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Urban Expansion and Its Impact on Sustainable Food Production: A Case Study of Dodowa, Ghana

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Abstract

Urban expansion is causing competition between built infrastructure and sustainable food production in Dodowa, where farmland is being lost to urban development. This expansion is occurring because of the growth of Accra, the capital city, which is causing cities to expand beyond their intended limits and encroach on once-agricultural communities. To better understand the impact of urban expansion and infrastructure on agriculture and food production, this study was conducted. The study used a quantitative approach that involved administering questionnaires to 100 households within Dodowa, a township in Ghana. Additionally, GIS and remote sensing techniques were used to analyze Landsat images from 2002, 2015, and 2024, while SPSS and Excel were used to analyze the quantitative data. The study also utilized change detection analysis of satellite images to identify land use and cover changes over a period of 22 years. The study revealed an increase in built-up infrastructure and a sharp decline in vegetation, suggesting urban sprawl. It was recorded that, within the 22 years of evaluated data, there was a 40% increase in built-up infrastructure while there was a 28% and 11% decrease in sparse and dense vegetation, respectively. The study concludes that the loss of agricultural lands due to urban expansion is causing a decline in food production and livelihoods. To address this issue, the study recommends a collaborative effort between traditional land tenure systems and government planning agencies. This would promote sustainable land management practices and ensure proper zoning for land use areas, preserving the environment's biodiversity.

Keywords: Agriculture, built infrastructure, livelihoods, sustainable food production, urban expansion.

Introduction

By 2050, urban population is expected to rise by roughly 2.5 billion, especially in middle and low-income countries (UN-Habitat, 2022). In Sub-Saharan Africa, urban population growth is showing exponential trends. This growth is often unplanned and unregulated in many cities, leading to severe environmental consequences. Research indicates that unchecked urban expansion adversely

affects biodiversity, water resources, and farmlands, and contributes to climate change—all while disrupting socio-economic activities such as livelihoods and community structures.

This rapid urbanization is primarily driven by natural population growth and migration (Songsore, 2020). Rural-urban migration has intensified the demand for space for both housing and industrial development (Selod & Shilpi, 2021). In Ghana, Accra is expanding into nearby rural agrarian towns (Doe et al., 2022; Agyemang, 2018), which are crucial in fulfilling the dietary requirements of both local households and the urban population. However, the existing population growth exacerbates food insecurity, as food demand surpasses production capacity, and farmland is lost to urban development.

Dodowa, a township in the Shai Osudoku District, has been significantly affected by overflow from the capital. Its population has more than doubled in the last ten years, exceeding expectations (Ghana Statistical Service, 2021). The changes in this area have affected the agricultural land in the community. The demand for land for urban housing has compelled farmlands to be transformed into settlements, resulting in a reduction of available farming land. Due to the town's rapid population growth, farmers may struggle to provide sufficient food to satisfy the increasing demands of both the community and surrounding areas, which could lead to higher food prices and scarcity. In addition, urban development poses risks to the livelihoods of farming families, potentially driving them into poverty.

Consequently, this study seeks to examine the effects of urban growth on agricultural land and, by extension, food production in Dodowa.

Material and Methods

The research gathered quantitative data through remote sensing and GIS to evaluate urban sprawl. A survey was conducted, distributing questionnaires specifically to the heads of selected households. One hundred households took part, employing simple random sampling to mitigate bias caused by dispersed settlements. The survey aimed to include both residents and newcomers for a well-rounded representation.

Remote sensing and GIS were employed to analyze urban sprawl using Landsat ETM+ and OLI imagery from the USGS for 2002, 2015, and 2024, showcasing spatial expansion over three decades. Shapefiles for administrative boundaries were obtained, with Dodowa's boundary defined manually using landmark addresses and Google Earth as a reference point.

The satellite imagery was processed with QGIS, employing Normalized Difference Vegetation Index (NDVI) for analysis due to its effectiveness in measuring temporal variations between vegetation and urban areas. NDVI is widely recommended for evaluating changes in land use and land cover (LULC), and is known to produce results closely matching field observations, thereby demonstrating high accuracy. Multi-temporal satellite images were calibrated and subjected to radiometric correction using QGIS. Moreover, QGIS assisted in detecting and analyzing changes in land use patterns, ultimately leading to the output of the final map. NDVI was crucial in illustrating the temporal shifts in vegetation and built environments. Consequently, classified maps were produced to represent urban sprawl dynamics and various types of LULC.

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

The primary data analysis was carried out with Excel and SPSS, generating graphs and charts for interpretation. Excel was utilized to measure the changes in the classified maps.

Results and Discussion

Urban expansion in Dodowa

The study on urban growth demonstrated a slow development phase in 2002, as illustrated in Figure 2-A. However, significant changes emerged around 2015 and 2024, with exponential growth

evident across the town, as shown in Figures 2-B and 2-C. This dramatic expansion points to the uncontrolled spread of constructed areas within the urban landscape.

