants from 26 countries (Figure 9), with representatives from State ministries, community-based organizations, regional entities, academia and interested persons from the public.

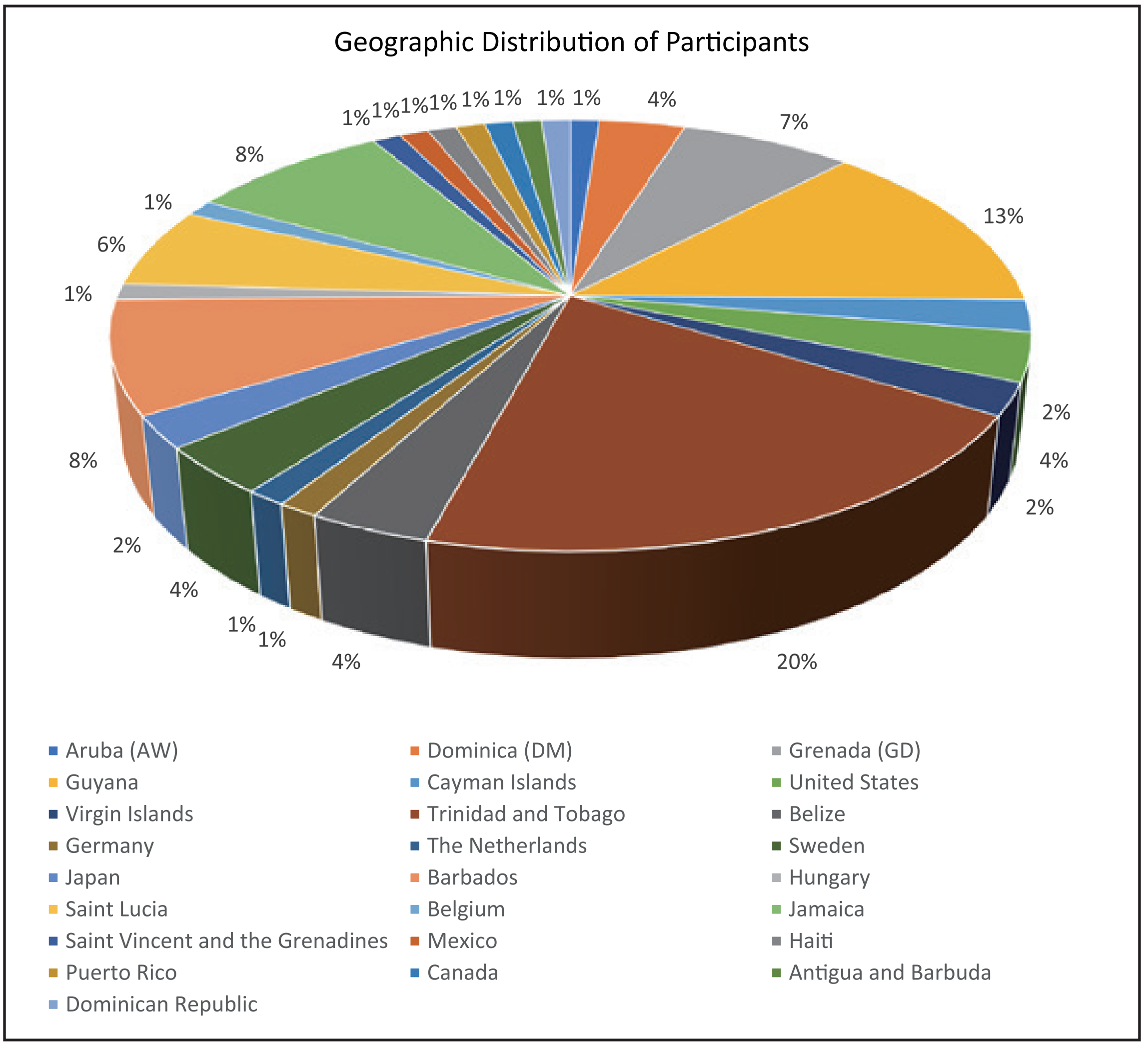

Figure 9. Showing the geographic distribution of the participants in the HELP consultation. Source: GWP-C, GWP and HELP on the ground consultation attendees listing.

In order to ascertain the views of participants, a polling exercise was conducted. Participants were asked to answer the following questions:

1. **In your opinion, how is the COVID-19 pandemic impacting water-related disaster risk reduction efforts in your country?**
2. **Which principle do you think offers the most practical advice to political leaders, managers, and all stakeholders on how to prepare and respond to water-related disaster risk reduction (DRR) under the COVID-19 Pandemic?**
3. **What do you think the first step in your country should be towards implementing the Principles?**

As seen in Figure 10, 56% of the participants indicated that they believe COVID-19 is impacting water-related disaster risk reduction efforts "severely" while 18% indicated they believed the impact to be "very severe", therefore, a combined 74% viewed it as a competing priority. While this may not be an actuality, it was clear that a significant percentage of stakeholders perceived it as such, leaning towards the view that the COVID-19 pandemic was potentially infiltrating water-related DRM efforts. In terms of the guiding Principles, the HELP strategy offers ten far-reaching and all-encompassing principles **(BOX 2).**

BOX 2: HELP Principles

- Principle 1: Enhance leaders' awareness on disaster risk reduction (DRR) in the pandemic.
- Principle 2: Integrate risk management of disasters and pandemics.
- Principle 3: Provide clean water, sanitation, and hygiene sustainably during and after disasters.
- Principle 4: Protect disaster risk management stakeholders from threat of COVID-19.
- Principle 5: Protect scarce medical resources from disaster impact.
- Principle 6: Protect disaster evacuees from threat of COVID-19.
- Principle 7: Protect COVID-19 patients from threat of disasters.
- Principle 8: Develop Specialized Evacuation Guidance for Cities and Areas under COVID- 19 Lock-Down
- Principle 9: Finance DRR actions under COVID-19 effectively to avoid economic catastrophe.
- Principle 10: Strengthen global solidarity and international cooperation to cope with these co-occurring challenges towards building our world back better.

The applicability of these will difference on a regional scale as circumstances will dictate relative importance. Participant responses indicated that the majority of participants (14) considered Principle 1 (ENHANCE LEADERS' AWARENESS ON DISASTER RISK REDUCTION (DRR) IN THE PANDEMIC) as the most practical. The next most popular choice was Principle 2 (INTEGRATE ACTIONS ON RISK MANAGEMENT OF DISASTERS AND PANDEMICS), which was selected by 12 participants and Principle 10 (STRENGTHEN GLOBAL SOLIDARITY AND INTERNATIONAL COOPERATION TO COPE WITH THESE CO-OCCURRING CHALLENGES TOWARDS BUILDING OUR WORLD BACK BETTER) which was selected by ten participants. These top three responses highlight the perceived importance of capacity building and knowledge transfer to DRM, particularly in relation to leaders along with the need for integration DRM efforts beyond COVID-19 management and the significance of global efforts towards effective management of disaster risk.

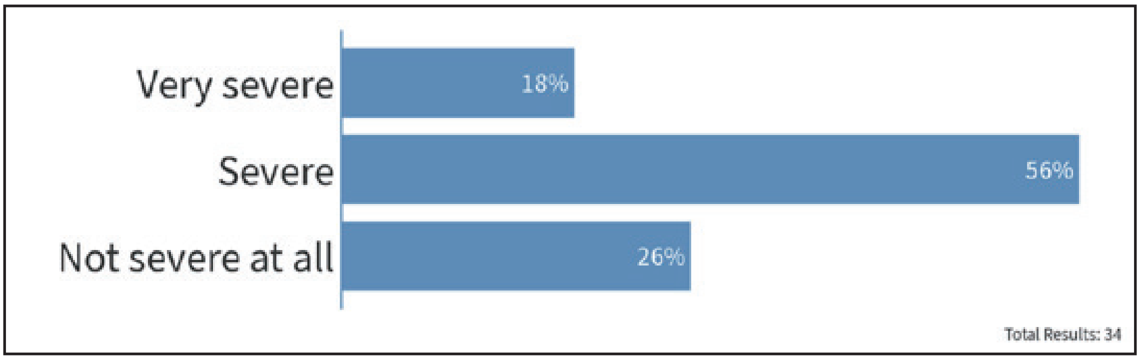

Figure 10. Showing the respondents poll results regarding COVID-19`s impact on water-related disaster risk reduction. Source: Poll results of the GWP-C, GWP and HELP on the ground consultation.

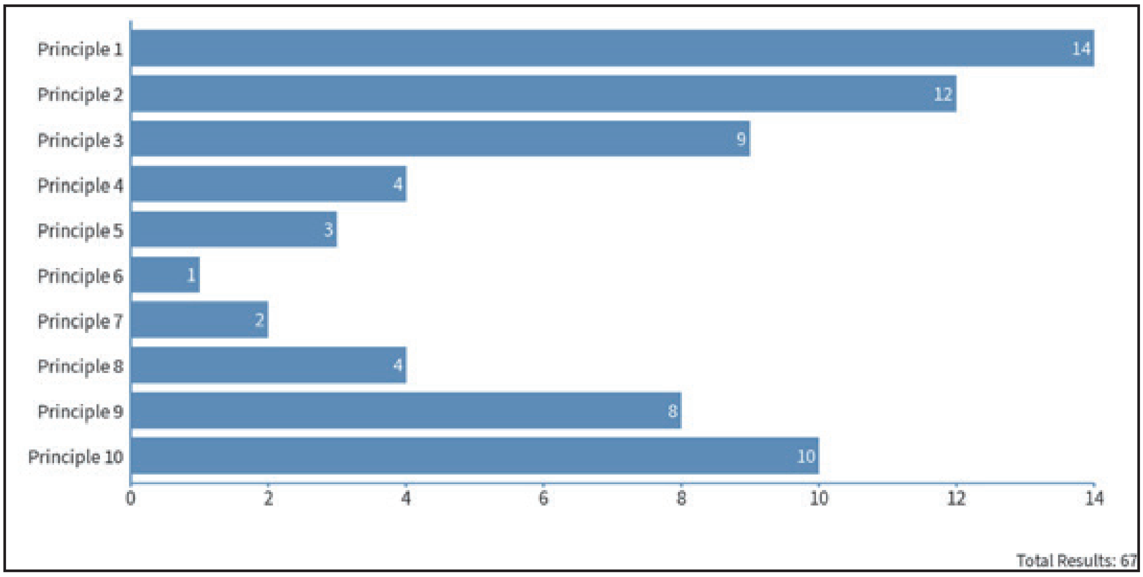

Figure 11. Showing the respondents poll results regarding their opinion on the (HELP) Principles` practicality in offering advice to stakeholders.
Source: Poll results of the GWP-C, GWP and HELP on the ground consultation.

