Article

Niamey: The ages of a city

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Abstract: Over the last few decades, countries in the South have been undergoing rapid urbanization, as if to make up for lost time. Sub-Saharan Africa is characterized by a very low urbanization rate compared to0 the rest of the world. Although the African continent reached its urban transition in 2015, Niger remains by far the least urbanized country, with a rate of 17%. The city of Niamey is the main urban center, with an estimated population of 1,449,801 hbts in 2023, spread over an area of around 33,100 ha. The aim of this study is to analyze the spatial expansion of the city of Niamey from 1984 to 2023. The main data used in this study are raster images from the United States Geological Survey (USGS), vector data from Open Sources Map (OSM) and GoogleEarth, secondary data from the National Institute of Statistics (INS) and field observation. This study enabled us to conclude that between 1984 and 2023, the city of Niamey underwent very strong spatial expansion. The city grew from 4,690 ha to 33,100 ha, i.e. 28,410 ha absorbed in 39 years, with exceptional growth between 2014 and 2023, when the urban area doubled. Its population has risen from 397,437 at the time of the 1988 general population and housing census to an estimated 1,449,801 in 2023 (INS), an increase of 1,052,364 in 35 years. Between these two dates, population density fell from 87.7 to 43.8 inhabitants/km^2, i.e. half that of 1984. This spatial expansion has resulted in unprecedented peri-urbanization.

Keywords: Niamey; diachronic analysis; spatial and demographic dynamics

1. Introduction

Urbanization is a global phenomenon that manifests itself in many different ways. While the global urban transition took place in 2008 (UN), it was not until 2015 that the African continent reached its urban transition, with a rate of 50.40% (Africapolis, 2020). The Sahelian country of Niger is still very rural, with an urbanization rate of just 17% (Africapolis, 2020). For more than 3 decades, Niger has been undergoing rapid urbanization. Niamey, the country's political and administrative capital, is home to most of this population, which has a voracious appetite for its peripheral space. This large-scale spatial expansion can also be seen in major West African and Maghreb cities such as Ouagadougou in Burkina Faso (Zoma et al., 2022), Bamako in Mali (Dembele, 2017), Parakou in Benin (Edea et al., 2019), Batna in Algeria (Benyahia et al., 2017).

Niamey's urban development is characterized by a lack of public action. The city has not had a planning document for a very long time. In fact, since the 1984 Urban Development Master Plan (SDAU), which unfortunately has not been approved by the relevant authorities to make it enforceable against third parties, the city of Niamey has developed through housing estates and other developments. In 2008, a simplified planning document, the PUR (Urban Reference Plan) was drawn up, but this too was

not approved, and was quickly overtaken by the city's dynamics. Niamey therefore developed without a planning document adopted by decree. This led to all kinds of abuse and disorganization. From the 2000 s onwards, following decree N°97-306/PRN/MI/I of 08 August 1997, setting out the procedures for drawing up, approving and implementing subdivision plans, the city's spatial expansion accelerated. The liberalization of the land production sector in 1997 led to an overproduction of plots against a backdrop of land speculation by the private sector, with the country's relative political stability from 1999 to 2023 and subsequent economic growth. What is the scale of this spatial expansion of the city of Niamey? What characterizes it? What are the main factors behind it?

The aim of this study is to analyze the extent of spatial expansion in the city of Niamey from 1984 to 2023.

We hypothesize that in recent decades, the city of Niamey has experienced dizzying and disorganized spatial growth.

2. Methodology

In carrying out this study, we adopted a methodological approach that enabled us to gather the data needed to conduct a spatio-temporal analysis of the city and the factors driving it.

2.1. Description of the methodology

To understand the spatial dynamics of a city over well-defined time intervals, several methods are used in remote sensing. However, the method chosen depends on the availability of data and the degree of prior knowledge of the terrain. For the purposes of this study, the analysis of land cover changes based on raster data using ArcGIS GIS software was chosen. Using these raster data, the spatial analysis method known as "supervised classification" was chosen. This method is based on the parameterization of the software operations used to produce land-use maps. It is used when we have a good knowledge of the area, unlike "unsupervised classification". As a result, it offers more reliable results.

