



Governing climate mobility

SCOPING STUDY OF TWO LOCALITIES IN GHANA

Joseph Teye, Francis Jarawura, Lily Salloum Lindegaard, Nauja Kleist,
Marie Ladekjær Gravesen, Philip Mantey, og David Quaye

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ABSTRACT

Climate change is widely expected to produce new and/or intensified mobility patterns, including migration and displacement. However, research on the relationship between climate change and human mobility is limited, especially regarding the role of governance contexts and interventions in shaping mobility responses. The Governing Climate Mobility (GCM) Research Programme seeks to address this gap by examining the relationships between climate change, mobility and governance in Ghana and Ethiopia. This working paper is a scoping study of the programme's case-study areas in the Upper West and Eastern Regions of Ghana and provides data and analysis on relevant environmental, socio-economic, governance and mobility dynamics. This includes multi-decadal analyses of changes in temperatures, rainfall and vegetation, linking these, and how they are experienced locally, to existing governance and mobility contexts. It builds on a previous GCM working paper on the historical links between climate, mobility and governance in Ghana and identifies key dynamics for further study.

1. INTRODUCTION

Climate change and mobility are central dynamics of societies, politics, economies and environments globally. Increasingly, the two are considered linked, with the expectation that climate change will produce new and/or intensified mobility patterns. However, only limited research exists on the relationship between climate change and human mobility, specifically on the implications of increasingly intense slow-onset climate change, such as weather variability and extremes. The research which does exist points to the complex and at times converse linkages between climate change and mobility, a counterpoint to the simplistic causal relation of climate change leading to movement that dominates popular and political discourse.

The Governing Climate Mobility (GCM) research programme, for which this working paper is produced, seeks to shed additional light on the relationship between slow onset climate change and mobility. Specifically, the programme seeks to examine the role of governance actors and interventions in shaping climate-related mobility. This focus on governance offers a novel addition to climate-related mobility literature, which rarely focuses on the role of governance contexts and interventions in shaping how climate change is experienced and how mobility is formulated as a response. To better understand the role of governance in climate-related mobility, the programme is conducting a comparative study of Ghana and Ethiopia, two countries affected by climate change, but with quite different governance contexts. Ghana presents a case of pluralistic and somewhat decentralized governance, where local institutions and actors, including traditional institutions, play an important role in governance, resource management and decision-making. This is in contrast to the more centralized governance structure of Ethiopia.

This working paper is the product of an initial scoping study of GCM's study areas in Ghana, namely the Eastern and Upper West regions. The scoping study provides preliminary assessments of these areas as a basis for further data collection, specifically aiding in the design of research instruments for the main data collection. To do so, it offers a detailed introduction to environmental, socio-economic, governance and mobility dynamics in the study areas, as well as identifying relevant trends, key dynamics and possible linkages for further study. It builds on a previous GCM working paper¹ that explores the historic linkages between climate, mobility and governance in Ghana and elaborates the programme's approach in the Ghanaian context.

The scoping study draws on extensive secondary data and initial primary data collection. This includes field visits by the Ghanaian research team to the study areas in December 2019 and preliminary qualitative data collection in selected communities in the study areas in June 2020, where interviews were conducted with residents and officials. Secondary data for the study includes background data on physical and socio-economic features of the study areas. Specific analyses on long-term changes in vegetation (i.e. change detection) and climatic variables (i.e. rainfall and temperature) in selected districts in each of the two study regions have also been conducted as part of the scoping study.

In the sections that follow, the working paper first provides a brief introduction to the study sites and general development and governance characteristics. This is followed by two main sections of the paper, examining climate, vegetation and relevant socio-economic and governance characteristics for the Eastern Region and the Upper West Region. Finally, a brief conclusion highlights main points and questions for further examination that emerge from the study.

1.1. Study regions and districts

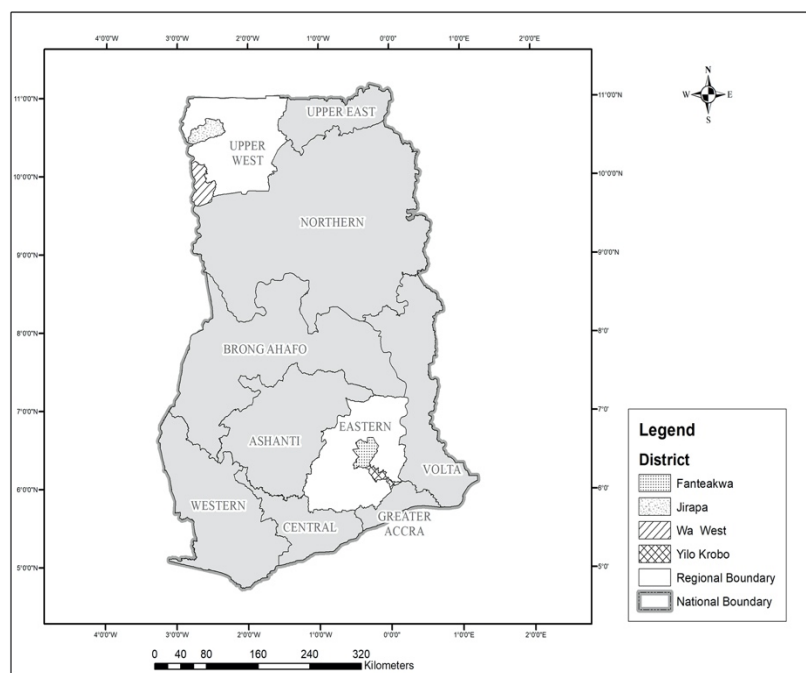
While Ghana lies within the tropical climate zone, the country is further divided into three distinct agro-ecological zones, namely the Northern Savannah Zone (which includes the Sudan and Guinea Savannah), the Tropical Forest Zone (including the Rainforest, the Semi-Deciduous Forest, and the Transitional Forest Zone) and the Coastal Savannah Zone. Of these, the savannah agro-ecological zone in the north of Ghana has received the most attention by climate change and migration studies (Yaro et al., 2015; Teye and Owusu, 2015). Consequently, there is very little understanding of climate change and migration within the forest zone. To help fill this gap, this study is being conducted in two agro-ecological zones, namely the Tropical Forest Zone (represented by the Eastern Region) and the Northern Savannah Zone (represented by the Upper West Region) in order to compare findings for the two.

Within each region, two districts have been selected as study sites encompassing both peri-urban and rural areas. By including both peri-urban and rural areas, the

¹ Graversen, M. L., Lindegaard L. S., Jarawura, F., Kleist, N. and J. Teye (2020) *Governance, Climate Change and Mobility in Ghana*. DIIS Working Paper 2020:06. Available at: <https://www.diis.dk/node/24180>

programme hopes to shed further light on the relationships between governance, climate change and mobility in these different settings, which can be characterised by differences in a range of factors with potential significance for climate-related mobility and governance of the same. This could include, for instance, differing livelihoods, reliance on natural resources and the environment, access to public goods, services and infrastructure, and differences in mobility patterns, etc. Including rural and peri-urban areas adds an additional comparative dimension within each region and across regions as well as across countries. Figure 1 provides an overview of the study regions and districts:

Figure 1. Map of Ghana showing the study regions and districts



Source: Authors' construct

The Eastern Region has been selected from the forest zone, which has been neglected in previous climate change studies in Ghana. The region is located between latitudes 6° and 7° North and between longitudes 1°30' West and 0°30' East in southern Ghana (see Figure 1). It is more urbanised and relatively economically stronger than the Upper West Region. Farmers in the Eastern Region produce cocoa (Ghana's most important cash crop) and food crops, such as plantain, tomato, cocoyam and cassava. As the region is relatively more developed, it serves as both a migrant sending and migrant receiving area. The Yilo Krobo and Fanteakwa districts have been selected as the main study sites from the Eastern Region. The Yilo Krobo District is adjacent to the Greater Accra Region. It covers an area of 805 square kilometres and lies within the dry equatorial climatic zone of Ghana. The Fanteakwa District is larger, with a total landmass of 1150 square kilometres.

The Upper West Region has been selected to represent a semi-arid zone of Ghana. The semi-arid zone is often studied in relation to climate change impacts in Ghana, as environmental conditions in the area are already challenging and socio-economic development is relatively lower, suggesting greater vulnerability to climate change

impacts. The Upper West Region is located in the north-western corner of Ghana (See Figure 1), bordering Burkina Faso to the north and Côte d'Ivoire to the west. The region lies in the Northern Savannah Zone, which is characterised by a single rainfall season (May-September). Agriculture is the main economic activity in this region, with cultivation of food crops such as yam, rice and sorghum. However, the region's agricultural economy has not been enough to lift residents beyond the poverty line, and the region has the highest reported poverty incidence in Ghana (GSS, 2018). Migration has been one of the key responses to environmental stress and shocks over the last few decades, though political dynamics have in some instances tempered this tendency (Van der Geest, 2011), pointing to the potential importance of governance factors. The Wa West and Jirapa districts have been selected as the main study sites from the Upper West. The Wa West District is a new political administrative district carved out of the Wa Municipality and is situated in the southwestern corner of the Upper West Region, bordering the Ivory Coast to the west. The Jirapa District is located towards the northwest of the region. Details of the characteristics of each region and the case districts are provided in the relevant sections.

1.2. Development and governance characteristics of the study areas

Ghana has undergone rapid development over the last decades. This is reflected in the country's living standards, which have generally improved as a result of socio-economic development, linked partially to various economic policies and development programmes over the years. As shown in Table 1, at the national level, the percentage of people classified as poor was halved over 25 years - from 51.7% in 1991/92 as measured in the Ghana Living Standards Survey 3 (GLSS 3) to 23.4% in 2016/17 (GLSS 7).

By region, poverty incidence is linked closely to migration and livelihoods. Greater Accra, for instance, has witnessed the lowest incidence of poverty since 1991 across all regions. Yet from 1999 to 2006, the incidence of poverty in the region more than doubled from 5.21% to 13.5%. This is attributed to increased migration of rural poor to Accra (Awumbila et al., 2014). Since 2006, the region has again witnessed tremendous decline in poverty levels. Low poverty in the region may be due to it being the most urbanised region, with many residents employed in the formal sector where they receive regular salaries. Many of the urban poor, however, work in the informal sector.

Looking at GCM's study regions, the Eastern Region has also witnessed a rapid decline in poverty levels (see Table 1 and Figure 2), from 48% in 1991/92 to 1% in 2016/17. It is now among the regions with the lowest incidences of poverty. In contrast, poverty in the Upper West Region has declined only slowly from 88.4% in 1991/92 to 70.9% in 2016/17, and poverty levels in the Northern Savannah Zone generally (Upper East, Upper West and Northern regions) have been consistently high. The Upper West Region has fared poorest of all regions over the years. The region's high incidence of poverty is partly attributed to a lack of valuable natural resources and effects of climate change, which provide a context for migration. In contrast, the Eastern Region is economically stronger because it has more fertile

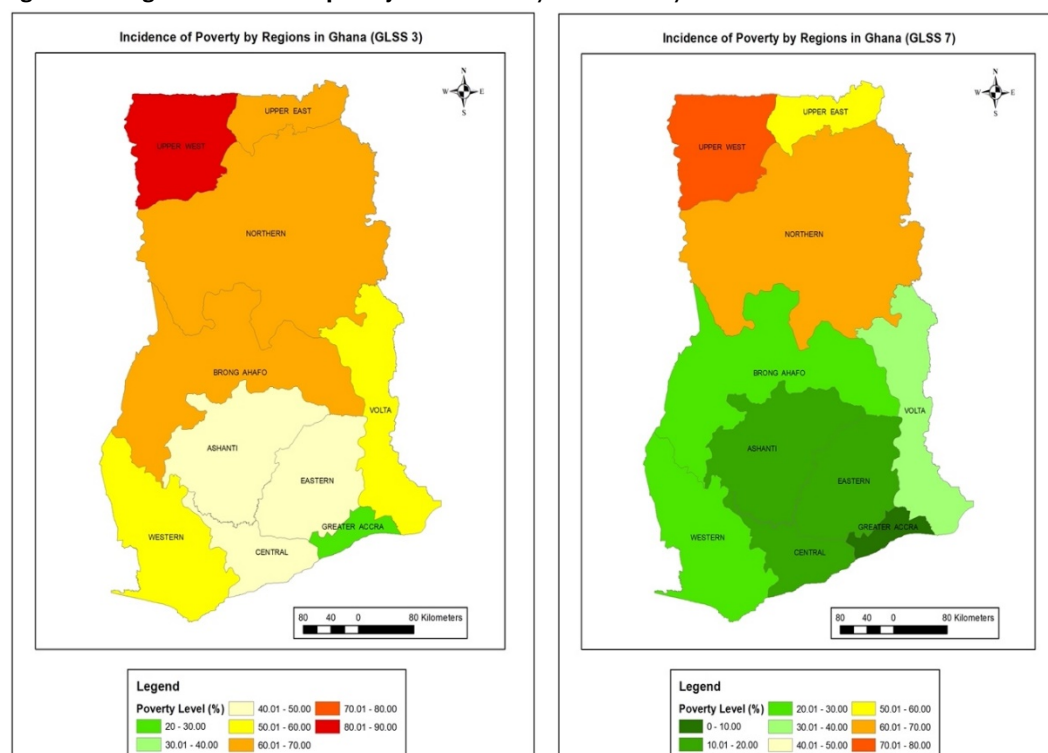
soils and better climate which supports the production of cash crops such as cocoa. The Eastern Region is also more urbanised and closer to Accra. Consequently, many of the people in the region are engaged in more profitable economic activities. Thus, with regards to living standards in our two study regions, the Eastern Region is far better off than the Upper West Region.

Table 1. Percentage of people classified as poor

Region	Percentage of people				
	GLSS3 1991/92	GLSS4 1998/99	GLSS5 2005/06	GLSS6 2012/13	GLSS7 2016/17
Western	59.6	27.25	22.9	20.9	21.1
Central	44.3	48.44	23.4	18.8	13.8
Greater Accra	25.8	5.21	13.5	5.6	2.5
Volta	57.0	43.68	37.3	33.8	37.3
Eastern	48.0	37.72	17.8	21.7	12.6
Ashanti	41.2	27.73	24	14.8	11.6
Brong Ahafo	65.0	35.84	34	27.9	26.8
Northern	63.4	69.2	55.7	50.4	61.1
Upper East	66.9	83.93	72.9	44.4	54.8
Upper West	88.4	88.15	89.1	70.7	70.9
All Ghana	51.7	39.45	31.9	24.2	23.4

Source: Ghana Living Standard Survey

Figure 2. Changes in incidence of poverty between 1991/92 and 2016/2017



Source: Authors' construct based on data from Ghana Statistical Service

Governance in Ghana is pluralistic and somewhat polycentric, with both formal and traditional institutions playing important roles. There exists a parallel but interactive system of local and informal authority comprised of chiefs and elders on the one hand and the formal government systems on the other. The local system is essentially made up of paramount chiefs, lower chiefs, and the elders who provide leadership to the people based on long standing albeit changing norms. In rural areas in particular, the chiefs settle day-to-day matters of living and also serve as the main connection to the formal government administration. Traditional authorities are also extremely important in managing land and resource access, which may be significant in terms of livelihoods, climate impacts and mobility. Unlike in the Upper West where the patrilineal system of kinship is overriding, in the Eastern Region both patrilineal and matrilineal systems exist. Whilst the matrilineal inheritance system is dominant in the Fanteakwa District, the patrilineal inheritance system is dominant in the Yilo Krobo District. There are, therefore, more female traditional leaders, or Queens, in the Eastern Region than in the Upper West Region.

Subnationally, the formal governance system starts at the apex with a regional administration followed by the district assemblies (DA). All assemblies have the same internal structure, with a government appointed district chief executive (DCE) as the head. The DCE's role is twofold, representing national government at the district level while also being responsible for the district's executive and administrative functions (CLGF, 2018). The assemblies consist of 70% elected members and 30% presidential appointees. Out of these members, 9% of the total seats are reserved for traditional authorities. As Crawford points out, the elected members "are the linchpin between communities and the DA, both articulating community needs and demands to the DA and communicating information from the DA to communities" (2010: 96). In terms of development programmes particularly, these are largely funded by the central government and development partners, such as World Bank, EU, and Danida. The DAs are responsible for their management.

In addition to these governance actors, the GCM programme will also consider the role of other informal governance actors, including religious institutions, local associations and networks, for instance migrant networks. However, the role of such actors did not emerge clearly in the initial data collection on which this scoping study is based. Exploring the role of such actors in the governance of climate-related mobility will therefore be taken up in subsequent data collection.