In terms of the applicability of the HELP Principles to Caribbean SIDS participants provided a range of responses and perspectives (Table 2). The views presented in this microcosm of stakeholders painted a picture of the current circumstances and areas of focus for the Caribbean Region. Numerous participants expressed views centred around "education and awareness" building at all levels, its urgency, and the need to ensure policy makers are properly informed about the crucial step towards the implementation of the HELP Principles. With many stakeholders sharing such a parallel perspective, it is evident that education and awareness of the Principles were limited. It is therefore critical that Caribbean Countries engage in capacity building activities and employ an effective knowledge transfer mechanism.

Table 2. Showing the Categories Given to the Perspectives documented from Participants

Education and Awareness	Analysis, Assessment, and Recognition	General Action Plans
➢ Raise awareness of the urgency and importance of the issues re. DRR and strengthen global solidarity. ➢ Creating awareness through education. Forming partnerships. ➢ Sharing knowledge. ➢ Public awareness regarding the Principles and review regarding other existing Principles. Awareness must include policy makers across the political divide. ➢ Awareness. ➢ Awareness Building at all levels. ➢ Awareness of leaders that DRR and COVID-19 should be addressed in integrated manners. ➢ Education and awareness of these key Principles. ➢ Let people know about this principle. ➢ Communicate the benefits of acting on the Principles.	➢ Analysis to identify the common components of DDR that are critical to all sectors so that those components are robust to address the differences in types of response required by each sector. ➢ Recognize the existing vulnerabilities that would be addressed with the Principles. ➢ Community Assessments and mapping. ➢ Assessing the true cost of the impact of COVID-19 experience to the water sector. ➢ Conduct an audit to see which principle best fits our local situation and action it. ➢ Need to conduct a gap analysis of the policies and systems already in place for dealing with the "twin risks" and what is missing or required. ➢ Review existing disaster preparedness measures. ➢ Mapping the relationship between flood and drought prone areas and COVID-19 spread. ➢ Reinforcing the urgency of the need to policy makers.	➢ More emphasis on food and water security locally. ➢ Hospital Business Continuity Plans. ➢ Mobilization of Local authorities to monitor aspects of Water related disaster activities. ➢ The Principles need to be incorporated into Disaster Plans--at least considered. ➢ Capacity building and program rollout. ➢ To reach to key stakeholders and develop an action plan.

Noting the intricacies of Caribbean societies, the cultural rigidity, and limited financial and human resources, emphasis must be placed on innovative techniques that extend beyond static inputs of knowledge while encouraging the use of knowledge rather than mere knowledge acquisition. Participants also made mention of the true cost of COVID-19 on the water sector, the identification of common components of DRM that are critical to all sectors, and a gap analysis of the policies and systems that are already in place for dealing with the "twin risks". **BOX 3** highlights some of the additional suggestions provided by participants required to improve resilience efforts in the Caribbean as it relates water-related disasters and the COVID-19 pandemic.

BOX 3: Suggestion Posed by Participants towards improving management of "twin risks"

- Understanding the need to integrate health into (DRR),
- Need for an established regional framework and policy pertaining to disaster risk management (DRM),
- Sharing of information and research,
- Importance of integration with the water sector,
- Understanding why integrating risk and pandemic is vital,
- Clear awareness of natural hazards in the region,
- The apparent need to review existing disaster risk reduction systems in light of COVID-19,
- The possible benefits of implementing disaster risk reduction Principles holistically,
- The usefulness of bi-lateral discussion and information sharing,
- Identifying the leaders that need to be engaged,
- The need to think system-wide and not sector-wide when tackling COVID-19, and
- The realization of Principles being strategic in guiding actions and the importance of an integrated approach when tackling 'dual' or 'triple' or "compound" risks.

Looking Ahead

The vulnerability of Caribbean SIDS to water-related hazards remains paramount and despite the numerous challenges brought on by the COVID-19 pandemic, efforts to treat with such must not be weakened. The need to effectively manage water resources in an integrated manner and guard against water-related disasters should not be compromised, as the threats remain a concern. The introduction of the HELP Principles and the regional consultation provided an opportunity not only to increase awareness on "twin risks" but it also enabled interactive, intersectoral and multidisciplinary knowledge transfer which are all crucial aspects for the actioning of effective and comprehensive DRM plans. Noting the uncertainty as it pertains to the "end" of the pandemic, along with the potential for future pandemics, implementation these principles will certainly play a crucial role towards enhancing the resilience of Caribbean SIDS against present and future co-occurring hazards. Despite the importance of the HELP principles in managing "twin risks", efforts towards improved DRM should also extend beyond the COVID-19 pandemic and water-related hazards. "Compound risk" rather than "twin risks" where all natural hazards are considered, inclusive of seismic and volcanic hazards, may be a more suitable and sustained approach, looking beyond the current pandemic situation, which will be over at some point. This will enable a pathway to holistic risk management strategies, that does not subvert focus away from any pre-existing threats.

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6 Analysis of economic impacts with a focus on DRR and CCA financing due to COVID-19

authors: Szönyi, Michael; Groth, Charlotta (Zurich Insurance Company Ltd); Quevedo, Adriana (ODI) and the Zurich Flood Resilience Alliance

Note: This analysis follows background reports that were written in collaboration with or on behalf of the Zurich Flood Resilience Alliance and Zurich Insurance Group, such as “At What Cost (Zurich Flood Resilience Alliance, July 2020)”, “Building Back Better (Zurich Flood Resilience Alliance, Sept. 2020)” and “COVID-19 impact on climate change and disaster resilience funding: Trends and Signals (ODI & ZFRA, 2020)”. It also follows from and picks up on recommendations of the UN HELP principles of addressing water-related disaster risk reduction under the COVID-19 pandemic.

Executive Summary

There are reasonable doubts whether existing commitments of ODA and in particular CCA will be met under financial strains to cope with the COVID-19 pandemic, and whether expectations are realistic that new financial commitments for CCA will be made. Despite indications that opportunities for a green and climate-informed recovery from the current shock exist, much needs to be done to ensure a majority of it is targeted to be green and the reminder applies at least exclusion criteria to avoid a climate-risk-uninformed recovery.

Following the global COVID-19 pandemic, there is an urgent need for emergency and recovery financing due to the health and economic crises and a drop in global GDP of minus 3 to minus 5%. The pandemic could push 265 million people into acute food insecurity and up to 500 million people into poverty. For the first time since 1990, development gains have reversed into development losses. Governments have made available pandemic funding in the order of USD trillions to respond. Additionally, global multilaterals have appealed for over USD 10 billion in humanitarian assistance. It remains clear, however, that preparations to such well-known risks remain inadequate and actions are mostly reactive. Reactions to the pandemic also indicated continued shifts from existing priorities not dealt with yet to newer, more urgent priorities, highlighting once more that following through on long-term commitments is hindered by the sudden onset of short-term issues. Existing global crises including the climate crisis continue to need tackling. While the year 2020 has seen important developments including the Race to Resilience added as a 2nd campaign to the Race to Zero, and new commitments for financing and for the implementation of action made, actions both for ensuring a 1.5°C future as well as for the necessary adaptation investments as we are more likely on a path towards a 3°C future remain inadequate, and inadequately financed. The size of the reaction to the pandemic dwarfs – by orders of magnitude – the actions taken to combat anthropogenic climate change and to finance a successful implementation of the Paris agreement. There are clear signals that the funding gap for climate change will widen despite the good opportunities for a green recovery from the pandemic. Over the next 15 years, investment needs are in the order of USD 90 trillion to align the global economy to a 1.5°C scenario. Many times, the recovery pathway from the pandemic has been suggested it should be a green one, including many policy and advocacy recommendations published and many multilateral organizations as well as sovereigns calling for building back better and greener. Analysis indicates however that this still lacks practical implementation to a large extent, with the “greenness of COVID-19 stimulus” positive only for few select cases currently. While up to one third of certain funds have been earmarked for climate action as a very positive signal, this leaves more than 2/3 of even those funds subject to subsidizing a brown or black recovery. It has been agreed that unrestricted funds should be committed to ‘do no harm’ to the EU’s 2050 net zero target. Both a strong focus on green recovery as well as assurance that remaining funds that do not specifically focus on green at least apply exclusion criteria to avoid subsidizing brown or black are called for.

When looking at the availability of Official Development Assistance (ODA) funding and how it is allocated to climate change mitigation (CCM) and climate change adaptation (CCA), it is clear that investments are insufficient to adequately prepare for the expected impacts of climate change. The desired balance between financing CCM and CCA has not been achieved. More importantly, the investments that are made available are not going to the countries and people that need it the most. Under COVID-19, this is likely to worsen as developing countries’ budgets will have less flexibility to meet or increase their financing for CCA. The ongoing support through ODA will be increasingly important, but COVID-19 will have a financial impact of -2.5-2.9% because of the fall of Gross National Income, as most bilateral donors couple their ODA to GNI, and potentially to three times as much if aid budgets are not ringfenced and donor governments take decisions to further reduce ODA. Last, there is the question of what happens of the budget portions allocated to CCA. Across ODA finance, CCA is under pressure already and even identified as overreported by up to 42%. It is evident from recent priority shifts that focus of ODA allocation as well as actual usage by recipients is likely to shift from CCA to address short-term issues of the pandemic shock to the health system and the domestic economy. Private

finance to ODA-eligible economies has also been assessed as vulnerable to shocks and it is expected to drop by USD 700 billion year-on-year, exceeding the impact of the 2008 global financial crisis.

COVID-19 and the need for persistence: Financing the prevention of an even-bigger-wave of avoidable climate change impacts

The year 2020 has seen impacts of a global pandemic not experienced in a century. Usually busy city centers are empty, people unemployed and without livelihoods, many areas of industry and the economy grounded. In May, the UN released an appeal for USD 6.7 billion in humanitarian assistance for low-income countries facing challenges in managing the COVID-19 pandemic and is looking to mobilize an additional USD 2 billion through the UN COVID-19 Response and Recovery Fund. The World Health Organization has also launched a USD 1.7 billion COVID-19 Response Fund, which to date (February 2021) has been fully funded by sovereigns and multilaterals, and an additional WHO COVID-19 Solidarity Response Fund, which to date has received USD 242 million.

It was estimated the effects of COVID-19 could push 265 million people more into acute food insecurity by the end of 2020 - almost double than the year before, and anywhere between close to 100 and up to >500 million people into poverty, reversing the recent, very positive trends from development gain to development loss for the first time since 1990 (Gerszon et al, 2020 and Sumner et al, 2020). The danger to achieving the Sustainable Development Goals related to poverty and wellbeing is clear and present.

