GOVERNMENT OF LIBERIA

COUNTY CLIMATE CHANGE BASELINE REPORT

BOMI COUNTY

2024

EXECUTIVE SUMMARY

Liberia, situated in West Africa, borders the North Atlantic Ocean and three neighboring countries: Guinea, Sierra Leone, and Ivory Coast. It covers 111,369 square kilometers, divided into 15 counties with various districts and clans. With a population of 5.2 million and a primarily agricultural economy, Liberia faces challenges due to climate change, exacerbated by its coastal vulnerability and reliance on climate-sensitive sectors. Climate change particularly impacts agriculture, fishing, mining, and forestry sectors.

This climate change baseline report for Bomi County employed a mixed-method approach, including a literature review, focus group discussions, and key informant interviews, targeting individuals from different sectors at the county level. Climate data analysis utilized information from the Climate Change Knowledge Portal and the Coupled Model Intercomparison Project. Also, hazard information and data were acquired from ThinkHarzard!

Bomi has experienced a significant increase in population over the years, rising from 1,942 in 1984 to 84,119 in 2022. As a result, it is now the eleventh most populous county in the country. Bomi's livelihood includes small-scale rubber production, farming, small businesses, and artisanal diamond mining. Currently, iron ore mining by Western Cluster Liberia Limited also contributes to the economy. Despite these developments, poverty remains a significant challenge, with 64% of the population living below the poverty line. Employment opportunities are mainly in agriculture, with some involvement in mining and services. The migration trend in Bomi shows that young people move to urban centers such as Monrovia, influenced by economic opportunities. Bomi's cultural landscape is rich, with deep-rooted traditions such as storytelling, traditional dances, and rites of passage. Bomi's ethnic diversity comprises many groups, such as Gola, Dei, Mandinka, and Kpelle, each with its own language and cultural practices.

Bomi's geography consists mainly of hills, plains, and valleys, with abundant water resources from rivers like Po, Wlein, Mahei, Bomi, and St. Paul, which are suitable for hydroelectric generation. The county has electricity in some parts, though energy access remains limited, with initiatives underway to improve electrification, especially in rural communities outside the capital. The county's sandy clay soil supports agriculture, with approximately 45% of the land covered by grassland. Bomi is known for its mineral wealth, including iron, diamonds, and gold, with the Bomi Hills Iron Mine being historically significant. The region is part of the Upper Guinea rainforests, hosting diverse biodiversity threatened by human activities like logging and mining. The Blue Lake provides hope for tourism.

Agricultural activities, mainly rice, oil palm, and rubber cultivation, contribute to the local economy, though challenges like governance and infrastructure hinder development. Bomi faces environmental challenges like deforestation and soil degradation, necessitating conservation efforts and sustainable land use practices.

In Bomi County, the temperatures remain consistently high throughout the year, with slight seasonal fluctuations. The climatic conditions of the county analyzed from 1991-2020, revealed trends in temperature and precipitation variability. The results show fluctuations in surface air temperatures and precipitation across the seasons, with notable increases observed in some parameters over the years.

Bomi, with a tropical monsoon climate, experiences distinct wet and dry seasons influenced by the West African Monsoon. Notably, the warmest month is May, with an average minimum temperature of 22.3°C, while January is the coldest, averaging 20.39°C. Precipitation varies significantly, with the lowest in January (24.96mm) and the highest in September (558.17mm). The county's weather patterns feature varying degrees of sunshine, partly cloudy days, and precipitation, impacting sectors like agriculture and fisheries. Risk assessments using ThinkHazard! revealed high vulnerability to river floods and wildfires, with medium risks of urban and coastal floods and extreme heat. Climate change impacts are expected to worsen food insecurity in Bomi, particularly affecting agricultural yields due to erratic rainfall and salinity increases in freshwater aquifers. Fisheries face similar risks, with climate-induced changes affecting productivity and exacerbating food insecurity in the county.

The Government of Liberia (GoL) acknowledges climate change challenges affecting livelihoods, particularly among vulnerable communities, and has integrated climate concerns into its development agenda. Various policies and frameworks have been established, such as the Nationally Determined Contributions (NDCs), the National Policy and Response Strategy on Climate Change, and the National Disaster Management Policy, amongst others, to address climate impacts and promote adaptation and mitigation measures. However, at the county level, Bomi lacks specific policies to address climate risks, relying instead on national frameworks.

At the national level, the institutional arrangements for climate coordination include the National Climate Change Steering Committee, the Climate Change Secretariat, and the Environmental Sector Working Group. Governance structures at the county level, outlined in the Local Government Act of 2018, involve regional, intermediate, and municipal levels, each with appointed leaders overseeing different sectors and sub-sectors. However, the implementation of these structures remains incomplete. Simply put, there is no climate change committee at the county level.

It is crucial to tackle climate change and its effects at the county level, and it should be integrated into the county's development agenda. In addition, measures must be taken to ensure reforestation, enforce laws against illegal logging, promote conservation education, invest in renewable energy, reform policies, and support value addition in key sectors to encourage sustainable development in Bomi County.

ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviation	Definition
°C	Degree Celsius
°F	Degree Fahrenheit
CBOs	Community-Based Organizations
CDA	County Development Agenda
CO	Carbon Monoxide
CO_2	Carbon dioxide
CSOs	Civil Society Organizations
ECE	Early Childhood Education
EPA	Environmental Protection Agency
FGDs	Focus Group Discussions
FTI	Forestry Training Institute
GDP	Gross Domestic Product
GFDDR	Global Facility for Disaster Risk Reduction and Recovery
Gg	Gigagrams
GHG	Green House Gas
GPE	Global Partnership for Education
Ha	hectares
IPCC	Intergovernmental Panel on Climate Change
IWI	International Wealth Index
Km	Kilometer
Km^2	Square Kilometer
LISGIS	Liberia Institute of Statistics and Geo-Information Services
LMICs	low- and middle-income countries
Mm	Millimeter
MoA	Ministry of Agriculture
MoE	Ministry of Education
MW	MegaWatts
NAP	National Adaptation Plan
NBSAP	National Biodiversity Strategy and Action Plan
NCCSC	National Climate Change Steering Committee
NDC	Nationally Determined Contributions
NGOs	Non-Governmental Organizations
NO_2	Nitrogen Dioxide
NPHC	National Population and Housing Census
NTFPs	Non-Timber Forest Products
O_3	Ozone
PI	Principal Investigator
PM 2.5	Particulate matter less than 2.5 microns
PM10	Particulate matter less than 10 microns
SO_2	Sulphur Dioxide
SLCP	Short-Lived Climate Pollutant
Sq. mi	Square Miles
UNFCCC	United Nations Framework Convention on Climate Change
UN-HDI	United Nations Human Development Index

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1. INTRODUCTION

1.1 NATIONAL CONTEXT

Liberia is a sub-Saharan nation in West Africa, located at 6°30′N 9°30′W. It borders the North Atlantic Ocean to the southwest and three other African nations on the other three sides: Sierra Leone to the northwest, Guinea to the northeast, and Ivory Coast to the east. The country comprises 111,369 square kilometers (43,000 sq. mi), with 96,300 sq. mi being land and 15,000 sq. mi water. Liberia's physical geography is roughly rectangular, measuring about 510 km (317 mi) in length from northwest to southeast. The coastline is about 680 km (423 mi), including river mouths and inlets up to one kilometer wide. The drainage of the whole country is direct to the sea, with a series of short rivers flowing directly into the sea.

Liberia is divided into a hierarchical arrangement of political jurisdictions consisting of 15 counties (each with a designated county seat), 136 districts arrayed within counties, and numerous clans arrayed within districts. Individual counties comprise from 4-18 districts and varying numbers of clans **(See Figure 1, the Map of Liberia showing various counties)**.

Figure 1: Map of Liberia Showing the 15 counties

Liberia has a population of 5.2 million and a growth rate of 3.0 (LISGIS, 2022). The population was about 5 million people as of 2020, with a growth rate of 2.4% (2019)[1]. In 2021, arable land as a share of land area for Liberia was 5.2 %. Arable land as a share of land area of Liberia increased from 3.8 % in 1972 to 5.2 % in 2021 growing at an average annual rate of 0.68%[2].

Land use in Liberia is mainly agricultural. Liberia has an area of 11,137 thousand hectares. The inland water is 1,505 thousand hectares and the other land is 122 thousand hectares. The total area equipped for irrigation is 3,000 hectares, and the surface area is 111,370 sq. km. The land area is 96,320 sq. km and forest area consists of about 75,872 sq. km and the forest area as a share of land area is 78.8 %. The Agricultural land, as a share of land area, is 20 %, while permanent cropland, as a share of land area, is 2.1 %[3].

The country's GDP is dominated by the agriculture sector (inclusive of fishing and forestry), which accounts for 34.2% of GDP, and the industry sector (including mining, construction, electricity, water, and gas), which contributes 12.2% of GDP[4].

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[1] World Bank Group-Climate Knowledge Portal: URL: https://climateknowledgeportal.worldbank.org/country/liberia

[2] World Data Atlas. (2023). Liberia Arable land as a share of land area, 1960-2023. Accessed at: https://knoema.com/atlas/Liberia/topics/Land-Use/Area/Arable-land-as-a-share-of-land-area

Arable land includes land defined by the FAO as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded.

[3] ibid

[4] World Bank Group-Climate Knowledge Portal: URL: https://climateknowledgeportal.worldbank.org/country/liberia

Liberia is highly vulnerable to adverse effects of climate change and environmental instability due to extreme poverty and high dependence on 'climate-sensitive' sectors such as agriculture, forestry, and fishing[5]. The low coastal belt is about 40 kilometers wide and constitutes tidal creeks, shallow lagoons, and mangrove marshes[6]. Climate projections for Liberia highlight increased frequency/intensity of extreme weather events, sea level rise, and increased temperature.

Liberia is situated in the center of the Upper Guinea Rainforest Region along the West Coast of Africa, which was originally covered by continuous, dense tropical rainforest, ranging from Guinea south through to Ghana. The region has a predominantly equatorial climate with three distinct topographical belts. Liberia has made significant economic and development progress since the end of its civil war in 2003. However, the country remains fragile and highly vulnerable due to several factors including high levels of inequality, unemployment, and poverty, with limited access to basic services such as water, sanitation, and energy.

1.2   METHODOLOGY

The study employed a mixed method, including Focus Group Discussions (FGD), Key Informant Interviews (KII), and observations, all at the county level. The selection of the participants for the FGD was based on various criteria, such as understanding or working in any of the nine (9) Nationally Determined Contributions (NDC) sectors – Transport, Waste, Energy, Forestry, Agriculture, Coastal Zones, Fisheries, Health, and Industry, etc. and having a history of the impact of climate change in the county.

For this study, a purposive non-probability sampling method was employed, and 20 participants (n=20) were identified for the FGD in the county. Participants were selected from different NDC sectors within the county to gather their understanding and knowledge of how climate change affects the county. These participants were selected based on their work, knowledge and experience in the sector. Questionnaires were developed and used consisting mainly of open-ended questions. The questionnaires of the FGD were analyzed through content analysis.

For the KII, several participants (n= 45) from various sectors and the communities at the county level were interviewed to gather their perceptions. The participants were drawn from the county authorities (superintendents, commissioners, city majors, town chief, etc.), government institutions in the county, non-governmental organizations (NGOs), Civil Society Organizations (CSOs), Community Based Organizations (CBOs), academia (community college, university or vocation institutions), prominent citizens, etc. Both opened and closed ended questions were developed using KoboCollect, to which the participants responded. The data and information were analyzed using tables, pie charts, and bar charts to display the responses to the questions asked.

For the climate information analysis (see **Chapter 4**), the data used was obtained from the Climate change Knowledge Portal[7]. Modeled climate data is derived from the Coupled Model Intercomparison Project, Phase 6 (CMIP6,). The CMIP efforts are overseen by the World Climate Research Program. CMIP6 is the foundational data used to present global climate change projections presented in the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC). CMIP6 relies on the Shared Socioeconomic Pathways (SSPs), which represent possible societal development and policy scenarios for meeting designated radiative forcing (W/m2) by the end of the century.

CMIP is a standard framework for the analysis of coupled atmosphere-ocean general circulation models (GCMs) providing projections of future temperature and precipitation according to designated scenarios. CMIP6 projections are shown through five shared socioeconomic pathway (SSP) scenarios defined by their total radiative forcing (a cumulative measure of GHG emissions from all sources) pathway and level by 2100.

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[5] ibid

[6] World Bank Group: Liberia Climate Risk Profile

[7] The site for Liberia can be assessed at https://climateknowledgeportal.worldbank.org/country/liberia.

2. COUNTY CONTEXT

2.1 DEMOGRAPHIC AND SOCIOECONOMIC ANALYSIS

2.1.1 Population

Over the years, Bomi County has experienced a notable increase in population as shown in the census data. The population of Bomi has grown from 1,942 people in 1984 to 84,119 in 2022 (refer to **Figure 2** for population trends of Bomi County), making it the eleventh most populous county in Liberia[8]. As of 2020, the county had a population density of 222 persons per square mile. Bomi has a 2.5 Percentage share of Liberia's population and there are more males than females in the county. As a small county[9], Bomi has the lowest population per household (3.5).
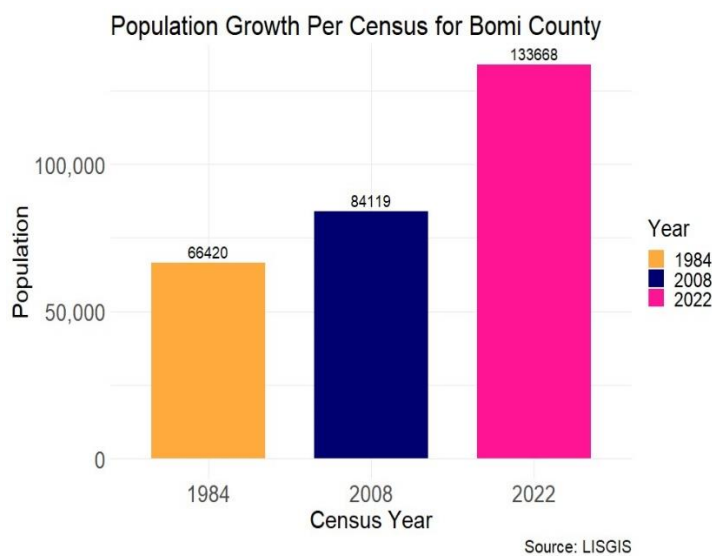
Figure 2: Population Growth and Trends for Bomi County, Liberia. Source data: LISGIS (2022)

2.1.2 EDUCATION[10]

The Government of Liberia, through the Ministry of Education (MoE), is responsible for the educational system in the country. MoE, in partnership with the Global Partnership for Education (GPE) and the World Bank, has recently implemented the Getting to Best in Education (G2B) Project to address challenges in the education system in Bomi County. The partnership was focused on improving access to quality early learning,

training and certifying teachers, reducing Early Childhood Education (ECE) fees, and enhancing equitable access to ECE in targeted counties.

According to the Liberia Education Statistics Report 2019-2020, in Bomi County, a total of 39,441 students are distributed across various education levels. ECE and Primary education comprise the majority, constituting approximately 46.4% (18,266 students) and 41.5% (16,409 students) of the total student population, respectively. Junior Secondary Education (JSE) and Senior Secondary Education (SSE) account for 7.8% (3,092 students) and 3.6% (1,435 students), respectively, reflecting a natural decline in student numbers as they progress through the education system. The Technical and Vocational Education and Training (TVET) program has a smaller share at 0.6% (226 students), and the Accelerated Learning Program (ALP) is the least represented, making up just 0.03% (13 students) of the total student population. This distribution shows a focus on foundational education, with room for potential enhancements in secondary education and vocational training opportunities in Bomi County.

The Forestry Training Institute (FTI) is a tertiary institution that is responsible for training middle-level technicians in sustainable forest management and biodiversity conservation. It was founded in 1976 by the Mano River Union (MRU) and is situated in Tubmanburg. At FTI offers both two-year and one-year programs in different concentrations[11].

Bomi Community College (BCC) is a public institution of higher learning that was established by an Act of Legislature on September 19, 2012. It is located in Tubmanburg City and has a mandate to provide co-educational teaching, learning, and research services within the Western Region of Liberia, which includes Bomi, Grand Cape Mount, Gbarpolu, and Rural Montserrado Counties. BCC offers Associate of Arts degrees in a few disciplines, as well as certification in TVET with a specialization in masonry, plumbing, and carpentry. Additionally, BCC offers a 'C' Certificate

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[8] LISGIS. (2017). Household Income and Expenditure Survey 2016: Statistical Abstract. Liberia Institute of Statistics & Geo-Information Services, Liberia.

[9] As per the 2022 census, small counties are those with a population of less than 150,000,

[10] Liberia Education Statistics Report 2019-2020

[11] https://www.ftiliberia.org/

extension program in teacher-training education that is available in Bopolu, Gbarpolu County.

2.1.3   LIVELIHOOD AND ECONOMIC ACTIVITIES

The livelihood system in Bomi involves small-scale private rubber producers, smallholder rice production, and artisanal diamond mining. These livelihoods are essential for many farm families in the area, and they are using these resources to secure access to food and income.

Western Cluster Liberia Limited, has been given the go-ahead by the Liberian government to mine the Western Cluster iron ore deposits located in Bomi Hills, Bea Mountain, and Mano River. The company is said to be providing some jobs and boasting economic activities in the county. Monrovia– Tubmanburg–Mano River corridor serving the Western Cluster deposits at Bomi.

Bomi's resources in diamond, rubber, timber, iron ore, gold, water, stone, sand, and fertile agricultural land and given the expansion of mining and designation of specific areas for industrial or economic development, have attracted people from other parts of the county to come in bigger towns like Tubmanburg areas to settle in semi-urban areas.

Bomi has a rich history of iron ore mining, rubber production, timber industry, agriculture, and natural resource extraction. The county was the first to host iron ore mining in the 1950s, contributing significantly

to the local economy. The county's contribution to the forestry and agriculture industries, including crop cultivation and livestock rearing, is vital for the local economy and livelihoods. Additionally, the county is known for extracting diamonds and gold, further contributing to the region's economic activities.

2.1.4   POVERTY ANALYSIS

Liberia remains one of the poorest countries in the world, ranking 178 out of 191 countries and territories on the United Nations Human Development Index (UN-HDI). An estimated 64 percent of Liberians live below the poverty line, of whom 1.3 million live in extreme poverty[12]. The highest level of poverty is found among

households headed by elderly persons (60+)[13]. Like many other counties in Liberia, Bomi County has a significant amount of its population who are considered poor and live below the poverty line. Bomi County is overwhelmingly poor with a poverty rate of 64% (2016).

2.1.5   EMPLOYMENT AND URBANIZATION PATTERNS

Liberia is urbanizing, with an urban population of 54.5% and a rural of 45.5%. Urbanization is seen mainly in Margibi, Maryland, and Montserrado. In 2022, Liberia's unemployment rate remained steady at 3.63 percent, marking the second consecutive decline in the country's unemployment rate[14]. Liberia is a fragile, low-income country of 5.2 million[15].

Bomi has a 25.6% urban and 74.4% rural population, respectively. Bomi has a 2.2 percentage share of the working population aged 5 years. Bomi has a predominantly agricultural economy, with a significant portion of the population engaged in subsistence farming. In Bomi, 32 % of households engaged in agriculture and the county holds 3.4% share of Liberia's agricultural households

The mining sector, particularly iron ore, has historically been an essential part of the county's economy, contributing to national development. Other sectors, such as forestry and rubber, also play a role in the county's employment sector. population shifts have been seen along current economic corridors, including the Monrovia–Tubmanburg,

A portion of the population in Bomi is engaged in subsistence agriculture, and significant amount of them have low incomes. In urban centers, income sources can include activities in the services, trade, and informal sectors. The county has significant natural resources, including iron ore, and timber, but the management of these resources and their contribution to the economy have faced challenges.

As per LISGIS (2017), in Bomi County, 39.1% of women and 64.3% of men aged 15-49 were employed in the agriculture sector (12 months preceding the survey). Thus, 49.6% of the women are in sales and

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[12] World Food Program (WFP). Liberia Programme (2013–2018).

