Exploratory Spatial Data Analysis (ESDA) – the Case of E-Government and E-Participation in Africa (2024)

T.P. Humanikwa

Department of Geography and Geo-Information Science

Faculty of Humanities and Social Sciences

ESDA

- Global statistics often mask local realities – a gap filled by Exploratory Spatial Data Analysis (ESDA)
- ESDA is a crucial set of techniques used to describe and visualize spatial (geographic) distributions
- It unveils patterns and disparities across space that might not be immediately obvious.
- The standardized nature of SDMX data, including its geographic dimensions makes it the perfect raw material for various spatial analyses.

Spatial Autocorrelation Concept

- Spatial autocorrelation is a statistical concept that measures the extent to which values in a dataset are spatially related
- Nearby locations tend to have more similar values than distant locations according to Tobler's law
- **Does high digital transformation in one country spatially correlate with digital transformation in neighboring countries?**
- This can reveal regional patterns and diffusion effects that are critical for policy-making.

Spatial Autocorrelation Statistics (SAS)

Univariate Spatial Autocorrelation Statistics

1. Global Moran’s I
2. Univariate Median Local for Moran’s I

Univariate Spatial Autocorrelation Statistics

1. Bivariate Global Moran’s I
2. Bivariate Median Local Moran's I

Lupane State University

Building Communities through Knowledge

Univariate Spatial Autocorrelation Statistics

Global Moran's I

- Purpose: To measure the overall degree of spatial autocorrelation for a continuous variable. It assesses whether values at nearby locations tend to be similar (positive autocorrelation/clustering) or dissimilar (negative autocorrelation/dispersion).
- Interpretation: Ranges from -1 (perfect dispersion) to +1 (perfect clustering). 0 indicates random spatial pattern.

- NB: The Univariate Median Local for Moran’s I was applied for both E-Government and E-Participation instead of the convectional Global Moran’s, considering the skewed nature of the variables

Global Moran Scatter plot

- **X-axis (horizontal):** Standardized values of a variable, e.g. E-Government (EGOV) for each country.
- **Y-axis (vertical):** Spatial lag of E-Government (the average of neighbors' standardized EGOV scores).
- **Each point:** A country.
- **Purple regression line slope:** Equal to the **Global Moran's I statistic**.