At the same time, despite delays such as the postponement of COP26 to 2021, cancellations of other events, and the move to digital, virtual environments, the climate debate has continued and seen some important developments including: the Race to Resilience added as a sister campaign to the Race to Zero; the efforts to elevate climate change adaptation through the Global Commission on Adaptation's Climate Adaptation Summit; and new commitments of financing and implementation of action made, with national commitments to net-zero targets now covering over 50% of global GDP. Yet, in the current situation of the pandemic crisis, unprecedented response and recovery actions were taken and often prioritized over other urgent needs in order to immediately protect vulnerable people, avoid or reduce the impact of overstressed and collapsing health systems, and provide fiscal stimuli to support affected sectors and economies. This is notable for five reasons:

Many actions were reactive and more often than not unplanned or underprepared – despite good knowledge about the likelihood of such global health crises, and despite good evidence that pre-event risk reduction and resilience building is more cost-effective than purely reacting ex-post. In 2006, the World Economic Forum's (WEF) Global Risk Report discussed a lethal influenza-type pandemic as one of four key risk scenarios that were widely discussed and seen as a global threat should the mutation (then thought to stem form an avian virus) be able to facilitate human-to-human infection. The 2006 report continued to identify – already then – that antiviral drug supplies would be insufficient to deal with the pandemic, which would be facilitated by a global economy and associated human behavior including travel patterns, and that early warning was not up to standard to allow timely action (WEF 2006 Global Risk Report).

This underlines the relevance of an up-to-date risk radar and risk inventory, and ensuring risks are adequately identified, assessed and pre-event action is taken, as reactive action is more costly and more damaging both from an economic as well as a humanitarian angle. Already existing disaster risk remains as imminent as ever during and after the pandemic. Concurrent disaster risk events were and continue to be an important element, as demonstrated by hurricane-induced destruction, especially flooding, in Latin America and cyclones hitting the coastal zones of South East Asia in 2020 during pandemic emergency measures. Considering only floods, which affect more people globally than any other type of natural hazard, the number of people exposed to flood risk is projected to grow to 150 million by 2030.

The focus was shifted from existing priorities to dealing with the pandemic, leading to isolated actions lacking integration into wider disaster risk management and lacking multi-hazard or compound-risk approaches where overlaps, potential knock-on effects or positive synergies can be identified and opportunities grasped.

The focus shift also highlighted once more that long-term commitments can be hindered by sudden onsets of shorter-term needs despite the longer-term problems not even remotely solved.

The size of the reaction to the pandemic dwarfed by orders of magnitude the actions taken to combat the previously biggest societal crisis visible on the horizon, the failure to act on climate change mitigation and adaptation and to successfully implement the Paris Agreement.

For these five reasons, we provide an updated analysis of the trends and signals we see today how finance for climate change, and in particular climate change adaptation, is likely to fare during and following the COVID-19 pandemic. We put the current macroeconomic indications in context of prior analysis which already outlined that climate change funding and the distribution of the funds to those most vulnerable and most in need of such finance was inadequate even before the onset of the pandemic. We assess the financial and economic impacts of COVID-19 and outline how ODA budgets, and DRR priorities in existing ODA programming, might be impacted. We explain the need to be persistent and develop capabilities to plan for, tackle and see through the management of longer-term crises such as the global climate crisis despite ongoing occurrences of more immediate and shorter-term impacts and provide thoughts and recommendations how to move to an implementation stage of such capabilities.

Since the onset of the pandemic now over a year ago, the emerging signals are unfortunately increasingly clear: The funding gap for climate change will widen, despite good opportunities to reap co-benefits for a “green” recovery from the pandemic that incorporates climate change and disaster resilience. The realities are:

COVID-19 recovery finance and implementation: Opportunities for green recovery pathways are likely to be missed in practice for a variety of reasons including perceived difficulty/complexity, potential delays in recovery implementation, and lack of experience.

ODA financing: Budgets are under pressure both in donor and recipient countries. ODA finance is shrinking in absolute and likely also in relative terms, consequently reducing the total funding available for climate change adaptation from donor countries.

DRR priorities in existing ODA programs: There are shifting priorities of internal budgets as well as ODA finance allocation away from CCA to other development areas, with a short-term focus of COVID-19 response over longer-term program implementation.

To leverage climate and disaster resilience finance, especially during the COVID-19 recovery phase, decision-making needs to be more risk-informed and must incorporate risks from multiple threats, and it must take a longer time horizon in line with the time horizon required to tackle the climate crisis and see the successes of mitigation and adaptation efforts in practice.

For climate change alone, by 2030, adaptation costs are expected to range between $140 bn and $300 bn a year, and rise to between $280 bn and $500 bn per year by 2050 (UNEP, 2016). For more severe scenarios of global warming these figures are expected to be much greater, with the potential of climate change related losses to affect up to 25% of GDP at the end of the century (G30, 2020). The longer adaptation and risk reduction efforts are put off by chronic underfunding in CCA and DRR, the more difficult and expensive it will be to manage adaptation needs and the harder it will be to save lives and mitigate suffering. The gap in CCA and DRR financing must be closed if the global community is serious about protecting the future wellbeing of those people most at risk from climate change. It would also be easier to reap co-benefits now as immense finance flows are injected into the economy from governments and multilaterals.

Following on from the UN-HELP COVID-19 paper (UN-HELP, 2020), we reiterate the recommendations to fully fund the needs to combat the pandemic while at the same time addressing and financing disaster and climate-related risks and while keeping in mind that compound hazards may cause irreparable catastrophe; to provide flexible funding and disbursement that enable DRR players to plan and respond to multiple risks under COVID-19; to update disaster risk management capabilities to form a global, digital and data-driven plan to address both the pandemic and other disasters, and to encourage digital finance flows to prevent further spread of COVID-19.

The macroeconomic impact of COVID-19 – and the potential for kickstarting a greening of the global economy

But how can this all be achieved during and following COVID-19? To answer this question, first an analysis of the COVID-19 impacts is required, followed by an understanding of what that impact means for other flows of funding, specifically for CCA and DRR financing and for the DRR priorities in ODA programming.

The Organisation for Economic Co-operation and Development (OECD) estimated in December 2020 that the financial impact from the pandemic will be felt through a GDP reduction of 4.2% for the entire year 2020 (https://www.oecd.org/economic-outlook/). The January 2021 International Monetary Fund (IMF) forecast estimates world GDP for 2020 at -3.5%, up from an -4.9% estimate earlier. The IMF, with a lending capacity of USD 1 trillion, has provided USD 165 billion in financial assistance to 83 countries. Where it was possible and budgets allowed, national governments helped with extraordinary monetary and fiscal support, of an estimated USD 7.5 trillion and USD 12-13 trillion, respectively, globally (IMF, 2020a and 2020c, Vivideconomics 2021). Nevertheless, the collapse in GDP and increase in debt has led to a surge in government indebtedness, both in emerging markets and developed economies, which constraints actions going forward.

On the emissions side, the COVID crisis triggered a 6.4% decline in CO_2 emissions, revised down from an earlier, more optimistic estimate of 8%. This decline comes close to match what’s needed every year until 2050 to keep the door open for limiting the rise in global temperature to 1.5°C. The COVID-19 crisis has therefore been an effective emissions disruptor and illustrates what such a decline looks like if it is achieved solely by curtailing economic activity. The social and economic costs of having a COVID-like crisis every year are clearly too high to be politically and socially acceptable. The only way to realistically tackle the climate crisis is therefore to decouple CO2 emissions from economic activity. But without investment – in new technology, in the electricity grid, in energy storage capacity, and in large-scale energy efficiency measures – this is not achievable. There is now hope that the COVID-19 crisis could act as a trigger, as unprecedented economic support measures could be used to launch investment for a greener and more climate-change-adapted economy.

This would be a very different approach compared to recovery from the Great Financial Crisis, which was a missed opportunity to reposition the global economy, with little attention paid to the environment in efforts to save the economy and financial markets. Back then, efforts to kick-start the global economy triggered a steep increase in CO2 emissions, which rose by a 7% from 2009 - 2011, fuelled by a rapid expansion in the global economy. This came alongside a boom of commodity prices and a surge in oil prices that triggered strong expansion in fossil fuel related investment. Such recovery must not be repeated.

Although subject to considerable uncertainty, cumulative investment needs of more than USD 90 trillion are estimated to be required over the next 15 years to align the global economy and energy systems to a 1.5°C scenario, with roughly half of this for the energy sector alone (IPCC SR15). Not all of this can be publicly financed – but governments will need to be part of the solution and help to pull in private funding. Given the size of investment needs, and the impact that the COVID-crisis have on public finances, it is critical that COVID support measures are targeted towards climate change transition. Currently most pressing and potentially the biggest provider of traction would be a binding, clear and fair price on carbon, which would facilitate a green recovery. In the absence of this, government measures will play an important role in generating traction. The IMF, as a response to Covid-19, blogged in April 2020 that “stimulus to reinforce the recovery could also be guided to advance a green and climate resilient economy” and subsequently has outlined guidance to governments on policy measures for ‘green’ recovery and social protection for low-carbon, resilient growth, though this has not yet been applicable to a majority of economic relief already supplied. Such measures include: supporting green, rather than brown, activities; making support to brown activities conditional on transitioning to green activities; pricing carbon right; assessing the climate impact of support measures; making the financing green; and developing new medium-term climate plans (IMF, 2020b).

However, despite the hope visible in many annual reports and reviews that these dire times provide an opportunity for building a better and greener future, and despite many discussions calling for a “greening” of the economic recovery following the pandemic including position papers from the OECD (Buckle et al., 2020) outlining three pathways of economic rebound, decoupling or wider well-being, and ultimately, despite a plethora of policy and advocacy documents producing recommendations on how to incorporate longer-term climate change thinking into the immediate actions to combat the present economic downturn, analysis indicates that all of this lacks practical implementation to a large extent. This is evident for example based on the IMF Fiscal Monitor for the 2nd half of the year 2020 (IMF 2020c), the consultation of the Grenness of COVID-19 stimulus index (Vivideconomics, 2021), and by reviewing the IMF policy tracker on the COVID-19 response, where “green strategies” are limited to select OECD countries and far from being standard practice or lacking mandatory minimum standards with regards to “green” elements within the emergency financing of a COVID-19 response. (https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19). Similar principles have been suggested by other multilaterals including development banks while in practice certain types of projects have been prioritized, especially those in health, social protection and economic development.

Most measures seen implemented in 2020 were emergency measures not targeted to be green. There is still hope for the next round of stimulus, deployed to secure a more resilient recovery. While such recovery plans will be put in place in some regions, increased debt and fiscal consolidation will be a constraint, limiting the extent to which they can trigger a broader shift towards greening the global economy. As should be well known, 2020 saw a steep increase in private and public sector debt, across all regions. Government debt in mature economies was elevated already before the pandemic, at over 100% of GDP, and it rose by a further 20 percentage points in 2020 in aggregate. The increase was smaller in emerging markets – at 11 percentage points – but this is nonetheless a challenging increase given higher funding costs, economic vulnerabilities, and a lower starting point for the level of debt. While indebtedness and vulnerability to higher funding costs has increased, the low global interest rate environment has so far helped to contain debt problems. As the economic cycle gains traction, US stimulus measures are deployed, and funding costs rise further, 2021-2022 is likely to be more challenging for countries with weaker macro fundamentals, with calls for fiscal consolidation set to intensify.

