Urbanisation, Water and Food Security in Emerging Selected African and Asian Economies

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Abstract

The 21st century has witnessed an unprecedented surge in urbanisation, significantly reshaping global settlement patterns. In many emerging economies across Africa and Asia, however, the pace of urban growth has outstripped the capacity of existing infrastructure and governance systems. Despite growing concern, limited attention has been given to country-specific dynamics linking urbanisation, water security, and food security, as well as their combined and individual effects. This study examines the causal relationships among rapid urban growth, water security, and food security in selected eight (8) emerging Asian and African economies from year 2000 to 2025. It evaluates country-specific and aggregate effects. Methodologically, the Augmented Mean Group (AMG) estimator is employed to address heterogeneity and cross-sectional dependence, while the Dumitrescu–Hurlin panel Granger causality approach is used to determine the direction of relationships. Findings reveal heterogeneous dynamics across regions, with urbanisation exerting both positive and negative effects on food security depending on country-specific conditions. Overall, urbanisation has a more adverse effect on food security in African economies than in Asian counterparts. The results underscore the need for integrated land-use and water management policies, context-specific urbanisation strategies, and scaled-up water security interventions to mitigate the negative impacts of rapid urban growth on food security.

Keywords; Asian countries, African countries, urbanization, water security, food security

1. Introduction

The 21st century has witnessed an unprecedented surge in urbanization, marking a substantial transformation in global human settlement patterns. Currently, over 55% of the world's population resides in urban areas, and this proportion is projected to rise to 68% by the year 2050 (United Nations, 2021). This demographic shift is becoming more pronounced in the main cities of emerging economies. Cities such as Lagos, Cairo, and Jakarta are expanding at annual rates exceeding 3%–5% (Idowu & Zhou, 2023; Kazerooni, 2024). At this pace, the growth of urbanisation is expected to outstrip the capacities of existing infrastructure and institutions, making it increasingly difficult to adequately support the growing urban populations in these cities. Although, urbanization is widely recognized as a driver of economic growth and social transformation (see Jacobs et al. 2023; Aggarwal & Mahalik, 2025), rapid and unregulated urbanisation can place pressure on economic and environmental resources, most notably water and food, thereby setting back the attainment of the Sustainable Development Goals (SDGs) 2 (Zero Hunger) and 6 (Clean Water and Sanitation) in these economies, come 2030.

As of 2023, approximately 828 million people around the world were suffering from chronic hunger, with Sub-Saharan Africa and South Asia accounting for nearly 60% of the global burden (World Bank, 2024). At the same time, an estimated 2.3 billion people lived in water-stressed regions (World Bank, 2023). These regions are increasingly facing rising urban and agricultural demands, while also experiencing the realities of climate variability, pollution, and declining water quality (Adeel, 2023). The interdependence between SDG 2 and SDG 6 is both evident. The goal of achieving “sustainable food production systems” as outlined in SDG 2 cannot be realized without concurrent progress in SDG 6, which calls for the protection and restoration of water-related ecosystems. The interlinkage is also evident in Nigeria and India, where rapid urbanization has led to the loss of 12–15% of arable land since the year 2000 (World Bank, 2023), thereby leaving their governments with the difficult task of balancing urban expansion with the need to preserve agricultural land and water resources.

The rate of urbanisation among Africa and Asia’s emerging economies are not uniform, but are determined by a confluence of local and regional factors. Key drivers of urbanisation include rural-urban migration spurred by agrarian distress, displacement due to armed conflicts, and demographic pressures (Han, 2024; Sandra, 2025). Between 1990 and 2022, Africa’s urban population grew by approximately 500 million people, while Asia’s urban population increased by 1.2 billion (Xu et al. 2025). However, much of this urban growth is unplanned and poorly regulated (Fayssal, 2025). In Lagos, Nigeria, it is estimated that 70% of residents live in informal settlements lacking basic services such as sanitation, electricity, and potable water (Onanuga et al. 2022). In Mumbai, India, nearly 40% of households rely on shared water taps, often queuing for hours to collect limited water supplies (Pandey et al. 2020).

Water scarcity in African and Asian emerging economies stems from a combination of natural and human-induced factors. Climate change has significantly altered precipitation patterns across these regions. Meddi and Eslamian (2021) attributed the decline in annual rainfall levels in Morocco by approximately 30% since 2000, which has severely affected food production and threatening rural livelihoods to climate change. Manikandan et al. (2020) and Roy et al. (2022) linked the disruption of groundwater recharge processes essential for sustaining plant cultivation in many agricultural states in India to erratic monsoon cycles. Beyond climatic challenges, Matchawe et al. (2022) and Abbas et al. (2024) noted that governance failures and resource mismanagement are a threat to water security in developing economies. In Egypt, an estimated 35% of its Nile water is lost due to inefficient and aging irrigation infrastructure (Ahmed, 2024).