[13] International Monetary Fund. Liberia: Poverty Reduction and Growth Strategy. URL:

https://www.elibrary.imf.org/view/journals/002/2021/010/002.2021.issue-010-en.xml

[14] Statista: Liberia: Unemployment rate from 2003 to 2022

[15] International Monetary Fund. African Dept.

services. Of the total number of farming households in Bomi County (12 498), the number of farming households engaged in cash crop production include Cocoa (137), Coffee (NA), Oil Palm (307), Rubber (1187), and Sugar Cane (204). Also, the number of farming households engaged in fruit production, Banana (640), Papaw/Papaya (294), Pineapple (626), and Plantain (891). Furthermore, households in Bomi County are engaged in vegetable production, including Bitterballs (4837), Cucumber (1837), eggplant (2050), Okra (3324), Pepper (4787), and Pumpkins (1675). Processing and selling palm nuts is a crucial source of income and also serves as a coping strategy across Liberia, but it is exceptionally high in Bomi (27%)[16] . Processing and selling palm nuts is a crucial source of income and also serves as a coping strategy across Liberia, but it is exceptionally high in Bomi (37%) and Bomi (27%).

Bomi, a county close to Monrovia, sees many youths migrate to the capital in search of better opportunities. Migration patterns are influenced by factors such as economic opportunities, education, health services, conflict, and the environment. Urbanization trends have seen people move from rural areas to more urbanized locations. The demographic landscape has also been impacted by post-conflict resettlement and the return of refugees.

2.1.6 CULTURAL AND RELIGIOUS ANALYSIS

The religion of Bomi County can be roughly sub-divided into two groups: Christians, estimated at 40% of the population, and Muslims, estimated at 60% [17] . Traditions and customs in Bomi County are deeply rooted in the daily lives of its people. These include various social and cultural practices, such as storytelling, traditional dances, and music that have been passed down through generations. Storytelling is an integral part of the cultural fabric, often used to impart moral lessons and preserve history. Basao Cultural Village in Bomi is a major institution that helps train, guide, develop, and protect the Liberian cultural heritage.

Cultural practices also extend to rites of passage, which mark important life events such as birth, initiation, marriage, and death. For example, traditional initiation societies like Poro (for men) and Sande (for women) play significant roles in the upbringing of young boys and girls, teaching them societal values, knowledge, and skills necessary for adulthood.

Festivals and celebrations are another important aspect of the cultural life in Bomi County. These events often involve traditional music, dance, and food, serving as a way to celebrate harvests, religious beliefs, and historical events. Such festivities provide an opportunity for community members to strengthen bonds and express their cultural identity.

Bomi County is also known for its craftsmanship, particularly in the areas of wood carving, weaving, and pottery. Artisans create masks, sculptures, and other items that are significant in cultural rituals or for everyday use. These crafts are not only a reflection of the artistic heritage but also serve as a source of income for many local families.

The cultural aspects of Bomi County are crucial for the identity and cohesion of the local community. They foster a sense of belonging and continuity, providing a link between past, present, and future generations. Cultural practices and traditional knowledge contribute to the social fabric and are considered invaluable in guiding behavior and maintaining social order. Efforts are underway in Bomi County to preserve cultural heritage by documenting and promoting traditional practices, supporting local artisans, and encouraging cultural exchanges. This not only honors ancestors but also enriches Liberia's cultural landscape.

2.1.7 ETHNIC DIVERSITY

Bomi's principal ethnic groups are Gola, Dei, Mandinka, and Kpelle, although all sixteen of Liberia's main ethnic groups (Dey, Gola, Gio, Vai, Kpelle, Mende, Bassa, Gbee, Grebo, Kru, Krahn, Mandingo, Sapo, Loma, Kissi, and Gbandi) are thought to be residing in the county[18]. The Golas are in the majority, followed closely by the Vai and the Kpelle, who are mainly settled in the boundary region between Bomi and Gbarpolu. The Mandingo are found under various Clans. Each ethnic

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[16] Comprehensive Assessment of the Agriculture Sector in Liberia (CAAS-Lib)

[17] Bomi County Development Agenda

[18] The Bomi County Development Agenda, Republic of Liberia, 2008 – 2012

group has its own language, but English remains the official language of Liberia and is used for education and government. In informal settings, however, people often speak their native tongues, and Liberian English, a colloquial, is widely spoken throughout the county.

3. GEOGRAPHY, ENVIRONMENT AND ECONOMIC DEVELOPMENT

3.1 GEOGRAPHY

Bomi County is situated in the Northwestern region of Liberia and bordered by Gbarpolu County in the North, Grand Cape Mount County in the West, Montserrado County in the East, and the Atlantic Ocean in the South. The capital city is Tubmanburg. There are four Administrative Districts (Klay, Dewien, Suehn Mecca, and Senjeh), comprising five Chiefdoms and 18 Clans (As shown in **Figure 3**). Bomi County has an area of 755 square miles.
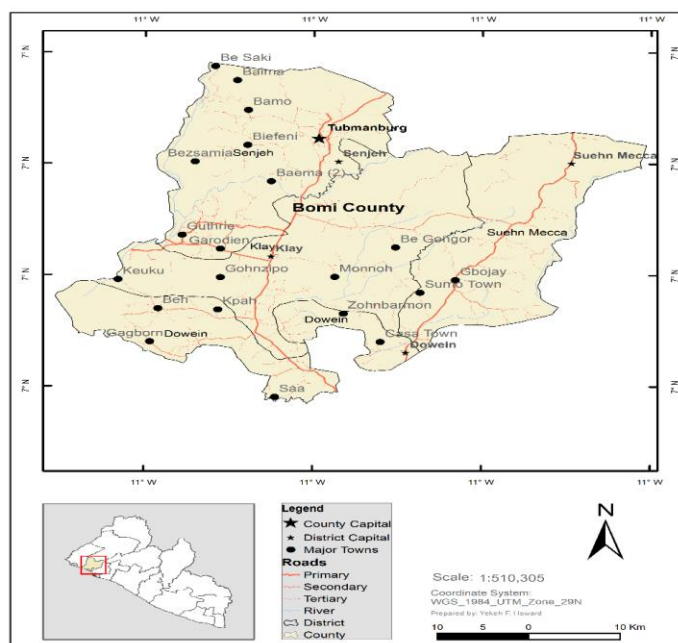
Figure 3: Map of Bomi County, Liberia.

Bomi County is generally hilly with a few plains and valleys. The County is endowed with ample water resources to supply fish and other livelihood options, including the Atlantic Ocean and the Po, Wlein, Mahei, Bomi, and St. Paul Rivers, among others. Many of the rivers are suitable for mini hydroelectric generation to supply electricity to citizens and industry.

The geological composition of Bomi County is primarily composed of a sandy clay soil type. There are few valuable commercial timber species found in the County. However, currently, no large-scale logging activity exists. Timber processing and chainsawing are carried out only on a small scale. Bomi County is a fertile land with rolling hills; approximately 45% of the land is covered by grassland.

3.2 AVAILABLE RESOURCES

This section provides the resources and land use activities in Bomi County (**Figure 4** for the Lanuse and cover change map).

3.2.1 MINERALS[19]

Bomi County, Liberia is known for the presence of several minerals, including iron, diamonds, gold, goethite, hematite, leucophosphite, limonite, magnetite, phosphosiderite, quartz, and rockbridgeite. The Bomi Hills Iron Mine, located in Bomi County, is of particular significance and has been associated with iron mineralization. The geological richness of Bomi County contributes to the local economy and aligns with the county's historical significance in mining. The presence of these minerals has had an impact on the economic and industrial development of the region. However, mining activities were shut down due to the civil war but has recently resumed in the county.

3.2.2 BIODIVERSITY

Bomi County is home to diverse and rich biodiversity. The region's ecosystems are part of the Upper Guinea rain forests, classified as one of the biodiversity hotspots in the world[20]. The largest of these man-made forests is the Bomi Hills in Bomi County with 3,521 hectares (Ha).

Bomi County biodiversity includes endemic species of wild fauna and flora that are distributed across the few patches of remaining forests. However, the region's (inclusive of neighboring counties) biodiversity is threatened by human-induced pressures such as logging, mining, hunting, and charcoal and fuel wood

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[19] Mindat: https://www.mindat.org/loc-145016.html

[20] Convention on Biological Diversity

collection [21] . Efforts to manage and conserve biodiversity in Bomi County include community-led coastal biodiversity management projects, biodiversity conservation awareness programs, and the development of reports and products to support conservation efforts. The region's biodiversity contributes significantly to its ecological and environmental importance, making it essential for conservation and sustainable management[22].

3.2.3 WATER BODIES

The Bomi is endowed with ample water resources to supply fish and other livelihood options, including the Atlantic Ocean and the Po, Wlein, Mahei, Bomi, and St. Paul Rivers, among others. Many of these rivers are said to be suitable for mini hydroelectric generation to supply electricity to citizens and industry.

The county has the Blue Lake, which is a highlight for travelers. The Lake is a beautiful sight to behold, nestled within the mountains and formed from the large craters left behind by an iron ore mining company. The water has a distinct blue color and is home to various kinds of fishes, as well as other creatures. Blue Lake has become a popular attraction for visitors and locals alike, with the surrounding shores serving as an excellent place for picnics and relaxation[23]. Additionally, the Lake is the source and namesake of a brand of mineral water produced nearby. The area surrounding Blue Lake is truly a site worth visiting, inviting visitors to enjoy its natural beauty and serene ambiance. These water resources are crucial for agriculture, fisheries, and domestic use and can support hydroelectric power generation.

3.2.4 ARABLE LAND

Liberia has arable land at 5.2%, permanent crops at 2.1%, permanent pastures at 20.8%, forests at 44.6%, and others at 27.3% (2011). Irrigated land covers 30 square kilometers of Liberia's land as of 2012[24]. Bomi like many other counties in Liberia, is known for its arable land, which provides a fertile foundation for agriculture. The county's arable land is suitable for the cultivation of various crops, including rice, cassava, oil palm, rubber, cocoa, and vegetables. The agricultural activities in Bomi County contribute to the local economy and food security.

The county's arable land is utilized for both subsistence and commercial farming, with rice being a staple food crop grown by local farmers. Additionally, oil palm and rubber plantations are significant contributors to the agricultural landscape of Bomi County. These plantations play a vital role in the production of palm oil and rubber for domestic consumption and export.

In Bomi County, there are efforts to improve agricultural productivity and promote sustainable land use. This includes modernizing agricultural practices, providing support for smallholder farmers, and promoting agribusiness development. The arable land in Bomi County is an important asset for agricultural development and plays a critical role in sustaining the livelihoods of the local population.

3.2.5 CHALLENGES IN ULTILISING AVAILABLE RESOURCES

The utilization of available resources in Bomi is essential for the economic and social development of the region. However, the challenges in utilizing these resources include issues related to governance, infrastructure, economic revitalization, and security, among others.

Similar to the rest of the country, Bomi County is currently used as a 'raw material county' that lacks manufacturing industries. Natural resources are produced are exported outside the country [25] . The implementation of a value chain system to create jobs, especially for the youth, and to improve living conditions, healthcare, and infrastructure development is needed in the county.

Furthermore, the Bomi County Development Agenda for 2008-2012 highlights the vision of the people of Bomi County, including good governance, reconciliation, peace and stability, advancement in

[21] USAID: Foreign Assistance Act 118/119: Tropical Forest and Biodiversity Analysis: Liberia Tropical Forest And Biodiversity Analysis

[22] ibid

[23] Ministry of Information, Culture & Tourism (MICAT): Discover Bomi County: https://enjoyliberia.travel/pages/bomi-county/

[24] USAID: Foreign Assistance Act 118/119: Tropical Forest and Biodiversity Analysis: Liberia Tropical Forest And Biodiversity Analysis

[25] Seward, D. (2021) Case Study on Value Chain Analysis of Natural Resource Exports in Liberia. *Journal of Service Science and Management*, 14, 597-626. doi: 10.4236/jssm.2021.146038.

social, economic, political, cultural and human development, active participation of youth and women, rapid industrialization, provision of electricity, increased job opportunities, and improvement of the standard of living of all citizens and residents.

In a nutshell, the challenges in utilizing available resources in Bomi County, Liberia, are multifaceted and require a comprehensive approach that addresses governance, economic development, infrastructure, and value chain analysis to create jobs and improve living conditions for the population.

3.3 STATUS OF THE ENVIRONMENT

Bomi County poses both challenges and opportunities for sustainable development, climate resilience, and the preservation of natural resources. The environment of Bomi County includes natural features such as Blue Lake, as well as the presence of agricultural areas and palm plantations.

Bomi is vulnerable to climate change and its impacts. Given these vulnerabilities, there are opportunities for adaptation and resilience-building measures to be implemented to address the challenges[26]. The vision of the people of Bomi County is inextricably linked to environmental sustainability.

3.3.1 AIR QUALITY

The air quality in Bomi is moderate, with some pollutants causing health concerns for a small number of people who are sensitive to air pollution[27]. The main pollutants include PM2.5 (Particulate matter less than 2.5 microns), CO (Carbon Monoxide), NO_2 (Nitrogen Dioxide), O_3 (Ozone), PM10 (Particulate matter less than 10 microns), and SO_2 (Sulphur Dioxide)[28]. The overall air quality is acceptable.

3.3.2 WATER QUALITY AND SANITATION

The groundwater quality in Liberia is facing challenges due to various risk factors, including geological characteristics, pollution from industrial and agricultural activities, and the impact of past civil unrest. There are ongoing efforts to improve water sanitation and hygiene (WASH) in Liberia, particularly in the context of public health and environmental recovery[29].

In many rural communities, water quality remains poor in some areas due to mining (e.g. iron ore pollutants), farming (e.g. agrochemical runoff) and industrial activities (e.g. discharge from rubber processing). Access to basic sanitation in Liberia is 18% nationally.

All the counties of Liberia practice open defecation, including Bomi County. According to LISGIS (2017) report[30], in Bomi County, 12% of de jure population has basic sanitation service, and 11.9% with limited sanitation service. Also, 23.9 % have Improved sanitation facilities, 12.0 % with unimproved sanitation facilities, and 64.1 % carried out open defecation.

3.3.3 SOIL TYPES AND QUALITY

Most soils in Liberia are oxisols and ultisols and contain oxides of aluminum and iron, which are very acidic[31]. The Ferralsols and Acrisols. Gleysols (Histosols), typical swamps and waterlogged valley floors during the rainy season, cover approximately 4% of the country. This provides much of the foundation for agriculture, mining, the forestry sector, and all the produce these sectors yield.

In general, Bomi County has a sandy clay soil type. According to the CDA, all the districts have good soil for agriculture. In Bomi County, agriculture and land management practices play a significant role in addressing and reversing the trend of soil degradation[32]. Yet, soil is being polluted by both natural and man-made factors. The latter include human-induced pressures through agricultural practices and contaminant inputs from waste application

Given the importance of soil quality for agricultural productivity and environmental sustainability, it is

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[26] Climate Risk Profile: Liberia (2021): The World Bank Group.

[27] The Weather Channel: https://weather.com/en-TZ/forecast/air-quality/l/2a206bf87fc0863774d9c8751fc3d579bf545eca952ce58249e366db953d19c1

[28] ibid

[29] British Geological Survey: Groundwater Quality: Liberia: https://nora.nerc.ac.uk/id/eprint/534396/1/Liberia.pdf

[30] This statistic covers the percent distribution of de jure population by type of sanitation, basic sanitation service, and limited sanitation service

[31] State of the Environment Report (SoER) for Liberia 2007-2018

[32] Liberia National Program to Combat Desertification: https://www.unccd.int/sites/default/files/naps/Liberia-eng-2013.pdf

essential to strengthen capacities for sustainable agriculture and prioritize interventions that mitigate soil degradation in Bomi County and across Liberia as a whole.

3.3.4 BIODIVERSITY LOSS

Liberia's rich biodiversity, including over 2,000 vascular plant species, 600 bird species, 75 reptile species, and 150 mammal species, is under threat, demanding comprehensive conservation efforts[33]. Bomi County, like other counties in Liberia, faces challenges related to biodiversity loss. Factors contributing to biodiversity loss in the area include deforestation, habitat degradation, overexploitation of biological resources, and human settlement encroachment[34].

Specific threats to biodiversity in Bomi County [35], include but are not limited to: Deforestation and habitat loss due to agricultural expansion, logging, and infrastructure development; Poaching and overexploitation of wildlife; Land use changes, including shifting cultivation practices; and Unsustainable resource extraction, such as timber exploitation and rubber plantations.

The National Biodiversity Strategy and Action Plan (NBSAP, 2017-2025) addresses biodiversity loss in Liberia including Bomi and other counties. This strategy aims to conserve and sustainably manage the country's biological resources, protect crucial ecosystems, and promote biodiversity research and conservation. Additionally, international collaborations and foreign assistance play a role in supporting biodiversity conservation and sustainable forest management in Liberia.

To address biodiversity loss in Bomi County and Liberia as a whole, comprehensive strategies for habitat restoration, wildlife conservation, sustainable land use, and community-based natural resource management are essential. Conservation efforts should also focus on promoting sustainable agriculture, reforestation, and raising awareness about the value of biodiversity for livelihoods and ecosystem services.

3.3.5 FOREST COVERAGE

Liberia is known for its rich tropical rainforests. Bomi County has relatively small forested areas, which were disturbed and deforested due to various factors. According to the Global Forest Watch[36], Bomi has about 87.3 kha of stable forest. In addition, Klay and Mecca are the top regions responsible for 97% of all tree cover gain between 2000 and 2020. This region had the most tree cover gain at 1.39 kha compared to an average of 721 ha.

Also, from 2000 to 2020, Bomi gained 1.44 kha of tree cover region-wide equal to 2.5% of all tree cover gain in Liberia. Klay has the largest relative plantation area in Bomi at 6.5%, most of which is in unknown plantations. As of 2001, 1.7% of Bomi's total tree cover was primary forest.

3.3.5.1 DEFORESTATION AND DEGRADATION

The impact of deforestation and forest degradation in Liberia is multifaceted and has implications for both the environment and communities. According to the Global Forest Watch, from 2002 to 2022, Bomi lost 380 ha of humid primary forest, making up 0.45% of its total tree cover loss in the same time period. The total area of humid primary forest in Bomi decreased by 11% in this time period. Between 2001 and 2022, forests in Bomi emitted 2.08 $MtCO_2e$/year, and removed -1.61 $MtCO_2e$/year. This represents a net carbon source of 465 $ktCO_2e$/year. In 2010, Bomi had 185 kha of natural forest, extending over 93% of its land area. In 2022, it lost 4.71 kha of natural forest, equivalent to 2.90 Mt of CO_2 emissions[37].

[33] Republic of Liberia National Biodiversity Strategy and Action Plan-II 2017-2025. (2017). https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf

[34] USAID: Foreign Assistance Act 118/119: Tropical Forest and Biodiversity Analysis: Liberia Tropical Forest And Biodiversity Analysis

[35] Republic of Liberia National Biodiversity Strategy and Action Plan-II 2017-2025. (2017). https://www.cbd.int/doc/world/lr/lr-nbsap-v2-en.pdf

[36] The Global Forest Watch definition for forest includes both tree and forest cover, which is slightly different from the forest definition of Liberia.

[37] https://www.globalforestwatch.org/dashboards/country/LBR

Half of the Liberian population lives within 2.5 kilometers of a forest[38]. These households spend over three hours daily collecting forest products for subsistence and for sale, which accounts for 35% of their income [39] . Forests provide a safety net of resources during crises such as droughts, fires, floods, and pandemics. The forestry sector is a significant contributor to Liberia's economy, employing a large number of workers, particularly in the informal sector (e.g., chainsaw milling and charcoal production).

Deforestation during the war when forest revenues were used to finance weapons, a growing population, and increasing human pressures have led to the loss of Liberia's forests[40].

Non-timber forest products (NTFPs) such as fruits, honey, meat, nuts, and plants are vital to the livelihoods of most of the rural population. The loss of forests due to deforestation and degradation can impact food security and income sources for local communities. These findings underscore the interconnectedness between forests and all aspects of Liberian society, including livelihoods, economies, and environmental conservation of which Bomi County is a part. Hence,

3.3.6   CONSERVATION EFFORTS

The conservation efforts in Bomi are primarily implemented by non-governmental organizations, CSOs and CBOs. The Government of Liberia, through FTI has been supported by USAID and the Government of Norway. The FTI trains foresters for forest protection and conservation within the county, and beyond. These efforts demonstrate a commitment to conservation, education, and community support in Bomi County, reflecting the importance of sustainable resource management, environmental preservation, and community well-being. A portion of the Lake Piso Multiple Use Reserve (LPMUR) is also situated in Bomi.

