Data Article

Long-term urban land use data in Maputo, Mozambique: A comprehensive dataset covering five decades (1964-2001)

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ABSTRACT

Rapid urban change and expansion pose significant challenges in the Global South, and Maputo, Mozambique, is no exception to this phenomenon. Among the multifaceted dimensions of urban transformations, land use stands out as a key factor in urban planning. The implications on environmental aspects, availability of land for public services, and overall quality of life make understanding these issues crucial.

This paper aims to address the afore mentioned challenges through a two-fold approach. Firstly, it provides open and free access to urban land use maps of Maputo city spanning five decades in a Geographic Information System (GIS) format, enabling the comprehensive study of the city's transformation over time. Secondly, it presents a detailed and comparable classification and nomenclature of urban land use, ensuring consistency and comparability in research and planning endeavors.

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The land use maps were created using image interpretation techniques, incorporating remote sensing data such as aerial photographs and high-resolution satellite images, as well as fieldwork and ancillary data. By combining these diverse sources, a comprehensive and accurate representation of Maputo's urban land use shapes was achieved.

This study contributes to the understanding of urban dynamics and their impacts on various aspects of city life in Maputo. The open access data and detailed classification presented here serve as valuable resources for researchers, planners, and policymakers, facilitating informed decision-making, sustainable development, and effective urban management in Maputo and beyond.

Specifications Table

Subject	Social Sciences (Geography, Urban Planning)
Specific subject area	Urban land use classification, Urban land use map, GIS
Type of data	Vector (shapefile – polygon)
How the data were acquired	The reference dataset is the land use maps of the city of Maputo, except for KaTembe urban district, for the years 1964, 1973, 1982, 1991 and 2001, published by Henriques [1]. The land use of Maputo was identified based on i) visual interpretation of aerial photographs, orthophoto maps and IKONOS satellite images; ii) ancillary data, such as the Urbanisation Master Plan (1969) and the Maputo City Addressing Map (1997); iii) several field survey campaigns. The paper maps and a detailed description of the methodology can be found in Henriques [1]. This dataset represents the digital version of the maps, wherein the topology has been verified and corrected in a GIS environment. Furthermore, the land use classification and nomenclature have been thoroughly revised.
Data format	Raw data (shapefile, ESRI)
Description of data collection	The original maps have been revised and made available in digital format through international open access repositories, in both Portuguese and English. The urban land use classification and nomenclature of Maputo has been modified, with the main aim of making it useful for the planning and management of the city, suitable for international dissemination and to be comparable with other African cities. The mapping process has undergone a topological verification/correction, and the attribute table has been modified to reflect the revised classification and nomenclature.
Data source location	The data cover the area of Maputo city, the capital of Mozambique, excluding the urban district of KaTembe.
Data accessibility	Repository name: Zenodo Data identification number: 10.5281/zenodo.8089260 Direct URL to data: https://doi.org/10.5281/zenodo.8069020

1. Value of the Data

- This is the only freely available digital dataset on urban land use in the city of Maputo for the second half of the 20th century (an update covering the last two decades is currently in progress).
- The maps are provided in vector format, making them compatible and user-friendly for utilization in GIS applications.
- The results of the urban land use classification serve as fundamental data that can be employed as a baseline for monitoring the urban land use change in the study area.
- The data is useful for researchers, urban planners and professionals working in the field.

2. Objective

Making the urban land use maps of Maputo freely accessible and providing information in a GIS-friendly format not only contributes to the study of urban land use change in Maputo but also ensures comparability with other African cities, promoting regional collaboration and best practices. Additionally, enhancing information accessibility for non-Portuguese speaking users fosters inclusivity and wider knowledge sharing on Maputo's urban development.

3. Data Description

This dataset comprises land use maps of Maputo city, excluding the urban district of KaTembe, for the years 1964, 1973, 1982, 1991 and 2001.

Urban land use has been classified according to a hierarchical classification system, and Levels I and II are available in this dataset. The detailed hierarchical nomenclature is described in Portuguese and English (Table 1).

