1.0 OCCURRENCE AND PROPORTION OF WATER RESOURCES OF THE EARTH

Water is distributed across earth. Most water in the Earth's atmosphere and crust comes from the world ocean's saline seawater, while freshwater accounts for only 2.5% of the total. Because the oceans that cover roughly 78% of the area of the Earth reflect blue light, the Earth appears blue from space, and is often referred to as the blue planet and the Pale Blue Dot. An estimated 1.5 to 11 times the amount of water in the oceans may be found hundreds of miles deep within the Earth's interior, although not in liquid form.

The oceanic crust is young, thin and dense, with none of the rocks within it dating from any older than the breakup of Pangaea. Because water is much denser than any gas, this means that water will flow into the "depressions" formed as a result of the high density of oceanic crust. (On a planet like Venus, with no water, the depressions appear to form a vast plain above which rise plateaux). Since the low-density rocks of the continental crust contain large quantities of easily eroded salts of the alkali and alkaline earth metals, salt has, over billions of years, accumulated in the oceans as a result of evaporation returning the fresh water to land as rain and snow.

As a result, the vast bulk of the water on Earth is regarded as saline or salt water, with an average salinity of 35‰ (or 3.5%, roughly equivalent to 34 grams of salts in 1 kg of seawater), though this varies slightly according to the amount of runoff received from surrounding land. In all, water from oceans and marginal seas, saline groundwater and water from saline closed lakes amount to over 97% of the water on Earth, though no closed lake stores a globally significant amount of water. Saline groundwater is seldom considered except when evaluating water quality in arid regions.

The remainder of the Earth's water constitutes the planet's fresh water resource. Typically, fresh water is defined as water with a salinity of less than 1 percent that of the oceans - i.e. below around 0.35‰. Water with a salinity between this level and 1‰ is typically referred to as marginal water because it is marginal for many uses by humans and animals. The ratio of salt water to fresh water on Earth is around 40 to 1.

The planet's fresh water is also very unevenly distributed. Although in warm periods such as the Mesozoic and Paleogene when there were no glaciers anywhere on the planet all fresh water was found in rivers and streams, today most fresh water exists in the form of ice, snow, groundwater

and soil moisture, with only 0.3% in liquid form on the surface. Of the liquid surface fresh water, 87% is contained in lakes, 11% in swamps, and only 2% in rivers. Small quantities of water also exist in the atmosphere and in living beings. Of these sources, only river water is generally valuable.

Most lakes are in very inhospitable regions such as the glacial lakes of Canada, Lake Baikal in Russia, Lake Khövsgöl in Mongolia, and the African Great Lakes. The North American Great Lakes, which contain 21% of the world's fresh water by volume, are the exception. They are located in a hospitable region, which is heavily populated. The Great Lakes Basin is home to 33 million people. The Canadian cities of Toronto, Hamilton, Ontario, St. Catharines, Niagara, Oshawa, Windsor, and Barrie, and the United States cities of Duluth, Milwaukee, Chicago, Gary, Detroit, Cleveland, Buffalo, and Rochester, are all located on shores of the Great Lakes.

Although the total volume of groundwater is known to be much greater than that of river runoff, a large proportion of this groundwater is saline and should therefore be classified with the saline water above. There is also a lot of fossil groundwater in arid regions that has never been renewed for thousands of years; this must not be seen as renewable water.

However, fresh groundwater is of great value, especially in arid countries such as India. Its distribution is broadly similar to that of surface river water, but it is easier to store in hot and dry climates because groundwater storages are much more shielded from evaporation than are dams. In countries such as Yemen, groundwater from erratic rainfall during the rainy season is the major source of irrigation water.

Because groundwater recharge is much more difficult to accurately measure than surface runoff, groundwater is not generally used in areas where even fairly limited levels of surface water are available. Even today, estimates of total groundwater recharge vary greatly for the same region depending on what source is used, and cases where fossil groundwater is exploited beyond the recharge rate (including the Ogallala Aquifer) are very frequent and almost always not seriously considered when they were first developed.

Where is Earth's water located?

For a detailed explanation of where Earth's water is, look at the data table below. Notice how of the world's total water supply of about 332.5 million mi^3 of water, over 96 percent is saline. Of total freshwater, over 68 percent is locked up in ice and glaciers. Another 30 percent of freshwater is in the ground. Rivers are the source of most of the fresh surface water people use, but they only constitute about 300 mi^3 (1,250 km^3), about $1/10{,}000^{th}$ of one percent of total water. **Note: Percentages may not sum to 100 percent due to rounding.**

One estimate of global water distribution (Percents are rounded, so will not add to 100)

Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Oceans, Seas, & Bays	321,000,000	1,338,000,000	--	96.54
Icecaps, Glaciers, & Permanent Snow	5,773,000	24,064,000	68.7	1.74
Groundwater	5,614,000	23,400,000	--	1.69
Fresh	2,526,000	10,530,000	30.1	0.76
Saline	3,088,000	12,870,000	--	0.93
Soil Moisture	3,959	16,500	0.05	0.001
Ground Ice & Permafrost	71,970	300,000	0.86	0.022
Lakes	42,320	176,400	--	0.013