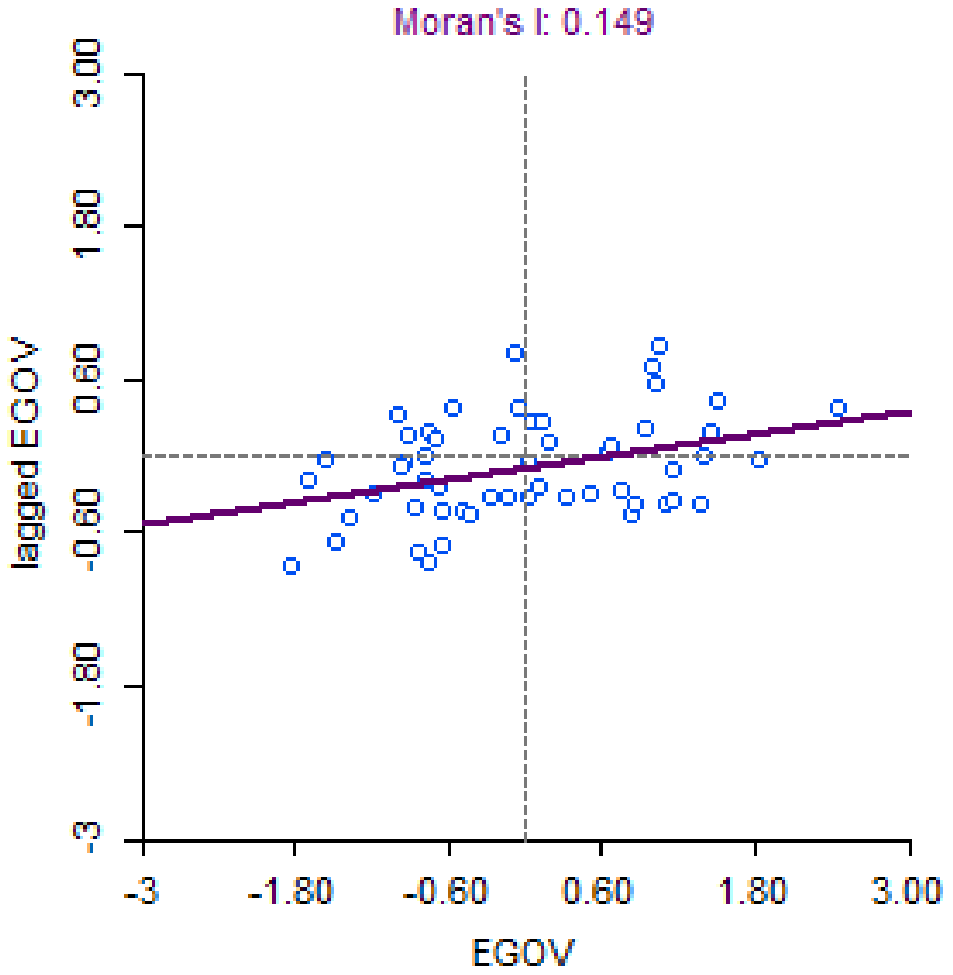
Global Moran's I for E-Government

Moran's I = 0.149

It means there is a slight positive spatial autocorrelation or weak clustering.

Countries with similar levels of e-government (high with high, low with low) tend to be near each other, but the effect is weak.

Some outliers exist (points in high–low and low–high quadrants), meaning a few countries with strong e-government are surrounded by weaker neighbors, or vice versa.



Global Moran's I for E-Participation

Moran's I = 0.017

This is extremely close to zero.

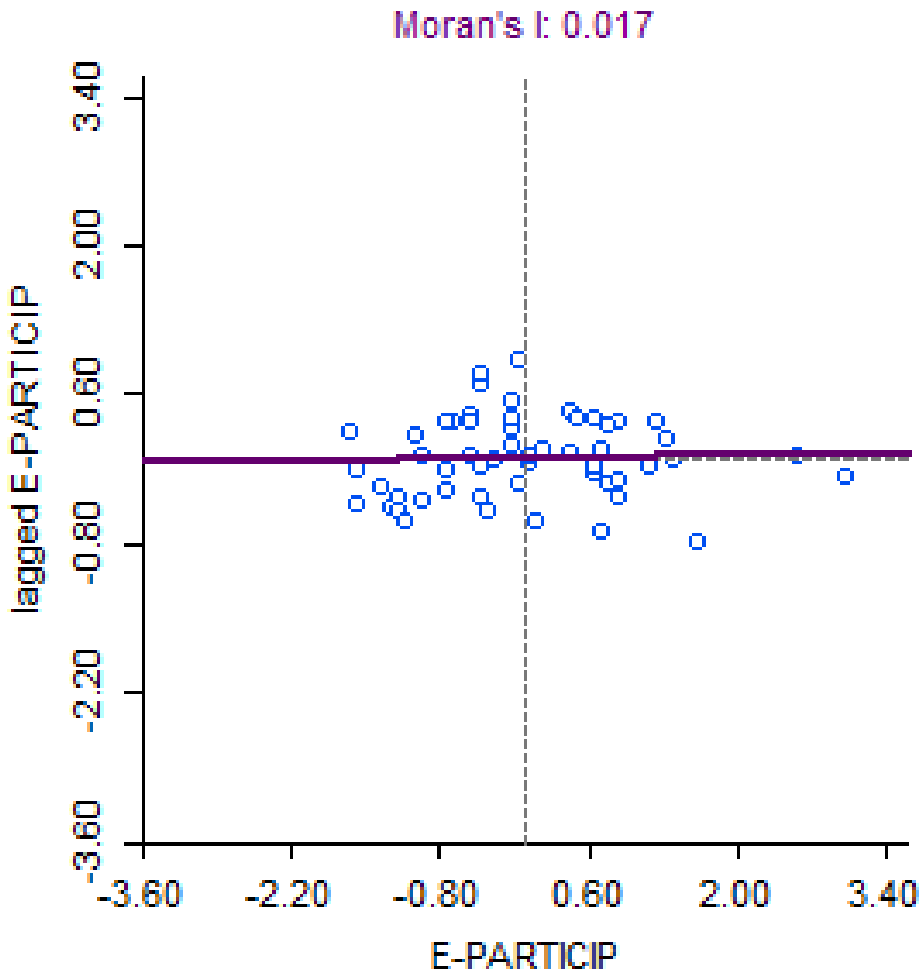
It suggests almost no global spatial autocorrelation in e-participation across Africa.

The scatterplot is flat, with no clear tilt.