Over the span of 22 years (Table 1), from 2002 to 2024, the urban infrastructure saw a substantial increase of 13.14 km², representing a 40% rise. In contrast, sparse vegetation experienced a decline, reducing to 9.3 km², which accounts for 28%, while dense vegetation shrank to 3.83 km², making up 11% of the area. These shifts highlight the evolving landscape and the environmental impact of urbanization in the region.

Table 1: Land Use Land Cover Change in Dodowa (2002 -2024).

Classes	2002 (Km ²)	2024 (Km ²)	Change in land area (2002-2024)	Percentage change (%)
Built-up & Bare land	3.70	16.85	13.14	40.60
Sparse Vegetation	23.49	14.18	-9.30	-28.75
Dense Vegetation	5.16	1.32	-3.83	-11.85
Total land area (Km²)	32.36	32.36		

The final images illustrate that vegetation was the primary land cover feature, crucial in biodiversity and agriculture, as shown in Figure 2-A. The town's built-up area was mainly concentrated in the northwest, stretching towards the center, which suggests a low population density. As a result, the food produced was adequate to satisfy the needs of the local populace and adjacent regions. However, by 2015 and 2024, a significant increase in built infrastructure was apparent, as depicted in Figures 2-A and 2-B. This expansion included the construction of schools, hospitals, government offices, and residential areas, which encroached on agricultural land and ultimately reduced food production.

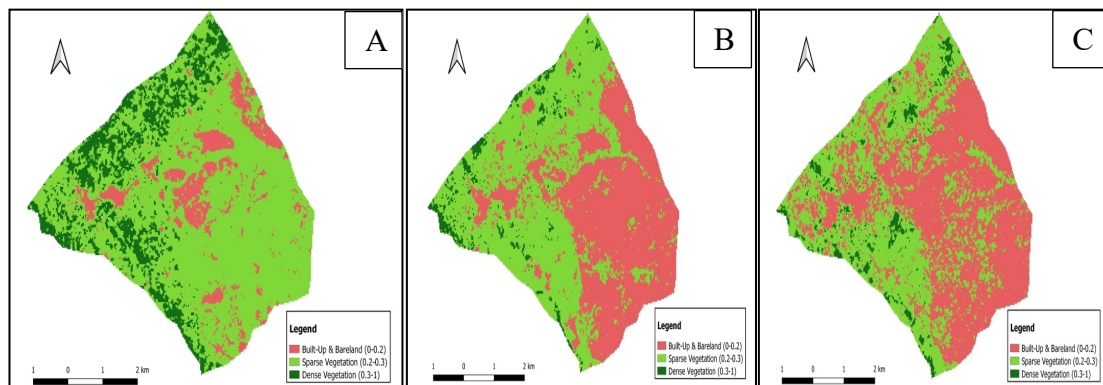


Figure 2: Map showing the urban expansion of Dodowa in 2002 (A), 2015 (B), and 2024 (C)

The data shows a significant reduction in vegetation, including agricultural lands, which correlates with findings by Tufa and Megento (2017) highlighting the adverse effects of urban expansion on farming areas and rural economies. Although Dodowa is recognized for its mango plantations (GSS, 2014), observations reveal that new developments are encroaching on these crucial farmlands. This situation raises alarms regarding a possible decrease in agricultural jobs in Dodowa, potentially exacerbating poverty among farming families, especially for mango growers who have not transitioned to other livelihoods.

Additionally, the reduction of forest cover threatens biodiversity, as pointed out by Attua and Fisher (2011). The ongoing urban development in Dodowa further pressures already declining species populations. The encroachment of urban growth on farmland also endangers food production, intensifying ecological issues and highlighting the need for sustainable planning and conservation efforts to protect both the environment and local communities.

Perception of Impact of urban expansion on food

The study found that the community primarily relies on cereals and tubers, with maize being the most widely consumed staple. However, urban expansion in Dodowa has notably impacted the prices, availability, and food quality. The transformation of agricultural land into developed areas has adversely affected food production, leaving many households unable to meet their dietary needs.

As food prices continue to rise, this trend indicates a decline in local agricultural yields. Farmers are losing their land to urban development, which reduces the supply of food products in the community. The increasing population has intensified demand, leading to a growing shortage of vital food items and escalating prices.

The decline in local food supplies has also affected neighboring urban areas, where the availability of essential goods has decreased. Farmers' livelihoods are increasingly at risk, contributing to heightened food insecurity not just for their families but also for the broader community. This urgent situation demands immediate action to guarantee sustainable food access and bolster local agriculture.

Conclusions and Outlook

The rapid urban expansion in Dodowa highlights the complex relationship between urban development and food security, as the growth in population and urban areas encroach on agricultural lands, leading to decreased food production and heightened pressure on local farmers. This loss of farmland threatens the livelihoods of those dependent on agriculture and exacerbates food insecurity within the community. Additionally, rising food prices and reduced availability of essentials point to the negative consequences of unchecked urbanization on local nutrition and well-being. To address these challenges, there is an urgent need for sustainable urban planning that prioritizes agricultural land preservation, biodiversity, and community health, requiring policymakers to implement integrated strategies that balance urban growth with local agricultural support to ensure food security and resilience in Dodowa and similar areas.

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