2. STUDY AREA I: EASTERN REGION OF GHANA

In this section, we discuss the physical and socio-economic characteristics of the study sites in the Eastern Region of Ghana, based on secondary data and primary qualitative data collected. The case districts within the region are Yilo Krobo and Fanteakwa Districts. As mentioned above, Yilo Krobo covers an area of 805 square

kilometres, while the Fantekwa District covers an area of 1150 square kilometres. Below we present three sections dealing with the climate, vegetation and socio-economic characteristics of the region. The first two sections offer findings from analyses of temperature and land cover data over multiple decades, providing an understanding of environmental changes in the case districts. This provides a backdrop for the final section discussing socio-economic characteristics of relevance to the GCM programme, specifically demographics, agriculture, migration and governance and development support.

2.1. Climate of the Eastern Region

A majority of the Eastern Region falls within the tropical forest climatic zone (specifically the semi-deciduous forest) in the southwestern part of Ghana. The area is characterised by two rainy seasons (April to July and September to November), with mean annual rainfall around 1800 mm (Ofori-Sarpong and Annor, 2001), though with local variations in rainfall and temperature. For instance, the Fantekwa District is wetter than the Yilo Krobo District, with around 1800 mm annual rainfall in contrast to the Yilo Krobo district's rainfall of roughly 750 mm in the northwest and 1600 mm in the southwest of the district. The climate of the Eastern Region is favourable for crop production. As a result of the double maxima rainfall pattern (i.e. two rainy seasons), farmers in the region engage in farming throughout the whole year, which ensures greater food availability when compared to the Upper West Region.

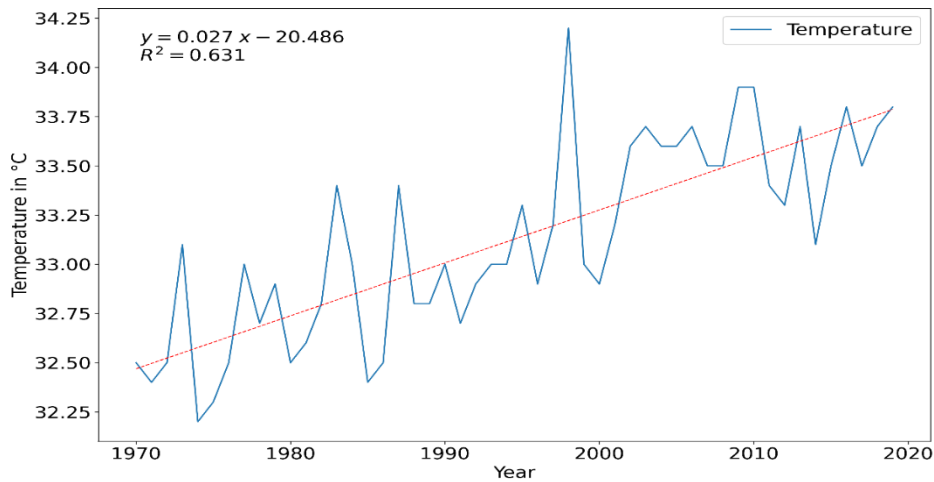
Given that temperature and rainfall are the most important variables influencing agricultural activities and livelihoods in West Africa (Owusu and Waylen, 2009; Teye et al., 2015), we examine long-term changes in temperature and rainfall based on data provided by the Ghana Meteorological Agency. We find notable changes in both temperature and rainfall in the period from 1970-2019, presented in detail below.

2.1.1. Long-term changes in temperature

Temperatures in the study sites show a clear warming trend over the last 50 years, as illustrated by the red trendlines in Figures 3 and 4 below. In Yilo Krobo District, the average maximum temperature has been increasing on average 0.027 °C annually since 1970, with a total average increase of 1.35 °C. Our analysis indicates an average maximum temperature of 33.2 °C and a low level of uncertainty associated with increasing temperatures (coefficient of variation [CV] of 1.48%).

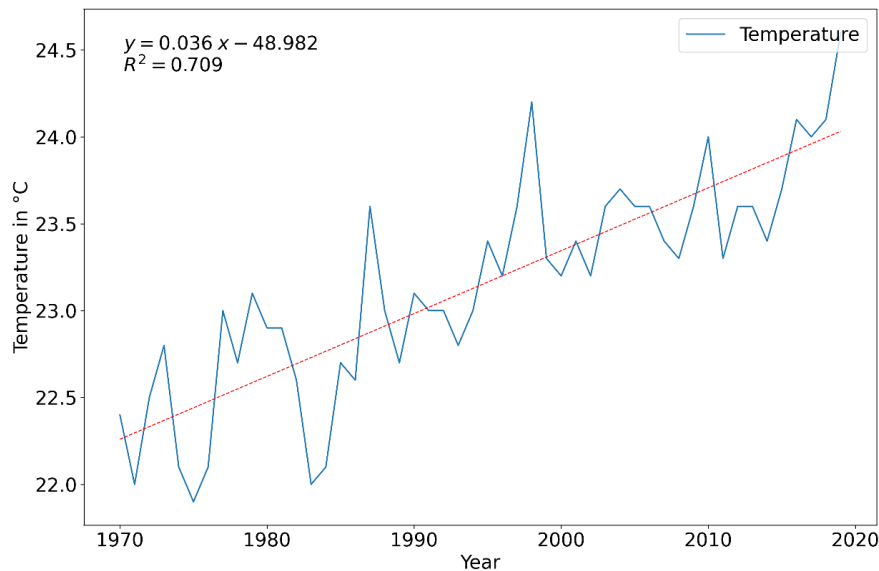
Since 2002, maximum temperatures have exceeded the average of 33.2 °C with the exception of 2014 which was 0.1 °C short. This is also an indication of the warming trend, as the maximum temperatures in recent years are consistently above the average for the full period. Similarly, the average minimum temperature has been increasing at 0.036 °C annually in Yilo Krobo District since 1970, a cumulative average increase of 1.8 °C. The analysis reveals an average minimum temperature of 23.1 °C with a CV of 2.70%.

Figure 3. Maximum temperature time series for Yilo Krobo District (1970 – 2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

Figure 4. Minimum temperature time series for Yilo Krobo District (1970 – 2019)

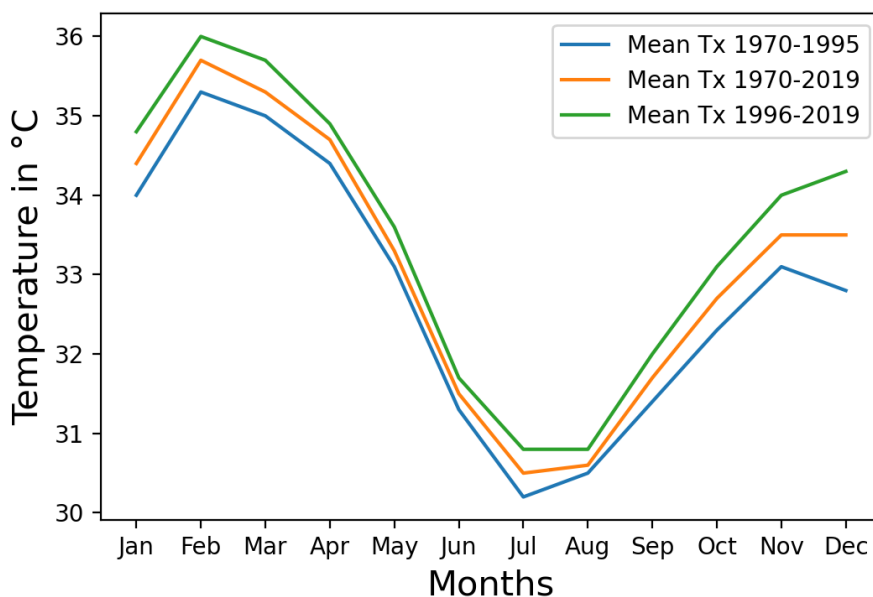


Source: Authors' construct based on data from Ghana Meteorological Agency

Time series analysis of temperature trends in the Fanteakwa District (not shown in diagram because of space constraints) shows similar upward trends. Given the importance of changes in monthly temperatures to farmers in the tropics (Owusu and Waylen, 2009), we also performed a multi-decadal analysis of temperature to understand how mean monthly minimum and maximum temperatures have changed since 1970. As shown in Figure 5, when the data was divided into earlier and later periods (1970-1995 and 1996-2019), we found that the mean maximum temperature was consistently higher during the more recent period than the earlier period. This can be seen in the comparison to the average for the full period (1970-2019), which consistently falls between the averages for the earlier period of lower temperatures and more recent period of higher temperatures (see Figure 5). This again illustrates the warming trend across decades. Similarly, as shown in Figure 6, the monthly minimum temperature, in the Yilo Krobo District has increased considerably during the last two decades (1996-2019). The extent of warming, however, swings throughout the year, with the greatest increase in maximum

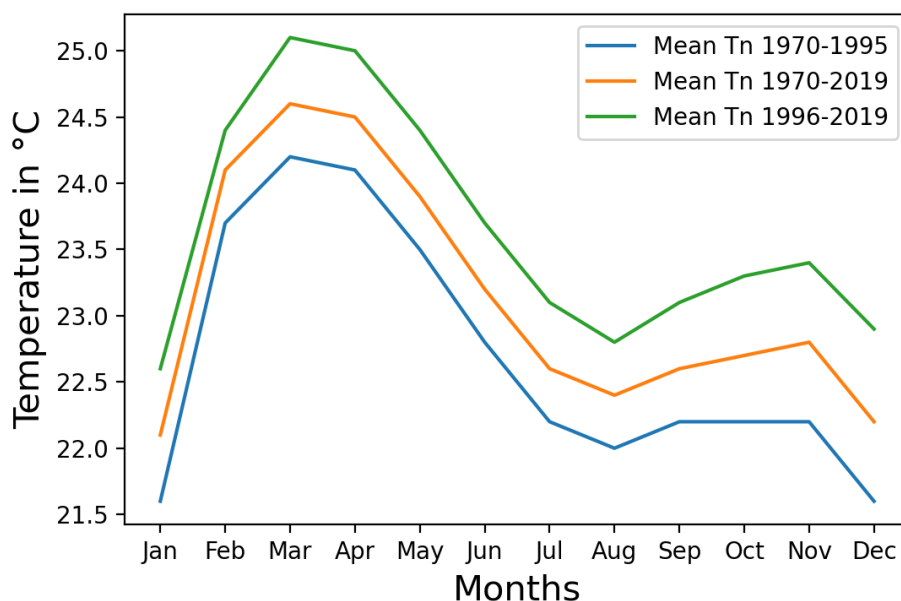
temperatures in December. Such increasing trend of temperatures affect crop production, water availability and general livelihoods.

Figure 5. Mean monthly maximum temperature for Yilo Krobo District (1970-2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

Figure 6. Mean monthly minimum temperature for Yilo Krobo District (1970-2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

Interviews conducted with some farmers during the scoping study indicate that many farmers in both the Fanteakwa and Yilo Krobo districts have observed rising temperatures as highlighted in the statement below:

When we were young, this place was not as hot as it is today. These days, it sometimes gets so hot during the day that we find it difficult to work on the farms. The heat [high temperature] also affects cocoa yield. [...] There were some years when the heat destroyed our food crops and we had to do

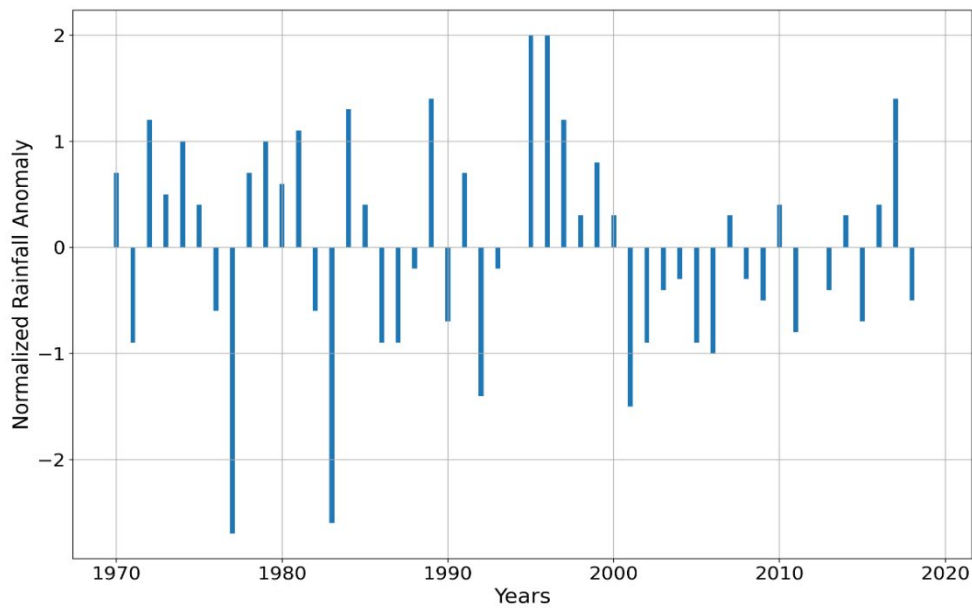
replanting (AAT, cocoa and food crop farmer, Fanteakwa District, Eastern Region).

The above suggests that while regions in the forest zone have often been assumed to be experiencing a favourable climate, increasing temperatures are indeed affecting agricultural production in the Eastern Region, despite it being in the forest zone. To put these temperature increases in perspective, the Paris Agreement aims to hold global warming to well below 2 °C and preferably to 1.5 °C. The findings from the Eastern Region indicate that average temperature increases have already reached 1.5 °C, which is striking for an area that has not received attention in research and scholarly literature on climate change impacts. This raises important questions in terms of the potential (lack of) awareness and intervention regarding the livelihood impacts and the role of governance institutions in addressing these impacts.

2.1.2. Long-term changes in rainfall

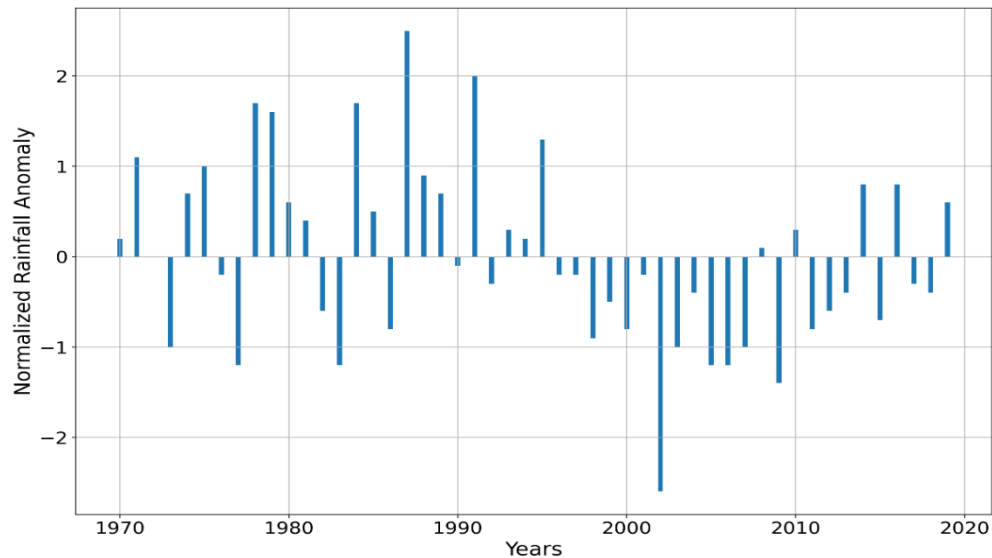
At the same time as temperatures have been increasing, rainfall has generally been decreasing. Our analysis of rainfall data (see Figure 7) reveals that rainfall distribution for the Yilo Krobo District since the year 2000 has been mostly below the long-term mean of 1048.6 mm. This presents a growing concern for current and future water availability in the region. The figure also demonstrates high variability of rainfall in the Yilo Krobo District from year to year. Similarly, Figure 8 shows that since 1996, rainfall distribution for the Fanteakwa District has been mostly below the long-term mean of 1334.9 mm. This again indicates a downward trend of annual rainfall which has negative implications for livelihoods and access to water in the district. Together, the downward trend and variability of rainfall present potential challenges to agricultural livelihoods and daily water access. This suggests possible questions to be taken up in further data collection, for instance around climate change adaptation efforts, water resource management, other forms of governance support and interventions, changing livelihoods or livelihood practices, and shifts in mobility practices.

