



WATER SECURITY AS A MEDIATOR, URBAN GROWTH AND FOOD SECURITY IN EMERGING AFRICAN ECONOMIES

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ABSTRACT

Rapid urban expansion in major cities across emerging economies contributes to water quality degradation, rising public health risks, and increasing pressure on food systems. Growing urban populations require greater quantities of water and food, while expansion of built-up areas can encroach on agricultural land and reduce the capacity of local food systems. This study examines the aggregate effect of rapid urban growth and water security on food security in four emerging African economies: Egypt, Nigeria, South Africa and Morocco and investigates the extent to which water security mediates the relationship between urban growth and food security. The study is anchored on the Environmental Kuznets Curve (EKC) theory and uses panel data covering 2000–2023. Data on prevalence of undernourishment, urban population growth, water withdrawal intensity, GDP per capita, agricultural employment, agricultural land, precipitation and surface temperature were obtained principally from the World Bank and Climate Knowledge Portal. The empirical analysis employs the Augmented Mean Group (AMG) estimator. The results show that urbanisation has a negative and statistically significant coefficient (-0.542 ; $p < 0.01$), confirming that increasing urbanisation is associated with declining food-security outcomes. Water withdrawal intensity has a positive coefficient of 0.318 and is significant at the 5% level. More importantly, the interaction term between urbanisation and water security is positive and significant (0.128 ; $p = 0.029$). This indicates that water security moderates the adverse relationship between urbanisation and food security: improved water security can reduce the severity of the negative food-security effects associated with urban growth. Urbanisation also reduces the sustainability of water-resource use. From the result a 1% increase in GDP per capita improves the sustainability of water resource use by 0.487% in Asia and by 0.532% . The results were significant at 5%. For emerging African economies, the result shows a positive influence of precipitation on sustainability of water resource, with stronger dependence in the emerging economies. Specifically, a 1% increase in precipitation raises the sustainability of water resource use by 0.264% in the emerging economies. The results were significant at 5% which implies that in the emerging economies, the sustainability of water resource use is more sensitive to rainfall. The study concluded that rapid urbanisation and intensifying water-resource pressures undermine food security, with the adverse effects being more pronounced in the selected emerging African economies. Therefore, it is recommended that emerging African economies should implement integrated land-use and water management policies. Governments in these countries should synchronize urban planning with agricultural water allocation by enforcing zoning laws to protect farmland, investing in water-efficient irrigation systems for peri-urban agriculture, and incentivizing vertical urban development.

Keywords: African, Economies, Urbanisation, Water, security, Food-security.

INTRODUCTION

Rapid urban expansion in major cities across emerging economies contributes to water quality degradation and rising public health risks in emerging economies (Abdulai 2022; Ahmad *et al.*, 2023). The rapid growth of urban populations leads to higher demands for both water and food, and increases the strain scarce resources. As noted by Ayele and Tarekegn (2020), the expansion of urban areas encroaches on agricultural land, leading to a decline in food production which strains food systems. In many cases, urbanization tends to prioritize infrastructure development and industrial growth, diverting attention and resources from managing sustainable water and food systems. This results in increased water usage intensity in urban areas, as growing populations and industries demand more water for domestic, commercial, and industrial purposes. Additionally, the contamination of water sources occurs



through increased pollution from untreated sewage, industrial waste, and agricultural runoff, which often flow into rivers, lakes, and groundwater supplies.

Governments have made considerable efforts to tackle food and water security challenges through various policy initiatives. In Nigeria, the National Agricultural Resilience Framework (NARF), introduced in 2021, focuses on improving irrigation infrastructure and promoting climate-resilient agricultural practices. Similarly, the Future of Egypt project (2020) was launched in Egypt to expand arable land by reclaiming desert areas. The Green Morocco Plan (2008), was put into place to enhance agricultural productivity and address water scarcity. In South Africa, the National Water Act of 1998 was initiated to ensure sustainable water use and improve access to water. Despite these efforts, the outcomes have often fallen short due to weak governance, corruption, and economic instability, which hinder the full realization of these policies. The failure to achieve adequate water and food security in these countries has far-reaching implications. Water and food insecurity can lead to malnutrition, poor health outcomes, and social unrest due to inequality. Meanwhile, unplanned urban expansion may overwhelm existing infrastructure, increase inequality and unemployment, strain public health systems, and contribute to the proliferation of slums with poor sanitation. Without a thorough assessment of the relationship among urbanisation, water and food security in the emerging economies, these economies will continue to struggle with long-term sustainability in food and water security which will undermine progress towards attaining the sustainable development goals 2 and 6. The objective of the study is to examine how rapid urban growth influences access to water resources and stability of food supplies in developing selected African Countries. The specific objectives are:

- i. Assess the aggregate effect of rapid urban growth and water security on food security in emerging African economies.
- ii. Investigate the extent to which water security mediates the relationship between rapid urban growth and food security in emerging economies across Africa.
- iii. Analyse the impact of urbanisation on sustainable water-resource use in emerging African economies.