2.2. Data and working tools

To carry out this spatial analysis, raster image data from the USGS (United States Geological Survey) website were collected. Image quality is the key criterion. It guarantees the reliability of the results. In addition to the quality of the satellite images, complete coverage of the study area was a determining factor. According to the various predefined dates, in particular the time interval between 1984 and 2023, Landsat 5, Landsat 7, Landsat 8 and Landsat 9 images from the USGS site were used.

In addition to this raster data, we also used shapefiles to define the boundaries of the study area and locate the city's infrastructure. These shapefiles are mainly derived from the OSM (Open Sources Map) database, but also from vectorized Google Earth backgrounds.

2.2.1. Data selection and acquisition

For the purposes of this study, which aims to carry out a diachronic analysis of the urbanization process in the city of Niamey from 1984 to 2023, the year 1984 has

been chosen as the starting point, as it corresponds to the year in which the last Urban Development Master Plan (SDAU) for the city of Niamey was drawn up. As for the year 2023, it corresponds to the date of our research period. The forty or so years covered by the study are basically divided into four intervals of ten years each. However, given the poor quality of some of the raster images acquired, a slight offset was necessary. The intervals are therefore shifted to correspond to the years 1984–1992–2003–2014–2023, i.e. intervals of 8 years, 11 years, 11 years and 9 years, fairly close to the ten-year target we have defined.

The analysis process is conducted in five main stages, as detailed in **Figure 1**.
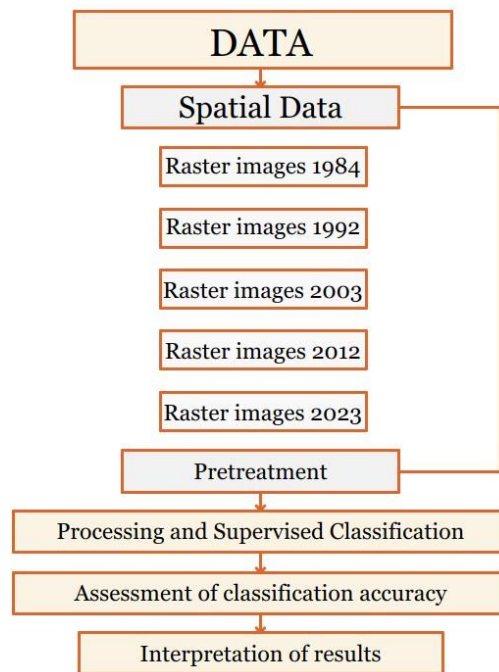

Figure 1. Spatial analysis methods and tools.

Source: Djakjak et al., (2020).

In addition, to enhance the reliability of the results and ultimately calculate the density of built-up areas within the urban perimeter of the city of Niamey, the latter is vectorized for the same periods using Google Earth software, which has the advantage of offering better image quality than raster data. Combining these two types of data enhances the reliability of the results and introduces a new approach to spatial analysis. That of highlighting building density on a city scale.

Table 1 below summarizes the characteristics of the different raster images used in the spatial occupancy analysis process.

Table 1. Years selected and characteristics of Landsat images.

Year	1984	1992	2003	2014	2023
Images Landsat	Landsat 5	Landsat 5	Landsat 7	Landsat 8	Landsat 9
Landsat image references	LT05_L2SP_193051_1984_11_14	LT05_L1TP_193051_1994_03_31	LE07_L1TP_193051_2003_02_12	LC08_L1TP_193051_20140306	LC09_L1TP_193051_2023-05-26
General Resolution	30 m	30 m	30 m	30 m	30 m

These images have a general resolution of 30 meters. On the basis of these images, we proceeded to extract the built environment in order to bring out the land-use maps both in the center and in the outlying districts of the city. This enabled us to highlight the limits of the urban front. This boundary was refined and compared with the one derived from Google Earth images, which enabled us to better characterize and locate dwellings on the edge of the city.

2.2.2. Analysis of factors supporting spatial expansion in Niamey

To determine the factors supporting the city's spatial expansion, we collected secondary data (statistics, activity reports, scientific articles and books) and carried out a series of semi-directive interviews with the main players in the city's land production, including the National Director of Urban Planning, the head of the Niamey City Domain Department, developers and canvassers.

All these data enable us to analyze the city's spatial expansion.