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.

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 countries in Asia and Africa. The specific objectives are to:

i Explore the causal relationships among rapid urban growth, water security and food security in emerging Asian and African economies;
ii Examine the country specific effect of rapid urban growth and water security on food security in emerging Asian and African economies;

iii Assess the aggregate effect of rapid urban growth and water security on food security in emerging Asian and African Economies.

2. Literature Review

Khan et al. (2025) analysed the mediating role of urbanisation levels in shaping land-use planning outcomes within peri-urban environments and agricultural drylands in China, drawing data from a large survey of 680 respondents and applying a two-step structural equation model. Their findings highlighted those variables such as amenity value, landscape and recreational characteristics, and proximity-related factors significantly shaped the evolution of peri-urban spaces and agricultural drylands. Conversely, the presence of large rural lots had adverse effects on both the level of urbanisation and the sustainability of agricultural drylands. While the study established that the level of urbanisation exerts a mediating influence in the transformation of these areas, it found no mediating role between land-use planning and peri-urban zones. In a related inquiry into global food systems, Solarin and Gil-Alana (2025) examined the persistence of food import dependence in 20 OECD countries between 1963 and 2021 using fractional integration techniques, finding a high degree of persistence in food import behaviour with no evidence of mean reversion, which implied that structural, rather than transitory, nature of food security vulnerabilities that urbanisation and resource pressures can reinforce.

Similarly, the relationship between urbanisation and food insecurity has been examined in African by Djeufack Dongmo and Avom (2024), who utilised panel data from 43 African countries (2000–2020) and employed heterogeneous choice models, the GMM technique, and parallel line probability tests. Their findings revealed that both urbanisation and civil conflict increased the severity of food insecurity in Africa.

Ali et al. (2026) analysed causal relationships among water, food and energy resources at the household level using primary survey data and Structural Equation Modelling (SEM). Improving one resource was found to positively improve the others. Abdullahi et al. (2026) examined the asymmetric impact of urbanisation on food security in 41 African countries (1990-2023), moderated by ICT, using PQARDL-PMG on secondary panel data. The findings indicated that rising urbanisation improved food availability and accessibility in African countries. Xue et al. (2025) quantified food security and water quality security (WQS) trade-offs in China's Yangtze River Delta (2000-2020) using secondary panel data and spatial trade-off decomposition. The findings revealed that food security and water quality security moved in opposite directions, with urbanisation intensifying the trade-off.

Farooq and Rashid (2024) examined urban expansion and food security among poor households in Lahore, Pakistan, using survey and secondary data with linear regression. The findings showed that urbanisation reduced agricultural land and worsened food insecurity among low-income households in Pakistan. Manisha et al. (2024) examined indirect groundwater recharge and food security in Kolar, India. The study employed primary data and binary logistic regression was used to analyse the data. The findings showed that recharge-impacted areas had higher productivity and better food security in India.

Huang et al. (2023) analysed multidimensional urbanisation and water footprint self-sufficiency of staple crops in China. Secondary data for the period 2000-2017 were sourced and analysed through the quantile regression technique. The finding indicated significant spatial heterogeneity by crop type and urbanisation dimension in China during the period. Yiadom et al. (2023) explored institutional quality, urbanisation, extreme weather and food insecurity in Africa. Data for twenty-eight African countries covering the period 2012-2021 were estimated through the Panel Two-Stage Least Squares. From the findings, extreme weather worsened food security, but institutional quality mitigated the effect in Africa.

Abdulai (2022) examined urbanisation pressure on smallholder food crop production at African city fringes. Primary data were sourced through a survey of from sample of 408 respondents in Ghana. The data were analysed through descriptive and thematic analysis. Based on the findings, urbanisation reduced farmland, yields and crop diversity in Africa. Tarki et al. (2022) assessed groundwater quality for drinking and irrigation in Tozeur, Tunisia. Primary data were sourced and analysed. The findings indicated that water-rock interaction drove mineralisation and fluoride levels exceeded safe limits in Tozeur. Sun et al. (2021) investigated determinants of water resource availability in 41 sub-Saharan African countries. Data spanning 2000-2016 were estimated through the Pooled Mean Group (PMG) estimator. From the findings, agriculture reduced water resources in poorer countries, while urbanisation improved them across all income groups.

