

Diversity and Availability of Green Spaces in Comparison with the World Health Organization (WHO) Standard: Evidence from Sahelian Cities of Niger, West Africa

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Abstract

As urban populations grow, accessible nature remains fundamental to balanced and resilient city planning. This study aims to assess public green spaces' typology and abundance in Niamey, Maradi, Tahoua, and Zinder cities. To identify green spaces, a transect survey method was employed alongside data acquired from the municipal authorities of these studied cities.

Findings revealed that Niger metropolises host 228 public green spaces distributed across eight specific types, including roadside trees (81.14%), urban woods (3.07%), the green belt (0.44%), memorial green spaces (0.88%), public gardens (1.75%), parks (1.32%), green roundabouts (2.63%), and squares (8.77%). The spatial configuration of these urban forests is overwhelmingly characterized by linear formations (81.14%). With an average area of 18.41 ha, this study highlights the predominance of small-sized public green spaces within these Sahelian cities. While 11.11% of urban forests exhibit no faunal occupancy, 38.64% of these green spaces are left unmaintained. Nevertheless, none of these studied municipalities achieved the World Health Organization's recommended target of 10 m² of public green space per capita for optimal livability. Consequently, municipal leaders of these four largest cities must prioritize green spaces in their upcoming urban planning strategies.

Keywords: Green spaces, biodiversity, urban ecology, Sahelian cities, Niger

Introduction

The twenty first century corresponds to a period where urban life's quality becomes a priority. Despite their small size, urban areas host more than half of world population (Center For International Earth Science Information Network, 2011). Estimated at 3.29 billion in 2007, the overall urban population is expected to be 6.4 billion by 2050. This sprawl of urban fabric could have significant effects on life quality and biodiversity conservation (Dye, 2008). In 1992, the Second Earth Summit in Kyoto recognized the vegetation to be good means of structuring urbanized settlements in developing countries (Khodja, 2000). In urban environment, green spaces are considered as main shelters of nature (Mehdi & Pietro, 2009) and act in limiting the unbroken tendency of urbanization (Choumert, 2009). This increasing urbanization context coupled with public awareness about environmental issues made urban biodiversity a scientific research subject and priority of urban public policy (Blinge, 2014; Peng et al., 2017). Consequently, vegetated areas are becoming more important especially in urban planning programs (Farkas et al., 2023). The urban forestry calls to the development and management of green areas, which are necessary to build sustainable cities (Carreiro et al., 2008). Many benefits such as social, aesthetic, environmental, and ecological functions are derived from city plants (Afuubi et al., 2021; Owusu et al., 2024; Ousseini et al., 2026a). Regarding these functions, 10 to 12 m² of green space per capita was recommended by the World Health Organization (WHO) for citizens' well-being (Ferrand, 2017; Jabot & Gall, 2019; Tassew & Fikresilassie, 2024). Unfortunately, these benefits are overlooked because urban green spaces'

integrity is facing several pressures from human activities (Abdourahamane et al., 2016). This remark has therefore lead to the occurrence of a new scientific discipline called urban ecology (McKinney, 2002). However, urban ecology research are lacking in African cities (Ousseini et al., 2026b) while facing a speedy urbanization (WUP, 2014; Bogaert et al., 2015). This phenomenon is more accentuated in West Africa where urban dwellers are less sensitive to urban vegetation due to the high density of built areas (Kouadio et al., 2016). The republic of Niger is a perfect illustration where public green spaces in cities experienced several fragmentations caused by municipalities and the Ministry of Urban Planning (Meyer, 2018). It is therefore imperative to assess the public green spaces richness for better enhancement, conservation, and sustainable utilization of this green patrimony. Consequently, this study's goal is to inventory public green spaces in these Sahelian cities of Niger in order to assess their current state and their availability compared to the recommendation set by the World Health Organization.

Methodology

Study area

The research was carried out in Sahelian major cities of Niger (Niamey, Maradi, Tahoua, and Zinder), where potential threaten of continuous urbanization lead by population explosion exists.

Capital of Niger since 1926, Niamey city is located between 13°24' and 13°35' North latitude and 20°00' and 20°15' East longitude and covers an area of 549.87 km² (**Figure 1**). Niamey is composed of five municipal districts and holds a special status or city (Niger, 2010). In 2024, the city of Niamey has a population estimated at 1,496,000 inhabitants (INS, 2019), which makes it the Niger's densely populated city.

Located between 13°27' and 13°30' North latitude and 7°5' and 7°10' East longitude (**Figure 1**), Maradi city is designated as the economic capital of Niger. With a special status or city (Niger, 2010) and occupying an area of about 73.97 km², Maradi city is subdivided into three municipal districts. The National Institute of Statistics estimated Maradi city's population at 412,364 inhabitants in 2024 (INS, 2019).

Situated at approximately 550 km from Niamey, Tahoua city is located between 14°50' and 14°58' North latitude and 5°5' and 5°24' East longitude (**Figure 1**). According to the National Institute of Statistics, Tahoua city shelters a population estimated at 232,616 inhabitants in 2024 (INS, 2019). With its two municipal districts, Tahoua urban municipality obtained a special status as a city (Niger, 2010) covering an area of 785.07 km².

Former capital of Niger, Zinder city is located between 13°37' and 13°52' North latitude and 8°56' and 9°2' East longitude (**Figure 1**), with an area of 547.27 km². In 2010, Zinder urban community was classified municipality gaining a special status or city with five municipal districts (Niger, 2010). Its population reached 631,000 inhabitants in 2024 (INS, 2019).

