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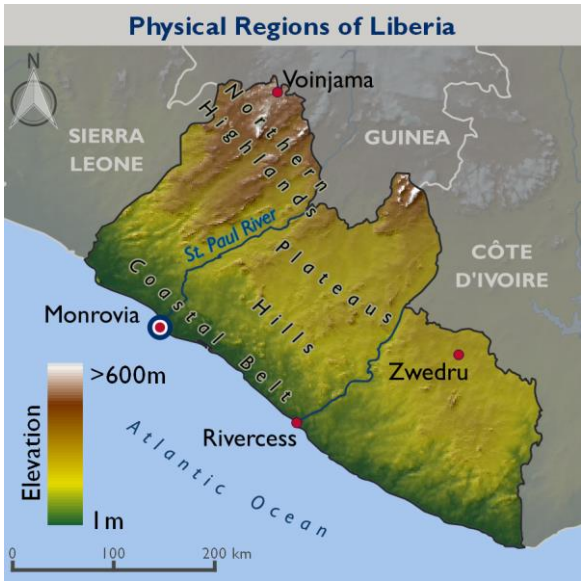
Climate Risk Profile

CLIMATE RISKS IN FOOD FOR PEACE GEOGRAPHIES
LIBERIA

COUNTRY OVERVIEW



Liberia's vulnerability to climate change and variability stems from high levels of poverty combined with heavy dependence on natural resource-intensive sectors that are climate-sensitive – such as agriculture, fisheries and forestry– for economic growth and livelihood support. Climate change is expected to result in more extreme weather events such as heavy rains, causing frequent flooding that damages infrastructure, homes and livelihoods. In coastal areas heavy rains, storm surges and sea level rise increase erosion, putting both urban and rural infrastructure at risk. Economic growth since the end of the civil war in 2003 has been driven by the country's natural resource wealth, particularly mining. Despite this wealth in natural resources, poverty remains widespread, fueled by and contributing to continued land degradation and deforestation. Agriculture is a major contributor to the country's GDP; in 2011 rubber exports represented 87 percent of total cash crop exports, followed by cacao beans at 12 percent. The population is mostly urban as many farmers deserted rural areas during the civil war; the urban population is currently increasing by 4.5 percent each year. Along with a high specialization in export crops, this has contributed to Liberia's heavy reliance on imported food. Climate change may exacerbate food insecurity by reducing agricultural yields due to already erratic rainfall patterns, increasing salinity of freshwater aquifers due to rising seas, and increasing sea surface temperatures, thereby altering marine fisheries dynamics. (1, 2, 4, 5, 7, 8, 10)

CLIMATE PROJECTIONS

- 0.9°–2.6°C increase in temperature by 2060
- More extreme weather, with intense precipitation and floods
- 0.13–0.56 meter rise in sea levels by the 2090s

KEY CLIMATE IMPACTS TO FFP PROGRAM AREAS

Agriculture and Livelihoods
Increased crop losses/failure
More pests, weeds, pathogens
Increased food insecurity

Health, Nutrition and WASH
Degraded water quality
Increased risk of vector- and waterborne diseases
Increased malnutrition and food insecurity

Fisheries
Shift in distribution of species
Habitat destruction and degradation
Increased food insecurity; loss of livelihoods

Small-Scale Infrastructure
Flooding and washing away of roads
Disruption of transport networks, impacting incomes, health, food security and education

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This document was prepared under the Climate Change Adaptation, Thought Leadership and Assessments (ATLAS) Task Order No. AID-OAA-I-14-00013 and is meant to provide a brief overview of climate risk issues. The key resources at the end of the document provide more in-depth country and sectoral analysis. The contents of this report do not necessarily reflect the views of USAID.

FOOD FOR PEACE PROGRAMMING

Over the past decade, Food for Peace (FFP) activities have been focused in the most vulnerable counties in Liberia to improve maternal and child health and nutrition, agricultural production, livelihoods, and youth education. The three target counties include two—Bong and Grand Bassa—that are also designated as focus counties in the USAID/Liberia Country Development Cooperation Strategy (CDCS) and in the Feed the Future zones of influence (see map to the right). The third county, River Cess, is contiguous to them, which may allow for programmatic linkages.