3.3.7   ENERGY ACCESS

Liberia has one of the lowest electrification rates (28 percent) in the world and a high grid tariff (24 ¢/kWh) with Liberia Electricity Corporation (LEC), the sector utility, facing financial challenges. The Mt. Coffee hydropower rehabilitation was completed recently and provides about 88 MW of hydropower during the wet season (June-December). However, due to the high seasonality of the hydropower, during the dry season (January-May), the country relies on expensive liquid fuel plants to meet its electricity needs. The effective thermal capacity of 32 MW is grossly inadequate to serve the demand, which resulted in massive load-shedding during the dry season leaving many areas with electricity supply for only a few hours of the day. Liberia is now connected to the regional network with support from the World Bank-financed Liberia Electricity Sector Strengthening and Access Project (LESSAP and CSLG). The electrification component of LESSAP targeted mainly two key areas, grid electrification in the capital Monrovia, and along the economic corridors of Kakata, Margibi, and Bomi counties.

In recent past, Bomi was faced challenges and had limited access to electricity grids and the prevalence of off-grid communities were common issues within the county. Until recently in 2023 with financial and technical support from the World Bank, LEC has extended its medium and low voltage lines into Klay and Tubmanburg. Prior to this, a private company, LIB Solar, provided solar electrification to homes in communities within the county for affordable amounts. The Mano substation is expected to transmit electricity to communities in Cape Mount, Bomi, and Gbarpolu counties.

As rural grid extension remains highly prioritized within the LEC, the recent connection of over 10,000 (ten thousand) customers is now linked to Liberia's national electricity grid network, extending into Bomi and Grand Cape Mount Counties [41] . The total peak electricity demand for the electricity grid as a whole is predicted

[38] Liberia: Understanding people's dependence on forests. (November 11, 2020.). Blogs.worldbank.org. https://blogs.worldbank.org/africacan/liberia-understanding-peoples-dependence-forests

[39] ibid

[40] Liberia: Understanding people's dependence on forests. (November 11, 2020.). Blogs.worldbank.org.

https://blogs.worldbank.org/africacan/liberia-understanding-peoples-dependence-forests

[41]Liberia Electricity Corporation: https://lecliberia.com/news-releases/lec-extends-its-grid-network-as-far-as-the-sierra-leonean-border-connects-several-towns-communities-in-bomi-grand-cape-mount-counties/

to reach roughly 500 MW in 30 years, of which Bomi County has 7MW.

3.3.7.1 CHALLENGES IN THE ENERGY SECTOR RELATIVE TO BOMI COUNTY

Bomi County, like much of rural Liberia, faces a low level of electrification. The majority of the population relies heavily on non-electric sources of energy for cooking and lighting, leading to challenges in accessing modern energy services [42]. Liberia has one of the highest electricity tariffs globally[43], creating a financial burden for both residential and commercial users, hindering economic development and access to essential services. The challenges of limited access to modern energy services in Bomi County contribute to hindered progress in health, education, and economic activities. The lack of access to reliable energy services may also impact social and economic well-being.

There is an unequal distribution of energy services, with urban areas such as Monrovia having relatively better access to electricity compared to rural areas like Bomi County. This disparity results in uneven development and hampers the opportunities for growth and well-being in rural communities.

These challenges underscore the urgent need for strategic interventions and investment in the energy sector. Addressing these issues will be vital for improving the living standards, economic opportunities, and overall development of the region. Moreover, it is important to explore sustainable and inclusive solutions to expand access to reliable and affordable energy services in Bomi County.

3.3.8   RECOMMENDATIONS

Given the backdrop, of the literature, the following recommendations are crucial for the better conservation measures of natural resources:

i.   Implement reforestation and afforestation initiatives to increase forest coverage, and establish sustainable forest management practices to ensure the long-term preservation of forest resources.

ii. Strengthen law enforcement to combat illegal logging and unsustainable land-use practices, and promote community-based conservation efforts that engage local stakeholders.

iii. Enhance conservation education and awareness programs, support capacity building for conservation practitioners, and establish partnerships with local communities to promote sustainable use of natural resources.

iv. Expand and effectively manage protected areas, promote biodiversity conservation, and integrate climate mitigation and adaptation strategies into protected area management plans.

v.   Invest in renewable energy infrastructure, expand grid connectivity, and support off-grid renewable energy solutions to improve energy access in rural areas of Bomi County.

vi. Implement policy reforms to improve the regulatory framework, attract private investment, and promote energy sector diversification to address the challenges of energy access and affordability.

vii. Support value addition in primary economic sectors such as agriculture, mining, and forestry, and promote sustainable and inclusive economic growth through capacity building and access to markets.

These recommendations aim to address the key challenges, enhance conservation efforts, and promote sustainable development in Bomi County. Each recommendation aligns with the specific needs and critical areas of focus in the points above, supporting the overall well-being and resilience of the county.

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[42] Rural Energy Strategy And Master Plan For Liberia Until 2030: https://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf

[i]bid
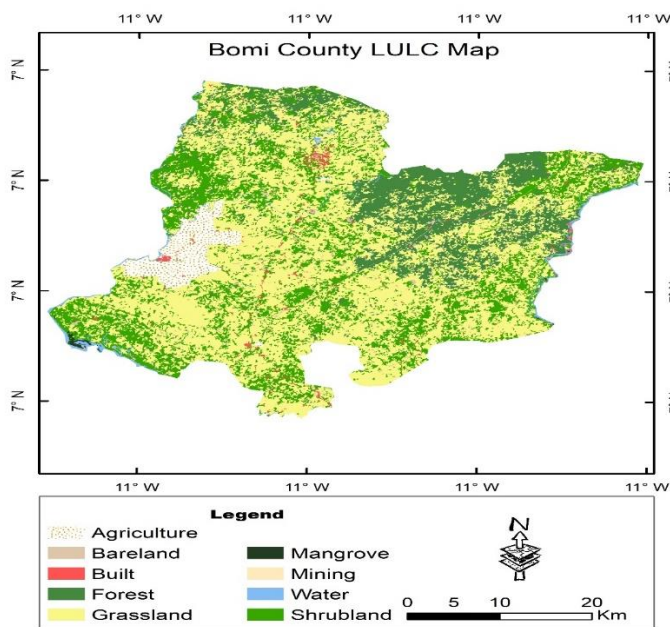
Figure 4: Land Use and Cover Change Map, Bomi County

4.   CLIMATE INFORMATION

4.1   NATIONAL PERSPECTIVES

Liberia is a small country located entirely within the humid Upper Guinean Forest Ecosystem in West Africa. West Africa's climate, including Liberia, is subject to considerable variability across a range of space and time scales. Liberia has a predominantly equatorial climate, with three distinct topographical belts. The low coastal belt is about 40 km wide and constitutes tidal creeks, shallow lagoons, and mangrove marshes. Moving inward, the second belt includes rolling hills that reach elevations of 60–150 m (200–500 feet). The third belt, which comprises the bulk of Liberia, is marked by abrupt changes of elevation in a series of low mountains and plateaus, which are less densely forested[44].

Liberia is one of the world's wettest countries, with the most precipitation occurring between May and October. The country's average annual rainfall is relatively high, nearly exceeding 2,500 mm. Rainfall is highest along the coast but decreases towards Liberia's interior plateaus and low mountains, where average rainfall reaches approximately 2,030 mm annually.

The wet season typically occurs between May and November, with average temperatures of 25°C. The relative humidity reaches 90%–100% during the rainy season. The dry season, typically from December to April, is dominated by the harmattan winds with average temperatures between 24 to 27°C. During the dry season, the relative humidity increases to a range of 60% to 90%.

Temperatures in Liberia are strongly influenced by season and determined by its tropical location, where the sun is almost overhead all year. Generally, the country experiences high temperatures, with slight variations. The temperature over the country ranges from 27-32° C during the day to 21-24° C at night. The temperature rises slightly in the dry season and decreases in July and August.

Liberia is one of the West African countries most vulnerable to climate change, with the projected increasingly severe weather occurrences expected to affect sensitive industries such as agriculture, fishing, mining, and forestry. Liberia remains fragile and highly vulnerable due to high levels of inequality, unemployment, and poverty, with limited access to basic services such as water, sanitation, and energy.

4.2   CLIMATOLOGY - BOMI COUNTY[45]

The climatic conditions of Bomi County are described in this section of the report. The figures/graphs used for the analysis are obtained from the World Bank's Climate Change Knowledge Portal. Amongst others, the monthly averages of surface air temperatures (mean, minimum, and maximum respectively) and precipitation for Bomi County, Liberia covering the period 1991-2020 are presented and analyzed.

The observed Annual Averages (Mean, Minimum, and Maximum respectively) Surface Air Temperature of Bomi, 1991-2020; Variability and Trend of Average (Mean, Minimum, And Maximum Respectively) Surface Air Temperature across the Seasonal Cycle across Seasonal Cycle, 1991-2020; and Change in Distribution of Average (Mean, Minimum, and Maximum Respectively) Surface Air Temperature are also presented and analyzed below.

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[44] Environmental Protection Agency of Liberia (2013). Liberia: Initial National Communication 2013. URL: https://unfccc.int/sites/ default/files/resource/lbrnc1.pdf

[45] https://climateknowledgeportal.worldbank.org/country/liberia/climate-data-historical

4.3   CLIMATOLOGY - TEMPERATURE

This section focuses on the temperatures observed in Bomi County from 1901 to 2022. It analyzes the annual mean, minimum, and maximum surface air temperatures to highlight the county's shifts and trends in climatic conditions over a century. By combining raw annual averages and a 5-year smoothing technique, the figures present a detailed perspective on year-to-year variability and overall trends, indicating a gradual warming of the county.

4.3.1   MONTHLY TEMPERATURE (MINIMUM, MEAN, AND MAXIMUM), 1991- 2020

Figure 5 below provides the monthly averages of surface air temperatures (minimum, mean, and maximum, respectively) for Bomi County, Liberia, covering the period 1991-2020. It provides valuable information covering both conflict and post-conflict periods in Liberia.

The average minimum surface air temperature has been observed to increase from 20.39°C in January to 21.49°C in December, indicating a rise of 1.10°C over the year. More specifically, the temperature steadily increased from January to May, reaching its highest point at 22.3°C, but then started to decrease until August (21.38°C), followed by an increase to 22.2°C in November, before falling again in December (21.49°C). As a result, the warmest month was May, with an average minimum temperature of 22.3°C, while the coldest was January, with an average minimum temperature of 20.39°C. Overall, the County has a typical tropical climate with mild winters and warm summers.

The average mean surface air temperature gradually increased from January (25.88°C) to December (26.08°C). However, there were fluctuations throughout the year. It rose from January to March but then steadily decreased until August. The highest average mean surface air temperature was recorded in March (27.55°C), while the lowest was in August (24.77°C).

Similar trends and patterns have been observed relative to the average maximum surface air temperature compared to the average mean surface air temperature analyzed above. The average maximum surface air temperature decreased from 31.47 °C in January to 30.77 °C in December. The highest recorded average maximum surface air temperature

was 33.24 °C (March), and the lowest was 26.26 °C (August).
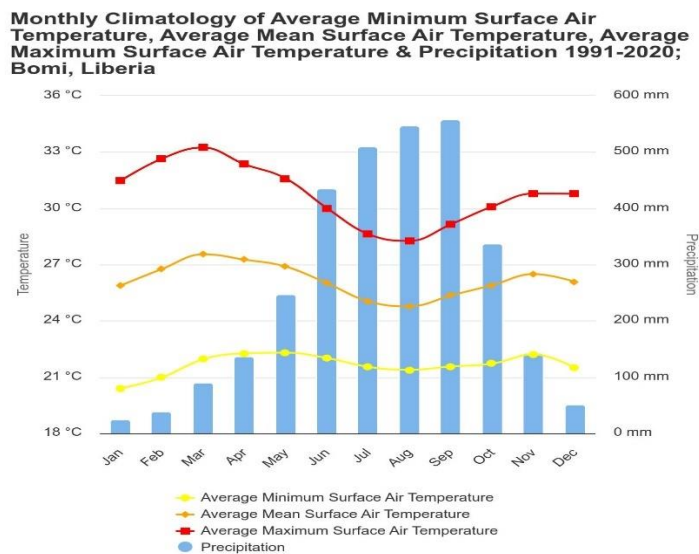
Figure 5: the monthly averages of minimum surface air temperatures (minimum, mean, and maximum, respectively) and precipitation, Bomi County

4.3.2   OBSERVED ANNUAL AVERAGE MEAN SURFACE AIR TEMPERATURE OF BOMI, 1991-2020

Figure 6 below displays the annual average mean surface air temperature of Bomi County from 1901 to 2022, indicating yearly variations. To summarize, the mean surface air temperature in Bomi County was 25.75 °C in 1901 and decreased to 25.47 °C in 2022. The highest observed annual average mean surface air temperature was recorded in 2016 (25.93 °C), while the lowest was in 1976 (24.47 °C). This suggests interannual variability and occasional temperature fluctuations in Bomi County indicate that the observed temperature was cooler than the reference year (1901).
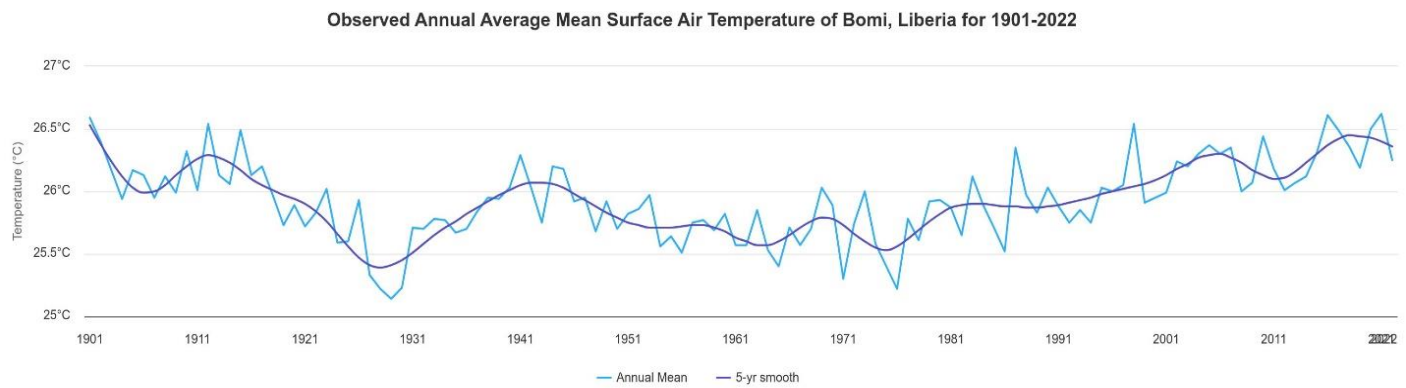
Figure 6: Observed Annual Average Mean Surface Air Temperature of Bomi County, from 1901 to 2022

4.3.3 OBSERVED ANNUAL AVERAGE MINIMUM SURFACE AIR TEMPERATURE, 1993- 2020

Figure 7 illustrates the Observed Annual Average Minimum Surface Air Temperature of Bomi County from 1901 to 2022. The temperature varies each year, and over the period, it decreased from 22.07 °C in 1901 to 21.74 °C in 2022. The highest temperature was recorded in 2021 and was 22.11 °C, while the lowest was in 1929, recorded at 20.56 °C. Therefore, it can be concluded that Bomi County experiences interannual variability and occasional fluctuations in temperature.

4.3.4 OBSERVED ANNUAL AVERAGE MAXIMUM SURFACE AIR TEMPERATURE OF BOMI, 1991-2020

As shown in Figure 8 below, the Observed Annual Average Maximum Surface Air Temperature of Bomi County varies yearly from 1901 to 2022. In summary, the temperature was 31.17 °C in 1901 but decreased to 30.83 °C in 2022. The highest Observed Annual Average Maximum Surface Air Temperature of Bomi County was in 2021 (31.2 °C), while the lowest was in 1929 (29.77 °C). Thus, interannual variability and occasional fluctuations in temperature were observed in Bomi County.
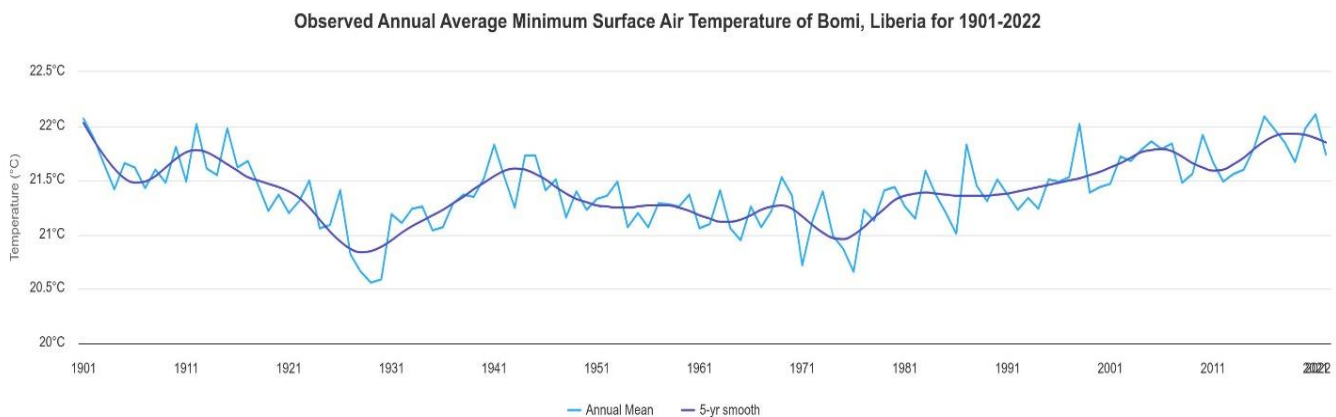
Figure 7: Observed Annual Average Minimum Surface Air Temperature of Bomi County, from 1901 to 2022

Observed Annual Average Maximum Surface Air Temperature of Bomi, Liberia for 1901-2022
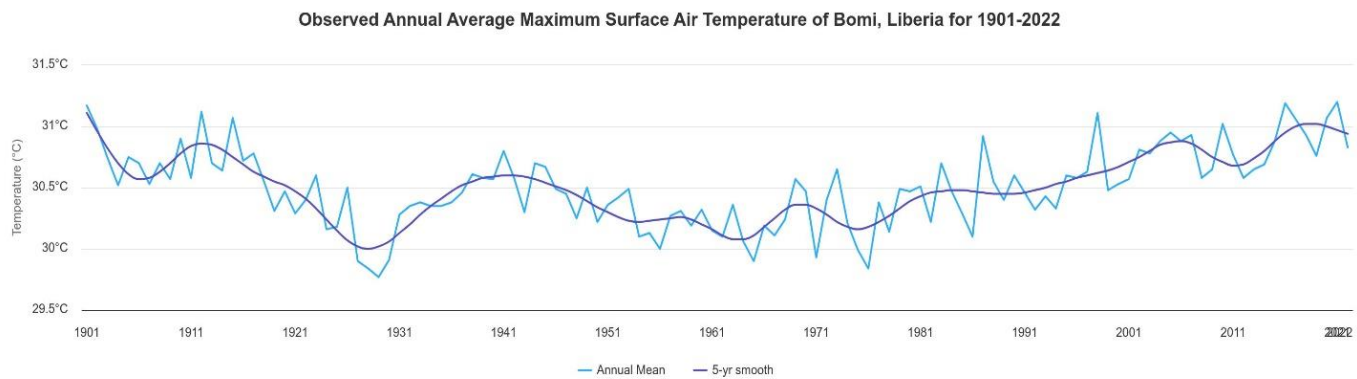
Figure 8: Observed Annual Average Maximum Surface Air Temperature of Bomi County

4.4   TRENDS AND VARIABILITY -TEMPERATURE[46]

To understand climate change, one must understand climate variability. As provided by the Climate Change Knowledge Portal, the trends and variability for Bomi are discussed in this section. Trends in climate — past, present, and future — always need to be understood in the context of naturally occurring variability. Climate variability, here, refers to the ways in which climate conditions (e.g., temperature and precipitation) "flicker" from year to year within their respective typical "range of variability". Variability in weather and climate inherently leads to the occurrence of extreme weather or climate events.

