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Understanding climate services for enhancing resilient agricultural systems in Anglophone West Africa: The case of Ghana

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ABSTRACT

Whilst the capability of climate services to reduce climate impacts is alluring, empirical evidence on how best to mainstream climate information services in Africa is lacking. This paper determines how climate information services have been incorporated into national policies by Anglophone West African states for building agricultural resilience and provides a detailed analysis of issues facing Ghanaian agricultural systems. The paper addresses the questions: (i) to what extent is climate change recognised as a threat to agricultural development in national climate facing policies of Anglophone West African states? (ii) to what extent have climate information services been incorporated into national and regional policy frameworks of Anglophone West African states for resilient agricultural systems? (iii) what are the key challenges in mainstreaming climate information services into national policies for resilient agricultural building in Ghana? The study employed thematic content analysis, multi-stakeholder workshops and expert interviews to understand climate discourses around climate services. Findings show that climate change is highlighted in national and regional level policies as a serious threat to socioeconomic development and agricultural productivity in West Africa. Anglophone West Africa countries are at various stages in establishing a National Framework for Climate Services to help guide future adaptation planning. This study shows that Anglophone West African states have not yet incorporated climate information services into strategic national and regional climate facing policies that are critical in shaping efforts aimed at managing climate risks. For the case of Ghana, the study reveals low awareness of climate change among policymakers, human and institutional capacity constraints as some of the key factors militating against the mainstreaming of climate information services. Capacity building of policy makers and institutional strengthening are both vital for more effective mainstreaming of climate services across West Africa.

Practical implications

- This paper shows that climate change is recognised as a serious threat to socioeconomic development and increased agricultural productivity in West Africa. National governments and stakeholders across the region are developing National Framework for Climate Services aimed at supporting vulnerable governments in building their resilience and adaptive capacity to address climate change risks. This is important in the light of the contribution of agriculture to livelihood sustainability in many households. Despite acknowledging the threats posed by climate change to agricultural development, the analysis shows that Anglophone West African states have not yet incorporated climate information services into strategic national and regional climate facing policy documents that serve as frameworks shaping decision-making and long-term planning on climate change issues. This is a gap that needs urgent attention in the next review of strategic national and regional policies. Ghana was employed as a case study country to explore the key challenges confronting policy makers in attempting to mainstream climate information into national policies and this identified the following key challenges.
- First, there is a low awareness on climate change and how climate information services can be used to build resilient agricultural systems in Ghana. Mainstreaming climate information services into development planning requires that stakeholders have full understanding and appreciation of the

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issues involved in climate change adaptation. However, at the sub-national and local levels where mainstreaming takes place, there is a low level of awareness of climate change issues.
- Second, we identified human and institutional capacity constraints for mainstreaming climate information. Incorporating climate information services into national policies and sectoral plans requires enhanced institutional capacity. Issues pertaining to climate change are added to existing roles and responsibilities at the local level where the actual implementation of national policies and sectoral plans are effected. This undermines efforts to address climate change through the use of climate information. Lack of institutional capacity is also related to insufficient resources as well as budgetary constraints across West Africa.
- The third challenge is the limited understanding and appreciation of the vulnerability status of various Metropolitan, Municipal and District Assemblies in Ghana. It is important that local assemblies are capacitated via capacity building workshops and short courses to undertake vulnerability assessments to understand their level of overall vulnerability in order to effectively target adaptation interventions.
- Overall, this study points to the need for capacity building of local level policy makers and institutional strengthening in order to prioritise the mainstreaming of climate services in Ghana and across West Africa more widely.

1. Background context

The Intergovernmental Panel on Climate Change (IPCC) 1.5 °C Special Report indicates that humanity needs to make unprecedented changes to avoid extreme heat, floods and poverty (IPCC, 2018). By 2030, the impacts of climate change could cause enhanced levels of extreme poverty (Hallegatte and Rozenberg, 2017), especially in sub-Saharan Africa (SSA), where climate change presents a major development challenge with disproportionate effects on agriculture, water resources and agro-based livelihoods (Niang et al., 2014).

Agriculture is the mainstay of SSA economies, contributing substantially to its Gross Domestic Product (GDP) and plays a significant role as a source of livelihood for a majority of Africans (Collier and Dercon, 2014). The attainment of the Sustainable Development Goals (SDGs), particularly Goals 1 (no poverty), 2 (achieving food security and improved nutrition), and 13 (climate action) and the Nationally Determined Contributions (NDCs) under the Paris Agreement is contingent on enhancing the resilience of the agricultural sector, and yet the agricultural sector is arguably the most vulnerable sector (Serdeczny et al., 2017).

Within SSA, West Africa is one of the most vulnerable regions to climate shocks, characterised by high levels of weather and climate-related risks including high rainfall variability, intense droughts and increasing temperature (Zougmoré et al., 2016; Nangombe et al., 2018). The majority of the people in the region are dependent on rain-fed agricultural systems (FAO, 2016), which accounts for approximately 96% of overall crop production (Rosenzweig et al., 2014). Accounting for an estimated 35% of West Africa's GDP, the agricultural sector employs 60% of the active labour force (Jalloh et al., 2013). Actual crop yield achieved in West Africa remains low due to inadequate soil moisture and nutrients (Serdeczny et al., 2017). Agriculture has been identified as one of the priority sectors for adaptations where the NDCs of West African states have pledged significant commitments (Antwi-Agyei et al., 2018).

