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Geostatistics for the development of urban spatial frameworks in Africa: case study of Luanda

I. Introduction

1.   The development of sustainable and thriving cities is crucial for the progress of African countries, and the key to achieving that lies in effective urban planning. In that context, a study was conducted to provide city planners with a geostatistical foundation to guide and support urban spatial frameworks for African cities. The study is set to pave the way towards equitable, connected, resilient and economically vibrant cities in Africa. The establishment of a spatial vision for urban development is within reach, as is a prosperous future for African cities.

2.   Urban spatial frameworks offer valuable tools for effective urban management, as such factors as land use, transportation and social dynamics are taken into consideration. By providing a systematic approach, those frameworks allow planners to analyse and transform urban environments with sustainability in mind. For instance, in the compact polycentric city model, sustainable urban forms are promoted by encouraging density and distributing economic activities.[1] In African cities, numerous challenges, such as informal settlements, spatial segregation, inadequate infrastructure and poor urban planning, impede sustainable development and lead to social inequalities and environmental degradation. Addressing those obstacles requires a comprehensive approach that is focused on affordable housing, infrastructure improvement and inclusive policies.[2] It is essential to develop a spatial framework for African cities because it offers a strategic road map for urban planning in which sustainability, resource efficiency and better infrastructure coordination are promoted. Through the framework, quality of life can be improved and private investment can be attracted, thereby guiding cities towards resilience and prosperity. Geostatistics, in which geographical information systems are incorporated into data analysis, plays a crucial role in the process, as insights into urban dynamics are gained, enabling informed

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[*] E/ECA/GGIM-A/10/1/Rev.1.

[1] Chih-Hao Wang, "Does compact development promote a seismic-resistant city? Application of seismic-damage statistical models to Taichung, Taiwan", *Environment and Planning B: Urban Analytics and City Science,* vol. 47, No. 1 (2020), pp. 84–101.

[2] Biyun Zhou and Lanfeng Yu, "The compact city form: case study of Shenzhen" (2011).

decision-making.[3] In addition, a well-defined spatial framework can help in integrating natural structures into urban planning, which promotes environmental sustainability and economic growth.[4] In conclusion, an effective spatial vision, such as compact polycentric cities, is necessary for promoting sustainable development in urban areas.

II. Problem statement

3. The successful implementation of a compact polycentric urban model in Africa is faced with a multitude of challenges, primarily stemming from the rapid pace of urbanization. The obstacles include substandard urban planning, the proliferation of informal settlements and inadequate infrastructure, such as deficient road networks and public transportation systems.[5] In addition, limitations in funding and regulatory barriers must be addressed while equitable socioeconomic status and environmental sustainability are strived for. Overcoming those challenges requires collaboration among various stakeholders, including urban planners, policymakers and communities, to build a liveable and sustainable urban environment grounded in robust governance.[6]

4. A crucial element of the proposed model is the creation of interconnected sub-centres linked through efficient transportation systems to enable easier access to jobs and reduce commuting times. The spatial development framework for Johannesburg, South Africa, serves as a prime example, as a balance in urban structure is sought through the prioritization of mixed-use development within an integrated natural environment.[7] The integration of demographic data into geostatistical analysis is essential for identifying initiatives that can enhance urban frameworks.[8] Insights garnered from previous urban studies in Australia and the United States of America highlight the critical role of spatial data in addressing such pressing issues as disparities in housing and health.[9] For instance, for such cities as Luanda, developing a compact polycentric urban model requires overcoming such challenges as centralized governance, informal settlements and the need to engage communities for the achievement of sustainable outcomes.

5. As African cities continue to grapple with urban development issues, including inadequate housing and poor connectivity, utilizing the power of

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[3] Iwona Jażdżewska, Lukasz Lechowski and Dominika Babuca, "GIS-based approach for the analysis of geographical education paths", *International Journal of Geo-Information*, vol. 11, No. 1 (2022).

[4] Fu Cai and others, "Analysis of precipitation for different periods in northeast China based on geo-statistics and GIS", *Chinese Journal of Agrometeorology,* vol. 27, No. 4 (2006), pp. 296–296 and 304.

[5] Ziyang Weng, Shuhao Wang and Yang Ming, "Type accounting: a mechanism for growing implicit geo-number chains for multi-objective evolutionary geometry", *2023 9th International Symposium on System Security, Safety, and Reliability (ISSSR)* (2023), pp. 300–305.

[6] David Rojas-Rueda and Emily Morales-Zamora, "Equitable urban planning: harnessing the power of comprehensive plans", *Current Environmental Health Reports,* vol. 10, No. 2 (June 2023), pp. 125–136.

[7] Hope I. Asala and others, "An integrated machine-learning approach to shale-gas supply-chain optimization and refrac candidate identification, *SPE Reservoir Evaluation & Engineering,* vol. 22, No. 4 (November 2019), pp. 1201–1224.

[8] P. Magiera, "Assessment of groundwater vulnerability using GIS and geostatistics" in *Groundwater 2000*, Poul L. Bjerg, Peter Engesgaard and Thomas D. Krom, eds. (London, CRC Press, 2000).