Figure 7. Normalised rainfall anomaly for Yilo Krobo District (1970 – 2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

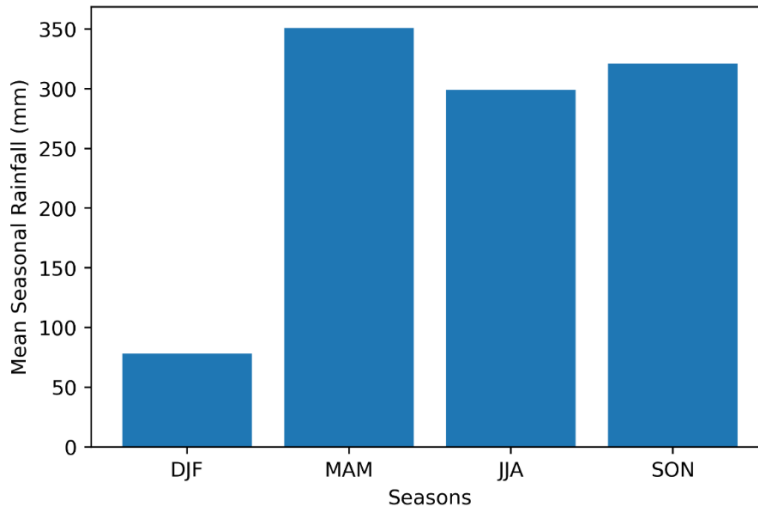
Figure 8. Normalised rainfall anomaly for Fanteakwa District (1970 – 2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

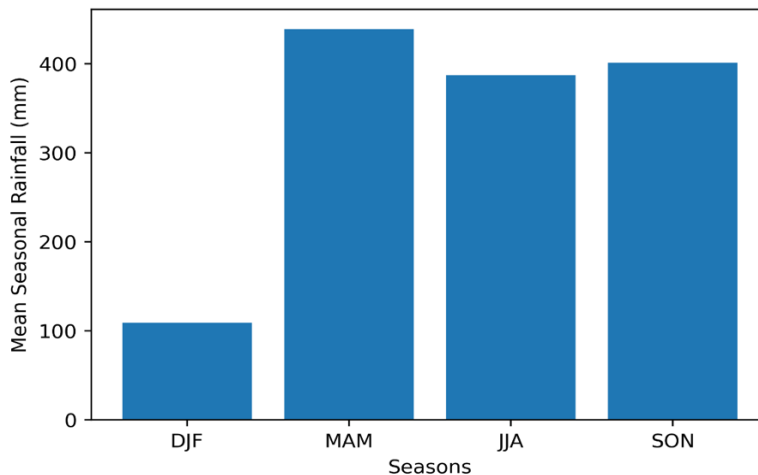
With specific reference to seasonal distribution of rainfall, the greater part of rainfall in the Yilo Krobo and Fanteakwa districts occurs during the spring and autumn months, producing major and minor rainfall seasons (Figures 9 and 10). This is characteristic for southern Ghana generally, which has a bimodal rainfall regime with peaks in May/June for the major season and September/October for the minor season (See Figures 9 and 10 below for an overview of seasonal rainfall in the study districts). It is also noteworthy that rainfall variability is generally greatest in the dry season of December/January/February (DJF), with CVs of roughly 58% for both districts. This can be compared to the rainy seasons, with CVs ranging from 25.6% to 31%.

Figure 9. Seasonal rainfall distribution for Yilo Krobo District (1970 – 2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

Figure 10. Seasonal rainfall distribution for Fanteakwa District (1970 – 2019)



Source: Authors' construct based on data from Ghana Meteorological Agency

The general decline in rainfall amounts in the Eastern Region in recent years has been observed by farmers in the communities studied as highlighted in the statement below:

The rains have been failing us. If we compare with the situation some 20 years ago, we see that the amount of rainfall has declined. [...] Sometimes we are expecting the rains to start so we can plant but it delays (BYT, Yilo Krobo District, Eastern Region).

Farmers' observations of climate variability in the Eastern Region are largely consistent with data from the weather monitoring stations. The overall findings of decreased rainfall are consistent with findings from other regions of Ghana (see Weber, 2010; Yaro, 2013; Teye et al., 2015), though these impacts in the Eastern Region have generally been overlooked in the academic literature.

2.2 Vegetation of the Eastern Region

While the Eastern Region lies mostly within the forest zone of Ghana, its vegetation varies slightly from one place to another. The Fanteakwa District and the northwestern part of the Yilo Krobo District fall within the semi-deciduous forest zone, while the southeastern lowlands of the Yilo Krobo District fall in the savannah vegetation zone. The Fanteakwa District and a few of the communities in the Yilo Krobo District fall within the Worobong Forest Reserve. Although agriculture is generally not allowed within the reserve, production of annual crops is sometimes allowed within degraded reserves. This is part of the 'Taungya system,' in which farmers are permitted to cultivate food crops on forest lands, while also planting trees on such farms (Teye, 2008).

During our scoping study, both key informants and farmers reported that the communities have witnessed significant deforestation in recent years in the forest zone. At Ahinkwa, a farming community in the Yilo Krobo District, for instance, farmers narrated how the forest cover has been depleted as a result of human activities:

This place was covered by a thick forest which was protected by the Forestry Department. The situation changed in the 1980s when we [farmers] were allowed to farm on the forest land and plant trees. In less than 10 years, we destroyed the entire forest (Farmer, Yilo Krobo District, Eastern Region).

The above statement on rapid deforestation in the 1990s is consistent with the high level of deforestation in Ghana, especially in the 1980s and 1990s. According to The Food and Agricultural Organisation (FAO; 2003), the rate of deforestation in Ghana from the 1990s to 2000 was 1.7% annually. Deforestation affected both reserved and off-reserve forests. An assessment of the forest cover by Hawthorne and Abu Juam (1995) shows that as a result of human activities, only 2% of the total area of forest reserves was in a "very excellent" condition as of 1993. The assessment further shows that of the 214 forest reserves in the country, 121 (representing about half of the entire reserves area) were seriously degraded or without forests at all. Several programmes, including participatory approaches, have been adopted to reduce deforestation (Teye, 2013) but the rate of forest loss is still high due to human activities, such as farming and logging. These challenges suggest the need to give attention to the role of government at different levels, including traditional institutions, in addressing both the short-term needs of individuals as well as collective and longer-term needs.

2.2.1 Vegetation change detection analysis

In order to better understand vegetation change in the study districts, we have conducted an analysis of the green cover rate and the level of change over time. To do so, we employed geographic information systems (GIS) techniques to analyse historical US Geological Survey (USGS) Landsat-4 and Landsat-8 satellite datasets between 1991 and 2020 to identify and quantify the rate and changes of green cover. Landsat data comprise the only long-term digital archive with a medium to high spatial and temporal resolution, meaning a medium to high number of data points

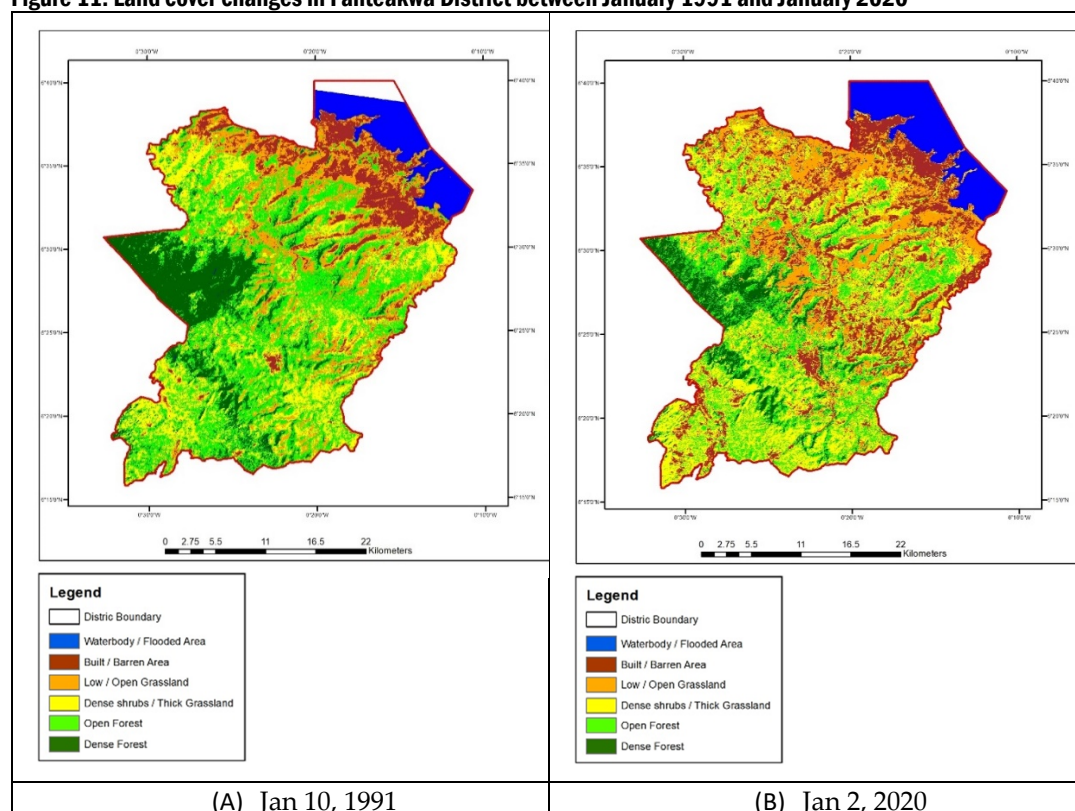
both over a given geographical area and over time. The dataset also has a relatively consistent resolution for satellite imagery.

To conduct the analysis, we employed the Normalized Difference Vegetation Index (NDVI), one of the most widely used indices for green cover extraction from satellite imagery (Guha et al., 2018; Sun et al., 2019;) as well as for spatio-temporal analysis of vegetation cover changes (ESRI, 2014; Guha et al., 2018; Sun et al., 2019). The NDVI can also be used to categorise and classify types and changes in different land-use landcover (LULC), for instance built/barren areas, open grassland, or dense forest (Guha et al., 2018; Chen et al., 2006). Finally, the NDVI allows generation of an image displaying greenness (relative biomass or health) of an area’s vegetation. Additional details on the data and methodology are available in the Annex, and the main findings are presented below.

2.2.2 Land cover changes in Fanteakwa District between January 1991 and January 2020

Figure 11 presents changes in land cover in Fanteakwa District between January of 1991 (A) and January 2020 (B). Notable changes over this period include a marked decrease in forested area as well as increases in built/barren areas, areas of dense shrub/thick grassland, and a slight increase in areas of open water. Table 2 provides detailed statistics of the incidence and changes of these various land cover classes for the two periods.

Figure 11. Land cover changes in Fanteakwa District between January 1991 and January 2020



Source: Authors’ construct based on USGS Landsat data

Table 2. Land cover changes in Fanteakwa District between January 1991 and January 2020

Land Cover	Jan. 10 1991			Jan. 2 2020			Change (+/-)	
	Pixels	Area (km ²)	%	Pixels	Area (km ²)	%	Area (km ²)	%
Waterbody	82626	74.36	6.85	101108	91.00	8.27	16.63	22.37
Dense Forest	174957	157.46	14.51	101036	90.93	8.26	-66.53	-42.25
Open Forest	359542	323.59	29.82	219812	197.83	17.97	-125.76	-38.86
Dense Shrub / Thick Grassland	256620	230.96	21.28	369035	332.13	30.18	101.17	43.81
Low / Open Grassland	215030	193.53	17.83	233966	210.57	19.13	17.04	8.81
Built / Barren Area	117097	105.39	9.71	197968	178.17	16.19	72.78	69.06
Total	1205872	1085.28	100.00	1222925	1100.63	100.00		

Source: Authors' construct based on USGS Landsat data

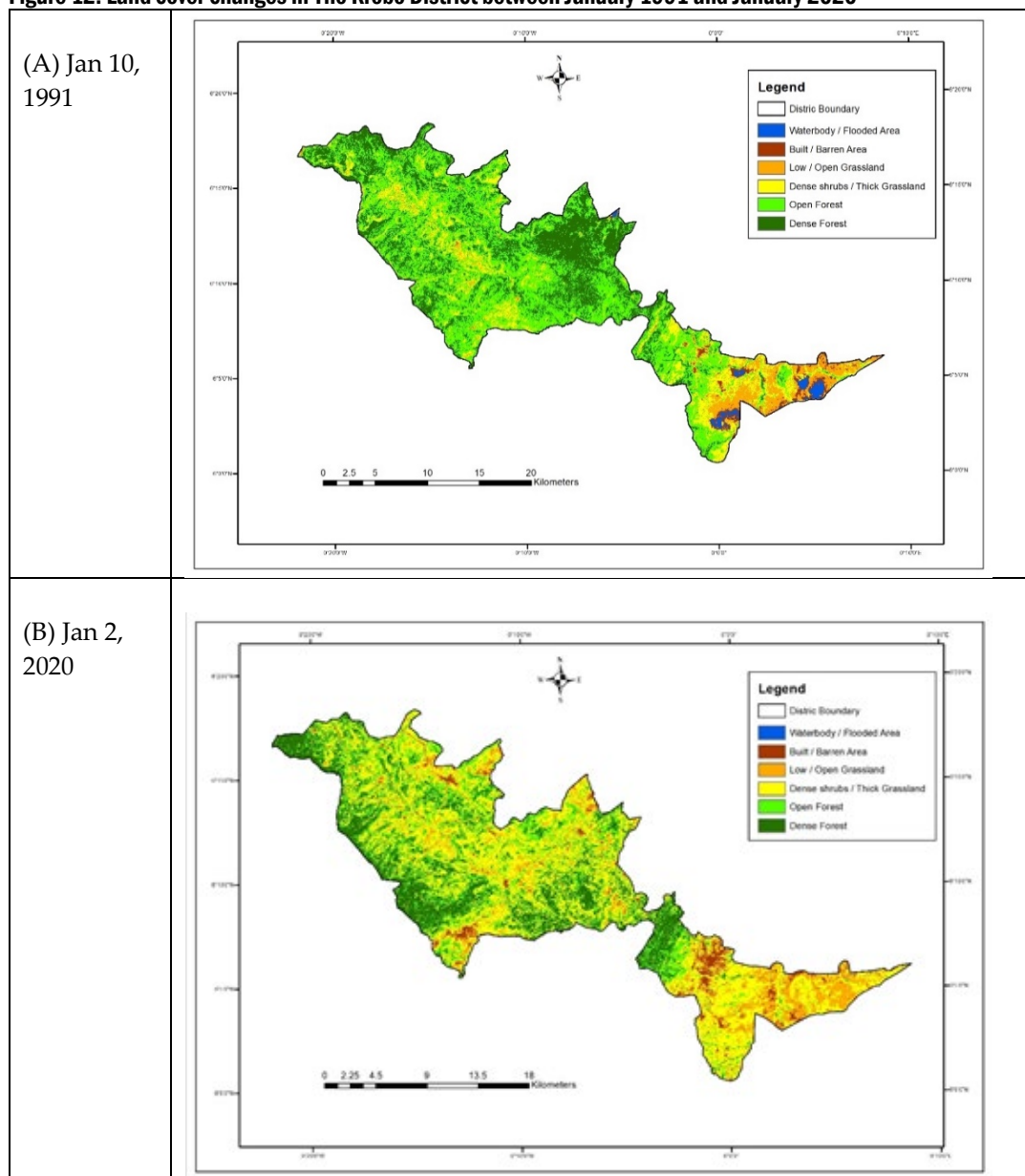
In January 1991 (Figure 12A), over 40% of the district was covered by forest, with dense forest vegetation (14.5% of total) mainly in the west and southwest and open forest vegetation (29.82%) in all but the northeastern parts of the district near the Volta Lake. Areas of grassland and dense shrubs made up just under 40% of the landcover, and the remainder was covered by built/barren areas (9.7%) and waterbodies (6.9%).

By January 2020 (Figure 12B), there had been a major decrease in forested area (-42.3% in dense and -38.9% in open forested areas) accompanied by increases in all other landcover categories. Most notably, built/barren areas, from settlement build up, roads and other land use activities, increased by 69% and areas of grassland and shrubs increased by 52.6%. There was also a 22.4% increase in water bodies. By 2020, shrub/thick grassland had become the single largest land cover category, overtaking dense and open forests combined.

2.2.3. Land cover changes in Yilo Krobo District between January 1991 and January 2020

Figure 12 presents changes in land cover in the Yilo Krobo District between January of 1991 (A) and January 2020 (B). The most striking changes are the decrease in forested areas and complete disappearance of open water sources, mirrored by increases in grassland, shrubs and built/barren areas. Table 3 provides detailed statistics of the incidence and changes of these various land cover classes for the two periods.

Figure 12. Land cover changes in Yilo Krobo District between January 1991 and January 2020



Source: Authors' construct based on USGS Landsat data

Table 3. Land cover changes in Yilo Krobo District between January 1991 and January 2020

Land Cover	Jan 10, 1991			Jan 2, 2020			Change (+/-)	
	Pixels	Area (km ²)	%	Pixels	Area (km ²)	%	Area (km ²)	%
Waterbody/Flooded Area	6027	5.42	1.11	0	0	0	-5.42	-100.00
Dense Forest	153616	138.25	28.38	116397	104.76	21.50	-33.50	-24.23
Open Forest	255144	229.63	47.14	119148	107.23	22.01	-122.40	-53.30
Dense Shrub / Thick Grassland	81362	73.23	15.03	216775	195.10	40.05	121.87	166.43
Low / Open Grassland	35797	32.22	6.61	68938	62.04	12.74	29.83	92.58
Built / Barren Area	9337	8.40	1.72	20025	18.02	3.70	9.62	114.47
Total	541283	487.15	100.00	541283	487.15	100.00		

Source: Authors' construct based on USGS Landsat data

In January 1991 (Figure 12A and Table 3), forest vegetation accounted for over 75% of the land cover in the district, with dense forest vegetation found mainly from the middle to the western parts and open forest vegetation found in all but the far east of the district. Built/barren areas, which represent settlements, roads and other cleared surfaces, accounted for under 2%. The remainder of the district land area was covered by dense shrubs/thick grassland (15.03%), low or open grassland (6.61%) and water surfaces (1.11%), comprising flooded areas in the eastern part.