3. Presentation of the study area: Niamey, a city straddling the river

Situated between 13°28′ and 13°35′ North Latitude and 2°03′ and 2°10′ East Longitude, Niamey lies on the left bank of the River Niger, on a plateau with an average altitude of 220 m, overlooking the alluvial plain on the right bank, which lies between 180 and 250 m above sea level (Motcho, 2020). The left bank plateau supports four of the city's five communal districts, thanks to its favorable topography for human settlement. The right bank of the river, made up solely of the Niamey V communal district, has also seen renewed interest since the construction of the Kennedy Bridge in 1970 and the completion of the second and third bridges in 2010 and 2021, which have opened up this communal district, which accounts for a large proportion of the land available to the City of Niamey. The latter is also an autonomous region covering an area of 255 Km^2, or 25,500 ha (Motcho, 2020). On the ground and on satellite imagery, the urban area covers more than 50,000 ha.
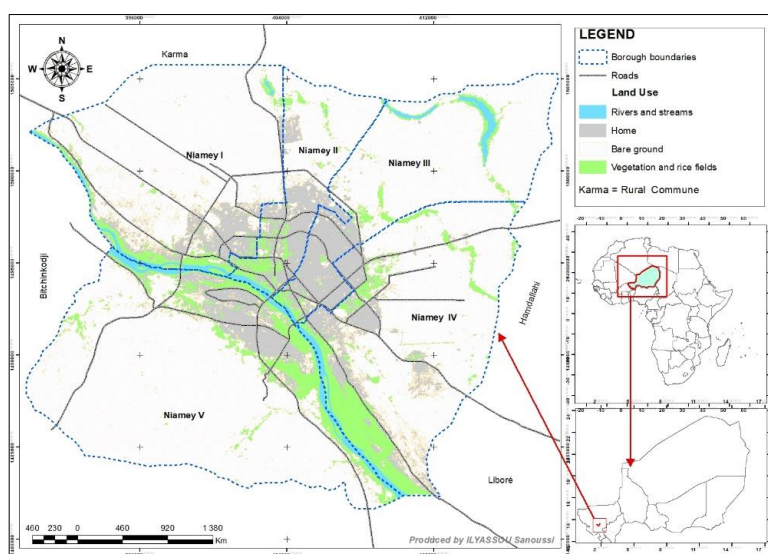

Figure 2. Presentation of the study area.

The city of Niamey is made up of five communal districts on either side of the Niger River. It is bordered to the north by the rural commune of Karma, to the south and west by the rural commune of Bitchinkodji and to the east by the rural communes of Hamdallahi and Liboré (**Figure 2**).

4. Results and discussion

In this section, we shall first present the main results we have achieved, and then discuss them, highlighting the main findings and comparing them with the existing literature.

4.1. Results

4.1.1. Rapid but disparate spatial growth

From 1984 to 2023, the city of Niamey underwent rapid spatial expansion. **Figure 3** shows a strictly increasing spatial expansion over the last thirty-nine years. It shows two important aspects of the city's physical space, namely the boundary of the urban area and the built-up area. Built-up space refers to the space occupied by buildings.
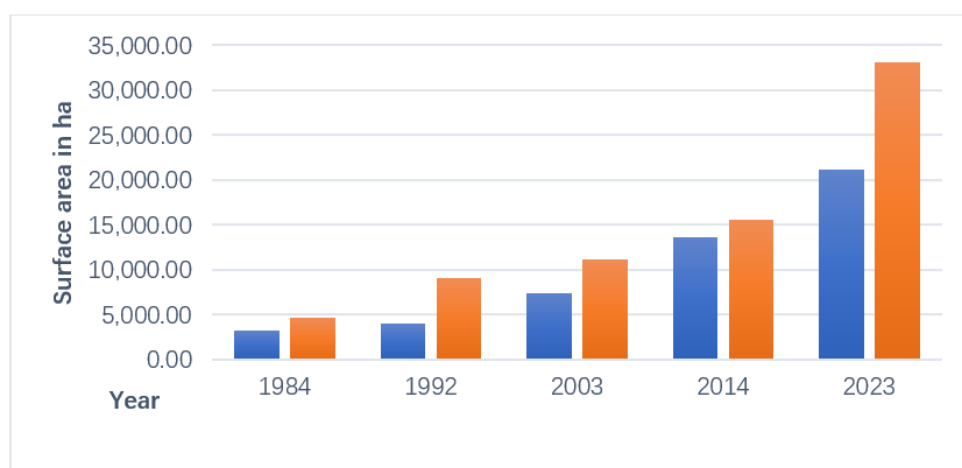

Figure 3. Urban growth in Niamey from 1984 to 2023.