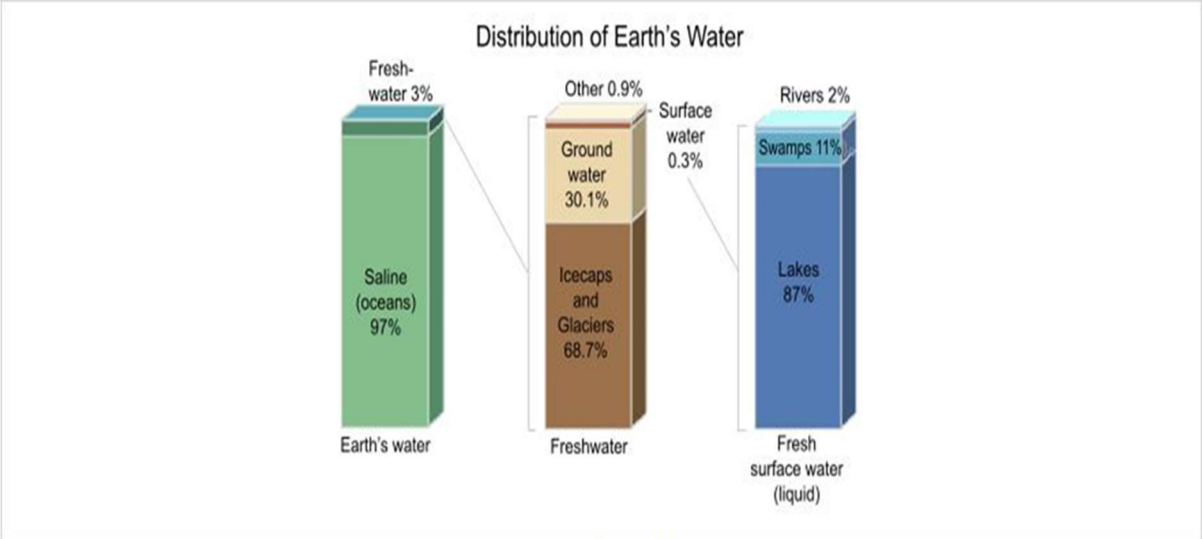
One estimate of global water distribution (Percents are rounded, so will not add to 100)

Water source	Water volume, in cubic miles	Water volume, in cubic kilometers	Percent of freshwater	Percent of total water
Fresh	21,830	91,000	0.26	0.007
Saline	20,490	85,400	--	0.006
Atmosphere	3,095	12,900	0.04	0.001
Swamp Water	2,752	11,470	0.03	0.0008
Rivers	509	2,120	0.006	0.0002
Biological Water	269	1,120	0.003	0.0001

Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources (Oxford University Press, New York).

DISTRIBUTION OF SALINE AND FRESH WATER

The total volume of water on Earth is estimated at 1.386 billion km³ (333 million cubic miles), with 97.5% being salt water and 2.5% being fresh water. Of the fresh water, only 0.3% is in liquid form on the surface. In addition, the lower mantle of inner earth may hold as much as 5 times more water than all surface water combined (all oceans, all lakes, all rivers).



Distribution of the Earth's Water

Credit: Timothy Bralower

DISTRIBUTION OF WATER IN THE OCEANS

Body of Water	Area (10^6 km^2)	Volume (10^6 km^3)	Mean Depth (m)
Atlantic Ocean	82.4	323.6	3,926
Pacific Ocean	165.2	707.6	4,282
Indian Ocean	73.4	291.0	3,963
All oceans and seas	361	1,370	3,796

2.0 BRIEF ON THE CURRENT FLOOD SITUATION IN NIGERIA

Heavy rainfall has caused the Niger and Benue rivers to overflow, displacing thousands across 12 states as of late August (DG ECHO 16/09/2018; 21/09/2018). The National Emergency Management Agency has declared an emergency in Kogi, Niger, Delta and Anambra states, and is monitoring eight other states in central and southern Nigeria (Floodlist 19/09/2018). In addition to river flooding, flash floods have occurred in central and northern Nigeria since July, affecting Katsina, Kano, Jigawa and Sokoto states. Thousands of houses have been destroyed across all affected states and the affected population has lost household and personal belongings. The floods

have caused considerable damage to farmland across Nigeria. There is an urgent need for shelter, NFI, food and livelihood assistance.

Over 100 people have died in floods in several Nigerian states following heavy rains that caused the Rivers Niger and Benue to overflow. The emergency body, NEMA, declared national disaster in the affected states of Kogi, Niger, Anambra and Delta. Eight other states are being monitored, the agency said. They are Taraba, Adamawa, Kebbi, Edo, Rivers, Benue, Bayelsa and Kwara states. More than 100 people have died in floods, the four states are in very bad condition; the remaining states are being monitored, but if the conditions of the remaining eight states (deteriorate) they would also be declared a national disaster.

Nigeria has faced flooding in recent years, with hundreds killed and thousands displaced. Details of the huge number of deaths were not immediately clear, but the BBC quoted NEMA as saying 40 people had died in Niger state alone. Earlier, the Kano State Government had confirmed the death of 31 people and destruction of more than 10,000 houses during the recent flood disaster in 15 Local Government Areas of the state.

Ali Bashir, the Executive Secretary of the State Emergency Relief and Rehabilitation Agency told the News Agency of Nigeria (NAN) in Kano that the cost of the disaster was estimated at over N5 billion. Of recent, the North-west zone of NEMA said 53 lives were lost to flood in both Katsina and Kaduna states. The agency recorded 51 deaths in Katsina State, two in Kaduna State, while 30 persons were confirmed missing in Jibiya, a border town in Katsina state.

The President Muhammadu Buhari had delegated authority to NEMA boss, Mustapha Maihaja, to declare a “national disaster’’ in the event that anticipated flooding turns a reality in parts of the country, the News Agency of Nigeria reported. The directive followed a warning by the Nigeria Hydrological Services Agency that Rivers Benue and Niger had almost reached levels that resulted in flooding in 2012. President Buhari later approved N3 billion for the first stages of preparedness, response disaster mitigation.