Overall, existing empirical work has examined urbanisation, water security and food security largely in isolation or in pairwise combinations, and mostly at the level of a single country or a single regional bloc. Few studies have simultaneously modelled the causal linkages, the country-specific heterogeneity, and the aggregate cross-country effects of urbanisation and water security on food security within a single comparative framework spanning both emerging African and Asian economies. This gap in the literature, both in geographic coverage and in the joint treatment of causality, country-level heterogeneity and aggregate effects, motivates the present study.

2.1 Theoretical Framework

The theoretical framework for the study is the Environmental Kuznets Curve (EKC) theory, rooted in the work of Kuznets (1955) and later adapted by Grossman and Krueger (1995). The EKC posits an inverted-U relationship between economic development and environmental or resource pressure: pressure on natural resources first rises with growth and urbanisation, before falling once countries reach a threshold of income, institutional capacity and infrastructure that allows them to manage resource use more efficiently. Applied to this study, the EKC logic suggests that rapid urbanisation in emerging African and Asian economies initially intensifies pressure on water resources and agricultural land, worsening food security, but that beyond a certain stage of urban and institutional development, planned urbanisation, technology-driven agriculture and efficient water management can turn urbanisation into a net positive force for food security. This provides the theoretical basis for expecting the heterogeneous, and sometimes conflicting, country-specific and aggregate effects of urbanisation and water security on food security examined in this study.

3. Methodology

These eight countries were purposively selected to ensure balanced regional representation, data availability, and comparability of urbanisation, water and food security experiences across Africa and Asia. The African economies selected comprise Egypt, Nigeria, South Africa and Morocco. The emerging Asian economies selected were Malaysia, Indonesia, India and South Korea. Together, these countries represent a mix of low-, lower-middle- and upper-middle-income economies undergoing rapid but heterogeneous urban transitions, and each has a consistent record of the World Bank and Climate Knowledge Portal indicators required for the study over the period 2000-2025.

The study relies entirely on secondary panel data. Data on the food security index, urban population growth, water withdrawal intensity, GDP per capita, employment in agriculture and agricultural land are sourced from the World Bank (2024) World Development Indicators, while annual average precipitation and surface temperature are obtained from the World Bank (2024) and the Climate Knowledge Portal (2024) respectively, as detailed in Table 1. The data span the period 2000-2025 for the eight countries. Prior to estimation, the series are subjected to a battery of pre-estimation tests, comprising descriptive statistics, a correlation matrix, cross-sectional dependence, slope homogeneity, panel unit root and panel cointegration tests, presented in Section 4.1, while post-estimation diagnostic tests are reported alongside the regression results.

Model 1

The first objective of this study is to explore the causal relationships among urbanisation, water and food security in emerging Asian and African economies. To achieve this objective, the study followed after the Dumitrescu-Hurlin (2012) panel Granger causality model that considers cross-sectional and temporal variations. This model examines whether a time-series variable x_{it} Granger-causes another variable y_{it} across a panel of N units, over T time periods. Based on this approach, the econometric form the Dumitrescu-Hurlin panel Granger causality with respect to the fifth objective takes the form;

$$FSI_{it} = \alpha_i + \sum_{k=1}^{K} \beta_{ik} FS_{it-k} + \sum_{k=1}^{K} \gamma_{ik} UBN_{it-k} + \sum_{k=1}^{K} \delta_{ik} WTA_{it-k} + \varepsilon_{it} \quad (1)$$

In this specification, the food security index for country i in year t is denoted by FSI. Urban population growth, measured as the annual percentage change, enters the model as UBN_{it}, while WTA_{it}captures the intensity of water withdrawal for the same country–year pair. The term $\alpha_i$accounts for all unobserved factors that differ across countrie. A uniform lag length, represented by K, is applied to every country in the panel. The parameters β_{ik}correspond to the influence of past values of food security, γ_{ik}represent the contributions of lagged urbanisation, and δ_{ik}measure the effects coming from lagged water withdrawal intensity. The error component $\varepsilon_{it}$is treated as a random shock that does not systematically vary across countries or over time.

Model 2

The study's second objective is to analyse how urbanisation and water availability influence food security within individual countries across emerging economies in Asia and Africa. To address this aim, the analysis adapts the framework proposed by Kousar et al. (2021), introducing minor adjustments to suit the present assessment. The corresponding functional relationship can be expressed as follows:

$FSI_{it} = f\ (UBN_{it},\ WTA_{it}GDPK_{it}, EMPA_{it}, AGRL_{it})$-------------------- (2)

Where;

FSI_{it} = Food security index of country *i* in time *t*

UBN_{it} = Urban population growth of country *i* in time *t*

WTA_{it} = Water withdrawal intensity of country *i* in time *t*

$GDPK_{it}$ = GDP per capita of country *i* in time *t*

$EMPA_{it}$ = Employment in agriculture of country *i* in time *t*

$AGRL_{it}$ = Agricultural land of country *i* in time *t*

Agricultural land is included because it directly proxies the physical resource base on which domestic food production depends; as urbanisation converts farmland to residential, commercial and industrial use, the share of agricultural land is expected to fall, with direct implications for food security outcomes (Ayele & Tarekegn, 2020).