[9] Amanda Carlson and others, "The wildland–urban interface in the United States based on 125 million building locations", *Ecological Applications,* vol. 32, No. 5 (March 2022).

geospatial data can inform strategic planning and investment decisions.[10] Adopting a data-informed approach to tackle the urban challenges Africa faces can yield resilient and sustainable cities, thereby fostering positive social and economic growth across the continent. Collaboration among various stakeholders and the integration of geospatial data into urban planning are critical components that will contribute to the success of a compact polycentric urban model in Africa.[11]

III. Main objective of the study

6.   The study was aimed at establishing a geostatistical foundation to assist urban planners in African cities in developing urban spatial frameworks that promote sustainable, equitable, connected, resilient and economically vibrant environments. The compact polycentric urban model is realized by creating a spatial vision to outline the overarching goals for urban development. The objective of the study was to implement a compact polycentric urban model, distribute economic activities and residential areas across multiple centres, enhance walkability, ensure access to essential services and minimize long-distance commuting. Transformation themes were emphasized, including the creation of a compact, inclusive, connected, resilient and generative city. Those themes were focused on critical aspects of urban development, such as compactness, the mixed use of land, social equity, affordable housing, accessible infrastructure, connectivity, mobility, disaster resilience and economic growth. Ultimately, the objective is to shape the future of urban development, improve the well-being of residents, and establish prosperous, liveable cities that are aligned with Sustainable Development Goal 11.

Specific objectives

7.   *Develop a compact polycentric urban model.* Collect, analyse and disseminate geospatial statistical data linked with demographic patterns to identify suitable locations for multiple targeted activity centres. Employ geostatistical techniques to evaluate the distribution of economic activities, residential areas and amenities.

8.   *Promote compactness, the mixed use of land and the efficient utilization of space.* Use geospatial data analysis to identify densification areas and assess current land-use patterns. Apply geostatistical methods to determine optimal land allocation for mixed-use development.

9.   *Foster social equity and affordable housing.* Employ geospatial data analysis to identify geographical areas with high concentrations of vulnerable populations or inadequate access to affordable housing. Utilize geostatistical techniques to analyse socioeconomic indicators and guide the equitable distribution of housing and infrastructure.

10.   *Enhance connectivity and mobility.* Analyse transportation networks through the use of geospatial data to identify bottlenecks, areas of high congestion and connectivity gaps. Use geostatistics to model and optimize transportation infrastructure for improved mobility.

11.   *Build resilience to shocks and stresses.* Analyse geospatial data, including climate and hazard information, to pinpoint areas vulnerable to

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[10] Robert Mutemi Kajiita and Simon Murote Kang'ethe, "Socio-economic dynamics inhibiting inclusive urban economic development: implications for sustainable urban development in South African cities", *Sustainability,* vol. 16, No. 7 (2024).

[11] N. Chanza, "Prospects of twinning climate change and urban sustainability issues through transformative adaptation: lessons for African cities", *Journal of Inclusive Cities and Built Environment*, vol. 2, No. 1 (2022), pp. 65–69.

natural disasters and climate impacts. Apply geostatistical techniques to assess risk levels and support effective land-use planning and infrastructure design.

12. *Promote economic growth and innovation.* Analyse geospatial data to locate potential areas for economic growth and innovation, such as clusters of startups or research institutions. Employ geostatistical techniques to inform decisions on attracting investment and nurturing talent.

13. *Develop urban spatial frameworks for African cities.* Analyse geospatial data to understand spatial patterns, identify suitable locations, optimize infrastructure, assess vulnerabilities and guide sustainable and inclusive urban development.

IV.   Expected outcomes

14. An urban framework in which such concepts as the compact polycentric city model, walkability and smart growth are promoted is aimed at optimizing land use, enhancing accessibility and improving the overall quality of life for residents. In addition, an objective is balanced development, which results in spatial inequalities being reduced and economic opportunities being promoted across different areas of a city.

15. In urban frameworks, environmental sustainability is emphasized through the encouragement of the preservation of open spaces and the reduction of dependency on cars. The utilization of such frameworks fosters social inclusivity through mixed-use neighbourhoods and diverse housing options, which creates communities that support people from all socioeconomic backgrounds. Moreover, they provide a structured approach to urban planning, which facilitates effective governance and decision-making for the achievement of the Sustainable Development Goals.

V.   Methodology

16. The success of any urban development project lies in its methodology and, for the study outlined above, a comprehensive and collaborative approach is essential. That involves collecting and analysing various types of data, such as geospatial, demographic and economic data, to identify patterns and relationships relevant to the objectives of the project. The next step is to engage the main stakeholders, such as city officials, urban planners and community members, to understand their perspectives and incorporate their input into the decision-making process. Through workshops, focus group discussions and interviews, it was possible to create a regional geospatial strategy for promoting compactness, the mixed use of land and the efficient use of space. The methodology also included visioning and goal-setting exercises, in which a spatial vision for the city was developed and clear objectives were set based on the priorities and aspirations of the stakeholders. The use of geospatial analysis tools and software enables the mapping and visualization of data, which aids in decision-making and communicating the proposed spatial vision. Scenario planning and modelling are also crucial components, as they help in assessing the potential impact of different strategies. The final steps are the development and implementation of a spatial strategic framework, and prioritizing and sequencing strategies based on their feasibility and potential impact. The comprehensive and collaborative approach, coupled with regular monitoring and evaluation, ensures the effective implementation of the project. The methodology is a data-driven and participatory process that combines various techniques to shape the spatial vision, transformation themes and strategies for sustainable urban development.

VI. Results

17. By analysing and combining the various geospatial data sets, it is possible to understand spatial patterns, identify suitable locations, optimize infrastructure, assess vulnerabilities and provide insights for sustainable and inclusive urban development.