Future FFP programming, as identified in Liberia's Country Specific Information (CSI), will focus on:

- **Community-level governance structures** that sustainably strengthen community-level responses to chronic food and nutrition security issues. This should complement existing and future governance, decentralization, civil society strengthening, capacity building and peacebuilding programming.
- **Nutrition, maternal–child health and WASH** activities that foster linkages to improve nutrition-specific (maternal, infant and child nutrition) and nutrition-sensitive (including WASH and family planning) community services, along with local capacity strengthening to sustain ongoing improvements.
- **Agriculture and livelihoods** activities that strengthen and diversify agricultural livelihood opportunities as a means of smoothing household consumption and increasing more stable incomes of vulnerable households in the three target counties.
- **Human capacity and livelihoods** activities that support strategic investments in literacy and numeracy, business development services for micro- and small enterprises, other relevant job skills training and placement, expansion of credit access among vulnerable rural households, and repair and rehabilitation of feeder roads.

CLIMATE TRENDS

Liberia has a predominantly equatorial climate, experiencing rainfall throughout the year. The northern regions are considered tropical and are affected by the West African monsoons. Rainfall is highest in the coastal plains and decreases toward the interior plateaus and low mountains. The seasonal rainfall varies considerably from year to year and from one decade to the next. Temperatures are generally higher on the coast than inland. With the exception of the southernmost parts of the country, which receive rainfall year-round, most of the country experiences two seasons:

- A wet season ("summer") between May and November, driven largely by the movement of the tropical rain belt (also known as the Inter-Tropical Conversion Zone, ITCZ), which oscillates between the northern and southern tropics over the course of a year; temperatures range from 24◦ to 25°C.
- A dry season ("winter") between December and April, where the dry and dusty "Harmattan" winds blow from the Sahara Desert; temperatures range from 24◦ to 27°C.

Trends since 1960 and projections for the mid to late 21st century of key parameters of relevance are noted in Table 1. (3, 7, 11)

Table 1: Key Climate Trends and Projections		
	Climate Trends	**Climate Projections**
Temperature 	• Increased mean annual temperatures throughout the country of 0.8°C. • Increase in the average number of "hot" nights per year by 57 (an additional 15.7 percent of nights).[1] • Decrease in the average number of "cold" nights by 18 (4.8 percent of nights). • Increased sea surface temperatures.	• The mean annual temperature is projected to increase by 0.9°–2.6°C by 2060. • The projected rate of warming is most rapid in the northern inland regions. • Substantial increases in the frequency of days and nights that are considered "hot" and decreases in the frequency of days and nights that are considered "cold."
Rainfall 	• Mean annual rainfall over Liberia has decreased since 1960, but it is difficult to determine whether this is part of a long-term trend because of the variable nature of rainfall in this region. • The rainfall record is punctuated by wetter and drier periods; the 1960s and late 1970s were particularly wet, while the early 1970s and 1980s were very dry. • Increased frequency of intense rainfall events.	• No consistent projections for rainfall (e.g., projections for Monrovia, the capital, range from a 36 percent decrease to a 21 percent increase), but models consistently indicate a trend toward overall increases in wet season rainfall: an increase of 3 percent by 2050 and 5 percent by 2080. • While rainfall projections are unclear, rising temperatures are certain to intensify the water cycle, increasing the occurrence of extreme rainfall events. • Decrease in dry season rainfall in the southern regions of the country by 2050.
Sea Level 	• No information available on current trends.	• Increase by 0.13 to 0.56 meters by the 2090s relative to the 1980–1999 period.

SECTOR IMPACTS AND VULNERABILITIES

CROP PRODUCTION

With the collapse of the formal economy during the war, the importance of agriculture and forestry as essential sources of economic growth and recovery rose after the war. Agriculture contributes 26 percent of GDP – primarily from exports – and constitutes the most important livelihood source for 67 percent of the population. While the country is richly endowed with water, mineral resources, forests and a climate favorable to agriculture, it lags in productivity relative to other countries due to poor human capital, lack of infrastructure, political instability, land tenure insecurity, and now climate-induced changes in yields and water availability. In addition, many fields were abandoned and left untended during the civil war, and food production, both in terms of extent of farmed area and productivity levels, has yet to return to pre-war levels.