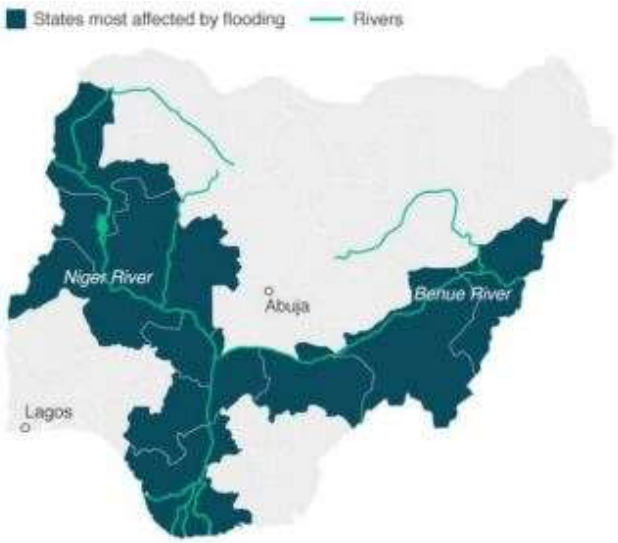
Nearly a quarter of a million households in Nigeria are at risk after heavy rains caused flooding that has inundated 80 per cent of the country. The rainfall began in July and has continued into October, causing Nigeria’s two main rivers – the Niger and the Benue – to burst their banks. The

resulting disaster is affecting 34 of the country's 36 states and has caused 141 deaths and 265 injuries to date.

The Government of Nigeria has declared a state of emergency in the four worst-affected states of Kogi, Niger, Anambra and Delta. The Nigerian Red Cross Society is conducting rapid assessments in coordination with the country's National Emergency Management Agency.

As well as the risk of further deaths and injuries, and damage to livelihoods and infrastructure, the Nigerian Red Cross is warning of a steep rise in the number of diarrhoea cases in Kogi, Niger, Anambra and Delta.

The International Federation of Red Cross and Red Crescent Societies (IFRC) has launched an emergency appeal on behalf of the Nigerian Red Cross, seeking 5,425,000 Swiss francs to support 300,000 of the most vulnerable people for nine months. The operation will provide shelter and the distribution of relief items; livelihoods including cash transfers; health; water, sanitation and hygiene, and protection, gender and inclusion.



States most affected by the Niger and Benue river floods (BBC 17/09/2018)

ANTICIPATED SCOPE AND SCALE

The main rainy season in Nigeria is expected to continue until October and heavy rainfall is predicted for the next three weeks. This could lead to further flooding in affected communities and floods in previously unaffected areas.

The extensive crop damage is likely to aggravate food insecurity in the region and to affect livelihoods. Flooding can have a long-term health impact on communities that are already exposed to conflict and displacement.

CAUSES OF FLOODING IN NIGERIA

These were attributed to climate change, rapid population growth, poor drainage facilities, poor practice of waste disposal, poor planning and inadequate preparedness. extraordinarily heavy rains and continued release of excess water from artificial reservoirs. While sometime the dams were accidently broken or overfilled. Others are the poor channel maintenance of drainage channels. Scenes of the flood show, settlements and infrastructure such as road at risk during inundation.

Conclusion and recommendations made are flood forecast and early warning of flood disaster in the country, prevention through effective urban planning, effective and proper waste disposal and flood disaster education should be included in the syllabus of all level of education.

Rains

Each time there are more rains than the drainage system can take, there can be floods. Sometimes, there is heavy rain for a very short period that result in floods. In other times, there may be light rain for many days and weeks and can also result in floods.

River overflow

Rivers can overflow their banks to cause flooding. This happens when there is more water upstream than usual, and as it flows downstream to the adjacent low-lying areas (also called a floodplain), there is a burst and water gets into the land.

Strong winds in coastal areas

Sea water can be carried by massive winds and hurricanes onto dry coastal lands and cause flooding. Sometimes this is made worse if the winds carry rains themselves. Sometimes water from the sea resulting from a tsunami can flow inland to cause damage.

Dam breaking (raptured dam or levee)

Dams are man-made blocks mounted to hold water flowing down from a highland. The power in the water is used to turn propellers to generate electricity. Sometimes, too much water held up in

the dam can cause it to break and overflow the area. Excess water can also be intentionally released from the dam to prevent it from breaking and that can also cause floods. An example was the release of water from the Lagdo Dam in Camerron causing devastating flooding in Nigeria.

On the other side, there are some activities by man that can lead to flooding.

Development and infrastructure in flood-prone areas

The development and building of infrastructure in flood-prone areas, such as along rivers, near ocean shorelines, or near river deltas, has led to an increase in vulnerability to flooding because the natural resiliency of the area to flood has been compromised by the development.

Blocked and narrow drainage systems

Dumping of refuse inside drainages can cause them to become narrower and then blocked leading to overflowing of and the area. Also, when the drainages are not properly directed or are made too narrow, it does not solve the problem of flood in the area but rather aggravates it.

Erection of buildings over flood drains and across canals

Construction of buildings over flood drains or water canals defeats the reason for the construction of the flood drains as they eject a huge amount of water from rainfall runoff back into the land and causing the area to become flooded.

Infrastructure failures

Floods can be caused by a breaking of an infrastructure that can cause large quantities of water to flood a local area. An example is when dams break due to faulty construction or maintenance, or when they are overwhelmed due to heavy rainfalls.

Deforestation

When the natural vegetation of an area is indiscriminately removed by cutting down the trees and hoeing of the area to remove grasses, there are no more trees to help soak up the water and reduce water flow over the landscape. Without these natural protections, the risk of flooding and erosion is increased whenever it rains.

Impermeable surfaces

In developed areas, like urban towns and cities, there are usually many impermeable surfaces like roads, concrete drainage basins, and other concrete structures that do not allow water to soak back into the soil. When large amounts of rain fall on these surfaces, the water then gathers and increase in volume thereby and leading to flooding of the low-lying areas if the runoff is not directed properly through a drainage that can handle the volume of accumulated water.