Currently, the EU’s recovery plan is the greenest among COVID fiscal support measures. The plan amounts to close to EUR 1.8 trillion (consisting of the EUR 750 bn Next Generation EU recovery fund and the EUR 1.1 trillion EU budget for 2021- 2027) and is set up to support the recovery and kick-start a multi-decade green investment wave. One third of funds have been earmarked for climate action. The idea is that this will help to close the green investment gap to meet the EU's net zero emission target by 2050, by also pulling in private investment initiatives. Details are still lacking for how funds will be spent however, and there is considerable uncertainty as to how green the stimulus will be in practice. More than 2/3 of the funds are also left unrestricted, potentially funding a 'brown' recovery, although it has been agreed that unrestricted funds should be committed to 'do no harm' to the EU's 2050 net zero target. There is also hope coming from the United States, who has officially rejoined the Paris climate agreement. The recent USD 1.9 trillion COVID-19 recovery package was not green, but plans for a multi-trillion dollar infrastructure package, which contains an important element of clean energy and climate change investment, are encouraging.

Clearly, impetus around creating a green recovery is building, but fiscal pressures will also build, likely limiting prospects for a truly green recovery from the COVID-crisis.

A look at economic and insured losses in 2020

Insurance and financial risk transfer generally is an important ex-ante instrument to agree how financial losses will be borne ex-post, improving financial liquidity, stability and providing the ability to plan ahead. In this way, insurance mechanisms contribute to the financial resilience of a society. However, certain underlying principles must be met to make a risk insurable, or better insurable, including diversification of risk and adequate means to model and measure risk to obtain a risk-reflective insurance premium. COVID-19 as a global pandemic shows the limitations of insurance alone for risk transfer, given the massive scale of financial requirements in a very short time and the lack of risk diversification.

COVID-19 insurance losses for 2020 for non-life business alone are expected to be in the triple-digit billion dollars, significantly eating into the profits of large (re-)insurance companies. Updated estimates from late 2020 and early 2021 show total insured non-life losses in the range of USD 100-150 billion. This extent is primarily due to two product lines, business interruption to SMEs, and the travel and event product lines, with losses deriving from cancellations and postponements. Both insuring the pandemic as well as quantifying the total losses from it are difficult for the aforementioned lack of diversification and the occurrence of losses almost everywhere at the same time – Lloyd's of London said 16 different lines of business were impacted overall, also including life and health insurance. Besides the more immediate effects of COVID-19 on insurance due to losses from above mentioned closures there also may be much more latent or masked losses, and those that might materialize only over the longer term, or both. Examples quoted by insurance experts include those from deferred health checks and postponed assessments and/or treatments of chronic diseases, which may increase mortality from diseases such as cancer over the coming years, and could also include areas like mental health (e.g. Swiss Re, 2020). Other examples of deferred losses stem from credit and mortgage insurance, where the economic downturn is leading to increased unemployment and personal financial crises ultimately causing more defaults of small business and private credits. However, it has to be pointed out that any global scale event like a global pandemic will always require government intervention including access to liquidity provisions such as from central banks – private insurance alone will not be sufficient.

In comparison, one can look at losses from natural hazards: The reinsurance industry has estimated that 2020 saw losses from natural hazard events at USD 210 billion, of which approx. USD 80 billion were insured, a total well above the 10-year average. While flooding in China was the largest individual loss event of the year, which amounted to roughly USD 17 billion, the year also had an extremely active hurricane season with over 30 named storms in the Atlantic.

It is interesting to note that typical reinsurance classifications for global losses fall into two main categories: "Natural" and "man-made" disasters, and the losses from the COVID-19 pandemic are currently attributed to neither but stand on their own. The question whether COVID-19 should be considered a natural disaster or not is an important one not only from a classification point of view (note: There is also need to qualify this from a legal perspective, e.g. whether there are legal grounds for contractual termination of events etc., which we explicitly exclude from the discussion here), but more generally how we as society perceive and act upon such a globally impactful crisis– a pandemic is no more or less natural than phenomena like earthquakes or cyclones in that the hazard itself is naturally occurring but the consequences derive from the interaction of the hazard with society and our decisions how we politically, socially and financially act and ultimately create or avoid risk from such hazards. As a consequence, the term "natural disaster" is a misnomer in any case – we underline that it is society's choice how risks are managed and avoid that natural events turn into humanitarian disasters (see corresponding campaign https://www.nonaturaldisasters.com/).

Current trends and signals – where the CCA and resilience financing seems to go

In 2009 at COP15 in Copenhagen, Denmark, (the Copenhagen Accord) wealthy countries committed to mobilize $100 bn in annual climate finance to assist low-income countries to address climate change by 2020 (UNFCCC, 2009, Section 8). The two key findings from our analysis of the current situation for this climate finance Accord

(Zurich Flood Resilience Alliance, 2020), marking the deadline of this commitment last year, were shocking and yet unsurprising:

There is insufficient investment in preparing for the impacts of climate change, and

Money is not going to the countries and people that need it most.

The balance between financing climate change mitigation and climate change adaptation has not been achieved. Global adaptation financing only reached USD 30 bn in 2017/2018 (CPI, 2019) of the USD 50 bn minimum commitment for 2020. Overall climate change debate and financing is preferring mitigation over adaptation (e.g. ODA Donor Tracking, climate subset, 2020 - https://donortracker.org/insights/financing-future-climate-finance-and-role-oda). Of the USD 30 bn available, only USD 15 m are distributed to lower- and middle-income countries.
Using publicly available data to compare climate change adaptation and disaster risk reduction finance per capita of those living in extreme poverty and climate vulnerability our analysis found that we are not acting on the often-heard mantra to focus on the most vulnerable and on the contrary, the global society **is currently leaving the most vulnerable behind.**

Even worse, new research from CARE International together with Civil Society Organizations has found current official figures to finance climate change adaptation are overstated, after reviewing whether in select countries the climate change adaptation finance is accurate and whether the reported funds are contributing to adaptation, based on a review of 112 projects (Care, 2021). Especially critical in this review is the revelation that budget components contributing to development or disaster risk reduction outside of climate change adaptation is still counted for the tracker. Based on the budgets associated with the reviewed projects of USD 6.2 billion, USD 2.6 billion has been overreported. One reason and challenge for this overreporting originates in the situation that 100% of program financing is counted towards adaptation even in cases where programs are not a full adaptation program but have only minor or some major adaptation elements. In conclusion, only 58% of total reported climate change adaptation finance is actually contributing to adaptation. This would also lead to OECD estimates of the flow of adaptation finance from developed to developing countries dropping from USD 16.8 bn to USD 9.7 bn.

What does this all mean for financing CCA under COVID?

Developing countries: The disproportionate effects on developing countries increase the pressure on their ability to raise adequate funding for Covid-19 recovery so it is unlikely they have flexibility in their budgets to meet or increase their financing for CCA. However, multilaterals like the IMF, World Bank, and other partners, including the Group of 20, called for creditors to suspend debt repayments to provide much-needed support to the poorest countries, which would reinvigorate budget flexibility to some extent (https://www.imf.org/external/pubs/ft/ar/2020/eng/spotlight/covid-19/).

Finance gap: On a global scale, there are concerns about the ability to close the CCA and DRR financing gap alongside current pressures on budgets as governments struggle to tackle the pandemic. Despite efforts to increase climate ambition, including replenishments of the GCF in 2019 and COP26 in 2021, it is likely that funding for climate change mitigation will continue to dominate the climate finance landscape.

ODA budget trends: The impact of Covid-19 on donor countries' economies is expected to lead to a fall in ODA in absolute terms due to the depth of the crisis and the economic recession it has triggered – but evidence from the past indicates that donors' sense of solidarity during a crisis has often countered expectations that ODA will fall. There is hope, as a joint statement by the Development Assistance Committee (DAC) was issued following the onset of the pandemic crisis, declaring their intention to protect ODA budgets and encourage other finance flows for partner countries (DAC, April 2020).

Economic COVID-19 recovery: Using International Monetary Fund (IMF) and OECD projections (IMF, 2020a; OECD, 2020c) of economic recovery from Covid-19 and evidence of the elasticity of ODA to GDP growth in previous crises, ODA flows could fall over 2020 and 2021 by approximately 7.1% and 11.8% in real terms, equivalent to $10.3 billion and $17.6 billion respectively. However, analyzing responses to past crisis such as the global financial crisis 2008, donors maintained their ODA to Gross National Income (GNI) ratio. If in the current pandemic crisis donors do not cut their aid budgets more than the decline in GNI, aid is projected to decline between 2.5 and 2.9%. Should no action be taken to ringfence aid budgets, then the fall in ODA could be much larger, as much as three times, as indicated by some large government donors incl. the UK, which is cutting back the ODA budget (Carson et al., 2021). In June 2020, the OECD estimated that total external finance (public and private) for low- and middle-income countries eligible for ODA will fall by $700 billion, a drop 60% larger than in the 2008 global financial crisis, when inflows declined by $425 billion (OECD, 2020).

ODA has traditionally been the most stable source of external financing to developing countries, though not the largest in volume. Remittances, which have become a stable and growing source of foreign income, could fall by USD 100 billion; and that government tax revenues, which were already insufficient to deal with current shocks and stresses, will further decline. Currently it appears that concerns around protectionism are overdone as trade has recovered strongly and as WTO indicated that trade facilitating measures have been put into effect as opposed to restrictive measures. Whether this translates also how development and CCA funding is dispersed remains to be seen.

So far, we analyzed ODA overall, not what happens to the proportion of CCA. It is evident from recent shifts of priority and from an apparent lack of preparedness in health systems and economic stability to health shocks that focus on development may also be shifted towards these issues. As ODA flows will then be allocated more specifically on development areas such as health, poverty alleviation and economic recovery, this may mean that climate-related ODA will likely be affected by the redirection and reallocation of funding, on top of an overall reduction in funding.

Donors are refocusing their development budgets to finance the international response to Covid-19. By how much and from which sectors is still not fully known as we go into 2021 with the pandemic still in full swing. According to some interviewees, multi-year CCA and DRR programmes have been sacrificed to alleviate funding pressures caused by the Covid-19 response, although the full magnitude of this is not known. For example, the DAC believes shifts in funding will hamper a comprehensive, multi-sector development approach and might miss achieving the SDGs (OECD, Oct. 2020); the UK's GNI was forecast to fall by 11.5% (OECD, 2020c) and did fall by 10.1%. Expectations are that programmes, including those on climate resilience, are asked to reduce budgets (reportedly by up to 30%) as a response to Covid-19. Conversely, DAC member countries reported in October 2020 that a total of USD 12 billion had been mobilized to help ODA-eligible countries respond to COVID-19, of which USD 7 billion was new funding.