However, by January 2020 (Figure 12B and Table 3), the total forested area had fallen precipitously (-77.53%). Dense shrubs/thick grassland and low or open grassland, on the other hand, saw an increase of 166.4% and 92.6%, respectively. Built/barren surfaces also showed a significant rate of increase (114.47%) by 2020. These changes affect livelihoods as deforestation generally affects availability of ecosystem services. In addition, the land cover analyses illustrate differences in the case study districts. For instance, the share of built/barren area remains significantly lower in Yilo Krobo (3.7%) than Fantekwa (16.2%).

2.3. Socio-economic characteristics of the Eastern Region

This section discusses the socio-economic characteristics of the Eastern Region, with focus on characteristics of relevance to the GCM programme. It presents the region's demographics, livelihoods, migration dynamics and governance and development support.

2.3.1. Demographic characteristics

The Eastern Region has a population of 2,633,154, representing 10.7% of the country's total population. As can be observed from Table 4, the population increased consistently during the period 1960 to 2010 covering the five censuses. The decrease in growth rate between 1970 and 2000 could be explained by out-migration of both internal and external nature, and by decline in birth rates. Population increase has led to increasing population density during the period.

Table 4. Population of Eastern Region 1960-2010

Year	Population			Per-centage increase	Popu-lation Density	Per-centage share	Growth Rate	Sex Ratio	Depen-dency Ratio
	Total	Male	Female						
1960	1,094,196	527,682	516,438		54	16.3		102.2	96.0
1970	1,261,661	599,595	610,233	15.3	63	14.7	2.0	97.9	108.8
1984	1,679,483	834,962	845,928	38.8	87	13.8	1.8	98.1	94.9
2000	2,106,696	1,036,371	1,070,325	25.4	109	11.1	1.4	96.8	90.6
2010	2,633,154	1,290,539	1,342,615	25.0	136.3	10.7	2.1	96.1	79.0

Source: 1960, 1970, 1984, 2000, 2010 Census Report Central Bureau of Statistics and Ghana Statistical Service

Nearly 40% of the population resides in four of the region's 21 districts - West Akim, Kwaebibirem and New Juaben and Kwahu North – which are relatively more urbanised. The Eastern Region as a whole, therefore, remains largely rural with 56.6% of its population residing in rural areas. This is as also reflected in the region's economy, which is largely agriculturally based. The two districts selected for the

study are among those with largely rural populations, though they also have peri-urban areas.

The population of Fanteakwa District is estimated at 108,614, or 4.1% of the regional population, according to the 2010 Population and Housing Census (PHC) (GSS, 2014a). The district has a slightly higher share of males (49.7%) than the region as a whole (49.1%). It also has a quite young population (38.4% of the population were under 15 years old as of 2010) (GSS, 2014a), which suggests the importance of developing the capacities of the youth in different sectors as they will in the future be in charge of the development affairs of the district. The majority of the population (72.5%) lives in rural areas (GSS, 2014a).

On the other hand, the population of the Yilo Krobo District, according to the 2000 population Census, was 86,107, signifying a 4.1% increase over the population in 1984. In 2010, the population recorded during the census was 87,847. Of this figure, 42,378 (48.2%) were males, slightly lower than for the region as a whole. Yilo Krobo is also highly rural, aside from the district capital Somanya, which houses about 25% of the district's population. Of the district's 237 settlements, only 25 of them have populations of 500 and above, and Somanya is the only settlement in the district classified as urban. About 68% of the district's population lives in rural areas. The district as a whole has a population density of 107 persons per square kilometre.

2.3.2. Livelihoods

The main economic activities in the Eastern Region are agriculture, small-scale enterprises and services. Of these, agriculture comprises the main livelihood for the majority of region's population with nearly sixty percent (59.2%) of all households in the region engaged in agriculture (GSS, 2012), which is largely rain-fed. There are, however, clear rural-urban disparities as over three quarters of rural households are engaged in agriculture (76.1%) versus about half of that (39.7%) in urban areas. This is characteristic of rural and urban employment in the developing world. At the individual level, agriculture, forestry and fishery employ 45.2% of the people in the Eastern Region.

Consistent with the general trend across the entire region, the Yilo Krobo District has a major proportion of its workforce relying on agriculture, forestry and fishery (41.2%) for their livelihoods. Other important areas of employment include wholesale and retail (11.2%) and manufacturing (6.5%). There are notable gendered differences in livelihoods, with agriculture, forestry and fishery employed 50.6% of males and 32.4 % of females, while women play a much greater role in the wholesale and retail sectors. In agriculture, medium to large scale farms have emerged in recent years. Large scale plantation crops like mango have become a very important source of income as a result of the interventions of the Ministry of Food and Agriculture and some NGOs. This indicates the importance of both formal and informal governance actors in shaping livelihoods, resource management and access, and potentially the implications of climate change impacts for the population. During data collection for the scoping study, some farmers indicated that the crops cultivated and the farming techniques have also changed in recent

years as a result of land degradation and climate change. At Ahinkwa, a farming community in the Yilo Krobo District, farmers used to cultivate plantain, cocoa and yam, adopting a bush following farming system. However, as a result of shortages of forest land, reductions in soil fertility and declining rainfall, farmers now cultivate pepper, garden eggs, cassava and tomato. The use of fertilisers has also now become a feature of agricultural practice:

As you know [referring to J.K. Teye] in those days, we only produced plantain and cocoyam but the plantain was the main crop. People used to come from the whole country to come and buy plantain. We just moved from one forest land to another to start a new plantation farm. Today the forest is gone and the soil is no longer good for the plantain so we have resorted to the production of garden egg, pepper and cassava. [...] The use of fertilisers and chemicals started in this community just about 10 years ago. When the forest was here, no one needed fertilizers but now it is necessary on some of the farms (ALIMO, Yilo Krobo District, Eastern Region).

Apart from crop production, livestock farming is also practiced in the Yilo Krobo District. In fact, most of those engaged in crop production are also involved in livestock rearing. The main types of livestock reared in the district are cattle, goats, sheep, chicken and pigs. Livestock rearing generally supplements nutritional requirements and provides additional income. The agriculture sector is followed by the following sectors: wholesale and retail (19.0%); manufacturing (12.6%); accommodation and food service activities (6.1%); education (4.0%); and construction (2.4%) (GSS, 2014b).

The livelihood options in the Fanteakwa District are similar to those of the Yilo Krobo District. However, the proportion of the population engaged in agriculture is higher in the Fanteakwa District, with (60%) of the workforce (15 years and older) employed in the agriculture, forestry and fishery. In terms of household employment, the agricultural sector employs about 75% of households, notably higher than the regional average of 59.2% (GSS, 2014a). This is not surprising given the rural nature of the district, and reflects the importance of the sector to the livelihoods of the people. The district's arable land is used for the cultivation of crops such as banana, cocoa, yam, cereals and vegetables, including tomato, garden eggs, okra and pepper, all produced on a small scale. Cocoa is the major cash crop and attraction of the district, although in recent times climate change and soil degradation has diminished production. Consistent with the situation in the Yilo Krobo District, environmental change has affected livelihoods, resulting in changes in agricultural practices and in migration. During preliminary interviews farmers narrated how they have responded to changes in soil quality and climate by moving away from the production of cocoa to tomatoes, pepper, garden eggs and watermelon. In addition, environmental changes have resulted in some farmers migrating to the Western and Ashanti regions to continue cultivation, discussed further in the following section.

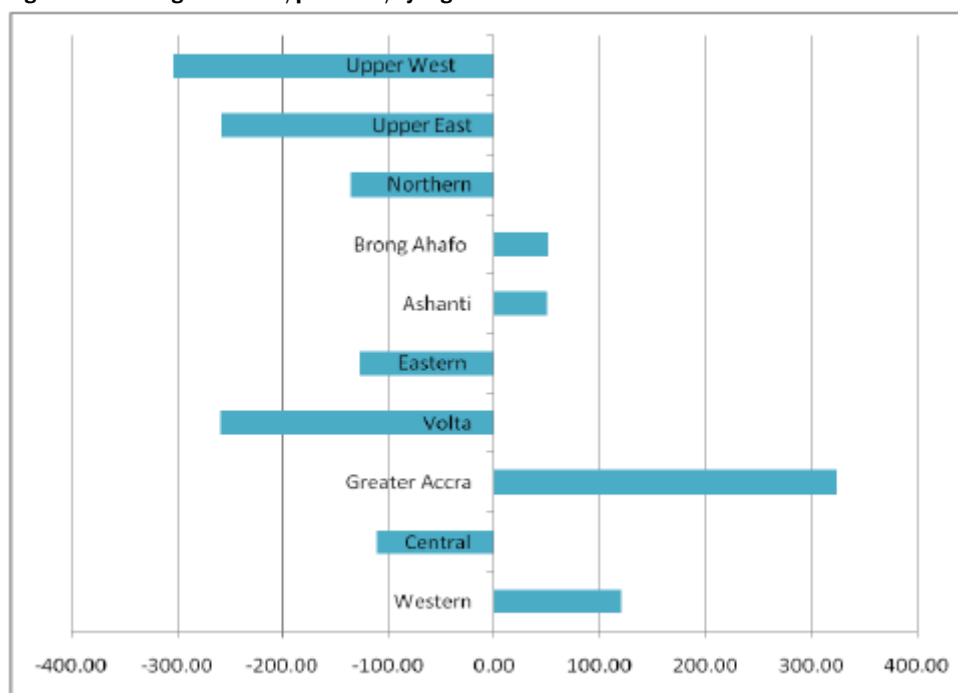
Apart from the agriculture sector, other important areas of employment in the Fanteakwa District include: wholesale and retail (repair of motor vehicles and

motorcycles) (11.2%); manufacturing (6.5%); financial and insurance activities (0.4%); administrative and support services (0.3%); arts and entertainment (0.2%); electricity gas stream and air conditioning supply (0.1%); and information and communication (0.1%) (GSS, 2014a).

2.3.3. Migration

Overall in Ghana, six regions - Volta, Northern, Eastern, Upper East, Central and Upper West - experienced negative net migration, while four - Greater Accra, Western, Ashanti and Brong Ahafo – recorded positive net migration, as shown in Figure 13 below. The four regions that recorded positive net migration are either industrial hubs, areas with high agricultural productivity or both. A similar pattern was found by the 2000 Population and Housing Census, suggesting an enduring dynamic. Besides the Eastern Region, the regions which recorded negative net migration are among the least developed in the country (GSS, 2012). The Eastern Region’s high level of out-migration may be explained by its proximity to the Greater Accra Region, a common destination for out-migration.

Figure 13. Net migration rate, per 1000, by region



Source: Ghana Statistical Service, 2010 Population and Housing Census.

The Eastern Region is also a destination of internal migrants from other regions in Ghana. The 2010 census reveals that 15.9% of those in the Eastern Region are migrants (people born outside the region). The districts with the highest proportion of people born outside the region are Birim South (76.4%) and Akyem Manso (75.7%).

In the Yilo Krobo District, nearly a third (31%) were born outside of the region but within the country. Looking at numbers of migrants by region of origin, there were fewest migrants from the Upper West Region (57 persons) in the district, an indication of a merely tenuous linkage between the two areas. The majority of Ghanaian migrants from outside the Eastern Region came from three neighbouring

regions – the Volta Region (2,429), Greater Accra (1,931) and Ashanti (1,188). International migrants constituted 2.2% of migrants (609 persons).

In-migration to Fanteakwa District has a similar character, though with slightly more in-migration from within the Eastern Region. It is reported that 69.1% of people born outside the district were born elsewhere in the region (GSS, 2014a). Those born outside the region, but within Ghana constituted 29.3% of migrants (GSS, 2014a). The greatest proportion of the migrants to the district again originated from neighbouring regions of the Volta Region (2,050), Ashanti Region (1,605) and Greater Accra Region (1,485) with the fewest from the Upper West Region (193) (GSS, 2014a). International migrants constituted about 1.6% of migrants in the district.

Initial data collection indicates that migration is an integral part of livelihoods in the districts within the Eastern Region. Respondents in the Yilo Krobo District noted that as a result of social transformation brought about by education and improved communication, young adults are now increasingly migrating to work in Accra, as highlighted below:

The few persons who migrated went to Sefwi to buy land for cocoa farms. Some also migrated to other areas because our land here is not fertile these days. For young people, everything has changed. Because of education, many of the young people don't want to work on the farms. Even when they are here, they are always on the phone with their friends and [older] siblings in Accra and we don't have any control over them. So, once they complete school, they want to go to college [high school] or travel to Accra for work (TRA, Yilo Krobo District, Eastern Region).

The observation above clearly supports findings elsewhere which suggest that social transformation can serve as a driver and outcome of migration (De Haas and Fransen, 2018). Farmers in the Fanteakwa District made similar observations about increasing out-migration but also noted that the area is witnessing in-migration from other parts of Ghana:

The young ones are those that are mainly leaving this community because they don't want to farm. [...] More people are also moving from other regions to come and work here. They say they have come because our land is more fertile. Some also come to work as labourers on our farms. [...] As I said before, our own children migrate to Accra to work and so we rely on the labourers from other regions come and here to work for us (ROTT, Fanteakwa District, Eastern Region).

Thus, the Fanteakwa District is experiencing what can be termed as 'replacement migration,' whereby farmers from other regions move to the area to fill spaces left by young adults.

2.3.4. Governance and development support

Living standards in the Eastern Region have improved dramatically over the last 40 years. In 1991/92, 48% of the population lived in poverty (GLSS1). That number had

declined to just 12.6% in 2016/17 (GLSS7). There continue to be many development programmes that seek to further improve living standards as well as access to services and economic output in the region. As noted previously, these are most often funded by the central government and development partners, such as World Bank, EU, and DANIDA, while DAs are mainly responsible for their management. Several programmes have been designed and implemented over the years in the agricultural sector to promote socio-economic development and reduce out-migration. As the major economic activity in rural areas is agricultural, rural development projects are usually linked to agricultural development. In the last two decades a number of programmes have been designed and implemented to promote agricultural modernisation and rural development in all the regions in Ghana. The features of these programmes are summarised in Table 5.

Table 5. Development policies/programmes implemented in the agricultural sector in all regions of Ghana

Programme/Policy	Main Policy Goals and Objectives
Food and Agriculture Sector Development programme (FASDEP I) 2002	This first major food and agriculture sector development policy sought to enhance food security; promote the production of agricultural raw materials for local industry; facilitate the production of agricultural commodities for export; enhance the efficiency in the supply and distribution of input; and facilitate effective and efficient output processing and marketing system
Food and Agriculture Sector Development Policy II (FASDEP II) 2007	This policy, which was heavily supported by the World Bank, sought to promote the commodity chains of key export crops, as well as address food security concerns. It placed emphasis on farm mechanisation.
Ghana Shared Growth and Development Agenda (GSGDA I) 2010-2013	The development programme was spearheaded by the National Development Planning Commission and heavily funded by the World Bank, USAID, GIZ. It sought to use agricultural modernisation to promote broader rural development and housing.
Ghana's Medium-Term Agricultural Sector Investment Plan (METASIP I and II) 2011-2015	The investment plan sought to achieve food security; increased income growth; enhanced integration into domestic and international markets; sustainable management of land and environment; science and technology applied in food and agriculture development and improved institutional coordination.
The Tree Crop Strategy 2012	This programme, which was funded by Agence Française de Développement (French Cooperation Agency), aimed to diversify export commodities to reduce the focus on cocoa. It focused on the development of cashew, citrus, cocoa, coconut, coffee, kola, mango, oil palm, rubber tree and shea nut, through sustainable agro-ecological practices.
Ghana Commercial Agriculture Project 2012	This project, which was funded by the World Bank and USAID, aimed to improve the investment climate for agribusiness and developing public-private partnerships and smallholder linkages intended to increase farm productivity and value addition in selected value chains.
Ghana Shared Growth and Development Agenda (GSGDA II) 2014-2017	This programme, which was funded by the World Bank, USAID, GIZ and implemented by the National development planning commission, aimed to promote broader rural development through agricultural modernisation, oil and gas development, and promotion of foreign investments in infrastructure, energy and housing.