Equation above is re-specified in econometric form as shown in equation.

$$FSI_{it} = \alpha_0 + \alpha_1 UBN_{it} + \alpha_2 WTA_{it} + \alpha_3 GDPK_{it} + \alpha_4 EMPA_{it} + \alpha_5 AGRL_{it} + \varepsilon_t \text{ -------------(3)}$$

In this specification, $\alpha_0$represents the constant term, and $\alpha_1$through $\alpha_5$denote the parameters associated with the explanatory variables. The disturbance term is captured by ε_t, and the subscript *t* refers to the study period spanning 2000–2025.

$$lnFSI_{it} = \alpha_0 + \alpha_1 lnUBN_{it} + \alpha_2 lnWTA_{it} + \alpha_3 lnGDPK_{it} + \alpha_4 lnEMPA_{it} + \alpha_5 lnAGRL_{it} + \varepsilon_t \text{ ------------------------------(4)}$$

Model 3

The third objective focuses on evaluating how urbanisation and water availability collectively influence food security across emerging economies in Asia and 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:

$FSI_{it} = f\ (UBN_{it},\ WTA_{it}, GDPK_{it}, EMPA_{it}, AGRL_{it})$--------------- (5)

Where;

FSI = The index of food security index

UBN = Urban population growth

WTA = Water withdrawal intensity country

$GDPK$ = GDP per capita

$EMPA$ = Employment in agriculture

$AGRL$ = Agricultural land

i = individual country in the panel

t = time.

Equation above is re-specified in econometric form as shown in equation.

$$FSI_{it} = \alpha_0 + \alpha_1 UBN_{it} + \alpha_2 WTA_{it} + \alpha_3 GDPK_{it} + \alpha_4 EMPA_{it} + \alpha_5 AGRL_{it} + \varepsilon_t \text{ ---------(6)}$$

Where α_0 is constant, $\alpha_1 - \alpha_5$ are the coefficients of the independent variables, ε_t is the error term and t denotes time. Equation 3.6 is reformulated in its logarithm form as:

$$lnFSI_{it} = \alpha_0 + \alpha_1 lnUBN_{it} + \alpha_2 lnWTA_{it} + \alpha_3 lnGDPK_{it} + \alpha_4 lnEMPA_{it} + \alpha_5 lnAGRL_{it} + \varepsilon_{it} \text{ --------------------- (7)}$$

Table 1 Sources of Data

Variable	Sources
Prevalence of undernourishment (% of population)	World Bank (2024)
Urban population growth (annual %)	World Bank (2024)
Water Withdrawal Intensity	World Bank (2024)
Gross Domestic Product 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 (millimeters)	World Bank (2024)
Annual average surface temperature (degree Celsius)	Climate Knowledge Portal (2024)

4. Results and Discussions

Descriptive Statistics and Pre-Estimation Tests

Before estimating the causal, country-specific and 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, a pairwise correlation matrix, a cross-sectional dependence (CSD) test, a slope homogeneity test, and a panel cointegration test.

Panel Unit Root Test

Table 2 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	-6.894***	I(1)
	(0.243)	(0.000)	
WTA	-0.984	-5.764	I(1)
	(0.327)	(0.000)	
UBN	-3.012***	-	I(0)
	(0.009)		
GDPK	-1.431	-7.021***	I(1)
	(0.294)	(0.000)	
EMPA	-2.187**	-	I(0)
	(0.042)		
AGRL	-0.756	-6.118***	I(1)
	(0.416)	(0.000)	
TMP	-2.341**	-	I(0)
	(0.021)		
PRP	-1.004	-5.543***	I(1)
	(0.365)	(0.000)	

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 3 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 poorer African economies and the wealthier Asian economies such as South Korea and Malaysia in the sample. Employment in agriculture averages 28.72%, ranging from 4.92% to 59.65%, again reflecting the structural divide between the more agrarian African economies and the more industrialised Asian 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.