Traditional smallholder farms primarily produce staple foods (rice and cassava) using rainfed subsistence methods. In the central part of the country, farmers grow tree crops such as coffee and oil palm nuts, rice and cassava, while vegetables and other food crops are grown on a smaller scale. The northern region—where the majority of the rice is grown—is traditionally Liberia's breadbasket, while populations in the coastal belt rely on fishing and tree crops as primary livelihoods. Rice is the main subsistence crop, cultivated by over 74 percent of farmers, followed by cassava, grown by 62 percent of the farmer population. Domestic production relies on traditionally low input/low output and shifting cultivation systems that leave crops

[1] "Hot" day or "hot" night is defined by the temperature exceeded on the 10 percent warmest of days in the standard climate period (1970-1999).

vulnerable to diseases and pests. Rice is highly sensitive to increased humidity, temperatures and rainfall intensity, and is vulnerable to pests that thrive with higher temperatures (see Figure 1 for optimal temperature ranges in the rice lifecycle). Upland rice, the predominant cropping system, will be negatively impacted by changes in seasonality of precipitation. However, increased temperatures may also increase the geographic range of rice production to the north. Cassava is more resilient to climate changes (particularly higher temperatures) and may provide an alternative food source in an increasingly variable climate. Effects of climate change on agricultural production are the most likely in the interior counties of Bong, Lofa and to a lesser extent Nimba. These were the primary agricultural areas before the conflict and are the most likely to experience higher temperatures and altered rainfall patterns. (1, 2, 6, 7, 16)

Figure 1: Critical temperatures for the development of rice plants at different stages
Source: EPA of Liberia 2013.

Growth Stages	Critical Temperature (°C)		
	Low	High	Optimum
Germination	18-19	45	18-40
Seedling emergence	12	35	25-30
Rooting	16	35	25-28
Leaf elongation	7-12	45	31
Tillering	9-16	33	25-31
Initiation of panicle primordia	15	-	-
Panicle differentiation	15-20	30	-
Anthesis	22	35-36	30-33
Ripening	12-18	30	20-29

The major agricultural exports of Liberia (rubber, cacao and coffee) were impacted by the war, further damaging efforts to ensure food security in both urban and rural areas, which are now also subject to the vagaries of climate. Commercial farms and foreign-owned concession plantations produce most of the exports. Rubber is one of Liberia's main export cash crops and Liberia is home to the world's largest contiguous rubber plantation. Around 75 percent of rubber trees are past prime production age. The increase in rainfall could damage rubber production, as it will be more difficult to maintain soil drainage on plantations to avoid waterlogging and retain critical topsoil. Also, sudden storms with very heavy rainfall and high winds over short periods could damage rubber trees. While cacao and coffee production and exports lag far behind rubber, they represent an area of economic growth and diversification for smallholder farmers. However, climate risks to these crops should be carefully considered as cacao and coffee (both Arabica and Robusta) have specific climatic requirements for optimal productivity (Figure 2). Taking into consideration current and future climate conditions, most of Liberia is suited to growing Robusta coffee and cacao as long as they are grown with shade trees to prevent heat stress from extreme temperatures in the dry season. See Table 2 for more stressors and risks. (1, 2, 4, 9, 11, 16)

Figure 2: Environmental limits of coffee and cacao. Source: CGIAR 2015.

