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Navigating Climate Challenges: A Comprehensive Assessment of Climate Change Impact and Preparedness in Sunyani Municipal

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ABSTRACT

This study intends to analyze climate change impact and readiness in the Sunyani Municipality, with an emphasis on land cover changes, climate mitigation activities, and disaster risk mapping. Land cover mapping using satellite photos from 1990 to 2020 shows a significant conversion of rural lands into agricultural and urban regions, with 62% of agricultural lands being repurposed for physical development. Climate change prevention initiatives by key organizations, such as NADMO and GNFS, are praiseworthy, but they confront problems such as limited resources. The Vulnerability Theory is used to identify the linked components that influence sensitivity to climate change impacts. Disaster risk mapping identifies flood-prone areas, putting 7,695 buildings and critical facilities at risk, underlining the importance of strong emergency response strategies. The report suggests improved spatial planning, regular reviews of development in flood-prone areas, and stakeholder collaboration to achieve full climate resilience. Finally, the findings emphasize the importance of proactive steps in moving Sunyani Municipality toward a more resilient and climate-ready future.

INTRODUCTION

Climate change is one of the century's most pressing issues (Miller & Edwards, 2001). Increasing levels of carbon dioxide in the atmosphere from fossil fuels, which warms the globe, are factors accounting for climate change. The average temperature of the earth's surface has risen by 0.6 degrees Celsius since the late 1800s, with projections likely to reach 5 degrees Celsius by 2100. (World Health Organisation, 2021). Unsustainably carbon dioxide levels in the atmosphere have a wide range of social, economic, and environmental consequences (Maon *et al.*, 2009). Africa is at the receiving end of climate change risk because of a lack of robust institutions and mechanisms to help adapt to flooding, drought, human health, migration, and conflict (Ajieh & Okoh, 2012). Food scarcity on the continent is a challenge with erratic rainfall patterns and an increase in drought days by over 20% (Hallegatte *et al.*, 2016).

Flooding engulfs countries such as Burkina Faso, Cameroon, Chad, Ghana, Niger, Mali, Nigeria, Congo Republic, and Senegal every year, affecting over 760,000 people. Variations in rainfall patterns and extreme temperatures have a significant impact on population health because they increase insect habitat suitability and the development of vector-borne diseases such as dengue fever, malaria, and yellow fever (World Meteorological Organization, 2020). With extreme weather conditions, mental health issues such as despair and anxiety are on the rise (Manning & Clayton, 2018). The only alternative for Africa is to implement climate change mitigation and adaptation measures with the primary goal of lowering the harmful effects of climate-related hazards (Jiang *et al.*, 2017; Dang *et al.*, 2019).

Climate adaptation measures must have specific goals

that are attainable within the operational constraints of organizations and individual households. The problem for African governments is obtaining financial resources to execute adaptation measures, as the region requires approximately \$50 billion each year. The expense of adaptation represents a significant financial burden on national budgets; yet, the continent's ability to invest and adapt to climate change poses a dangerous future. Commitments from foreign governments and internal contributors are useful in securing financing for strengthening climate change adaptation. This study intends to analyze climate change impact and readiness in the Sunyani Municipality, with an emphasis on land cover changes, climate mitigation activities, and disaster risk mapping.

METHODOLOGY

Sunyani is located within the geographic coordinates 2° 12' 32" W, 7° 22' 55" N to the Northwest and 2° 28' 50" W, 7° 5' 15" N to the SouthEast. Its neighboring districts are Sunyani West to the North, Tano North to the East and Asutifi North to the South (Figure 3.1).

The municipality covers an area of about 506.69 km, The municipality also serves as the administrative capital of the Bono Region with several government institutions. The municipality has a two-sided population grouped into urban and rural. Urban areas cover communities like Abesim, Penkwase, Nkwabeng, Airport, Berlin Top, Baakoniaba, Yawhima. Rural communities include Atronie, Antwikrom, Yawsackrom, Ohukrom.

