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Impact of Climate Change (CC) on Surface and Groundwater in Liberia

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Abstract - *Because of the increase in population growth, there has been an increase in floods. In Liberia, the floods remain unabated because of the heavy downpour of rain, no proper drainage and the construction of the building in the waterways. Because of this, CC is having a mass reaction on the sudden and long time period impacts on the surface water (SW) and the groundwater (GW) resources in Liberia. This may include floods, droughts, rise in the sea level, or sometimes the rivers dry up due to the change in the atmosphere which heats the land because of which the water dries along with the poor water quality in the SW and GW system because of the contamination, the precipitation and the disturbance in the water vapour pattern because of the distortion in the natural environment. When all these effects are compounded together will create a catastrophic impact on the ecosystem and the overall nature, ranging from the economic and the social impact to the health and food insecurity, which affects many areas in Liberia. Moreover, all these present issues are human-made, for instance, the emission of CO2, absorption of the oceans and the increase in precipitation.*

***Key Words*: Climate Change, Surface water, Groundwater, Liberia**

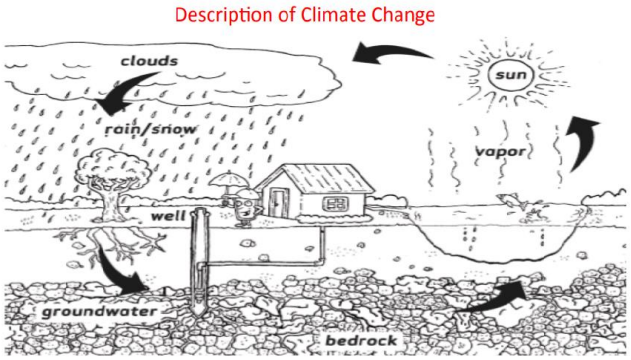
1. INTRODUCTION

The world is going through different problems and climate change is one of them. Climate change affected different things like groundwater, land, humans, and also other living organisms. In this competitive era where each country trying to compete with each other by improving its security system, more use of weapons, improving in economy and others. Different countries like the USA, UK, China, Japan, Singapore and others achieved a high level of growth but unfortunately, growth had also impacts on the environment (Leng et al., 2015). More use of weapons, carbon dioxide, technology, intensive use of water, deforestation and others have negative impacts on climate change which also weakened the ozone layer. Thus, different countries now facing the problem of climate change. Due to climate change different countries like India, Iran, Yemen, Qatar, Libya, Morocco, different African countries and other countries facing the problem of scarcity of clean water and natural resources. Domestic, agriculture, industrial sectors and humans increase the use of water worldwide which decrease the availability of clean water and increased different wasted materials from industries also impacted climate change which decreased the availability of natural resources. It can be seen that human activities heavily contribute to the emission of the generated greenhouses gases excluding the H20 vapour. Moreover, it can be said with the proof that the upset in the balance of the environment is caused by human activities. Moreover, increasing population is also cause of the impact on climate change because of dramatically heavy use of natural resources and other products by humans which polluted the environment (O'Neill et al., 2001). From past, it can be cleared that heavy use of chemicals and gases and deforestation change the climate which affected on groundwater and surface of the earth. The under-developed and developing countries are not only responsible for that problem but also different developed and powerful countries which dramatically increased the use of natural resources and also dangerous gases and chemicals. Climate change is the main issue of these problems like scarcity of clean water, erosion of land and other natural resources and climate change is affected due to worldwide increase of population and their interest.