West African farmers are also confronted with challenges relating to the selection of crop varieties as well as the timing of planting, and other agronomic practices (Niang et al., 2014; Zougmoré et al., 2018). The region produces an estimated 30% of the food requirements of the African continent, yet, droughts, extreme weather events, economic downturns, frequent food crises and famines characterize this region (Taylor et al., 2017). Jalloh et al. (2013) projected a 1.5 °C–2.3 °C rise in temperature by 2050 across West Africa, with devastating consequences for agro-based livelihoods. Therefore, building the resilience of agricultural systems by mainstreaming climate information services is of critical importance (Nkiaka et al., 2019; Vogel et al., 2019).

Climate services involve "the generation, provision, and contextualization of information and knowledge derived from climate research for decision-making at all levels of society" (Vaughan and Dessai, 2014, p.1). Climate services develop and disseminate climate relevant information for decision-making (Brasseur and Gallardo, 2016) and are critical in reducing climate vulnerability and developing resilience (Carr and Onzere, 2018). Singh et al. (2017) reported that externally provided climate information services play important role in building on local knowledge to shape understanding of climate risks and guide decision–making across scales. At present, the extent to which climate information services (hereafter CIS) have been incorporated into national policies and agricultural programmes of West African states has not been evaluated in detail. Mainstreaming climate services involves contextualizing climate services in national policies, plans, strategies and budgets which is critical for adaptation planning (Sultan et al., 2020).

The National Meteorological Agencies across West African states provide forecast information and disseminate such information via national broadcasting networks. However, access to available climate information at the local level by smallholder farmers for agricultural decision-making is limited because of a misalignment between the climate information needs and the actual information that is being provided (Nkiaka et al., 2019), poor observational records, weak communication and computational facilities coupled with a low level of investment in climate science (Kusangaya et al., 2014). Therefore, there is an urgent need to prioritise climate information to build resilience in food systems and to inform national-level planning development.

Past studies have identified the lack of climate information as a key barrier constraining farmers' ability to make appropriate and timely decisions, including agricultural land management and cropping decisions that can help them overcome the challenges associated with extreme weather and climate change (Adenle et al., 2017; Jones et al., 2015; Vaughan and Dessai, 2014). Smallholder farmers in West Africa rely on rain-fed agriculture for their daily subsistence, making these farmers extremely vulnerable to the adverse impacts of climate fluctuations (Coulibaly et al., 2015). Hence, improving climate information services is acknowledged as a useful tool in addressing uncertainties associated with climate and to help improve crop management decision-making.

Whilst acknowledging the critical role played by CIS in climate risk management, studies on how climate information has been incorporated into strategic national policies and frameworks of West African countries for resilient agricultural systems have been lacking. This poses significant challenges to the efforts of various national stakeholders aimed at addressing the threats of climate change on key sectors including agriculture, energy, water, health and transport across West Africa. This paper addresses this important research and policy gap by determining how climate information services have been incorporated into national policies by Anglophone West African states for building agricultural resilience to climate change and by providing a detailed analysis of issues facing Ghanaian agricultural systems. This paper builds on previous studies highlighting the importance of climate information services in building the capacity of smallholder farmers to manage climate risks (Antwi-Agyei et al., 2020; Sultan et al., 2020; Naab et al., 2019; Hansen et al., 2019).

The paper answers the following research questions: (i) to what extent is climate change recognised as a threat to agricultural development in national policies of Anglophone West African states? (ii) to what extent have climate information services been incorporated into climate facing national and regional policy frameworks of Anglophone West African states for resilient agricultural systems? (iii) what are the key challenges in mainstreaming CIS into national policies and sectoral plans for resilient agricultural building in the case of Ghana? This paper will guide the development of appropriate policy interventions and

collective efforts to support smallholder farmers in managing the risks associated with climate change and variability.

2. Efforts at establishing National Framework on Climate Services

In an effort to enhance the delivery of climate services and address the threats of climate change on key sectors, the World Meteorological Organisation (WMO) launched the Global Framework for Climate Services (GFCS) – a multi-stakeholder user interface platform enabling the development and delivery of climate services at country level – in 2012. As a WMO-led initiative, the GFCS coordinates and facilitates WMO member states and stakeholders to provide climate information for decsion-making (WMO, 2012; Hewitt et al., 2012). The GFCS is mandated to provide and facilitate access to weather and climate services and focuses on improving co-production, tailoring, delivery and use of science-based climate predictions and services focused on the five GFCS priority areas: agriculture and food security, disaster risk reduction, energy, health and water (WMO, 2012). Vaughan and Dessai (2014) argued that the GFCS was a response to the need for user-driven climate services.

The GFCS achieves this mandate through observations and monitoring; research, modelling, and prediction; capacity building; and the creation of user interface platforms (Hewitt et al., 2012). It aims to enable society to better manage the risks and opportunities arising from climate change and variability, especially with a view to those who are most vulnerable to such risks, by developing and incorporating science-based climate information and prediction into planning, policy and practice.