Variable		Arabica	Robusta	Cocoa	Unit
Annual mean temperature	Optimal	18–22	22–26	22–25	°C
	Tolerance	16–24	20–28	20–27	
Annual precipitation	Optimal	1400–2300	1700–3000	1200–3000	mm/year
	Tolerance	750–4200	900–4000	900–7600	
Dry months	Optimal	1	1	0	Consecutive months
	Tolerance	0.2–3	0–2	1–3	
Min/max range	Optimal	14–28	20–30	21–32	°C
	Tolerance	8–32	12–36	10–38	

Table 2: CROP PRODUCTION – Climate stressors and risks	
Climate Stressors	**Climate Risks**
Increased temperatures	Yield reductions; crop failure/loss
	Increased crop water demand; reduced soil moisture availability
	Increased heat stress on coffee and cacao trees, particularly during dry season
	Increased incidence of pests, diseases and weeds
Increased frequency of intense precipitation	Shorter maturation of cacao pods, leading to harvesting during wet season when sun drying is difficult
Increased humidity and extreme temperatures	Insufficient drying times for rice grain pre- and post-harvest
	Increased food insecurity/ hunger
	Accelerated erosion of critical topsoil
	Soil nutrient leaching and increased fungal attacks due to high levels of humidity

FISHERIES

Fish is a popular food source in Liberia and the primary source of protein for children in many coastal areas. Liberia has three types of fisheries: 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 of noncoastal communities. Aquaculture in Liberia is a growing source of animal protein and integrating aquaculture with other agricultural activities is one of the country's priorities to meet food security needs. As in other formerly productive sectors, fishing and aquaculture resources are vastly underutilized and inefficient compared to the pre-war period, and face several threats from climate change and variability. Mangroves provide critical breeding grounds for important fish species and rising seas pose a risk to these ecosystems, along with other pressures such as the need for fuel and firewood and land for road building. As very little research has been conducted in Liberia on fisheries, most climate change impacts are based on generalizations from studies elsewhere. In marine fisheries, the most prominent risk is an increase in sea surface temperatures. Temperature increases impact fish physiology by limiting oxygen transport to tissues. This can change the distribution of marine species, expanding the range of warmer water species and contracting that of cold water species. For inland fisheries, precipitation and evapotranspiration changes, including an increase in extreme events, could affect the magnitude and timing of high and low river flows, which in turn can adversely affect fish habitats, reproduction, growth and mortality. Additionally, changes in temperature can negatively impact the reproductive cycles of fish used for aquaculture (namely Nile tilapia, African catfish, sampa, mango tilapia and red tilapia), including the speed at which they reach sexual maturity and the size of the eggs they lay. Temperature increases could exceed the optimal range for many species. See Table 3 for more stressors and risks. (8, 10, 19, 22)

Table 3: FISHERIES – Climate stressors and risks	
Climate Stressors	**Climate Risks**
Increased surface temperatures of seas and inland ponds and lakes	Altered phenology, physiology, development and yields
	Sedimentation and erosion
	Disruption to fish reproductive patterns and migratory routes
	Coral bleaching (affecting reef fisheries)
Increased frequency of intense precipitation	Reduced aquatic biodiversity and productivity
	More frequent loss of fishing days due to bad weather; increased loss of nets, traps and longlines; increased damage to boats and shore facilities; increased loss of life among fishermen

Table 3: FISHERIES – Climate stressors and risks	
Climate Stressors	**Climate Risks**
Increased frequency of extreme events	Reduced water quality
	Damage to infrastructure and transportation networks
	Loss of mangroves, a critical habitat of artisanal fisheries
	Reduced nutrition

PESTICIDE USE

Although chemical pesticide use is historically low throughout most of Africa compared to other parts of the developing world, some increase in pesticide use is occurring as income levels rise. While there are no data for pesticide use in Liberia for specific crops, donor-funded programs sometimes support pesticide use. Therefore, it is important to be aware of climate risks that may have implications for pesticide use in the agriculture sector. See Table 4 for stressors and risks.

Table 4: PESTICIDE USE – Climate stressors and risks	
Climate Stressors	**Climate Risks**
More intense rainfall	Increased surface runoff
	Increased percolation/groundwater infiltration
Longer dry periods	Increased threat from current pests/introduction of new pests
	Reduced effectiveness of pesticides applied topically
	Stored pesticide leakage
Increasing temperatures	Reduced effectiveness of pesticides that are activated/distributed by water
	Increased threat from current pests/introduction of new pests
	Reduced willingness on the part of farmers to use Personal Protective Equipment (PPE) due to increased temperatures