Yagaso *et al.* (2024), examined the impact of rainfall variability and temperature changes on food access in the Gibe III Dam watershed in the southern region of Ethiopia. Using survey data of 384 households and the Mann-Kendall and ordered logistic regression, the study developed strong evidence that seasonal changes in climatic conditions served as a catalyst in jeopardizing food security in the region. Food insecurity was found to be widespread with 74.7 percent of households found to be food insecure and although dietary diversity was moderate with a mean of 7.75, the level of food security varied significantly across localities, with Rasch scores of 15.3 in Kindo Koisha and 13.2 in Loma Bosa. Age structure of households and agronomic practices were found to be the main predictors of food security. Nasser and Adam (2024) examined the impact of rapid urbanisation on agricultural land use with the help of Landsat imagery and support vector machine algorithms to analyze changes in Niamey, Niger, between 1975 and 2020. Their results revealed that there were sharp declines in the cropland of between 3,428 to 648 hectares and dramatic increases in built-up areas, but the bare land, rock surfaces and vegetation declined drastically. Despite the fact that the rice fields and water bodies increased marginally, the overall trend indicated that urban growth has exerted extreme pressure on the agricultural land, and hence the need to introduce sustainable planning measures to protect urban agriculture.

Khurshid and Abid (2024) shed more light on the factors that drive food security. Their study measured the relationship between climate change, political globalization, global inflation, and food security in Pakistan using NARDL estimation techniques on secondary data between 1981 and 2021. Their results revealed that increased CO₂ emission and increased mean temperature had positive relationships with food security, which is an indicator of dependence of Pakistan on the agricultural systems which are sensitive to climate. Conversely, there was a strong negative relation between political globalization and food security both in the positive and negative stages respectively and this shows that there are structural vulnerabilities which are associated with global political and economic integration.



The rural viewpoint presented by Adeoye *et al.* (2024) is complementary. They conducted their research on a household level investigation of food and water availability in Langai district in Nigeria. They used chi-square tests and logistic regression to analyze the data of 201 households. Their results determined that low food expenditure, non-participation in household agriculture, and stable access to borehole or pipe-borne water, and minimal negative coping behaviours were key predictors of food security. Farooq and Rashid (2024) reported the adverse connotations of urbanisation to local food production. The research used mixed-methods approach which combines surveys, interviews, and secondary data to examine the effects of urban expansion in the District Lahore, Pakistan, on food security among poor households. The linear regression was the technique used on the data. They discovered that the high rate of urbanisation has taken over agricultural lands, leaving a gap in the food production capabilities as well as increasing the food insecurity among the low-income earners

In other similar thematic research studies, Apeloko *et al.* (2024) undertook a study to understand the impacts of climatic changes on food security in the Ogun State, Nigeria. They used a qualitative data, which was gathered among the agricultural officers and the academic researchers. Their thematic analysis disclosed that climate change had a significant negative impact on food availability in the period between 2019 and 2023, which led to the development of the policy and strategic interventions to alleviate food shortages induced by climate change.

Similarly, Rehman *et al.* (2024) tested the long-run and short-run associations between climate change and renewable energy and agricultural credit and food security across the South Asian countries between 1990 and 2021 using the Dynamic Common Correlated Effects estimator. Their results showed that climate change decreases food availability, and raises insecurity, with renewable energy only contributing to food security in the short term. Nevertheless, agricultural credit was always linked to better food security results, indicating the significance of financial inclusion in agricultural resilience. The reviewed literature above points to a connected urbanisation, water, and food relationship. However, much of the existing evidence focuses on individual countries, households, cities or single components of the nexus. The present study contributes by examining the relationship jointly across four selected emerging African economies and by testing the role of water security in the urbanisation, food security relationship.