The GFCS is aimed at supporting vulnerable governments in building their resilience and adaptive capacity to address climate change risks. Member states of the WMO are therefore challenged to develop their own National Framework for Climate Services (NFCSs) that will guide the implementation of Climate Information Services in their respective countries. As a mechanism, the NFCSs support the Paris Agreement, through the provision of climate services for climate vulnerabilities assessment; targeting of adaptation interventions whilst enhancing adaptation planning and implementation in climate-sensitive sectors. Additionally, the NFCSs complement National Adaptation Plans (NAPs). The process of establishing a NFCS involves: (i) assessing the baseline on climate services; (ii) organizing a national stakeholder consultation workshop on climate services; (iii) developing a national strategic plan and action plan for the National Framework for Climate Services; (iv) endorsing the national strategic plan and action plan for the National Framework for Climate Services; and, (v) launching a National Framework for Climate Services. New skillsets and partnerships are required for the production and delivery of user-oriented climate services as envisaged in National Framework for Climate Services (Mahon et al., 2019).

3. Research design and methods

The study adopted a three-phase methodology. In phase one, the study employed policy analysis to understand the extent to which climate information has been incorporated into national policies relating to agricultural development and production in Anglophone West Africa (Ghana, Liberia, Nigeria, Sierra Leonne and The Gambia) (Table 1). The policy analysis was conducted using a thematic content analysis approach to determine the climate discourses in national policy documents. The analysis involved exploring the frequency at which important keywords appeared in policy documents in a similar approach to Mbeva et al. (2015), Antwi-Agyei et al. (2018) and Naab et al. (2019). Keywords including climate information, climate services, climate information services, climate change information, climate change services, weather information, weather forecasting, meteorological services, and climate risks among others were retrieved and counted (Table 2). During the textual analysis, we painstakingly examined each hit and evaluated relevance to addressing the threat of climate change. National policies such as the National Climate Change Policy, the Nationally Determined Contributions, Food and Agricultural Policy, National Communications to the United Nations Framework Convention on Climate Change (UNFCCC), National Climate Change Adaptation Strategy, and National Environmental Policy were analysed. Regional level policy documents such as the ECOWAS Agricultural Policy and the Africa Union's Agenda 2063 were also analysed. These policies were selected because they act as national and regional frameworks for decision making on climate change and building long-term climate resilience. As such, we focused on addressing the threats posed by climate change to agriculture and other climate-sensitive sectors. The National Communications of the study countries were retrieved from the UNFCCC website.

In phase two of the research, Ghana was used as a case study country to explore the challenges of incorporating climate and weather information into national and sectoral programmes and plans for resilient agricultural systems. Ghana was used as a case study country because; it has demonstrated regional leadership in addressing threats of climate change and was among the first of West African states to develop a national climate change policy (Antwi-Agyei et al., 2017; Mawunya and Adiku, 2013). Ghana's vulnerability to climate change has also been documented because of its dependence on climate sensitive sectors and the role of the inter-tropical convergence zone (ITCZ) across the country (Stanturf et al., 2011). Using regional and national sectoral leads and two regional stakeholder workshops held in Bolgatanga (in September 2019, n = 26) and Navrongo (in September 2019; n = 27), with experts drawn from across Government Departments, regional extension officers, civil society organisations, non-governmental organisations (NGOs), and academic researchers, the challenges of incorporating climate information into the existing agricultural practices were explored. Stakeholders were purposively selected because of their roles in agriculture and environmental (including climate change) issues at

Table 1
Characteristics of Anglophone West African countries.

Country	Estimated Population (millions) (2019)[a]	Surface Area (km^2)[a]	GDP per capita (USD) (2019)[a]	Main Economic Sectors[b]	Main Economic Crops
Ghana	30.42	238, 535	2,202.12	Agriculture, industry, tourism, services	Cocoa, cotton, oil palm, pineapples etc.
The Gambia	2.35	11, 295	777.81	Agriculture, industry, tourism	Peanuts, cotton lint, palm kernels etc.
Liberia	4.94	111, 369	621.89	Agriculture, industry, services	Rubber, cocoa, coffee, timber, cassava etc.
Nigeria	200.96	923, 763	2229.90	Agriculture, industry, oil, mining, services, energy & overseas remittances	Groundnut, cocoa, oil palm, kola nut, ginger, etc.
Sierra Leone	7.81	71, 740	527.53	Agriculture, mining, telecommunications, tourism, transport	Oil palm, coffee, cocoa, cashew nuts, rice and cassava

[a] The World Bank (2019).
[b] African Development Bank (2018).

Table 2
Reviews of national climate facing documents and policies of Anglophone West African states.

