# MAPPING THE FOUR DIMENSIONS OF FOOD AND NUTRITION SECURITY IN UGANDA: A SPATIAL INTEGRATION OF OPEN SOURCE DATASETS

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## Introduction

Food and Nutrition Security (FNS) remains one of the most pressing global challenges, disproportionately burdening those who are already most vulnerable, particularly in parts of Sub-Saharan Africa, including Uganda[1]. FNS is multidimensional and can only be achieved when all four dimensions are met simultaneously, namely; access, availability, utilisation and stability[2]. Each dimension is influenced differently by spatial factors and therefore a multidimensional approach is needed to target interventions effectively. However, many open-source data resources collect information on only one or two dimensions of FNS. This study aims to integrate multiple open-source datasets through Geographical Information Systems to create four spatial indicators corresponding to each dimension of FNS at district level in Uganda, to inform policy and practice in targetting interventions effectively.

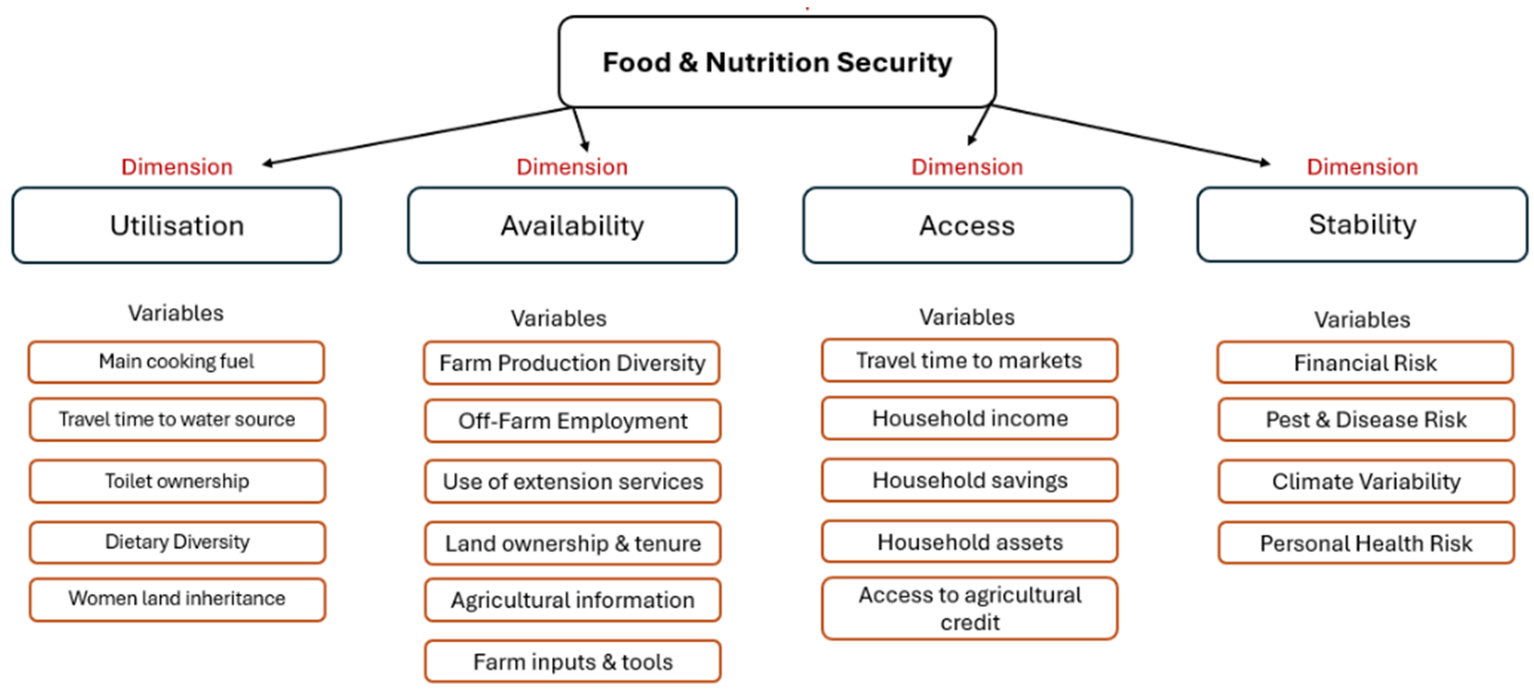


Figure 1: Conceptual Framework of the four dimensions of food and nutrition security with the selected variables

## Methods

Identify open-source datasets → Integratation of variables → Exploratory Analysis → Weighting of indicators → Analysis

Extensive search of open-source datasets to identify variables representing each dimension (fig.1) that can be integrated to spatially & temporally

Variables spatially joined and integrated to district level with 104 Ugandan district shapefiles in ArcGIS Pro

Hotspot Analysis (Getis-Ord GI*) on a sample of variables to confirm if spatial clustering exists within the data

Principal Component Analysis (PCA) to create four indicators corresponding to dimensions of FNS