Conversely, recipient countries have requested funding intended for CCA and DRR to be diverted in order to respond to Covid-19. For instance, India, Nepal and Pakistan have made such requests to the Global Facility for Disaster Reduction and Recovery. Other countries have reallocated response funding typically available for recurrent natural hazard events, mostly flooding, to a large extent to respond to the pandemic – and this already despite many cases where the pandemic and the flood risk have compounded such as hurricanes in Southeast Asia and Central America hitting the population during the pandemic.

External finance inflows to ODA-eligible economies have been assessed as vulnerable to shocks and the extent of private finance is expected to drop by USD 700 billion in 2020 compared to 2019 levels, exceeding the impact of the 2008 global financial crisis by 60% (OECD, June 2020).

Can commitments to finance climate change adaptation and resilience be upheld or even expanded? Recommendations of what could be done

While it is still difficult to fully answer this question as nations and sectors continue to struggle under COVID-19 impacts, and as budgetary planning for 2021 is increasingly volatile as global policy and economic uncertainty remains, there are serious doubts whether existing commitments will be met and whether expectations are realistic that new ones will be made.

Concerns include whether climate change and disaster resilience actions will be deprioritised, existing commitments to fund those will be withdrawn or, even worse, measures taken as part of pandemic recovery and economic stimulus that directly or indirectly increase vulnerability to climate and disaster risks. As outlined in ODI & ZFRA, 2020, it is recommended:

Funders that have the financial capacity and stability to do so should cover the predicted shortfalls in climate finance and support a climate-smart and risk-informed Covid-19 recovery phase.

To counter both short-term and long-term crisis, short-term and single-risk thinking needs to be avoided and humanitarian funding and response action must be coupled with long-term efforts that enhance resilience.

It should be avoided to create standalone Covid-19 recovery plans but integrate them into low-carbon and climate-change adapted development plans, especially building on existing and ongoing efforts and financing projects already waiting for finance and ready for implementation.

Adapt existing anticipatory action/early warning and response finance mechanisms to a broader range of threats, including pandemics, and continue improving their design and implementation ex-ante rather than ex-post.

Donor countries should ensure they continue to be on a fiscal path to meet their commitments to achieve the USD 100 billion per year target of the climate finance agenda, and wherever possible go above and beyond current commitments and increase their ODA budgets to meet the 0.7% of GNI target.

However, with these recommendations in mind, the importance for climate finance is very clear, and the need for implementation is increasingly urgent, as research already

Under scenarios where global warming remains below 2°C, adaptation costs are expected to range between USD 140 bn and USD 300 bn per year by 2030, and rise to between USD 280 bn and USD 500 bn per year by 2050. For more severe scenarios of global warming these figures are expected to be much greater (UNEP, 2016) and could surge to 25% of GDP by the end of the century (G30, 2020).

An additional 50 million people per year will be in need of humanitarian aid (66% more compared with 2019) by 2030; and by 2050 an estimated 200 million people each year will need humanitarian aid (85% more compared with 2019) (IFRC, 2019)

By 2030, the cost of humanitarian aid (excluding conflict) is expected to increase to USD 20 bn a year, increasing present humanitarian needs by 35%; and by 2050 would be 50%higher than present (IFRC, 2019)

Floods already affect more people globally than any other type of natural hazard and cause some of the largest economic, social, and humanitarian losses. By 2030, an estimated 150 million people more will be exposed to flooding, and 15 million people and USD 177 bn in urban property will be impacted annually by coastal flooding, while 132 million people and USD 535 bn in urban property will be impacted annually due to riverine flooding (approximately double the number of people compared to 2020) (WRI, 2020).

This requires the opportunities for a green recovery from the COVID-19 pandemic to be reaped in practice, and not remain well-meant but theoretical recommendations not reflected in policy and action. Currently, available statistics on the greenness of stimulus indicates much of this opportunity untapped, and where it is taken up, actions could be improved to ensure not only a fraction of specific "green" allocations but ensuring the remaining proportion applies strict do-no-harm conditionalities as to environmental requirements, energy focus, and more. The transition to a greener economy can act as a stimulus for long-term job creation and could kick-start the necessary dynamic in climate change finance and action. The COVID-19 stimulus globally must be a green one, and like all climate change finance, must adequately balance between mitigation and adaptation action, and must target countries and populations most vulnerable and most in need. Likewise, under increased net-zero ambitions, investor demand for green opportunities have soared but they are oversubscribed in perceived low-risk countries using existing avenues e.g. green bonds, but those associated with higher risk are struggling to access funding but are likely the areas where both innovation and benefit-cost-ratios are highest and where human impact will be best.

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7 Developing resilience to address water disasters – case studies from Africa

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The two main water-related disasters, floods and droughts, caused worldwide more than 166,000 deaths, affected another three billion people and caused total economic damage of almost US$700 billion over the past two decades (EM-DAT, 2019, UNESCO, 2020). The High Level Panel on Water (HLPW) in its outcome document 2018 'Making Every Drop Count' highlighted that Water-related disasters, such as floods, droughts, storm surges and tsunamis, account for 90% of all disasters in terms of number of people affected. Furthermore, the overwhelming majority of disasters (90%) have been caused by floods, storms, droughts, heatwaves, and other weather-related events and by 2050, desertification alone will threaten the livelihoods of nearly one billion people in about 100 countries. Thus, there is an urgency to reduce the negative impacts of floods and droughts, by implementing Disaster Risk Reduction (DRR) measures and strategies aimed at reducing both current and future risk.

Through the interface of education, natural and social sciences, culture and communication and information, UNESCO's Intergovernmental Hydrological Programme (IHP) supports member states to implement the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework), which is aligned with the 2030 Agenda for Sustainable Development and the Paris Climate Agreement. IHP envisions a water secure world where people and institutions have adequate capacity and scientifically based knowledge for informed decisions on water management and governance to attain sustainable development and to build resilient societies. In order to achieve this vision the programme supports member states by providing tools, methodologies and approaches to reduce flood and drought risks and vulnerabilities and by increasing flood/drought disaster resilience of the populations. Furthermore, by operating at the interface between natural and social sciences, education, culture and communication, UNESCO plays a vital role in building a global culture of resilient communities in a trans- and cross-disciplinary manner.

This paper presents two case studies undertaken in coordination with UNESCO Category II centers and scientific networks highlighting established water disaster platforms to enhance climate resilience. These case studies provided examples of use of operational tools to address flood and drought related challenges and support human capacity building in developing resiliency to water related disaster.

Can commitments to finance climate change adaptation and resilience be upheld or even expanded? Recommendations of what could be done

For many years, several countries of the West African region have been experiencing recurrent flood disasters with challenging socio-economic impacts. For example, a flood in 2007 affected around 2,400,000 people in 13 countries of West Africa. More generally, due to various reasons including poverty, climate conditions and others, IPCC Reports have clearly identified Africa as the most vulnerable continent to climate change. It is likely that climate change will amplify climate-related disasters such as floods in West Africa countries. A recent evaluation showed an exponential increase of flood magnitude and frequency in the region (Valentin et., 2016). For example, Niamey the capital of Niger was flooded in 2008, 2010, 2012, 2013, 2015, 2016, 2017 and 2019. The average economic loss due to floods in Niamey was recently estimated by UNDP-Niger to be 2 billion CFA francs (3.5 million USD). Globally, low and lower-middle income countries experience major economic losses due to climate-related disasters, which constituted 91% of all disasters between 1997 and 2017 with US$ 21 billion losses (Wallemacq and House, 2018). There is therefore a need to replace the current approach of crisis management with a risk management approach for future flood disasters.

UNESCO-IHP, AGRHYMET Regional Center and the International Centre for Water Hazard and Risk Management (ICHARM) in Japan, a UNESCO Category 2 Centre, in collaboration with the Niger Basin Authority (NBA) and the Volta Basin Authority (VBA) implemented a project on the development of an effective flood early warning system (FEWS) and contributes to build capacity at local, national and regional levels on flood risk management through integrated flood management approaches. The platform covers the eleven countries of the Niger and Volta River basins (Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Ghana, Guinea, Mali, Niger, Nigeria and Togo). The project provided a solid technological and educational foundation on the virtual environment of FEWS and flood risk management information to enhance resilience in the region. The project trained around 280 professionals and experts on the new technology through e-Learning system using only short online live engagement with self-study pre-recorded materials considering internet infrastructure and language barriers of the West African countries. The e-Learning methodology adopted during the project already drew the attention of national and local authorities and the international community as an alternative methodology of enhancing resilience by addressing flood disaster during the COronaVIrus DIsease 2019 (COVID-19) Pandemic situation. Therefore, this should be replicated in other regions as a success story.

The FEWS prototype version 1.0 for Niger and Volta basins (Fig. 1), on Data Integration and Analysis System (DIAS) platform conducts several steps of data and information flow to develop flood-related information for AGRHYMET, NBA, VBA, and eleven countries of the Niger and Volta River basins. These steps, which provide raw and statistically bias-corrected satellite GSMaP (Global Satellite Mapping of Precipitation) rainfall datasets, river discharge, flood inundation depth, and e-Learning materials, are described below:

i. Real-time GSMaP and JRA-55 (Japanese 55-year Reanalysis) data are archived on the DIAS computation server (①,②). Historical in-situ data obtained during the African Water Cycle Coordination Initiative (AfWCCI) project are also archived in the FEWS prototype version 1.0 and made available on DIAS (③).

ii. Real-time data subsetting, statistical bias-correction and unified data format conversion of historical in-situ rainfall, GSMaP and JRA-55 data (④, ⑤).

iii. Real-time hydrological and flood inundation simulation is conducted by the regional and national Water and Energy Budged-based Rainfall-Runoff-Inundation (WEB-RRI) models with bias-corrected GSMaP rainfall (⑥).

iv. Real-time visualization of the FEWS prototype version 1.0 includes historical in-situ rainfall, real-time satellite rainfall of original source and statistically bias-corrected outputs for West Africa and simulated WEB-RRI models' outputs for the Niger and Volta River basins and two flood hot spots. In addition, real-time evaluation test covering e-Learning content of three introductory lectures prepared in the WADiRE-Africa e-Learning training can be taken on the DIAS Visualization Server.
v. Granting access to the FEWS version 1.0 information of raw and bias-corrected GSMaP satellite rainfall datasets, simulated river discharge and flood inundation outputs, and e-Learning training materials to the registered Users on DIAS (⑧).
vi. Accessing the FEWS prototype version 1.0 for West Africa from AGRHYMET, NBA and VBA to DIAS for archived data, real-time outputs and e-Learning materials (⑨).
vii. Accessing the FEWS version 1.0 from eleven countries of the Niger and Volta basins to DIAS for archived data, real-time outputs and e-Learning materials (⑩).
viii. Accessing e-Learning training materials from AGRHYMET, NBA, and VBA to DIAS for distribution at relevant countries of the Niger and Volta River basins (⑪).