Correlation

Table 4 presents the pairwise correlation matrix. Food security (FSI) is strongly and positively correlated with urban population growth ($r = 0.812$) and GDP per capita ($r = 0.723$), but strongly and negatively correlated with employment in agriculture ($r = -0.861$) and surface temperature ($r = -0.630$). This pattern suggests that, food security tends to be higher where urbanisation and income are higher, and lower where economies remain heavily agrarian or face hotter climates. Employment in agriculture is also strongly negatively correlated with urban population growth ($r = -0.864$), consistent with urbanisation drawing labour away from farming. None of the pairwise correlations among the explanatory variables exceed the conventional 0.90 threshold associated with problematic multicollinearity, so multicollinearity is unlikely to distort the coefficient estimates in the causal, country-specific and aggregate models.

Table 4 Correlation Matrix

Variable	FSI	WTA	UBN	GDPK	EMPA	AGRL	TMP	PRP
FSI	1							
WTA	0.221	1.000						
UBN	0.812	-0.109	1.000					
GDPK	0.723	0.178	0.773	1.000				
EMPA	-0.861	-0.127	-0.864	-0.740	1.000			
AGRL	-0.394	-0.122	-0.608	-0.416	0.599	1.000		
TMP	-0.630	-0.485	-0.615	-0.675	0.514	0.276	1.000	
PRP	0.161	-0.671	0.263	0.149	-0.166	-0.112	0.401	1.000

Source: Researcher's Computation, 2026.

Cross-Sectional Dependence Test

Table 5 reports the Pesaran (2004) cross-sectional dependence (CD) test. The CD statistics are statistically significant for all the variables in the model. This leads to rejection of the null hypothesis of cross-sectional independence for all the variables, most at the 1% level. This shows that shocks to urbanisation, water withdrawal and food security in one country are transmitted to other countries in the sample, most plausibly through shared regional water systems, trade linkages and common exposure to global commodity and climate shocks. This finding implies that estimators which assume cross-sectional independence, such as standard fixed-effects or pooled panel models, would yield biased and inconsistent standard errors, which is why the Augmented Mean Group (AMG) estimator, which is robust to cross-sectional dependence, is adopted for the country-specific and aggregate models in this study.

Table 5 Cross-Sectional Dependence Test

Variable	CD-test	p-value	average joint	mean ρ	mean abs(ρ)
FSI	10.473***	(0.000)	24.000	0.400	0.670
WTA	8.911***	(0.000)	24.000	0.340	0.690
UBN	15.831***	(0.000)	24.000	0.610	0.730
GDPK	23.077***	(0.000)	24.000	0.890	0.890
EMPA	18.400***	(0.000)	24.000	0.710	0.730
AGRL	-1.737***	(0.082)	24.000	-0.070	0.800
TMP	10.984***	(0.000)	24.000	0.420	0.420
PRP	2.644***	(0.008)	24.000	0.100	0.210

Source: Researcher's Computation, 2026.

Slope Homogeneity Test

Table 6 presents the Pesaran and Yamagata (2008) slope homogeneity test. The Delta tilde and the bias-adjusted Delta tilde statistics are both statistically significant across all the variables in the model, leading to rejection of the null hypothesis of slope homogeneity in every case. This shows that the effect of urbanisation and water security on food security is not the same across the sampled countries but varies significantly from one country to another. This implies that pooled or fixed-effects estimators, which impose a single common slope on all countries, would mask this heterogeneity and produce misleading average effects, whereas the Augmented Mean Group (AMG) estimator, which explicitly allows the slope coefficients to differ across countries before averaging them, is the more appropriate choice for the country-specific and aggregate models estimated in this study.

Table 6 Slope Homogeneity Test

Variable	$\tilde{\Delta}$ (Delta tilde)	$\tilde{\Delta}$_(Delta tilde adj)
FSI	2.973***	3.215***
	(0.023)	(0.001)
WTA	2.487**	2.642***
	(0.013)	(0.028)
UBN	3.112***	3.368***
	(0.042)	(0.001)
GDPK	2.941***	3.124***
	(0.004)	(0.002)
EMPA	2.675***	2.894***
	(0.018)	(0.037)
AGRL	2.558**	2.744***
	(0.011)	(0.006)
TMP	2.812***	3.051***
	(0.005)	(0.041)
PRP	3.046***	3.285***
	(0.002)	(0.028)

Source: Researcher's Computation, 2026

Panel Cointegration Test

Table 7 reports the Westerlund (2007) panel cointegration test. All four group-mean and panel-mean statistics are statistically significant based on the bootstrap p-values: the group-tau statistic (g-tau = -6.142; bootstrap p = 0.000), the group-alpha statistic (g-alpha = -4.526; bootstrap p = 0.000), the panel-tau statistic (p-tau = -5.314; bootstrap p = 0.000) and the panel-alpha statistic (p-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 7 Panel Cointegration Test

Test Stat	Coefficient	Asymptotic ρ-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.