Bridges

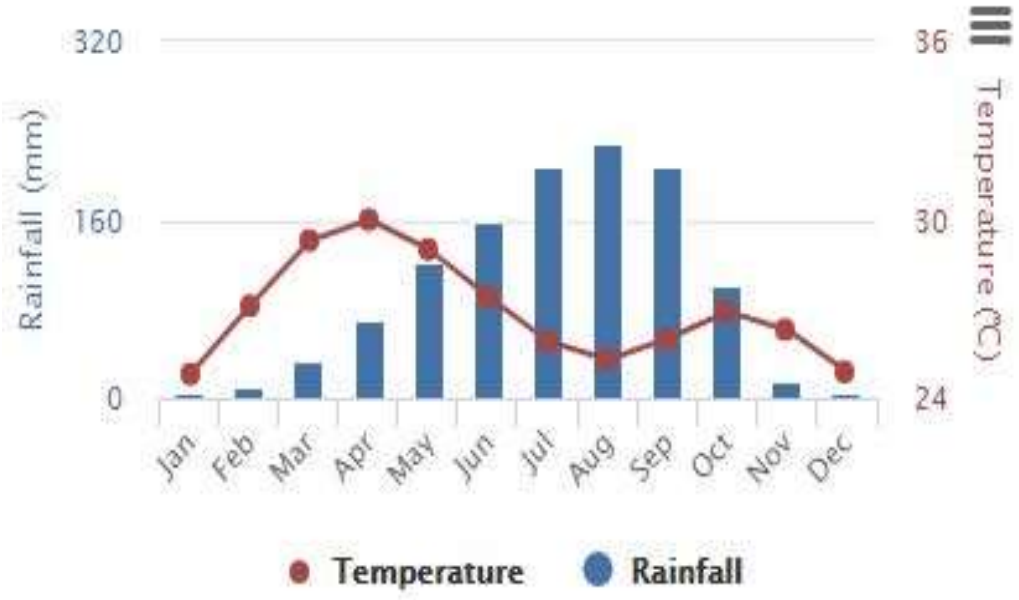
Sometimes, bridges that have been built over rivers can slow the discharge of water and reduce the river's capacity to hold more water.

Four factors, which determine the consequence of flooding disasters.

These are:

a. The level of predictability: This affects the timing, accuracy and communication of warnings given before a flood event.
b. The rate of onset to which flood occurred: How quickly the water arrives and the speed at which it rises will govern the opportunity for people to prepare and respond effectively for a flood.
c. The speed and depth of the water: This dictates the level of exposure of people and property to a flood. It is difficult to stand or wade through even relatively shallow water that is moving. Flood water often carries debris, including trees and water over 1m in depth can carry objects the size of cars. Fast flowing water can apply devastating force to property and other receptors.
d. The duration of the flood: This is another important factor in determining the extent of its impact, particularly on individuals and affected communities.

2.1 MEAN MONTHLY RAINFALL IN NIGERIA FROM 1901 – 2018



Flooding in Nigeria usually occurs between the months of July and October. The last major flooding disaster occurred in 2012. Plateau State is usually the state most affected by flooding due to rain fall, with the most casualties recorded there. Below is a graph of the average rainfall in Jos, Plateau State (state capital) with data gathered over the years.

Taraba - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	35	37	37	35	33	31
Average low in °C	18	20	24	24	23	22
Av. precipitation - mm	1	1	20	72	136	161

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	30	30	30	31	33	34
Average low in °C	22	22	22	22	20	17
Av. precipitation - mm	152	186	211	119	4	1

Benue - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	34	36	36	35	32	31
Average low in °C	19	22	24	24	23	22
Av. precipitation - mm	4	2	33	88	164	181

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	29	29	30	31	33	34
Average low in °C	22	22	22	22	21	18
Av. precipitation - mm	211	225	221	114	4	1

Sokoto - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	33	36	39	41	39	36
Average low in °C	16	17	22	26	26	24
Av. precipitation - mm	0	0	1	5	35	98

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	33	31	33	37	36	33
Average low in °C	23	22	22	22	19	16
Av. precipitation - mm	164	193	96	15	0	0

Edo - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	32	33	33	32	32	29
Average low in °C	21	22	22	23	22	22
Av. precipitation - mm	10	50	103	159	180	250

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	28	28	28	30	32	32
Average low in °C	21	21	22	22	22	21
Av. precipitation - mm	360	293	344	238	59	28

Kwara - Nigeria

Temperature – Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	34	36	36	34	33	31
Average low in °C	19	21	23	23	22	22
Av. precipitation - mm	7	12	42	100	154	205

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	29	28	29	31	33	34
Average low in °C	21	21	21	21	21	18
Av. precipitation - mm	157	141	221	125	13	9

Adamawa - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	36	37	39	39	36	32
Average low in °C	18	21	24	26	24	23
Av. precipitation - mm	0	0	4	51	101	137

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	31	31	31	33	36	35
Average low in °C	22	22	22	22	19	17
Av. precipitation - mm	176	210	185	48	5	0

Kano - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	30	33	37	38	37	34
Average low in °C	13	15	19	24	24	23
Av. precipitation - mm	0	0	2	9	44	111

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	31	29	31	34	33	31
Average low in °C	22	21	21	19	16	13
Av. precipitation - mm	184	246	105	12	0	0

Niger - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	35	37	38	37	33	31
Average low in °C	20	22	23	24	23	22
Av. precipitation - mm	2	5	16	59	128	146

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	29	29	30	32	34	35
Average low in °C	22	22	21	21	20	19
Av. precipitation - mm	197	252	236	104	3	0

