

Effects of climate change on water resources(a case study in Liberia)

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Abstract: Liberia is vulnerable to climate change due to its warmer temperatures, and continues to increase in annual rainfall, and increases heavy rainfall frequency (USAID, 2010). The study was conducted to determine the major effects climate change has on Liberia, using a qualitative research method with focus on both foreign and domestic literature that validate the situation. From the study, the researcher found that climate change mainly through a heavy downpour of fall causes floods and deplete water resources during dry season. Generally, it threatens the survivability of community dwellers and demonishes their properties as well. Nevertheless, according to article 12 of the United Nations frame convention on climate change that Liberia is expected to produce its National Strategy to mitigate the effect of Climate Change and the inventories of Greenhouse and sinks (NCSA, 2003). The Government of Liberia through a vibrant effort of the Environment Protection Agency promised to reduced or eliminate the threats climate change is imposing on Liberia.

Keywords: Flood, Rainy and dry seasons, Climate change etc.

1. Overview of Climate Change in Liberia

Many African nations are experiencing water stress, which is defined as utilizing more than 20% of their renewable water resources (WBGU, 2003), with withdrawals of more than 40% indicating significant water stress (Pittock, 2005). According to studies, the average annual water intake in Nigeria throughout the 1990s was 28 cubic meters per person (Gleick, 2000; World Bank, 2003). Water stress would rise dramatically in existing dry places, according to the International Dialogue on Water and Climate (2004). (such as sub-Saharan Africa). Similarly, the impact of climate change has also made Liberia completely vulnerable to water resources resulting from floods due to an increase in annual rainfall (USAID, 2010). Liberia constitutes 14% of surface water and wetlands with fifteen river basins drainage system However, it lacks in infrastructure and services to reach everyone with safe drinking water And that is having a serious effect on beneficiaries especially in rural Liberia.

Liberia has a lot of water resources all around the place. Water availability per capita in Sub-Saharan Africa is the third highest, at 49,028m³, and is much greater than the Falkenmarki water stress threshold. Abstractions of water are likewise fairly low. Water withdrawals are less than one percent of renewable supply (USAID, 2017). Even though there is plenty of surface water, dry season flows might be minimal. The Mount Coffee Dam, which is the primary source of municipal power and a key supply of electricity for Monrovia, sees a considerable reduction in hydropower output due to low water levels on the St. Paul River (IPCC, 2018).

Climate change would increase rainfall intensity and flood hazards, increasing the likelihood of waterborne illness epidemics in urban areas, especially in informal settlements, according to a USAID assessment on water resource profile. Seasonal storms and tidal surges will become more invasive as sea levels rise, threatening to inundate coastal wetlands and mangroves, ruin infrastructure, and displace coastal people (USAID, 2017). Due to high water tables, the majority of groundwater is polluted and is the principal supply of drinking water in rural and urban regions. Contamination of shallow groundwater can endanger the health of populations that rely on it for their drinking water.

2. Liberia Climate Change Assessment

Climate change is the phrase used to describe the major long-term alteration (or fluctuation) of the climate caused by human activity. (Niasse et al., 2004), referenced the Intergovernmental Panel on Climate Change (IPCC) significant modification. In addition, (Gatter, 1997) acknowledges that Liberia's climate is influenced by its tropical position. In general, the nation is subjected to constant high temperatures with minimal change. The temperature in

the nation fluctuates from 27 to 32 degrees Celsius during the day and 21 to 24 degrees Celsius at night (MPEA, 1983). The average yearly temperature near the shore is between 24 and 30 degrees Celsius (MPEA, 1983). The rise in temperature in Liberia is largely affected by the seasons. Temperatures are quite low throughout the rainy season due to near-complete cloud cover, and there is minimal diurnal change in temperature. Because the southwesterly flow sweeps the clouds inland, giving coastal locations with greater solar radiation, temperatures near the shore are often higher than inland at this time of year. During the dry season, it increases somewhat, then drops in July and August. The Liberian Environmental Protection Agency (EPA) recently published the following vulnerability and assessment analysis of Liberia's climate change:

The expected climate for Liberia from 2010 to 2050 is based on a collection of Regional Climate Models (RCMs). The average air temperature is expected to rise from 0.4°C to 1.3°C, according to all forecasts. The average temperature increase for the year 2020 is expected to be 0.6°C. According to the scenarios and trends, the temperature will rise by 1.3°C by the middle of the twenty-first century (EPA, 2021).

3. The Effects of Climate Change on Water Resources

Climate change has two main effects on Liberia: rainy and dry seasons (USAID,2010). In the central and eastern provinces, isohyets run almost parallel to the shore. Because the steep mountain ranges in western Liberia are aligned northeast-southwest, the monsoon flow is channeled and the rainy season is extended, the isohyets penetrate significantly deeper into the interior. Annual rainfall is substantially greater than usual for the coastal region where monsoon winds meet strong coastal promontories (Gatter, 1997).

