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14/ENG03/017

CVE 505 WATER RESOURCES ENGINEERING

QUESTION 1:

Write a 2 or more pages on the 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 evaporationreturning the fresh water to land as rain and snow

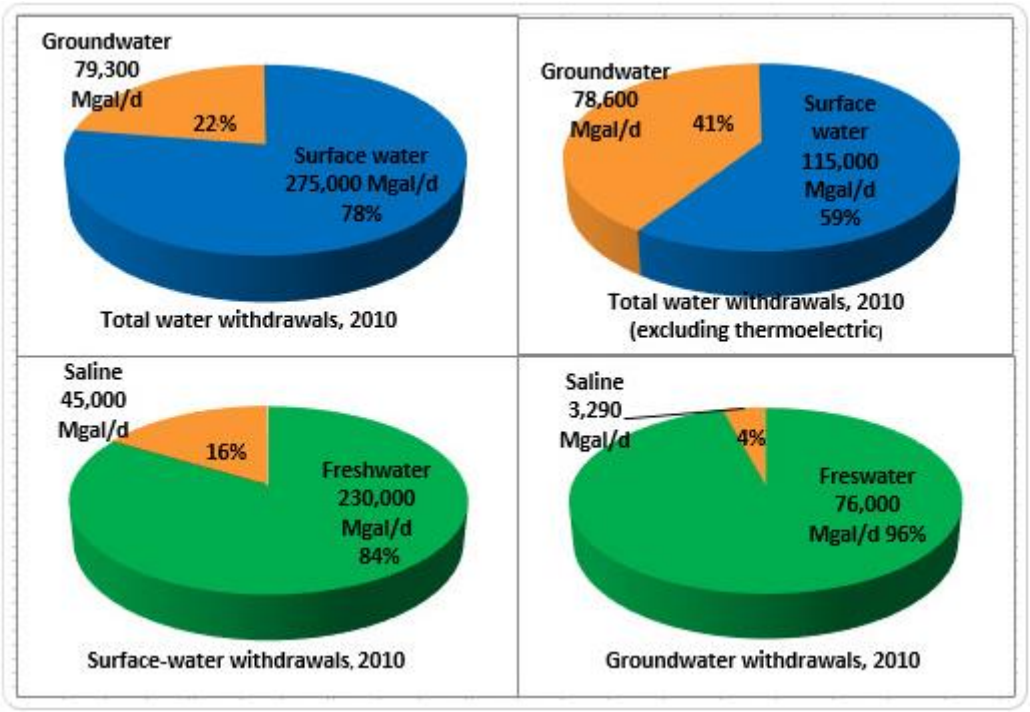
The vast majority of water on the Earth's surface, over 96 percent, is saline water in the oceans. The freshwater resources, such as water falling from the skies and moving into streams, rivers, lakes, and groundwater, provide people with the water they need every day to live. Water sitting on the surface of the Earth is easy to visualize, and your view of the water cycle might be that rainfall fills up the rivers and lakes. But, the unseen water below our feet is critically important to life, also. How do you account for the flow in rivers after weeks without rain? In fact, how do you account for the water flowing down a driveway on a day when it didn't rain? The answer is that there is more to our water supply than just surface water, there is also plenty of water beneath our feet.

Even though you may only notice water on the Earth's surface, there is much more freshwater stored in the ground than there is in liquid form on the surface. In fact, some of the water you see flowing in rivers comes from seepage of groundwater into river beds. Water from precipitation continually seeps into the ground to recharge aquifers, while at the same time water in the ground continually recharges rivers through seepage

Humans are happy this happens because we make use of both kinds of water. In the United States in 2010, we used about 275 billion gallons of surface water per day,and about 79.3 billion gallons of groundwater per day. Although surface water is used more to supply drinking water and to irrigate crops, groundwater is vital in that it not only helps to keep rivers and lakes full, it also provides water for people in places where visible water is scarce, such as in desert towns of the western United States.