METHODOLOGY

The Study Area

The study covers four selected emerging African economies: Egypt, Nigeria, South Africa and Morocco, over the period 2000–2023. The study looks at the four emerging economies across African regions: Nigeria in West Africa with the landmass of 923,768km² and a population of 242,431,832 people, Morocco in North- West Africa with the landmass of 446,550km² with the population of 38,762,441 people, South Africa with the landmass of 1,221,037km² and a population of 65,453,084, and Egypt with the landmass of 1,002,450km² with a population of 120,101,175. The analysis uses panel data. The principal food-security indicator is the prevalence of undernourishment, while urbanisation is represented by urban population growth and water security by water withdrawal intensity. Control variables include GDP per capita, agricultural employment, agricultural land, annual precipitation and annual average surface temperature. The study relies entirely on secondary panel data.

Method of Data Collection

This study makes use of secondary data research which rely on existing data. No primary field work was used in this research work for the period 2000 – 2023. These data were extracted specifically from World Bank, and Climate Knowledge Portal.

Method of Data Analysis

Data were analyzed using Augmented Mean Group (AMG) analysis to test the direct effect of urban growth on food security. Before estimating the aggregate model, the series are subjected to a set of pre- estimation diagnostics: a panel unit, descriptive statistics, and a panel co integration at 1% significant level.



Table 1: Sources of Data

Variables	Source
Prevalence of undernourishment (% of population)	World Bank (2024)
Urban population growth (annual %)	World Bank (2024)
Water withdrawal intensity	World Bank (2024)
GDP per capita (constant 2015 US\$)	World Bank (2024)
Agricultural value added (% of GDP)	World Bank (2024)
Agricultural land (% of land area)	World Bank (2024)
Annual average precipitation (millimetres)	World Bank (2024)
Annual average surface temperature (°C)	Climate Knowledge Portal (2024)

Model Specification

Model 1: The first objective focuses on evaluating how urbanisation and water availability collectively influence food security across emerging economies of Africa. To address this aim, the analysis draws on the modelling approach of Kousar *et al* (2021), with minor adjustments introduced to suit the present study. The general functional specification can be expressed as follows:

$$FSI_{it} = f(UBN_{it}, WTA_{it}, GDPK_{it}, EMPA_{it}, AGRL_{it})$$

Model 2: The second objective of the study is to investigate the extent to which water availability mediates the relationship between urbanisation and food security in emerging economies of selected Africa countries. To achieve this objective, the model specified by Kousar *et al* (2021) was adapted. The functional form of the model is specified as follows:

$$FSI_{it} = f(UBN_{it}, WTA_{it}, MDT_{it}, GDPK_{it}, EMPA_{it}, AGRL_{it})$$

Model 3: The third objective aims to explore how the expansion of urban populations influences sustainable water resource management across emerging economies in of Africa. To address this aim, the study adapts the modelling framework proposed by Balha *et al* (2020). The general functional specification of the model is presented as follows:

$$WTA_{it} = f(UBN_{it}, GDPK_{it}, PRP_{it}, TMP_{it})$$

Descriptive Statistics and Pre-Estimation Tests

Before estimating the aggregate models, the series are subjected to a set of pre-estimation diagnostics: a panel unit root test (presented first, to establish the order of integration of the variables), descriptive statistics, and a panel cointegration test.

Panel Unit Root Test

Table 1 reports the Pesaran (2007) Cross-Sectionally Augmented IPS (CIPS) panel unit root test. From the result, the CIPS Statistic of urban population growth, employment in agriculture, and temperature were significant, which implies that they were stationary in levels, and are therefore integrated of order zero, I(0). On the other hand, the CIPS statistic of food security index, water withdrawal intensity, GDP per capita, agricultural land, and were insignificant at level, but become stationary after first differencing, and are therefore integrated of order one, I(1). This mixed order of integration, with some variables I(0) and others I(1), rules out the use of standard panel estimators that assume a common order of integration and instead justifies the adoption of the AMG estimator applied in this study.



Table 2: Panel Unit Root Test

Variable	CIPS: Levels	CIPS: 1st Difference	Order of Integration
FSI	-1.562 (0.243)	-6.894*** (0.000)	I(1)
WTA	-0.984 (0.327)	-5.764 (0.000)	I(1)
UBN	-3.012*** (0.009)	-	I(0)
GDPK	-1.431 (0.294)	-7.021*** (0.000)	I(1)
EMPA	-2.187** (0.042)	-	I(0)
AGRL	-0.756 (0.416)	-6.118*** (0.000)	I(1)
TMP	-2.341** (0.021)	-	I(0)
PRP	-1.004 (0.365)	-5.543*** (0.000)	I(1)

Note: Figures in parentheses are p-values. *** denotes significance at the 1% level. CIPS = Cross-Sectionally Augmented IPS test (Pesaran, 2007). Source: Researcher's Computation, 2026.