Figure 3 above shows that the spatial dynamics of Niamey began to take off in 2003. Between 2003 and 2023, the city's surface area tripled from 11,100 ha to 33,100 ha. The decade from 2014 to 2023 is the turning point in the city's spatial growth. During this decade, the space occupied by the city is greater than the surface area of Niamey in 2014. It increased from 15,500 ha to 33,100 ha.

These results are shown on **Figure 4**, which illustrates the various changes in the urban area from before 1984 to 2023, with an overflow of the administrative boundary from 2014 onwards.
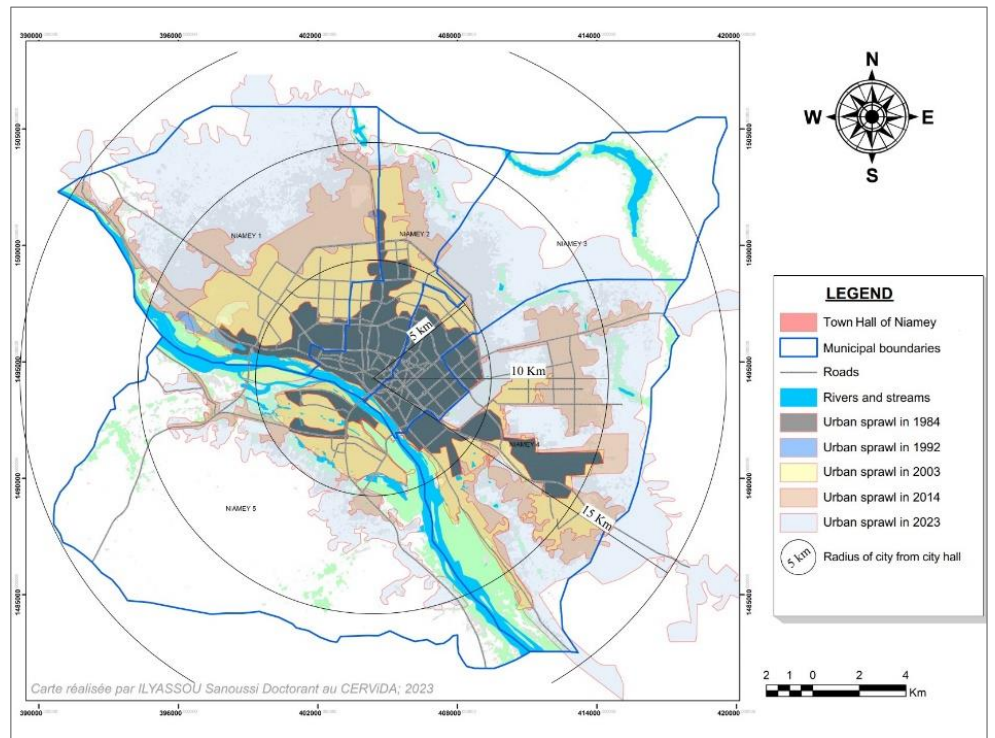
Figure 4. Spatial evolution of Niamey from 1984 to 2023.

This spatial growth took place at varying speeds over the different time intervals covered by our analysis.

4.1.2. Speed of urbanization

One of the indicators for assessing the spatial dynamics of an urban area is the speed of urbanization, which is obtained by dividing the area consumed by the time between two dates (Benyahia et al., 2017), i.e.:

$$\text{Speed of urbanization} = \frac{\text{Area consumed (ha)}}{\text{Time between two periods}}$$

Area consumed: the difference in area between a date To and a date Tn (in hectares)

Duration between two periods: the time between a date To and a date Tn (in years)

Urbanization speed: the average speed at which a city expands between date To and date Tn.