Liberia is an under-developed country facing more problems due to changes in climate such as clean water, heavy rainfall, scarcity of natural resources and others. But this thesis is more focused on problems of groundwater and surface due to climate change in Liberia. Liberia is already in the phase of underdevelopment and has not much ability to respond to climate change effectively. Climate change not only affected natural resources but also decrease overall social and economic development. Already Liberia has low development and increasing population per year also impact on climate change and scarcity of natural resources. 25% population in Liberia facing the problem of water scarcity and almost 70% have water abundant but water is not in the condition of usage, though climate change seriously affected groundwater and surface of Liberia (Adaptation-undp.org, 2022). Since the civil war 1989-2003, the government of Liberia, international and national bodies working on climate change and its causes to better understand its impacts on the surface and groundwater in the world, especially in Liberia. Almost 75% population of Liberia depends upon the agriculture sector and the agriculture sector contribute about 61% of the GDP of the country in 2009. But for a few years, climate change seriously affected

agricultural land and decreased the production of foods. Heavy Rainfall also increased in Liberia and statistically about 5% per year chances of rainfall increase and rainfall impacts on land by different dangerous floods. Due to floods, agricultural lands became eroded eventually lands slowly decreasing soil quantity which decreasing crop production in Liberia (Wiles, D.L., 2005). If the government of Liberia does not resolve this climate issue then it lead to an increase in overall prices of production which may impact inflation which is already is high.

Liberia is considered to have abundant water resources as compared to different Sub-Saharan countries. Per capita of water availability in Liberia is 49,028 m^3 which is considered as third highest per capita of water as compared to Sub-Saharan countries, according to report of USAID report. Moreover, Liberia is considered one of the countries which face heavy rainfall so they have more water resources. Despite this, Liberia has fewer flows of dry seasons and due to less flow of the dry season, St. Paul River is unable to produce enough hydropower energy at the Mount Coffee Dam. Mount Coffee Dam is the largest source of hydropower energy in Monrovia – the capital of Liberia (Schroth et al., 2016). It is reported that artisanal and due to mining operations on large scale and uses of different chemicals by industries polluted land and also depletion of water resources. Thus, a poor system of sanitation and not much effective solid waste management in different cities of Liberia may have the risk of public health. Groundwater in Liberia is considered for high tables and the primary source of drinking water in both rural and urban areas. But due to unprotected wells and pit latrines, the groundwater becomes useless for use and different waste decrease pure water. Different chemicals, environmental factors and waste by humans made water contaminated which increased the serious risk of pure water scarcity. Thus, the health rate of Liberia is decreased due to these reasons. Thus, climate change increased overall water scarcity and groundwater problems. Each year Liberia is at risk of heavy rainfall and flood risks which increased the chances of waterborne diseases in urban areas – especially in informal sectors. Heavy rainfall increased sea level which become the reason for risky storms and the sudden increase of tides destroyed infrastructure, agricultural lands and create other problems for Liberians. Different departments, management entities don't have much effective coordination to manage these problems. They also don't have enough funds and limited technology to implement the Integrated Water Resources Management (IWRM) policy for the management of water resources (Schilling et al., 2020). But after the interruption of the World Bank, the responsible entities for water resource management were distributed in different ministries to resolve the problems. World Bank also recommended a ministry and water management body for increased coordination and link between different departments. Despite management and coordination of different entities, Liberia's government is unable to implement the IWRM policy because of a lack of funding. The impacts of low funding and technology increased the risk of floods, water degradation and pollution in different cities of Liberia – especially in Monrovia. Different governments and other international and national bodies working and helping the government of Liberia to resolve these problems such as World Bank, IMF and others (Nanda, V.P., 2021).



Source:https://meas.illinois.edu/wpcontent/uploads/2016/03/Greaves-Edmord-and-Kenneh-Aaron-2016 Presentation-Effects-of-Climate-Change-in-Liberia.pdf

1.1 Research Problem

Climate change has serious impacts on natural resources like land, water, forest and others. The competitive world competes with each other by using natural resources and different chemicals which increased problems of deforestation, water scarcity, degradation of water and erosion of lands. Different studies (Linnerooth-Bayer, and Mechler, 2015), (Shukla, 2019), (Zaman et al., 2016) focused on different problems related to climate change issues to developed and developing countries but none can discuss the country "Liberia" and the issues related to the climate change impact on the surface and groundwater.

1.2 Research Questions

What are the ways through which climate change impacts to surface and groundwater problems?

What are the ways through which government can manage and implement policies related to the impacts of climate change on surface and groundwater?