INVASIVE SPECIES

Invasive species can reduce crop and livestock production, encroach on native biodiversity and increase production costs. Considerable evidence suggests that climate change will increase the likelihood of invasive species gaining a foothold and/or expanding their range in forests and rangelands. Many invasive species are, by nature, highly flexible, respond to environmental change more quickly than do native species, and are more likely to thrive in a more variable climate compared to native species. The full impact of alien and invasive species in Liberia is not well understood as no comprehensive inventory has been undertaken. However, Table 5 presents some invasive species that have been observed in Liberia and how increased temperatures will likely support their proliferation. A recent example is the explosive quantity of *Sargassum* seaweed reaching the shores the Caribbean and West Africa (including Liberia), linked to the warming of oceans. (10, 20, 21)

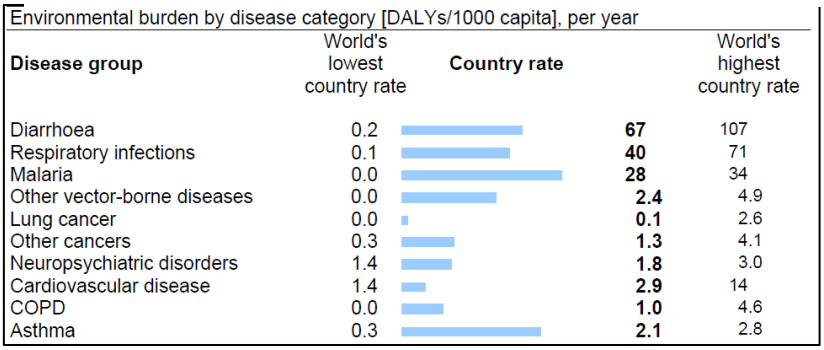
Table 5: INVASIVE SPECIES – Characteristics and link to climate		
Species	**Characteristics**	**Link to Climate**
***Sargassum* seaweed**	Free-floating brown seaweed that blossoms naturally in the warm waters of the Sargasso Sea of the Northern Atlantic Ocean. When invasive, inflicts severe ecological and socioeconomic impacts, particularly to the tourism sector and coastal fishing activities.	Thrives in warm waters and recent expansion is linked partially to warming of oceans due to climate change
Leucaena leucocephala	A forage tree that is often promoted to use for firewood, timber, human food, green manure, shade and erosion control. Grows quickly and forms dense thickets that crowd out any native vegetation.	Very drought-tolerant, even during establishment
Chromoleana odorata	Fast-growing perennial shrub. Due to abundant vegetative development, out-competes young trees, leading to poor natural regeneration. Also provides habitat and breeding spaces for harmful insects such as the variegated grasshopper, *Zonocerus variegates*, which attacks cassava fields, causing substantial yield losses. During the dry season, it constitutes a fire hazard.	Tolerates a variety of temperate and tropical climates; tolerates a wide range of soil conditions and severe drought
Water hyacinth	One of the most globally well-known water weeds, a free-floating aquatic plant that develops extensive mats that can cover thousands of hectares of previously open water. Populations can double in as little as six days. When invasive, water hyacinth forms a complete covering of the water surface that excludes most light and air for submerged organisms, depriving them of essentials for survival. Impacts biodiversity, fisheries, water supply systems, drainage canals, inflows to hydropower generators, and movement of shipping and river flows.	Exacerbates water availability; causes evapotranspiration, leading to significant water loss from reservoirs and other water bodies

HEALTH, NUTRITION AND WASH

Community health services are underdeveloped in Liberia particularly with regard to maternal, infant and early childhood health. These limited services are even scarcer in the face of high birthrates, lack of access to safe water and sanitation, and chronic food insecurity, the latter of which are factors that will be negatively impacted by climate change.