How much water is there on (and in) the Earth? Here are some numbers you can think about:

- If all of Earth's water (oceans, icecaps and glaciers, lakes, rivers, groundwater, and water in the atmosphere was put into a sphere, then the diameter of that water ball would be about 860 miles (about 1,385 kilometers), a bit more than the distance between Salt Lake City, Utah to Topeka, Kansas. The volume of all water would be about 332.5 million cubic miles (mi^3), or 1,386 million cubic kilometers (km^3). A cubic mile of water equals more than 1.1 trillion gallons. A cubic kilometer of water equals about 264 billion gallons.
- About 3,100 mi^3 (12,900 km^3) of water, mostly in the form of water vapor, is in the atmosphere at any one time. If it all fell as precipitation at once, the Earth would be covered with only about 1 inch of water.
- The 48 contiguous (lower 48 states) United States receives a total volume of about 4 mi^3 (17.7 km^3) of precipitation each day.
- Each day, 280 mi^3 (1,170 km^3)of water evaporate or transpire into the atmosphere.
- If all of the world's water was poured on the contiguous United States, it would cover the land to a depth of about 107 miles (145 kilometers).
- Of the freshwater on Earth, much more is stored in the ground than is available in lakes and rivers. More than 2,000,000 mi^3 (8,400,000 km^3) of freshwater is stored in the Earth, most within one-half mile of the surface. But, if you really want to find freshwater, most is stored in the 7,000,000 mi^3 (29,200,000 km^3) of water found in glaciers and icecaps, mainly in the polar regions and in Greenland.



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
Ice caps, 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
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).

QUESTION 2:

Write a 2 or more pages brief on the current flood disaster in Nigeria. What are the causative factors. Plot a mean monthly rainfall for Nigeria and the affected state capitals and any links between rainfall and flooding for these states.

According to Nigeria's National Emergency Management Agency (NEMA), nearly half a million people are currently affected by flooding in 8 states of the country. At least 108 people have died in the flooding, with a further 192 injured.

The affected states include Anambra (64,331 people affected), Benue (2,201), Delta (37,017), Edo (31,113), Kebbi (94,991), Kogi (118,199), Kwara (41,680) and Niger (51,719).

Earlier this month NEMA declared a state of emergency for flooding in the four states of Niger, Kogi, Anambra and Delta.

A total of 13,031 houses have been damaged or destroyed. As of 24 September there were 141,369 people displaced by the floods. NEMA says there is an urgent need for food and non-food relief items.

Flooding also affected parts of Rivers and Beyelsa states over the last few days, and teams from NEMA and the military have started evacuating families trapped in their homes, relocating them to nearby relief camps.

As of 24 September, the Niger river at Lokoja had fallen slightly from previous levels and stood at 11.05 metres

Rainfall patterns in Nigeria (1978 to 2007) suggests that rainstorms are getting more intense. The data show that there are fewer rainy days, yet the total yearly amounts of rainfall have not changed much from previous decades. This means that more rain is falling on the days that there is rain, which in turn means that rain storms in the city are getting more intense, increasing the threat of flooding.

In addition to more intense rain storms, the other possible cause of flooding in coastal regions is rising sea levels. Although up-to-date data on the rising sea levels in Nigeria are scarce, it's believed that if nothing is done, this is likely to aggravate flooding in the future, particularly in coastal cities.

Areas at risk include Lagos, which is on the coast, as well as the Niger Delta region which has many low-lying towns and villages. Being on the coast also makes these places more susceptible to storm surges. While these areas are no stranger to floods, evidence suggests that floods have become increasingly common and intense in recent times.

In the northern parts of the country, heavy rains are likely to cause rivers to overflow their banks and cause flooding in the adjoining states. The changes in rainfall patterns, particularly in frequency and intensity, have meant that these events have begun to happen more frequently.

In Nigeria's cities, the most common cause of flooding after excessive rains is poor drainage systems that can't cope. This is called pluvial flooding.

Causation of Flooding in Nigeria

Generally, causes of flood in Nigeria could be as a result of Natural Cause or Human Cause. Natural Cause in form of

- Heavy or torrential rains / rainstorm

- Oceans storms and tidal waves usually along the coast.