Therefore, climatology must be understood as a mean with variability. Variability can be substantial from year to year (i.e., the high latitudes) and in a few locations, and for specific variables, it can be small (i.e., temperatures in the tropics).

The Climate Change Knowledge Portal offers three themes to explore and understand differences in variability, trends, and significance of change across the last 70-, 50- and 30-year periods. It is meant as an informational tool to augment the views from the climatology pages (Current Climatology- Climatology tab). The three sections present different aspects of how variability might need to be considered. For simplicity of navigation, the variables presented are only a subset of the full indicator catalog. Data used on this page is derived from the ERA5 reanalysis (here used at 0.5º x 0.5º resolution) to extract also the daily variability.

4.4.1   VARIABILITY AND TREND OF AVERAGE MEAN SURFACE AIR TEMPERATURE ACROSS THE SEASONAL CYCLE ACROSS SEASONAL CYCLE, 1991-2020

Figure 9 provides the average mean surface air temperature across the seasonal cycle from 1951 to 2020. The data is divided into 10-year periods and monthly. As seen, there is some variability in the average mean surface air temperature across the seasonal cycle.

For January, the lowest average mean surface air temperature was 24.35 °C recorded from 1961 to 1970 (precisely in 1965), while the highest was 26.82 °C but recorded during the 2011-2020 period (precisely 2020). Also, in March, the lowest was 25.21 °C (1951-1960, precisely 1956), and the highest was 27.79 °C (1991-2000, precisely 1998). Thus, the same is done over the other months. Per the trend per decade, Bomi County has a 0.09 °C average mean surface air temperature.

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[46]

https://climateknowledgeportal.worldbank.org/country/liberia/trends-variability-historical
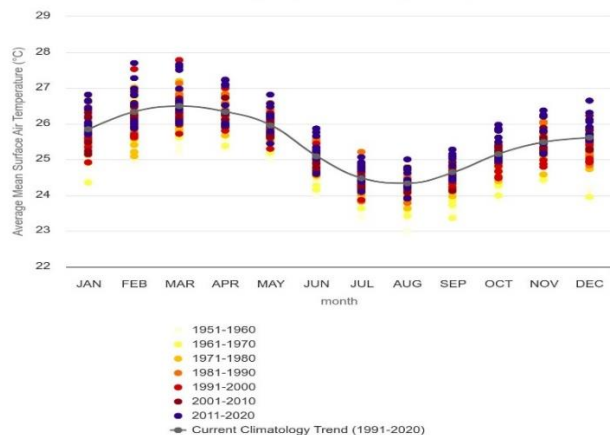
Figure 9: Variability and Trend Of Average Mean Surface Air Temperature Across the Seasonal Cycle Across Seasonal Cycle, 1991-2020
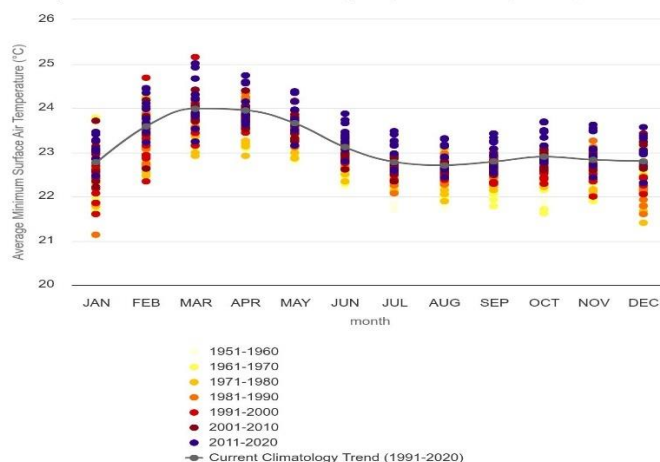
Figure 10: Average Minimum surface air temperature across the seasonal cycle from 1951 to 2020

4.4.2 VARIABILITY AND TREND OF AVERAGE MINIMUM SURFACE AIR TEMPERATURE ACROSS THE SEASONAL CYCLE ACROSS SEASONAL CYCLE, 1991-2020

Figure 10 displays the average minimum surface air temperature observed from 1951 to 2020, categorized by monthly and 10-year periods. The data demonstrates some variability in the average mean surface air temperature across the seasonal cycle. From 1951 to 2020, the average minimum surface air temperature increased slightly across all months.

The highest average minimum surface air temperature of 25.16 °C was recorded in March 1998 (1991-2000 period), while the lowest of 21.14 °C was recorded in January 1983 (1981-1990 period).

During the 1971-1980 period, four months had the lowest average minimum surface air temperature, followed by three months for both 1951-1960 and 1961-1970 periods (ranging from September to November). However, the highest average minimum surface air temperature was mainly recorded from May to December during the 2011-2022 period (eight months in total), followed by three months ranging from February to April in the 1991-2010 period. The data also indicates that the months of January to March experienced the highest climate variation in temperature.

4.4.3 VARIABILITY AND TREND OF AVERAGE MAXIMUM SURFACE AIR TEMPERATURE ACROSS THE SEASONAL CYCLE ACROSS SEASONAL CYCLE, 1991-2020

Figure 11 displays the Average Maximum surface air temperature throughout the seasonal cycle from 1951 to 2020, divided into 10-year periods and monthly. As we can see, there is some variation in the average Maximum surface air temperature across the seasonal cycle. Every month has seen a slight increase in the average Maximum surface air temperature from 1951 to 2020.

The highest average Maximum surface air temperature recorded across all months during the seasonal cycle from 1951 to 2020 was 32.61 °C (precisely in February 2020, for the 2001-2020 period), while the lowest was 25.04 °C (precisely in August 1954, for the 1951-1960 period). Nine (9) of the months with the lowest average Maximum surface air temperature occurred in the 1951-1960 period, ranging from 25.04 to 28.99, while the months with the highest average Maximum surface air temperature fell within the 2011-2020 period, consisting of nine (9) months, ranging from 27.58 to 32.61.

Regarding trends, the average Maximum surface air temperature increased from January to August, but then it declined until August, and later it increased again until December. A significant decline in trends and variability of average Maximum surface air temperature

was experienced during the peak of the rainy season (July to September).
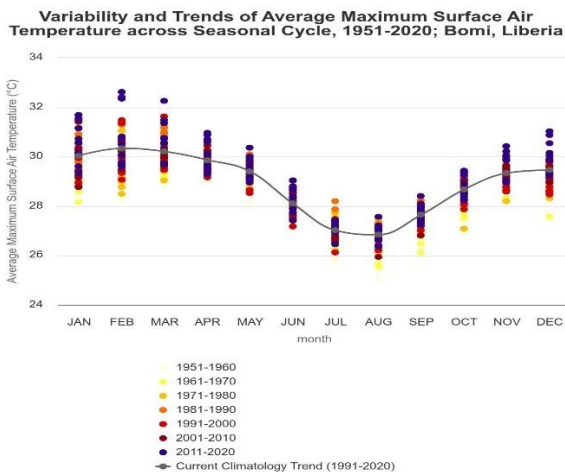
Figure 11: Average Maximum surface air temperature across the seasonal cycle from 1951 to 2020

4.5 VARIABILITY AND CHANGE IN VARIABILITY - TEMPERATURE

4.5.1 CHANGE IN DISTRIBUTION OF AVERAGE MAXIMUM SURFACE AIR TEMPERATURE

Figure 12 illustrates the median values representing the change in the distribution of average maximum surface air temperatures for three different periods: 1951-1980, 1971-2000, and 1991-2020. The temperature was recorded at 28.45°C with a distribution of 1.16 for the 1951-1980 period, 28.80°C with a distribution of 1.17 for the 1971-2000 period, and 28.91°C with a distribution of 1.03 for the 1991-2020 period.
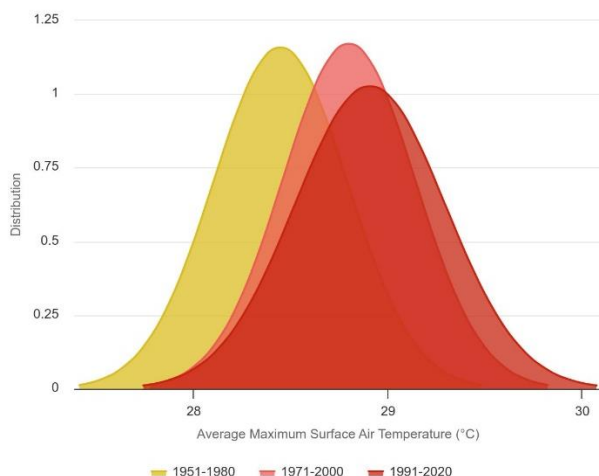
Figure 12: Change in Distribution of Average Maximum Surface Air Temperature; 1951-2020; Bomi, Liberia

4.5.2 CHANGE IN DISTRIBUTION OF AVERAGE MINIMUM SURFACE AIR TEMPERATURE

Figure 13 illustrates the median values representing the change in distribution of average minimum surface air temperatures for three different periods: 1951-1980, 1971-2000, and 1991-2020. During the 1951-1980 period, it was 22.75°C with a distribution of 1.37. In the 1971-2000 period, the temperature was 22.87°C with a distribution of 1.68, and in the 1991-2020 period, it was 23.15°C with a distribution of 1.35.

Figure 13: Change in Distribution of Average Minimum Surface Air Temperature; 1951-2020; Bomi, Liberia
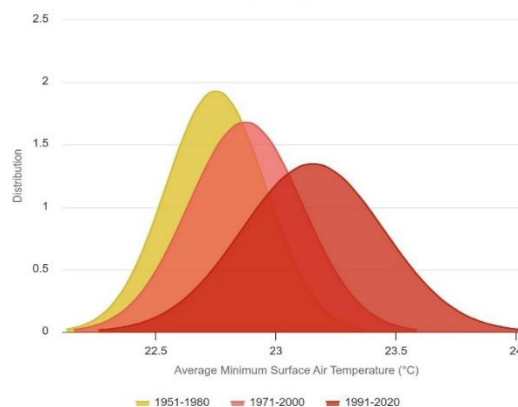
4.5.3 CHANGE IN DISTRIBUTION OF AVERAGE MEAN SURFACE AIR TEMPERATURE

Figure 14 illustrates the median values for the change in average mean surface air temperature distribution for the periods of 1951-1980, 1971-2000, and 1991-2020. During the 1951-1980 period, the temperature was 25.03°C with a distribution of 1.37. In the 1971-2000 period, the temperature increased to 25.33°C with a distribution of 1.61. Finally, in the 1991-2020 period,

the temperature further increased to 25.48°C with a distribution of 1.27.
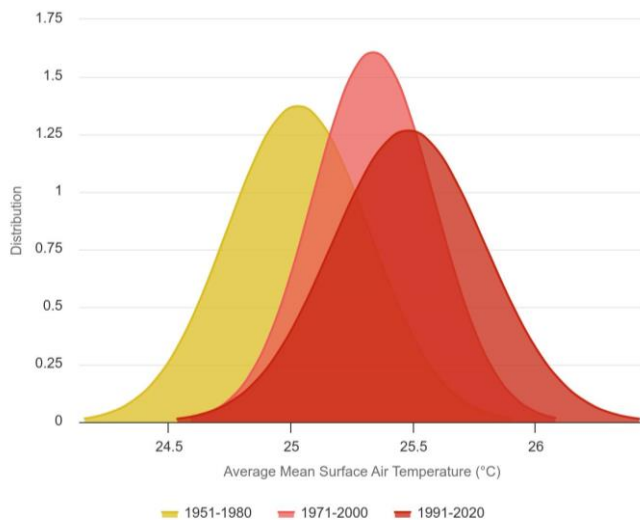
Figure 14: Change in Distribution of Average Mean Surface Air Temperature, 1951-2020, Bomi, Liberia

4.5.4   MAXIMUM TEMPERATURES

Figure 15 gives an overview of the highest temperatures in Bomi County, specifically in Tubmanburg. It shows the number of days in a month when the temperature exceeded certain thresholds: 30 °C, 25 °C, and 20 °C.

Throughout the year, temperature patterns were fluctuating. January saw 21.1 days above 30°C and 9.9 days above 25°C. February had only 6 days above 25°C, while March had 23.8 days above 30°C. April saw a drop to 19.6 days above 30°C, followed by a rise to 22.4 days above 25°C in May. June had only 0.5 days above 30°C, while July had none. August had 10.9 days above 25°C, September had none above 30°C, and October had 0.3 days. November had 3.6 days above 30°C, and December had 13.5 days. The diagram shows the temperature patterns throughout the year, highlighting the highest and lowest thresholds.
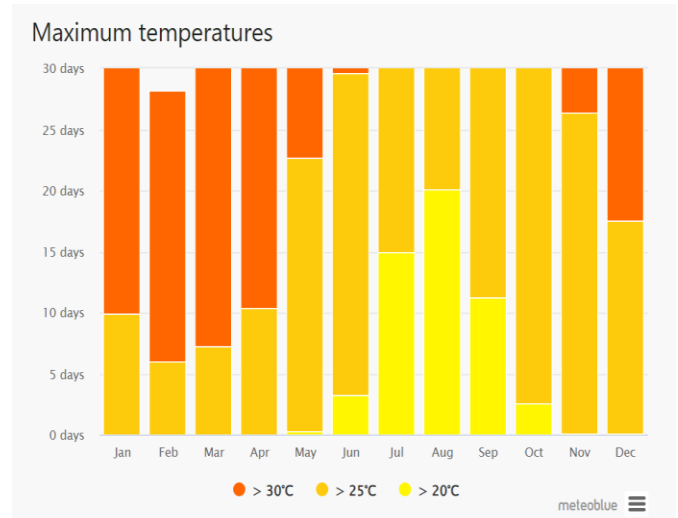
Figure 15: Maximum Temperatures

4.6   CLIMATOLOGY-PRECIPITATION

4.6.1   MONTHLY PRECIPITATION, 1991- 2020

Figure 16 provides the monthly precipitation for Bomi County, Liberia, covering the period 1991-2020. The precipitation in Bomi County has undergone significant changes over time. In January, the lowest precipitation of 24.96mm was recorded, while in September, the highest precipitation of 558.17mm was observed. From January to September, the precipitation continued to increase, but it decreased from September to December. The months of July, August, and September are considered the peak months for high rainfall, which is regarded as the 'heart' of the rainy season. On the other hand, the months of December, January, February, and March are the 'center' of the dry season, and the precipitation is at its record low during this time.
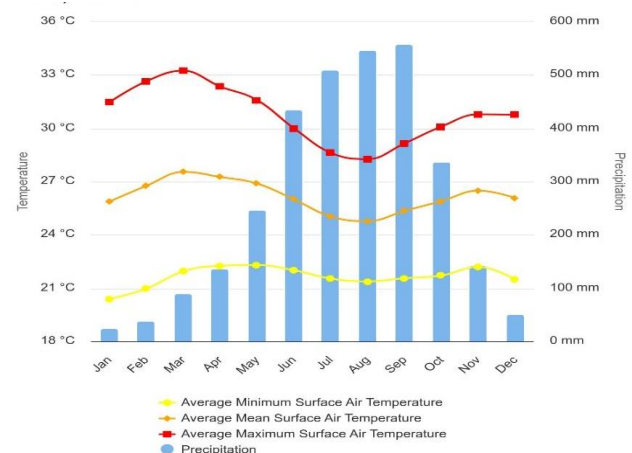
Figure 16: Monthly Precipitation (blue histogram)

4.6.2   OBSERVED ANNUAL PRECIPITATION OF BOMI, 1991-2020

As shown in **Figure 17** below, from 1901 to 2022, the Observed Annual Mean Precipitation of Bomi County, Liberia, was 3117.15 mm in 1901 but decreased to 3115.25 mm in 2022. The annual mean precipitation varied and fluctuated throughout the years. The lowest Observed Annual Mean Precipitation of Bomi County was in 1986 (2493 mm), while the highest was recorded in 1966 (4276.15 mm).

variability and trends in precipitation across all months from 1951 to 2020.
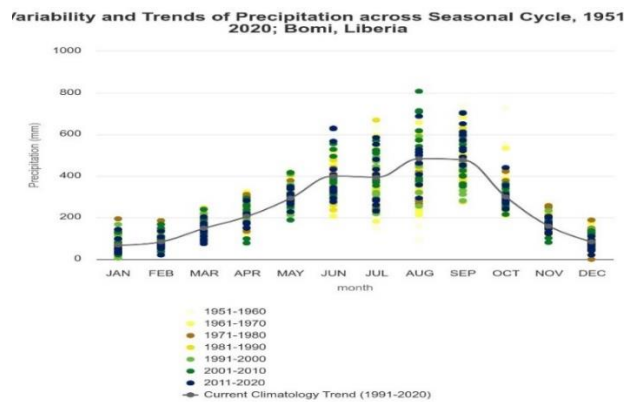
Figure 18:Variability and Trends of Precipitation across Season Cycle, 1951 to 2020
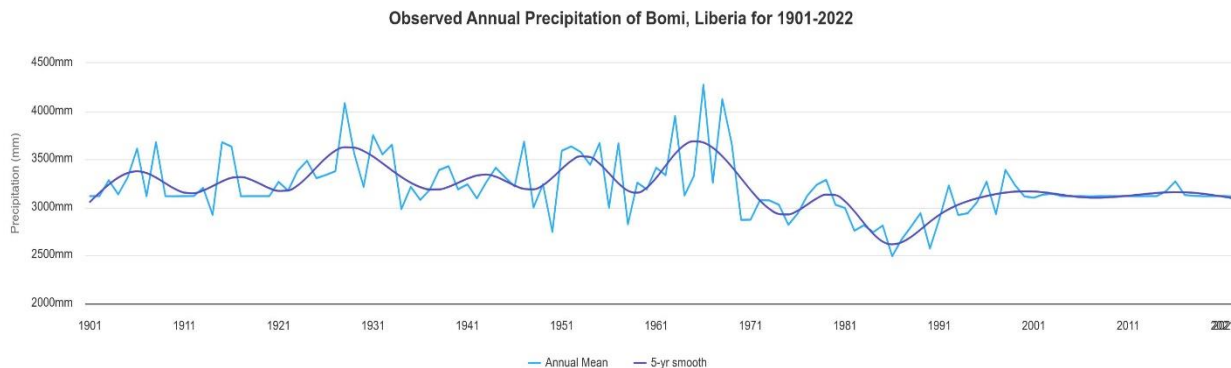
Figure 17: Observed Annual Precipitation of Bomi, 1991-2020

4.6.3   VARIABILITY AND TREND OF PRECIPITATION ACROSS SEASONAL CYCLE 1951-2020

Figure 18 shows the precipitation variability and trends from 1951 to 2020 for Bomi County shows that all months experienced climatic variability. The lowest precipitation was 0.3mm in December 1978 and the highest was 807.99mm in August 2010. July to September had the highest peak during the rainy season in Liberia. Precipitation increased from January to June, slowed until July, increased until September, then rapidly declined. Overall, the report highlights

4.6.4   CHANGE IN DISTRIBUTION OF PRECIPITATION; 1951-2020

Figure 19 shows the median values for the change in precipitation distribution during three different periods. Between 1951-1980, the value was 3107.03mm, with a distribution of 0.00. From 1971-2000, the value was 3011.16mm, with a distribution of 0.00. Finally, between 1991-2020, the value was 3101.29mm, with a distribution of 0.00.
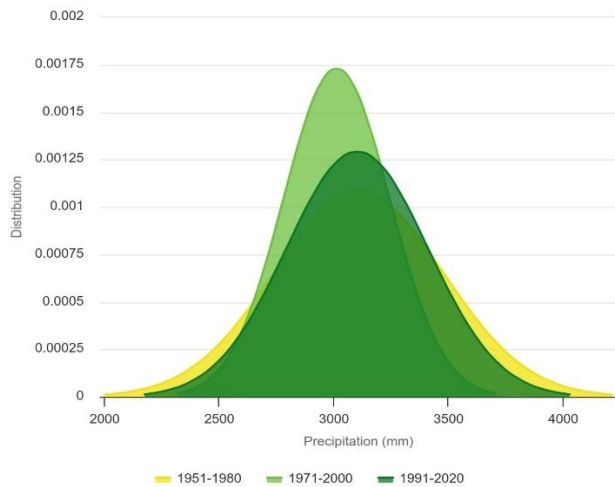
Figure 19: Change in Distribution of Precipitation; 1951-2020

Based on the data provided, it is evident that Bomi County experiences distinct weather patterns characterized by dry and rainy seasons. The number of sunny days is highest in January, gradually declining as the year progresses, with June recording the lowest number. The pattern for partly cloudy days is relatively consistent throughout the year, with February recording the highest number. Overcast days are relatively rare, with July recording the highest number. Precipitation days are highest in May and October, with the months of June to September also experiencing significant rainfall. Overall, the data suggests a pronounced rainy season from May to October, with January, February, and December exhibiting relatively sunnier and partly cloudy days.