Final maps, available in ESRI shapefile format, are provided in the local UTM projection (WGS 84 UTM 36 South - EPSG: 32376). They include predefined symbology-legend files for the two classification levels, for use in QGIS and ArcGIS. Additionally, each polygon is annotated with a code and description, for each level (Table 2).

Fig. 1 displays the land use maps for the Level I classification and the respective symbology specifically created for this purpose, spanning the decades between 1964 and 2001.

Fig. 2 illustrates the land use map of 2001, showcasing the 31 classes of Level II along with their respective symbology.

Table 1

Urban land use nomenclature (English version).

Level I		Level II		Description
Code	Class	Code	Class	
BUILT-UP AREAS	**Areas with no predominant use**			
1.0	Mixed-uses	1.0.1	Mixed-uses	Fully developed infrastructure areas, normally grid patterned, with high and low-rise buildings, where residential, commercial, cultural, and administrative activities coexist.
	Predominantly residential areas			
2.1	Residential, fully infrastructure			Residential areas, grid patterned, with paved roads and a building scheme mainly composed by:
		2.1.1	Residential, fully infrastructure, high density	. apartment blocks;
		2.1.2	Residential, fully infrastructure, medium density	. mixed, with apartment blocks and single-family dwellings;
		2.1.3	Residential, fully infrastructure, low density	. single-family dwellings.
2.2	Residential, partially deprived			Residential areas, grid patterned with unpaved roads, and building scheme mainly composed by single family dwellings, with a density:
		2.2.1	Residential, partially deprived, high density	. greater than 6,000 dwellings/km^2;
		2.2.2	Residential, partially deprived, medium density	. between 2,100 and 6,000 dwellings/km^2;
		2.2.3	Residential, partially deprived, low density	. less than 2,100 dwellings/km^2.
2.3	Residential deprived			Residential areas, with unsystematic spatial arrangement, lacking basic infrastructure, with a building scheme mainly composed by single family dwellings with a density:
		2.3.1	Residential, deprived, high density	. greater than 6,000 dwellings/km^2;
		2.3.2	Residential, deprived, medium density	. between 2,100 and 6,000 dwellings/km^2;
		2.3.3	Residential, deprived, low density	. less than 2,100 dwellings/km^2.
2.4	Residential emergent areas	2.4.1	Residential emergent areas, infrastructure	Planned, under construction single-family dwellings, interspersed with voids, in grid pattern and infrastructure areas.

Table 1 (*continued*)