The rainy season in Liberia is when the amount of rainfall is increased or at a high intensity. It runs from the middle of April until the middle of October. The annual average rainfall ranges from 4500mm to 4624mm, resulting in flooding at some time. If not appropriately managed, changes in rainfall patterns may have a detrimental impact on water supplies through flooding (USAID,2010). The coastal belt receives an average of 4000 mm of rainfall each year, with some months getting more than 1000 mm (McSweeney et al, 2008).

During the dry season, the intensity of sunlight is quite high, causing most crops (particularly pasture plants) to lose nutrients. It runs from the middle of October until the middle of April. Drought affects some countries throughout the dry season. Drought is a period of low precipitation that causes substantial crop damage and, as a result, a loss of productivity. In other terms, it is a lengthy dry period that can occur in the natural climatic cycle. Liberia is affected by climate change in two ways: wet and dry seasons (USAID,2010). In the provinces in the center and east, isohyets run almost parallel to the shore. Because the steep mountain ranges in western Liberia are aligned northeast-southwest, the monsoon flow is channeled and the rainy season is extended, the isohyets penetrate significantly deeper into the interior. Annual rainfall is substantially greater than usual for the coastal region where monsoon winds meet strong coastal promontories (Gatter, 1997).

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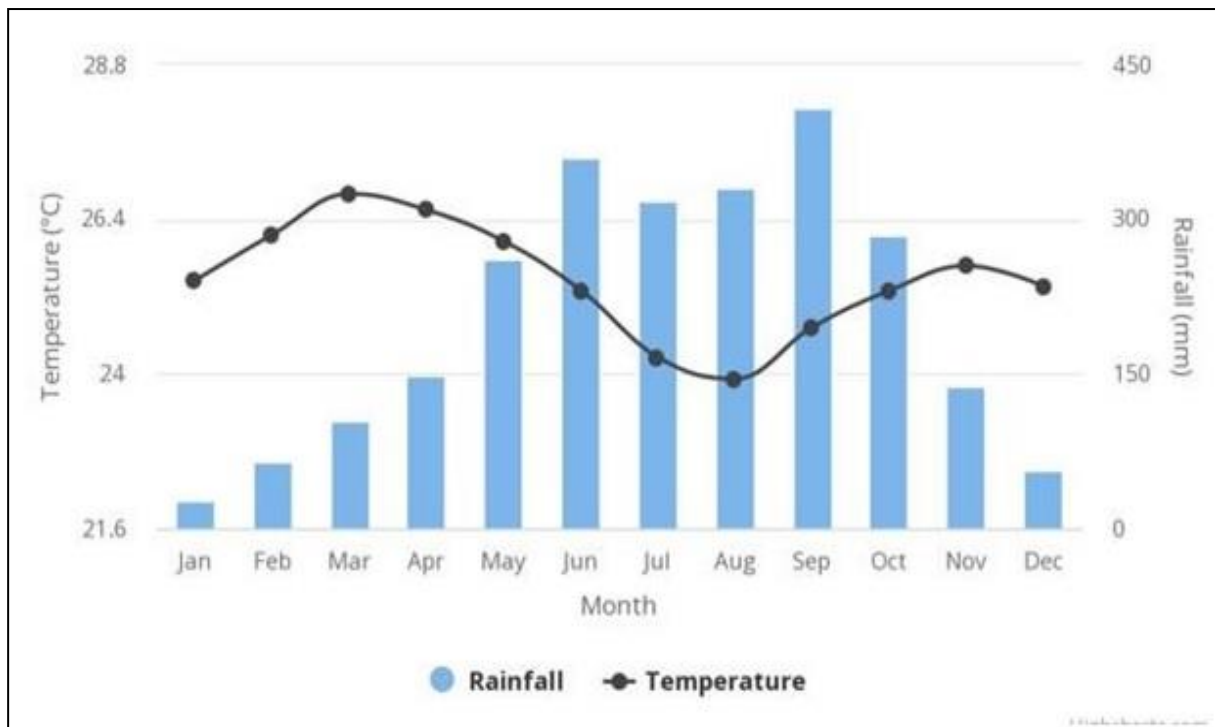
When it comes to flooding on the continent, Liberia's capital, Bangui (the capital of the Central African Republic), and Mbuji-Mayi (in the Democratic Republic of Congo) are the three cities most at risk. Monrovia receives up to 5

meters of rain every year during the rainy season, which runs from May through October, with a peak in June and July. A massive flood hit Liberia in July 2008, affecting more than 20,000 people and displacing at least 800 individuals in around ten neighborhoods of the capital. Referencing (Afrol, 2019), one of the biggest floods in Liberia's history struck the capital, Monrovia, on July 22, forcing citizens to escape their homes due to severe and torrential rainfall. An interview with the EPA Director General was also published, urging residents to refrain from developing in wetlands. He stated that not everyone can afford to construct in marshy places due to the high cost of the technologies necessary.