4.6.5   PRECIPITATION

Figure 20 shows precipitation patterns in Bomi County, focusing on Tubmanburg. The dry season is from December to March. The rainy season starts in April, increasing until June and July when precipitation is highest. August and September have less rain, and October and November have fewer rainy days. December is the driest month. Overall, Tubmanburg has distinct dry and wet seasons.
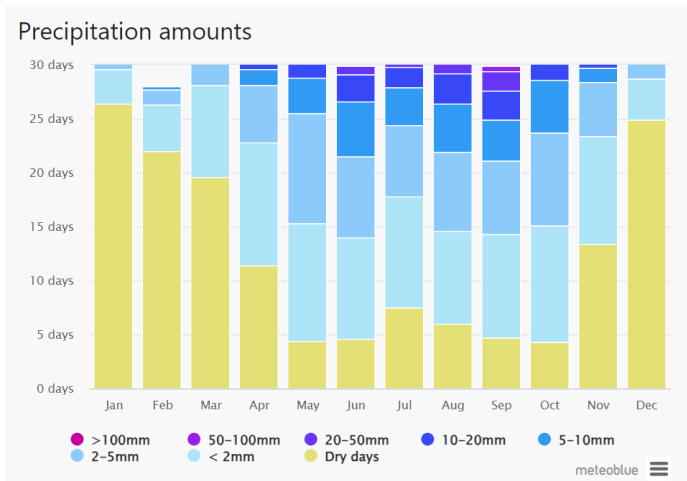
Figure 20: Precipitation Amount

4.7   SIMULATED HISTORICAL CLIMATE & WEATHER DATA FOR BOMI

4.7.1   CLOUDY, SUNNY, AND PRECIPITATION DAYS

Figure 21 presents the number of sunny, partly cloudy, overcast, and precipitation days throughout the year.

Figure 21: Cloudy, Sunny and Precipitation days

4.7.2   WIND SPEED

Figure 22 shows the number of days per month with wind speeds ranging from 0 km/h to over 61 km/h. January is relatively calm, with no days of complete calmness and occasional light breezes lasting for 0.6 days. The number of days with winds surpassing 5 km/h increases significantly to 23.2 days. February experiences occasional light breezes lasting for 0.2 days. There is a significant increase in winds surpassing 12 km/h, reaching 14.1 days. March sees a slight increase in the duration of light breezes lasting for 0.5 days. Winds surpassing 12 km/h increase to 19.7 days. April is relatively stable with no days of complete calmness.

In addition, May and June experience a decrease in the intensity and frequency of moderate winds. July and

August indicate a slight increase in the intensity and frequency of moderate winds. September is relatively calm compared to the preceding months. October and November showed an increase in the occurrence of light breezes. December is relatively calm. In conclusion, the diagram provides a better understanding of the climatic conditions in the region, showcasing the varying intensity and frequency of winds throughout the year.

Figure 22: Wind Speed

5. CLIMATE CHANGE SITUATIONAL ANALYSIS

This section presents and analyzes the climate change situation in Bomi County and its impacts on different NDC sectors relative to the county. For the impact analysis, an overview and adaptation options are also included.

5.1 CLIMATE CHANGE SITUATION IN BOMI COUNTY

Bomi County has a tropical monsoon climate. The county's climate features two seasons due to the West African Monsoon, with a wet season occurring in the summer months between May and November and a dry season occurring in the winter months, December to April[47].

Covering the period 1991-2020, the warmest month was May, with an average minimum temperature of

22.3°C, while the coldest was January, with an average minimum temperature of 20.39°C. Overall, the County has a typical tropical climate with mild winters and warm summers. The precipitation in Bomi County has undergone significant changes over time. In January, the lowest precipitation of 24.96mm was recorded, while in September, the highest precipitation of 558.17mm was observed. the months of December, January, February, and March are the 'center' of the dry season, and the precipitation is at its record low during this time.

Bomi County experiences distinct weather patterns characterized by dry and rainy seasons. The number of sunny days is highest in January (this month experienced about 21.1 days above 30°C) while February has the highest number partly cloudy days. Overcast days are relatively rare, with July recording the highest number. Precipitation days are highest in May and October, with the months of June to September also experiencing significant rainfall. In Tubmanburg, Bomi County, there is a varying intensity and frequency of winds throughout the year.

5.2 VULNERABILITIES AND RISK ASSESSMENT ON FLOODING[48]

Table 1 provides the risk assessment and vulnerability of Bomi to flooding hazards with the hazard variables, level and explanation provided.

ThinkHazard! was used to analyze the different hazards in the county in general and the different districts. It is an analytical tool dedicated to improving knowledge and understanding of natural hazards. It provides hazard levels for 11 hazards for a selected location, including Geophysical hazards (Earthquake, Tsunami, and Volcanic eruption), Hydraulic hazards (Floods (pluvial and fluvial), Landslides, Coastal floods), and Meteo-Climatological hazards (Cyclonic Strong Winds, Water scarcity, Extreme temperatures, and Wildfires). ThinkHazard! provides general education about the global distribution of multiple hazards and how to manage them. It is developed and maintained by the Global Facility for Disaster Reduction and Recovery (GFDRR Labs).

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[47] https://weatherandclimate.com/liberia/bomi

[48] https://thinkhazard.org/en/report/1814-liberia-bomi/WF

Table 1: Bomi Risk and Vulnerability Assessment

No	Hazard variables	Hazard Level	Explanation
1	River Flood	High	This means that potentially damaging and life-threatening river floods are expected to occur at least once in the next 10 years. Project planning decisions, project design, and construction methods must take into account the level of river flood hazard.
2	Wildfire	High	This means that there is greater than a 50% chance of encountering weather that could support a significant wildfire that is likely to result in both life and property loss in any given year. Based on this information, the impact of wildfire must be considered in all phases of the project, in particular during design and construction.
3	Urban Flood	Medium	This means that there is a chance of more than 20% of potentially damaging and life-threatening urban floods occurring in the coming 10 years. Aside Senjah District, the rest have 'very low' rating.
4	Coastal Flood	Medium	This means there is more than a 20% chance of potentially-damaging coastal flood waves occurring in the next 10 years. Based on this information, the impact of coastal flood should **be** considered in different phases of the project for any activities located near the coast. This is applicable only in the Dowein District.
5	Extreme Heat	Medium	extreme heat hazard is classified as **medium** based on modeled heat information currently available to this tool. This means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years.
6	Tsunami	Low	This means that there is more than a 2% chance of a potentially-damaging tsunami occurring in the next 50 years. Based on this information, the impact of tsunami may be considered in different phases of the project for any activities located near the coast. This is applicable only in the Dowein District.
7	Earthquake	Very low	This means that there is less than a 2% chance of potentially-damaging earthquake shaking in your project area in the next 50 years.
8	Landslide	Very Low	This means that this area has rainfall patterns, terrain slope, geology, soil, land cover and (potentially) earthquakes that make localized landslides a rare hazard phenomenon. Based on this information, planning decisions such as project siting, project design, and construction methods, may want to consider the potential for landslides.
9	Water scarcity	Very Low	water scarcity is classified as **very low** or non-existent according to the information that is available to this tool. However, additional information may show some level of hazard. If local or additional information sources suggest that there is drought hazard, follow the recommendations below and seek expert guidance on additional recommended actions. In the area you have selected droughts will occur much less than once every 1000 years. Based on this information, **drought hazard does not need to be explicitly considered for your project**.
10	Volcano	No data	
11	Cyclone	No data	

With the explanation given in **Table 1**, Figure 21 shows the maps different hazards in Bomi County, Liberia.

Bomi Costal Flood

Bomi Earthquake

Bomi Extreme Heat

Bomi Landslide

Bomi River Flood

Bomi Tsunami

Bomi Urban Flood

Bomi Water Scarcity

Bomi Wildlife
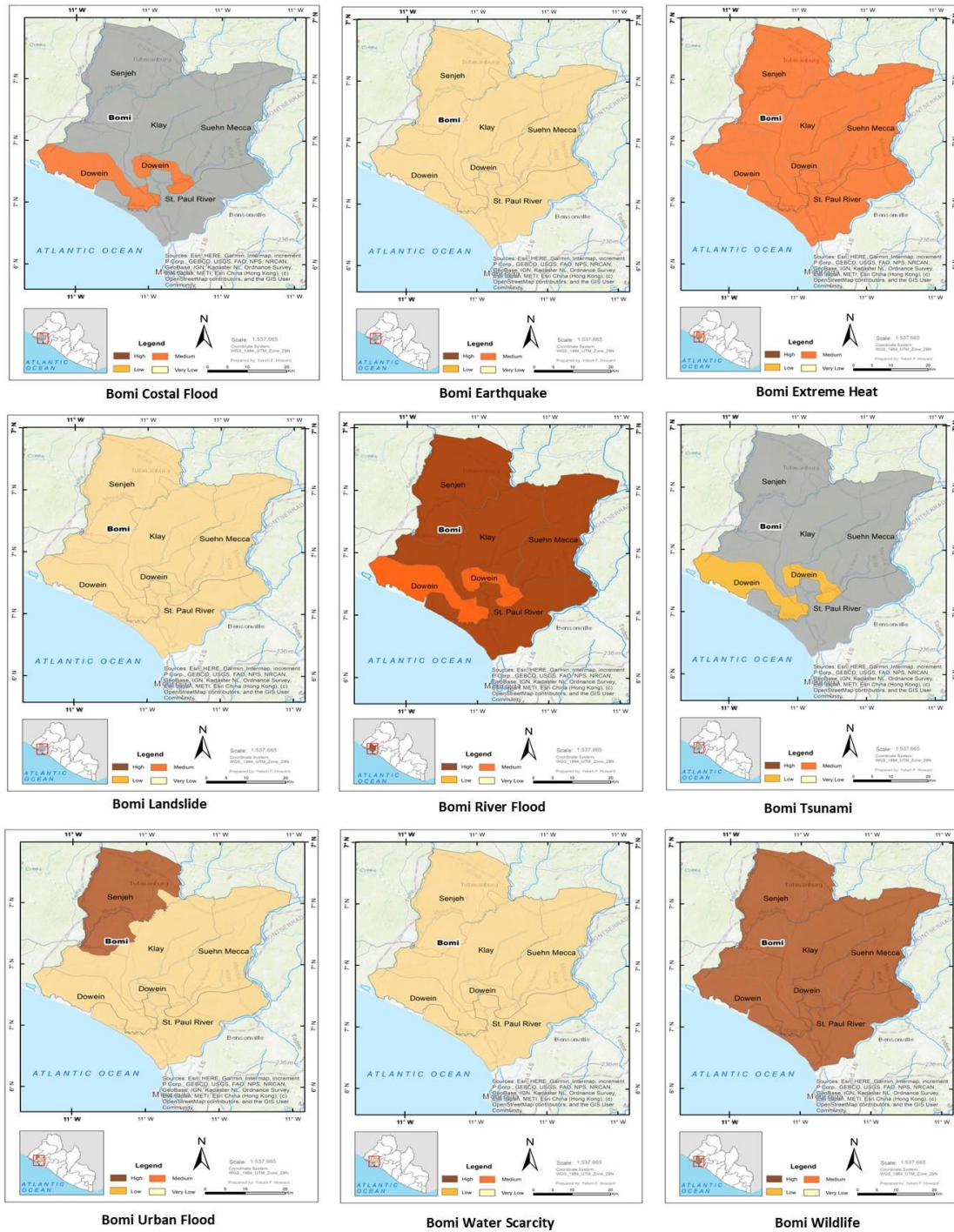
Figure 23: Bomi hazards maps

5.3 IMPACTS OF CLIMATE CHANGE ON DIFFERENT NDC SECTORS RELATIVE TO BOMI

The climate in Liberia has already changed, with increases in mean annual temperature and decreases in mean annual rainfall since 1960[49]. Thus, the same is true for Bomi. Projected future changes include further temperature increases and decreases in annual rainfall, with a greater likelihood of extreme rainfall events. These changes are expected to adversely impact Liberia's coastal, forestry, and agricultural sectors, potentially flooding lowland areas[50].

5.3.1 IMPACTS ON AGRICULTURE

5.3.1.1 Overview

Like most counties, Bomi County's agriculture is rainfed. The sector is the foundation of the county's economy and the key to food security and poverty reduction. Agriculture practices are characterized by traditional slash-and-burn and shifting cultivation. According to 2020 data, the country's GDP is dominated by the agriculture sector (inclusive of fishing and forestry), which accounts for 42.6% of GDP.

The agricultural sector supports many families who work in the cassava, rubber, rice, oil palm, cocoa, and sugarcane industries. According to LISGIS (2017), in Bomi County, 39.1% of women and 64.3% of men aged 15-49 were employed in the agriculture sector (12 months preceding the survey). Relative to the estimated production of rice based on farmer estimate, Bomi has 12,498 farming households, with a total rice production of 13,413MT and total cassava production of 27,916 MT.

Of the total number of farming households in Bomi County (12 498), the number of farming households engaged in cash crops production include Cocoa (137), Coffee (NA), Oil Palm (307), Rubber (1187) and Sugar Cane (204). Also, the number of farming households engaged in fruits production, Banana (640), Papaw/Papaya (294), Pineapple (626), and Plantain (891**).** Furthermore, households in Bomi County are engaged in vegetable production including Bitterballs (4837), Cucumber (1837), Egg Plant (2050), Okra (3324), Pepper (4787), and Pumpkins (1675).

However, climate change may exacerbate food insecurity in Bomi by reducing agricultural yields due to erratic rainfall patterns and increasing the salinity of freshwater aquifers. Like all other counties in Liberia, Bomi is no different from these trends of climate change in the agricultural sector.

5.3.1.2 Risks and Impacts

The agriculture sector in Liberia is vulnerable to the negative consequences of climate change. Due to the sector's reliance on the weather forecast, it is more susceptible to the daily changes in weather and climate. Bomi is one of the most vulnerable counties to the effects of climate change, with the projected increasingly severe weather occurrences expected to affect the agriculture sector. It has been estimated that future climate scenarios will exacerbate the already experienced reduced productivity on agriculture. Key climate impacts on agriculture and livelihoods in Bomi include increased crop losses/failure, more pests, weeds, and pathogens, as well as increased food insecurity.

The changes in precipitation patterns have impacted crop schedules and agricultural management timing. A decrease in agricultural production has been connected in recent years to climate change-related fluctuations in precipitation patterns and rising temperatures, which reduce soil moisture and water resources for farming applications. Additionally, changes in the onset and duration of rainy seasons could occur. Crops are vulnerable to climate variations, resulting in reduced yields during droughts and varying productivity. In the country, food insecurity is widespread, with approximately 20% of households considered food insecure. The highest rates of food insecurity are found in Bomi (55%).

The traditional slash-and-burn and shifting cultivation lead to rapid deforestation, environmental degradation, and the release of greenhouse gases (GHGs), especially carbon dioxide (CO_2), by cutting trees and burning vegetation.

5.3.1.3 Adaptation Options

As per the National Adaptation Plan 2020-2030, the recommended adaptation measures for agriculture in Bomi are to introduce climate-resilient farming

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[49] Climate Change / Liberia | Interactive Country Fiches. (n.d.). Dicf.unepgrid.ch. https://dicf.unepgrid.ch/liberia/climate-change

[50] Climate Risk Profile: Liberia (2021): The World Bank Group.

practices, encourage crop diversification, improve water management, and invest in infrastructure to reduce the negative effects of extreme weather conditions.

Also, the county aims to reduce vulnerability to climate change by decreasing risk exposure and increasing adaptive capacities and national resilience strategies. There are several contributing factors to Bomi's vulnerability to climate change conditions including mal-adapted agricultural activities, an overdependence on biomass leading to high levels of deforestation, inadequate infrastructure, low level of socio-economic development, low institutional, amongst others. Thus, these issues need to be addressed to reduce the risk and potential impacts on the agriculture sector.

Additional issues to be addressed to reduce the risk and potential impacts on the agriculture sector: (1) Access to road, transportation, and storage facilities; (2) Adapt to new technology and use of improved and adapted rice seeds; (3) Irrigation to reduce impacts of flood events; (4) Diversification of both livelihood and cash crops to improve resilience; (5) Use of equipment for early land preparation; and (6) watering machines for vegetable farmers.

Furthermore, farmers should be encouraged to move away from upland to lowland farming, which reduces the incidence of slash-and-burn agriculture and its impact on the environment. Thus, ensure that lowland farming is sustained through the provision of needed tools. Sustainable climate-smart upland farming using improved small-scale solar irrigation schemes and other cost-effective water management practices should be championed.

Finally, investing in research and extension services can improve the capacity and effectiveness of providing information to the agricultural sector, especially with regards to climate change and the adoption of adaptation strategies.

5.3.2   IMPACTS ON FORESTS

5.3.2.1 Overview

The impacts of climate change on forests in Liberia are significant and encompass various environmental, social, and economic aspects. Liberia, the most forested country in West Africa, is home to most of the remaining Upper Guinean Rainforest, a global biodiversity hotspot. Liberia contains approximately 7.5 million hectares of tropical forest that comprise more than 43 percent of the remaining upper guinea forest of West Africa, extending from neighboring Guinea to Togo[51].

Bomi County is a region with a diverse and rich range of species. The county's ecosystems are part of the Upper Guinea rain forests, which are classified as one of the world's biodiversity hotspots. Compared to other counties in the northwestern region, Bomi has the smallest forested areas. These areas have been disturbed and deforested due to various factors, including logging activities, mining, agricultural expansion, poaching, and infrastructure development over many decades.

5.3.2.2 Impacts

Climate change impacts on Bomi's forests are significant and have the potential to affect the ecosystem and the services provided by forests. projected increasingly severe weather occurrences expected to affect the forestry sector. There were 19,382 deforestation alerts reported in Liberia between 6th of January 2024 and 13th of January 2024, covering a total of 237 ha of which 0.42% were high confidence alerts detected by a single system and none were alerts detected by multiple systems[52]. With the given statistics of forest depletion in Liberia, and as the case in any other county within the country, climate change in Bomi can alter the growth and productivity of forests through changes in temperature, rainfall, and other factors.

Elevated levels of carbon dioxide can also influence plant growth, affecting the overall health and productivity of forests. Climate change is likely to alter the frequency and intensity of forest disturbances, including wildfires, storms, insect outbreaks, and the occurrence of invasive species. These disturbances can have detrimental effects on forest ecosystems. Climate change exacerbates the problems faced by forests from land development and air pollution. The combined impact of these factors is already leading to

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[51] Liberia National Forest Inventory, 2019

[52] Global Forest Watch

changes in forests, compromising the valuable goods and services provided by forests.

It has been estimated that future climate scenarios will exacerbate the already experienced reduced productivity on forests. Increased precipitation will impact vulnerable zones of forests and biodiversity and may see an increased incidence of flooding and erosion due to deforestation and habitat degradation.

Most natural resources are sensitive to climate change. Plant and animal species respond to extreme weather conditions, and communities are scattered across different climate zones. Climate change impacts on natural forested ecosystems, especially protected areas, are exacerbated by short-term stresses from development activity.

5.3.2.3 Adaptation Options

The adaptation options for forests in Bomi include implementing sustainable forest management practices, reforestation efforts, ecosystem-based approaches to conservation, and the development of resilient forest landscapes. Additionally, initiatives such as community-based forest management and the restoration of degraded forest areas can contribute to building adaptive capacity and enhancing the resilience of forests in the face of climate change impacts.