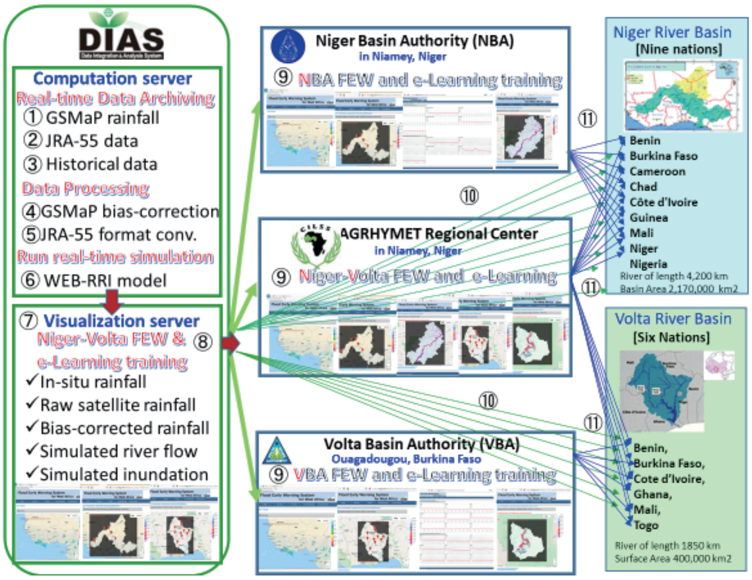

Figure 1. Schematic diagram of the flood early warning system (FEWS) prototype version 1.0 for West Africa on Data Integration and Analysis System (DIAS).

Flood discharge and inundation simulations

The FEWS prototype version 1.0 for Niger and Volta basins, West Africa utilizes the technology of the WEB-RRI model on DIAS to simulate real-time rainfall-runoff and flood inundation processes with four main modules (Fig. 2). The WEB-RRI main modules of grid-based atmosphere-land interactions, soil moisture dynamics, surface and subsurface flows, and river flow are:

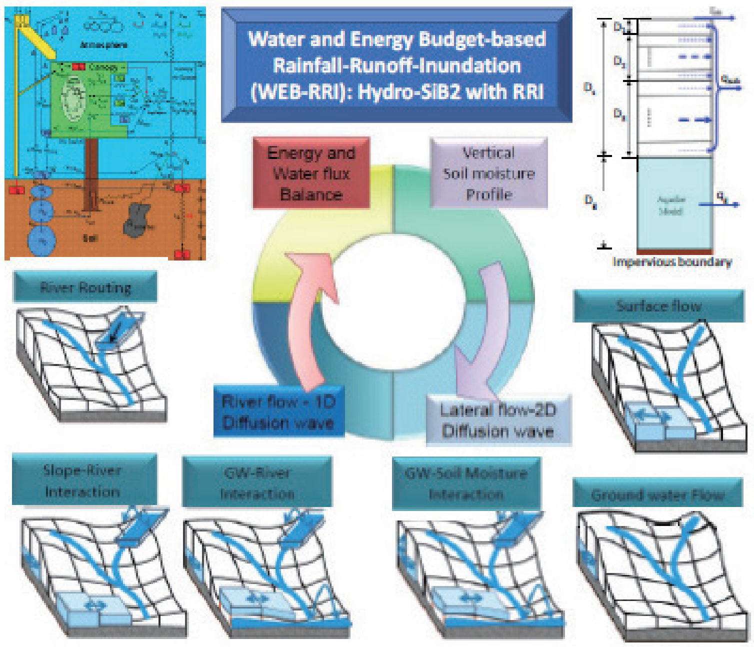

Figure-2 Schematic diagram of simulated processes in the Water and Energy Budged-based Rainfall-Runoff-Inundation (WEB-RRI) model.

the Simple Biosphere Model 2 (SiB2) module (Mohamed et al., 2019) for the vertical energy and water flux transfer between land and atmosphere at each model grid; 2) the vertical soil moisture distribution module based on Richard's equation and Darcy's equation for groundwater recharge; 3) the 2-D diffusive wave lateral surface flow module; and 4) the 1-D diffusive wave river flow routing module. The WEB-RRI model structure was developed by integrating the RRI model's diffusive wave flow equations with a land surface model (Hydro-SiB2) to incorporate water and energy budget processes such as land-vegetation-atmosphere interactions, soil moisture dynamics, and 2-D lateral water flows for seamless real-time flood peak and inundation as well as low flow early warning applications (Sayama et., 2012). The WEB-RRI model treats slope and river channel cells separately following the RRI model structure, which estimates the lateral water flow on the slope and the river flow in the river channel using the 2-D and 1-D diffusive wave equations, respectively. The water exchange between the river channel and the slope is calculated depending on water levels in the slope and the river cells with the levee-height conditions and the fifth-order Runge-Kutta approximation with adaptive time-step control is applied to solve equations based on the RRI model solver. In the current version, the WEB-RRI model takes into account entire hydrological cycle processes in a catchment except the lateral flow within the unsaturated soil layer. As a result, the WEB-RRI model with a merit of flood and drought studies is adopted for the FEWS development in the Niger and Volta River basins.

The major outcomes of the WADiRE project are summarized as follows:

1. Human capacity on flood risk management, operating on Data Integration and Analysis System (DIAS) and Water and Energy Budget-based Rainfall-Runoff-Inundation (WEB-RRI) systems, as well as basin and hazard mapping and contingency planning enhanced by organizing face-to-face training programme;
2. Development of DIAS Flood Early Warning (FEW) core systems for the Niger and Volta basin and access provided to AGRHYMET and NBA and VBA countries through the e-Learning training programme;
3. E-Learning materials of training of experts (ToE) produced and transferred to AGRHYMET, and NBA and VBA countries.
4. Enhanced human capacities on FEW and flood risk management of VBA and NBA countries at national, regional and local levels by organizing e-Learning ToE trainings. The project trained around 280 professionals and experts on the new technology through e-Learning system.
5. Development of Pilot national DIAS platform in one NBA country and one VBA country.
6. Implemented training of trainers (ToT) programme for VBA and NBA countries with selected ToE participants and transferred e-Learning materials.

Milestones and key achievements:

Despite COVID-19 imposed limitations and uncertainties, the successful development of the FEWS prototype on DIAS provides a robust infrastructure with real-time operation for disseminating natural flood information among eleven Niger and Volta basin countries. The implementation of capacity building and flood risk training is done via e-Learning system consisting of materials in English and French languages in the FEWS prototype on DIAS, for AGRHYMET, NBA, VBA and eleven Niger andVolta basin countries. As a result, the WADiRE-Africa Project has established a solid technological and educational foundation of the FEWS and flood risk management information to enhance West Africa population's resilience and to pave the road for follow-up activities in future.

Case study: Flood and drought monitoring systems for the Lake Chad Basin

Developed by Princeton University, the flood and drought monitoring system monitors and forecasts meteorological, agricultural and hydrological drought at various temporal and spatial scales. It also has a multi-decadal, historical reconstruction of the terrestrial water cycle against which current conditions can be compared. The system is based on the continental African Flood and Drought Monitor (AFDM), which has been updated to a higher resolution near real-time system using a combination of existing datasets used in the operational AFDM and newly available datasets. The product is intended to provide advance warning of impending floods and droughts.

The hydrological model, which provides daily, freely accessible historic data and forecast ensembles for several key hydrological variables, including soil moisture, evaporation, runoff, and streamflow. The meteorological forcing is derived by merging a wide range of station, satellite, and atmospheric model data to obtain the best possible predictions across all climate zones in Mozambique and Zimbabwe. The runoff estimates from HBV are routed downstream using a highly computationally efficient RAPID discharge routing scheme, which increases the resolution and robustness of the streamflow predictions.

The African Flood and Drought Monitor (AFDM), developed by Princeton University with the support of UNESCO-IHP, was deployed in 2010 in combination with extensive training in Western Africa in 2011 and 2013 and in Eastern Africa in 2012 (Sheffield et al., 2014). Further improvements were made in the recent years. The AFDM uses satellite-based precipitation from the TRMM Multi-Satellite Precipitation Analysis (TMPA) which is available in near real-time and is bias-corrected in the AFDM to match the long-term statistics of the climatology.

The Lake Chad Basin Flood and Drought Monitor

A demonstration regional flood and drought monitoring system for the Lake Chad Basin (CHAD-FDM; Abou et al., 2021) was developed in 2019 based on the continental African Flood and Drought Monitor (AFDM, Sheffield et al., 2014). The system provides historic surface water conditions and associated flood and drought indices at 5km, daily resolution for the period since 1979 and in near real-time using a combination of existing datasets used in the operational AFDM and newly available datasets, such as the MSWEP precipitation dataset (Beck et al., 2019). This has been upgraded to use the real-time version of the MSWEPV2 precipitation dataset (Beck et al., 2017) which merges data from satellite, gauge and reanalysis products to provide a best estimate given available data. Other meteorological variables (e.g. temperature, wind speed) are taken from analysis fields from the Global Forecast System (GFS) as is currently done for the AFDM and downscaled to the 5km resolution of the CHAD-FDM system. The hydrological modeling has been calibrated using a global regionalization approach. The system has further been upgraded to use a vector based streamflow routing model, which increases the resolution and robustness of the streamflow predictions. Local station data has been incorporated into the system and is available from the online interface. This interface has also been substantially upgraded to improve the layout, accessibility of data (system and local), and provide a more intuitive and aesthetically pleasing interface. The system runs about 2-3 days behind real-time, which is based on the availability and latency of the satellite and analysis data products. This interface has also been substantially upgraded to improve the layout, accessibility of data.

Evaluation of Historic Simulation

Simple comparisons between the CHAD-FDM and datasets are made at the basin average and spatial map level. All datasets were averaged to monthly means, if not already available at monthly resolution. For the basin average comparisons, all datasets were interpolated to the CHAD-FDM resolution (0.05-deg, ~5km), masked to the basin, and then spatially averaged, to produce monthly time series. The spatial map comparisons are based on average maps calculated over all years of the comparison period. All datasets were compared over the period
2000-2016, although some remote sensing products are available for shorter time periods within this. A capacity development course was organized via training to improve the utility and uptake of the Lake Chad Monitor system with background material on the monitoring system and methodologies, hands-on training on using the system, accessing data, and using the system for decision making.