What are the factors through which surface and groundwater problems impact Liberia?

1.3 Significance of the Study

The main purpose of this study is to find out the factors that impact climate change on the surface and groundwater. Climate change occurs because of many factors like burning of the fossil fuels (oil and gas, coal) and many others. This in turn creates harmful gases which is the main cause of global warming. Because of this, there has been a projection of the melting of the ice. This sure will increase the sea level. Deforestation can be another factor of climate change since

forests are been cut down and buildings are been made in their place. Because of climate change, there can be flooding, which will affect the water quality since a large volume of water can carry contamination into the water which results in contaminating the water quality. The findings of this research will help in taking proactive measures in order to overcome climate change which will automatically reduce the groundwater system.

2. Literature Review

According to the researchers (Caney, S., 2015) and the policy-making body, it has been seriously recognized that the threat is created by the climate change in Liberia, as out of 10 people 7 are dependent on agriculture as it is their livelihood. Some of the past flooding experiences, a change in the rainfall patterns, rising temperature and some other climate changes are having a serious effect on the imputations for food safety but it may also have an impact on the health sector, education sector and some other development sectors. In accordance with these threats, the government has decided to build up a national policy and strategy centre which forecasts the CC issues which can help in coming up with the mitigation strategies in accordance with the development planning processes. This will comprise of the examining system which detects the changes in agricultural production.

It has been noted that the most prominent factor in climate change, which is thoroughly studied and have been brought to the notice by different researchers and scientists is related to the SW quality and quantity changes. Climate change is reported to have a direct effect on the soil, and hydrologic systems as the increase in the temperature, high evapotranspiration potential and great variation in the rainfall in terms of the timings, form and quantity which is expressed by increasing frequency of the extreme events as floods and drought. Less refill of the SW will be made clearer in semi-arid and arid regions as they have seen some predicted impacts which are already ignoring the climate variability, and thus the CC is expected to only intensify the current occurring trends (Hosseini et al., 2018).

The North-African countries are facing numerous environmental challenges which are a concern to the scarcity of water since the economic sectors or the agriculture is the most affected sector because of this present climate consideration. The current study has gone from arid to semi-arid CC which are been marked by the seasonal climatic variables. Since they are influenced by the Mediterranean climate, which is been moderately hot summers and sometimes there are cold winters, as rainfall decreases from the Atlas range (north) to the Sahara “Grand Erg of North Africa” platform (south). It has been noticed that the sea waves ranging from the height of 5 and 10 m have been recorded in the coastal region (Algeria, Tunisia, Spain and Portugal), sometimes snowstorms in the Atlantic region of North Africa which are higher than the 1000 m in the altitude and the windstorms having a speed of 150km/h in the desert region of the Erg Basin of northern Africa (Algeria, Tunisia and Libya) (Gosling et al.,2016).

2.1 Climate Change and Surface Water

It has been found that humic substances in the soil and the wetlands notably contributes to the CC by producing greenhouse gases. 81% of the organic carbon resources are used in degrading soil organic matter which results in increasing the CO2 emission from the soil. It is been shown that an increase in the 1°C temperature would result in the loss of 10% carbon in the area having the mean temperature of 5°C, but on the other hand, the loss of 3% is incurred were the same temperature increases since the mean temperature is around 30°C. So the important differences in the soil organic matter loss and carbon dioxide production are to be expected. In the natural environment, the carbon will enter the soil in little portions, which provides the substrate for the formation of the soil organic matter (Koopet al, .2017). As the amount of the humic substance in soil organic matter can be controlled by the HS production (intake of the plants to the animal waste) by the rate of the degradation. The degradation and the soil organic matter, both are temperature dependent. The change in the soil carbon storage in response to climate warming depends on the balancing they have with each other.

It is been acknowledged that Methane (CH4) is considered to be a greenhouse gas that has a global warming potential of around 28-36 times higher than carbon dioxide having a total of 100-year time scale. It has been seen that around 15% to 40% of the Methane comes from the wetlands, where the unicellular activity is different from the upland ecosystems (Lipczynska 2018). It is noticed that wetlands cover almost 6% of the Earth's total land surface. There are some temporary areas that are present between the land and water with not always well-defined boundaries. It is shown that they contribute about 12 % of the global carbon pool and they also play a significant role in the global carbon cycle.