It is crucial for all stakeholders to participate in the monitoring, assessment, and adaptive management of forests to ensure their long-term sustainability and preserve the ecosystem services they provide. Collaborative efforts among governmental agencies, local communities, and conservation organizations are essential to address the impacts of climate change on forests in Bomi and implement efficient adaptation measures.

5.3.3   IMPACTS ON COASTAL ZONES

5.3.3.1 Overview

Bomi is one of Liberia's coastal counties. Climate change has significant impacts on coastal zones in Liberia, including coastal erosion, sea level rise, and increased vulnerability to storm surges. These impacts threaten coastal communities, infrastructure, and ecosystems. Liberia's coastal zone, home to nearly 60% of the population, is at risk due to climate change[53]. Liberia is recognized as highly vulnerable to climate change, particularly for the coastal zones, public health, agriculture, water, and fishery sectors and sea level in the country is projected to rise 0.13-0.56 m by the 2090s, relative to the sea level from 1980-1999[54].

5.3.3.2 Impacts

The climate change impacts on coastal zones in Bomi, Liberia, have significant implications for the region. The impacts include rising temperatures, changes in rainfall patterns, sea level rise, coastal erosion, and an increased risk of natural disasters. Sea level rise, coastal flooding, and erosion are increasing stress on the region, causing significant damage to agriculture, fishing, and infrastructure[55]. Liberia's EPA warned that rising sea levels could lead to migration to higher lands and shock waves of inundation. The combined effects of ongoing coastal erosion, climate change-induced sea-level rise, storm frequency and intensity, precipitation increases, and warmer ocean temperatures will create significant risks in coastal areas.

5.3.3.3 Adaptation Options

The adaptation options for the county's coastal areas include, but not limited to, the following:

-   Develop and implement coastal zone policy, design, and management plan (NDC, 2015)
-   Assess and build the capacity of agencies at the county level responsible for managing coastal adaptive capacity in the sector.
-   Develop an integrated management plan for coastal zone management as well as an early warning system that includes training and capacity development for coastal management and monitoring.
-   Promote and implement disaster risk management in general (especially disaster preparedness).

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[53] Liberia: National Adaptation Plan 2020 – 2030.

[54] Climate change / Liberia | Interactive Country Fiches. (n.d.). Dicf.unepgrid.ch. Retrieved January 18, 2024, from

http://dicf.unepgrid.ch/liberia/climate-change#:~:text=Liberia%20is%20recognised%20as%20highly

[55] Liberia: National Adaptation Plan 2020 – 2030.

- Support the rehabilitation and protection of wetlands, including awareness and education of their host communities.
- Develop and implement a program for climate-proofing new investments in infrastructure (roads, sewers, water supplies, and other infrastructure) in coastal settlements and rural areas to protect continuous access to livelihoods, health care, and education.
- Design and implement a strategic communication action plan to inform and educate people about changes and challenges associated with coastal areas related to climate change at the county level and how they can adapt to cope with these changes and challenges.
- Construct sea walls or revetment (NDC, 2015), where there is high risk of coastal erosion. Hence, the risk level in Bomi County (especially Dowein District which has coastal communities) may not be high in comparison to other coastal communities in different counties.

5.3.4   IMPACTS ON FISHERIES

5.3.4.1 Overview

There is no doubt that the fishery sector has enormous potential for lifting the poor out of poverty and, over the years[56]. Species of fish are an essential component of the Liberian diet and the primary source of protein in coastal areas. Liberia's fisheries include coastal marine fisheries involving industrial and artisanal activities; inland river and lake fisheries, which are underdeveloped and artisanal; and aquaculture, which consists of small, freshwater ponds producing tilapia in rural areas non-coastal communities.

Having already suffered during the civil war, the fisheries sector now faces risks from climate change and climate variability. Climate change is a major

driving force to the decline in fish species in Liberia's fishery sector.

5.3.4.2 Climate Change Impact

In general, the fisheries sector has been affected by climate change through increased sea surface temperature[57]. The USAID (2017) report indicates that an increase in temperature is causing disruption to production patterns and migration of fish species and has reduced aquatic biodiversity and the overall productive capacity. While on the other hand, the increased frequency of intense precipitation has led to more frequent loss of fishing days caused by bad weather, loss of income and livelihoods, and reduced protein intake. Rising sea surface temperatures reduce biodiversity and overall stocks because of death, diminished reproductive cycles, and migration to cooler waters. Changing rainfall patterns, particularly during the dry season when the inland river and pond levels are low, are causing significant numbers of fish to die. Those that survive are often exposed to waters contaminated from pesticide runoff and other pollutants.

Indeed, climate change has impacted the fishery sector by shifting the distribution of species, biodiversity loss, and loss of livelihoods[58]. Changes in precipitation and evapotranspiration are more likely to affect freshwater fisheries through increased sedimentation from extreme events, lower water levels from drought, and other biophysical processes including eutrophication.

Climate-induced differences in Liberia's biophysical characteristics, along with extreme events, have had significant effects on the ecosystems that support fish (mostly inland). With respect to marine fisheries, climate change risk assessment indicated that fish species might experience low productivity or may migrate away from Liberian waters. Decreasing fisheries productivity will impact communities in several ways, including reduced earnings from fish exports and increased food insecurity[59].

Inland fisheries, particularly crucial for small-scale artisanal fishers in Liberia and an integral part of

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[56] FAO, 2006.

[57] USAID. (2017). Climate Risks in Food for Peace Geographies. USAID.

[58] USAID. (2017). Climate Risks in Food for Peace Geographies. USAID.

[59] Fobissie, K. Kannah, J., & Luo, H. (2019). Climate Vulnerability and Risk Assessment for the Sectors of Agriculture, Fisheries, and Forestry in Liberia. Monrovia: EPA.

Liberian rural livelihood and food security systems, could be severely impacted by climate change. Nearly the entire inland fishery lies in the Southern Upper Guinea Aquatic Eco-region. About 20% of the 151 fishes from the eco-region are endemic [60]. Nevertheless, so little is known about the inland fishery regarding rates of exploitation, diversity, and status of fishes exploited, several fishers, and state of the aquatic ecosystem that projections of climate change impacts on this critical national resource are virtually impossible beyond broad generalizations.

During the fisheries sector assessment [61], 116 fishermen respondents associated the fishery sector's climate vulnerabilities with sea-level rises, flooding, and coastal erosion. The fishermen also revealed that sea storms resulting from increased precipitation have reduced fish catch, which has impacted the activities of the women involved in drying fish.

5.3.4.3 Adaptation Options

Relative to the national level[62], the following options are provided:

- Strengthen the capacity of the Bureau of National Fisheries (BNF), including staffing and logistics for research monitoring and enforcement. More so, BNF should have its presence at the county-level.
- Invest in and support artisanal fishing communities, including training, fishing gear, and alternative livelihoods.
- Set up robust Monitoring, Reporting, and Verification (MRV) system that captures and reports timely and accurate changes in the stock of productivity and pressure on fisheries; and implement adaptive management practices for managing the sector.
- Support research to fully understand pressures on fisheries related to climate change impacts and identify appropriate measures, including diversification of livelihood portfolio of fishery-dependent communities.
- Identify, map, and protect areas valuable for fisheries (e.g., deep pools in river systems that

serve as spawning areas), including the setting up of marine protected areas.
- Support the establishment of a system to reduce external stressors on fisheries by instituting changes in a vessel or gear types as well as instituting actions and regulatory measures to reduce land-based sources of pollution (e.g., agricultural, and urban runoff) and destructive fishing practices (e.g., fishing with explosives and poisons).
- Integrate fisheries fully into climate change adaptation and food security policies at the national level (draft and enact where non-existent) to ensure incorporation into broader development planning.
- Support the diversification of the livelihood portfolio of fishery-dependent communities.
- Support the establishment of early warning systems to identify probable threats and risks related to fisheries.
- Support the establishment of improved information and communication networks for decision making and planning and between fishing communities to support information sharing about potential shocks in the system.
- Establish a surveillance system to promote a smart fishery system.
- Promote sustainable fishing practices and policies Regulate fishing practices to prevent overexploitation and fishing in restricted areas
- Conduct capacity building among the sector.

5.3.5   IMPACTS ON HEALTH

5.3.5.1 Overview

The Health Care system in general is poor and lack basic systems and facilities. Eighty percent of clinics across the country were shuttered during the war by looting, destruction, and flight of health personnel[63]. Rural communities suffered from high mortality and morbidity, resulting from a combination of poor living conditions and lack of quality health care. In Liberia, malaria is one of the leading causes of morbidity and mortality in Liberia, and the number one cause of death

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[60] Liberia: National Adaptation Plan 2020 – 2030.

[61] ibid

[62] ibid

[63] National Transitional Government of 2004 as cited in Kruk, M. E., Rockers, P. C., Tornorlah Varpilah, S., & Macauley, R. (2011).

Population preferences for health care in liberia: insights for rebuilding a health system. *Health services research*, *46*(6pt2), 2057-2078.https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3392998/

for children under age five. Life expectancy in Liberia is much lower than the world average. Communicable diseases are widespread, including tuberculosis, diarrhea, malaria, HIV, and Dengue.

The impact of climate change on health in Liberia is significant and encompasses a wide range of challenges. Bomi is expected to experience health effects caused by climate change, mainly due to the increasing incidence of rising temperatures, heat waves, and floods. Some of the highest rates of diseases are caused or exacerbated by environmental factors and will likely be further intensified by climate change. Public Health care facilities in the county are heavily dependent on the international community, including NGOs, for assistance.

The county faces climate-related hazards such as epidemics, floods, tropical storms, tidal abnormalities, and coastal erosion. Vulnerability to climate change is particularly high in coastal zones, public health, agriculture, water, and fishery sectors.

A national vulnerability risk assessment and mapping for priority hazards was implemented in all 15 counties, leading to the identification of 33 hazards[64]. A total of 12 of these hazards were prioritized and profiled, namely COVID-19, Lassa fever, meningitis, Ebola, rabies, measles, cholera, acute bloody diarrhea (shigellosis), flooding, yellow fever, chemical spills (of cyanide, arsenic, lead and mercury) and fire.

5.3.5.2 Impacts

Liberia has already experienced changes in its climate, including an increase in mean annual temperature and a decrease in mean annual rainfall. Projections indicate further increases in temperature and changes in rainfall patterns. Increased/ excessive rainfall and flooding and higher temperatures will increase the incidence of vector and waterborne diseases such as cholera, malaria, diarrheal diseases, yellow fever and schistosomiasis.

Increased Mean Annual Temperature: The mean annual temperature in Liberia has increased by 0.8°C between 1960 and 2006, with projections indicating a further increase by 2060. This increase in temperature can lead to a range of health issues such as heat-related illnesses. Increase in extreme rainfall intensity

is leading to more concentrated and intense precipitation events, which can cause flooding, landslides, and the spread of waterborne diseases. The specific health impacts include increased health emergencies.

5.3.5.3 Adaptation Options

The adaptation options for the health sector consist of the following:

- Implement public health programs to address heat-related illnesses, waterborne diseases, malnutrition, and other health impacts resulting from climate change.
- Develop early warning systems, emergency response plans, and infrastructure to mitigate the impacts of floods, tropical storms, and other climate-related hazards on public health.
- Ensure access to clean and safe water sources to mitigate the health impacts of water scarcity and prevent the spread of waterborne diseases.
- Invest in healthcare infrastructure and facilities to provide adequate healthcare services in response to climate-induced health emergencies.

5.3.6 IMPACTS ON TRANSPORT

5.3.6.1 Overview

Climate Change Impacts on Transport sector and vice versa. As of 2021, Liberia had about 29 airports, of which two airports have paved runways with a concrete or asphalt surface, but not all have facilities for refueling, maintenance, or air traffic control. The remaining 27 airports have unpaved runways with a surface composition such as grass or packed earth and are most suited to the operation of light aircraft [65]. Unfortunately, Bomi doesn't have any domestic airport.

The country also boasts of 4 km oil pipelines. The railways are about **total:** 429 km (2008). The total merchant marine is 4,311 (2022) constituting bulk carriers 1,673, container ships 962, general cargo 141, oil tanker 907, other 628. The major seaports are Buchanan and Monrovia. Bomi has had a railway that

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[64] https://www.who.int/about/accountability/results/who-results-report-2020-2021/country-profile/2021/liberia

[65] CIA Fact book

was destroyed during the civil war. The county doesn't have a seaport also.

Liberia's current road network reaches approximately 73 percent of the total population and that road quality has long been a matter of concern. The road network deteriorated significantly because of the chronic lack of maintenance during and since the long civil war. According to the World Bank[66], more than 90 percent of paved roads are in good or fair condition, but nearly 60 percent of unpaved roads remain in poor or very poor condition. The secondary and tertiary road networks, which constitute last-mile connectivity in rural areas, appear in particularly poor condition. Approximately 40 percent of primary roads, 50 percent of secondary roads, and 60 percent of tertiary roads are in poor or very poor condition, figures which compare unfavorably with Liberia's neighbors.

The major sources of transport from Bomi to other parts of the county and country are by road with taxis, trucks, buses and motorbikes being the major means of transportation.

5.3.6.2 Impacts

The mean annual temperature has increased by 0.8°C between 1960 and 2006 and is projected to increase further. Higher temperatures can impact road infrastructure and vehicle performance. Reduced rainfall can impact road conditions and transport accessibility. Projections indicate an increase in extreme rainfall intensity by mid-century, leading to potential flooding, landslides, and road damage. Also, coastal erosion and sea level rise pose risks to transportation infrastructure and affect accessibility in coastal areas.

5.3.6.3 Adaptation Options[67]

The following adaptation options recommended in Liberia's NAP and NDC:

- Implement resilient road and transportation infrastructure to withstand the impacts of climate change, including flooding, coastal erosion, and extreme weather events.

- Develop and maintain effective drainage systems to mitigate the impact of increased rainfall intensity on road conditions and transportation accessibility.
- Implement coastal zone management strategies to address coastal erosion and sea level rise impacts on transportation infrastructure.
- Incorporate climate resilience into transport planning, including the development of alternative transport routes to address access challenges due to climate change impacts.

5.3.7 IMPACTS ON INDUSTRY

5.3.7.1 Overview

Liberia's vulnerability to climate change and variability stems from high levels of poverty combined with a heavy dependence on natural resource-intensive sectors such as agriculture, fisheries, and forestry. The country's natural resource wealth, particularly mining, has driven economic growth since the end of the civil war in 2003.

5.3.7.2 Impacts

Increased mean annual temperature by 0.8°C between 1960 and 2006, with further projected increases in mean annual temperature and decreases in mean annual rainfall. The projected decrease in annual rainfall but increased extreme rainfall intensity, leading to potential flooding in lowland areas, and adverse impact on coastal, forestry, and agricultural sectors. It is also projected that sea level rise of 0.13-0.56 meters by the 2090s will lead to erosion, damage to infrastructure, and population displacement in coastal areas. Note, if these impacts occur, the industries at the national and local level will be affected.

5.3.7.3 Adaptation Options

Adaptation options for addressing the impacts of climate change on industry in Bomi, Liberia, may include:

- Implementing measures to reduce land degradation and deforestation.
- Developing resilient agricultural practices to mitigate the impact of changing rainfall patterns on crop yields.

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[66] https://elibrary.worldbank.org/doi/pdf/10.1596/978-1-4648-1286-6_ch2

[67] Climate Risk Country Profile: Liberia (2021) by the World Bank Group; Problems of Climate Change in Liberia: A Review of Major

Impacts and Adaptation Strategies for the Key Sectors (2020) by the Environment Protection Agency (EPA), Liberia

- Enhancing infrastructure resilience to withstand flooding and coastal erosion.
- Strengthening coastal management and adaptation measures to address sea level rise and erosion.
- Addressing water quality issues and increased risk of vector- and waterborne diseases through improved water, sanitation, and hygiene (WASH) practices.

5.3.8 IMPACTS ON ENERGY

5.3.8.1 Overview

Liberia's energy sector is vulnerable to climate change, and variability stems from increasing temperature and decreasing precipitation. The energy sector in Liberia, especially in Bomi, is likely to be affected by changes in climate and extreme weather events. The Mt. Coffee hydropower provides about 88 MW of hydropower during the wet season (June-December). However, due to the high seasonality of the hydropower, during the dry season (January-May), the country relies on expensive liquid fuel plants to meet its electricity needs. Thus, few communities in Bomi County are currently connected to the national grid.

5.3.8.2 Impacts

Climate Change has an impact on the energy sector due to changes in temperature and precipitation patterns. Mean annual rainfall over Liberia has decreased since 1960, with projected further decreases and an increase in extreme rainfall intensity, affecting hydropower generation and water availability for energy production. This affects reliability of energy sources for heating and lighting in homes. Due to the high seasonality of hydropower and high electricity demand, massive load-shedding during the dry season leaves many areas with electricity supply for only a few hours of the day. For instance, very "hot" days and nights are already being observed in some parts of the country, already increasing demands for electricity to cool temperatures and thus also increasing the cost of living.

5.3.8.3 Adaptation Options

Options for addressing the impacts of climate change on energy in Bomi, Liberia, may include:

- Diversification of energy sources to reduce dependence on hydropower and to increase the resilience of the energy supply.
- Investment in renewable energy sources such as solar and wind, as well as energy storage solutions to ensure a reliable and resilient energy supply.
- Enhancing the resilience of energy infrastructure to withstand extreme weather events and natural disasters.
- Implementation of climate-resilient energy policies and practices to ensure sustainable and reliable energy access in the face of climate change impacts.

5.3.9 IMPACTS ON WASTE

5.3.9.1 Overview

Liberia is facing significant challenges in its municipal solid waste management system (MSWM), exacerbated by urbanization and inadequate waste management infrastructure [68]. The impact of urbanization and lack of sustainable waste management practices have contributed to environmental degradation, public health risks, and economic strain on infrastructure and social facilities. Bomi doesn't have the required waste collection facilities.

5.3.9.2 Impacts

The impacts of climate change on the sector are not well understood owing to limited data. The waste management sector of Liberia is challenged with inadequate waste management systems, poor engineering facilities, inadequate regulation, and insufficient logistical and human resource capacity to handle the enormous waste generated in densely populated communities.

The climate in Liberia has already changed, with increasing mean annual temperatures and decreasing rainfall. The country is projected to experience further warming and changes in rainfall patterns, leading to potential flooding and adverse impacts on coastal, forestry, and agricultural sectors. Additionally, climate-related hazards such as floods, tropical storms, and coastal erosion pose significant risks, with sea level rise projected to affect coastal zones and informal

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[68] Rethinking sustainability: a review of Liberia's municipal solid waste management systems, status, and challenges

(https://www.tandfonline.com/doi/pdf/10.1080/0734242X.2022.2035420)

settlements. The seasonality in Liberia provides different patterns of consumption and waste generation. Populated communities in the county (incredibly informal settlements) are prone to water-borne diseases due to poor waste management.

5.3.9.3 Adaptation Options

To address the challenges, collaborative efforts that focus on waste minimization, recycling, resource recovery, and sustainable waste management practices are recommended. Policies and legislation alone are insufficient; the effective management of waste requires financial and technological proficiency, skilled human capacity, technical and social resources, educational awareness programs, and active public participation.

5.4   VULNERABILITY ASSESSMENT ON DIFFERENT SECTORS

Table 2 below provides the vulnerability assessment on different NDC sectors as it pertains to Bomi County.