Satellite photography from 1990 to 2020 served as the major data source for land cover mapping, which used advanced remote sensing techniques. The investigation involved fieldwork to investigate the conversion dynamics

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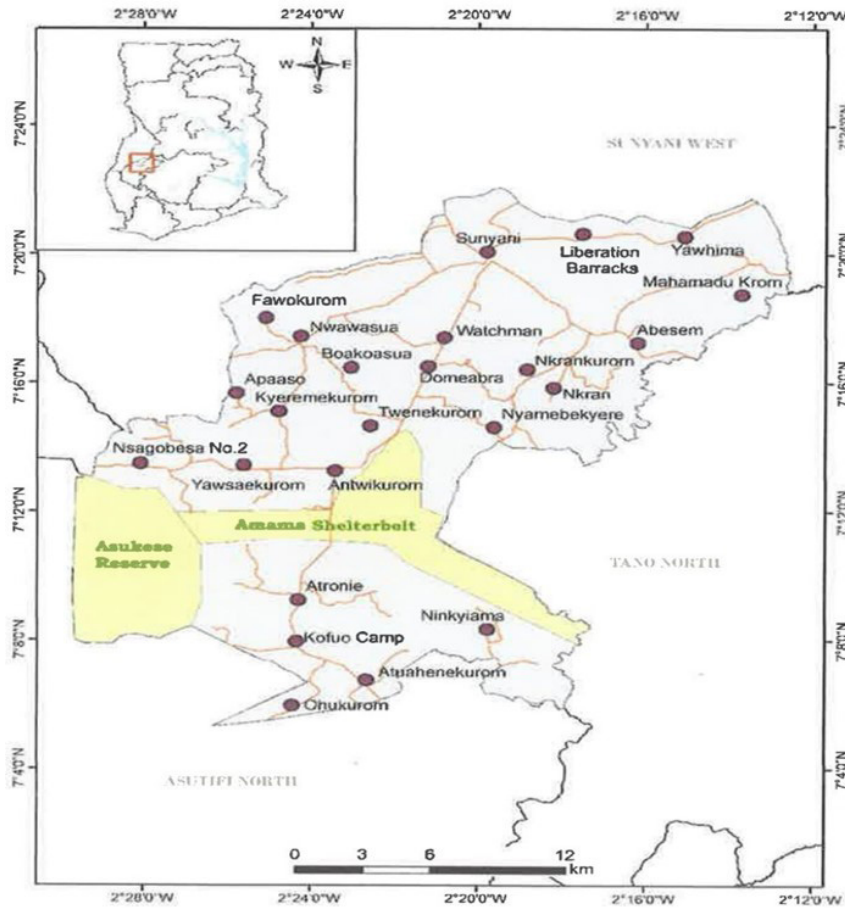


Figure 1: Map of Sunyani Municipal

of rural lands into agricultural and urban regions throughout time. In parallel, a comprehensive assessment of climate change prevention and reduction activities was undertaken through interviews and questionnaires with major institutions such as NADMO, GNFS, and the Agriculture Department.

This data collection approach assessed the effectiveness of existing initiatives and identified difficulties to climate change mitigation efforts. Simultaneously, disaster risk mapping and emergency response plans were reviewed, followed by field assessments to identify flood-prone areas and infrastructure sensitive to climate-related

consequences. Stakeholder engagement initiatives, such as interviews and focus group discussions, provided useful insights into community viewpoints, in line with the concepts of the Vulnerability Theory (Adger, 2006; Cutter *et al.*, 2003). Quantitative studies were then used to monitor land cover changes, evaluate program success, and determine vulnerability levels.