Or Human Causes.

- Burst water main pipes
- Dam burst levee failures
- Dam spills.

Flooding occurs throughout Nigeria in following forms:

- Coastal flooding
- River flooding
- Flash floods
- Urban flooding
- Dam burst levee failures
- Dam spills

Coastal flooding occurs in the low-lying belt of mangrove and fresh water swamps along the coast.

River flooding occurs in the flood plains of the larger rivers

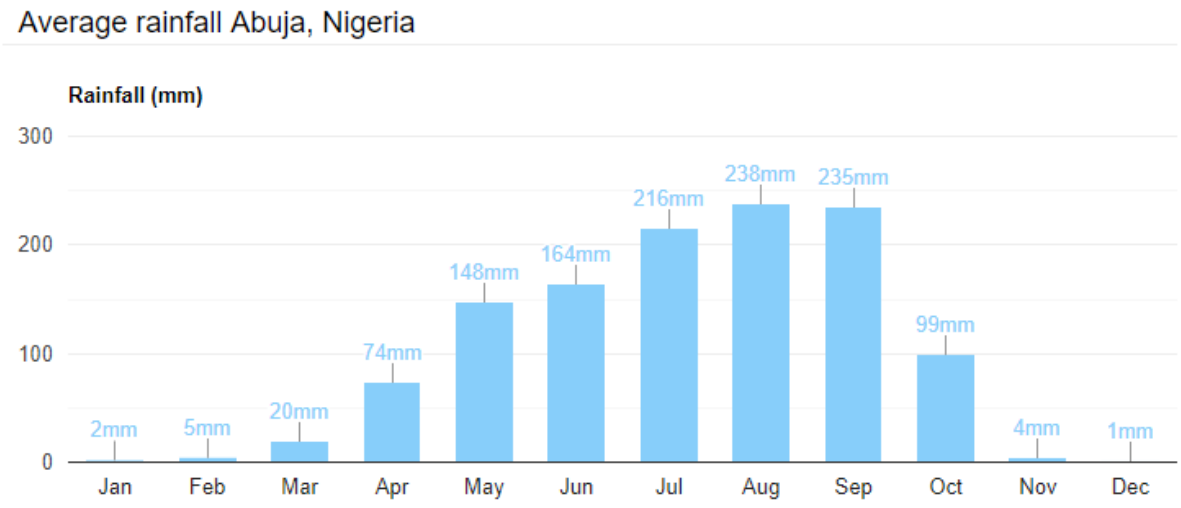
Flash floods are associated with rivers in the inland areas where sudden heavy rains can change them into destructive torrents within a short period.

Urban flooding occur in towns located on flat or low lying terrain especially where little or no provision has been made for surface drainage, or where existing drainage has been blocked with municipal waste, refuse and eroded soil sediments. Extensive urban flooding is a phenomenon of every rainy session in Lagos, Maiduguri, Aba, Warri, Benin and Ibadan.

Virtually every Nigerian is vulnerable to disasters, natural or man-made. Every rainy season, wind gusts arising from tropical storms claim lives and property worth million of Naira across the country. Flash floods from torrential rains wash away thousands of hectares of farmland. Dam bursts are common following such flood. In August 1988 for instance, 142 people died, 18,000 houses were destroyed and 14,000 farms were swept away when the Bagauda Dam collapsed following a flash flood. Urban flooding such as

the Ogunpa disaster which claimed over 200 lives and damaged property worth millions of Naira in Ibadan, are common occurrence