A. Develop a compact polycentric urban model for building urban spatial frameworks

18. The key to building successful and sustainable cities is in the spatial framework. One way to create such a framework is through the use of a compact polycentric urban model (see map 1).[12] In that model, the focus is on developing multiple centres for targeted activities within a city, which creates a more balanced and efficient distribution of resources and amenities. To implement such a model, integrated geospatial and statistical data must first be collected, analysed and disseminated. Through the examination of demographic patterns, it is possible to identify suitable locations for those centres and ensure that they are accessible to all members of the community. Such an approach also involves the use of geostatistical techniques to assess the distribution of economic activities, residential areas and amenities. An understanding of the quantitative descriptions of urban patterns and their spatial structures enables effectively planning and allocation of land use and related human activities and infrastructures. Ultimately, that holistic approach will lead to more vibrant and liveable cities with a well-designed spatial framework to support the needs and aspirations of inhabitants.

Map 1
Eight suitable sites for a compact polycentric city model, Luanda
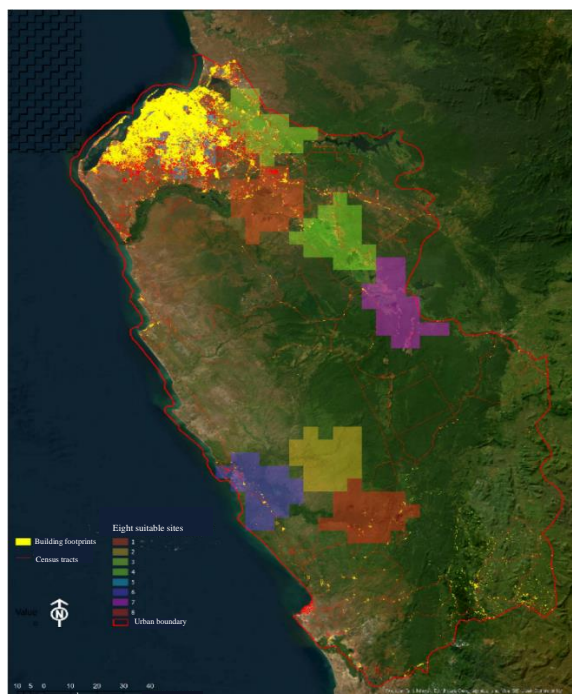
Source: Geospatial Information Services Section, African Centre for Statistics, Economic Commission for Africa, 2024.

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[12] Material on the maps appearing in the present document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

19.   In the ever-growing world of urban development, the concept of compact polycentric cities has gained significant traction. That approach is aimed at creating multiple self-sufficient urban centres within a larger city, thereby promoting efficient land use and reducing the need for long-distance travel. However, to successfully implement that model, planners must consider a multitude of factors, from infrastructure distribution to building types and natural elements. Using such measures as a built-up surface spatial raster, building heights and land-use patterns are crucial for creating a detailed understanding of the current distribution of built-up areas and guiding decisions on optimizing spatial efficiency. Moreover, anticipating population growth, distribution and changes is essential for sustainable development within a polycentric framework, as is understanding urbanization trends and patterns. Using a holistic approach in which environmental factors, household characteristics and infrastructure quality are also considered is key to creating functional and resilient urban spaces. In that context, the integration of such features as transport infrastructure, digital elevation models and temperature and soil data highlights the range of considerations necessary for creating liveable and sustainable cities. By analysing those factors, planners can design compact polycentric models in which land use is optimized and a balanced distribution of resources and opportunities is promoted.

20.   As the capital and largest city in Angola, Luanda faces rapid urbanization and development pressures, which makes it essential to consider the city's unique challenges and opportunities. By applying a compact polycentric urban model, planners can strive to create a more sustainable and efficient urban environment for the city's growing population. To do so, such factors as the current distribution of built-up areas, the heights of buildings and built-up volume changes must be carefully analysed to identify suitable locations for developing multiple urban centres within the city. That approach can help to create a more balanced distribution of resources and amenities throughout Luanda, ensuring a more equitable and liveable city. In addition, the consideration of land-use patterns is crucial for promoting efficient spatial planning and optimizing land use, while also anticipating future population density and distribution. By incorporating such features as natural areas, waterways and green spaces into the urban framework of Luanda, planners can enhance liveability, promote sustainability and mitigate the impact of rapid urbanization on the city's environment.

B.   Promote compactness, the mixed use of land and the efficient use of space

21.   Cities are constantly evolving and expanding, which presents the challenge of using limited space efficiently. The solution lies in taking a holistic approach in which a range of critical factors are considered. A built-up spatial raster, building heights and built-up volume changes act as the foundation for creating compact urban structures. Those variables, with their high suitability values, have a direct impact on spatial layout and densification, which sets the course for efficient land use. However, to truly achieve compactness and sustainability, other factors must also be considered, including land-use patterns, infrastructure distribution, population density and urbanization trends. The mixed use of land, well-planned infrastructure and higher population densities all work together to optimize space and promote the efficient use of urban areas.

22.   Utilizing geospatial data analysis can greatly aid in promoting compactness, as it provides a comprehensive understanding of a city's land-use patterns (see map 2). By analysing those data, urban planners can identify areas that are suitable for densification and the mixed use of land. That can include designating areas for mixed-use developments, combining residential and

commercial spaces, and maximizing the use of available space. Applying geostatistical methods to determine optimal land allocation can further ensure that space is used efficiently and effectively. That data-driven approach allows for strategic decision-making in the context of urban development, ultimately leading to a more liveable and sustainable city.