Kogi - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	33	35	36	34	33	32
Average low in °C	19	22	24	24	23	22
Av. precipitation - mm	3	10	37	97	163	164

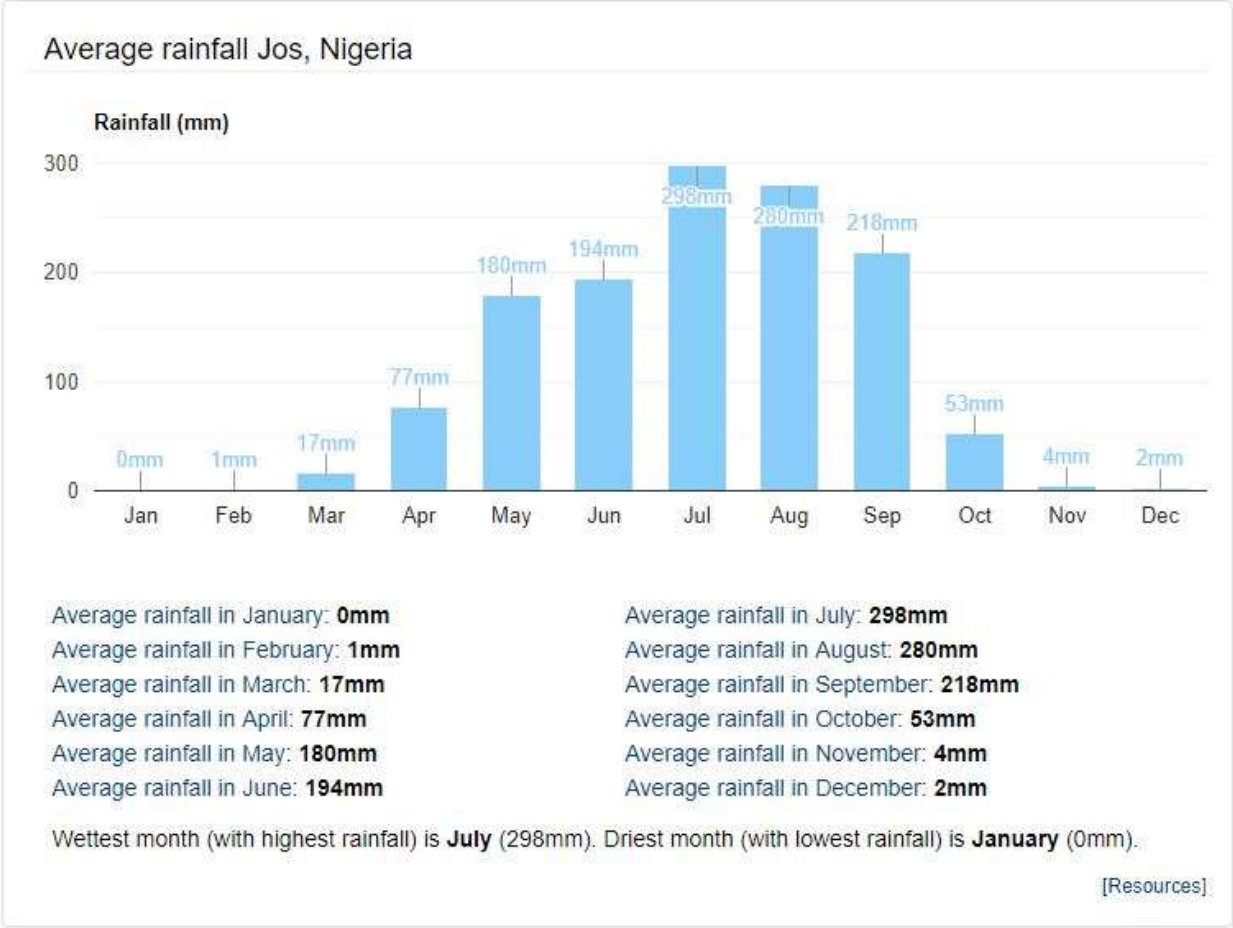
	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	31	31	31	32	33	33
Average low in °C	22	22	22	22	22	19
Av. precipitation - mm	187	195	248	115	11	1

Plateau - Nigeria

Temperature - Precipitation °C | °F

	Jan	Feb	Mar	Apr	May	June
Average high in °C	28	30	32	31	29	27
Average low in °C	14	16	18	19	18	18
Av. precipitation - mm	0	4	16	91	158	197

	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	25	24	27	29	29	28
Average low in °C	17	17	17	17	16	14
Av. precipitation - mm	303	287	201	58	1	1



Similar data is recorded in neighboring states affected by flooding.

3.0 HISTORY OF FLOODING IN NIGERIA

Historically, Nigeria typically experiences light to moderate flooding annually in those affected areas between the months of July and October. Due to government negligence, no solution has

been carried out over the years. In 2012, flooding in these regions reached historic levels- the worst in the previous 40 years.

2012 NIGERIA FLOODS

The 2012 Nigeria floods began in early July 2012, and killed 363 people and displaced over 2.1 million people as of 5 November 2012. According to the National Emergency Management Agency (NEMA), 30 of Nigeria's 36 states were affected by the floods. The floods were termed as the worst in 40 years, and affected an estimated total of seven million people. The estimated damages and losses caused by the floods were worth N2.6 trillion

July

On 2 July 2012, many Nigerian coastal and inland cities experienced heavy rains, and residents of Lagos were "gasping for breath" due to the flooding. In addition, there was a gridlock on major roads, causing people to cancel or postpone appointments they may have had. Thousands of stranded commuters had to pay increased fares for the few bus drivers who were willing to risk travelling on the roads, and construction of work by the Nigerian government on the inner Oke-Afa Road took a "heavy toll."