The consequences of CC are very difficult to be predicted. It includes the rise in the sea level, increases in the emission of gases, maximum weather events, and changes in bioavailability and environmental stability. Moreover, it can be predicted that CC will overcome the existing freshwater problems. As we know that freshwater, which is considered a necessity for us contributes only about 2.5% of the water present on the Earth. As some of it is locked in the permafrost and 30% in the ground. The water on the surface, in the lakes and in the river, all together makes up a total of 1.2% of total freshwater (Kundzewicz et al., 2008). It has been seen that CC will raise the water cycle. Warming brings an increase in rainfall and extreme precipitation, including flash flooding. As some places will experience storm surges and longer droughts, there will be milder weather in other places. As an increase in the rainfall, CC is expected to have lower rainfall in those regions which are already dry. As per the estimation of IPCC, CC will be brought

in a situation where around one billion people belonging to the dry regions will bear the shortage of water.

Recent studies (Baranyi et al., 2015), (Barrios et al., 2019) and (López et al., 2014) have shown that the effects of humus on soil biodegradation have been extensively investigated. As a result, less attention has been paid to the effects of HS and CC on the oxidation and biodegradation of some organic pollutants present in freshwater ecosystems and sediments. Some of the findings of the study confirm that interactions with HS pollutants can reduce the toxicity of pollutants and their biodegradation. Global warming and changes in precipitation patterns are expected to change the fate and behaviour of some organic pollutants present in surface waters. Interactions between chemical reactions involving some of the dissolved organic matter and some of the microbial processes and their contaminants have been found to be stable at high temperatures. Climate change is also expected to have an effect on the transport and the redistribution pathways of the pollutants because the absorption processes are dependent on the temperature and because of this they are directly affected by climate change. Some more intense disasters like storms and rainfall and also flooding causes a release of pollutants which is stored in the snow and ice and as the result, it brings them back in the aquatic ecosystems (Du, Y et al.,2016). Dissolved organic matters have nutrients like N, P and Fe metals and also contain other pollutants, which are affecting their toxicity and bioaccumulation. In the altered environmental conditions, dissolved organic matters structure and its interaction with the contamination can change which leads to the release of the bound nutrients and pollutants, which includes the toxic free metal cations.

2.1 Climate Change and Groundwater

Beyond the direct effect of the CC which impacts the SW availability and its sustainability for utilisation, the evaluation for the climate varies, as the consequences on the GW resources is still complicated (Delpla, I et al.,2009). The impact of the drought on the hydrogeologic system is often tested in terms of the quantity and quality deterioration which depends on both the natural and the anthropogenic effects. Having a direct effect is related to the infiltration of the rainfall water, changes in the recharge conditions, and interaction with the SW while having indirect effects are considered to remove water from the storage and increase the pumping, which in turn affect the hydraulic connectivity, storage capacity and the compaction acceleration of the aquifer (De Wit et al., 2006). If we speak about the Mediterranean countries, those countries are directly linked to the exploitation of the subterranean water reservoir. So, the combined effect of the arid conditions and the CC leads to the increased deterioration of the groundwater resources, which are widely studied for many years in many regions.

For this purpose, there are exclusive tactics that are used within the assessment of the GW for unique use. Some of the past researches have proved that those waters are frequently not worthy for home use and rural activities. The growth within the exploitation of the saline and brackish water affects the growth which is the danger for the soil salinisation and alkalinization (Slama, F et al., 2020). As we've got a visible insight into the "Grand Erg" basin of North Africa (southern Tunisia and Algeria), the constant exploitation of the saline groundwater induces extreme soil degradation. Furthermore, it can additionally have an effect on the principle area that's without delay associated with the populace and the earnings of the agriculture with the aid of using reducing the yields and affecting vegetation first-class.