Map 2
Suitable locations for compactness, the mixed use of land and the efficient use of space in the city model for Luanda
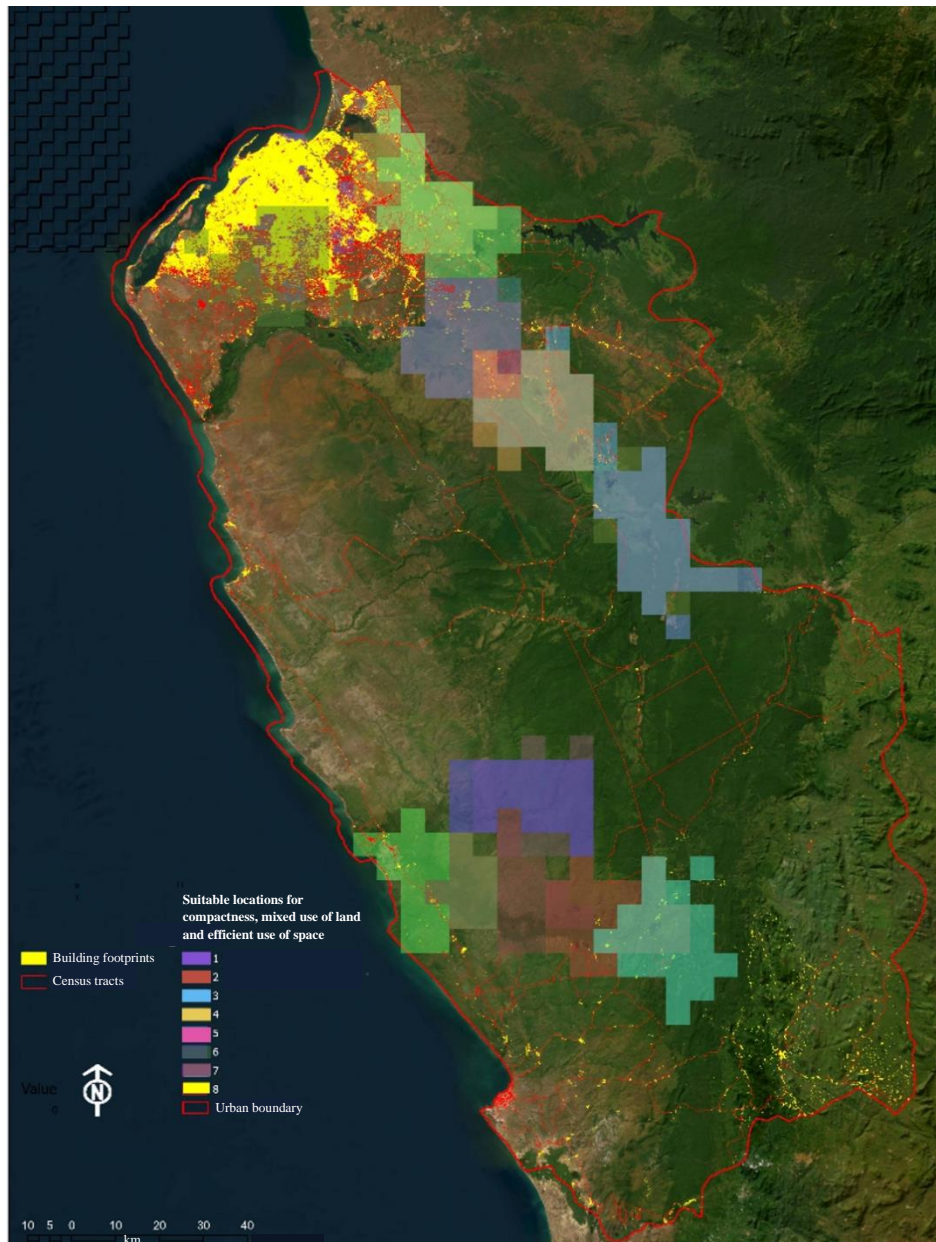
Source: Geospatial Information Services Section, Centre for Statistics, Economic Commission for Africa, 2024.

23. With its rapidly growing population and urbanization, Luanda is facing numerous challenges related to land use, infrastructure and socioeconomic development. However, by applying the principles of promoting the compact and efficient use of space, city planners can work towards more sustainable and liveable urban development. That can be achieved with the consideration of such factors as the built-up surface spatial raster, building heights and volumes, land-use patterns, infrastructure distribution, population density and urbanization trends. By promoting density, patterns of the mixed use of land

and well-distributed infrastructure, the city's urban planners can optimize land use and address spatial demands within the city. Furthermore, incorporating socioeconomic factors, such as household characteristics and access to amenities, can contribute to creating a vibrant and inclusive urban environment. By using a holistic approach to urban planning and development, city planners can create a more sustainable and efficient future for the residents of Luanda.

C. Foster social equity and affordable housing

24. One way to achieve social equity is through the use of geospatial analysis, a powerful tool with which the power of data and maps is harnessed to pinpoint areas with a high concentration of vulnerable populations and inadequate access to affordable housing (see map 3). By applying geostatistical techniques, it is possible to gain a thorough understanding of the spatial patterns of socioeconomic indicators, which can then be used to guide the distribution of housing and infrastructure in an equitable manner. Using that approach not only helps to address the root causes of social and economic disparities, but also ensures that resources and support are directed to those who need it most. By fostering social equity and affordable housing using geospatial analysis, it is possible to take a significant step towards building a more inclusive and just society.