Figure 5 below shows the spatial evolution of the city of Niamey between 1984 and 2023.
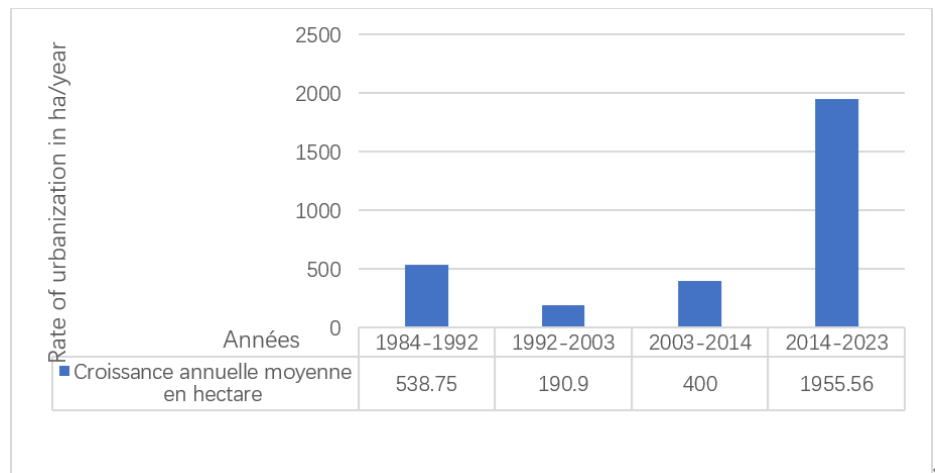
Figure 5. Average annual growth in hectares.

Figure 5 shows that the city's urbanization rate falls between 1984–1992 and 1992–2003, before rising slowly between 2003-2014 and then soaring between 2014 and 2023. This graph highlights the urban dynamic better than **Figure 4**, which shows the evolution of Niamey's urban area between 1984 and 2024.

The city's strong spatial growth has led to a sharp change in its compactness.

4.1.3 Compactness index

The compactness index, or shape coefficient, is used to assess the spatial expansion of the city, and is the ratio of the perimeter of the site to that of a circle of the same area (Benyahia et al., 2017). There are several types of compactness index. For the purposes of this study, we chose the Gravelius index, which is characterized by the fact that the closer the index value is to 1, the more compact the city. It is presented by the following formula:

$$\text{IGravelius} = \frac{P}{2\sqrt{\pi S}}$$

$I_{Gravelius}$ = Compactness index
P = Perimeter in km
S = Surface area in km^2

Figure 6 shows that in 1992 the Gravelius index was low, at around 2.91. Its highest level was recorded in 2014, with a value of 5.29. From then on, the index falls to 3.64 in 2023. So, 2014 is the year when Niamey is the least compact city.
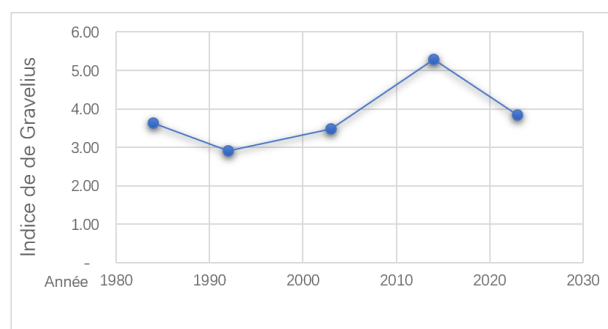

Figure 6. Trends in Niamey's compactness index from 1984 to 2023.

Source : Supervised classification ILYASSOU Sanoussi.

4.1.4. Sawtooth evolution of gross density in the city of Niamey

One of the indicators used to express a city's sprawl is its density, which is the ratio between a quantifiable element (inhabitant, job, square meter of floor space, for example) and a surface area of a reference space (Lefebvre, 2013). There are many different types of density, depending on the scale and composition of the elements and the value to be conveyed.

To fully understand urban sprawl, it's important to calculate the density of housing in relation to the empty spaces contained within the urban fabric. It's also an essential indicator for understanding mobility conditions and their cost implications. Thus, housing density is the ratio of the surface area of built-up areas to the total surface area of the city (urban area), i.e.:

$$\text{Gross density} = \frac{\text{Built} - \text{up area}}{\text{Urban area of the city}}$$

Built-up area: total area of classes corresponding to housing;

Urban footprint: the total spatial footprint of the city.

The value of gross density is between 0 and 1. The closer it is to 1, the denser the city is in terms of built-up areas, and vice versa.