Table 2: Vulnerability of NDC sector relative to Bomi County

Sector	Hazard	Exposure	Vulnerability (Sensitivity + Adaptive Capacity)	Impacts
Agriculture	Temperature and rainfall during the growing season as well as salinity.	Several acres of farms with both food and cash crops (rice, cassava, oil palm, rubber, cocoa, etc.) are exposed. Household incomes and the country's GDP	There will be negative changes in crop yield. Dependence on food from other parts of the country will increase. Agriculture will remain rainfed for a period of time, as there is a lack of irrigation infrastructure to supply water to farms, especially during the dry season. Simple farming machines are needed, and farming technologies are limited (no weather stations, new farming systems, etc.).	Key climate impacts on agriculture and livelihoods in Bomi include increased crop losses/failure, more pests, weeds, and pathogens, as well as increased food insecurity. The traditional slash-and-burn and shifting cultivation lead to more deforestation, environmental degradation of Bomi, and the release of greenhouse gases (GHGs), especially carbon dioxide (CO2), by cutting trees and burning vegetation. Loss of jobs in the agriculture sector and effect on the country's GDP.
Forests	Temperature and precipitation shift, insect and disease outbreaks, human and land-use activities (drivers of deforestation and degradation)	Forest areas (community, conservation, and commercial forests)	Weak law enforcement, limited community resource management capacity, limited awareness and education on resource importance	Biodiversity loss; ecosystem services will be affected; livelihoods will be impacted greatly
Coastal Zones and Fisheries	Coastal erosion, Sea-level rise, Storm surges, changes in precipitation patterns, ocean warming and acidification	Communities, livelihoods, coastal infrastructures (ports, landings, canoes, boats, etc.), settlements, and mangroves	Weak governance, limited adaptation measures, increasing coastal population, dependence on fishing activities, ineffective early warning systems	There has been an increase in coastal erosion, destruction of properties and infrastructure, loss of livelihoods, increased poverty, and a reduction in coastal resources and services. There could be a decline in fish stock and oceanic resources.
Health	Heatwaves, Vector-borne diseases (malaria, dengue fever, etc.), Waterborne Diseases (	The general population (especially elderly and vulnerable groups), coastal terrains, Low-income communities	asthma, cardiovascular diseases, diabetes patients, Elderly individuals, children, pregnant women, fragile healthcare systems, less equipped health centers, healthcare infrastructure resilience, early Warning Systems,	There has been an increase in heat-related illnesses and diseases carried by vectors, which has led to strained public health systems and higher mortality and morbidity rates.

	cholera and diarrheal diseases), Food Insecurity and floods		training healthcare professionals, community engagement, and poor WASH sector	
Transport	Extreme weather events (storms, floods, and landslides), temperature extremes, and Sea level rise	Canoe landing, Road networks (laterite and asphalt), bridges, and supply chain distortion	More laterite/earth roads, poor/limited drainage system, impact on travel plans/movements, resilient infrastructure investment, diversified transport systems, transport planning, a need for effective early warning systems and emergency response plans	Stranded travelers and communities, food insecurity, disrupted supply chains, increased road maintenance and construction costs, and increased construction costs.
Energy	Extreme Weather Events (storms, floods which can damage power plants, transmission lines, and distribution networks.), Sea Level Rise, high temperature, and low precipitation	Thermal plants, sub-stations, Hydro power plants, energy distribution networks. Dependency on Water	Hydroelectric power is heavily relied upon, while energy sources lack diversity. Some Infrastructures are outdated. There is a need for an energy mix (technological advances). Increased energy demand	Reduced power generation capacity; increased risk of outages; hindrance to economic activities Decreased power generation capacity, power outages, a low energy supply, security issues, livelihood issues, and high business costs hinder economic growth.
Industry	Extreme weather events (storms, floods, and heat waves), Water scarcity, energy disruption	Industrial facilities and processes, reliant on natural resources, supply chains	Industrial infrastructure, water and energy demands, limited wastewater treatment facilities, product quality, Investments in technology and innovation, Improving resource efficiency and waste management practices, Developing risk management strategies	Businesses may face decreased industrial productivity, increased operational costs, and the potential relocation or closure of vulnerable industries.
Waste	Weather events (temperature, precipitation, Flooding), sea-level rise	Waste management facilities and operations, population/residents, and landfills/dumpsites	Waste infrastructure lifespan, high capital costs, influence on waste management practices and treatment technologies, Climate-related regulations and policies. Investments in resilient waste management infrastructure, promote sustainable waste management, and improve or foster community engagement.	Increased public health risks, groundwater risk, water quality issues, bad odor, affect aesthetic view

5.5 RESILIENCE IMPROVEMENT STRATEGIES

These strategies reflect the importance of building resilience in different sectors to address climate change impacts, enhance adaptive capacity, and promote sustainable development. To promote conservation and sustainable forest management in Bomi, the following resilience strategies could be employed:

5.5.1 Forest Areas

- Building resilience for adaptation to climate change through sustainable forest management.
- Enhancing the ecological resilience of forested areas through the protection and restoration of natural buffers such as forest covers etc.
- Addressing climate change impacts on the delivery of crucial goods from forests through adaptive management strategies.

5.5.2 coastal zones

- Establishing integrated adaptation strategies that address the unique challenges faced by coastal areas, such as infrastructure development, ecosystem-based adaptation, and policy advocacy.
- Implementing early warning systems and emergency preparedness to reduce the vulnerability of coastal communities to climate change and disasters

5.5.3 Fisheries

- Enhancing the resilience of fisheries and aquaculture sectors to disaster and climate change impacts.
- Empowering local communities and building capacity to implement and sustain climate adaptation initiatives

5.5.4 Health

- Improving the resilience of the health system to disasters and disease outbreaks, building on lessons from past crises such as the Ebola and COVID-19 outbreaks.
- Strengthening national and local capacity to respond to public health emergencies and climate change impacts on health

5.5.5 Transport

- Developing and implementing resilience strategies for transportation systems to proactively address climate change impacts and extreme weather events.
- Conducting vulnerability assessments and integrating advanced climate analytics and geographically specific climate models with infrastructure data

5.5.6 Industry

- Implementing climate risk and resiliency programs to maintain and gain investor buy-in and adapt to climate change impacts.
- Ensuring sustainability in logistics and supply chain management through sustainable certifications and practices

6. CLIMATE CHANGE PERCEPTION INDEX

The Climate Perceptions Index provides new and unique data and information on people's awareness of climate change, their perception of its associated risks, and their commitment to climate action. It aims to offer insights for political leaders on how to improve public support for climate action in their country[69].

The index covers Bomi County, taking into consideration the NDC sectors. This section provides an overview of the index's methodology and findings. The index is based on the FGD and KII held at the county level. The FGD was held in January 25, 2023 at the FDA's Headquarters, while the KII was done from January 25 – February 10, 2023. It considered both opened and closed ended questions grouped into 3 dimensions of Climate Perceptions: Awareness and Educcation, Risk/Impacts Perception, and Commitment to Action.

6.1 PERCEPTION FROM THE FOCUS GROUP DISCUSSION (FGD)

6.1.1 Forestry Sector Highlights

The discussion with the FDA team, including the Regional Forester, highlighted current forestry activities in the county, including chainsaw milling and logging (mostly from lower Bomi towards Gbarpolu County). The sector (forest area) is being adversely affected by farming (slash and burn), charcoal production, and

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[69] Shtitich, M., Krylova, P., Harmacek, J., Lisney, J. (2022). Climate Perceptions Index.

sawn-timber production, which contribute to deforestation and degradation that are driven by poverty stemming from the lack of alternative economic activities.

Stakeholders are adequately aware of climate change, however community awareness and education efforts remain insufficient, with no specific programs initiated yet. The impacts of climate change include changes in weather patterns that exacerbate food shortages and water scarcity, and reduced agricultural production which leaves the forest sector vulnerable to climate hazards.

Climate governance exists at the regional level and through stakeholder engagement, but there are gaps in policy development and implementation. Despite previous investments by the World Bank to raise awareness, there is a lack of support mechanisms for stakeholders. This highlights the need for more training opportunities that can be funded by county and social development funds. Ongoing and planned projects are focused on raising community awareness and suggest collaboration opportunities among stakeholders. Regular monitoring and evaluation are essential for improvement and better outcomes.

6.1.2 Transport Sector Highlights

Transportation in the county primarily involves road transport between urban and rural areas. However, feeder roads are severely affected by climate change-induced damage during the rainy season.

Despite these challenges, there are no ongoing efforts or initiatives to address climate change in the transport sector, and stakeholders have minimal knowledge of its impacts. It has been observed that poor road conditions can lead to vehicle damage, limited movement, and increased transport costs. However, vulnerable communities are not being specifically identified.

It's worth noting that there are currently no known strategies, policies, capacity-building initiatives, or investments in climate change projects within the transportation industry. This is largely due to a lack of technology utilization and collaboration opportunities, which makes it difficult to monitor and evaluate progress. As a result, urgent intervention and comprehensive strategies are needed to address climate change resilience and sustainability in the transportation sector.

6.1.3 Agriculture Sector Highlights

The Ministry of Agriculture (MoA) team in the county provided insights into the current agricultural practices, strategies and impacts related to climate change in Bomi County. Key findings during the FGD included the reliance on rain-fed agriculture with minimal external inputs in the county. It was also found that there is high awareness of climate change impacts such as flooding and drought leading to crop shrinkage and low productivity. There are available adaptation strategies including encouraging lowland farming and water harvesting.

The agriculture sector has a decentralized governance structure involving stakeholders such as farmers, extension workers, district agriculture officers, and county coordinators. However, the sector faces challenges due to limited policies, low education levels, and under-resourced support mechanisms.

It seems that in the sector, there have been successful capacity-building programs through previous donor-sponsored projects. However, at present, there are limited investments and ongoing projects aimed at addressing climate change in the county. Despite opportunities for collaboration, the transfer of climate-smart technologies is facing some challenges. The sector has a monitoring mechanism that relies on production patterns, with feedback incorporated through sectorial meetings. Additionally, there are plans to scale up successful local actions, but the novelty of climate change issues is hindering progress in this regard.

6.1.4 Fishery Sector Highlights

The assessment of climate change impacts and adaptation strategies in the fishery sector, facilitated by the CSO Land Working Group, reveals significant gaps and challenges in climate change awareness, adaptation, and governance. Current fishery practices in the county include catching nets, hanging hooks, and laying baskets, with the main fishing methods employing local chemicals and water fences. However, there is a limited understanding of climate change impacts on the sector, exacerbated by minimal education efforts. Observations of climate-related phenomena like rough seas due to strong winds highlight existing challenges, including flooding and hot temperatures, affecting fish stocks and catch rates.

Despite the challenges mentioned earlier, there are currently no effective strategies in place to adapt to climate change, and stakeholders lack the necessary support resources to undertake climate change initiatives. The absence of policies, funding, and technological solutions further impedes adaptation efforts, and coordination and collaboration among stakeholders and government agencies remain inadequate. To enhance climate resilience in the fishery sector, it is recommended to engage with communities, build capacity, and improve governance structures. Robust monitoring and evaluation mechanisms are also needed to track progress and incorporate stakeholder feedback effectively.

6.1.5 Energy Sector Highlights[70]

Liberia Electricity Corporation for the county level revealed a landscape where primary energy sources, including Thermal Plants, Mount Coffee Hydro Power Plant, and CLSG Transmission Lines, contribute significantly (80-85%) to the county's energy needs, albeit facing challenges such as low production, high distribution, and consumption due to climate change impacts. While there are awareness initiatives and policies in place, resource constraints hinder effective adaptation and mitigation efforts, with limited investments and technology accessibility posing additional barriers. Overall, there's recognition of the need for sustainable energy practices and climate change resilience, but concerted efforts and resource allocation are required to overcome existing challenges and maximize impact.

Several households in the county are utilizing solar energy for lighting purposes. These systems vary in size, ranging from small and portable setups to larger ones. However, the majority of the population still relies on charcoal and fuelwood as their primary sources of energy for cooking, heating water, and other needs. Consequently, even households with access to LEC electricity use the aforementioned energy sources.

6.1.6 Waste Sector Highlights[71]

Bomi County is currently facing a situation where waste disposal practices involve digging holes outside the city, which suggests a need for more adaptation to climate change. Although many residents claim to be aware of climate change, there has been no observed change in waste disposal methods. To address this

issue, current adaptation strategies include encouraging community members to place waste in visible areas for collection. But the other question is: even if collected, where will the waste be disposed of? The respondent identified logistical support and financial remuneration as necessary resources to enhance waste disposal resilience in the county. Bomi County's governance structure for waste disposal involves the City Mayor, City Inspector, and cleaners, who make decisions through consultative meetings. Despite ongoing discussions, there are no specific capacity-building initiatives or policies to address climate change adaptation concerning waste disposal practices in the county.

6.2 PERCEPTION OF KEY INFORMANTS INTERVIEW

This section of the report presents the viewpoints of key informants gathered through interviews, aimed at evaluating the current climate situation in Bomi County. This forms the basis for future climate action plans and emphasizes the importance of understanding how the local climate impacts various sectors in the County. The detailed tables are found in **Appendix 1**

6.2.1 Demographic and Socioeconomic Profile

The age range was 26-56 years or older. Of the respondents, 40% were 26-35, while 31.11% were 36-45. About 84.44% of participants interviewed have over 15 years' residence in the county. Thus, this enriches the dataset with longitudinal observations of climate change impacts. Bomi County has a youthful population that seems to possess a natural ability to adapt and be resilient toward the long-term consequences of climate change. With 46.67% of participants having only primary education, simplifying climate change communications is crucial to enhance understanding across all community segments.

Out of the respondents (n=45), 66.67% reported having a household size of 3-4 members thus highlighting the need for family-oriented adaptation strategies, which is consistent with LISGIS (2022) data showing an average household size of 3.5 in Bomi. The county's primary source of livelihood, agriculture and farming, accounts for 48.89% of their reliance, underscoring the

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[70] Abstracts on discussion with the Manager of the LEC sub-office in Bomi

[71] The discussion with the former Acting City Mayor at City Hall reveals

imminent threat of climate change and necessitating sector-specific adaptation strategies.

6.2.2 Climate Change Awareness and Perceptions

High familiarity (84.44%) and concern (93.33%) provide a strong foundation for deeper community engagement in climate change initiatives. 97.78% (44) of the key informants acknowledged anthropogenic causes of climate change, signaling readiness to support mitigation measures.

6.2.3 Observed Environmental Changes and Impacts

Over the past 15-30 years, respondents (100%) have consistently acknowledged the start of the rainy season to be in April, which remains the case today. They also acknowledged that over the past 15-30 years, the season ended around October (97.8%). When asked also about the end of the rainy season in recent years, 57.8% of respondents said October and 22.2% said November.

According to the survey, 84.4% of respondents reported an increase in annual rainfall, while 15.6% reported a decrease. Additionally, the survey found that 84.4% of respondents stated that the frequency of rainy days had increased, 93.3% reported an increase in temperature, 68.89% reported an increase in flooding, and 75.6% reported more frequent drought periods.

With the observed changes in weather patterns (temperature and rainfall), it is clear that agriculture is being impacted, with 97.78% responding. There is an urgent need to adapt farming practices to this new climatic reality, which is supported by 97.78% of data. Due to the disruption in seasonal cycles, traditional agricultural timetables are being affected, and there is a need to develop climate-resilient cropping calendars. Respondents have pinpointed to several challenges caused by climate change. 38.4% responded to the difficulties in obtaining water.

6.2.4 Response to Climate Change

In Bomi, taking climate action is critical to address the impacts of climate change at all levels. NGOs (39.1%) and civil society groups (39.1%) are taking action, but respondents (100%) believe that the Government of Liberia (GoL) should take more action to address climate change. 48.91% of the respondents think the government should incentivize individuals to adopt more climate-friendly behaviors, such as providing tax incentives for renewable energy usage. 47.25% of the respondents believe that taking action will protect vulnerable communities from climate-related disasters like floods and droughts.

From an individual standpoint, 33.6% believe that individuals can participate in sustainable agriculture programs, 32.06% believe that they should reduce personal energy consumption, and 30.53% believe that individuals should adopt sustainable farming techniques. Overall, the respondents believe that the main drivers of climate change and environmental degradation in Bomi are urbanization and population growth (30.41%), logging and timber extraction (29.73%), and mining (29.73%).

This scenario presents an opportunity for targeted educational programs using preferred platforms like social media. There is a need for the encouragement of sustainable agriculture and forestry practices (90.7% responded). The unanimity on the need for increased governmental intervention (100%) underscores a critical gap in current strategies, with an emphasis on enhancing public awareness, education, and renewable energy investments.

The encouragement for individual actions underlines a readiness to partake in mitigation efforts but is hindered by financial constraints, lack of knowledge, and a perceived insignificance of individual actions, identifying clear areas for intervention

6.3 SUMMARY

Forestry activities in the county, including chainsaw milling and logging. Also the county is experiencing deforestation and forest degradation. The county is reliance on rain-fed agriculture, but there is high awareness of climate change impacts such as flooding and drought leading to crop shrinkage and low productivity. Current fishery practices in the county include catching nets, hanging hooks, and laying baskets, with the main fishing methods employing local chemicals and water fences.

The transport sector primarily involves road transport between urban and rural areas. However, feeder roads are severely affected by climate change-induced damage especially during the rainy season thus increasing transport costs. Overall, stakeholders are adequately aware of climate change but with varying knowledge on its impacts to different sectors.

The KII perception revealed significant awareness and concern about climate change. The county has observed detrimental weather pattern shifts, prompting various adaptive strategies. However, barriers such as financial limitations and a lack of comprehensive understanding hinder broader engagement in mitigation efforts. The report underscores the urgent need for enhanced climate education and awareness. Strengthening these areas could vastly improve Bomi County's resilience and proactive response to the impacts of climate change.

7. CLIMATE GOVERNANCE

7.1 NATIONAL POLICIES, LAWS, REGULATIONS AND PROGRAMS RELATIVE ADAPTATION

Climate change continues to be a challenge that exerts constraints on livelihoods. Poor communities heavily depend on their livelihood in a stable and hospitable climate. The Government of Liberia (GoL) has since recognized and committed itself on focusing climate change concerns into its development agendas. The GoL recognizes the threats posed by climate change and has taken steps to formulate measures aimed at providing mitigation strategies and adaptation measures. **Table 2** below provides a list of legal and policy frameworks, though not exhaustive, that have developed to address the impact of climate change in Liberia.

Table 3: Policy and Legal framework addressing Climate Change in Liberia

Policy, Laws, Regulations and Program (PLRPs)	PLRPs Summary
Nationally Determined contributions (NDCs, 2020)	(NDCs) are at the heart of the Paris Agreement and achieve these long-term goals. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change. It communicates Liberia's contributions to meeting the goals of the Paris Agreement. The NAP process can help to identify NDC adaptation goals and translate them into action or strategy. Both the NAP and NDC are complementary processes and should ideally be aligned to
	strengthen national climate change adaptation.
National Policy and Response Strategy on Climate Change (2018)	This National Climate Change Policy and Response Strategy (NPRSCC, 2018) was developed to guide national response measures in addressing climate change. The strategy further guides integrating climate change issues into national development planning processes at national, county, district, and local levels for effective coordination. It also outlines policies for adaptation and mitigation in crucial sectors in the country.
The Initial National Communication (INC, 2013)	The Initial National Communication to the UNFCCC was developed to conduct a national-level analysis of the technologies and practices that can either reduce the sources of GHG emissions (reduction) and/or enhance their sinks (uptake) while supporting sustainable development. The INC provides strategic recommendations for increasing the implementation of GHG mitigation technologies in Liberia.
Second National Communication (2021)**:**	This report provides an update on Liberia's progress in implementing the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. It also highlights the country's vulnerability to climate change and outlines its adaptation and mitigation strategies.
Liberia Rising Vision 2030	This is the government's comprehensive vision for the country's development, which includes pillars, sector goals, strategic objectives, and outcome indicators. It aims to build Liberia's capacity for adaptation and mitigation.
Initial National Communication (2013)	This report provides an overview of Liberia's vulnerability to climate change and outlines the country's adaptation and mitigation strategies. It also highlights the country's

	progress in implementing the UNFCCC and the Kyoto Protocol.
This National Disaster Management Policy (NDMP, 2012)	This National Disaster Management Policy (NDMP, 2012) seeks: - To create a foundation for developing a practical and functional legal, and institutional framework and good governance for disaster risk management (DRM). - To provide the basis for sound DRM national and local organization, capacity enhancement, and clear roles and responsibilities. - To provide overall direction for integrating disaster risk reduction into development, recovery, and humanitarian response policy and plans..
National Adaptation Programme of Action (NAPA, 2008)	The NAPA provides a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change – those for which further delay would increase vulnerability and costs at a later stage. Adaptation to increasing climate variability and climate change is a critical topic in Liberia. While some national coping strategies have already been developed to deal with extreme climatic phenomena, they are only a beginning. As such, the NAPA process has allowed.
Pro-Poor Agenda for Prosperity and Development (PAPD) (2018-2023)	The PAPD focuses on strengthening the capacities of the people to thrive and further draws all Liberians into the national development process. The plan focuses on meeting the basic needs of Liberians, improving access to basic services, and creating opportunities for self-improvement

	in an inclusive and stable environment.
National Energy Policy of Liberia (NEP, 2007)	The principal objective of the National Energy Policy is to ensure universal access to modern energy services in an affordable sustainable and environmentally-friendly manner in order to foster the economic, political, and social development of Liberia.
The Environmental Protection and Management Law (EPML, 2003)	This law provides a legal framework for sustainable development, management, and protection of the environment and natural resources. It involves collaboration between the Environment Protection Agency, relevant ministries, autonomous agencies, organizations, and the people of Liberia. It covers various environmental issues, including impact assessment, guidelines, international obligations, education, and awareness.
National Environmental Policy (NEP, 2003)	The principal objective of the NEP is to ensure universal access to modern energy services in an affordable, sustainable and environmentally-friendly manner in order to foster the economic, political, and social development of Liberia.