<p>Ghana's Medium-Term Agricultural Sector Investment Plan METASIP III (2017-2021)</p>	<p>As part of implementation of this programme, the Ministry of Food and Agriculture launched a flagship programme "Planting for Food and Jobs" (PFJ) in 2017. The PFJ, which forms part of the government's main agricultural programme, focuses on increasing food production, providing raw material for industry and creating jobs. In April 2019, the government launched the Planting for Export and Rural Development (PERD) programme as part of the Tree Crop Module of the PFJ programme. The PERD programme seeks to promote the production and marketing of nine tree crops, namely mango, cashew, coffee, oil palm, coconut, mango, citrus, cotton, shea and rubber.</p>
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Source: Teye and Torvikey (2018)

In addition to these national level development projects, there have been specific development projects, such as expansion of schools and rehabilitation of markets, implemented in the districts selected in the Eastern Region. In the Yilo Krobo District, a newly established university is expected to create jobs in the area. During our scoping study, a few research participants stated their belief that the government has been doing well to promote economic development in general. Other participants stated the belief that many of the programmes implemented by various government entities have been poorly implemented:

When it comes to campaigns, the programmes that all the governments have been talking about are fine. But when we vote for them and they come to power, they don't do much. [...] The current government has made so much noise about the planting for food and jobs programme but farmers here wait for a long time without getting fertilisers under the programme (TREETP, Fanteakwa District, Eastern Region).

Apart from the projects implemented by government agencies, local communities led by traditional authorities also sometimes design and implement their own community development projects. These projects may include community schools and health facilities. In some cases, diaspora and translocal hometown associations and NGOs also develop and implement development projects in some of the communities in the region.

3. STUDY AREA II: UPPER WEST REGION OF GHANA

In this section, we discuss the physical and socio-economic characteristics of the Upper West Region of Ghana, based on secondary data and qualitative data collected from the Wa West and Jirapa districts.

3.1. Climate of the Upper West Region

The Upper West Region experiences two marked seasons, the wet and dry seasons. Mean annual rainfall in the area ranges between 840 mm and 1400 mm. The rainfall regime is characterised by high variability thus high unpredictability. For instance, in some years, the first rains in April and May are followed by a short dry spell of three to five weeks, resulting in serious crop damage. Rainfall variability is a result

of the region's location in the sub-equatorial zone with changing wind regimes throughout the year. During the dry season (September – March), the region is influenced by the dry north-east trade wind (Harmattan). During the rainy season (April – August), the area is under the influence of the maritime air from the south-west monsoon. In addition, the region experiences high temperatures, further discussed below. These climatic conditions pose challenges to agricultural production, the region's main economic activity.

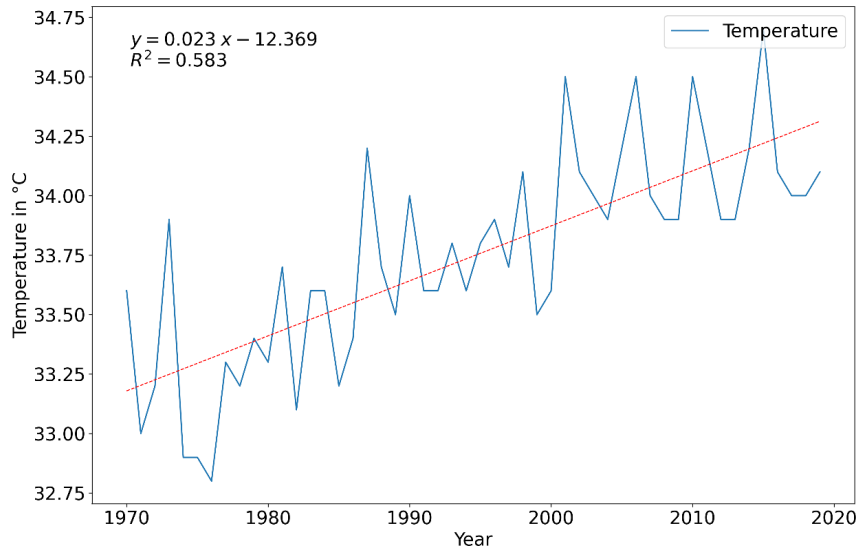
3.1.1. Long-term changes in temperature

As the two districts selected in the region (Jirapa and Wa West) are both close to the Wa weather monitoring station, figures from the station were used for the analysis of temperature and rainfall changes in the district. As in the Eastern Region, a clear warming trend is evident in the Upper West as indicated by the red trendline in Figure 14 below. The annual average maximum temperature over Wa has an upward trend with a slope of 0.023, meaning maximum temperatures have been increasing at an average of 0.023 °C every year in Wa since 1970. That indicates a cumulative average increase of 1.15 °C since 1970. The average maximum temperature for the period analysed (1970 – 2019) is 33.7 °C with a CV of 1.30%. This value represents a low uncertainty in the maximum temperature distribution in Wa, meaning that there is a high probability that temperatures will continue to rise. Since 2001, maximum temperatures have been greater than the observed average. 2015 emerges as the hottest year with a temperature of 34.7 °C. Furthermore, the figure reveals moderate swings in maximum temperature across years.

Similarly, as shown in Figure 15, the annual mean minimum temperature over Wa has an upward trend with a slope of 0.024, implying that minimum temperatures have been increasing at 0.024 °C every year in Wa since 1970, a cumulative average increase of 1.2 °C. The empirical analysis of the data reveals a long-term mean (1970-2019) minimum temperature of 22.5 °C with a CV of 2.19% indicating low uncertainty in the minimum temperature distribution in Wa.

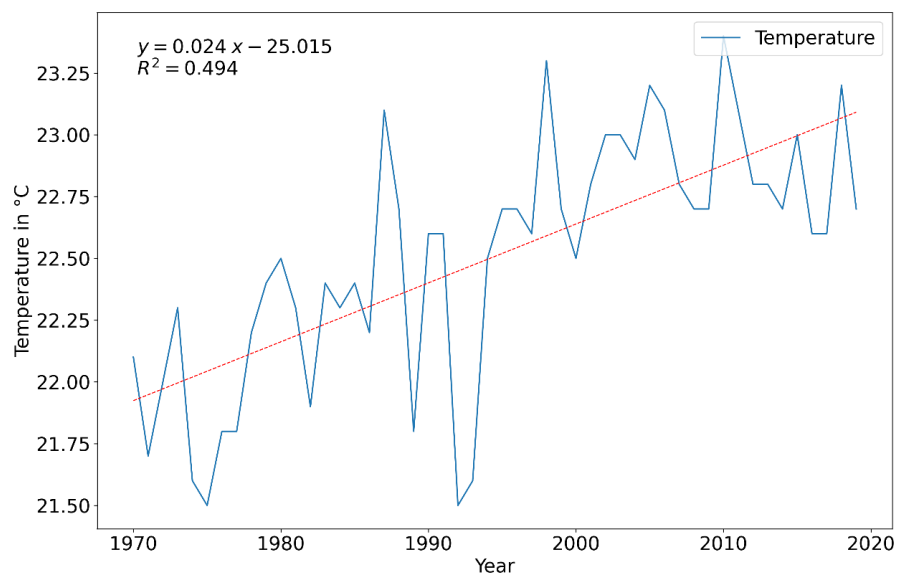
These findings are surprising in that research on climate change impacts on Ghana emphasise the northern regions as particularly affected. However, the temperature increases documented for the Upper West Region are lower than those for the Eastern Region, presented in Section 2.1. This suggests that other regions of Ghana may be experiencing notable, but overlooked, climate change impacts.

Figure 14. Maximum temperature time series for Wa (1970 – 2019)



Source: Authors' construct based on data from the Ghana Meteorological Agency

Figure 15. Minimum temperature time series for Wa (1970 – 2019)



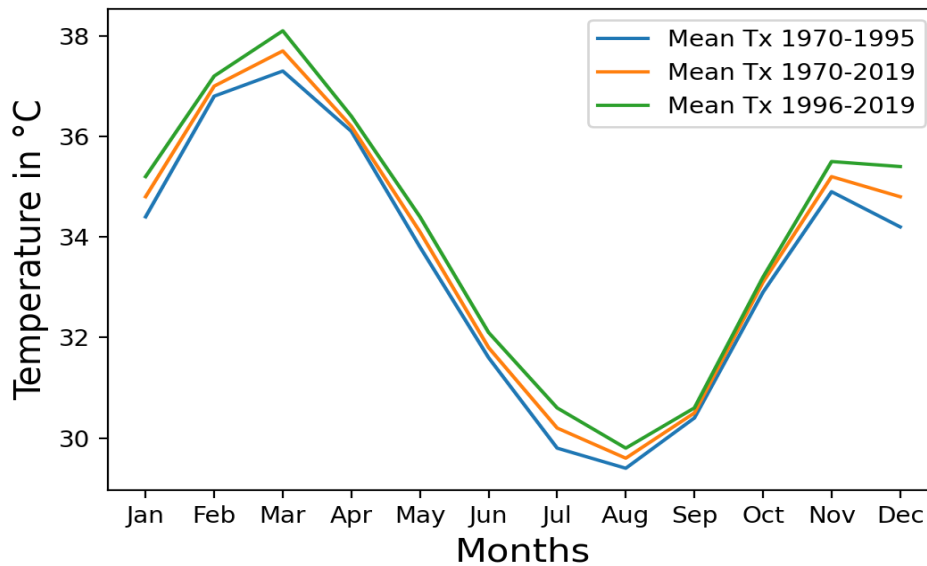
Source: Authors' construct based on data from the Ghana Meteorological Agency

Our analysis of mean monthly maximum temperature (see Figure 16 below) shows that the maximum temperature for Wa has increased for all months over the last two decades. For all months, the mean maximum temperature in the last two decades (1996-2019) is higher than the long-term average (1970-2019). Increases are not consistent throughout the year, with an increase of only 0.1 °C in the months of September and October compared to 0.6 °C in December. The temperatures reflect the annual seasonal cycle, with the highest temperatures recorded between February and April before the onset of the rainfall season in June and the lowest temperatures recorded in August, which marks the peak of the rainfall season.

Similarly, the minimum temperature for Wa has increased during the last two decades as shown in Figure 17. The least amount of increase is 0.2 °C in the months of April, August and September, and the highest is 0.6 °C in November and January.

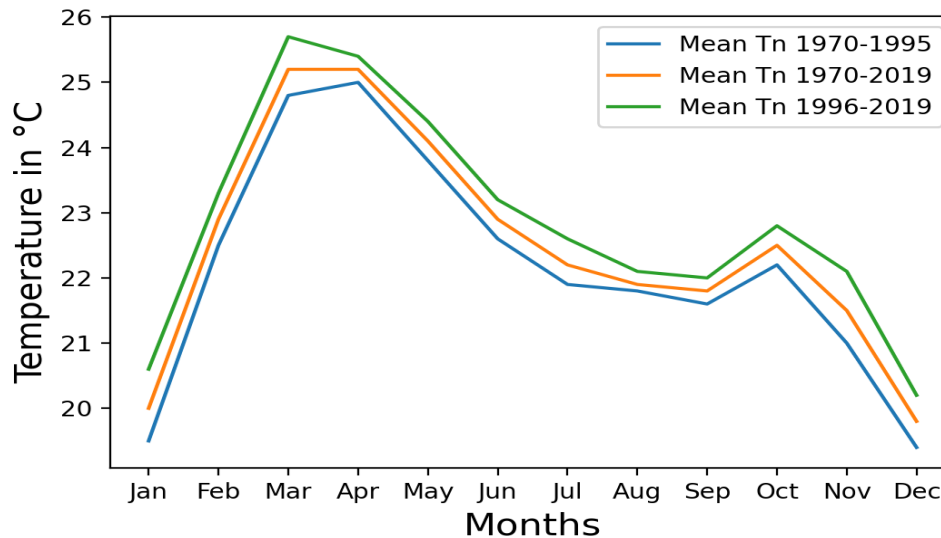
Observing the climatology, we see that the highest minimum temperatures are recorded between March and April before the onset of the rainfall season in June and lowest minimum temperatures recorded during the winter months of DJF. While temperature increases in the Upper West Region are evident, they are lower than those for the Eastern Region, which again is a striking and unexpected finding.

Figure 16. Mean monthly maximum temperature for Wa (1970-2019)



Source: Authors' construct based on data from the Ghana Meteorological Agency

Figure 17. Mean monthly minimum temperature for Wa (1970-2019)



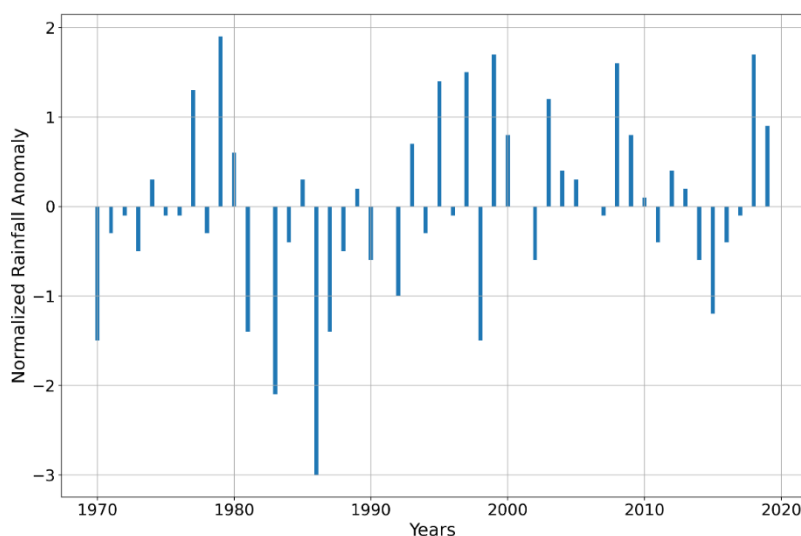
Source: Authors' construct based on data from the Ghana Meteorological Agency

3.1.2. Long-term changes in rainfall in Upper West Region

Analysis of rainfall data reveals notable precipitation swings, with significant deviation of annual rainfall values from the long-term mean of 1009.9 mm. As shown in Figure 18, the rainfall data for Wa shows an extended period of rainfall deficit from 1980 to 1990, reflecting a large-scale drought affecting Ghana and neighbouring countries in this period. Again from 2010, the rainfall distribution for

Wa has mainly been below the long-term mean. This has implications on water availability and drought severity across the region.

Figure 18. Normalised rainfall anomaly for Wa (1970 – 2019)

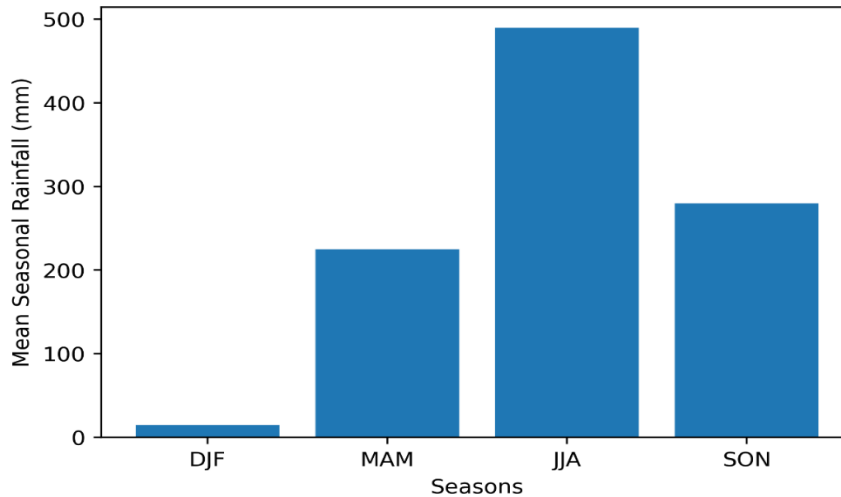


Source: Authors' construct based on data from the Ghana Meteorological Agency

Regarding seasonal distribution of the rainfall (Figure 19), the greater part of rainfall in Wa occurs during the summer months, June, July and August. Northern Ghana, as a whole, experiences a unimodal rainfall regime with a single peak in July or August. Empirical analysis shows that mean seasonal rainfall during the wet season is 489.7 mm, with a CV of 21.9%. The dry season, DJF, has a mean seasonal amount of 15.2 mm with a CV of 156.3% implying that most dry seasons in Wa cannot be relied on for significant rainfall. As will be discussed later, although research participants have divergent views on the nature of changes in rainfall, they largely believe that there are delays in the onset of the rains, as highlighted in the statement below:

The rainfall is not good. The rain is balancing. For raining, in the past, when you are returning from "Jonga" (dry season migration), after your casual labour in March to April, you are always late (to join the farming). By then all your peers at home might have finished planting but now it is not like that. Now you can come around the 6th month but still people are still planting (55-year-old male, Jirapa District, Upper West Region).