Countries are spread around the origin, with no strong clustering into the high–high (upper right) or low–low (lower left) quadrants.

E-participation shows virtually random spatial distribution.

E-participation levels appear to vary independently, suggesting countries pursue digital citizen engagement policies in more individualized, country-specific ways, not strongly influenced by neighbors.



Univariate Median Local for Moran’s I for E-Government

- Decomposes Global Moran's I to assess spatial autocorrelation at a local level
- Similar to the coventional Local Moran’s I, but uses Median instead of the average.
- It identifies specific clusters (high-high or low-low) and detects spatial outliers (e.g., high-low or low-high).
- Helps pinpoint exactly where E-Government is thriving or struggling, allowing for a more nuanced and geographically targeted approach to policy-making and resource allocation.

Univariate Median Local for Moran's I for E-Government Cont.

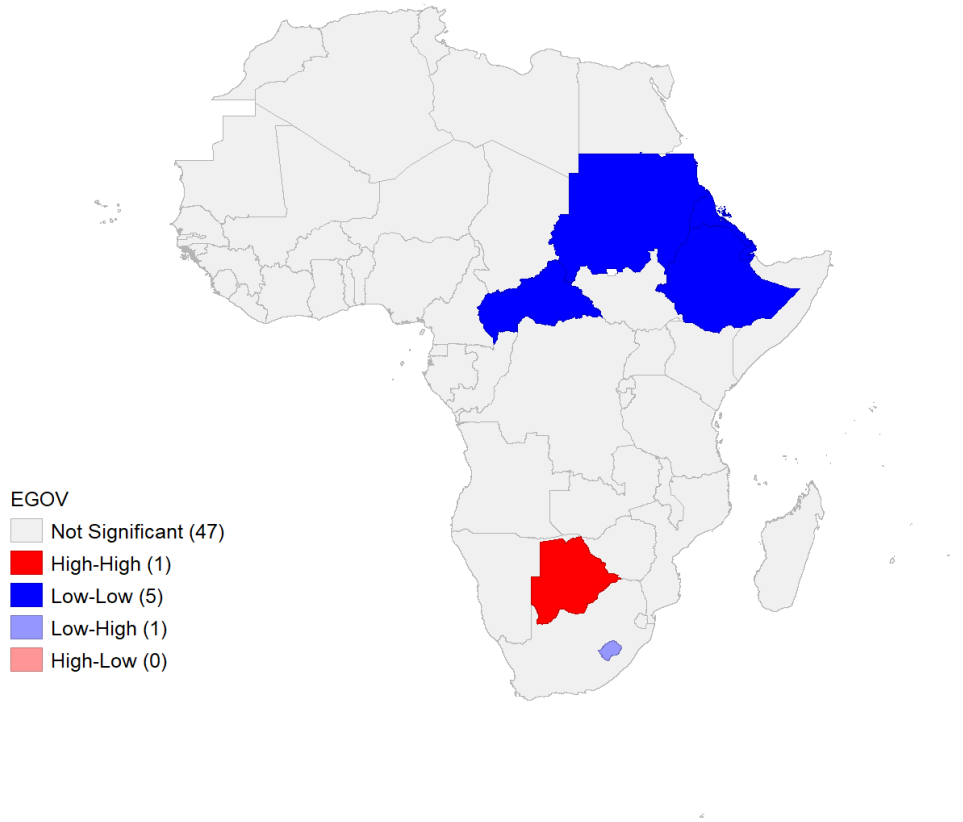
- Hotspot – cluster of high values (HH)
- Coldspot – cluster of low values (LL)
- HL and LH are the spatial outliers
- High-Low (HL) Outlier represents an area with a high E-Government score surrounded by neighbors with low scores. This might indicate an isolated success story or a particularly innovative government entity within a region of low development.
- Low-High (LH) Outlier represents an area with a low E-Government score surrounded by neighbors with high scores. This might be a lagging government entity in an otherwise digitally advanced region.