According to **Figure 7**, 2014 was the year in which the city of Niamey was the densest, and 1992 the year in which it was the least dense.
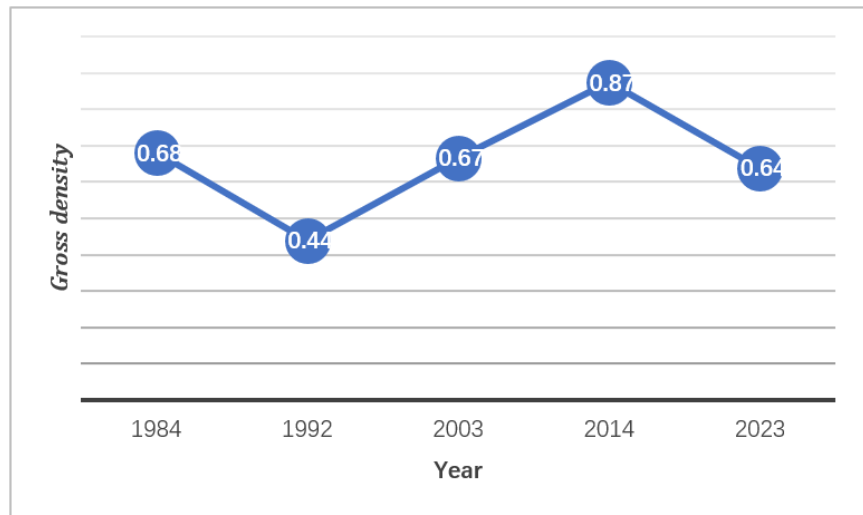

Figure 7. Gross density trends in Niamey from 1984 to 2023.

Source: Supervised classification ILYASSOU Sanoussi.

4.1.5. Factors driving Niamey's spatial expansion

The above indicators show that the city of Niamey expanded considerably between 1984 and 2023. This growth is due to a number of factors, including demographic, social and administrative factors.

The demographic factor

Demography is one of the key factors in a city's spatial growth. Data from the various RGP/H, from 1977 to 2012, reveal exponential demographic growth in the city of Niamey, as shown in **Figure 8**.
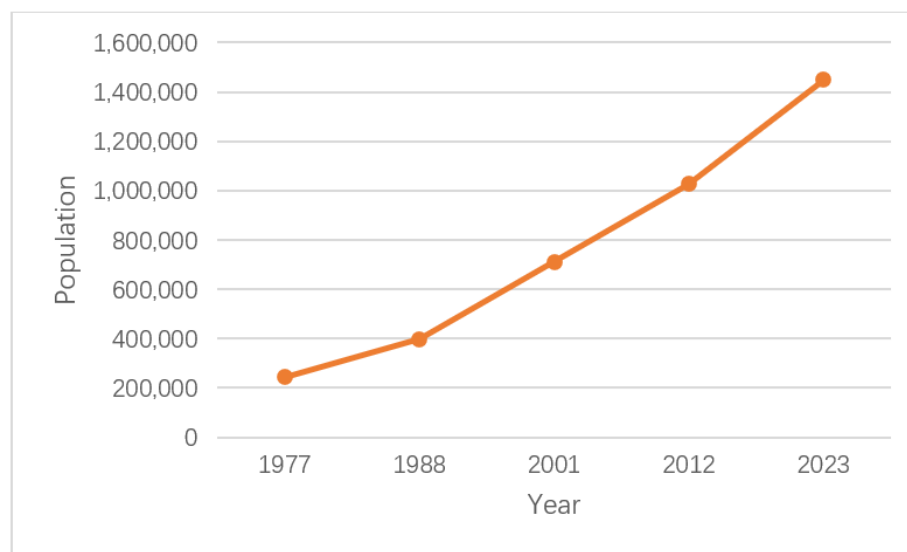
Figure 8. Population trends in Niamey from 1977 to 2023.

Figure 8 shows strict population growth in the city of Niamey, with a gradual decline in the average annual intercensal growth rate from 4.7% between 1988–2001, to 2.9% between 2001–2012 and 3.08% between 2012 and 2023 (INS, 2023).

City of Niamey.

By decree N°97-306/PRN/MI/I of 08 August 1997, setting out the conditions for establishing, approving and enforcing allotment plans, the State of Niger created the loophole that has led to land overproduction over the past 20 years. From 2006 to 2019, 16,400.89 ha were officially subdivided (according to the various subdivision authorization decrees issued by the Ministry of Urban Planning), equivalent to 1171.49 ha per year. These figures do not take into account unofficial subdivisions, or those whose surface areas are not specified on the subdivision authorization decrees. The city of Niamey is landlocked by the department of Kollo, so to take advantage of the value of their land, the communes bordering the city and private developers have carried out subdivision operations on the outskirts of Niamey. By way of illustration, between 2015 and 2019, some 3800 ha were subdivided in these surrounding communes on their borders with Niamey.