RESULTS AND DISCUSSIONS

Findings

Land cover Map of the Municipality

The map shows how rural lands were turned into

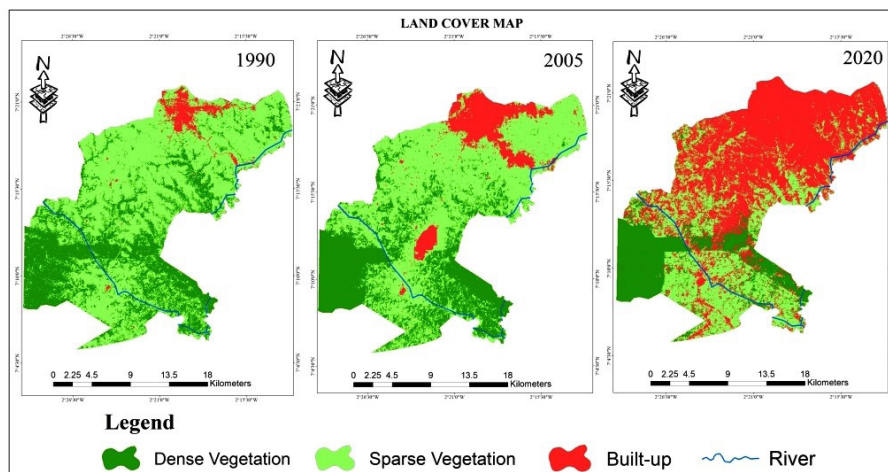


Figure 2: land Cover Map

agricultural lands for residential and commercial purposes between 1990 and 2020. In fact, 62% of agricultural land has been converted from farming to physical development. According to the World Bank (2016), urbanization has resulted in the shift of 60% of agricultural areas to non-agricultural uses. This tendency is reinforced by a research by Shuttleworth *et al.* (2021), which underlines urbanization's significant impact on land cover. These findings highlight the necessity of tackling urbanization and its implications for land use and agricultural sustainability. The examination of land cover maps, combined with supporting vulnerability theory, demonstrates the significant impact of urbanization on rural and agricultural regions. This shift in land use has substantial consequences for food security, environmental sustainability, and the overall well-being of the populations affected by these changes (Adger 2006). According to Cutter *et al.* (2003), the vulnerability theory helps to elucidate how urbanization has heightened sensitivity by reducing agricultural lands and, consequently, impacting food security.

Assessment of Information for Climate Change Impact Prevention and Reduction Planning

The Sunyani Municipality has long been involved in climate change education and mitigation efforts. Different institutions run different programming and employ various methodologies. The National Disaster Management Organization, Ghana Fire Services, the Agriculture Department, and the Development Department are the primary groups driving the climate fight in the municipality, using the media and community outreach. The active engagement of stakeholders, as well as public knowledge, are critical to the success of climate change prevention and reduction activities.

Radio programmes tend to be the most common and preferred means of climate education by most of the institutions because of the large audience. Also, the urban nature of the municipality makes radio programmes the most effective approach. While community outreach activities are used in the rural and farming communities within the municipality.

Table 1: Earlier Climate Change activities by the Sunyani Municipal

Activity	Organization	Approach	Time / Duration	Funding
Climate Change and Disaster awareness	National Disaster Management Organization, NADMO	Radio and Community Engagement	Yearly	NADMO
Forest Fires and Household fire education	Ghana National Fire Service, GNFS	Radio and Community Engagement	Yearly	GNFS
Climate Change Education, Fertilizer Application, seedlings Pest control	Department of Agric	Community and Farmer Engagement	Yearly	Ministry of Food and Agriculture

Climate change Programmes by NADMO

Radio programs are the most popular form of education used by the NADMO, and they are frequently conducted before to the rainy season to warn residents about the potential dangers of flooding in the municipality. The United Nations Office for Disaster Risk Reduction (UNDRR) is a key advocate for incorporating climate change into disaster risk reduction measures (Shen *et al.*, 2016). The radio shows include education, conversations with other agencies such as the Ghana Fire Service, Assemblymen, and consultants, as well as phone-in sessions where the public can contribute. The radio programs are usually preceded by visits to flood-prone regions such as Penkwase, Market, Nkwabeng, Baakoniaba, and South New Town to assess the amount of development and potential damage during a flood. Education initiatives and field visits have not been effective in slowing development in flood-prone areas, as new physical developments may be observed sprinkled around waterbodies. Recognizing the importance of local communities in climate change resilience, disaster management agencies are increasingly implementing community-based adaptation programs to build capacity, raise awareness, and educate the public about disaster risk reduction measures (Kundzewicz

et al., 2019). In addition, NADMO has been active in climate and catastrophe programs aimed at reducing fire threats inside the municipality. This exercise is carried out with the Unit Committee and Assemblymen in rural areas of the municipality, including Atronie, Adadaase, Asuagya, Ohunukrom, and Framose. The biggest difficulty for NADMO in reducing the municipality's increasing vulnerability is a lack of resources and their fundamental mandate of prevention and response rather than enforcement. Despite great progress, difficulties remain, including resource restrictions, insufficient data for risk assessments, and the need for increased public awareness (Rosenzweig *et al.*, 2018). NADMO activities are limited to reporting and cautioning people from developing within risk areas but do not have the power to evacuate them from such areas. Coordination with other departments such as the Works Department and the Physical development Department has been a challenge in directing developments within risk areas. The issue of land management and ownership hinders the enforcement ability of Works and Physical Developments. Landowners tend to have less regard for spatial planning regulations which prevent development in flood risk zones'