Key terms in climate services	Ghana					Nigeria					Sierra Leone					The Gambia						Liberia			
	FASDEP II	NCCP	1st UNFCCC	2nd UNFCCC	NDC	NCCAS	NAP	1st UNFCCC	2nd UNFCCC	NDC	NAPA	NSADP	1st UNFCCC	2nd UNFCCC	NDC	NAPA	NNP	1st UNFCCC	2nd UNFCCC	NCCP	NDC	NCPS	NFAPS	1st UNFCCC	NDC
Climate	1	689	459	642	27	983	1	378	577	122	217	15	323	596	51	268	3	420	280	560	146	625	24	600	35
Climate change	1	545	381	520	10	826	0	279	367	87	157	10	239	386	35	149	0	271	188	376	92	430	13	391	23
Climate information	0	2	0	1	0	0	0	3	4	0	0	0	0	6	0	4	0	0	1	4	1	3	0	11	1
Climate service (s)	0	0	0	0	0	0	0	1	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Climate information services	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Climate change information	0	0	0	2	0	2	0	0	1	0	0	0	1	3	0	0	0	1	11	0	1	4	0	5	0
Climate change service(s)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Climate change adaptation	0	17	1	25	0	202	0	0	7	10	0	0	0	2	5	1	0	1	1	10	8	18	1	6	2
Climate change mitigation	0	0	0	14	0	1	0	1	24	1	0	0	1	2	0	0	0	0	2	3	2	7	0	5	1
Climate change risk	0	2	0	1	1	13	0	0	0	2	0	0	0	0	0	0	0	0	0	6	0	2	0	0	0
Climate risk	0	0	0	2	0	7	0	0	0	1	0	0	0	1	0	3	0	0	2	18	0	2	0	0	0
Climate scenario (s)	0	1	14	15	0	9	0	1	20	0	0	0	2	9	0	0	0	24	17	2	0	0	0	3	0
Climate change variables (bility)	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0
Climate variables (bility)	0	3	0	14	0	6	0	3	13	2	11	0	8	7	0	0	0	4	2	2	2	11	0	9	0
Climate change scenario(s)	0	3	35	21	0	3	0	7	17	0	2	0	14	25	0	0	0	87	11	1	0	0	0	10	0
Meteorological information	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0
Meteorological services	0	4	7	5	0	0	0	1	0	0	3	0	3	1	1	0	0	5	0	0	0	1	0	14	0
Weather information	0	0	0	0	1	0	0	0	2	0	0	0	0	2	0	1	0	0	1	0	0	0	0	6	0
Forecast(ing)	0	3	2	7	0	13	0	12	13	3	20	0	4	9	0	9	0	3	9	3	2	1	0	55	0
Total	2	1270	900	1270	39	2065	1	687	1045	232	410	25	595	1053	92	435	3	816	525	985	255	1105	38	1119	62

FASDEP II = Food and Agricultural Sector Development Policy Phase II; NCCAS = National Climate Change Adaptation Strategy; 1st UNFCCC = 1st National Communication to the United Nations Framework Convention on Climate Change; 2nd UNFCCC = 2nd National Communication to the United Nations Framework Convention on Climate Change; NDC = Nationally Determined Contributions; NCCP = National Climate Change Policy; NAP = National Agricultural Policy; NAPA = National Adaptation Programme of Action; NSADP = National Sustainable Agricultural Development Plan; NNP = National Nutrition Policy; NCPS = National Climate Policy Response and Strategy; NFAPS = National Food and Agriculture Policy and Strategy.

regional and local levels. Both Bolgatanga and Navrongo are located in the savannah agro-ecological zone, characterised by high rainfall variability (Antwi-Agyei et al., 2012). These regional stakeholder workshops were aimed at understanding the role of different stakeholders in facilitating the delivery of climate services in northern Ghana.

The third phase involved expert interviews across Ghana, with experts drawn from various ministries, departments and institutions including the Ministry of Food and Agriculture, Ministry of Environment, Science, Technology and Innovation, Environmental Protection Agency, and National Development Planning Commission. Others included the National Disaster Management Organization, Civil Society Organisations, NGOs and the Academic and Research Institutions. These institutions were purposively selected given their roles in climate change adaptation and local development issues in Ghana. Experts were selected from these organisations through purposive sampling, based on their longstanding and comprehensive knowledge on climate change adaptation issues in Ghana (Creswell and Plano Clark, 2011). Expert interviews were conducted from September to October 2019. Stakeholders consented to participating in the study and were aware that they could withdraw from the interview at any time. Participants in the expert interviews were made aware that they would not be identified or identifiable in the report resulting from the research. Interviews were conducted in person by the lead author. We also reviewed pertinent literature and conducted interviews with relevant stakeholders to understand the status for the establishment of the National Framework for Climate Services. Responses from stakeholders and experts interviews were recorded with the consent of interviewees. Qualitative data from stakeholders' workshops and expert interviews were analysed thematically via inductive coding (Creswell, 2014). This allowed dominant narratives and themes to be identified from interview responses.