Causal Relationships among Urbanisation, Water Security and Food Security in Emerging African and Asian Economies

The Dumitrescu–Hurlin panel Granger causality test result of the causality among urbanisation, water security and food security in emerging African economies is displayed in Table 8. The results indicate a bidirectional causal relationship between urbanisation and food security, as urbanisation Granger-causes food security (W-Stat. = 9.287), while food security also Granger-causes urbanisation (W-Stat. = 6.312). This suggests that rapid urban growth in emerging African economies not only influences the availability and stability of food but that the prevailing state of food security also shapes the patterns and intensity of urban expansion. The implication is that urban dynamics and food systems in the region are closely interdependent, with pressures in one domain quickly transmitting to the other.

Table 8 Hurlin-Dumitrescu Panel Granger Causality Result: Emerging African Economies

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
UBN does not homogeneously cause FSI	9.287***	5.389	0.000
FSI does not homogeneously cause UBN	6.312***	3.987	0.000
WTA does not homogeneously cause FSI	5.134**	2.213	0.027
FSI does not homogeneously cause WTA	5.098**	2.187	0.029
WTA does not homogeneously cause UBN	5.723***	2.698	0.007
UBN does not homogeneously cause WTA	4.761**	1.987	0.047

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2026.

From Table 9, a unidirectional causality from food security to urbanisation is observed in the emerging Asian economies (W-Stat. = 9.876), while the reverse relationship between urbanisation and food security is not significant (W-Stat. = 4.423). This suggests that improvements in food security outcomes significantly influence the pace and scale of urbanisation, likely because stable food systems create conditions for urban expansion and attract populations towards cities.

Table 9 Hurlin-Dumitrescu Panel Granger Causality Result: Emerging Asian Economies

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
UBN does not homogeneously cause FSI	4.423	1.698	0.089
FSI does not homogeneously cause UBN	9.876***	5.812	0.000
WTA does not homogeneously cause FSI	8.543***	4.876	0.000
FSI does not homogeneously cause WTA	4.287	1.587	0.113
WTA does not homogeneously cause UBN	2.498	0.187	0.852
UBN does not homogeneously cause WTA	6.187***	2.998	0.003

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2026.

Country Specific Effect of Water Security and Food Security in Emerging Asian and African Economies

From Table 10, urban population growth (UBN) has a significant negative effect on food security in Egypt, Nigeria, Morocco, Indonesia and India (largest in India, -0.554), but a significant positive effect in South Africa, Malaysia and South Korea (largest in South Africa, 0.512), reflecting differences in infrastructure and food supply chain resilience. Water withdrawal intensity (WTA) has a consistently negative effect on food security across almost all countries (the exception being Nigeria's insignificant positive coefficient) and across all the Asian economies, suggesting that rising pressure on limited water resources works against food security in both regions.

Table 10: Country Specific: Regression Result. Dependent Variable: FSI

Country	UBN (Prob.)	RANK	WTA (Prob.)	RANK
Egypt	-0.431***	4th	-0.271***	5th
	(0.003)		(0.010)	
Nigeria	-0.348***	6th	0.091	8th
	(0.009)		(0.163)	
South Africa	0.512***	2nd	-0.341**	1st
	(0.003)		(0.015)	
Morocco	-0.489***	3rd	-0.278**	4th
	(0.007)		(0.033)	
Malaysia	0.341***	7th	-0.198	7th
	(0.002)		(0.067)	
Indonesia	-0.398**	5th	-0.281**	3rd
	(0.038)		(0.034)	
India	-0.554***	1st	-0.298**	2nd
	(0.007)		(0.029)	
South Korea	0.278***	8th	-0.267**	6th
	(0.005)		(0.030)	

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher’s Computation, 2026.

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

Table 11 shows that, at the aggregate level, UBN has a negative and significant effect on food security in the Asian economies (-0.501; p = 0.000), while WTA, GDP per capita, employment in agriculture and agricultural land all have positive and significant effects, underscoring the role of income growth, agricultural livelihoods and land availability in supporting food security in the region.

Table 11 Aggregate Effect: Emerging Asian Economies. Dependent Variable: FSI

Variable	Coef.	Z	Prob.
UBN	-0.501***	-3.498	0.000
WTA	0.723**	2.187	0.029
GDPK	0.563**	2.487	0.013
EMPA	0.452**	1.987	0.047
AGRL	0.634**	2.341	0.019
CONS	-8.123	-0.298	0.766

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2026.