An increase in the salinity in the coastal aquifers which is mainly connected to their overexploitation exceeding the regenerative level of the reservoir includes another dimension to the problem of water quality degradation. Decreases in the piezometric level below the seawater level induce the continuous saline water intrusion from the sea and link it to the coastal aquifer. Since these highly mineralized resources found are considered to be unfit for the particular use. This phenomenon is highly expressed in Tunisia along the Mediterranean coast of the country which is present in the southeastern part (Gabe's Gulf) and also in the Cap Bon areas (Tunisia and Hamamet Gulfs) (Colombani, N et al., 2016).

3. Methodology

The research philosophy is based on positivism to satisfy the objectives of the study. The research approach is deductive as the study goes from general to specific. Descriptive methods research locates in the centre of the spectrum as the study incorporates the element of the qualitative descriptive approach (Scibek et al.,207). This study reflects the qualitative study which is based on descriptive nature as it describes the events and patterns of CC and its impact on the SW and the GW. Using descriptive qualitative data, the researcher describes the characteristics of CC and the impact of SW and GW in Liberia.

3. 1 Data Collection and Instruments

This study employs longitudinal data to explain the patterns of CC and its impact on the SW and GW. Data was collected through different sources, reports and published articles (Scibek et al.,207). In this study, the unit of the study consists of different variables such as patterns, heavy rainfall, weather trends in Liberia, safely managed water accessed by households. These all units of analysis were conducted in the Liberia province. This study focuses on the impact of climate change on the GW and the SW and the techniques which are used by the government in order to explain the trends and patterns related to climate change and the impact which is affected on the GW and SW.

In this study, the observational method was used in order to find the factors which shows the impact of climate change on surface and groundwater along with the different level of the data from the internet resource which includes studies from

Liberia where the behavior of certain events is observed and recorded (Ferguson et al.,2010).

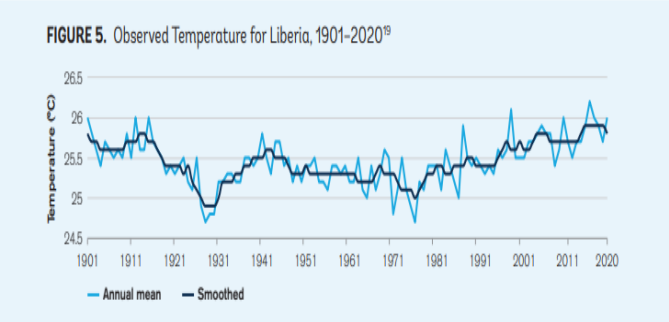
3. 1 Data Analysis

This study helps in analyzing the data trend within the period having descriptive research having non-statistical data. The data analysis was conducted using images and graphical representation. The data was analyzed in accordance with the period in order to find the impact of CC on SW and GW (Green, T.R et al., 2011). Moreover, the qualitative nature of this study shows that this study data is derived from the different internet resources which cover different factors in terms of water level.

4. Results

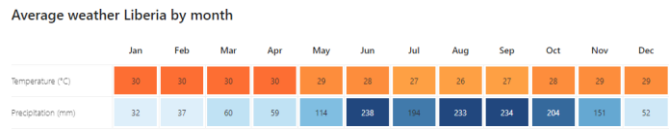
The researcher will be providing the descriptive statistics of the data which was gathered through online reports, articles and images which was used to observe the trend in the CC and its impact on the SW and GW in Liberia. This part contains a discussion of every single factor related to this specific study.