4. Results and discussion

4.1. Climate change as a recognised threat to development and agricultural productivity in West Africa

The results of the analysis of national policy documents are presented in Table 2. This shows that climate change is acknowledged and highlighted by most of the national policies as a threat to socioeconomic development and increased agricultural productivity in West Africa. For instance, Ghana's National Climate Change Policy (NCCP), 1st National Communication to the UNFCCC and the 2nd National Communication to the UNFCCC mentioned climate change 545, 381 and 520 times, respectively. Similarly, the 1st National Communication of Nigeria, Sierra Leone, the Gambia and Liberia mentioned climate change 279, 239, 271 and 391 times, respectively (Table 2). Nigeria's National Climate Change Adaptation Strategy states: "in order to build climate change adaptation into every aspect of national life, people must have knowledge – and access to knowledge – of what climate change is, how it is impacting them and how they can adapt" (Federal Ministry of Environment, 2015, p. 30). Nigeria's NDC indicates: "climate change poses a significant threat to the achievement of development goals, especially those related to eliminating poverty and hunger and promoting environmental sustainability (Federal Ministry of Environment, 2015, p. 4). Sierra Leone's NDC points out the threats posed by climate change as follows: "our vulnerable population has low capacity to adapt to climate change and the rural populations will be the most affected because of their high dependence on rain-fed agriculture and natural resource-based livelihoods" (EPA Sierra Leone, 2015). Ghana's Climate Change Policy (Ministry of Environment, 2013) recognises the threats by climate change and highlights that the nation is particularly vulnerable to climate change and variability due to reliance on sectors that are sensitive to climate change, such as agriculture, forestry and energy production.

The analysis further shows that at the regional level, climate change is acknowledged as a threat to agricultural development in policy documents (Table 3). For instance, the Africa Union's Agenda 2063 which details development objectives for all African states indicates: "whilst Africa at present contributes less than 5% of global carbon emissions, it bears the brunt of the impact of climate change" (Africa Union Commission, 2015, p.3). The ECOWAS Policy for Disaster Risk Reduction (2006, p. 5) states that: "climate change factors are likely to worsen drought conditions and coastal erosion, change vegetation patterns, and increase tidal waves and storm surges." The Land Policy in Africa: West Africa Regional Assessment (AUC–ECA–AfDB Consortium, 2011, p.19) indicates: "due to the geographical location of the region, drought, desertification, floods and climate change are discussed as part of the sustainable management of the environment." It also indicates that climate change poses a serious threat to development and should be contended with in the region (AUC–ECA–AfDB Consortium, 2011).

Analysis of national development plans of Anglophone West African countries also reveals that climate change is recognized as a threat to socioeconomic development. For instance, the Medium-Term National Development Plan of Sierra Leone (Ministry of Planning and Economic Development, 2019, p. 96) states that: "climate change will have severe consequences in Sierra Leone, as the average annual temperature has increased by 0.8°Celsius since 1960, and projections suggest an increase in annual temperature by 1 to 2.6°Celsius by the 2060s." The Gambia

Table 3
Analysis of regional climate facing documents and policies for West African sub-region.

Key terms in climate services	African Union's Agenda 2063	Regional Agricultural Policy for West Africa (ECOWAP)	Land Policy in Africa: West Africa Regional Assessment	ECOWAS Policy for Disaster Risk Reduction
Climate	13	1	6	7
Climate change	8	1	5	3
Climate information	0	0	0	0
Climate service	0	0	0	0
Climate information services	0	0	0	0
Climate change information	0	0	0	0
Climate change service(s)	0	0	0	0
Climate change adaptation	0	0	0	1
Climate change mitigation	1	0	0	0
Climate change risk	0	0	0	0
Climate risk	0	0	0	0
Climate scenario (s)	0	0	0	0
Climate change variables (bility)	0	0	0	0
Climate variables (bility)	0	0	0	1
Climate change scenario(s)	0	0	0	0
Climate sensitive(ty)	0	0	0	0
Climate resilient (ce)	2	0	0	0
Meteorological information	0	0	0	0
Meteorological services	0	0	0	0
Weather	0	0	1	1
Weather information	0	0	0	1
Forecast(ing)	0	0	0	3
Total	**24**	**2**	**12**	17

National Development Plan indicates: "The Gambia is susceptible to the vagaries of the environment and climate change, e.g. droughts and flooding, which cause much damage to coastal ecosystems, farmlands, settlements, and livestock" (Ministry of Finance and Economic Affairs, 2018, p. 137).

Our review and stakeholder engagements also reveal that many national stakeholders across West African countries are in the process of establishing National Framework for Climate Services. National stakeholders are engaging in national workshops, capacity building sessions and national consultations towards the NFCSs. Anglophone West Africa countries are at various stages of establishing and implementing a NFCS. For instance, whilst The Gambia has already launched and validated its NFCS, countries including Ghana, Liberia, Nigeria and Sierra Leone have developed their national strategic plans and a costed action plan and awaiting national endorsements to launch the NFCSs, implement the national action plans and conduct rigorous monitoring and evaluation.

All these narratives from national and regional level policy documents as well as development plans are consistent with previous studies (including Wossen et al., 2018; IPCC, 2014) suggesting that climate change poses a great threat to agriculture and socioeconomic development in West Africa. Agriculture is critical in efforts to combat poverty and food insecurity in this region, with majority of low income households depending on it for their livelihoods. Climate services provide opportunity for farmers to make critical climate-sensitive livelihood decisions so as to improve food security (Vaughan et al., 2019), and anticipate climate risks and take advantage of favourable conditions. The ECOWAP (2005) recognises the role of agriculture in driving economic development in West Africa. It states: "agriculture plays a key role in the Economic Community of West African States. As the backbone of the economy, it affects society at many levels since national economies and people's jobs, incomes and food security depend upon it" (ECOWAP, 2005, p. 3).