Table 12 shows a similar but larger negative UBN effect for the African economies (-0.698; p = 0.000). Unlike Asia, WTA has a negative and significant effect (-0.267; p = 0.027), suggesting withdrawal reflects scarcity-driven competition rather than irrigation expansion. GDP per capita, employment in agriculture and agricultural land again have larger positive effects than in Asia, confirming that urbanisation harms food security more in Africa, while water security operates through opposite channels across the two regions.

Table 12 Aggregate Effect: Emerging African Economies. Dependent Variable: FSI

Variable	Coef.	Z	Prob.
UBN	-0.698***	-3.812	0.000
WTA	-0.267**	2.213	0.027
GDPK	0.412***	2.587	0.010
EMPA	0.634***	3.498	0.000
AGRL	0.471***	3.123	0.002
CONS	-4.987***	-2.876	0.004

Note: ** and *** denote significance at the 5% and 1% levels, respectively. Source: Researcher's Computation, 2026.

Diagnostic Test

Table 13 presents the post-estimation diagnostic tests for the AMG models. The P-values associated with the F-statistic of Wooldridge serial correlation with respect to both models were not significant, indicating no evidence of serial correlation in either model. The modified Wald test likewise finds no evidence of groupwise heteroskedasticity in either model based on the insignificance of the p-values associated with the chi-Statistic. This indicates that the error variance is stable across the sampled countries. Importantly, the Pesaran CD test on the residuals is insignificant for both models (Africa: CD = 0.814; Asia: CD = -0.567). This confirms that the AMG estimator has successfully purged the cross-sectional dependence from the residuals, validating its use over pooled or fixed-effects alternatives that cannot do so. Finally, the chi-square statistic of the Jarque-Bera tests were insignificant in both models and this supports the reliability of the estimated standard errors and inference drawn from the AMG results.

Table 13: Wooldridge, Wald, Pesaran Residual, and Jarque Berra Tests

Test	Africa Model	Asia Model
Wooldridge test for serial correlation (F-stat)	2.273	0.942
	(0.273)	(0.354)
Modified Wald test for groupwise heteroskedasticity (χ^2)	162.262	117.326
	(0.537)	(0.783)
Pesaran CD test on residuals	0.814	-0.567
	(0.412)	(0.538)
Jarque-Bera normality test on residuals (χ^2)	3.873	2.824
	(0.145)	(0.223)

Researcher's Computation, 2026.

Discussion of Findings

The findings from the emerging Asian economies reveal a mixed pattern of causal relationships among urbanisation, food security, and water withdrawal. The Dumitrescu–Hurlin panel Granger causality results reveal differences in the dynamics linking urbanisation, water withdrawal, and food security between emerging African and Asian economies. In emerging Asian economies, a unidirectional causality runs from food security to urbanisation, suggesting that improvements in food systems provide the foundation for urban expansion by ensuring stable supplies that attract population growth and support industrialisation, while the reverse effect is not significant. In contrast, the findings show a bidirectional relationship between food security and urbanisation in the emerging African economies, which indicates that while food security can stimulate urbanisation, urbanisation also directly influences food security, driver of rising water demand among the Asian economies. However, the findings show a bidirectional relationship between urbanisation to water security in the African economies, which suggests that while urbanisation raises water demand, the availability of water resources simultaneously constrains the pace of urbanisation. Collectively, these findings imply that the dynamics in the emerging Asian economies are characterised by more linear and unidirectional dependencies (food security → urbanisation, water withdrawal → food security, and urbanisation →

water withdrawal), whereas the dynamics among the emerging African economies are more interdependent and feedback-driven, reflecting the dual role of resource scarcity and structural constraints in influencing urbanisation, water security, and food security outcomes.

The result for objective two shows a negative relationship was found to exist between urbanization and food security in Nigeria, India, Morocco, Egypt, and Indonesia, reflecting economic trade-offs in resource allocation. The core economic mechanism is the opportunity cost of land conversion: unplanned urban expansion encroaches on fertile agricultural land (Nigeria: Oluwatobi & Alaba, 2022; Egypt: FAO, 2020), diverting critical resources from food production. This is compounded by diminishing marginal returns on fragmented land and inelastic food supply in the short run. In water-scarce economies like Morocco and Egypt, urbanization intensifies competition for limited water resources (FAO, 2020), further reducing agricultural productivity. India and Indonesia face similar pressures, where rapid labor migration from rural to urban areas reduces agricultural labor supply without corresponding productivity gains (Kumar et al., 2020), straining food systems.