Temperature



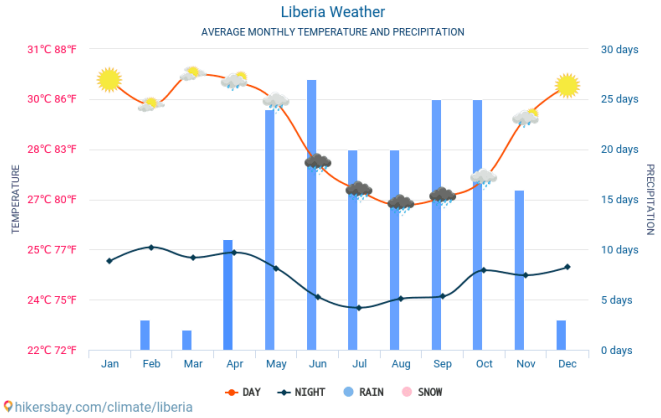
Source:https://climateknowledgeportal.worldbank.org/sites/default/files/202107/15917WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf

From the above picture, it can be seen that the annual temperature increases to 0.8 degrees centigrade between 1931 and 1975 which shows an average rate of 0.18 °C per decade (Climate knowledge e-portal 2022). On the other hand, other observations show that the average temperature from 1960 to 2006 was 0.10 degrees Celsius higher than before, and the average temperature per decade was 0.20 degrees Celsius. In addition, inland Liberia is warming faster than coastal areas.



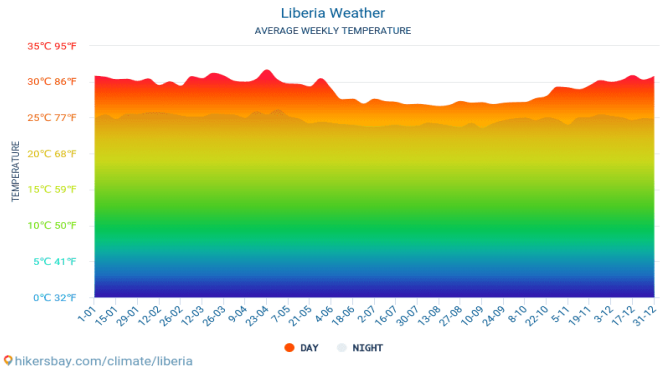
This chart here shows the total average of the temperature and precipitation for the whole year. In January, the temperature is 30°C and the total precipitation is 32mm. In March the temperature is 30°C but there is an increase in the precipitation which is around 60mm as compared to the last two months which were January and February. In May the temperature is 29°C but the precipitation increases to 114 mm. In June the temperature decreases to 28°C while the precipitation increases to 238mm. And from June onwards the temperature remains between 26°C to 30°C and the precipitation also varies in all the months.

Weather



Source:https://climateknowledgeportal.worldbank.org/sites/default/files/202107/15917WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf

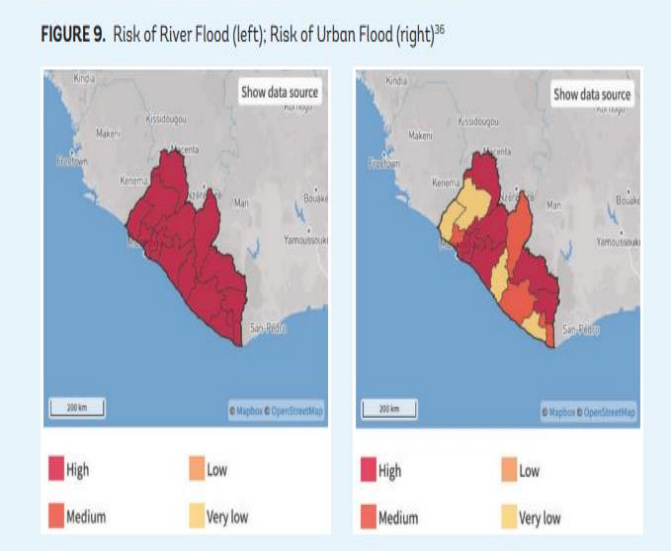
From the above graphical representation, it can be seen that the weather of Liberia have a variety in the climate change, as it can be seen that there has been heavy rainfall in the month of May, June, September, October. In addition, Liberia's annual temperature is recorded as a highlighted monthly temperature of 25.7 ° C, which exceeds 30 ° C from January to December. Due to the lack of daily temperature trend data for all weather patterns, the average hot night temperature increased by 60 years from 1960 to 2003, and the cold nights in Liberia decreased slightly. The number of days in a year. This is because the rate of change is highlighted in June and September (Manogaran et al., 2018).