Getis-Ord GI* Cluster Analysis & Geographically Weighted Regression Analysis

## Preliminary Findings

Table 1: Characteristics of data sources selected for study

| Dataset | Source | Scale / Resolution | Dimension of FNS |
|---|---|---|---|
| Uganda National Panel Survey (UNPS) | Uganda Bureau of Statistics | Yearly 2009 - 2020 Household | Access, Availability, Stability |
| Uganda Demographic and Health Survey | Uganda Bureau of Statistics, World Bank | Every 5 years 2000-2022 Enumeration areas | Utilization, Access |
| CHIRPS Rainfall | Climate Hazards Center | 5km Daily, monthly | Stability |
| MODIS NDVI | NASA Earthdata | 500m monthly | Availability, Stability |
| OpenStreetMap Roads & Markets | OpenStreet Map, Geofabrik | Variable vector resolution | Access |

Five datasets were identified which could be integrated spatially and temporally and provided national coverage for Uganda, each contributing to various dimensions of FNS. The years in which the datasets overlap are 2010 - 2020, and therefore this was selected as the 10-year study period.

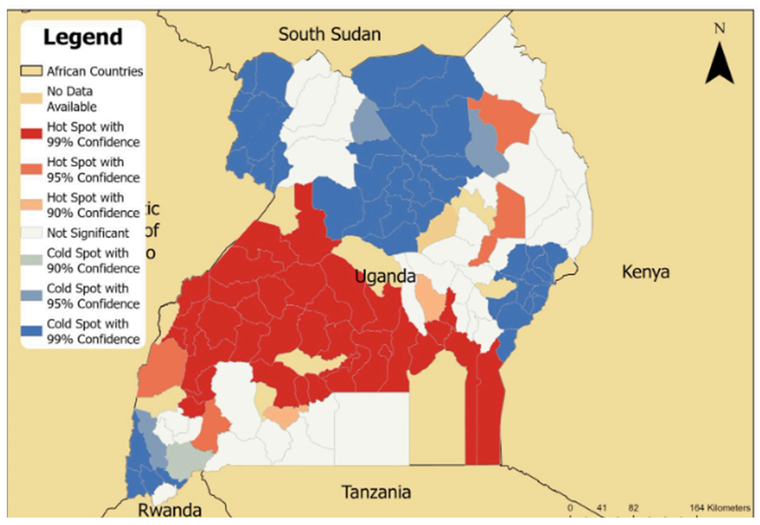


Figure 2: Map showing the results of Getis-Ord GI* hotspot analysis on acres of landholdings variable in 2020 at district level in Uganda (UNPS).

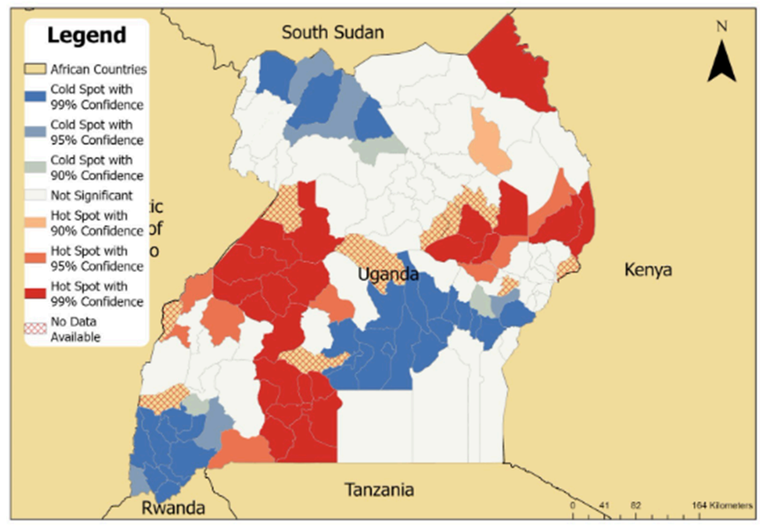


Figure 3: Map showing the results of Getis-Ord GI* hotspot analysis on acres of access to clean water variable in 2020 at district level in Uganda (UNPS).

- Exploratory Getis-Ord GI* results showed spatial clustering at the 95% and 99% confidence level for sampled variables in 2020, revealing that a strong spatial component to the distribution. For example, clusters of districts with lower average landholdings (hotspots) were located in Central - South Uganda whilst a cluster of districts with higher average landholdings (coldspot) is located in the North (fig.2).
- However, clusters were not geographically consistent across different variables, highlighting the importance of multiple indicators which capture various dimensions of FNS uniquely. For example, while hotspots for poor access to clean water (utilization dimension) are similar to land holdings (availability dimension) in the West, contradicting patterns are observed in the East (fig. 3).

## Challenges

- Lack of sub-national data available in open-source format
- Lack of consistency in temporal scale of open-source datasets
- Missing data for whole districts or regions

## Conclusions & Future Work

- Whilst there remain challenges in identifying datasets which can be spatially and temporally integrated, data for each dimension of FNS was successfully identified and acquired.
- Preliminary findings support further analysis of spatial patterns, particularly a multidimensional approach.
- Next steps in this project is to conduct Principal Component Analysis to create composite indicators for each dimension, before conducting the final cluster and regression analysis.

References
1. Atamanov et al (2020) Monitoring Impacts of COVID-19 and other shocks on Households in Uganda: Findings from Round 9 of the High-Frequency Phone Survey, World Bank
2. Peng and Berry (2019) The concept of food security. Encyclopedia of food security and sustainability