In mid-July 2012, flooding in the Ibadan metropolis caused some residents at Challenge, Oke-Ayo, and Eleyele to flee from their residences and save their lives. The flooding also prevented some Christians from attending churches in the morning, while a few bridges caved in. The Nigerian government said that certain structures on waterways had to be demolished as a result of the flooding, while Commissioner for Information and Orientation, Bosun Oladele, announced that there weren't any casualties from the flooding.

In late July 2012, at least 39 people were killed due to flooding in the central Nigerian Plateau state. Heavy rainfall caused the Lamingo dam to overflow near Jos, sweeping across a number of neighborhoods in Jos, and approximately 200 homes were submerged or destroyed. In addition, at least 35 people were missing, while Manasie Phampe, the head of the Red Cross in the state, announced that relief efforts were ongoing. The floods left 3,000 people homeless, many of whom are taking refuge in government buildings in Jos.

August

In mid-August, flooding killed at least 33 people in central Nigeria's Plateau state, and co-ordinator of the National Emergency Management Agency in central Nigeria Abdussalam Muhammad said that homes were destroyed while roads and bridges were washed away, obstructing relief efforts. Over 12,000 people were affected by the flooding in six districts of the state, while hundreds were rendered homeless.

September

Release of water from the Lagdo Reservoir in Cameroon caused the death of 30 people in Benue State.

October

In early-October, the floods spread to Delta State and Bayelsa State and rendered about 120,000 people homeless, according to state authorities and the Nigerian Red Cross. Several temporary displacement sites set up were also flooded forcing people to flee. In Yenagoa, 3,000 people were sleeping at the Ovom State Sports Complex. In Delta State, among the buildings destroyed by the floods were 20 health clinics, five hospitals, many schools, churches and government buildings. Schools were either closed or occupied by internally displaced persons. The floods also spread across Benue State where a local river overflowed causing the displacement of over 25,000 people.

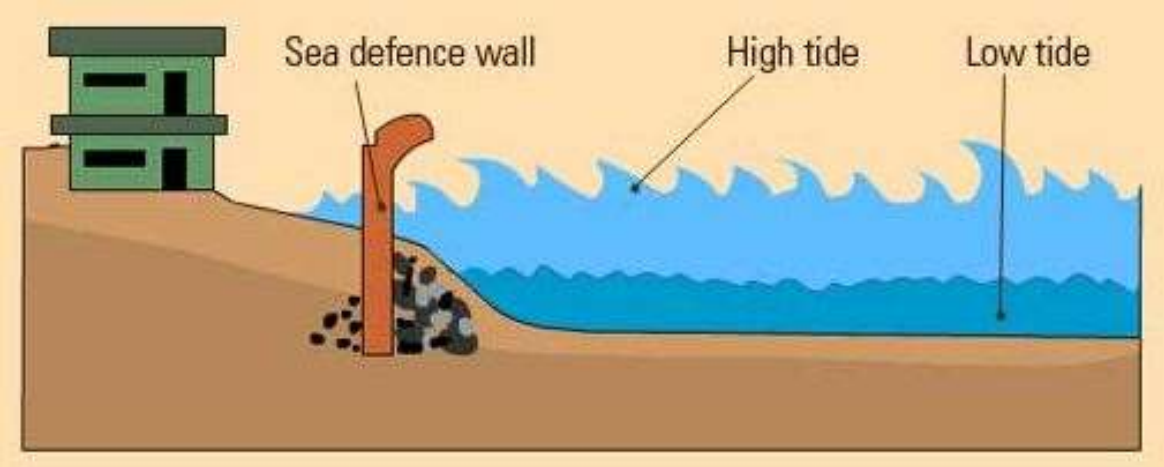
On 9 October, Nigerian President Goodluck Jonathan released 17.6 billion naira (US$111 million) to various states and agencies for damage response, flood relief and rehabilitation.

Kogi State was the worst affected with 623,900 people being displaced and 152,575 hectares of farmland destroyed, according to a NEMA coordinator. President Goodluck Jonathan called these floods "a national disaster".

4.0 METHODS OF FLOOD PREVENTION

Sea / Coastal Defence Walls

Sea walls and tide gates have been built in some places to prevent tidal waves from pushing the waters up ashore. In some areas too, sand bags are made and placed in strategic areas to retain floodwaters.



Retaining walls

In some places, retaining walls levees, lakes, dams, reservoirs or retention ponds have been constructed to hold extra water during times of flooding.

Town planning

It is important that builders acquire permission before buildings are erected. This will ensure that waterways are not blocked. Also, drainage systems must be covered and kept free from objects that chock them. This way, water can quickly run through if it rains and minimize any chance of town flooding. Drainage systems should also be covered to prevent litter from getting into them.

Vegetation

Trees, shrubs and grass help protect the land from erosion by moving water. People in low-lying areas must be encouraged to use a lot of vegetation to help break the power of moving flood water and also help reduce erosion.

Education

In many developing countries, drainage systems are chocked with litter and people have little knowledge of the effects that can have during a rain. When it rains, waterways and culverts are blocked by massive chunks of litter and debris, and water finds its way into the streets and into people's homes. Education is therefore very important, to inform and caution people about the dangers of floods, what causes floods, and what can be done to minimize its impact.