According to a report by the Comprehensive Act Alliance, flash floods affected the Liberian counties of Montserrado, Grand Cape Mount, Margibi, Bomi, and Lofa, causing flooding in numerous communities around Monrovia and nearby counties. As a result, at least 187 dwellings and other property have been damaged or destroyed (LBR191, 2021).

Tables and Figures

Figure 1: Average Monthly temperature and rainfall in Liberia from 1901 – 2016



(EPA, Survey, 2021)

Figure 1 shows the levels of rainfall and temperature due to climate change in Liberia. This graph indicates heavy downpours of rain were recorded in the months of June and September. However, the temperature rate during these months were almost average of the rain level. It is also observed that even though September accounted for the heaviest rain but temperature in June was higher.

Figure 2: Major hazard-prone areas in Liberia as of 2019(NDMA, 2020)

Figure 2 shows the flood-prone areas in Liberia. From this graph, almost all of the regions in Liberia are affected by flood. Lofa, Gbarpolu, Bong etc are major subdivisions experiencing flood hazard.

Figure 3: Elevation model to identify areas of a high risk of floods in Monrovia(Gonz, 2019)

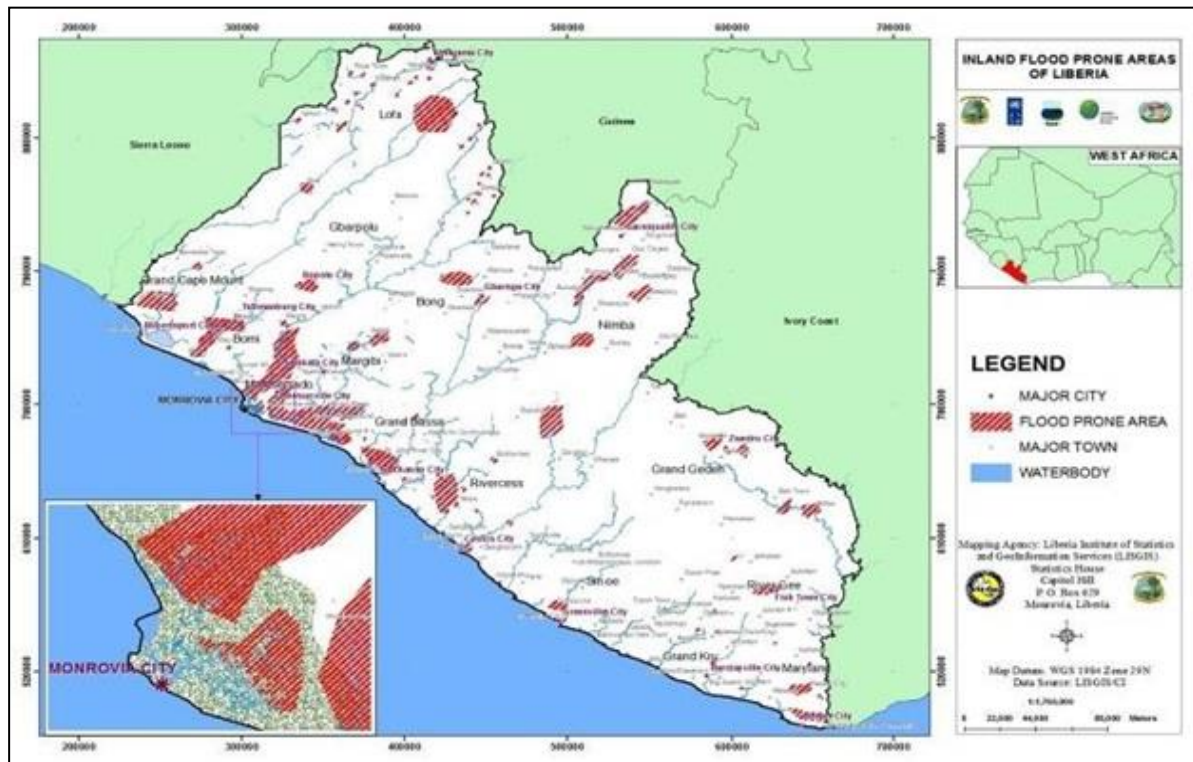


Figure 3 shows accounts for the elevation of rainfalls in Monrovia. However, the map indicates portion of rain records in Margibi County, near Monrovia. According to the EPA (2021) report, showing this map further explained that, "Flooding has affected 2,556 individuals in Margibi County, with Joe Blow Town being the most hit, with 1,596 people affected. Unification Town, Duwo Town, and Duazon were also damaged elsewhere in Margibi County."