Domestic and Forest Fire Education Programmes by Ghana National Fire Services

The Ghana Fire Service complements NADMO activities with radio programmes and community engagements. The education programmes are mostly in two sessions one focused on domestic fires and the other on forest fires. Educating the populace on domestic fires is geared towards how to manage Liquefied Petroleum Gas (LPG) and wiring of houses with standard electric cables. On forest fires, Ghana Fire Service Personnel educate farming communities not to burn farms and forest areas and, where necessary to seek the help of the Ghana Fire Service or Community Fire Volunteers and Unit Committee Members. Ghana Fire Service activity to reduce climate change involves training of community fire volunteers. Trained community fire volunteers are to complement the activities of the Ghana Fire Services in the community on daily basis. They help with extended teaching and guiding of farmers to practice controlled burning. Also, they serve as the first point of call for any fire disasters in the community before the intervention of the Ghana Fire Services. Challenges faced by the Ghana Fire Service in the fight against domestic fires is the Usage of substandard electric cables. Developers and house owners tend to opt for low cost electric cables which are prone to fire. Also, persons tasked to do wiring of houses lack training and certification to perform such activities increasing the vulnerability of houses to domestic fires. With forest fires, farmers preference for burning as means of closing the land derail the efforts Ghana Fire Services. Hunting parties in the present's great challenges to Ghana Fire Services by using fire in hunting parties are difficult to regulate and track. The challenge is compounded by limited number of motivated and ageing fire volunteers at the community.

Climate Intervention by the Agriculture Department

The Agriculture Department of the Sunyani Municipality through the Ministry of Food and Agriculture has also

been instrumental in the fight against climate change. The programmes by the department focus on training farmers on the adaptation of new seedlings farming practices, fertilizer, and pesticides applications. Farmers are empowered with timely and relevant information, and the Agriculture Department offers climate information services (programs to assist farmers in making informed decisions in response to changing weather conditions) (Balasubramanya & Stifcl, 2020). The municipality and region's irregular rainy seasons put farmers at danger of losing their produce due to inadequate precipitation. Agriculture Department promotes the usage of drought resilient crops to minimize the effects Education focuses on sowing weeks earlier than the usual planting season The Department educates farmers on the usage of less or no chemical-based fertilizers to reduce their carbon footprint.

To boost agriculture outputs in the municipality, the Department has been involved in Planting for Food and Jobs especially in Vegetable Production. Through the programme the Department have been able to increase vegetable production by 35% in the municipality with farm sizes ranging from about 2 to 40 acres. Also, to boost production, Agric Extension Agents have been furnished with motorbikes to help in their supervision and outreach activities for the government Planting for Food and Jobs. The Agriculture Department has also been instrumental in Animal farming support for poultry farmers is also an intervention to help alleviate the impact of climate change in the municipality Poultry diseases have been on the increase within the municipality. The Department and the MOFA provides veterinary services on good farming practices. Also, subsidies are a times given to poultry farmers to alleviate their loses.

Disaster Risk Maps and Emergency Response Plan for Urban Sunyani

The Municipality with has a Disaster Risk Mapping and Emergency Response Plan which unearthed that flood