Descriptive Statistics

Table 2 presents the descriptive statistics. The food security index (FSI) averages 55.56, ranging from 33.00 to 78.60, with a standard deviation of 11.76, indicating that food security outcomes differ considerably across the sampled countries. Water withdrawal intensity (WTA) averages 52.76%, but ranges widely from 2.89% to 141.17%, reflecting sharply unequal pressure on water resources, with some countries withdrawing well beyond sustainable levels relative to renewable supply. Urban population growth (UBN) averages 55.55%, ranging from 27.67% to 81.94%, consistent with the sample spanning both early-stage and advanced urban transitions. GDP per capita averages \$6,334.59, but spans a wide range from \$442.04 to \$35,125.52, underscoring the sharp income disparities between the African economies.

Table 3: Descriptive Statistics

Variable	Mean	Minimum	Maximum	Std. Dev.
FSI	55.556	33.000	78.600	11.762
WTA	52.761	2.892	141.166	38.940
UBN	55.552	27.667	81.936	15.737
GDPK	6,334.592	442.035	35,125.520	7,837.603
EMPA	28.723	4.923	59.645	14.829
AGRL	555,735.700	15,730.000	1,809,750.000	569,376.900
TMP	22.175	11.660	27.910	4.964
PRP	1,299.514	10.800	3,568.850	1,068.344

Source: Researcher's Computation, 2026.

Panel Cointegration Test

Table 3 reports the Westerlund (2007) panel cointegration test. All four group-mean and panel-mean statistics were statistically significant based on the bootstrap p-values: the group-tau statistic ($g\text{-tau} = -6.142$; bootstrap $p = 0.000$), the group-alpha statistic ($g\text{-alpha} = -4.526$; bootstrap $p = 0.000$), the panel-tau statistic ($p\text{-tau} = -5.314$; bootstrap $p = 0.000$) and the panel-alpha statistic ($p\text{-alpha} = -3.198$; bootstrap $p = 0.000$). This leads to rejection of the null hypothesis of no cointegration for the panel as a whole and for the individual countries within it. This shows that urbanisation, water withdrawal intensity and food security move together in a stable long-run equilibrium relationship, even though the series are of mixed order of integration, rather than drifting apart indefinitely. This implies that any



short-run deviations from this equilibrium, arising for instance from a sudden surge in urban growth or a drought-driven spike in water withdrawal, are eventually corrected over time.

Table 4: Panel Cointegration Test

Test Stat	Coefficient	Asymptotic p-value	Bootstrap p-value
g-tau	-6.142**	0.028	0.000
g-alpha	-4.526**	0.017	0.000
p-tau	-5.314***	0.001	0.000
p-alpha	-3.198**	0.036	0.000

Source: Researcher's Computation, 2026.

RESULTS

Aggregate Impact of Urbanisation, Water Security and Food Security in Emerging African Economies

The Augmented Mean Group estimates indicated that urbanisation has a negative and statistically significant effect on food security. The coefficient of urbanisation is -0.667 and is significant at the 1% level. This implies that a 1% increase in urbanisation is associated with an estimated 0.667% reduction in the food-security index, holding other factors constant.

Table 5a: Augmented Mean Group Estimates

Variable	Coefficient	Z	Probability
UBN	-0.667^{***}	-3.580	0.000
WTA	-0.296^{**}	2.440	0.015
GDPK	0.423^{***}	2.680	0.007
EMPA	0.612^{***}	3.380	0.001
AGRL	0.488^{***}	3.260	0.001
CONS	-5.143^{***}	-2.980	0.003

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2025.

The first objective finds that urbanisation negatively affects food security in the selected emerging African economies. Rapid and often poorly planned urban expansion can convert agricultural land to residential, commercial and infrastructure uses. The displacement of farming communities and reduction in cultivable land can weaken local food production and increase dependence on external supplies. At the same time, concentration of population in urban centres raises demand for food and can increase prices, particularly for low-income households.

The negative coefficient of water withdrawal intensity in the aggregate model suggests that increased freshwater withdrawals do not automatically improve food security. Where irrigation systems are inefficient, infrastructure is inadequate and water-conservation technologies are limited, greater withdrawals can place additional pressure on already stressed resources without producing corresponding gains in agricultural productivity. This is particularly important in economies where agriculture remains vulnerable to rainfall variability and drought.