Liberia has some of the world's highest rates of diseases that are caused or exacerbated by environmental factors (Figure 3), and will likely be further intensified by climate change (Table 6). Increased rainfall and flooding and higher temperatures will increase the incidence of vector- and waterborne diseases such as malaria, cholera and diarrheal diseases. Malaria is one of the leading causes of morbidity and mortality in Liberia, and the number one cause of death for children under five years of age (15). Cholera, measles and Lassa virus (LASV) are the next highest causes of morbidity. LASV is carried by the multimammate rat, whose reproductive rate is linked to increased rainfall, and incidences of LASV have been reported up to three times higher during the rainy season (2). Dengue fever, already present in neighboring Cote d'Ivoire, could expand into Liberia as temperatures increase. Yellow fever, transmitted by mosquitoes (*Aedes aegypti*), is likely to increase in wet weather and meningitis is most prevalent in hot, dry months. Respiratory diseases may be exacerbated by heat stress and inhalation of pollutants from stagnant air. Other respiratory

Figure 3: Liberia's environmental disease burden. Source: WHO 2009.



ailments such as asthma may increase with warming climates, as there is evidence that when it is hotter, plants produce more pollen, a principal allergen for asthma.

Table 6: Changes in Disease Prevalence Due to Climate Change *(Source: Adapted from INC)*

Disease	Strength of Climate Relation	Remarks
Cholera, Malaria	Climate is the primary factor in determining at least some epidemics	Regional epidemics occur seasonally and are associated with periods of excessive rainfall and warm temperatures
Meningococcal meningitis	Climate plays a significant role	Hot, dry and dusty conditions are primary causes
Yellow fever	Climate plays a moderate role	Epidemics are associated with high rainfall and high temperatures
Intestinal worms, Schistosomiasis	Climate link is evident, but weak	Sensitive to changes in temperature and soil; increases in temperature and rainfall lead to higher transmission rates

Liberia ranks low on nutrition indicators due to persistent food insecurity from low agricultural output, high reliance on food imports, and weak infrastructure, all of which are susceptible to climate variability and change. Food insecurity is widespread, with every fifth household considered food insecure, mainly affecting poor rural households with informal livelihoods. The highest rates of food insecurity are found in Bomi (55 percent), Grand Kru (46 percent) and River Cess (45 percent) counties (13). Rates of chronic and acute undernutrition decreased in the past six years, but almost one-third of children under five remain stunted and micronutrient deficiencies are highly prevalent. Agricultural yields of subsistence crops (rice and maize) are some of the lowest in the region; these yields will be further threatened by higher temperatures and increased rainfall variability. Liberia imports 73 percent of its food needs and interruptions in transport conduits in the regional market due to a more variable climate, coupled with higher food prices, threaten the country's food security. Weak infrastructure undermines income-earning opportunities, limits access to health and education facilities, and raises the price of goods and services. Areas with the poorest road networks are the most food insecure as roads, particularly in rural areas, often become impassible during the rainy season (June–October), contributing to reduced economic productivity and exacerbating lean season malnutrition. With projected trends of more intense precipitation and floods, Liberia's road network will be further stressed.

Access to water and sanitation declined substantially during the civil war, but during the last decade signs of progress were noticeable. Around 70 percent of the population has access to improved water sources though Liberia has an abundant water supply (from both surface and groundwater) (12). Nevertheless, water quality remains poor in some areas due to mining (iron ore pollutants), farming (agrochemical runoff) and industrial activities (discharge from rubber processing); changes in rainfall patterns may negatively impact the water balance if water resources are not properly managed. In rural areas, water access is largely supplied via shallow wells, which are highly susceptible to rainfall variability, particularly during the dry months (November–April). Reduced water levels further stress water quality as pollutants are more concentrated and people resort to surface water when the wells dry up. Decreased availability and compromised quality of surface water supply will heighten the vulnerability of populations depending on these sources for daily activities; more intense and frequent storms and flooding may cause storm water flows, which increase the likelihood of water contamination of both surface sources and shallow wells. A mere 6 percent of the rural population has access to improved sanitation facilities (compared to 28 percent in urban areas), and almost half of Liberia's population practices open defecation (17). A weak water and sanitation environment is easily compromised by climate variability, increasing the risk of transmission of some of Liberia's most deadly and prevalent diseases. See Table 7 for more stressors and risks. (2, 13, 14, 15, 18)