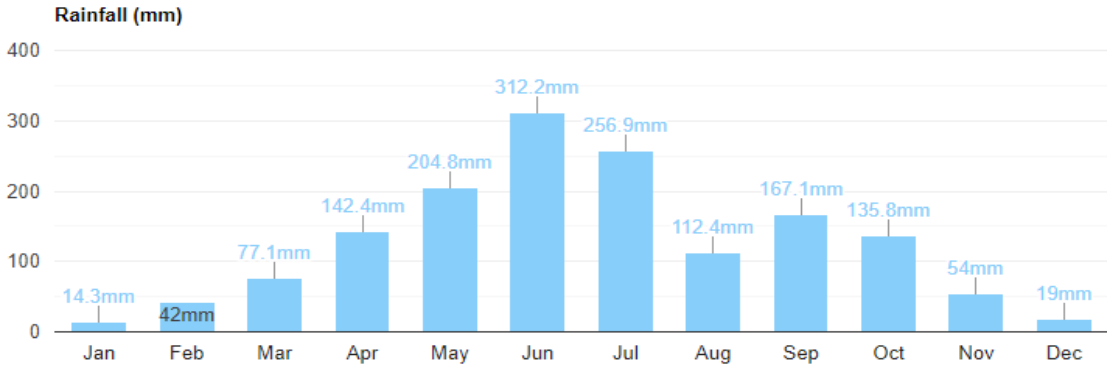
Floods paralyze economic activities in many towns and cities in the country. Major roads, some linking States are flooded causing hardship to motorists. When these roads were constructed, the flooding problems were not there, and the companies that constructed the roads probably did not anticipate the problem.



Average rainfall in January: **2mm**
Average rainfall in February: **5mm**
Average rainfall in March: **20mm**
Average rainfall in April: **74mm**
Average rainfall in May: **148mm**
Average rainfall in June: **164mm**
Average rainfall in July: **216mm**
Average rainfall in August: **238mm**
Average rainfall in September: **235mm**
Average rainfall in October: **99mm**
Average rainfall in November: **4mm**
Average rainfall in December: **1mm**

Wettest month (with highest rainfall) is **August** (238mm). Driest month (with lowest rainfall) is **December** (1mm).

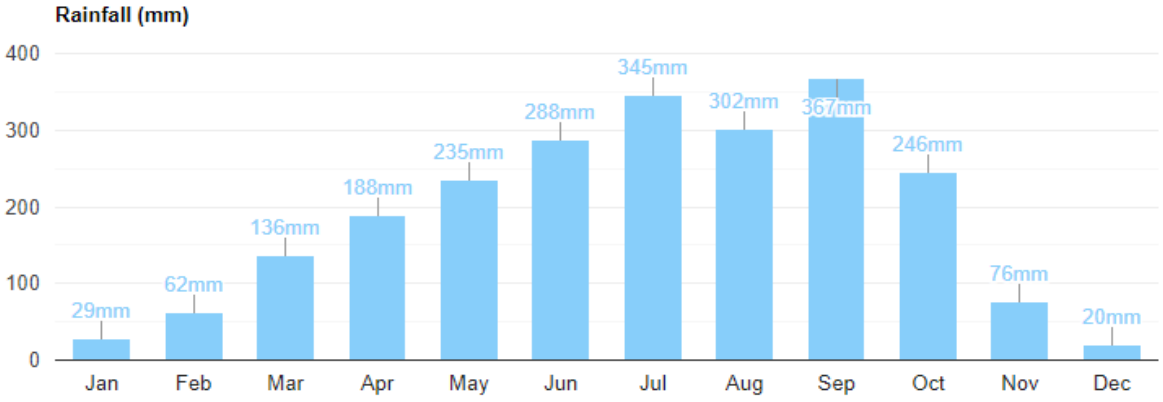
Average rainfall Lagos, Nigeria



Average rainfall in January: **14.3mm**
Average rainfall in February: **42mm**
Average rainfall in March: **77.1mm**
Average rainfall in April: **142.4mm**
Average rainfall in May: **204.8mm**
Average rainfall in June: **312.2mm**
Average rainfall in July: **256.9mm**
Average rainfall in August: **112.4mm**
Average rainfall in September: **167.1mm**
Average rainfall in October: **135.8mm**
Average rainfall in November: **54mm**
Average rainfall in December: **19mm**