Figure 19. Seasonal rainfall distribution for Wa (1970 – 2019)



Source: Authors' construct based on data from the Ghana Meteorological Agency

3.2. Vegetation of the Upper West Region

The Upper West Region falls under the Guinea savannah type of vegetation, with a high density of certain tree species. These species include the locust (*Parkia biglobosa*), shea (*Vitellaria paradoxa*), mahogany (*Khaya senegalensis*) and silk-cotton (*Ceiba pentandra*). Baobabs (*Adansonia digitate*) are also very characteristic of former human settlement (Blench, 2006). The vegetation of the region is also characterised by dawadawa trees. The fruit of the shea provides a source of cooking oil, pomade and a source of income, mostly to women. The dawadawa similarly provides food and income from its fruit. Both the shea and dawadawa are used as a source of fuel wood and material for house construction. The neem (*Azadirachta indica*) and the mango (*Mangifera indica*), non-native species, are also common trees, especially in uncultivated areas (Blench, 2006).

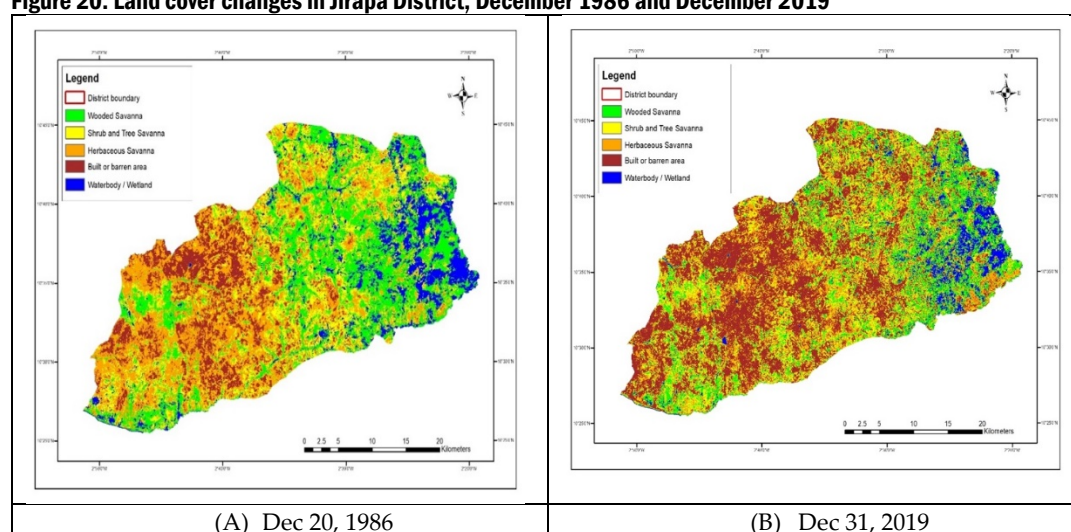
Much of the eastern stretches of the Upper West Region have higher density of forest than the other areas. The northern ends of the Mole Game Reserve and the Bui Reserve are situated in these areas (GSS, 2012). However, focus groups have pointed to a rise in deforestation which they claim is fast eroding the vegetation. The trees most affected are the shea and the rosewood. The shea is mostly cut to produce charcoal and also for use as wood fuel. The rosewood, on the other hand, is mostly cut for exports.

In this section we present findings of vegetation change detection analysis and land cover change analysis, which also indicate decreases in wooded areas in the two case districts. We find decreases in forest, savannah and waterbodies/wetlands, accompanied by sharp increases in built/barren areas in both districts. While these analyses cannot provide explanations for land cover changes, their results may indicate changes to land use and livelihoods. For example, it may give us an impression of the extent of conversion of forest lands to farming and also the extent of deforestation for charcoal production. Agricultural extensification and charcoal production are two important dimensions of contemporary livelihoods in the Upper West Region.

3.2.1. Land cover changes in Jirapa District between December 1986 and December 2019

The change detection performed for the Upper West Region used similar data and the same procedures as that performed for the Eastern Region (see Annex). Figure 20 below presents maps of the Jirapa District for December 1986 (A) and December 2019 (B), indicating changes in land cover in this period. Most notably, built/barren areas almost tripled in this period, from 144.7 km² to 420.1km² of a total 1190.1km². This was accompanied by decreases in all other land cover classes, most notably shrub and tree savanna (-49.1%) and waterbodies/wetlands (-40.6%). Wooded savanna also saw a significant decrease (-30.1%). Detailed statistics of land cover classes and change are provided in Table 6, below.

Figure 20. Land cover changes in Jirapa District, December 1986 and December 2019



Source: Authors' construct based on USGS Landsat data

Table 6. Land cover changes in Jirapa District between December 1986 and December 2019

Land Cover	Dec 20, 1986			Dec 31, 2019			Change (+/-)	
	Pixels	Area (km ²)	%	Pixels	Area (km ²)	%	Area (km ²)	%
Water Body / Wetland	127217	114.50	9.62	75617	68.06	5.72	-46.44	-40.56
Wooded Savanna	352522	317.27	26.66	244010	219.61	18.45	-97.66	-30.78
Shrub & Tree Savannah	287535	258.78	21.74	146605	131.94	11.09	-126.84	-49.01
Herbaceous Savannah	394274	354.85	29.82	389361	350.42	29.44	-4.42	-1.25
Built / Barren Area	160815	144.73	12.16	466770	420.09	35.30	275.36	190.25
Total	1322363	1190.13	100.00	1322363	1190.13	100.00		

Source: Authors' construct based on USGS Landsat data

In December 1986 (Figure 20A), one fourth of the district was covered in wooded savannah vegetation, mainly in the east. Shrub and tree savannah accounted for just over a fifth of the land cover. Thus, in all, tree vegetation accounted for almost half

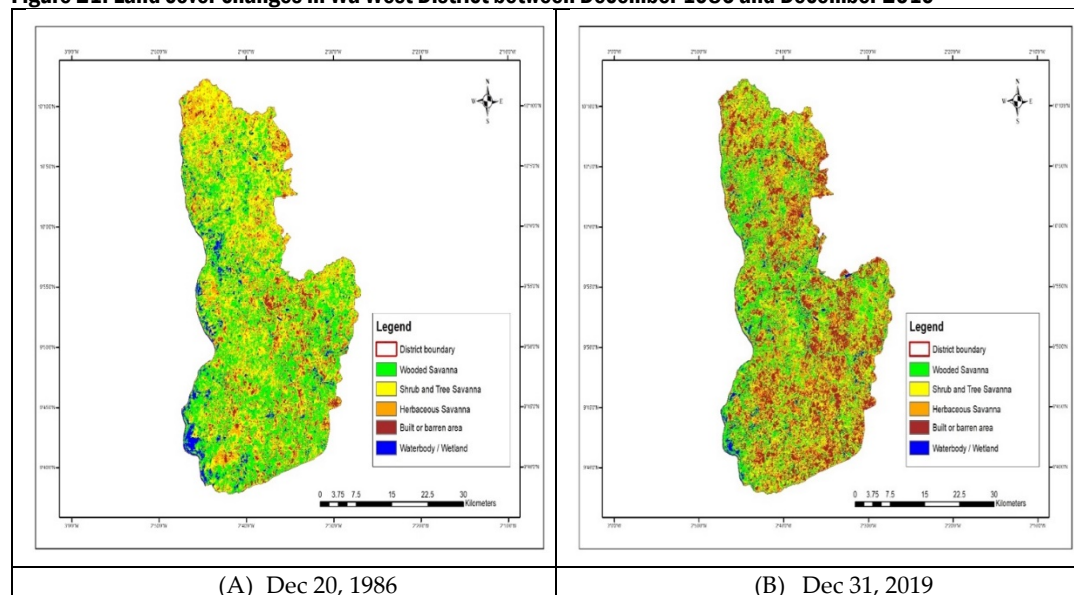
(48.4%) of the land cover in the district in 1986. Also significant was herbaceous savannah, which at some 30% of the district's surface area was the largest single land cover class. The remainder was either built or barren areas which represent settlements, roads and other cleared surfaces (12.16%) or waterbodies/wetlands (9.62%).

However, in December 2019 (Figure 20B), the wooded savannah and shrub and tree savannah had decreased from almost a half to under a third of the district's area. The area of herbaceous savannah decreased only marginally, maintaining almost a third of the district's area (29.4%). Water bodies and wetlands decreased from 9.6% to 5.7% of the total area. These decreases were mirrored by a sharp (190.3%) increase in built /barren to over a third of the district's surface area.

3.2.2. Land cover changes in Wa West District between December 1986 and December 2019

Figure 21 below presents land cover maps for the Wa West District for December 1986 (A) and December 2019 (B). Overall, the analysis indicates decreases in wooded areas and waterbodies/wetlands and a considerable increase in built/barren areas, which almost quadruple over the period of analysis. Table 7 shows detailed statistics of the various land cover classes for the two periods under analysis.

Figure 21. Land cover changes in Wa West District between December 1986 and December 2019



Source: Authors' construct based on USGS Landsat data

Table 7. Land cover changes in in Wa West District between December 1986 and December 2019

Land Cover	Dec 20, 1986			Dec 31, 2019			Change (+/-)	
	Pixels	Area (km ²)	%	Pixels	Area (km ²)	%	Area (km ²)	%
Water Body / Wetland	80381	72.34	4.84	56448	50.80	3.40	-21.54	-29.77
Wooded Savanna	592029	532.83	35.67	433095	389.79	26.09	-143.04	-26.85
Shrub & Tree Savanna	585813	527.23	35.30	424680	382.21	25.59	-145.02	-27.51
Herbaceous Savanna	290885	261.80	17.53	336375	302.74	20.27	40.94	15.64
Built / Barren Area	110625	99.56	6.67	409135	368.22	24.65	268.66	269.84
Total	1659733	1493.76	100.00	1659733	1493.76	100.00		

Source: Authors' construct based on USGS Landsat data

In December 1986 (Figure 21A), out of a total area of some 1500 km², over two thirds (70.97%) of the district was covered by tree vegetation. This was made up partially of wooded savannah, which covered over one third of the district mainly in the north, and shrub and tree savannah accounting for the remaining third. Built/barren areas accounted for under 100 km² (6.67%) of the land cover, with the rest distributed between herbaceous savannah at 261.80 km² (17.53%) and waterbodies/wetlands covering 72.34 km² (4.84%).

However, in December 2019 (Figure 21B), wooded areas and waterbodies had decreased, while built/barren areas had increased significantly. Total wooded areas fell to just over half of the district area, amounting to a reduction of almost 300km² of wooded areas. Areas of waterbodies/wetlands decreased by just under a third, from 4.84% to 3.40% of the district area. At the same time, the area covered by herbaceous savannah increased slightly to just over a fifth of the district area. Built/barren surfaces saw the largest change by far, with an increase of some 270% to almost a fourth of the district area.

3.3. Socio-economic characteristics of the Upper West Region

This section presents the demographic characteristics, agricultural activities, governance and migration patterns of the Upper West Region.

3.3.1. Demographic Characteristics

The Upper West Region hosts approximately 2.8% of Ghana's population (702,110 persons), consisting of 48.6% males and 51.4% females. The population of the region is largely youthful; those under 15 years constitute 41.7% of the population, while those between 15 and 64 years constitute 52.3%. Persons 65 years and older comprise only 6.0% of the population (GSS, 2012). The average growth rate is 1.7% while the intercensal growth rate is 1.9% (GSS, 2012). In terms of the distribution of the regional population across districts, the GCM programme's two case districts Wa West and Jirapa fall in the middle, with just over 81,000 (11.6%) in Wa West and over 88,000 (12.6%) in Jirapa.

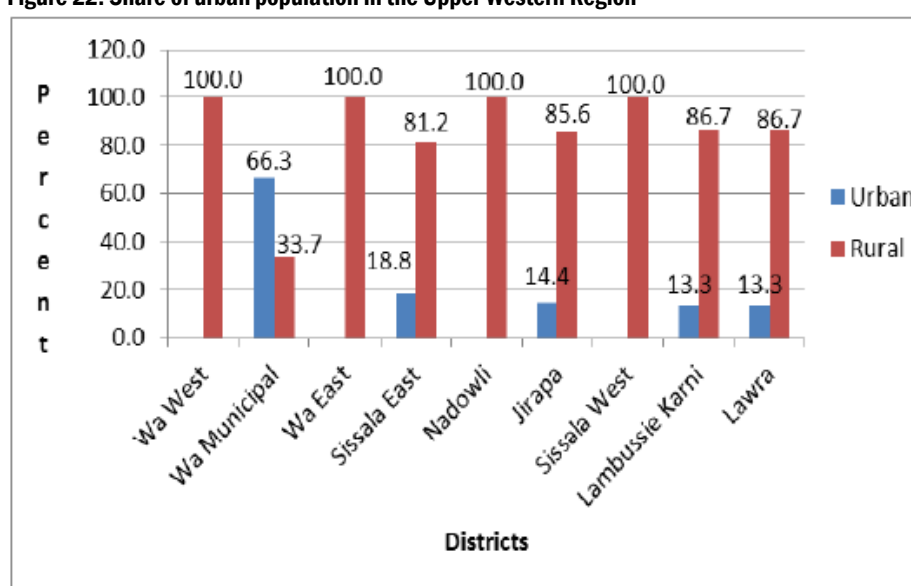
In 2015 the African Development Bank projected the region’s population at 771,394 persons with a density of 42 persons per square kilometre. The vast majority of the population (83.7%) live in rural areas, as can be seen in Figure 22 (GSS, 2012). Certainly, a large proportion of people depend on agriculture for their livelihoods, an important dynamic to consider in the context of environmental challenges and climate change impacts. In terms of governance and administration, the population of the Upper West Region generally lives in smaller villages, which easily deny them the generic 5,000 population benchmark required by the government of Ghana to declare a community an urban area. Urban areas tend to receive more attention from government and local development authorities not least because they are the centre of economic activities and also possess larger voting populations. As shown in Figure 22, all but one district (Wa Municipal) have more than 80 % of their populations living in rural areas. Regarding the GCM case districts, Wa West’s population is entirely rural, while Jirapa has 14.4% of its population living in urban areas.

Table 8. Population distribution in the Upper West Region

District	Population	Share of district population (%)
Total	702,110	100.0
Wa West	81,348	11.6
Wa Municipal	107,214	15.3
Wa East	72,074	10.3
Sissala East	56,528	8.1
Nadowli	94,388	13.4
Jirapa	88,402	12.6
Sissala West	49,573	7.1
Lambussie Karni	51,654	7.4
Lawra	100,929	14.4

Source: GSS 2012

Figure 22. Share of urban population in the Upper Western Region



Source: GSS, 2012

3.3.2. Livelihoods

The workforce in the Upper West Region mainly engage in skilled agricultural, forestry and fishery, with much smaller shares also working with crafts and related trades (10.4%) as well as service and sales (7.5%). As shown in Table 9 about 77.1% of households in the Upper West Region engage in agriculture. More specifically, 95.7% engage in crop farming activities, 63.7% in livestock rearing, 1.9% in tree planting, and 0.1% in fish farming as their major economic activity (GSS, 2012). There is also a clear rural-urban difference. While nearly 9 out of 10 rural households engage in agriculture, only three out of 10 urban households do so. In spite of rural-urban differentials, there is no doubt of the general importance of agriculture in the livelihoods of the people of the Upper West Region. The region has the second highest number of households in agriculture in the country. This not only indicates the population's high dependence on agriculture, but also suggests the precarious nature of their livelihoods. As in the rest of the country, agriculture is still mostly rain-fed and therefore susceptible to climate variations. Furthermore, the largely rural based population have few non-farm job opportunities to diversify and spread risks. These challenges are further discussed below.

Table 9. Proportion of households in agriculture in the Upper Western Region

Region	Total Households			Urban Households			Rural Households		
	No	Agric	%	No	Agric	%	No	Agric	%
All regions	5,467,136	2,503,006	45.8	3,049,336	662,775	21.7	2,417,800	1,840,231	76.1
Western	553,635	275,975	49.9	248,919	55,341	22.2	304,716	220,634	72.4
Central	526,764	270,854	51.4	255,365	72,151	28.3	271,408	198,703	73.2
Greater Accra	1,036,426	68,715	6.6	950,336	41,734	4.4	86,090	26,981	31.3
Volta	495,603	291,224	58.8	178,814	59,487	33.3	316,789	231,737	73.2
Eastern	632,048	374,257	59.2	293,547	116,605	39.7	338,498	257,652	76.1
Ashanti	1,126,216	412,055	36.6	715,462	117,052	16.4	410,743	275,003	71.8
BrongAhafo	490,519	336,097	68.5	236,283	121,961	51.6	254,232	214,136	84.2
Northern	318,119	117,631	75.5	106,071	49,537	46.7	212,048	190,901	89.9
Upper East	177,631	148,660	83.7	41,941	21,578	51.4	135,688	127,082	93.7
Upper West	110,175	84,931	77.1	22,628	7,329	32.4	87,546	77,602	88.6

Source: GSS, 2012

In the Wa West District, the agricultural, forestry and fishery industry employs a majority of the work force (84.0%). With about eight out of every ten people engaged in agriculture, the district has the highest proportion of agricultural engagement among the four districts of the study. This is not striking given the relative deprivation and the typical rural nature of the district. It is useful to point out here that the Wa West District not only finds itself in the poorest region in the country, but it is indeed the poorest district in the entire country (GSS, 2018). This indicates that existing agricultural systems and livelihoods have generally failed to enable people to move out of poverty, raising questions on how the district has been and is being governed by both national and local authorities. At the household level, as much as 91.6% of households are engaged in agriculture as a main source of livelihood. A majority (97.2%) of them are engaged in crop farming (GSS, 2014c). The main crops grown are millet, guinea corn, groundnuts and yam beans. Given the very high engagement in agricultural, forestry and fishery there is relatively little engagement in other livelihoods sources. These include mining and quarry

(0.4%); manufacturing (6.9%); construction (0.2%); accommodation and food service activities (1.3%); and education (1.4%).