Source:https://climateknowledgeportal.worldbank.org/sites/default/files/202107/15917WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf

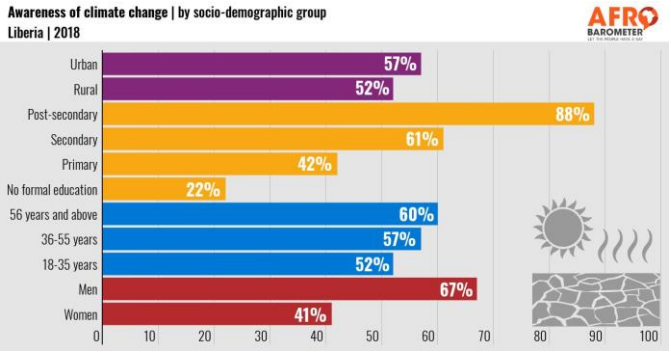
The graphical visual shows that the duration of the daytime in Liberia does not have any frequent impact over the year by just remaining only 44 minutes in a total of 12 hours overall. Moreover, it has been noticed that the shortest day in Liberia is the 21st of December which have a total of eleven hours and thirty minutes of daylight while the longest day in Liberia is 20th June which have 12 hours and 45 minutes of total daylight.

The climate of Liberia is usually tropical and hot, with a year-round rainy season from May to October due to the African monsoon, so other months as well, except for the short dry season that occurs between December and October. It rains quite often. On the other hand, February will be more prominent in the north (Wiles, D.L., 2005). Rainfall from coastal routes exceeds about 3000 mm, which is about 118 inches per year. On the northern coast of Monrovia, on the other hand, annual rainfall reaches up to 5 meters (16.5 feet). In addition, rainfall is usually low, mostly less than 2000 mm in some areas, and equivalent to 79 inches per year. Speaking of winter, it rarely rains in the northern part of from December to February, but it can rain, so there is plenty of sunshine. Speaking of temperature, it is about 30/32 ° C (86/90 ° F) during the day, and the coastal and inland forests are humid. However, in most cases, dry winds could fill the atmosphere with dust, blowing Harmattan out of Sahara. In some hills and peaks, Mt. Wuteve is the highest at around 1440 meters and can be chilly at night or a little cold at night. During March and April, there is an increase in the temperature, and the showers become more frequent within that period (Broderick, C.E., 1995). As sometimes it gets very hot and sometimes the temperature rises to 40°C (104°F). When the real monsoon arrives in May and heavy rain falls on the shore. Cloud coverage often increases from October, with daytime temperatures dropping to 30 ° C (86 ° F). In mid-July and August, the rain front shifts north. This means that precipitation will be significantly reduced compared to in the south. The past few months have rained in November, with a slight decrease in compared to the other months. However, temperatures have risen slightly throughout the day due to the persistence of sunlight, which can reach 30 ° C (86 ° F).



Source:https://climateknowledgeportal.worldbank.org/sites/default/files/202107/15917WB_Liberia%20Country%20Profile-WEB%20%281%29.pdf

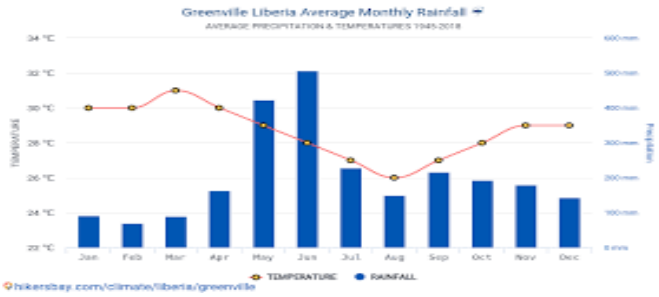
In the above-given map, it can be seen that there has an alert situation in the whole country since the whole country will be experiencing a high river flood which will affect the groundwater plus it will be a great threat to human life as it is occurring in the year. As it is further seen that Liberia is on the worth of facing a highly risky urban flood and the coastal flooding will affect the sea level forcing it to increase. Moreover, the visual representation also shows that the population densities like Monrovia and the coastal zone will face an overlapping because of the flood zones having high vulnerability.