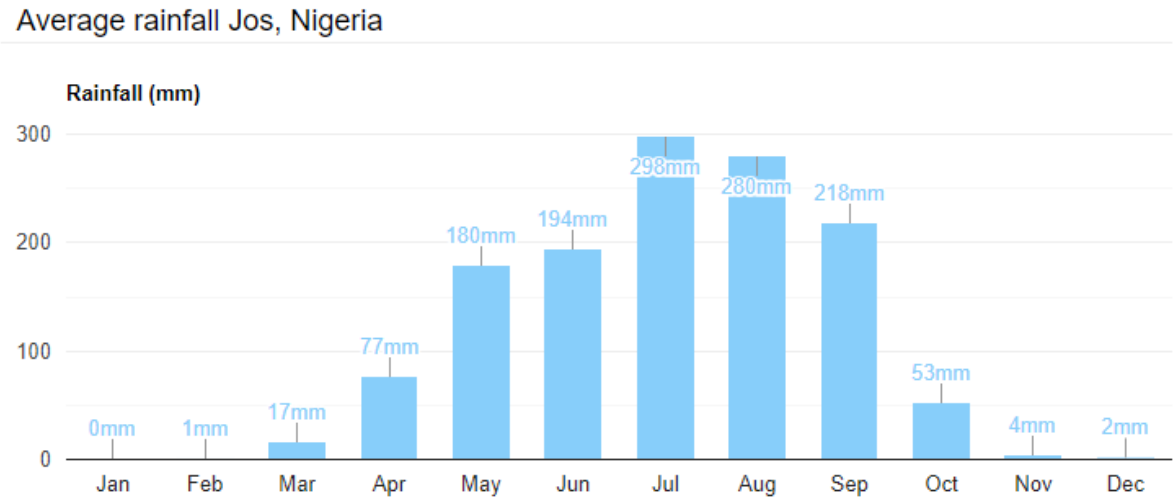
Wettest month (with highest rainfall) is **June** (312.2mm). Driest month (with lowest rainfall) is **January** (14.3mm).

Average rainfall Port Harcourt, Nigeria



Average rainfall in January: **29mm**
Average rainfall in February: **62mm**
Average rainfall in March: **136mm**
Average rainfall in April: **188mm**
Average rainfall in May: **235mm**
Average rainfall in June: **288mm**
Average rainfall in July: **345mm**
Average rainfall in August: **302mm**
Average rainfall in September: **367mm**
Average rainfall in October: **246mm**
Average rainfall in November: **76mm**
Average rainfall in December: **20mm**

Wettest month (with highest rainfall) is **September** (367mm). Driest month (with lowest rainfall) is **December** (20mm).



Average rainfall in January: **0mm**
Average rainfall in February: **1mm**
Average rainfall in March: **17mm**
Average rainfall in April: **77mm**
Average rainfall in May: **180mm**
Average rainfall in June: **194mm**
Average rainfall in July: **298mm**
Average rainfall in August: **280mm**
Average rainfall in September: **218mm**
Average rainfall in October: **53mm**
Average rainfall in November: **4mm**
Average rainfall in December: **2mm**

Wettest month (with highest rainfall) is **July** (298mm). Driest month (with lowest rainfall) is **January** (0mm).

QUESTION 4

Profer modality to prevent re-occurrence of flooding in these states in Nigeria

Flooding means there is an excess of water on land that is normally dry. Floods can be caused by heavy rainfall, hurricanes, or a lack of proper drainage in urban areas where there is little open soil to absorb water. Floods can be prevented with proper planning and adoption of effective mitigation measures, particularly in areas prone to flooding.

Improving Drainage

Improving water drainage helps control floods by facilitating easy flow of excess water, especially in urban areas during flash floods. Drainage efficacy can be improved by rehabilitating and cleaning water drainage systems, including removing debris and solid waste from drainage systems like storm drains and French drains, de-silting trenches and underground water channels and building galleys. Effective drainage systems can ensure flood waters find a clear waterway, leading to non-risk areas.

Building Dikes and Levees

Dikes and levees are flood-control structures built to fight river flooding and water surges. Dikes and levees restrain rivers during floods by providing artificial water channels that prevent runoffs from bursting floodplains. Floodplains are natural waterways that carry excess river water during heavy rainfall. Dike engineers/constructors alter and develop floodplains by building dikes and levees to boost flood-prevention when floodplains well up.