Univariate Median Local for Moran's I for E-Government

Botswana is a country surrounded by countries with relatively high digital governance

Lesotho is a spatial outlier country with low digital governance close to countries of high digital governance such as Botswana

Sudan, South Sudan, Djibouti, Eritrea and Central African Republic are a cold spot



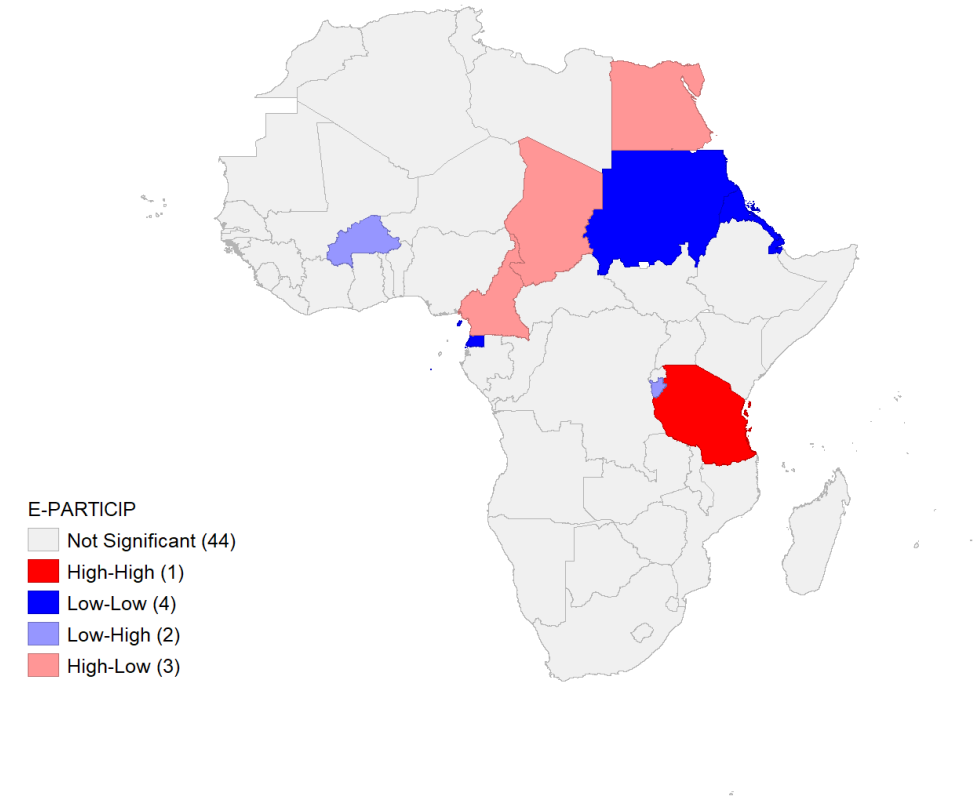
Univariate Median Local for Moran's I for E-Participation

Spatial Randomness rather than spatial dependence

Burundi and Burkina Faso are countries countries of low E-Government having countries of relatively high E- government as neighbours

Egypt, Chad and Cameroon have high E-Participation being neigbours to E-Participation cold spots (Sudan, Eritrea)