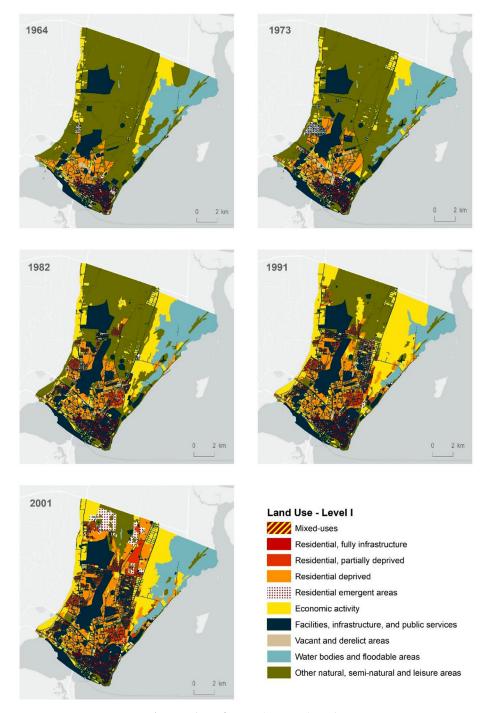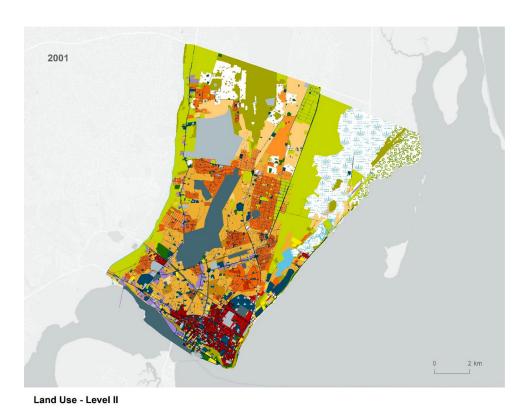|	Level I		Level II		Description
	Code	Class	Code	Class	
			2.4.2	Residential emergent areas, deprived	Under construction single-family dwellings, without a systematic spatial arrangement and infrastructure, interspersed with voids and/or natural areas.
	Non-residential areas				
	3.0	Economic activity	3.0.1	Industrial, warehousing and repair	Factories, warehouses, workshops, and construction sites.
			3.0.2	Commercial and services	Commercial activities and private services.
			3.0.3	Agriculture and livestock farming	Agricultural activity normally organised in horticultural plots or walled farms and where there may be greenhouses or poultry houses in elongated buildings.
			3.0.4	Extractive industries	Sand and salt extraction.
	4.0	Facilities, infrastructure, and public services	4.0.1	Health	Hospitals and other public health centres.
			4.0.2	Educational	Educational establishments.
			4.0.3	Other social facilities	Sports, cultural, religious, and other community support facilities, namely, for children and the elderly, market, cemetery, waste dump.
			4.0.4	Traffic and road infrastructure areas	Roads and supporting areas.
			4.0.5	Technical and transport infrastructure	Water and electricity distribution units, sanitation, telecommunications, and transport hubs.
			4.0.6	Administration services	Public administration and safety services.
			4.0.7	Other public services	Collective organisations and international representations.
NON BUILT-UP AREAS	5.0	Vacant and derelict areas	5.0.1	Vacant and derelict areas	Areas within the consolidated urban fabric, without any function and/or ruins.
	6.0	Water bodies and floodable areas	6.0.1	Mangrove	Mangrove.
			6.0.2	Other floodable areas	Other temporarily flooded areas.
			6.0.3	Water bodies and water courses	Permanently flooded areas: rivers or sea inlets.
	7.0	Other natural, semi-natural and leisure areas	7.0.1	Shrubland	Shrubland.
			7.0.2	Wooded areas, parks, and gardens	Planted tree vegetation and built-up green areas in the built-up space.
			7.0.3	Beach	Beach.
			7.0.4	Other natural areas	Bare lands.

Fig. 1. Land use of Maputo (1964–2001), Level I.

Fig. 2. Land use of Maputo in 2001, Level II.

Table 2
Urban land use records.

Variable	Type	Description
N_I_C	[string]	code of level I
N_I_D_PT	[string]	name of level I, in Portuguese
N_I_D_EN	[string]	name of level I, in English
N_II_C	[string]	code of level II
N_II_D_PT	[string]	name of level II, in Portuguese
N_II_D_EN	[string]	name of level II, in English

4. Experimental Design, Materials and Methods

4.1. Original data and methods

The original data source corresponds to the land use maps published by Henriques [1]. Using several sources (Table 3), the identification of land use was carried out in a GIS environment.

Table 3
Data sources for the identification of land use in the city of Maputo.

Sources	Type	Year / Month	Scale / Resolution
Images	Aerial photographs	1964, 1982, 1991	1:10,000; 1:20,000
	Ortophoto maps	1973	1:2,000; 1:5,000
	IKONOS-II	2000 (July); 2001 (July)	Pan: 0.7m; MSS: 4m
Documents	Urbanization Master Plan	1969	1:10,000
	Maputo City Addressing	1997	1:15,000
Field work	Functional survey	2003 - 2006	

The following procedures were used to classify land use:

(A) Visual interpretation of images, including: i) primitive-based object identification, through the study of remote sensing images [2]; ii) interpretation, based on the analysis of relationships, observed regularities, and deduction expressed through associations and correlations.; iii) Recognition of spatial patterns and delineating areas (polygons) that exhibit morphological and functional homogeneity.

(B) Verification of homogeneity and identification of typologies with a high degree of specification, through various methods, including: i) ancillary data, namely the Urbanisation Master Plan (1969) and the Maputo City Addressing (1997); ii) functional surveys, carried out between 2003 and 2006 - a crucial stage for validating the identified uses and identifying some functions that could not be detected by remote sensing. They also enabled the discrimination of use typologies at a more detailed hierarchical level.