In the Jirapa District, the agricultural, forestry and fishery industry employs 67.1% of people in the district, and 15.2% are employed in manufacturing. The remaining industries together constitute less than 20.0% of the population. At the household level, agriculture remains the main economic activity with 82.7% of households involved. Similar to the Wa West District, smallholder farmers dominate the agricultural sector. However, there are some farmers within the district who are involved in large-scale production of cereals and legumes located in the Han and Mwankuri areas. In addition to crop farming, residents rear cattle, sheep, goats, pigs and poultry with large-scale livestock production in the Han and Ping areas (GSS, 2014d).

While agriculture is the main livelihood activity in both the Wa West and Jirapa districts, there are some differences. First, Wa West District has a more agrarian focus as 91.6% of households in the district are engaged in agriculture as compared to 67.1% in the Jirapa District. This depicts a considerable difference in terms of urbanisation and livelihoods diversity. As noted above, Wa West is completely rural while Jirapa is about 86% rural and 14% urban. The Jirapa municipality is characterised by far more services, agro-processing and small-scale manufacturing activities (GSS, 2014d).

The high reliance on rain-fed agriculture in the Upper West Region in the context of a highly variable climate and widespread and enduring poverty has remained a major concern for the population. As noted earlier, the climate is characterised by a single maxima rainfall regime with high inter- and intra-annual variability and high unpredictability. Focus group discussions point to high risk of crop failure from the vagaries of the weather and climate trends and events. Two agricultural extension officers who were interviewed also shared this opinion, explaining that the climate of the region was changing along global trends in climate. They pointed to decreasing rainfall, increasing dry spells and rising temperatures over the last three decades. Unlike the agricultural extension officers, focus groups had a more difficult time agreeing on the nature of the climate over the last three decades. Though there seemed to be a consensus that the climate was changing over the period, there was contestation over the nature of the change. While most participants agreed that the amount of rainfall over the last three decades had declined, a few others were of the opinion that rainfall amounts had remained the same. The former argued that the character of the rains had changed, making it difficult to predict the season as indicated by the following statements:

At first rains were having names depending on the period it rains but now it has no names. In the past, there were different types of rains that fell and various names are given to it. During our time there was particular rain that falls after bushes are burnt. This was one called "Vonvooglu Saa" meaning "ash rain" which rain after the bush is burnt. This type of rain falls to wash away the ashes away. This happened in the dry season which is around December to January... but now it is not there again. It used to rain heavily

that will last for longer and we normally used it in raising mound for planting yams but now it is not there. This type of rain was beneficial to us as we feed our animals with fresh grasses that germinate for animals to graze on, wild vegetables are also available through the rain and water is available for animal to drink. People with cassava also develop leaves...now there is either no rain in that period or they are too little to do what we need (70-year-old, Siiru Village, Wa West District, Upper West Region).

“Saa Gyeu” falls around the 3rd or the 4th month. It was very big rain. We were also having a rain that falls after dawadaw tree are flowering. There was also another heavy rain that falls to aid people who could not raise yam mounds before December to do so. This happens when dawadawa start to bear fruits. This is called “Songhole Saa,” in March or sometimes April. After this that the actual season starts. But these rains have changed by intensity and timing (60-year-old, Siiru Village, Wa West District, Upper West Region).

The difficulty in identifying some key rains that have names as narrated by the respondents affects people’s ability to predict the coming season including when and how to sow their seeds. The group of people who share this opinion also perceive the rainfall pattern as shifting forward. The latter group, much smaller, argued further that farmers wrongly attributed poor yields and crop failure to declining rainfall and that the blame should be place on declining soil fertility. Accordingly, the fertility of the soils had declined leading to poor water retention and dry spells with adverse consequences for yields. Those of this perception, however, agreed with the others that there was a declining trend in vegetative cover, which could have consequences on the climate in the future. In terms of the patterns of rainfall and of (expected) drought, there was a consensus of a change over the period. They explained the two most important rains signifying the beginning of the rain-season had shifted forward in time when indeed the actual rainfall season had already begun. This is said to mislead many farmers who then plant their crops late and increase their risk of crop failure.

These initial findings indicate that there are close interactions between various forms of environmental change, from anthropogenic climate change to vegetation cover depletion and soil degradation. In addition, there are strong perceptions of links between environmental change and livelihoods. For the GCM programme, that raises questions of how such environmental changes arise and are addressed, the role of various governance actors and interventions in this, and possible linkages with mobility practices, for instance in livelihood diversification or the use of remittances to support *in situ* adaptation.

3.3.3. Migration

As described previously, many people in the Upper West Region practice migration, involving permanent, circular, and dry season migration, of both internal and external nature. The 2010 Population and Housing Census provides insight into migration dynamics in the Upper West Region. The Upper West Region was among the regions to consistently record a negative net migration in the

country from 2000 to 2010 (with most of its out-migrants heading southwards (see Figure 13). The region has the highest rate of out-migration of all regions in Ghana. The region's out-migration rate was 28 percent. This was followed by the Volta Region (26.2%), Central Region (25.5%), Eastern Region (25.5%) and Upper East Region (25.14%) (GSS, 2012).

Immigration is quite low in the Upper West Region. Nearly nine out of every ten persons (93.6%) residing in the Upper West Region were Ghanaians by birth. Non-Ghanaians constituted 3.0 percent while Ghanaians with dual nationality accounted for 2.6 percent of the population (GSS, 2012). Just 3.44% of the Non-Ghanaian population are resident in the region. A majority of immigrants are concentrated in the southern Ghana. The relative higher wealth and more economic opportunities in the south might be the key reasons for this distribution. Internal migration from other regions to the Upper West Region is also relatively low. Many of the internal migrants in the region are from other towns and villages within the region. For the Jirapa District, a total of 11,931 migrants to the district were enumerated with 7,236 (60.6%) having been born elsewhere within the Upper West Region and the remaining 39.4% having been born in other regions of Ghana (GSS, 2014d).

For the Wa West District 6,772 people were reported to have migrated into the district. Of these, 57.0% were born in other parts of the Upper West Region while about 43.0% were born outside the region. Of those born in another region of Ghana, most came from Ashanti Region (29.8%), about 20.3% came from the Brong Ahafo Region, 16.7% from the Upper East, and 15.5% from the Northern Region (GSS, 2012). The relatively large percentage of migrants from the Ashanti Region reflects the long-standing migration history between Wa West and the Ashanti regions. Children born to Wale and Dagara migrants who migrated to the Ashanti Region in search of better climate and soils eventually come back home with their parents.

For outmigration in the region, the dominant stream is southwards movement. This is mostly to rural areas in the Forest and Transitional agro-ecological zones, in the southern parts of the country, in search of mostly farm but also non-farm jobs. This pattern has mainly been influenced by deliberate colonial forced labour recruitment and underdevelopment strategies that secured male labour from the north of the country to work in the mines and plantations in the south (Songsore and Denkabe, 1995). This migration trend has only been reinforced by the failure of independent era governments to equalise the imbalance in development between the northern and southern parts of the country (Van der Geest, 2011). Focus group discussions also emphasize the role and facilitation of people from the region already settled in these destination areas as crucial in the continuous southward migration of the people. These already settled migrants attract and enable the migration of their family members and friends who come to help them on their farms in addition to the migrants pursuing their own jobs, as part of the informal living arrangement. This is consistent with the migration networks proposition on the importance of relatives, friends and other people in not only providing initial ideas but connecting people to the migration stream (Hummel et al., 2012).

Focus groups also point to a gender and *tribe* distinction in contemporary out-migration patterns. Gender wise, males are said to be more migratory than females. There is also differentiation by occupation at the destinations. It is said that men are mostly involved in all aspects of farming, illegal gold mining (*galamsey*) and illegal logging, while females mainly engage in harvesting activities, hospitality activities and domestic work. Fewer females are said to engage in illegal gold mining. It is claimed by some respondents that such females mostly work during the day as laborers and caterers for the gold miners and at night some work as sex workers. It is indicated that females who purposely migrate to gold mining areas as sex workers have to disguise themselves by engaging in some other work in order to be accepted.

In terms of tribe differences, Dagaaba females are said to have pushed their migration further to the cities of Accra and Tema during the last few decades to brew and sell a beer originally from northern Ghana in what is largely seen as a sign of independence in migration decisions. It is claimed that Waala females mainly migrate to cities for domestic work and more recently also to engage in sex work – their main destinations being southern Ghana and the northern city of Tamale. It is further claimed that Waala males until recently were hardly seen in the farming enclaves in the south and still maintain a small presence. It is explained that traditionally, people from the Waala group mostly migrate to big towns and cities where they engage in trading. However, changes in the business landscape, such as the increased presence of foreigners, including Koreans, Chinese and Nigerians, in commerce, is said to have forced the Waala out of business and caused them to seek alternatives sources of income.

An emerging, norm challenging, yet important form of mobility, is the internal migration to newly discovered gold mining areas within the Upper West Region. This form of mobility is a significant form of internal labour migration in the region because of its non-agrarian context. It is unlike long- standing internal migration patterns that were situated in the farm employment system. Given the long enduring quest for agricultural jobs in the south one would have thought that they would be attracted to Tumu, a growing agricultural hub within the region, but this does not appear to be happening at a significant level. The new stream is also important because it is a constellation of both new out-migration and return migration. For the return migrants, coming back home to their region affords them a better stake in the illegal mining realm as it is within an area they are more familiar with, where they have better networks with chiefs and land owners, middle men or women who offer more favourable concessions than in the south. Accordingly, the first intra-regional '*galamsey* migration' (illegal gold mining) was to communities in the Bole District (the then Northern Region, now Savannah Region), such as Banda/Nkwanta, Mandari, Tinga and Tasilma from the 2000s. However, since about 2010 illegal mining in these areas received a big blow when the government started cracking down on trespassers. This probably gave further impetus to search for new areas of mining including those within the Upper West Region where there would be little attention from the government. Many youth consider gold discoveries a rare opportunity to widen or change their livelihood outlook as noted by a respondent:

At first, during our fathers' era, by the 4th month everybody has finished sowing and in the 5th month of the year, there was green vegetable all over to feed our children but now we sow around the 7th month and we are not getting food early to eat, as we are sitting now, we are living by hunger till the crops are ready. [...] Our children are not motivated to go into farming again. They are resulting into going to Galamsey instead of farming. They are saying that farming is not profitable so they wish to get money from the Galamsey and use it to buy from the market than farming themselves. Our children are not getting anything from so they are right to migrate and to dig for gold (65-year-old female, Goziri village, Upper West Region).

From about 2012, discovery of gold in the village of Takpo-Niire in the Nadowli-Kaleo District in the Upper West Region has also attracted the attention of the youth, albeit with less enthusiasm not least because the right to mine in the area is bridled with conflicts. It is understood that earlier attempts at mining in the community was led by in-migrants from within other parts of the Upper West Region, including mainly return migrants with experience in mining, but also return migrants with no experience in mining and those who had not migrated before. The return of natives in the year 2020 who were driven out of their illegal mining hubs in the south of the country by the government campaign against illegal mining changed the landscape of illegal concessions though. The return migrants planned their return, thus not only bringing back mining skills they had gathered over time but equipment and chemicals bussed in to take control of mining concessions from a gang leader hailing from Wa (the capital), popularly known as Sisco (whose political party is currently in power). This led to confrontations with the local chiefs, landowners, formal government officials and politicians who had given consent or support to the prospectors and miners. But well-armed and ferocious, the return migrants took over their 'fathers' land' and started to make a livelihood out of it, albeit also struggling to contain constant tenure battles arising out of families defending their agricultural lands through the traditional tenure systems.

What is apparent with the unfolding situation is not only an interesting case of return migration and of immobility, but a reflection of the consequences of return migration not least on the path of environmental degradation and social transformation. This is seen in the institutional struggle to either maintain long-standing tenure and access mechanisms or to enact new and perhaps more fluid mechanisms. A modification of land governance in a rather chaotic manner led by solely capitalistic ideals, as seems to be ongoing in the newly found mining areas in the Upper West Region, could have dire consequences for agrarianisation and mobility in the region. Meanwhile development efforts and formal governance, in both land tenure and in the agrarian sector, offer a rather blurred picture. Formal authorities are almost powerless, or careless, about the ensuing power struggles around land and only occasionally intervene to try to stop illegal mining using the police and army. This approach obviously has not offered any sustainable solution to the situation in the country (Kpienbaareh et al., 2021). On the other hand, governance in the agrarian sector does not seem to offer enough incentive to discourage the use of arable lands for illegal mining.

3.3.4. Governance and Development Support

Formal governance structures in the Upper West Region are similar in some ways to what has been discussed for the Eastern Region. As is the case in the Eastern Region, there exists a parallel but interactive system of local or informal authority comprised of chiefs and their elders on the one hand and the formal government system on the other. The local system includes paramount chiefs, lower-ranking chiefs, and the elders who provide leadership to the people based on long-standing albeit changing norms. Alongside the chiefs, although contested, are the *tendamba*. These *tendambas* are the custodians of the land and the spiritual leaders responsible for sacrifices to the gods and ancestors. The chiefs and the *tendambas* together determine access to land resources.

The formal government system functions as has been described for the Eastern Region, with central government and development partners funding many of the region's development projects. The central government works with the DAs to provide the needed amenities and services such as roads, irrigation dams, water and electricity. Focus group discussions revealed the general opinion that the government had failed fulfilling such obligations thereby paving the way for environmental and other shocks to easily affect their supposedly fragile livelihoods. Focus groups further contend that this failure on the part of the government to fulfil its obligations remains a key reason for the increasing outward mobility of particularly young and aspiring people from the region.

Since 2000, a number of the districts in the Upper West Region have reportedly also benefited from the national level development projects implemented in the agricultural sector (see Table 5 in Section 4.4). While some of these were directed at a general improvement of the sector, others were tailored to climate change adaptation. Participants of focus group discussions (FGDs) were tasked to identify and discuss the impacts of some of these projects and programmes. Two developments programmes were of particular interest to FGDs and agricultural extension officers and for this reason this scoping study will focus on the stories around the two programmes. First, Planting For Food and Jobs (PFJ), which began in 2016 and is still in operation, is geared to foster farmer access to essential inputs and machinery. The PFJ programme has recently supplied tractors to farmers across the country. FGDs conducted in the region consider the tractors to be inferior and not appropriate to help even one household deal with its tilling. As the discussion ensued about the nature of the PFJ programme in the village of Siiru, the participants pointed to a tractor making its way up the hill towards us. But it was stopped in its tracks as a piece of metal broke and separated from the main carriage. *'You see what we were just telling you, this tractor is useless,'* one of the participants claimed. The farmer with the tractor then struggled to move the engine of the mini tractor to store in a neighbour's house. *'This is the second time it has broken down in three weeks,'* the farmer explained. Focus group participants claimed the quoted farmer was given the equipment because of his position as local representative of the NPP government that is currently in power. This suggests a partisan bias in selecting beneficiaries of government projects in the region. The PFJ programme is, however, said to have generally increased farmers access to improved seeds and fertilizers through a carpet subsidized scheme. Farmers, however, complained of

the timing of the arrival of seeds and fertilizers as well as their availability. Specifically, farmers in Pinyiri attributed the scarcity of subsidised fertilisers to the activities of smugglers who illegally sell the goods to neighbouring countries for higher profits.