Map 3
Social equity and affordable housing in the city model for Luanda
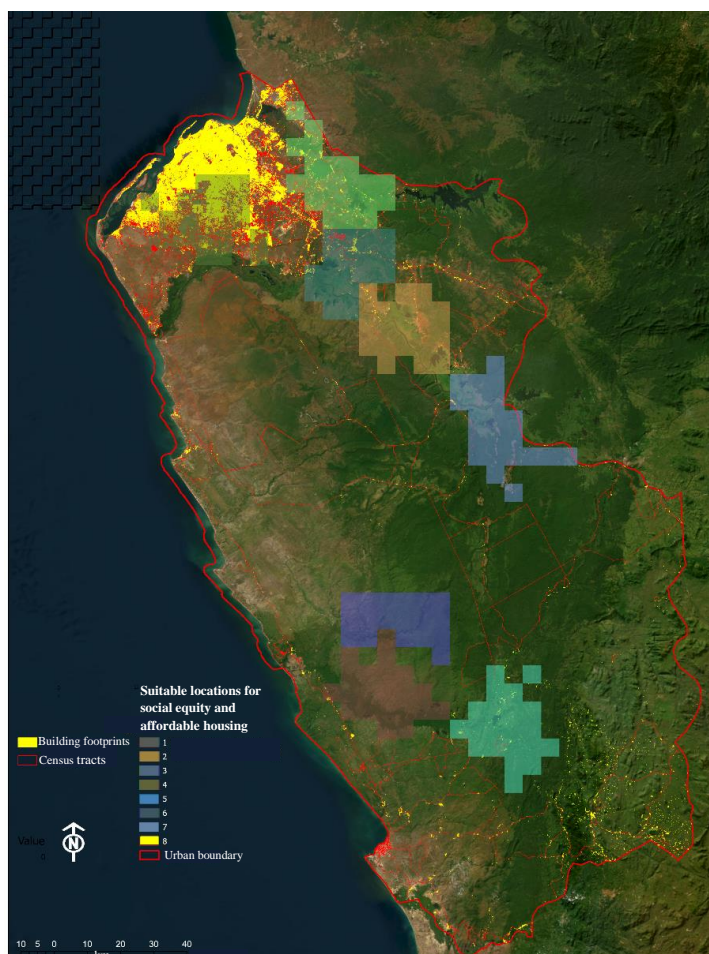
Source: Geospatial Information Services Section, African Centre for Statistics, Economic Commission for Africa, 2024.

25. To foster social equity and provide affordable housing, it is crucial to consider various spatial factors in the planning and development process. An

essential tool for that is the built-up surface spatial raster, which provides detailed information on urban areas and aids in identifying suitable locations for affordable housing developments. Changes in building heights and volumes also play a significant role, as taller buildings can increase housing density; however, careful consideration is required to ensure affordability and social equity. Understanding land-use patterns can also help in identifying appropriate areas for affordable housing and in promoting the mixed use of land for a more equitable distribution. Infrastructure distribution is another critical factor, as equitable access to basic services is vital for residents of affordable housing. Population density, growth, distribution and other changes also need to be considered in affordable housing strategies so that future housing needs can be met while social equity goals can be addressed. Urbanization trends and patterns play a crucial role in planning for affordable housing that is aligned with the city's growth and social equity goals. By taking spatial factors into consideration, it is possible to create affordable housing developments that not only cater to diverse housing needs but also contribute to social equity and a thriving community.

26.   As Luanda continues to experience rapid growth, the utilization of geospatial analysis and the consideration of such factors as land-use patterns, building heights, infrastructure distribution and population density can assist urban planners in targeting interventions to promote social equity and ensure access to affordable housing. If areas with high concentrations of vulnerable populations or inadequate access to housing options are identified, interventions can be effectively tailored to specific needs. Furthermore, understanding trends and patterns in urbanization and population growth will inform housing strategies to meet future needs while promoting social equity goals.

D.   Enhance connectivity and mobility

27.   The state of connectivity and mobility in a city goes hand in hand with its economic growth, overall liveability and environmental impact. In this fast-paced world, it is crucial for urban planners to constantly innovate and improve transportation networks. One powerful tool that can significantly aid in that endeavour is geospatial data and analysis. By utilizing geostatistics, planners can pinpoint the bottlenecks, congestion hotspots and gaps in connectivity that hinder efficient mobility within the city (see map 4). That valuable information enables them to create data-driven solutions to optimize transportation systems, design more efficient routes, enhance public transport services and implement smart traffic management solutions. Furthermore, geospatial analysis allows for the prediction of future transportation needs, which helps urban developers to proactively plan for an ever-growing population, changing urban development dynamics and evolving travel behaviour. The power of geospatial technology can truly transform a city's connectivity and mobility, creating a more connected, accessible and sustainable urban environment in which the quality of life of its residents is ultimately improved. The use of geostatistics should be embraced so that a better and more efficient urban landscape can be created.