(C) Land use classification, using a hierarchical classification system, with tree levels: Level I - contains the main forms of occupation of the territory: built-up areas (residential, economic activity and equipment and infrastructure) and unbuilt areas (empty or "natural"); Level II - distinguishes the higher hierarchical level according to its functional land use; Level III - presents classes with a high degree of specification of use, where, in addition to photo-interpretation with an important deductive component, a systematic field survey becomes indispensable.

4.2. Dataset improvement

The urban land use classification and nomenclature of Maputo was reviewed, focusing on its applicability to urban planning and management, as well as its alignment with international standards. Although there is no standard urban land classification specifically tailored for African cities, several classifications were consulted [3–8]. This dataset includes Level I and Level II (Table 1).

Level I, which comprises 10 classes, aimed at analysis for policy-making and resource management at regional or national level. The main classification criteria used are the predominant use and function and the level of infrastructure of the residential areas. As a result: i) Residential areas were renamed according to their level of infrastructure. ii) Areas with no predominant use and emerging residential areas have now been incorporated into Level I classes.

Level II, consisting of 31 classes, distinguishes the higher hierarchical level based on functional land use, making it valuable for urban planning and management, such as in the development of urban master plans. Some classes that were originally categorized under Level III have been reclassified under Level II due to their significance in the urban planning and management process. These include certain basic facilities, services, and environmentally relevant areas. The following classes are now included in Level II: Health, Education, Circulation and Transport Infrastructure Areas, and Mangroves.

Some terms have been revised, not only to accommodate the reclassification, but also to ensure compatibility with international bibliographies in English. The updated nomenclature in both language versions is available in a deliverable document. Additionally, all maps have undergone topological verification and correction, while the symbology and attributes table has been modified to reflect the revised classification and nomenclature. Symbology files have been created for both Level I and II, and they are available in Portuguese and English versions for use in ArcGIS and QGIS.

Ethics Statement

The authors adhered to Data in Brief ethical guidelines. The current study does not involve human participants nor animal experiments.

Data Availability

Urban Land Use Dataset (1964-2001) of Maputo city, Mozambique (Original data) (Zenodo)

CRediT Author Statement

Cristina D. Henriques: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing; **Ezequiel Correia:** Conceptualization, Methodology, Writing – review & editing.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] C.D. Henriques, Maputo. Cinco décadas de Mudança Territorial. O uso do solo observado por tecnologias de informação geográfica [Maputo. Five decades of territorial transformation. Land use assessed by geographical information technologies], Instituto Português de Apoio ao Desenvolvimento, Lisboa, 2008 (ISBN: 978-972-8975-22-7).

[2] T. Lillesand, R. Kiefer, J. Chipman, Remote Sensing and Image Interpretation, 7th Edition, Wiley, New York, 2015 (ISBN: 978-1-118-34328-9).

[3] CopernicusMapping Guide v6.2 for a European Urban Atlas, European Union, 2020.

[4] A. Di Gregorio, L.J.M. Jansen, Land Cover Classification System. Classification Concepts and User Manual, Land Cover Classification System. Classification Concepts and User Manual, FAO, 2005 (ISBN: 92-5-105327-8).

[5] A. Haines, et al., Land Use Resource Guide. A Guide to Preparing the Land Use Element of a Local Comprehensive Plan, Center for Land Use Education, University of Wisconsin-Stevens Point/Extension, 2005.

[6] A.R. Harrison, National Land Use Database: Land Use and Land Cover Classification. Version 4.4, Office of the Deputy Prime Minister, London, 2006.

[7] M. Simwanda, Y. Murayama, Integrating geospatial techniques for urban land use classification in the developing sub-Saharan African City of Lusaka, Zambia, Int. J. GeoInformation 6 (2017) 102, doi:10.3390/ijgi6040102.

[8] A. Weldegebriel, E. Assefa, K. Janusz, M. Tekalign, A. Van Rompaey, Spatial analysis of intra-urban land use dynamics in sub-Saharan Africa: the case of Addis Ababa (Ethiopia), Urban Sci. 5 (2021) 57, doi:10.3390/urbansci5030057.