Detention basin

These are small reservoirs built and connected to waterways. They provide a temporary storage for floodwaters. This means in an event of flooding, water is drained into the basin first, giving people more time to evacuate. It can also reduce the magnitude of downstream flooding.

a. Efficient mapping, monitoring, and maintenance of all floodplains, sea coast, natural lakes and reservoirs (i.e. dams) in Nigeria.

b. Establishment of Efficient Monitoring Stations at each sea coast should be made.

c. There is a dire need for collaboration between hydrologists, remote sensing and GIS experts, environmental scientists, engineers, surveyors and other professional bodies, etc in monitoring the annual hydrological cycle and weather patterns as well as giving appropriate advice to the government.

d. As all prognoses available suggest that Nigeria will experience alterations in weather patterns throughout 21st century, with changes in temperature, rainfall, rise in sea level, therefore, data from NIMET should be obtained quarterly and measures should be implemented based on predicted future events.

e. Fast evacuation should always be carried out to minimize consequences of floods whenever they occur. This could only be achieved through supervision by serious minded personnel. Both rural and urban dwellers of riverine and sea coast areas should be educated on the risk and consequences of floods or even compensated with safe alternative land Procurement of cutting-edge flood modelling, prediction and mitigation should be highly motivated.

5.0 RECENT FLOODING IN INTERNATIONAL COMMUNITIES

2018 KERALA FLOODS

Beginning on 15 August 2018, severe floods affected the south Indian state of Kerala, due to unusually high rainfall during the monsoon season. It was the worst flooding in Kerala in nearly a century. Over 483 people died, and 15 are missing. At least a million people were evacuated, mainly from Chengannur, Pandanad, Edanad, Aranmula, Kozhencherry, Ayiroor, Ranni, Pandalam, Kuttanad, Aluva, and Chalakudy, N.Paravur, Chendamangalam, Eloor and few places in Vypin Island. All 14 districts of the state were placed on red alert. According to the Kerala government, one-sixth of the total population of Kerala had been directly affected by the floods and related incidents. The Indian government had declared it a Level 3 Calamity, or "calamity of a severe nature". It is the worst flood in Kerala after the great flood of 99 that happened in 1924.

Thirty-five out of the fifty-four dams within the state were opened for the first time in history. All five overflow gates of the Idukki Dam were opened at the same time, for the first time in 26 years. Heavy rains in Wayanad and Idukki have caused severe landslides and have left the hilly districts isolated. The situation was regularly monitored by the Prime Minister, and the National Crisis Management Committee coordinated the rescue and relief operations.

CAUSE OF KERALA FLOODS

- Low pressure
- Heavy rain
- Large discharge from dams
- Landslide

Kerala received heavy monsoon rainfall, which was about 256% more than the usual rain fall in Kerala, on the mid-evening of August 8, resulting in dams filling to capacity; in the first 24 hours of rainfall the state received 310 mm (12 in) of rain. Almost all dams had been opened since the water level had risen close to overflow level due to heavy rainfall, flooding local low-lying areas. For the first time in the state's history, 35 of its 54 dams had been opened.

The Government of Kerala argued in the Supreme Court that the sudden release of water from the Mullaperiyar Dam by the Tamil Nadu government was one of the reasons for the devastating flood

in Kerala. The Tamil Nadu government rejected the argument, saying that Kerala suffered the deluge due to the discharge of excess water from 80 reservoirs across Kerala, spurred by heavy rains from within the state; It also argued that the flood surplus from the Idukki dam is mainly due to the flows generated from its own independent catchment due to unprecedented heavy rainfall, while the discharge from Mullaperiyar dam was significantly less. Though it is difficult to attribute any single event to climate change, its possible role in causing the heavy rainfall event over Kerala cannot be ruled out.

IMPACT

A state official told AFP that 370 people have died, while The Economic Times has reported that 33,000 people have been rescued. The Kerala State Disaster Management Authority has placed the state in a red alert as a result of the intense flooding. A number of water treatment plants were forced to cease pumping water, resulting in poor access to clean water, especially in northern districts of the state. Over 3,274 relief camps have been opened at various locations to accommodate the flood victims. It is estimated that 1,247,496 people have found shelter in such camps. The flooding has affected hundreds of villages, destroyed an estimated 10,000 km (6,200 mi) of roads and thousands of homes have been damaged or destroyed. The Government cancelled Onam celebrations, whose allocated funds have been reallocated to relief efforts. On August 12,Cochin International Airport, India's fourth busiest in terms of international traffic, and the busiest in the state suspended all operations until 29 August, following runway flooding. Many schools throughout the state have been closed, and tourists have been dissuaded or banned from some districts due to safety concerns. Kochi Metro was closed briefly on August 16, and has since begun offering free service to aid those affected by the flooding. Due to heavy rain and rising water levels the southern railway has suspended train services on the Thiruvananthapuram-Kottayam-Ernakulam and Ernakulam-Shoranur-Palakkad sections.

PREVENTION

Unfortunately, hurricanes that cause deadly flooding cannot be prevented. Attempts by scientists to prevent them have led to devastating consequences.

Controversial schemes to modify the weather have been attempted by many countries, but critics often doubt their success due to the relatively poor knowledge about the mechanisms that cause weather in the first place. Some of these controversial schemes are listed below:

1. Russian military pilots have admitted that they seeded rain clouds to wash out radioactive fallout from the air in an attempt to protect the capital Moscow in the wake of the Chernobyl nuclear disaster.

2. A recent cloud seeding operation to clear the skies of rain ahead of public holidays this month went wrong when cement dropped from one of the aircraft failed to fragment and smashed through the roof of a house in Moscow.

3. The United States has tried seeding clouds using silver iodide released from aircraft in a bid to beat droughts and increase crop yields. Despite millions of dollars of investment, the techniques effectiveness have never been proved. The US military also attempted to use cloud seeding in Vietnam in an attempt to spark floods that would destroy Vietcong supply routes in an operation known as Project Popeye.

4. The Chinese authorities have said they intend weather modification to protect outdoor venues from rain during the Olympic Games later this year. They claim they have perfected a technique that reduces the size of rain drops and can delay rainfall.