Map 4
Enhanced connectivity and mobility in the city model for Luanda
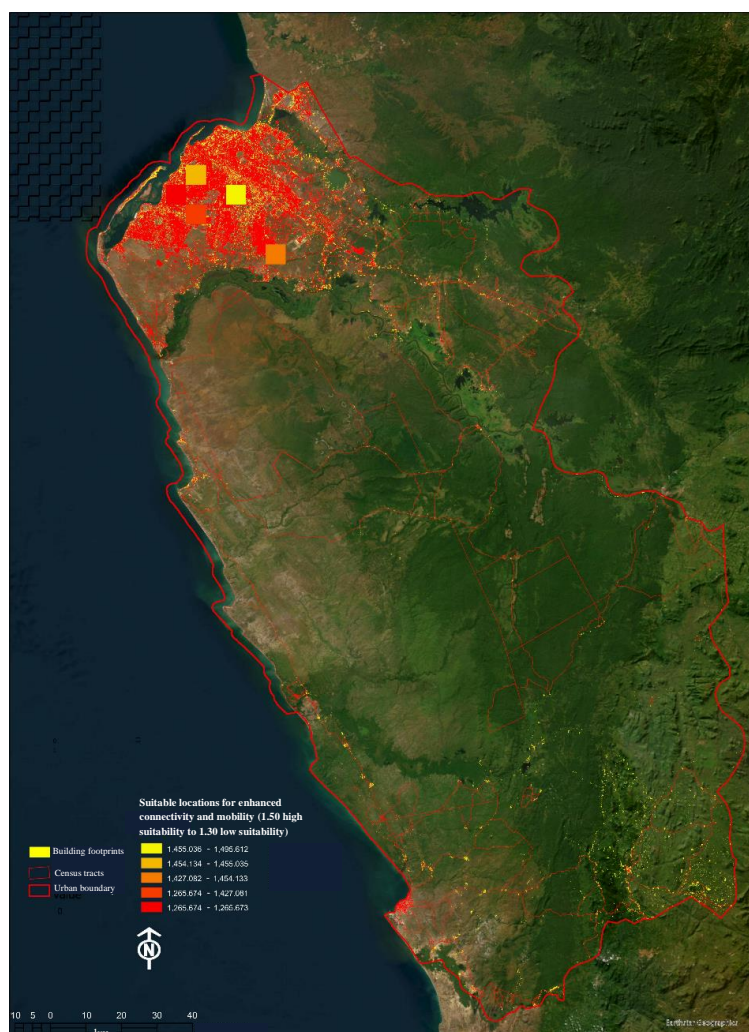
Source: Geospatial Information Services Section, African Centre for Statistics, Economic Commission for Africa, 2024.

28.   In order to truly improve connectivity and mobility in Luanda through the incorporation of geospatial analysis and attention paid to important elements (such as the built-up surface spatial raster, building heights and built-up volume changes), the city's infrastructure and transportation network planning can be optimized. The positive suitability scores for such factors as population density, urbanization trends and the presence of hospitals highlight their crucial role in fostering connectivity and mobility in Luanda.

E.   Build resilience to shocks and stresses

29.   In light of the increasing frequency and severity of natural disasters and climate change impacts, it is more critical than ever to build resilience in communities and infrastructure. That task is multifaceted, requiring a multidisciplinary approach in which geospatial data analysis is integrated with geostatistics. With the use of geospatial data analysis, including climate and hazard data, it is possible to identify areas that are most susceptible to those crises (see map 5). By employing geostatistical techniques, it is possible to assess the vulnerability and risk levels of different locations, which would provide crucial information for effective land-use planning and infrastructure design. Using that comprehensive approach ensures that communities and infrastructure are better prepared to withstand and recover from shocks and

stresses, ultimately increasing resilience in the face of adversity. The integration of geospatial data analysis and geostatistics is crucial for creating more sustainable, resilient and safer communities, which would allow communities to better prepare for and mitigate future shocks and stresses.

Map 5
Locations for building resistance to shocks and stresses in the city model for Luanda
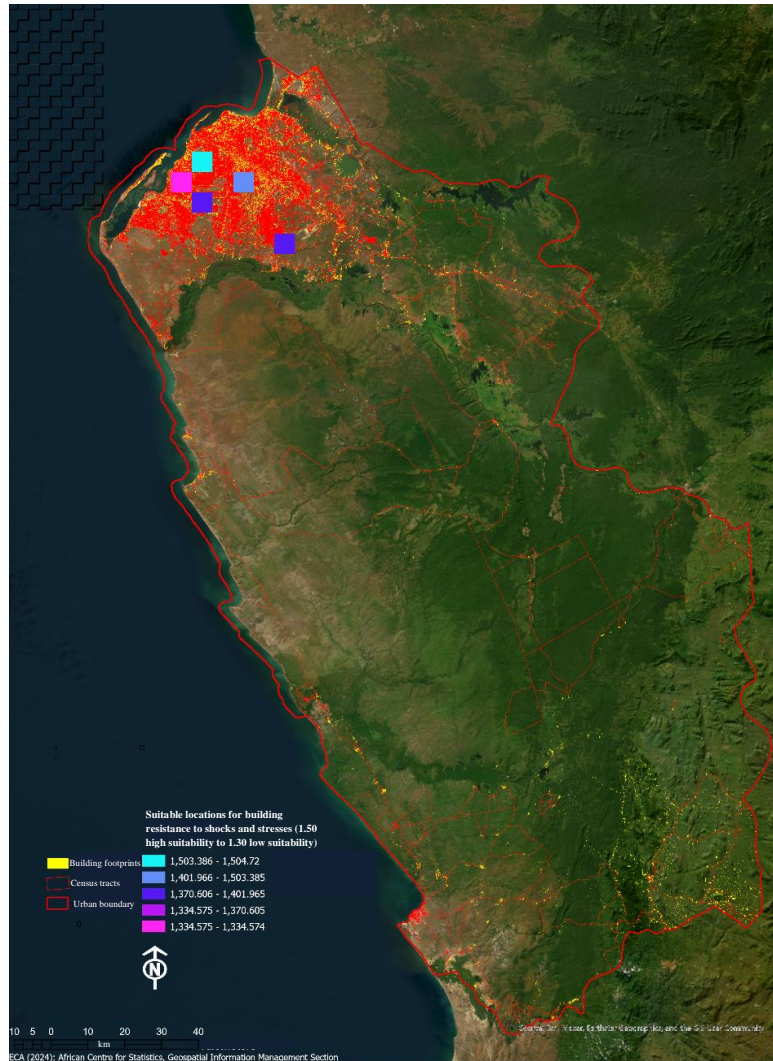
Source: Geospatial Information Services Section, African Centre for Statistics, Economic Commission for Africa, 2024.