7.2 INSTITUTIONAL ARRANGEMENTS[72]

Liberia has an institutional arrangement for coordinating climate change, as addressed in some of the PLRPs provided in **Table 2**. In Liberia, climate change activities are coordinated at the high-level policy by the **National Climate Change Steering Committee (NCCSC)**. However, The EPA as government designated entity coordinates, along with other ministries and agencies, the full implementation of major activities under the policy.

The **National Climate Change Secretariat (NCCS)**, housed at the EPA headquarters, spearheads climate change related activities including access to information and monitoring of program activities. The

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[72] Adapted from the National Climate Policy and Response Strategy

NCCS promotes inter-agency cooperation, provides coordination, monitors and evaluates the operational arm of the NCCSC. Already being established in key sectors, the **Environmental Sector Working Group (ESWG)**

serves as a multi-stakeholder forum for the exchange of ideas, including for the provision of updates on ongoing and planned climate change initiatives. To ensure sectors & cross-sectors coverage, sub-working group will be created.

The current governance structures and institutional arrangements are inadequate for facing the inherent challenges faced with addressing climate change. Therefore, an effective institutional arrangement must seek to establish the political basis through which social, economic, ecological and environmental vulnerabilities associated with climate-related risks are addressed.

7.3   EXISTING POLICIES, REGULATIONS AND FRAMEWORKS AT THE COUNTY LEVEL[73]

As already provided, there exist PLRPs at the national level which is expected to be decentralized at the county-level. However, Bomi lacks county level policies to address the adverse risks and impact of climate change in the county. As such, the county is dependent national PLRPs which needs to be addressed in the context of multi-level climate governance. This absence of county-level climate change policies affects the development planning process in Bomi as climate change risks and potentials impacts are not being considered.

However, the readily available information and development document Bomi has the County Development Agenda (CDA, 2008). Bomi's CDA reflects the overriding desire of the Citizens of Bomi County to be active participants in the noble national endeavor known as the Poverty Reduction Strategy (PRS 2008-2011). The CDA is Bomi County's contribution to the PRS effort, wherein the people stand up and express their desires for development, and make a commitment to helping achieve their collective goals. The CDA represents an important step toward addressing these issues and achieving the sustained and inclusive national development described in the PRS. Thus, the logic was to have the people

themselves articulate where they want the country to go, and in which areas they would like to see our limited financial and human resources focused.

Bomi's CDA has a section on 'governance and rule of law interventions' which is to build and operate efficient and effective institutions and systems, in partnership with the citizens, that will promote and uphold democratic governance, accountability, justice for all and strengthen peace. The strategic objectives are as follows: (1) To increase and enhance citizen participation in and ownership of government policy formulation and implementation; (2) To strengthen and enhance the effectiveness and efficiency of public institutions and functionaries; and (3) To expand Access to Justice, and enhance the protection and promotion of human rights under the Laws of Liberia.

In addition, the section on 'Economic Revitalization Interventions' goal was to restore production in the leading natural resource sectors, especially agriculture, while ensuring the benefits are widely shared; and reducing production costs to establish the foundation for diversification of the economy over time into competitive production of downstream products, and eventually manufactures and services. Similarly, this section has strategic objectives which are provided: (1) Develop more competitive, efficient, and sustainable food and agricultural value chains and linkages to markets; (2) Improve food security and nutrition, especially for vulnerable groups such as pregnant and lactating women and children under five; and (3) Strengthen human and institutional capacities to provide needed services, create a strong enabling environment, and **reduce vulnerability**.

Sadly, the realities have changed at the county level but the CDA has not been updated since previously done. There is a need for an updated CDA which will provide new information and assessed the targets set in previous version.

7.3.1   LOCAL STRUCTURES AND COORDINATION MECHANISMS[74]

In Liberia, the county is the next level below the national government, of which there are 15 counties with Bomi being one. The Local Government Act (LGA) of 2018

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[73] Bomi County Development Agenda (CDA)

[74] Information obtained from the Local Government Act of 2018, County development Agenda (CDA, 2008).

looks at governance at different levels: Regional; Intermediate; and Municipal.

Local Administration is the sum-total of personnel who run the various political sub-divisions of the Country as Local Government. This leadership structure comprises the following: County Superintendent; County Inspector; Statutory District Superintendent; District Commissioner; Township Commissioner; Paramount Chief; Clan Chief; General Town Chief; and City Mayor (Municipal Leader).

At the Regional Level, Bomi is governed by a county administration headed by a Superintendent and three deputies, all appointed by the president. The LGA of 2018 provides for the establishment of county councils in the 15 counties, including Bomi, with powers including: promulgating county ordinances, rules, and regulations for the maintenance of public order and the delivery of basic public goods and services; imposing local taxes, rates duties fees and fines; approving the county development plan and the annual county budget. The county council is composed of nine members serving for a four-year term, renewable once. This provision and others in the law are yet to be implemented.

At the intermediate level, each county is subdivided into smaller units known as districts with each being headed by a commissioner who is also appointed by the president or the minister of internal affairs acting on presidential authority, on the recommendation of the superintendent. Thus, there are four Administrative Districts (Klay, Dewien, Suehn Mecca and Senjeh), comprising five Chiefdoms and 18 Clans in Bomi. According to the provisions of the LGA 2018, the district commissioner shall establish a seven-member district advisory council of citizens to "advise on governance, finance, budget, development, peace, security and reconciliation". These councils are yet to be set up.

At the municipal level, LISGIS 2008 census nationally identified 24 cities, 15 of which are county administrative headquarters. The Liberian census and statistics authority defines a city as a settlement with 5000 or more inhabitants. While most cities are administered by a single municipal authority, there are other self-administered satellites known as townships, or boroughs within some larger municipal conurbations. Cities, townships and boroughs are headed by city mayors, township commissioners and borough administrators, all appointed by the president with the consent of the Senate.

The Constitution provides for the election of municipal officials, but there have been no such elections in almost 50 years. Overall, the governance approach provided in the Local Government Act of 2018 is a means of delegating national government functions to regional entities for more effective control and better results. However, up to present, this level of government is not yet politically, administratively or fiscally autonomous from the central government.

Table 4: Main Responsibility Sectors and Sub-Sectors[75]

Sectors and Sub-Sectors	Regional Level	Intermediate Level	Municipal Level
1. General public services (administration)	Oversight of local government at district, municipal and town levels; coordinate/monitor services provided by central government agencies in the county	Oversight of local government functions in the district; coordination of traditional authorities and customary and traditional activities parallel to state functions	Management of city corporation, implementation of ordinances and support for council activities
2. Public order and safety	Coordinate county security council (shared)	coordinate district security council (shared)	City Police
3. Economic affairs / transports			regulation of markets and SMEs
4. Environment protection	Receives report from Environmental Protection Agency		Parks, solid waste management, swamps, waterways
5. Housing and community amenities			
6. Health	Head of county management board	Head of district health management board	
7. Culture & Recreation	Coordinate annual county sports festival (shared)		Playgrounds, beaches, bars, motels, etc.
8. Education	Head of county development steering committee		
. Social Welfare	Receive report on women, children and social protection		

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[75] OECD/UCLG. (2022). 2022 Country Profiles of the World Observatory on Subnational Government Finance and Investment. https://www.sng-wofi.org/country-profiles/liberia.html

8. CONCLUSION

The climate change situational analysis for Bomi indicates the county's vulnerability to climate-related hazards, particularly flooding. The analysis highlights the impacts of climate change on various sectors, including agriculture and fisheries, emphasizing the need for adaptation measures. Vulnerability and risk assessments reveal high exposure to river and urban flooding and wildfires, necessitating proactive mitigation strategies.

Regarding climate governance, the Government of Liberia (GoL) has formulated national policies, laws, regulations, and programs to address climate change. Notable initiatives include the Nationally Determined Contributions (NDCs) under the Paris Agreement, which outline Liberia's commitments to emission reduction and adaptation. The National Policy and Response Strategy on Climate Change provides a framework for integrating climate issues into national development planning, while the National Adaptation Plan identifies priority activities for adaptation. However, challenges persist in implementing governance structures at the county level, where Bomi lacks specific climate policies, relying instead on national frameworks.

Institutionally, Liberia has established bodies such as the National Climate Change Steering Committee (NCCSC) and the National Climate Change Secretariat (NCCS) to coordinate climate-related activities at the national level. However, there are gaps in the implementation of governance structures at the sub-national level, hindering effective climate governance in Bomi County.

At the local level, Bomi County's development agenda, articulated in the County Development Agenda (CDA), aims to address poverty reduction and promote inclusive development. However, the absence of updated climate policies in the CDA hampers efforts to effectively address climate risks and impacts. Moreover, governance structures at the county level are yet to be fully implemented, posing challenges to decentralized climate governance.

Liberia's commitment to addressing climate change through policy development and institutional coordination underscores the importance of multi-level governance in fostering resilience and sustainable development amidst climate uncertainty. Effective climate governance requires robust policies, institutional mechanisms, and coordination across all levels of government to mitigate risks and enhance adaptive capacity in vulnerable regions like Bomi County.

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9. APPENDICES

Appendix 1: Tables from Perception survey

Age Bracket

	Count	Percent	CumCnt
26 - 35 years	18	40.00	18
36 - 45 years	14	31.11	32
46 - 55 years	8	17.78	40
56 years or older	5	11.11	45
N=	45		

What is level your level of education?

	Count	Percent	CumCnt
Primary School	21	46.67	21
Secondary School	10	22.22	31
Tertiary School	14	31.11	45
N=	45		

How many members are there in your household?

	Count	Percent	CumCnt
1-2 Members	10	22.22	10
3-4 Members	30	66.67	40
5-6 Members	5	11.11	45
N=	45		

What is the primary occupation of the head of the household?

	Count	Percent	CumCnt
Agriculture/Farming	22	48.89	22
Education/Healthcare Services	1	2.22	23
Manufacturing/Construction	3	6.67	26
Miner	2	4.44	28
Professional/Technical Services	7	15.56	35
Retail/Wholesale Trade	10	22.22	45
N=	45		

How many years have you been residing in this county?

	Count	Percent	CumCnt
1-5 years	1	2.22	1
11-15 years	5	11.11	6
6-10 years	1	2.22	7
More than 15 years	38	84.44	45
N=	45		

Are you aware or have you heard of the term "climate change"?

Are you aware or have you heard	Count	Percent	CumCnt
I have heard of it but don't fully understand it.	7	15.56	7
Yes, I am familiar with it.	38	84.44	45
N=	45		

Which of the following statements best describes climate change?

	Count	Percent	CumCnt
Climate change is the long-term alteration of earth's climate patterns, primaril	44	97.78	44
I don't know.	1	2.22	45
N=	45		

How concerned are you about climate change?

	Count	Percent	CumCnt
Moderately concerned.	2	4.44	2
Not concerned at all.	1	2.22	3
Very concerned.	42	93.33	45
N=	45		

In your opinion, what are the primary causes of climate change?

	Count	Percent	CumCnt
Human activities, such as burning fossil fuels and deforestation.	44	97.78	44
It is not clear to me what causes climate change.	1	2.22	45
N=	45		

Have you noticed any changes in your local weather patterns over the past few years?

	Count	Percent	CumCnt
Yes	45	100.00	45
N=	45		

What climate changes have you noticed in your community or county?

	Count	Percent	CumCnt
Change in rainfall pattern	44	41.51	41.51
Increased temperatures (hotter days, hotter nights, extreme heat)	44	41.51	83.02
Sea level rise	0	0.00	83.02
More frequent and extreme weather events (floods, droughts, violent winds/storms)	18	16.98	100.00
	106		

When was the start of the rainy season in the past (15 - 30 years ago) before 2008?

	Count	Percent	CumCnt
April	45	100.00	45
N=	45		

When does the rainy season start now?

	Count	Percent	CumCnt
April	44	97.78	44
May	1	2.22	45
N=	45		

When was the end of the rainy season in the past (15 - 30 years ago) before 2008?

	Count	Percent	CumCnt
Can't remember the particular month	1	2.22	1
October	44	97.78	45
N=	45		

When does the rainy season end now?

	Count	Percent	CumCnt
October	26	57.78	57.78
November	10	22.22	80.00
December	0	0.00	80.00
Don't know the particular month	9	20.00	100.00
	45		

Annual rainfall

	Count	Percent	CumCnt
Decreased	3	6.67	3
Increased	42	93.33	45
N=	45		

Number of rainy days

	Count	Percent	CumCnt
Decreased	7	15.56	7
Increased	38	84.44	45
N=	45		

Flooding

	Count	Percent	CumCnt
Increased	31	68.89	31
No Change	14	31.11	45
N=	45		

Temperature

	Count	Percent	CumCnt
Decreased	2	4.44	2
Increased	42	93.33	44
No Change	1	2.22	45
N=	45		

Number of hotter days

	Count	Percent	CumCnt
Decreased	4	8.89	4
Increased	41	91.11	45
N=	45		

More frequent drought periods

	Count	Percent	CumCnt
Decreased	3	6.67	3
Increased	34	75.56	37
No Change	8	17.78	45
N=	45		

How do these changes affect your activities, livelihood, and environment?

	Count	Percent	CumCnt
Affect crop yield and agricultural productivity (low yield, pests and livestock	44	97.78	44
Health impacts (new sicknesses and diseases)	1	2.22	45
N=	45		

Have you noticed any changes in your daily activities due to climate change?

	Count	Percent	CumCnt
Yes	45	100.00	45
N=	45		

Please specify the changes you have experienced

	Count	Percent	CumCnt
Changes in energy consumption patterns	16	14.29	14.29
Altered agricultural practices	40	35.71	50.00
Difficulties in transportation	7	6.25	56.25

	Count	Percent	CumCnt
Increased waste management challenges	6	5.36	61.61
More difficulties in obtaining water	43	38.39	100.00
	112		

Have you received any formal education or training on climate change?

	Count	Percent	CumCnt
I have come across information but not through formal education.	18	40.00	18
No, I have not received any education or information on climate change	27	60.00	45
N=	45		

Which of the following sources do you rely on to stay informed about climate change?

	Count	Percent	CumCnt
News channels and newspapers	8	6.56	6.56
Social media platforms	45	36.89	43.44
Scientific journals and research papers	4	3.28	46.72
Environmental organizations	20	16.39	63.11
Friends and family	45	36.89	100.00
None of the above	0	0.00	100.00
	122		

How would you rate the overall awareness and media coverage of climate change?

	Count	Percent	CumCnt
Insufficient awareness and negligible media coverage	34	75.56	34
Moderate awareness and limited media coverage	11	24.44	45
N=	45		

How would you rate your knowledge about the causes and effects of climate change?

	Count	Percent	CumCnt
Moderately knowledgeable	37	82.22	37
Not knowledgeable at all	1	2.22	38
Very knowledgeable	7	15.56	45
N=	45		

Are there actions and measures taken to address climate change in your community or county

	Count	Percent	CumCnt
No	2	4.44	2
Yes	43	95.56	45
N=	45		

What specific response has been taken.

	Count	Percent	CumCnt
Encouragement of sustainable agriculture and forestry practices.	39	90.70	39
Implementation of renewable energy sources such as solar and wind power.	4	9.30	43
N=	43		

Who are those taking the actions?

	Count	Percent	CumCnt
Government	4	3.64	3.64
NGO	43	39.09	42.73
Civil society group	43	39.09	81.82
Cooperative	1	0.91	82.73
Individual effort	19	17.27	100.00
	110		

Please state the action and measures that have been undertaken:

	Count	Percent	CumCnt
Changes in agricultural practices (for example, diversification of crops, water	42	93.33	42
Improved waste management practices	1	2.22	43
Others (please specify)	2	4.44	45
N=	45		

Do you think more actions need to be taken by the government to address climate change?

	Count	Percent	CumCnt
Yes, they should prioritize it.	45	100.00	45
N=	45		

What specific actions do you believe should be prioritized in combating climate change?

	Count	Percent	CumCnt
Implementing stricter environmental regulations.	3	3.00	3.00
Investing in renewable energy sources.	27	27.00	30.00
Promoting sustainable transportation options (resilient roads and environmentally friendly vehicles)	7	7.00	37.00
Supporting scientific research on climate change.	18	18.00	55.00
More public awareness, education, and training on climate change	45	45.00	100.00
Agriculture	0	0.00	100.00
	100		

In your opinion, what are the potential benefits of government/NGOs taking more action to address climate change?

	Count	Percent	CumCnt
Reduction in greenhouse gas emissions.	24	26.37	26.37
Preservation of natural resources.	23	25.27	51.65
Creation of green jobs and economic opportunities.	0	0.00	51.65
Protection of vulnerable communities from climate-related disasters (For example, flood, drought).	43	47.25	98.90
Resilient agriculture	1	1.10	100.00
	91		

What actions do you think individuals can take to combat climate change?

	Count	Percent	CumCnt
Reducing personal energy consumption.	42	32.06	32.06
Recycling and reducing waste.	1	0.76	32.82
Supporting sustainable businesses.	0	0.00	32.82
Advocating for climate-friendly policies.	2	1.53	34.35
Participate in sustainable agriculture program	44	33.59	67.94
Adopt sustainable farming techniques	40	30.53	98.47
Practicing water conservation at home by facing leaks, using water saving devices and being mindful of water usage	2	1.53	100.00
	131		

What motivates or hinders individuals from taking action against climate change?

	Count	Percent	CumCnt
Lack of knowledge or information.	45	32.85	32.85
Financial constraints.	16	11.68	44.53
Convenience and habit.	34	24.82	69.34
Belief that individual actions have minimal impact.	42	30.66	100.00
	137		

How can governments incentivize individuals to adopt more climate-friendly behaviors?

	Count	Percent	CumCnt
Providing tax incentives for renewable energy usage.	45	48.91	48.91
Offering subsidies for electric vehicles.	0	0.00	48.91
Implementing educational campaigns on sustainable practices.	44	47.83	96.74
Establishing stricter environmental regulations.	2	2.17	98.91
Promoting resilient agriculture	1	1.09	100.00
	92		

Are you aware of any actions and measures that can be taken to mitigate climate change?

	Count	Percent	CumCnt
I have heard of some measures but need more information to fully understand them	20	44.44	20
No, I am not aware of any measures to mitigate climate change.	1	2.22	21
Yes, I am aware	24	53.33	45
N=	45		

Which of the following actions do you think can help mitigate climate change?

	Count	Percent	CumCnt
Reducing carbon emissions from industries and vehicles.	**0**	**0.00**	**0.00**
Promoting renewable energy sources for example solar panels.	**7**	**5.51**	**5.51**
Planting more trees and preserving forests.	**35**	**27.56**	**33.07**
Encouraging sustainable agricultural practices.	**45**	**35.43**	**68.50**
None of the above.	**40**	**31.50**	**100.00**
	127		

How prepared do you feel to adapt to the impacts of climate change (example flood, drought and heat wave?

	Count	Percent	CumCnt
Moderately prepared.	10	22.22	10
Not prepared at all	35	77.78	45
N=	45		

Do you believe individuals can make a difference in combating climate change?

	Count	Percent	CumCnt
Yes, individual actions collectively contribute to mitigating climate change.	45	100.00	45
N=	45		

Which of the following do you believe are the main drivers of climate change and environmental degradation in your county?

	Count	Percent	CumCnt
Urbanization and population growth	45	30.41	30.41
Agricultural expansion	14	9.46	39.86
Mining	44	29.73	69.59
Deforestation and forest degradation	1	0.68	70.27
Logging and timber extraction	44	29.73	100.00
	148		