5. Declassified documents have confirmed the UK's Ministry of Defence conducted experiments with rain clouds in 1952, code named Operation Cumulus. After the experiment, a destructive rain storm destroyed the village of Lynmouth, Devonshire and killed 35 people.

Instead, the best way to reduce the damage would be to evacuate the area before the storm and create more drainage channels for smoother flow of the water.

2018 JAPAN FLOODING

In late June through mid-July 2018, successive heavy downpours in southwestern Japan resulted in widespread, devastating floods and mudflows. The event is officially referred to as Heisei san-jū-nen shichi-gatsu gōu (平成30年7月豪雨, "Heavy rain of July, Heisei 30") by the Japan

Meteorological Agency. As of 20 July, 225 people were confirmed dead across 15 prefectures with a further 13 people reported missing. More than 8 million people were advised or urged to evacuate across 23 prefectures. It is the deadliest freshwater flood-related disaster in the country since the 1982 Nagasaki flood (ja) when 299 people died.

Approximately 54,000 members of the Japan Self-Defense Forces, police and firefighters have been searching for the people trapped or injured in landslides and flooding triggered by the heavy rain, while the Japanese government has set up a liaison unit at the crisis management center of the prime minister's office to gather information.

IMPACT

On 28 June 2018, a seasonal Meiyu front extending west from a non-tropical low near Hokkaido became stationary over Japan. Multiple rounds of heavy rain occurred in the subsequent days, primarily in northern Kyushu. On 3 July Typhoon Prapiroon brought heavy rains and winds to southwestern Japan. The surge of moisture brought north by the typhoon interacted with and enhanced precipitation along the front in Kyushu, Shikoku, and western and central Honshu. Enhanced rainfall extended as far west as Okinawa Prefecture. Large swathes of these areas saw 10-day rainfall accumulations in excess of 400 mm (16 in). Deadly floods began on 5 July, primarily in Kansai region which was struck by a deadly earthquake three weeks prior. Accumulations peaked at 1,852.5 mm (72.93 in) in Shikoku.

Multiple areas saw their greatest one-hour and three-day rainfall totals on record. Some areas were hit by more than 1,000 mm (39 in) of rain, prompting the Japan Meteorological Agency (JMA) to issue emergency heavy rain warnings[note 1] for eight prefectures: Okayama, Hiroshima, Tottori, Fukuoka, Saga, Nagasaki, Hyogo, and Kyoto. This marked the largest issuance of these warnings since their implementation. An official at the JMA described the event as "heavy rain at a level we've never experienced".

The torrential rain triggered landslides and flash flooding, with water levels reaching 5 m (16 ft) in the worst hit areas. Motoyama, Kōchi, saw 584 mm (23.0 in) of rain between 6 and 7 July. One town in Kōchi measured 263 mm (10.4 in) of rain in two hours. Mount Ontake observed its greatest three-day rainfall on record at 655.5 mm (25.81 in). Although the Yura River remained within its banks in northern Kyoto Prefecture, an embankment built after Typhoon Tokage in 2004 prevented

runoff from flowing into the river. This inadvertently led to flooding in Maizuru after the flood gate was closed.

As the rain lessened on July 9, high temperatures reaching 30 °C (86 °F), coupled with some 11,200 households without electricity, raised concerns over heatstroke and unsafe drinking water.

CAUSES OF FLOODING

In some cases, flooding is not preventable, but the damage can be reduced. These are some of the reasons why flooding in Japan has been so deadly.

Extreme weather

Remnants of Typhoon Prapiroon fed into a seasonal rainy weather front fuelled by warm air from the Pacific Ocean - a pattern similar to one that caused flooding in southwestern Japan exactly a year ago that killed dozens of people.

The recent rainfall was unprecedented and disaster experts said torrential rains are becoming more frequent, possibly due to global warming.

Risk awareness

Municipalities in Japan have been required since 2005 to create and publicise "hazard maps" showing the risk of flooding and landslides. By 2013, 95 percent of municipalities had produced flood hazard maps and 81 percent for landslides, according to the land ministry.

However, experts say many homes in Japan were built in risky areas before the 2001 requirement to distribute hazard maps.

Kurashiki city in Okayama prefecture, where the Mabi district was especially hard hit by this week's floods, distributed a hazard map in 2016, the Yomiuri newspaper said.

Despite orders and advisories to evacuate, which may have been issued too late, some residents appear to have ignored the warnings because they did not know where to go or how to get to safety.

Quakes not floods

Japan, one of the most seismically-active places in the world, has stressed earthquake preparedness and regulations to make buildings quake-proof, but it has done less about potential flood disasters, said Okuma from Niigata University.

After several smaller disasters in recent years, the Ministry of Land, Infrastructure, Transport and Tourism has drafted plans to improve flood control and evacuation planning.

Land use

The government monitors weather conditions and issues early warnings, but the nation remains vulnerable to disasters because much of the country outside major cities is mountainous and construction takes place on virtually every bit of usable land.

Reforestation policies after World War Two saw many mountains logged and replanted with trees that have roots that are less able to retain water. That has contributed to the danger of landslides, which accounted for many of the deaths in this latest disaster.

PREVENTION

Japan also has the world's biggest infrastructure for flood prevention: a gigantic main reserve tank, five containment silos and a network of more than six kilometres of underground pipes of a diameter of 10.6 metres.

The system collects water, drains flooding from four rivers and spurts out up to 200 cubic metres of water per second into the region's main river, near Tokyo.

6.0 WATER RESOURCE AGENCIES IN NIGERIA

Nigeria Hydrological Services Agency (NIHSA)

Nigerian Integrated Water Resources Commission

National Water Resources Institute (NWRI)

River Basin Development Authorities (RBDA's)