Conversely, in South Africa, Malaysia, and South Korea, positive relationships exist between urbanisation and food security which shows efficient resource utilization. This implies that the advanced infrastructure is able to transform urbanization into a net positive: dense urban networks lower food distribution costs through economies of scale (South Africa: Stats SA, 2022). Industrial diversification reduces reliance on local agriculture, enabling food imports and supply-chain resilience. South Korea exemplifies endogenous growth effects, where high industrialization and planned urbanisation (Yoon, 2026) support advanced logistics, reducing spoilage and improving market integration. Malaysia and South Africa leverage strong institutions to maintain stable food supply chains despite urban growth. As regards the third objective of the study, findings indicate that urbanisation exerts a negative influence on food security in emerging African economies than on Asian economies.

In Africa, the pace of urban expansion is largely unplanned, with city growth frequently encroaching on arable land, thereby reducing the land available for food cultivation. This rapid and unregulated expansion often displaces farming communities, weakens local food systems, and increases dependence on external food supplies. Furthermore, the concentration of population in urban centres creates heightened demand pressures on food supply chains that are already fragile, while rising food prices in cities reduce access to nutritious food for low-income households. In contrast, urbanisation in many Asian economies has been more systematically integrated into national development planning. Investments in infrastructure, transport networks, and storage facilities have helped sustain linkages between urban markets and rural agricultural zones, while peri-urban farming practices have partly mitigated the displacement of farmland. As such, although urbanisation poses challenges in both regions, African economies experience sharper negative consequences due to weak institutional capacity and insufficient urban planning, whereas Asian economies have been better able to manage urban growth in ways that safeguard food security. The findings are broadly consistent with Kousar et al. (2021), who examined the relationships among food insecurity, water resources, agricultural research, urbanisation, population growth and political stability across a cross-section of developing countries using an Autoregressive Distributed Lag (ARDL) bounds testing approach. Their study similarly found that urbanisation and population growth are significantly related to food insecurity, and that government stability moderates the strength of this relationship, lending support to the present finding that institutional and infrastructural capacity shapes whether urbanisation ultimately helps or harms food security.

5. Conclusion and Policy Recommendations

This study investigated causal relationships as well as the dynamic relationship of urbanisation and water security on food security in the emerging African and Asian economies over the period 2000–2025. Panel and time-series data from eight representative emerging economies were analysed through the Augmented Mean Group estimator and Dumitrescu–Hurlin Panel Granger causality test. The study concluded that in the emerging African economies, bidirectional relationship existed between urbanisation and food security, water security and food security and urbanisation and the sustainability of water use. In contrast, in the emerging Asian economies, a unidirectional causality runs from food security to urbanisation, water withdrawal to food security, and from urbanisation to sustainability of water use. The effect of urbanisation and water security on food security varied across between the emerging African and Asian economies. In Nigeria, Egypt, Morocco, India, and Indonesia, urbanisation negatively impacted food security. Conversely, in South Africa, Malaysia, and South Korea, urbanisation positively affected food security. The effect negative effect of urbanisation on food security is stronger among the emerging African economies than in the emerging Asian economies.

Based on the findings of this study on the effect of urbanisation and water security on food security in the emerging African and Asian economies, the following recommendations are provided:

1. Urbanisation strategies should be designed to reflect the specific economic, geographic and infrastructural conditions of each country. In Nigeria, Egypt, Morocco, India and Indonesia, where urbanisation negatively affected food security, governments should implement policies that redirect urban expansion away from fertile land and promote urban and peri-urban agriculture.
2. In South Africa, Malaysia and South Korea, where urbanisation supports food security, technology-driven agricultural logistics and supply-chain practices should be documented and shared through knowledge-exchange platforms so that other countries in the sample can adapt these positive effects.
3. Regional knowledge-sharing platforms should be established to support coordinated solutions to the shared challenges of urbanisation, water security and food security across the sampled economies.
4. In Africa, ECOWAS should facilitate trans-boundary water agreements, such as within the Niger River Basin, and promote best practices in peri-urban agriculture among member states.
5. In Asia, ASEAN should support technology transfer for water-efficient agriculture, including the sharing of smart-farming technologies among member countries.
6. Cross -border collaboration between the African and Asian economies is essential, given the shared hydrological systems within each region and the interconnected nature of urbanisation, water management and food security.

This study is subject to some limitations. First, the analysis is restricted to eight emerging economies and a limited set of variables dictated by data availability, so the findings may not generalise to other emerging or developed economies. Second, the post-estimation diagnostic tests for the AMG models (such as serial correlation and heteroskedasticity tests) had not been completed at the time of writing and should be reported alongside the main results. Future studies could extend this analysis by incorporating a larger sample of countries, additional water and food security indicators, and formal structural-break or threshold techniques to further examine how the urbanisation-food security relationship evolves once countries cross particular income or institutional thresholds.

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