Moderating Effect of Water Security on Urbanisation and Food Security in Emerging African Economies

The results showed that urbanisation has a negative and statistically significant coefficient (-0.542 ; $p < 0.01$), confirming that increasing urbanisation is associated with declining food-security outcomes. Water withdrawal intensity has a positive coefficient of 0.318 and is significant at the 5% level. More importantly, the interaction term between urbanisation and water security is positive and significant (0.128 ; $p = 0.029$). This indicates that water security moderates the adverse relationship between urbanisation and food security: improved water security can reduce the severity of the negative food-security effects associated with urban growth.



Table 5b: Augmented Mean Group Estimates

Variable	Coefficient	Z	Probability
UBN	-0.542***	-3.640	0.000
WTA	0.318**	2.360	0.018
MDT	0.128**	2.180	0.029

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2025.

The second objective shows that water security positively moderates the urbanisation–food-security relationship. Reliable and efficiently managed water resources can support agricultural production, urban–rural food linkages and food-system stability. Consequently, strengthening water security can reduce the adverse effects that rapid urbanisation places on food systems. However, weak institutions, limited irrigation coverage and unequal access to water may constrain this buffering effect.

Impact of Urbanisation on Water Resource Sustainability in Emerging African Economies.

The third model indicates that urbanisation has a negative and statistically significant effect on sustainable water-resource use. The coefficient of urbanisation is -0.468 and is significant at the 1% level, implying that a 1% increase in urbanisation is associated with a 0.468% decline in the sustainability indicator for water-resource use.

Table 5c: Augmented Mean Group Estimates

Variable	Coefficient	Z	Probability
UBN	-0.468***	-3.900	0.000
GDPK	0.532**	2.500	0.012
PRP	0.264**	2.300	0.021
TMP	-0.356**	-2.400	0.016
CONS	-2.311***	-3.000	0.003

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2025.

The third objective demonstrates that urbanisation reduces the sustainability of water-resource use. Rapid population growth increases domestic, commercial and industrial water demand, while inadequate infrastructure and weak management can lead to excessive withdrawals and losses. Climate variability may further intensify these pressures. The finding is consistent with literature showing that rainfall and temperature variability can threaten food security and that urban expansion can reduce access to agricultural and water resources.

Overall, the results demonstrate that urbanisation, water security and food security should not be treated as separate policy issues. Urban planning affects agricultural land; agricultural production affects water demand; and water availability affects food production and access. Integrated management is therefore necessary for sustainable urban development in emerging African economies.

The result above is in accordance with Nasser and Adam (2024) that explored how rapid urbanisation has impacted agricultural land use by examining Niamey, Nigeria using Landsat satellite and support vector machine algorithms to study variation in land use between 1975 and 2020. Their results depicted extreme changes in the extent of cropland, a decrease in 3,428 to 648 hectares and drastic increases in built-up land, with bare land, rock surface, and vegetation reduction. Findings indicated that despite slight increment of rice fields and water bodies, the combined trend depicted that urban development has exerted tremendous pressure on agricultural lands in Nigeria.

CONCLUSION AND RECOMMENDTION

The study found that urbanisation has a significant negative effect on food security. Water security positively moderates the relationship between urbanisation and food security, suggesting that improved water management can cushion some of the adverse consequences of urban growth. The study also found that urbanisation reduces the sustainability of water-resource use.



The country level evidence reported in the original study indicates that urbanisation negatively affected food security in Nigeria, Egypt and Morocco, while the effect was positive in South Africa. This variation suggests that national institutions, infrastructure, agricultural systems and urban-management capacity can influence how urbanisation affects food outcomes. The following are the recommendations:

- 1) Emerging African economies should coordinate urban planning with agricultural and water policies. Zoning regulations should protect productive farmland from uncontrolled conversion, while peri-urban agriculture should receive access to efficient irrigation systems. Compact and well-planned urban development can also reduce pressure on surrounding agricultural land.
- 2) Governments should modernize irrigation infrastructure, promote drought-tolerant crops and encourage precision agriculture. These measures can improve agricultural productivity while reducing unnecessary water withdrawals. Countries facing high water stress should give priority to water-efficient technologies and better allocation systems.
- 3) Governments should expand rainwater harvesting, wastewater reuse for appropriate agricultural purposes and community-based water storage systems. Such interventions can diversify water sources, improve resilience during periods of scarcity and strengthen the ability of food systems to withstand climate variability.
- 4) Urban planners, water authorities, agricultural agencies and environmental institutions should coordinate their policies and investments. Stronger monitoring, enforcement and transparent resource allocation are necessary to ensure that urban growth does not undermine long term water and food security.

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