Another cold Spot is Equatorial Guinea and Sao Tome and Principle

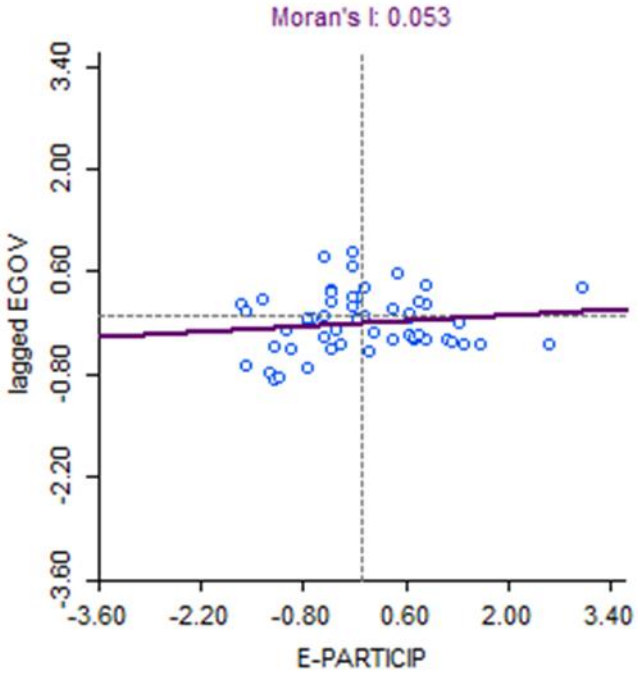


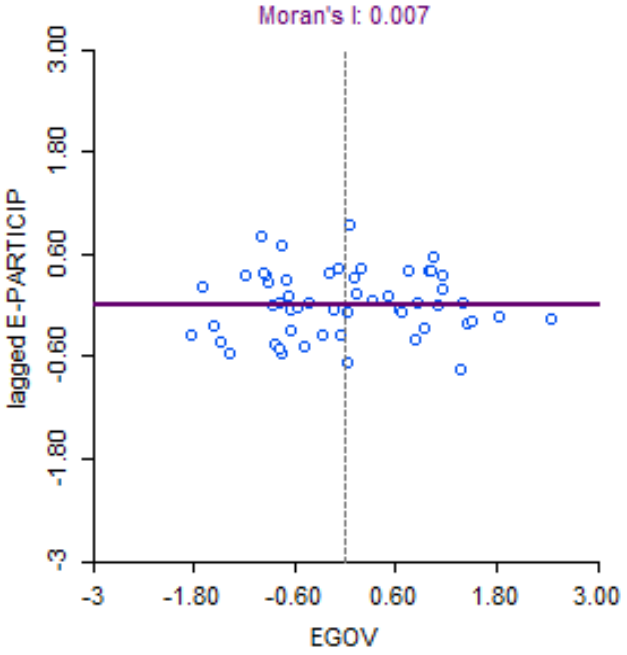
Bi-variate Moran's I

- Maps the spatial relationships between the two variables at each individual location.
- The result is a map that categorizes each location into one of four key types of spatial correlation:

1. High-High Cluster (HH): An area with a high e-government score is surrounded by neighbors with high e-participation scores. These are "hot spots" of both variables.
2. Low-Low Cluster (LL): An area with a low e-government score is surrounded by neighbors with low e-participation scores. These are "cold spots" for both variables.
3. High-Low Outlier (HL): An area with a high e-government score is surrounded by neighbors with low e-participation scores. This indicates a location where e-government is strong, but e-participation in the surrounding area is not.
4. Low-High Outlier (LH): An area with a low e-government score is surrounded by neighbors with high e-participation scores. This suggests a disconnect where e-participation is high despite poor e-government in that specific location.

Bi-variate Moran's I Cont.





Moran's I either way is extremely close to zero meaning virtually random spatial distribution with no spatial autocorrelation.

E-Government to E-Participation

Tanzania has both high e-government development and high e-participation levels, surrounded by neighboring countries with similarly high values such as Rwanda, Kenya and Uganda.

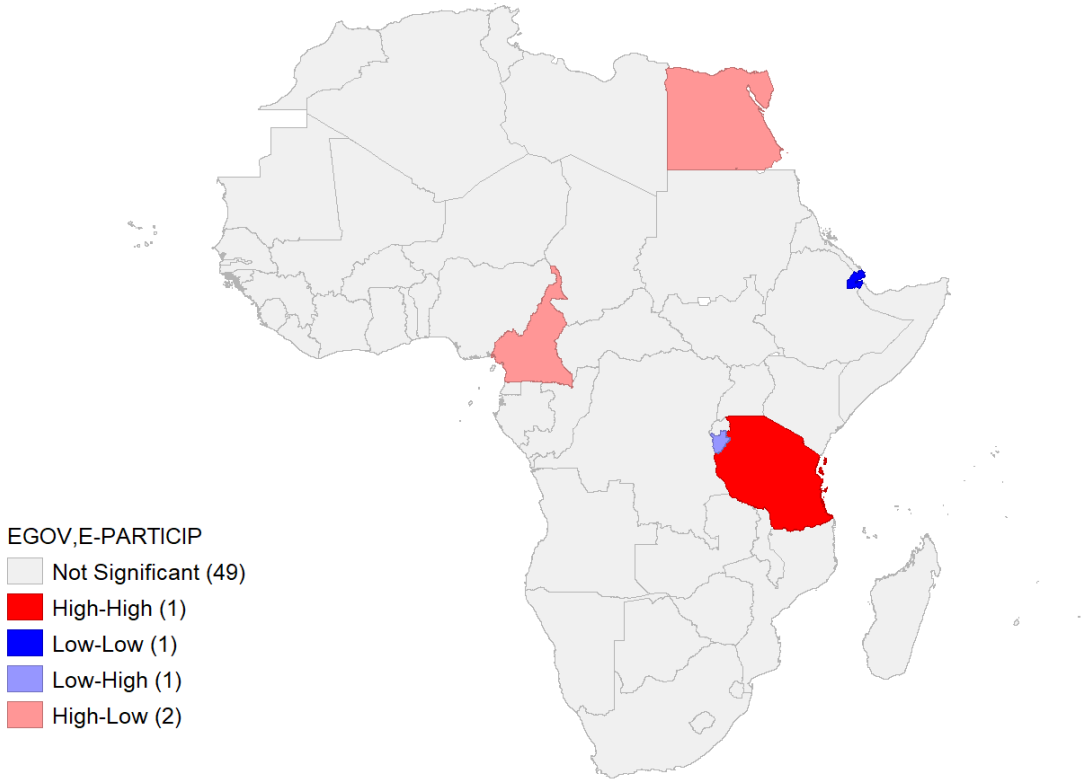
East African Community (EAC) is probably digitally advanced