Climate change continues to adversely affect agricultural productivity in many countries across West Africa. For instance, the growth rates of maize, guinea corn, millet and rice have reduced due largely to rises in temperature in Nigeria (Ebele and Emodi, 2016). The late onset and early cessation of rainfall have contributed to the variation of yields of cereals and cash crops per season in The Gambia (Badjie et al., 2019). In Sierra Leone, the current major climate change threats include bushfires, dry spells, high temperatures, early rains, late rains, intensive rains, thunderstorms, landslides and floods (Rhodes et al., 2016). In Ghana, increasing temperatures during the early and late seasons have resulted in reduction of the net revenue per hectare of sorghum (Nyuor et al., 2016). The FAO (2013) argues that CIS provides unique opportunity for increasing agricultural productivity in Africa. In Senegal, Ouedraogo et al. (2018) reported that the use of climate information helped farmers to make strategic farm management decisions.

Although climate change is a global concern, its management requires concerted efforts at the local and national levels through the formulation and implementation of appropriate policy interventions aimed at building the adaptive capacity of climate sensitive sectors including agriculture. This is where the incorporation and subsequent implementation of CIS into national and regional policies that provide framework for driving socioeconomic development become critical.

4.2. Climate information services for addressing climate change in West Africa

Analysis reveals that CIS has not been incorporated into these climate facing strategic national and regional policy documents (Table 2). For instance, important national climate change documents including the NDCs of Ghana and Sierra Leone never made mention of CIS (see Table 2). The NDCs of The Gambia and Liberia mentioned climate information only once (see Republic of the Gambia, 2015; Republic of Liberia, 2015). In a few cases, Sierra Leone National Communications to the UNFCCC highlights the potential of climate services to address climate change. Sierra Leone advocates for the "establishment of network with local grassroots organizations, international non-governmental organizations and line ministries for the enhancement of development and use of climate information and services" (EPA Sierra Leone, 2015). The Gambia's NAPA also seeks to "ensure adequate climate change research for informed decision-making, and promote timely access to climate information and early warning of climate risks." Nigeria's NDC mentions climate services 4 times. Even when climate information has been acknowledged, its usefulness in addressing climate change is unclear in most of these documents. The general lack of appreciation of CIS to address the threat of climate change in this vulnerable region is quite worrisome given the strong deep connection between crop production and climate variability (Sultan and Gaetani, 2016; IPCC, 2014; Antwi-Agyei et al., 2012). Naab et al (2019) reviewed 17 policy documents related to agricultural policy in Ghana and found that CIS was hardly mentioned in these policy documents.

The Paris Climate Agreement marks a landmark achievement in multilateral diplomacy on climate change discourse, and seeks to hold global warming to well below 2 °C above pre-industrial levels (Northrop et al., 2016). Antwi-Agyei et al. (2018) observed good alignment between NDCs of West African countries and the attainment of the Sustainable Development Goals particularly goals relating to poverty reduction (SDG 1), food security (SDG 2), quality water (SDG 6), affordable energy (SDG 7) and climate action (SDG 13). Parties to the UNFCCC were required to submit the mitigation and adaptation actions aimed at addressing the threats of climate change in their NDCs. Anglophone West African countries highlighted specific adaptation measures including planting drought-resistant varieties of crops, using indigenous knowledge, climate-smart technologies, early warning systems and resilience building.

The utility of climate information for driving farm management practices and decsion-making in relation to when and what crops to plant in relation to climate change and variability cannot be overemphasised (Vaughan et al., 2019; Singh et al., 2017). However, CIS which holds great prospects for addressing the threats posed by climate change has not been given prominence in the submitted NDCs of Anglophone West African countries. CIS has been hailed as a climate-smart agricultural technique that has the potential to increase productivity and enhance the adaptive capacity of smallholder farmers to manage climate risks at the local level. It is important that the next review of these policy documents should incorporate mechanisms for mainstreaming climate information at the local level to address climate change impacts on agricultural systems. This could be done through stakeholder workshops highlighting the potential of CIS. Additionally, there should be appropriate strategy to merge CIS with local traditional agro-ecological knowledge for effective decision-making for climate risks management by smallholder farmers across West Africa. The delivery of CIS via national meteorological agencies in West African countries have often tended not to prioritise agro-meteorological information that is essential for decision-making. This may also account for the low level of appreciation of the potential of CIS for addressing the effects of climate change.

4.3. Challenges of mainstreaming climate services into local and sectoral plans in Ghana

The study explored Ghana as a case study country to identify the key challenges of mainstreaming CIS into national policies and sectoral plans using workshop with participants across different governance levels and different stakeholder groups. Workshop participants highlighted a number of key challenges including low awareness of climate change among policy makers, low prioritisation of CIS, human and institutional capacity constraints and the low appreciation of the vulnerability status of various local assemblies.