Building Canals

Canals are artificial water channels that can be crucial to flood prevention. Canals facilitate control of water levels passing through, and form linear reservoirs and water locks. During flooding, excess water is channeled through canals to non-risk areas further downstream or to other areas with high demand for water, such as arid and semi-arid areas. Canals can also be used to lock excess flood waters in its linear reservoirs to prevent flooding and store water for future use.

Harvesting Rain Water

Harvesting rainwater involves collecting and storing rainwater and can not only prevent floods, it can also curb urban water scarcity. Harvested rain water can be cleaned for human consumption and distributed to people in rural areas, as well as urban areas in times of water scarcity. Rain water harvesting is carried out in different ways, including building ponds, storm drains, water retention basins and flood-control dams

QUESTION 3

History of flooding in these states in Nigeria

Based on the 2012 survey of flooding in Nigeria.

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"

QUESTION 5

Write on recent flooding in other parts of the world : USA, Japan, India etc. choose any 2 countries or regions of the world. Provide the causative factor for the flood. Write also on the methods used to check, ameliorate or prevent the re-occurance of flooding in the locations

THAILAND

This fall, Thailand has been in crisis due to relentless monsoon rains which resulted in massive flooding. Many have said that it is the worst flooding in the country in 70 years. The waters have taken a tremendous toll on the country, the people and the economy, but with reconstruction already underway, there is hope for the future.

Since the beginning of the monsoon season this past August, rain waters have been unstoppable. Monsoon rains in the north have caused flooding further south—even affecting areas of Bangkok. The disaster is blamed for several hundred deaths and more than 200 billion Baht (nearly 7 billion USD) in damage.

Flooding has also slowed Thailand's growing economy. Although solutions are already being implemented, the Thai economy will feel the effects of the crisis in the next several months. Thailand is a major supplier of hard disk drives and automobiles. Reports have said 70% of Thai automobile production has been affected and a Honda plant was forced to shut down production until April 2012.

The apparel sector has also been hit as raw materials are hard to come by during the floods. The industry lowered its growth projections for the year and is lobbying the government to lower tariffs on textile imports to aid in supply chain reorganization.

There are also things suppliers can do to help their own recovery. It's important for factory owners to review their buyer contracts and to see what options they have. If they've been affected, there may be clauses in their contracts that allow for halting production due to natural disasters, or that allow for changes in the supply-chain to ease burden. Manufacturers should also look into government-run programs introduced to support affected businesses in relocating machinery and raw materials.

The government has established the Strategic Formulation Committee for Reconstruction and Future Development and the Strategic Formulation Committee for Water Resources Management to solve problems and restore confidence in Thailand's ability to manage crises in the future. Not only are these programs intended to optimize Thailand's recovery, but also to build the irrigation systems and economy back better than before the flood. Successful implementation of these new policies will be vital to restoring investment interest and confidence in the country.

Despite the losses, there is good economic news for the future. Even though floods have rocked local business, Thailand's economy still grew in 2011 compared to 2010. The projected growth of 4% was lowered to 1.5% but it maintains Thailand's steady upward path of recent years. Recovery in exports is expected by the second quarter of 2012 as the factories are predicted to resume production by then.

The Thai restoration will count on foreign support as well as infrastructural support. The government has made it clear in the past months that Thailand remains an economically robust country and will rebuild even stronger

Causes of flooding in Thailand

Main cause of flooding in Thailand is heave rain in monsoon season, overloaded capacity of dam, river. Geographical of Thailand, Northern Thailand is hill side, when there is heavy rain the water flow from northern river such as Ping, Wang, Yom, Nan to Chaopraya river, flood-plain area which is central area. When Kangsuaten dam and Naresuan dam are at full capacity, the water is released to central region to Pasakjolasit dam, if Pasakjolasit dam reach full capacity water will be released to lower region of Chaopraya river. Therefore flood happen.