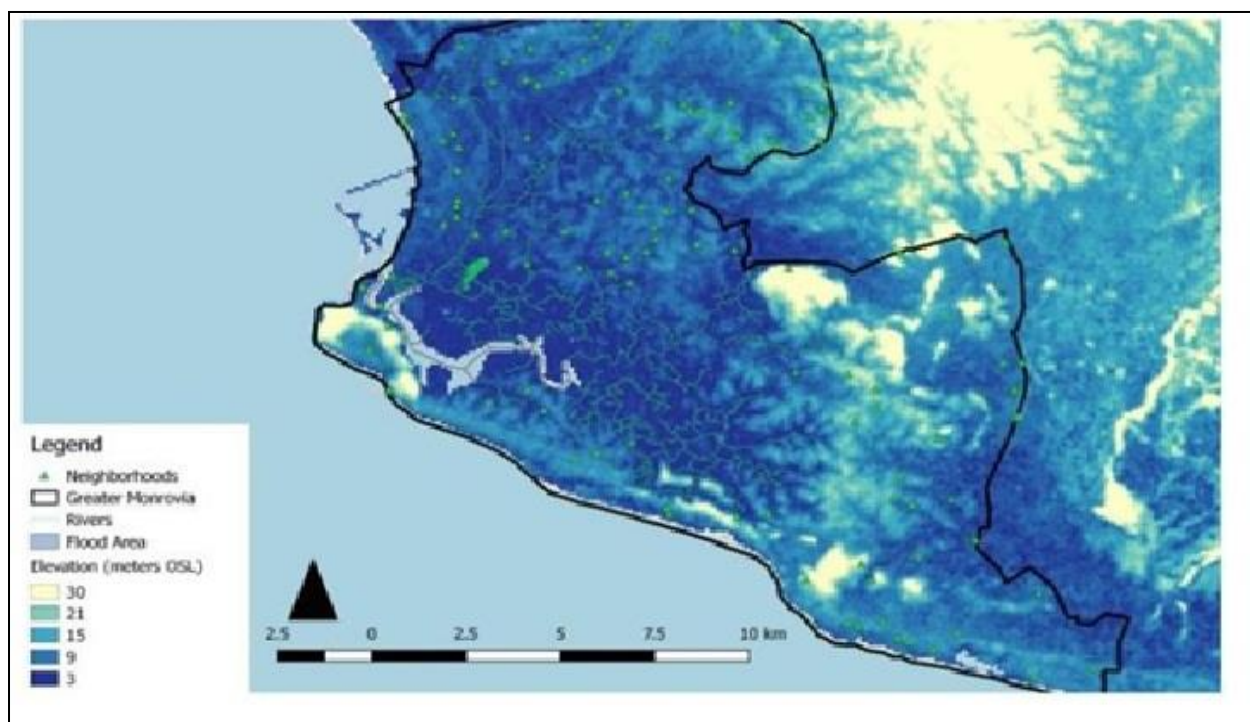


Table 1: Liberia flood reports, NDMA, 2018 (all affected communities are in Montserrado County)

Affected Community	# of person	Total male	Total female	Total children	Property damaged
West Point Kru Beach	289	126	70	98	10
New Kru Town	3000	1750	1250	2000	7
New Kru Town Point 4	350	105	70	175	10
New Kru town Popo Beach	187	59	45	83	6
New Kru Town Colonel West	500	196	112	252	40
New Kru Town Fundye	71	28	30	13	16
New Kru Town Bonis Bridge	3500	1400	875	1225	15
Caldwell Cheachepe Road Gemeve Community	2500	880	480	830	3
Caldwell Road Crab Hole Community	300	135	60	105	5
Caldwell Road Beyond Monoprix Supermarket	6000	2000	1250	1750	10
St. Paul Bridge Crab Hole	3000	1200	750	1050	N/A
St. Paul Bridge Whea Town	2500	875	500	1125	N/A
Total	27,948	8,754	5,492	8,712	122

Table 1 shows exactly those renowned areas that are flooded every rainy season. This Table further reveals the degree of casualty caused by flood, recording the number of persons (males and females) including children and the numbers of property damaged. Importantly, floods flooded Caldwell Road past the Monoprix shop, impacting 6000 people, whereas New Krun Town Fundye was the least impacted locality, with only 71 individuals affected.

5. Conclusion

Climate change poses a challenge to every location and ecosystem, displacing people and causing property harm. Climate change has affected almost every region of Liberia, causing floods and loss of water resources. However, a comprehensive study discovered that in order to address climate change, a government must prioritize the integration of adaption strategies into growth planning (OECD). The national climate adaptation strategy for Liberia is aimed at simulating the uncontrollable consequences of climate change on the country's wealth.

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