Djibouti has both low e-government development and low e-participation, surrounded by neighbors with similarly low values.

Spatial concentration of barriers to digital governance development, possibly due to shared regional challenges such as infrastructure limitations, economic constraints, or institutional weaknesses in the horn of Africa.

Burundi has low e-government but surrounded by areas with high e participation.

Egypt and Cameroon have high e-government but relatively low e-participation, surrounded by areas with low values in both dimensions serving as digital oases.



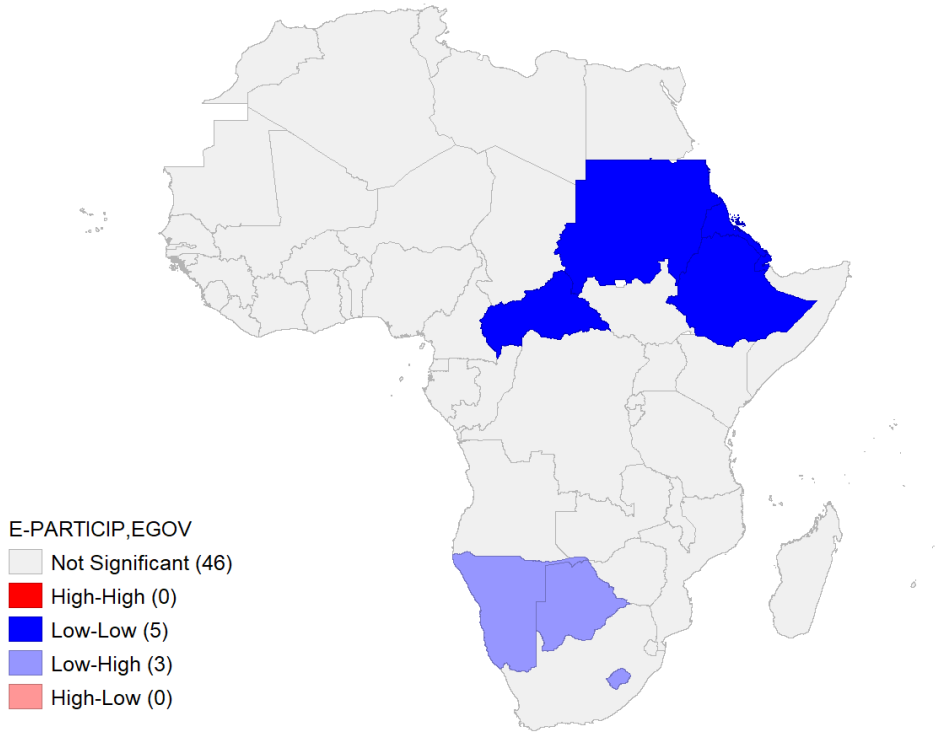
E-Partipation to E-Government

No high-high clusters were found in Africa, indicating no regions where both high citizen participation and strong E-Government development are spatially concentrated

Ethiopia, Djibouti, Eritrea, Sudan, South Sudan and Central African Republic have low E-Participation surrounded by neighbors with low E-Government development

The Horn of Africa, extending into Central Africa seems to be a digital desert with a dual challenge of e-participation and e-development

Namibia, Botswana and Lesotho have low E-Participation surrounded by neighbors with high E-Government development suggesting E-Government infrastructure exists but citizen participation is lagging



On a closing note …

- There are quite a number of regional mismatches in E-government and E-Participation across Africa as shown by spatial outliers.
- Some countries are digital deserts whilst others are digital oases.
- Based on all the ESDA tests conducted, at least 44 countries (about 81%) reflected no statistically significant spatial correlation.
- This means E-Government and E-Participation are not strongly spatially related across most of the continent — policies and progress seem more country-specific.
- There is need for inclusive digital growth and overall partnership for the goals (SDG17) to ensure that ‘Noone is left behind’.