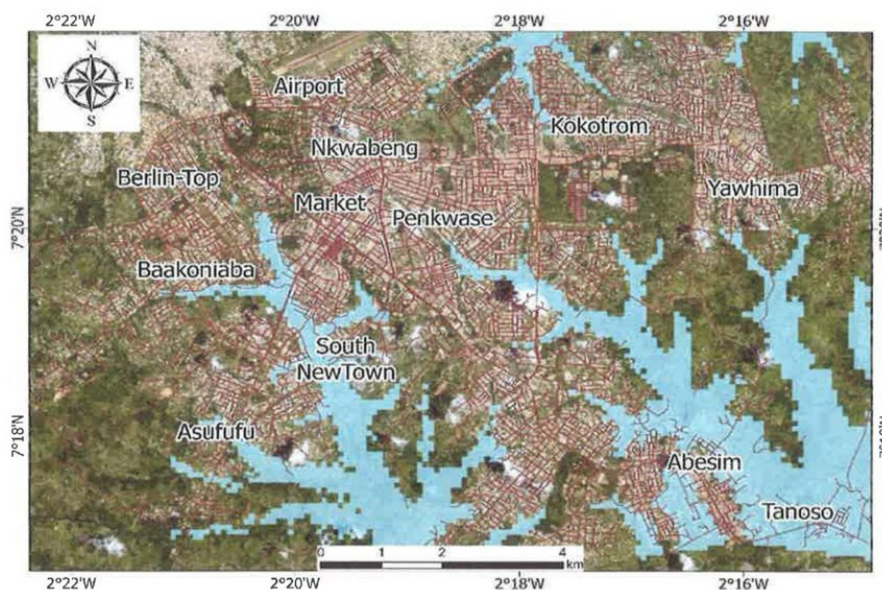


Figure 3: Flood prone areas in urban Sunyani

risk zone in the urban core covers an average area is about 6,985 acres (2,826.89 hac) with areas such as Penkwase, Baakoniaba, Nkwabeng, Airport Area, Pastoral Centre Area and Abesim at risk. With increasing urbanization and the growing threat of catastrophes, developing disaster risk maps and adequate emergency response plans is vital for assuring urban safety and resilience (British Broadcast Corporation, 2020).

With the flood area, an estimated 7,695 buildings in the municipality are exposed to flood events (Figure 4.1). Effective disaster risk maps take into account many hazards, including floods, earthquakes, and wildfires, to provide a comprehensive knowledge of the dangers that metropolitan areas confront (Hallegatte *et al*, 2020). The number of people at risk based on modelled flood areas is about 38,475 people with items valued at GHC 11,925,453 at risk. The project also found that facilities which can serve as safe haven during flooding such as the Twene Amanfo Senior High School, Sacred Heart High School, Latter Days Saint Church, Sacred Heart Catholic Church and International Pentecost Church were all within flood areas. In addition, road infrastructure was at risk to flood with principal streets such as the main Sunyani-Berekum Road from the Ghana Post roundabout through the Sunyani Parks and Garden at risk. The roads connecting Newtown Roundabout to Newtown, Asufufu and Atronie were within the flood zone. The Baakoniaba road, which connects Apollo Junction to Methodist Technical Institute, is prone to flooding. Vulnerability Theory improves the subtle processes that contribute to the municipality's sensitivity to climate change impacts, allowing for the formulation of tailored resilience-building initiatives (Eakin and Luers, 2006).

With the high levels of risk to flood, adaptive capacity was low with structures within an average distance of 103.4m from river bodies which is below the recommended 300 meters by the Land Use and Spatial Planning Authority. There are buildings within the flood zones with makeshift structures with unconsolidated materials. Although the majority of the structures are made of blocks, their foundations were low to the water table in flood-prone locations, allowing water to flow beneath them. Urban disaster response plans must include effective evacuation techniques that take into account the population density and infrastructural characteristics of the area (Ford *et al*, 2011). The project advocated for full execution of the Land Use and Spatial Planning Authority's physical development plans. The project also proposed a monthly review of physical development in flood-prone areas. The project created a detailed disaster emergency plan that outlines the method and procedures for addressing disasters in the municipality. The disaster management plan outlined the responsibilities of the Municipal Chief Executive, Chiefs, NADMO, Ghana Fire Services, Police, and Disaster Volunteers in declaring an emergency, preparing evacuation and shelters, and sourcing finances and materials for impacted people.

CONCLUSIONS

The study emphasizes the critical need for proactive climate change mitigation and adaptation strategies in the Sunyani Municipality, which is positioned within the larger context of Africa's vulnerability to climate-related threats. The land cover mapping research demonstrates a considerable conversion of rural lands to agricultural and urban regions, with far-reaching consequences for food security, environmental sustainability, and community well-being. Climate change prevention and reduction activities conducted by organizations such as NADMO, GNFS, and the Agriculture Department are noteworthy, but obstacles remain, including resource constraints and coordination issues. The Vulnerability Theory provides a useful lens for understanding the linked aspects that influence a municipality's sensitivity to climate change consequences. The identified flood-prone locations and susceptible structures highlight the crucial importance of adequate disaster risk maps and emergency response strategies. The study's recommendations include for ongoing efforts to enforce spatial planning standards, undertake frequent assessments of development in flood-prone areas, and build stakeholder collaboration for overall climate resilience. These findings lay the groundwork for informed decision-making, directing the municipality toward a more resilient and climate-ready future.

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