Table 7: HEALTH, NUTRITION AND WASH – Climate stressors and risks	
Climate stressors	**Climate risks**
Increased temperatures **Heavy rains, storms and floods**	Pollution of wells and/or flooding of latrines leading to increased incidence of infectious diseases, reduced water quality and challenges to hygiene/sanitation practices; increase in pools of standing water, leading to higher incidence of infectious diseases
	Reduced drinking water quality from pollution, flooding and reduced water levels
	Increased food insecurity and hunger
	Reduced access to health services due to transportation breaks and infrastructure damage
	Extended range of disease vectors such as anopheles mosquitos to higher elevations

SMALL-SCALE INFRASTRUCTURE

Critical infrastructure and services are an important element of food distribution and food security. According to the Liberian government's Food and Agriculture Policy Strategy, higher levels of poverty and malnutrition exist in more remote districts with the lowest access to markets, health care, education and other critical services and infrastructure. As a result of years of civil conflict and social unrest, Liberia's infrastructure network is in dire need of rehabilitation, and thus highly vulnerable to extreme weather events. Access to critical infrastructure and services such as health, education, safe drinking water and sanitation is less than 25 percent of pre-war levels. The national road network is limited in coverage and generally in poor condition, and flooding of roads and key transportation connectors is common during the rainy season. Considering the dependence of rural areas on unpaved roads and the high susceptibility of unpaved roads to degradation under adverse weather conditions (e.g., high rainfall), the impacts of future climate change on the road network need consideration and monitoring. See Table 8 for more risks and impacts. (2, 5, 12)

Table 8: SMALL-SCALE INFRASTRUCTURE – Climate stressors and risks	
Climate stressors	**Climate risks**
Increased temperatures **Increased frequency of intense precipitation**	Compromised pavement integrity (softening, cracking, etc.); thermal expansion of paved surfaces; temperature-induced break in soil cohesion, leading to larger volumes of dust in the air during the dry season, causing health problems and traffic accidents
	Increased instability or loss of embankments; wash away of roads; increased soil moisture levels, affecting structural integrity; standing water on the road base
	Damage and/or destruction of bridges and culverts

KEY SOURCES

1. CGIAR. 2015. Climate vulnerability and adaptation of the smallholder cacao and coffee value chains in Liberia.
2. Environmental Protection Agency (EPA) of Liberia. 2013. Initial National Communication to the UNFCCC.
3. McSweeney, C., New, M. & Lizcano, G. 2012. UNDP Climate Change Country Profiles: Liberia.
4. Ministry of Agriculture. Food and Agriculture Policy Strategy: From Subsistence to Sufficiency.
5. Nordic Development Fund. N.d. Climate Resilient Roads: Cambodia Rural Roads Improvement Project: Results from Climate Change Adaptation.
6. Swedish International Development Cooperation Agency (SIDA). 2014. Liberia Environmental and Climate Change Policy Brief.
7. UNDP. 2010. Priorities and Challenges of Adaptation to the Impacts of Climate Change – A Focus on the Liberian Agricultural Sector.
8. USAID and US Forest Service Office of International Programs. 2013. Liberia Climate Change Assessment.
9. USAID Office of FFP. 2015. Food Security Desk Review for Liberia, 2016–2020.
10. USAID. 2008. Liberia Environmental Threats and Opportunities Assessment (ETOA), Final Report.
11. USAID. 2012. Climate Change Adaptation in Liberia: Country Fact Sheet.
12. USAID. 2016. Country-Specific Information: Liberia, Fiscal Year 2016 Development Food Assistance Program.
13. USAID. 2014. Liberia Nutrition Profile.
14. WHO. 2009. Country Profile of the Environmental Burden of Disease.
15. WHO. 2015. Liberia: WHO Statistical Profile.
16. WFP. 2010. State of Food and Nutrition Security in Liberia.
17. World Bank. Databank. Liberia.
18. UNICEF and GWP. 2014. WASH Climate Resilient Development Strategic Framework.
19. FAO. 2007. Fishery Country Profile.
20. Chenje, M. et al. 2006. Invasive Alien Species in African Environment Outlook. UNEP.
21. FAO. 2010. Global forest resources assessment: Liberia.
22. USAID. 2016. Fishing for Food Security.