Zimbabwe and Mozambique Flood and Drought Monitor (ZFDM) and Early Warning

To support Member States in Southern Africa with the development of Flood and Drought Early warning, two Flood and Drought Monitors were developed in 2019 and 2020 in collaboration with Princeton University. These integrate near-real time monitoring of key hydro-meteorological variables and provide short-term forecasts of upcoming water-related hazards, as well as seasonal forecasts of precipitation and temperature conditions. Information is aggregated to administrative boundaries to allow quick assessments of drought and flood risks at the district level. Figure 3 presents the online user interface for Zimbabwe available through http://stream.princeton.edu/zim_app/

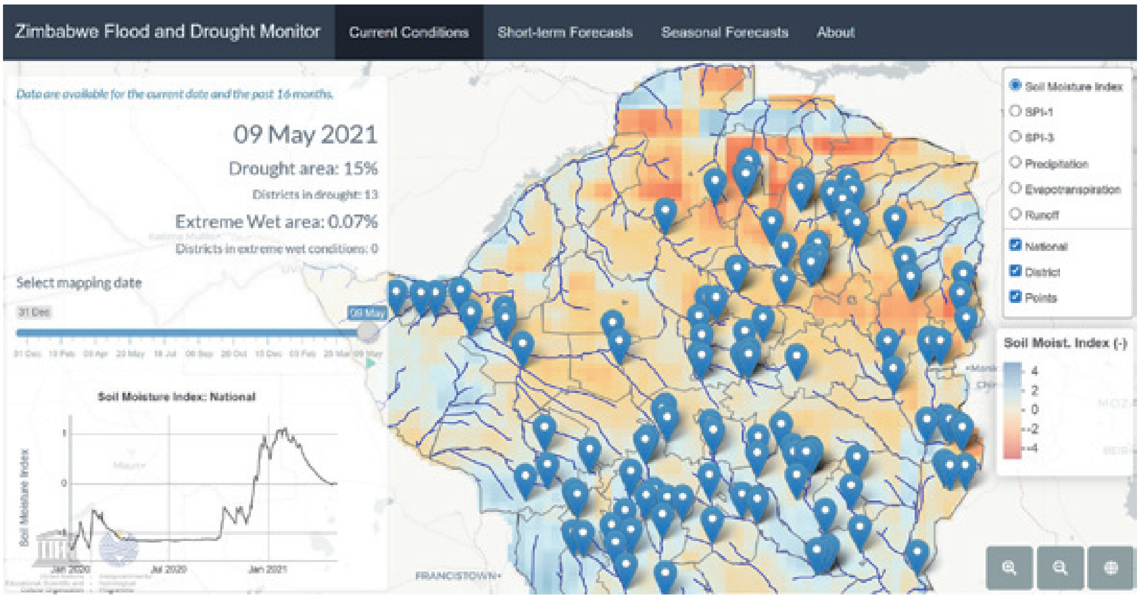

Figure 3. The Zimbabwe Flood and Drought Monitor.

These national systems provide historic surface water conditions and associated flood and drought indices at 5km, daily resolution for the period 1979-present with short-term and seasonal forecasts, using a combination of remote sensing data, modelling and station observations. The systems runs operationally about 1-2 days behind real-time, which is based on the availability and latency of the satellite and analysis data products.

Data Validation

The systems are validated historically in three ways: 1) comparison of the meteorological data with independent observed data from rain gauges, and gridded observation-based datasets; 2) comparison of the streamflow outputs with observational data from stream gauging stations where available; 3) comparison with independent satellite-based estimates of evapotranspiration and soil moisture. For the forecasts, these are evaluated against the historic system data using a range of error statistics, and some examples are shown of recent forecasts.

The systems are forced by the MSWEP-V2 precipitation dataset (Beck et al., 2019a), which merges data from satellite, gauge and reanalysis products to provide a best estimate given available data. This dataset has been evaluated globally against all available competing datasets and has been shown to outperform them when compared to streamflow observations (Beck et al., 2017; Beck et al., 2019b). Other meteorological variables (e.g. temperature, wind speed) are taken from MSWX, a similar blend of reanalysis datasets weighted based on their relative performance when compared against available station data. The precipitation is evaluated against available station records across southern Africa (257 stations) in terms of the 3-day correlation, bias, mean annual number of dry days error, and the mean 99.9th percentile error, which represent various aspects of performance.

The monitoring systems estimate streamflow using the Routing Application for Parallel computation of Discharge (RAPID) streamflow routing scheme (David et al., 2011), which is driven by runoff generated by the hydrological model HBV. The RAPID model provides very high resolution and realistic representation of the spatial distribution of streamflow across a vector river network developed from the MERIT hydrography database. The modeled streamflow was evaluated against daily observations from the Global Runoff Data Centre (GRDC) for 13 and 67 stations, for Mozambique and Zimbabwe, respectively.

Capacity Building

In order to train key stakeholders on the effective use of the monitor, a capacity building workshop was organized in 2019 in Harare, Zimbabwe and in 2020 in Mozambique. The two day training workshops strengthened the skills of the stakeholders to use the monitor with an aim to develop an encompassing solution to the lack of preparation and foresight, providing the capacity to significantly reduce the threat to human life in future flooding occurrences as well as reduce the impacts of drought episodes.

The training session also gave the stakeholders an opportunity to bring up recommendations to be considered in the continuous refining of the Zimbabwe and Mozambique Flood and Drought Monitor. This will contribute to the further development of a long-term project on the development of a community-centered decision-support-system for monitoring and early warning of climate risks in Zimbabwe and Mozambique, particularly focusing on the transboundary river basins.

Capacity Building

The UNESCO IHP in cooperation with partner organizations has provided flood early warning tools piloted and implemented in the Niger and Volta River basins, and further implemented in Lake Chad, Mozambique and Zimbabwe a Flood and Drought Monitor (CHAD-FDM, MOZ-FDM and ZIM-FDM) to enhance the resilience of countries. The activities were supported by capacity building effort. The e-Learning methodology adopted during the WADiRE-Africa project already drew the attention of national and local authority and international community as alternative methodology of enhancing resilience by addressing flood disaster during the COVID-19 Pandemic situation, so this should be replicated in other region as success story.
The presented case studies will be further implemented in other countries during IHP IX (2021-2029) with further development of scientific methodology on drought and flood early warning (EWS) systems and vulnerability assessment to increase resilience to floods and droughts strengthening policy and institutional and human capacities for integrated flood and drought management at the local, national and trans-boundary levels to ensure risk informed decision-making.

The policy advice based on scientific early warning is expected to improve the effectiveness of water governance, which is a major challenge and needs to be strongly supported as a cornerstone of IHP-IX to enable Member States to implement evidence-based decisions to build more resilient and peaceful communities. This ninth phase of IHP-IX will cover the next eight years almost until the end of agenda 2030. It is designed to support Members States in achieving SDG6 and other water-related SDGs and international water-related agendas towards a water secure world and resilient societies.

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8 COVID-19 and Water in Asia and the Pacific – ADB Guidance Note – Abridged Version

ADB Guidance Note

The Water Sector Guidance Note was published in June 2021. It provides a comprehensive look at the impacts of the coronavirus disease (COVID-19) pandemic on the water sector from March to December 2020, the actions taken by water service providers in response to various challenges, the potential pathways toward postpandemic recovery, and the role of the Asian Development Bank (ADB) in supporting water sector recovery and rejuvenation.

The guidance note serves three objectives:

(i) Provide interim stock of and guidance on the recent developments in the water sector with respect to the ongoing COVID-19 crisis.

(ii) Summarize the key learning and lessons of the water organizations and service providers dealing with the challenges of COVID-19 first-hand

(iii) Outline fundamental principles for effective recovery of the water sector toward a sustainable and resilient “new normal.”

This article is an abridged version of the ADB Guidance Note.

The Three Pandemic Phases

The Guidance Note is structured to present an overview of three phases of the COVID-19 pandemic: response, recovery, and rejuvenation. Although much of the COVID-19 literature makes reference to these three phases, there is no internationally accepted standard or definition to demarcate a clear distinction. It is quite possible for these phases to overlap, and where there is a resurgence of cases (a second or third wave) there is a rebound from recovery to response phase. Epidemiologists are expecting a multimodal pattern to emerge with repeated peaks and troughs in patient numbers over the next 3–5 years at least, not related to seasonality. During these cycles, it is important to review which policies and approaches have been effective and which need to be revised to minimize consequences.

The response phase is the period that follows official (usually national) government pronouncement of community lockdown or quarantine measures that expressly signify the growing risk of COVID-19 transmission risk among the population. This reckoning period differs among countries, and indeed among cities within a country, as lockdown measures were announced or took effect at different times across Asia and the Pacific.

The recovery phase corresponds to a period of gradual return to “almost-normal” levels of business and social activity while maintaining cautionary measures and continuing to boost healthcare capability. This entails lifting of strict lockdown protocols which allows for a limited variety of commercial and social activities to resume, provided safety measures are observed such as wearing of masks, physical distancing, and, in some areas, curfews. The recovery phase may be triggered by the decreasing number of COVID-19 cases, an indication that the initial response measures have been effective in managing transmission. However, this is not always the case, as many countries and cities have lifted initial lockdowns despite having no reduction in cases. As such, the recovery phase may be motivated more by economic recovery or politics rather than recovery in the public health sense.

Compared to the response and recovery phases, the rejuvenation phase is clearly demarcated by the availability of a vaccine and widespread immunization that allows a “new normal” for social activities and business operations. Governments can shift their focus to reviving and spurring economic and social activities, as well as preventing succeeding waves of COVID-19 cases. The availability of a COVID-19 vaccine is the precursor for the rejuvenation phase. Mass delivery of the vaccine and widespread immunization may even be considered the first step in the rejuvenation phase—a critical step toward the “new normal.”

COVID-19 and Water

The relationship of water and SARS-CoV-2, the virus that causes COVID-19, is complex but is increasingly determinable. Knowledge about this relationship has rapidly evolved in the last few months, and there is consensus on key transmission routes. Various guidelines and protocols have been promulgated internationally that aid water sector organizations in crafting their response and operations. The COVID-19 pandemic highlights the importance of adequate disinfection of water for domestic use and human consumption, as well as wastewater treatment and monitoring of environmental waters. Contact with recreational water (even river water contaminated with untreated sewage) appears so far to be low risk, although not free of risk, so caution should be exercised.

Response

The management of water resources and systems for the delivery of public services are collectively handled by service providers and various sector institutions. Although there are often overlaps in their responsibilities and activities, these entities can be distinguished by the services they provide. To collect primary data on water sector impacts and responses, ADB conducted a survey among service providers in DMCs.

COVID-19 affects all water service providers (e.g., water supply, sanitation, wastewater, and irrigation), but the operational impacts are broader among water supply, sanitation, and wastewater service providers. The pandemic has altered the key drivers of the water sector—water demand and wastewater discharge—which in turn necessitates changes in various aspects of technical and commercial operations. As safety of workers and customers is paramount, the pandemic has posed significant challenges in workforce and human resources management.