30. To effectively and comprehensively prepare for shocks and stresses, such as natural disasters and climate change impacts, a wide range of important factors must be considered. Key among those are population dynamics, infrastructure distribution, access to clean water and the presence of hospitals within a community. Taking a holistic approach that includes understanding and managing population growth, distribution and other changes is crucial in planning resilient communities. That enables communities to accommodate changing demographic patterns and promote sustainable development. Furthermore, infrastructure distribution plays a vital role in resilience, as it ensures access to essential services and resources during times of crisis.

31. As a bustling urban centre, Luanda faces a unique set of challenges with regard to building resilience. With such factors as population dynamics, infrastructure distribution and access to clean water and health-care facilities all playing critical roles, it is essential to approach planning with a holistic and

proactive mindset. The city's population growth and distribution must be carefully managed to accommodate evolving demographics, while access to essential services and resources during times of crisis must be ensured through strategic infrastructure distribution. The city's vulnerability to climate change and its reliance on water make the efficient management of waterways and access to clean water crucial for resilience. Furthermore, well-equipped hospitals are vital for enhancing community resilience and preparedness to respond effectively to emergencies. By incorporating those main factors into strategic planning tailored to the specific needs of Luanda, a strong foundation for resilience and sustainability can be established in the city.

F.   Promote economic growth and innovation

32.   Through the use of geostatistics, economists and policymakers can harness the power of geospatial data to drive economic growth and spur innovation. Through the careful analysis of geographical patterns and trends, it is possible to identify important areas with untapped potential for development and progress. That approach can be thought of as a treasure map for decision makers to locate clusters of start-up activities, research institutions and other hubs of innovation. Armed with that knowledge, they can make informed decisions on where to invest resources and how to nurture talent and create a business-friendly environment to fuel growth and innovation. That data-driven approach equips leaders with powerful insights and enables them to put strategic plans into action, ultimately leading to a more vibrant and prosperous economy. Embracing geostatistics would unlock the potential of using the geographical landscape for a better tomorrow.

33.   For a city such as Luanda, it is crucial that city planners consider the diverse spatial variables that influence the city's economic landscape. At the forefront of urban planning efforts must be an understanding of the built-up surface spatial raster, building heights, built-up volume changes, building types, land-use patterns, infrastructure distribution, population density, population growth and other changes, transportation, water and waterways, and the presence of hospitals. All of those factors can be helpful in the implementation of tailored strategies that foster economic growth and innovation in specific sectors. From the identification of areas ripe for development to the effective management of population density, those spatial factors provide key insights into the city's potential and offer opportunities for sustainable growth and innovative urban design. By leveraging the unique characteristics of Luanda and harnessing the power of those variables, stakeholders can pave the way for a vibrant and prosperous economic landscape that thrives on innovation and embraces sustainable development.

G.   Develop urban spatial frameworks for African cities: blueprint for the city of Luanda

34.   Creating an urban spatial framework for Luanda is an intricate process that requires a combination of advanced techniques. It involves harnessing geospatial data analysis to gain insights into the city's geographical features, such as the topography, land-use patterns and transportation networks. The framework would not only serve as a foundation for informed decision-making but also allow for a thorough understanding of the city's existing spatial patterns. It is essential to identify suitable locations for various developments, which requires a detailed analysis of such factors as accessibility, land availability and environmental considerations. In addition, optimizing existing infrastructure and planning for future developments play crucial roles in enhancing the connectivity and overall functionality of the city. Furthermore, assessing vulnerabilities, such as environmental risks, and integrating

resilience measures into the framework are essential for sustainable and inclusive urban development in Luanda. Through that meticulous process, a comprehensive and well-informed urban spatial framework can be created to guide the city towards a prosperous and resilient future.

VII. Conclusion

A. Develop a compact polycentric urban model for building urban spatial frameworks

35.   As concluded through the study on Luanda, it is important to emphasize implement a compact polycentric urban model to address the challenges of rapid urbanization and development pressures. By carefully analysing such factors as the current distribution of built-up areas, building heights, land-use patterns and population density, planners can identify suitable locations for developing multiple urban centres within Luanda. That approach is aimed at creating a more sustainable, efficient and liveable urban environment for the city's growing population. By integrating such features as natural areas, waterways and green spaces, and focusing on transport infrastructure and traffic patterns, planners can enhance the city's liveability, promote sustainability and manage the impact of rapid urbanization effectively. Ultimately, tailoring urban planning considerations to the unique context of Luanda would lead to the creation of a resilient and vibrant city where the needs of its inhabitants are met.