The second development program of high interest to the FGDs and thus this study has to do with irrigation schemes, which are regarded as having a potentially high impact on dry season farming in the Upper West Region. However, as noted in the literature and by FGDs and agricultural extension officers, despite irrigation being seen as key to managing climatic challenges in the region, very little, indeed cursory, attention has been given to its development. FAO notes that on a country-wide scale, less than two percent of the 1.9 million hectares of the potentially irrigable land of Ghana is developed (Mendes et al, 2014). In the Upper West Region, as of 2016, there existed only nine dams, sixteen irrigation pump stations and 70 groundwater pumps. These are seen as woefully insufficient for the region's 702,110 persons by FGDs and agricultural extension officers. Many of the existing irrigation systems are either partially complete or in a deplorable state. Generally, the irrigation schemes have not been properly maintained for many years and are either not in operation or operating well below capacity (SADA, 2016). For example, the irrigation system at Kokoligu is replete with broken pipes that are supposed to serve as canals and discharge water into chambers located across the field. The Karni dam, one of the oldest, which uses a gravity system, is also in a deplorable state. The main canal and seven laterals of the dam are in an unusable state and cause more water to leak into the ground than what reaches the farms. The Pinyiri irrigation system shown in Figure 23 also highlights the incomplete state of irrigation schemes in the region. As most schemes are either broken or deficient, farmers struggle to get water to their small plots manually with small buckets or by using pumps, neither of which allow them to make the most out of the irrigation schemes.

Figure 23. Pinyiri village fenced irrigation area with no lateral canals



Source: Field visit July 4, 2020

4. CONCLUSIONS

Initial findings from the scoping study indicate that the proposed study is timely and will contribute to the literature on governance and climate-related mobility in Ghana. Preliminary data from interviews and focus group discussions indicate a role for governance actors and interventions in shaping how climate change is felt in the largely agrarian case contexts. The study districts are clearly witnessing environmental change, and development priorities, interventions and practices have shaped how this is experienced by different social groups. This is evident, for instance, in how historical development pathways have affected current environmental conditions and livelihood opportunities, as with deforestation, or how governance interventions, including failures, have affected agrarian livelihoods as seen in the deteriorating irrigation infrastructure in the Upper West Region. At the same time, mobility dynamics seem to be closely linked to livelihood opportunities as well as aspirations, for instance around education. This indicates that livelihoods will be an important focus for the programme when exploring the linkages between environmental change, governance and mobility, as well as the potential importance of other social transformations.

The geographical scope of the study, with focus areas in both the Eastern and Upper West Eastern regions, also offers unexpected and valuable insights. While many of the earlier studies on climate change and mobility in Ghana tend to focus only on the savannah zone (See Teye et al., 2015; Yaro, 2013), based on the assumption that the forest zone is not experiencing climate change and variability, our rigorous climate data analysis has shown that both the forest zone of the Eastern Region of Ghana and the savannah zone of the Upper West Region of Ghana have witnessed long-term changes in temperature and rainfall, with the changes in the Upper West Region being more dramatic. Change detection analysis also shows that both regions have experienced significant changes in vegetation, as a result of human activities. These findings suggest that slow-onset environmental change is likely occurring under the radar of formal planning and interventions, which may have important implications for climate-related mobility. This is particularly evident regarding the Eastern Region, which has not received attention for climate change impacts, despite temperature increases topping 1.5 °C.

In terms of governance, the study highlights important differences of relevance to climate-related mobility. While the formal governance systems are similar in the two regions, the governance and development contexts differ significantly in terms of levels of development infrastructure and living standards, with the Upper West Region being the poorest in Ghana while the Eastern Region is among the economically stronger regions. This raises important questions as to what governance factors influence climate-related mobility and how; for instance, if the development outcomes of governance interventions are more important than the nature of governance or the relationship between governance actors and societies. Preliminary interview data does suggest that there are perceived linkages between governance failures in delivering development outcomes, climate change impacts and mobility. Further data collection will work to unpick these relationships.

Regarding mobility, while the current research design assumes that the two regions are migrant source regions, the scoping report indicates that, particularly within the Eastern Region, there are areas which are experiencing both out-migration and in-migration. This calls for further examination of both out-migration and in-migration in order to understand the dynamics of mobility in both areas. A mobilities perspective may be a relevant approach, by supporting a more nuanced examination of these mobility flows.

Ultimately, the scoping study offers important findings as well as questions for further examination. It documents the presence and intensity of environmental change in both the Eastern and Upper West regions, a central finding. In addition, it confirms the importance of livelihoods as a fulcrum and important empirical entry point to studying the interplay between governance, climate and mobility. It also points to key questions, such as which governance factors are significant, indicating the continued importance of considering governance broadly, both across scales and with the inclusion of a range of governance actors. Further data collection, including a household survey, key informant interviews and focus group discussions, will draw on these findings to further explore the linkages between climate change, governance and mobility.

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ANNEX: SUPPLEMENTARY TECHNICAL INFORMATION

This section provides supplementary technical information on the methods and data for the vegetation change detection analysis.

Method and technical information on the vegetation change detection analysis

As described in the main text, we employed geographic information systems techniques to analyse historical Landsat-4 and Landsat-8 multispectral satellite datasets between 1991 and 2020 to identify and quantify the rate and changes of the green cover in the study areas. The approach employed the use of Normalized Difference Vegetation Index (NDVI, which is one of the most widely used indices for green cover extraction from satellite imagery (Guha et al., 2018; Sun et al., 2019) as well as for spatio-temporal analysis of vegetation cover changes (ESRI, 2014; Guha et al., 2018; Sun et al., 2019). The NDVI can also be used to categorise and classify different land-use/landcover (LULC) types and changes by the suitable threshold values (Guha et al., 2018; Chen et al., 2006). As a standardised index, the NDVI allows for the generation of a single-band image displaying greenness (relative biomass or health) of vegetation of an area from multispectral satellite datasets.

To determine the density of green cover on a patch of land, the distinct reflection in the Red (R) and near-infrared (NIR) bands by the plants are observed. Range of NDVI is -1 to $+1$. Higher value of NDVI refers to healthy and dense vegetation. Lower NDVI values show sparse vegetation with values near zero and decreasing negative values indicate non-vegetated features, such as barren surfaces (rock and soil), water, snow and clouds. We employed NDVI-derived greenness index in a post-classification change comparison. For each district, independently produced image classification results of NDVI images from the two dates of interest were obtained. This was followed by a pixel-by-pixel or segment-by-segment comparison to detect changes in the land cover classes. By adequately coding the classification results, we were able to define the change classes and calculate the transition rates between classes from the change matrix that was constructed. The main strength of this approach lies in the fact that the problem of radiometric calibration between dates or using images from different satellite sensors is minimized. The ability to group classification results selectively also allows for the observation of any subset of the image. It also allows for detecting the levels and changes of the greenness. Besides, human errors such as pixel misclassification is avoided as its computer-based algorithm is not so dependent upon the analyst.

Data for change detection analysis

The data for the change detection analysis was made up of available time series Level-1 Landsat-5 Thematic Mapper (TM) and Landsat-8 (Operational Land Imager) images covering the study districts from 1986-2020 which were downloaded from the USGS (<https://earthexplorer.usgs.gov>). Landsat Level-1 products are precision and terrain corrected which provide for radiometric and geodetic accuracy by incorporating ground control points while employing a Digital Elevation Model (DEM) for topographic displacement. These images were viewed and the quality for potential green cover change analysis was determined.

January and December had the most cloud-free and usable images for the study sites. These months also coincided with the dry season where subtle rainfall effects on vegetative growth are unlikely. Thus, these months are the most suitable for conducting green cover rate and change level analysis spanning several years. Priority was given to anniversary and near-anniversary date images to reduce scene-to-scene variation due to sun angle, soil moisture, atmospheric condition, and vegetation phenology differences (Table 10). The characteristics of the different satellite sensors involved are shown in Table 11.

Table 10. Image datasets used for land cover change analysis

No.	Sensor	Bands	Path/Row	Date
1	Landsat 5 - TM	1-7	195/053	20.12.1986
2	Landsat 5 - TM	1-7	193/056	10.01.1991
3	Landsat 8 - OLI	1-9	195/053	31.12.2019
4	Landsat 8 - OLI	1-9	193/056	02.01.2020

Table 11. Satellite sensor characteristics

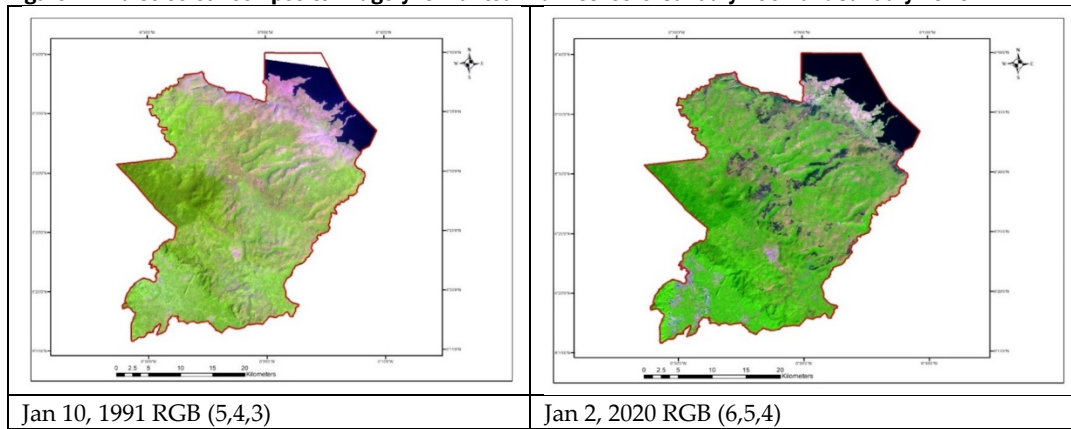
Sensor	Band	Characteristics				
		Spectral range	Ground resolution (m)	Temporal resolution	Inclination (degrees)	Swath width
Landsat TM	1	0.45-0.53 μm	30	16 days	98.2	185km
	2	0.52-0.60 μm	30			
	3	0.63-0.69 μm	30			
	4	0.76-0.90 μm	30			
	5	1.55-1.75 μm	30			
	6	10.4-12.5 μm	120			
	7	2.08-2.35 μm	30			
Landsat OLI	1	0.43 - 0.45 μm	30	16 days	98.2	185km
	2	0.45 - 0.51 μm	30			
	3	0.53 - 0.59 μm	30			
	4	0.64 - 0.67 μm	30			
	5	0.85 - 0.88 μm	30			
	6	1.57 - 1.65 μm	30			
	7	2.11 - 2.29 μm	30			
	8	0.50 - 0.68 μm	15			
	9	1.36 - 1.38 μm	30			

Data pre-processing

Geo-rectification of the selected images was not required as these were Level-1 Precision and Terrain (L1TP) corrected data which are within prescribed image-to-image tolerances of ≤ 12 m radial root mean square error (RMSE) suitable for time series analysis. The selected images were corrected for atmospheric and radiometric distortions using radiometric rescaling coefficients provided in the product

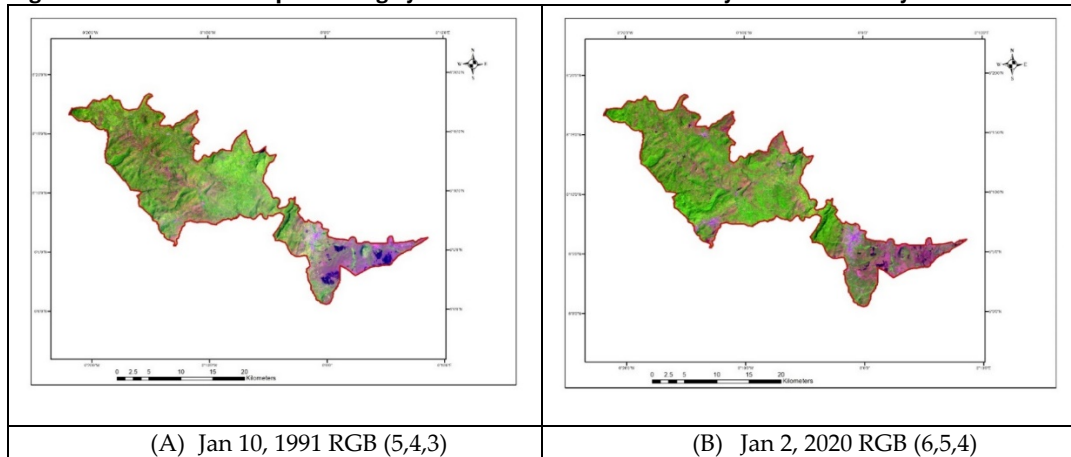
metadata file for the conversion of digital numbers (DNs) to top of atmosphere (TOA) reflectance. False colour composites of the datasets are presented in Figures 24 and 25.

Figure 24. False colour composite imagery for Fanteakwa District for January 1991 and January 2020



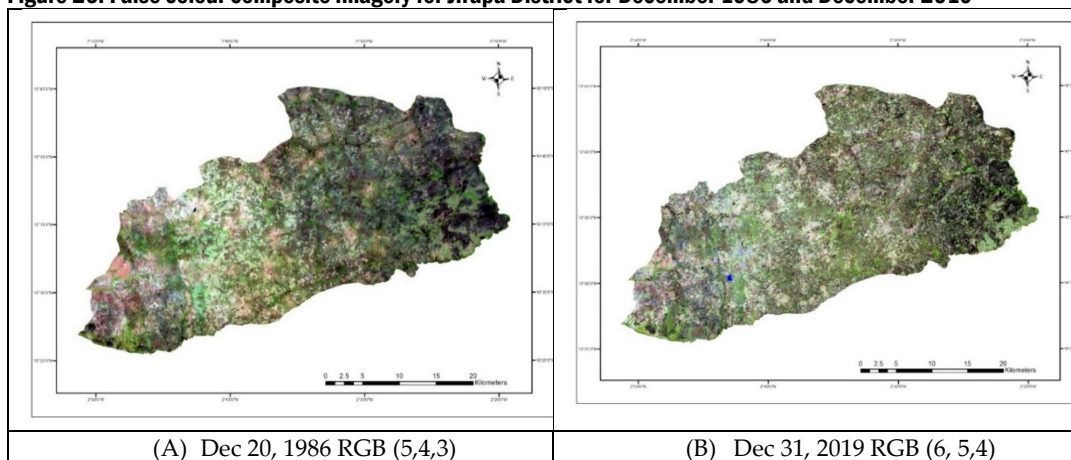
Source: USGS Landsat Data

Figure 25. False colour composite imagery for Yilo Krobo District for January 1991 and January 2020



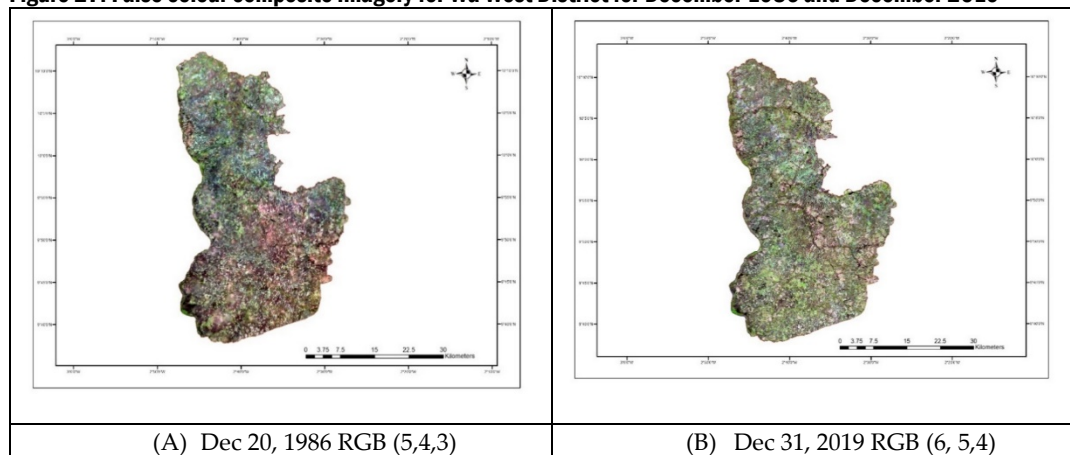
Source: USGS Landsat Data

Figure 26. False colour composite imagery for Jirapa District for December 1986 and December 2019



Source: USGS Landsat Data

Figure 27. False colour composite imagery for Wa West District for December 1986 and December 2019



Source: USGS Landsat Data

NDVI computation and image classification

The NDVI was used to quantify the green cover, as it is useful in understanding vegetation density and health and assessing changes over space and time. It is calculated as a ratio between the R and NIR bands and is given as:

$$NDVI = \frac{NIR - R}{NIR + R} \quad NDVI = \frac{NIR - R}{NIR + R} \dots\dots\dots(1)$$

The NDVI images for all the datasets were computed using the built-in utility within Erdas Imagine 2013 software. The NDVI images were subsequently classified using the threshold values provided by ESRI (2014) as shown in Table 12. Land cover classes for each independently produced image classification result were obtained. A change matrix was then constructed to define the change classes and to calculate the transition rates between classes for each pair of dates being analysed.

Table 12. Classification of the green cover type

NDVI Range	Green cover type
< 0	Water
0.0 – 0.1	Built/barren areas
0.1 – 0.2	Low and open grassland
0.2 – 0.3	Shrub and grassland
0.3 – 0.6	Low to moderate forest
≥ 0.6	Dense forest