Low awareness of climate information is high among key stakeholders including local policy makers and farmers who are the end-users

of climate information at the local level. An expert on climate change indicated: "*most of the key stakeholders at the local level do not understand and appreciate the links between climate change and development. This is critical as it hampers the collective resolve to address the risks posed by climate change*" (Expert Interview, Accra, October 2019). A workshop participant indicated: "*we need to create awareness on the significance of climate information in managing climate change for different stakeholders to appreciate these concerns. This can be done through workshops, capacity building sessions, and briefing notes among others*" (Workshop Participant, Bolgatanga, October 2019). These statements are made within the context of increasing reliance on agro-ecological indigenous knowledge by farmers across Ghana. It could also be attributed to the seemingly limited reliability of climate information provided by national meteorological services as a tool for managing crop production in vulnerable farming systems. Pasquini (2019) argued that, local level climate change adaptation planning and policy action is important because local governance systems are the "closest entities" for planning and implementing adaptation strategies suitable for the particular geographical and social context in which they are located. Mainstreaming CIS into development planning and agricultural systems requires that stakeholders especially smallholder farmers have full understanding and appreciation of the issues involved in climate change adaptation (UNDP, 2012). Various studies (Ayers et al., 2014; Ellis et al., 2013; Pilato et al., 2018) have highlighted the need to build awareness of climate change issues amongst stakeholders in order to mainstream climate change issues. Lack of awareness or trusted information about uncertainties, risks, opportunities, and trade-offs present challenges to policy makers (Pilato et al., 2018). To foster awareness on climate change issues and the value of climate information for smallholder farmers, policy makers and national agencies and ministries including the Ministry of Food and Agriculture and the National Meteorological Agencies should be capacitated to run training programmes aimed at creating awareness and enhancing understanding of climate change issues.

Human and institutional capacity constraints was reported as one of the key issues militating against the mainstreaming of CIS in Ghana. A stakeholder remarked: *"climate concerns are relatively recent and many policy makers are yet to understand the concept and its mitigation and adaptation principles. There is a general problem of equating awareness with knowledge and understanding but in reality stakeholders are increasingly becoming climate-aware but more is needed to conceptualize and operationalize mitigation and adaptation strategies before policies can adequately reflect them as Nationally or Locally Determined Contributions in agricultural systems"* (Expert Interview, Accra, October 2019). Within the context of other developmental challenges, climate change issues are relatively new, meaning capacities to address these challenges are usually limited, especially at the sub-national and local levels, where adaptation implementations are usually undertaken. Another stakeholder remarked: "*addressing the risks posed by climate change in agricultural systems requires that policy makers have sound understanding of climate change issues, which is mostly lacking in most agencies and departments of many government sectors and ministries across the country*" (Agricultural Development Officer, Bolgatanga, September 2019). An expert at the Ministry of Food and Agriculture indicated: "*in most instances, the capacity to incorporate climate information may be lacking at the sub-national and local levels and this is worrying considering the threats posed by climate change on rural livelihoods."* Incorporating CIS into national policies and sectoral plans requires enhanced institutional capacity to achieve this. This requires strengthening the capacity of local level institutions in order to successfully mainstream climate change adaptation issues into policy planning at the local level. However, it was noted that in most agencies and departments, the necessary institutional arrangements (such as the creation of climate change desk) required for mainstreaming climate is mostly non-existent.

African's vulnerability to climate change is documented; yet, the capacity to address these vulnerabilities is often limited. Capacity-building is fundamental to ensuring the effectiveness of climate services delivery for resilience building for vulnerable smallholder farmers in Ghana and West Africa more widely (Sultan et al., 2020). West African countries should take advantage of training initiatives managed by national and international organizations including those organized by the World Meteorological Organization Training Centres. Capacity building through workshops and training sessions to smallholder farmers and the wider community of technicians in national agro-meteorological services provide a plausible mechanism to deliver new information tools and deeper awareness on climate change impacts.

Issues pertaining to climate change are added to existing roles and responsibilities at the local assembly where the actual implementation of national policies and sectoral plans are effected. This undermines efforts to address climate change through the use of climate information. Such findings suggest that inadequate human and institutional capacities can militate against the effective mainstreaming of CIS for economic development. A study in the water, sanitation and hygiene (WASH) sector indicated that, the absence of a desk officer or focal person in charge of climate change issues at decentralised local government set up was a key challenge militating against the mainstreaming of climate change adaptation into WASH development planning in Ghana (Alhassan and Hawden, 2017). Naab et al. (2019) observed that there are institutional challenges including poor collaboration between relevant stakeholders in the production of climate information that prevent the mainstreaming of climate information in Ghana. Insufficient resources as well as budgetary constraints have also been identified as key institutional challenges that need to be addressed with concerted efforts (Antwi-Agyei et al., 2018). There is therefore the need to enhance the capacity of institutions and adequately provide the needed resources to enable such national and local level institutions to effectively execute their mandate to address the threats posed by climate change. Capacity building workshops for policy makers aimed at heightening awareness of climate change offers good platform to achieve this.