The coronavirus disease COVID-19 pandemic has raised global alarms on public health and safety; to curtail widespread transmission, water utilities have been at the forefront of ensuring regular water supply provision to communities. The pandemic also underscored the importance of sanitation and wastewater management, amidst initial fears that Severe acute respiratory syndrome-related coronavirus (SARS-CoV-2) may persist in sewage or water bodies and either remain infectious or lie dormant with the ability to regain infectivity at a later date. To understand the impact of COVID-19 on the water sector, it is important to look at the impacts on service providers, authorities, and organizations responsible for water management. By their nature of providing essential services to various sectors in society (including agriculture, industry, and marginalized communities), water, wastewater, sanitation, irrigation, and drainage service providers and authorities (collectively water service providers or simply "service providers") contribute to many development outcomes such as poverty reduction, food security, rural development, and public and environmental health protection.
Many governments have intervened to ensure the continuity of critical water services during the pandemic, in some cases providing direct financial support to water service providers. In the absence of government relief, the financial burden of the pandemic is currently borne by water service providers. Prolonged uncertainty over how service providers will be compensated for losses incurred due to the pandemic—either through government transfers or increased customer tariffs—may lead to reduced capital and maintenance spending, as well as significant changes to operating and maintenance planning, in the future.

The pandemic is highlighting persistent inequalities in water and sanitation access. Water sector response has been particularly difficult for urban slums; most responses are temporary measures that do not guarantee sustainable access. Poor households that are connected to the piped network may be temporarily insulated by government-mandated freezing of water rates, suspension of cutoffs, and extension of various payment schemes, including deferral and discounts.

Multiple crises are to be expected with climate change, at it is of vital importance to anticipate and understand the compounding risks. A high-level understanding of country risks can also help prepare against worst-case scenarios of multiple crises hitting DMCs at once. In October 2020, the Philippines was hit by a series of "super typhoons" that resulted in the influx of more than 345,000 people into dense and poorly serviced evacuation centers, posing significant risks in COVID-19 transmission. Disaster risk reduction and response under a pandemic scenario is made more challenging not only because of public health safety concerns, but also because local government resources are more thinly spread. The High-Level Experts and Leaders Panel on Water and Disasters (HELP) offers principles and practical guidance on addressing water-related disaster risk reduction under the COVID-19 pandemic.

ADB swiftly responded to support DMCs in the wake of the pandemic. As with many other multilateral development banks and international aid agencies, ADB's financial support aimed to provide fiscal stimulus for frontline healthcare measures, such as broadening COVID-19 testing capability and purchasing medical equipment. Nevertheless, some lessons can be gleaned from the COVID-19 experience that can improve ADB's crisis response support in the future.

Early identification of country risks and vulnerabilities is essential in crisis response preparedness and management. As such, a high-level mapping and identification of water sector risks for each DMC can be helpful. Pre-identifying risks will make response times quicker and ADB's support can be made more targeted to country-specific needs. The objective should be to help governments address the most pressing risks that, if resolved, will enable them to move forward with resolving other risks. This is also the first step to designing effective coordination mechanisms between WASH and the health sector to systematically address risks faced by DMCs.

Recovery

Whether short-lived or prolonged, transitioning into the recovery phase affects key drivers of the water sector such as volume of water demand and wastewater discharge. It is possible for service providers to project how these key drivers will turn out under best- to worst-case scenarios; this exercise is particularly useful for stresstesting their financial standing under a worst-case scenario (e.g., protracted lockdown due to multiple waves of COVID-19 cases). Exiting the "emergency mode" during the response phase allows service providers to begin shoring up their resources and efforts into recovery efforts.

Service providers' priorities shift during the three phases. In the response phase, the abrupt decline in commercial and industrial water demand and wastewater generation result in rapid operational adjustments. Service providers cautiously balance maintaining an adequate level of service while ensuring the safety of personnel. In the recovery phase, the gradual opening of commercial activity and increasing mobility eases the emergency protocols of service providers. However, the possibility of reversion into emergency mode puts service providers on high alert. Even as commercial activity picks up, the recovery phase does not represent prepandemic economic activities and service providers are likely to operate at less than full capacity.

To support the recovery of the water sector, the immediate priorities for recovery follow:

(i) ensuring public safety through the continuous provision of essential services while protecting the health of staff, which is of paramount concern for all water service providers during the pandemic;

(ii) supporting the financial recovery of water service providers that strikes a balance between the need to extend continuing financial relief to customers in need and ensuring the resumption of critical capital works that will enable broader water and sanitation access;

(iii) enhancing service providers' resilience by integrating the lessons of the COVID-19 pandemic into planning and operations; and

(iv) protecting the well-being and ensuring social outcomes for vulnerable sectors, such as women, children, the disabled, and the poor, who have historically been marginalized from basic public services and who have suffered disproportionately more during the COVID-19 pandemic.

Rejuvenation

In the rejuvenation phase, service providers gradually return to normal or prepandemic levels of operation as business-as-usual ensues. This postpandemic period will see the emergence of a "new normal"—that is, how the lessons and experiences from the pandemic change the way we live, work, and play.

In the rejuvenation phase ADB will support the long-term yet urgent need to "build back better" in the face of deep uncertainty and unprecedented development challenges in Asia and the Pacific water sector. Service providers' capabilities must be enhanced with the use of innovative, fit-for-purpose technologies. The specific needs of each country, city, and service provider will differ widely depending on context. The key to promoting technology adoption and innovation is to understand the bespoke needs of service providers to match them with value-adding technologies, or spur the development of new technologies that can deliver these values. Where the specific needs and integration opportunities are not well-defined, ADB can play an important role in helping service providers and other water-sector stakeholders craft bespoke roadmaps and strategies for technology innovation. There is a need to step up investments to ensure that DMCs achieve universal access to quality water services, upgrade with digital technologies that enable smarter planning and operations, and enhance service providers' resilience.

Rebuilding a more sustainable and resilient water sector can be achieved on four levels:

(i) preventing and responding to future health crises;

(ii) accelerating the universal access to water and sanitation;

(iii) adopting appropriate digital technologies; and

(iv) increasing the resilience of irrigation systems for long-term water and food security.

Future health crises can be prevented and responded to more effectively by integrating water, sanitation, and hygiene (WASH) into the public health strategy (among other social objectives such as improving education poverty reduction and gender mainstreaming), improving crisis preparedness and response management of water service providers, and employing wastewater-based epidemiology. Accelerating universal WASH access in line with Sustainable Development Goal 6 (SDG-6) will require large investments as well as exploring innovative methods for water and sanitation service such as decentralization and employing nature-based solutions.

Digital technologies are increasingly available at cost-effective pricing, but the key in digital innovation is to adopt technologies that add the most value to service providers and their customers. Resilience in irrigation can be achieved by improving productivity and market access, as well as adopting innovations in automation, mechanization, and e-commerce.

The characteristics of the "new normal" provide guidance not only to ADB but also to governments, service providers, and other water sector stakeholders. ADB must evaluate its internal processes and procedures to enable swift adjustments in all stages of project procurement, design, and implementation. Project preparation should consider potential risks and mitigations. Adopting digital technologies could add flexibility, such as by employing satellite imagery and analytics to replace site surveys. ADB may benchmark with other multilateral development banks to assess comparative advantages, niche areas of support and operations, and cooperation in times of worldwide crises.

Delivering on ADB's Strategy 2030 and getting Asia and the Pacific back on track to achieving the SDGs, particularly SDG-6, will be a tall order, especially in DMCs where government budgets are spread thinly across many priorities. Hoy and Summer suggested that none of the best-case post-COVID-19 growth scenarios can pull off the "SDG hat-trick" of sustained economic growth, eliminating poverty, and significantly reducing inequality. They concluded that developing countries must pursue "historically unprecedented growth paths" to meet the poverty and inequality SDG targets. ADB suggested that green recovery strategies, including investments in water and sanitation, can deliver accelerated economic growth while protecting people and the planet.

ADB survey respondents ranked the resumption of deferred capital works as the top priority that will support their postpandemic and long-term recovery. Aside from providing funding through financial instruments such as loans, grants, and guarantees, ADB can help fill the investment gap by mobilizing private sector capital and other innovative financing strategies. In a new publication, ADB (2020) pushes for green recovery strategies which would require longer-term economic recovery packages. This includes a portfolio of measures that include government recovery packages, capital market instruments (e.g., green bonds), and catalytic mechanisms to de-risk green recovery projects.

As countries deal with pandemic recovery, ADB funding for holistic recovery that includes water sector financing and support remains critical. ADB's response has evolved since COVID-19 initially hit. For example, funding from the government of Japan enabled grant resources to deal with COVID-19 economic impacts which includes integrating WASH and health approaches at the regional level, addressing co-occurrence of natural disasters, and enabling behavior-centered design access to WASH. Sustainable and quality WASH services and sustained hygiene behaviors are fundamental toward building back better, even as ADB is ready to support countries in vaccine rollout.

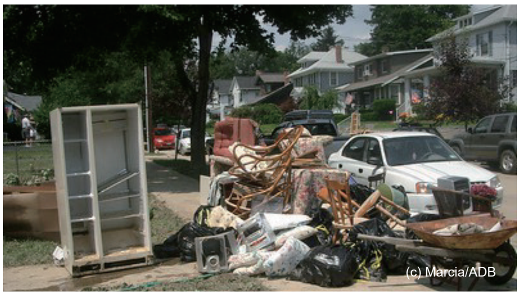
Private sector investment is an important component of financing water sector recovery and rejuvenation through public–private partnerships (PPPs). Chronically underfunded service providers could explore PPPs, as in Japan's promotion of PPPs for rural municipalities and water utilities. However, countries with little or no prior experience with PPPs may not be as quick to adopt PPP arrangements to fund large-scale water and sanitation projects. Most governments have a supportive stance for some form of private sector participation in the water sector, which has led to experiments on hybrid and tailored PPP models and the growing importance of domestic companies as foreign players streamline and rationalize their international market participation. ADB must continue supporting private sector participation and investment in the water sector and co-leverage funds where applicable.

ADB's financing support must be coupled with capacity building at the subsector level. A number of the survey respondents indicated that capacity building is needed for planning future pandemic responses. ADB can support more robust planning for crisis preparedness, which must include pandemic scenarios, through capacity building of service providers.

ADB and Rejuvenation

ADB already plays an important role in promoting technologies and de-risking innovation in the water sector. This includes open innovation competitions and startup support through ADB Ventures. These efforts have to be refined with our changing understanding of water sector needs and the rapid development of technology solutions. Investing in the right technological upgrades is key to navigating an increasingly uncertain future. For example, the ADB project to evaluate fit-for-purpose and appropriate asset management information system solutions for the United Water Supply Company of Georgia is a step toward sustainable and resilient asset management.

ADB is very well positioned to support the recovery and realizing the "new normal" for the water sector in Asia and the Pacific through financing of projects and programs, capacity building, and promoting technology and innovation. The insights in the Guidance Note can be helpful in determining the priorities for the water sector, although each country or city must carefully assess their respective local contexts in crafting their respective strategies.



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