Due to climate change, it become harder to predict the amount of water each year. There are about 6 main dams in central Thailand; only 3 of them were built to retain water. In 2010, first six month of the year Thailand face drought, so most of the dams retain water up to 90% capacity, when heavy rain occur dam capacity was full, flooding occur.

Urbanization, the flood-plain areas that used to be the area to retain water were cover up to support unwell plan expansion of the city, block the natural drainage mechanism.

Lack of cooperation between government's organizations, some project may be an obstacle for other project. Government should issue clear regulation for usage of land in flooding area as a long-term prevention, not just some relief plans after floods occur.

UK (RAILWAYS)

In September we'll start work on a £9 million flood defence scheme on our Wessex route to better protect the railway line.

We'll reduce the likelihood of local flooding from a one in five-year risk, to a one in 20-year risk by installing two 550-tonne underground culverts - tunnels carrying drains - at Axe Valley in Devon.

In July, we completed culvert installation work near Exeter as part of £26.5m flood alleviation scheme for the south west.

Flooding in the Cowley area had been a longstanding problem that had had a devastating impact on this part of the Great Western Mainline, resulting in numerous delays and closures.

The Cowley culverts project was one of the schemes under the Department for Transport's £26.5m Flood Resilience Programme. It was established after extreme weather in 2012 and

2014 caused extensive disruption to the rail network. Its aim is to reduce the risk of flooding at key locations in the Thames Valley and south west and ensure that when flooding does occur, train services can be resumed at a quicker rate, reducing disruption for passengers.

There are lots of reasons why the railway is prone to flooding

Many sections of the railway were built in cuttings and tunnels that are lower than the surrounding area. Other lines sit on flat, low-lying land with limited drainage that can be overwhelmed by heavy rain. For these reasons, many of our lines can flood, and this can cause serious problems for the railway. That's why we're always looking for ways to prevent floods happening in future.

Building on land near the railway can also increase flooding because rain that previously would have soaked into the ground can run off the new hard ground and onto the tracks. To help prevent this, we review planning applications for developments near railway lines to make sure the drainage systems proposed are adequate.

How flooding affects the railway

When the railway does flood, our engineers and contractors who work on the railway carry out repairs so trains can safely run again as soon as possible. There are lots of different things they have to check and repair.

When flood water rises above the rails, trains must slow down to prevent damage to the train. Flooding can cause a short circuit and cut the power if the track has a live conductor rail.

It's not just during a flood that journeys can be disrupted but afterwards as well.

Trackside points and signalling equipment that rely on intricate wiring and power supplies can easily fail during flooding and need to be replaced before trains can run on the track again.

When flood water drains away, it can wash away the 'ballast' - the bed of stones that supports the sleepers - and this destabilises the track. To make the line safe again, this ballast must be relaid.

How we reduce the effects of flooding and prevent delays

• We continually monitor the weather - as soon as we receive a flood warning from the Environment Agency and Flood Forecasting Centre, we send people and equipment to at-risk areas so we're in position to act quickly.

• We deploy flood defence systems, including barriers with a membrane that seals to prevent water getting through, and inflatable barriers filled with water.

• Branches, leaves and debris in ditches and drainage systems prevent water runoff – so we clear these out both on and near the track

• Thanks to our ongoing project to build pumping stations in flood-prone locations, we have the resources in place to enable us to quickly pump flood water away when needed.

• As lines are renewed in flood prone areas, we install the tracks and signalling equipment at a higher level so it's less likely they'll be flooded

QUESTION 6

Provide names of water and weather resources agencies and organisations at three
i) Local/state
ii) National
iii) international

LOCAL/STATE

- Kaduna State Water Resources Agency
- Rivers State Water Resources Agency
- Lagos State Water Resources Agency

NATIONAL

- Nigeria Hydrological Services Agency (NIHSA)
- Nigerian Integrated Water Resources Commission
- National Water Resources Institute (NWRI)
- River Basin Development Authorities (RBDA's)

INTERNATIONAL

- World Meteorology Organisation WMO
- Integrated Water Resources Management IWRM
- Canadian Water Resources Management CWRM