Participants at the stakeholders' workshops and expert interviews highlighted the lack of prioritisation of CIS in Ghana. A participant remarked: "*in most instances, climate change issues are not prioritised at the local level because of scarce resources and poverty levels in this part of the country*" (Workshop Participant, Navrongo, September 2019). Ghana is practising a decentralisation governance system where decision-making resides in the local assembly. However, these local assemblies are often confronted by a range of climatic and non-climatic stressors that sometimes interact to exacerbate the vulnerability of smallholder farmers in these assemblies. An expert remarked: *"many of the policy makers, especially at the local levels may not appreciate the value of weather and climate information for agricultural systems and therefore there is the need for sensitisation workshops to create the awareness on climate change issues and the value of climate information*" (Expert Interview, Bolgatanga, October 2019). Such assertions are in line with previous studies that have shown that poor countries are often pre-occupied with other pressing socio-economic needs than the focus on the environmental including climate change issues (Neumayer, 2003). Government and its institutions are sometimes driven by short-term economic gains over long-term environmental (including climate) benefits (Ellis et al., 2013; Pilato et al., 2018). Consequently, issues pertaining to mainstreaming of CIS for resilient agricultural systems are sometimes not given immediate priority by the government and its agencies. This is important given that the livelihoods of the majority of millions of people in West Africa in general and Ghana in particular are dependent on rain-fed agricultural systems. This makes it more pressing to ensure that climate services are integrated into our farming planning to enhance the capacity of the smallholder farmers to manage climate risks.

Limited understanding and appreciation of the vulnerability context at the local level by policy makers was also highlighted as a key factor constraining the mainstreaming of CIS to address climate change. A workshop participant reported: "*most of our policy makers do not appreciate the vulnerability of the agricultural sector to the adverse impacts of climate change. Our agricultural systems are predominantly rain-fed and are*

hardest hit by the adverse impacts of climate change." (Workshop Participant, Bolgatanga, September 2019). The agricultural sector is the bedrock of Ghana's economy contributing substantially to its economy; yet, the sector is the most vulnerable. Thus, socioeconomic development of the country is linked to the agricultural sectors. Other stakeholders reported that governmental agencies responsible for planning and development at the local levels often lack logistical resources and capacity to undertake a thorough assessment of their vulnerability status. A stakeholder within Ghana's Ministry of Food and Agriculture indicated: "*our agencies and departments are confronted with several challenges that they most often relegate environmental issues including climate issues to the background. We need to equip our policy makers with adequate knowledge on climate change to help them understand the key vulnerabilities across sectors of the economy.*" (Expert Interview, Accra, October 2019). Ghana's vulnerability to the adverse impacts of climate change is well documented (Antwi-Agyei et al., 2012; Asante and Amuakwa-Mensah, 2015). Yet, vulnerability is spatially distributed across the various agro-ecological zones (Antwi-Agyei et al., 2012) but most local assemblies have not conducted local level vulnerability assessments. Consequently, institutions and agencies that are mandated to address climate change may not fully understand the climate change issues and the various vulnerability hotspots that require intervention. This is a critical gap that requires urgent attention. Vulnerability assessments at the local levels are essential to identify potential climate change hotspots to effectively target adaptation interventions for maximum benefits to the most vulnerable members of the local communities.

National and local level policy makers and planners should therefore be capacitated through workshops to understand the levels of climate vulnerabilities at the local level to appreciate the need to prioritize climate change issues in municipal and district planning and budgetary allocations.

5. Concluding remarks

Climate change presents significant development challenges for economies across West Africa because of their reliance on rain-fed agricultural systems. This analysis sought to determine the extent to which climate information services have been incorporated into existing national and regional policies and sectoral plans of Anglophone West African states for agricultural resilience building. This analysis shows that climate change is highlighted in national and regional level policies as a serious threat to socioeconomic development and increased agricultural productivity in West Africa. The Nationally Determined Contributions, National Climate Change Policies, National Agricultural Policies and the National Communications to the United National Framework Convention on Climate Change (UNFCCC) all have documented the threats posed by climate change. At the regional level, strategic regional policy documents including the ECOWAS Policy for Disaster Risk Reduction, Africa Union's Agenda 2063 and the Land Policy in Africa, West Africa Regional Assessment have also indicated the threats posed by climate change in the region. The results suggest that Anglophone West Africa countries are developing National Framework for Climate Services to guide adaptation planning in the sub-region.

The analysis reveals that Anglophone West African states have not incorporated CIS into strategic national and regional policy documents that serve as framework in shaping decision-making and planning on climate change issues in these countries. For the specific case of Ghana, the study further reveals that a number of challenges, chiefly low awareness of climate change among local level policy makers, limited appreciation of vulnerability status of the local assemblies and human and institutional capacity constraints amongst policy developers militate against the mainstreaming of climate change into national policies and sectoral plans for resilient building. Conscious and concerted efforts should be made to address these challenges through regular training and capacity building workshops that will increase awareness and understanding of climate change issues to policy makers and planners. Ghana's efforts at establishing a National Framework for Climate Services to enhance the mainstreaming of climate information services into national policies and sectoral plans should be expedited to ensure that vulnerable smallholder farmers are provided with appropriate climate agro-meteorological advisory services to manage climate risks through adaptation planning.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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