The liberalization of the land production sector has also encouraged the proliferation of real estate operations consisting either of simple subdivisions with no servicing, or subdivisions with summary servicing consisting of laying out a few lateritic roads, and placing a few electricity poles often not connected to the NIGELEC electricity network. Some developers have built a few show villas for advertising purposes only, while others have built housing estates such as the Salou Djibo and Airtel estates, or social housing built by charitable NGOs.

Figure 9 below shows the evolution of housing estates according to the data we were able to collect from 2006 to 2019.
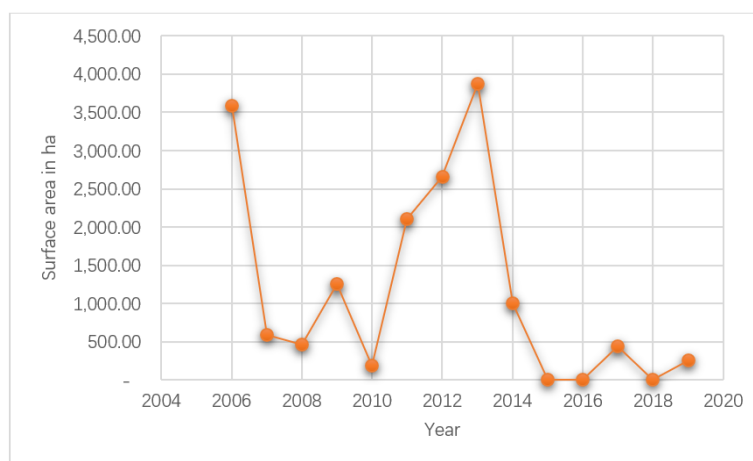
Figure 9. Development of Niamey's subdivided areas from 2006 to 2020.

According to **Figure 9**, 2006 and 2013 mark the extremes in land production over the last 20 (twenty) years, with a production record of almost 4000 ha in 2013.

Gentrification and annexation of surrounding villages.

Most of Niamey's central districts have been undergoing gentrification in recent decades. Old banco buildings are giving way to large commercial and office blocks. These neighborhoods, which were once essentially residential, are losing this function to commercial activities. The neighborhoods most affected are Lacouroussou, Maourey and Deyzebon (Adamou, 2012), located in the city's commercial triangle comprising the Katako market, the Grand Marché and the commercial wasteland left by the small market that was cleared after a fire in April 2012. Other districts have also recently been affected by this gentrification phenomenon, albeit to a lesser extent than the previous ones, and now cover virtually the entire central ring of the city.

In the course of its growth, Niamey has also annexed the first villages located nearby.

5. Discussions

Four main results emerged from our study:

(1) The city of Niamey is experiencing very strong spatial growth, with an extraordinary evolution between 2014 and 2023, resulting in a doubling of its urban area;

(2) **Figures 6** and **7** show an astonishing complicity between the city's compactness index and gross density, which are evolving in the same direction;

(3) And finally, a number of factors are driving the city's spatial expansion, including demographic growth, which is strong but less vigorous than spatial dynamics.

Staggering spatial expansion over the last two decades

A demo-spatial analysis of the city of Niamey from 1984 to 2023 reveals its vigorous growth. In 39 years, the city's spatial footprint has multiplied by 7, with the urban area doubling between 2014 and 2023. This strong growth began in 2003. From 2003 to 2023, the city's footprint tripled in 20 years, whereas from 2001 to 2023, the city's population only doubled. This shows that the city's spatial growth outstrips its demographic dynamics. This is leading to the city's spatial sprawl. This situation was also observed in the city of Lomé between 970 and 1981, when the area of the city

tripled while its population only doubled (Guézéré, 2013). At some point in their growth, African cities record high population growth, but at a lower rate than their spatial dynamics. This theory is corroborated by the cities of Parakou in Benin (Edea et al., 2022) and Batna in Algeria (Benyahia et al., 2017). This phenomenon is due, among other things, to the gentrification of central and pericentral neighborhoods, which lose their population between general population censuses as highlighted by Adamou (2012) to the benefit of peripheral neighborhoods. Our results support the view that other factors influence spatial dynamics, such as the overproduction of land following the liberalization of the subdivision sector, which led to the completion of an average of 1261.61 ha/year between 2006 and 2019, compared with 349.80 ha/year during the 1990–2000 decade (Adamou). These figures do not take into account illegal allotments, customary holdings and allotments where surface areas were deliberately omitted. To these factors must be added those of an administrative and political nature, notably the liberalization of the allotment sector by Decree N°97-306/PRN/MI/I of 08 August 1997, which opened up a loophole through which private developers rushed in, generating overproduction.