B. Promote compactness, the mixed use of land and the efficient use of space

36.   When it comes to urban planning, it is crucial to prioritize compactness, the mixed use of land and the efficient use of space. That not only leads to vibrant and sustainable cities, but also helps to lessen the environmental impact of urban development. That can be achieved using geospatial data analysis, a powerful tool that allows urban planners to strategically identify areas suitable for densification and the mixed use of land. By considering such factors as the built-up spatial raster, building heights, land-use patterns, infrastructure distribution and socioeconomic aspects, the available space can be maximized and well-planned and efficient living environments can be created. That comprehensive approach to urban planning is vital for creating thriving cities in which the well-being of residents is prioritized while sustainable development is promoted. Planners in Luanda and other cities facing similar challenges can look to that integrated approach as a means to overcome obstacles and work towards a more sustainable and liveable future for all.

C. Foster social equity and affordable housing

37.   Social equity and affordable housing are not just noble ideals; they are essential for creating a thriving society. However, achieving those goals requires a multi-dimensional approach in which various factors are considered and innovative tools, such as geospatial analysis, are utilized. By leveraging geostatistical techniques, urban planners can gain a deeper understanding of spatial patterns and use that information to address disparities in access to affordable housing. That can be further enhanced through the utilization of the built-up surface spatial raster to gather crucial data on urban areas. Luanda and other similar cities can benefit greatly from such interventions, as they are aimed at promoting social equity, accommodating urban growth, repurposing existing structures and creating inclusive communities in which the well-being

of all residents is prioritized. By combining geospatial analysis with thoughtful urban planning strategies, significant strides can be made towards building a more just, equitable and sustainable society for everyone. It is through that collaborative effort that there can be a brighter future, when all individuals have access to safe, affordable and inclusive housing, regardless of their socioeconomic background.

D. Enhance connectivity and mobility

38. The vitality of connectivity and mobility in a city cannot be overstated, as it is a crucial factor in driving economic growth, improving overall liveability and mitigating environmental impacts. To achieve those goals, urban planners must utilize such cutting-edge tools as geospatial data and analysis. The use of that approach can help to identify problem areas within the city's transportation networks, allowing for the design of efficient routes and the implementation of smart traffic management solutions. Moreover, the use of geospatial analysis can empower urban developers to plan proactively for future needs while taking into consideration such factors as population growth and changing travel behaviours.

39. To enhance connectivity and mobility in Luanda, a comprehensive strategy is crucial. By utilizing geospatial analysis and focusing on such critical elements as the built-up surface spatial raster, building heights and urbanization trends, planners can optimize the city's infrastructure and transportation network planning. Furthermore, if such factors as population density, health-care accessibility and urbanization trends are taken into consideration, the development of public transportation systems can be tailored to the city's unique needs. In addition, the incorporation of data-driven insights on land-use patterns and infrastructure distribution can strategically enhance urban planning efforts, which would create a more connected, vibrant and liveable city for its diverse residents. By prioritizing the enhancement of connectivity and mobility, stakeholders can establish Luanda as a modern, dynamic and cohesive city for its residents.

E. Build resilience to shocks and stresses

40. Building resilience to shocks and stresses, such as natural disasters and climate change impacts, requires a multifaceted approach in which geospatial data analysis is integrated with geostatistics. By leveraging such tools as geostatistical techniques and climate data analysis, communities can identify vulnerabilities, assess risks and strategically plan land-use and infrastructure development to better withstand and recover from adverse events. Incorporating main factors, such as population dynamics, infrastructure distribution, and access to clean water and health-care facilities, is crucial for comprehensive and effective resilience-building strategies. By tailoring strategic planning to address specific challenges faced in urban centres such as Luanda, communities can establish a strong foundation for resilience and sustainability, enabling them to thrive in the face of future adversities.

F. Promote economic growth and innovation

41. The integration of geostatistics and geospatial data analysis into economic planning and policymaking holds immense potential to drive growth and innovation globally. By dissecting geographical patterns, decision makers can pinpoint areas with unrealized possibilities for advancement. That data-driven approach acts as a guiding map, directing investments towards areas of entrepreneurial activity, research centres and innovation hubs. Through the

strategic allocation of resources and the fostering of talent, leaders can cultivate environments conducive to growth and progress. Embracing geostatistics empowers policymakers to make informed decisions and implement targeted strategies, thereby shaping a dynamic and prosperous economy. Moreover, as demonstrated by the case of Luanda, understanding diverse spatial variables is essential in urban planning efforts to fuel economic development and innovation. By harnessing those insights and tailoring strategies to specific spatial characteristics, stakeholders can unlock the city's potential, drive sustainable growth and foster a thriving economic landscape rooted in innovation.

G. Develop urban spatial frameworks for African cities

42.   There is an urgent need for sustainable and resilient urban planning for African cities with an emphasis on developing urban spatial frameworks, as illustrated in the case study for Luanda. In that study, a compact polycentric urban model is used to provide an effective solution to the challenges of rapid urbanization, such as informal settlements and inadequate infrastructure. In that model, geospatial data and geostatistical techniques are used to determine suitable locations to develop economic activity centres, promote social equity and affordable housing, improve connectivity and mobility, and build resilience to shocks and stresses. Using geospatial analysis for land-use planning, optimizing infrastructure and assessing risk in order to drive economic growth and innovation is critical on the continent, and developing urban spatial frameworks is appropriate to attain that goal. The comprehensive approach of developing urban spatial frameworks is aimed at creating sustainable, equitable, connected, resilient and economically vibrant cities throughout Africa. Utilizing geospatial data and geostatistics is considered crucial to achieving those goals and promoting a better quality of life for urban residents.

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