Source: https://afrobarometer.org/publications/ad268-climate-change-making-life-worse-liberia-only-half-citizens-have-heard-it

From the above graph, it can be seen that 57% population of Liberia lives in the urban region while, on the other hand, 52% of the population lives in the rural region. On the other hand, about 88% of the population has the education to till the post-secondary level. On the other hand, 61% of the population has education till secondary level. 42% population has primary education while 22% does not have

any formal education. About 52% population age ranges between 18-35 years. While 57% have the age between 36-55 years and 60% have ages ranging from 56 years and above (Witinok et al., 2021). The gender part shows that 41% population belongs to women while 67% population belongs to men.



Source:http://hikersbay.com/climateconditions/liberia/greenville/climate-conditions-in-greenville.html?lang=en

The above graph shows the average rainfall and temperature of Liberia from the year 1990 to 2012. It can be seen that in Jan the average rainfall was very low. In February it increased a little bit. In May, it went to above 200 mm and in June it further increased coming close to 400mm. In July, there was a slight decrease as compared to June (Greenville, 2022). In August, it increases a little bit as compared to July. But in September, It reached 400mm. And in December, it decreased. On the other hand, if we talk about the temperature, there have been an up and down in the graph. The temperature was above 25 degrees centigrade in January. Consequently, it peaked at 27 degrees centigrade in March. In August, it dropped to 24-degree centigrade and in November it again rises close to 26-degree centigrade and in December it drops to below 26 degrees centigrade and close to 25 degrees centigrade (Greenville, 2022).

5. CONCLUSIONS

In the end, it can be concluded that climate change (CC) is an important region of science which have been in focus and studied for many years. The climate change in Liberia has a great impact on the SW and the GW in many of the African countries. Some of these impacts include the contamination of the water, burning of fossil fuels, flooding, the unexpected rise in the sea level, droughts in the land creating problems in the surface and groundwater network.

The overall impact of these factors will have devastating effects on surfaces and ecosystems, resulting from health and anxiety, and social ecosystems such as water pollution and rising temperatures and climates, threatening Liberia. The fossil fuel records taught us the most about the situation on Earth long before humanity arrived. They are now living in an exclusive era where their scientific skills not only provided them with the exact age according to the Earth, the world itself. Livelihood individuals live on food, which is characterized by climate-dependent growth and vegetation. As a result, erratic changes (ECs) in climate endanger billions of lives. But it is of utmost importance that they talk about it, monitor it and ensure that the climate in different regions remains at natural levels. The literature suggests that global warming (GW) is caused by the extreme emissions of GW gas from advanced companies and the automotive sector is the cause of EC. If unchecked, GW will drive the Earth's climate towards the goal of achieving the goal of tilting the Earth, where the surviving Earth could not sustain life, and by mass extinction the species in the Earth. Change the route of history that progresses through. It is the responsibility of all international people to be aware of this and come up with successful solutions together to mitigate the problem, as minor negligence can result in higher costs later. Not listening to this immediate international call is a serious mistake. That's because it may destroy or build your future group.CC and its impact on the SW and the GW are considered to be the study for the global developments since it will be getting attention from all over the world. If the analyzed impact of the contaminated water and other factor are been checked to ensure that the overall ecology system remains proper to balance the nature and human nature in Liberia as focusing on the CC and its impact on the SW and the GW.

Recommendations

Based on the findings of the research, it can be concluded:

1. The government of Liberia needs to reduce wastage and control the greenhouse gases which are damaging our atmosphere.
2. Moreover, the government and the citizen should come up with strategies to reduce the toxic gases from the factories and the industries.
3. The toxic material or the waste from the factories and industries should be dumped properly in order to protect the water and the land to become contaminated.
4. Proper filtration of the water should be made in order to control the environmental problems.

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