The opening up of certain areas from the 2014–2015 period, notably through the development of Boulevard Tanimoune, which has opened up a large part of the neighborhoods beyond this boulevard in the four communal districts on the left bank. It is also worth noting the strong impact of certain structuring infrastructures, including the General Reference Hospital and the women's campus of the Islamic University in Niger, as well as the road that has facilitated their accessibility, in enhancing the value of their neighborhoods through the rapid settlement of populations.

This strong spatial dynamic can be seen in both large and medium-sized sub-regional cities. For example, the city of Lomé, whose official limit is 9000 ha, already covered an area of 35,000 ha in 2010 (Tonou); the city of Bamako, which had a built-up area of 8296 ha in 1986, covered an area of 49,044 ha in 2014 (Dembelé). The Beninese secondary towns of Bahicon and Abomey had built-up areas of 501 ha and 444 ha respectively in 1986, compared with 3656 ha and 2918 ha in 2017 (Tossou et al., 2018). This strong spatial dynamic is therefore a sub-regional reality that is asserting itself in both capital cities and secondary West African towns.

An increasingly compact but less dense city

The previous result shows a strong spatial evolution of the city, with a pivotal period between 2014 and 2023. Paradoxically, the Gravelius compactness index is falling, showing that Niamey has become more compact, and therefore less linear, although the value of the index falls from 5.29 in 2014 to 3.85 in 2023, i.e. far from the optimum of 1. This reflects a gradual concentration of construction in the spaces between the national roads linking the capital to the country's other cities: this is the case along the RN1 Dosso-Niamey-Tillabéri, the RN25 Niamey-Balayera, the RN31 Niamey-Kollo and the RN24 Niamey-Ouallam.

Strong demographic growth, but still low in relation to spatial growth

The population of Niamey has grown from 242,973 in 1977 to 1,449,801 in 2023, a 6-fold increase in 46 years. These results are in line with those of Sow et al. (2014), who show that Ziguinchor's population more than tripled in 28 years (between 1960 and 1988) and almost doubled in 15 years (between 1997 and 2012).

The 2000–2020 decades have seen relative political stability in the country, leading to relative economic development and the emergence of a sizeable middle class. The latter, eager to acquire property, is creating a race to acquire land. Furthermore, the failure of the city's Urban Reference Plan, drawn up in 2008, has not helped to reframe the city's uncontrolled dynamics. The absence of a planning document remains the main cause. However, Law N°2017-20 of 12 April 2017 laying down the fundamental principles of urban planning and development, has come to create the appropriate legal framework for better urban planning on a national scale. Among other things, this law makes it compulsory for towns at all scales to have an urban planning document. these include a Master Plan for Urban Planning and Development (SDAU) for large conurbations, a Urban Reference Plan (PUR) for medium-sized towns and a Town planning sketches for market towns.

6. Conclusion

The aim of this study is to analyze the spatial expansion of the city of Niamey and to highlight the main factors that have made it possible. Our work shows that from 1960, the year of Niger's independence, to the present day, the city of Niamey has undergone rapid demographic and spatial growth. Spatial growth, however, has been faster than demographic growth. In 35 years, from 1988 to 2023, the population has multiplied by 3.6, while space has multiplied by 7. Above all, the city has been spreading out at a dizzying pace since 2014. This spatial growth is mainly due to an overproduction of land as a result of land speculation made possible by the liberalization of the subdivision sector and in a context of poor monitoring of planning documents. This urban sprawl is favored by rapid demographic growth and reinforced by the annexation of outlying villages and the gentrification of central districts, whose populations are settling in neighborhoods farther and farther from the city center, where most of the economic and administrative life is concentrated.

The main consequence of this demo-spatial growth, which shows an unprecedented spatial sprawl of the city, is the lengthening of distances for people living in outlying districts. Against a backdrop of low car ownership and a lack of urban transport infrastructure, this study opens the way to a more in-depth analysis of the impact of this spatial sprawl on the mobility of the population of outlying districts.

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