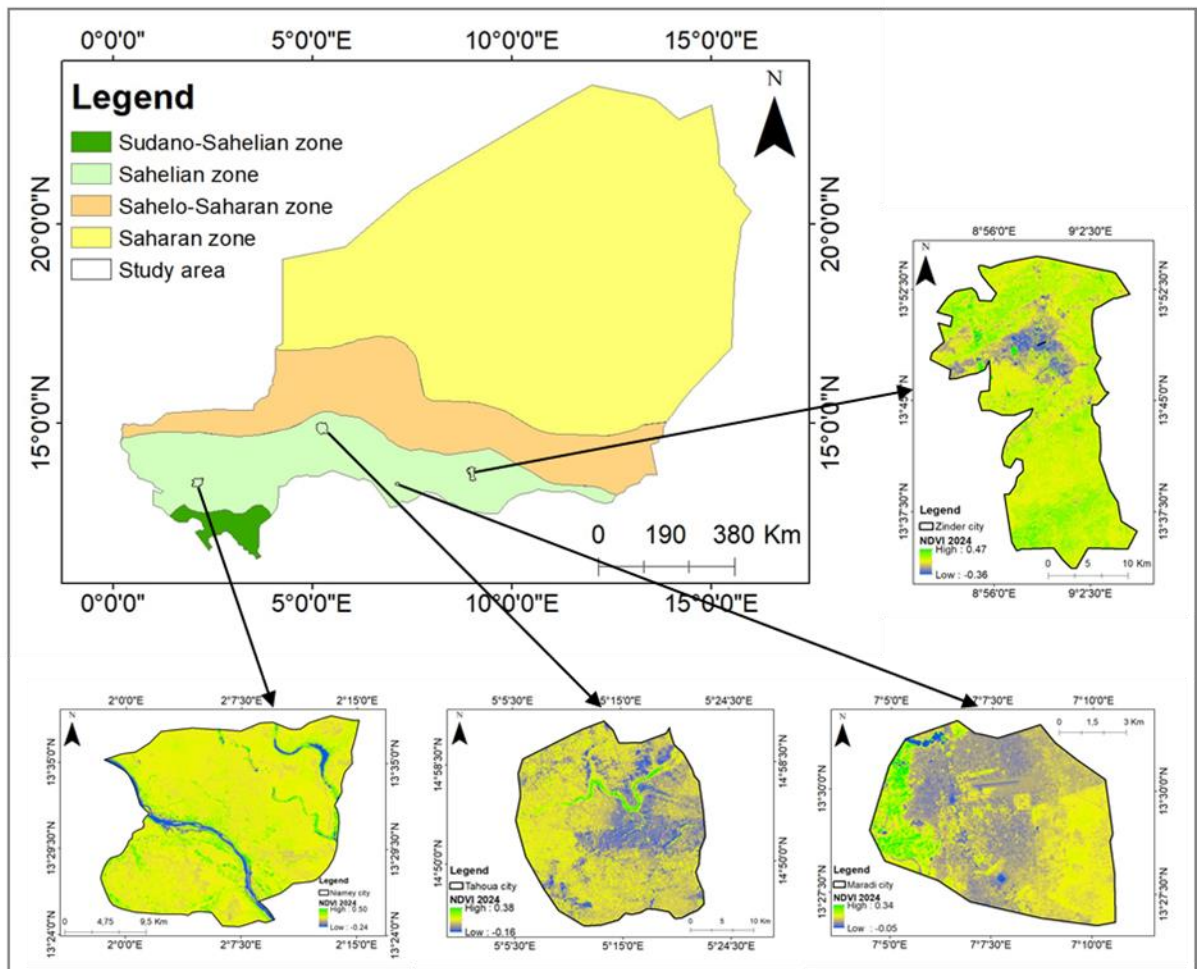


Figure 1: Study area localization map

Public green spaces sampling

For the surveys, only Niamey, Maradi, Tahoua, and Zinder cities holding the status of city under Ordinance No. 2010-56 of September 17, 2010 were concerned. Thus, in each city, the study area was divided into municipal districts based on the stratified random sampling. Then, the overall public green spaces and their characteristics encountered within each of these municipal districts were inventoried.

Field data collection

We first prioritized local authorities as information sources to make credible the field data collection. Accordingly, green spaces management services in different municipalities were preliminary consulted for the acquisition of green spaces registry in these four Sahelian cities. Thereafter, an inventory has been conducted in order to assess and document the current state of existing public green spaces within urban fabrics of studied cities. This investigation made it possible to collect information on several aspects such as the shape, the area, the type, the level of maintenance, the presence of infrastructures, the presence of potential degradation threatens, and the ability to support urban fauna.

Data analysis and processing

- **Typology of public green spaces across Nigerien cities**

For this study, the green spaces' adopted typology was based on their name, their form, and their function to ensure a consistent classification. We considered this aforementioned typology because it is structured to take into account all green spaces types independently of their location, size, or condition.

- **Availability of public green spaces across Nigerien cities**

The public green spaces' abundance was assessed by calculating certain parameters such as the density, the coverage rate, and the public green space per capita ratio.

- **Density in public green spaces (DPGS) across Nigerien cities**

The coming formula was used to calculate the density in public green spaces within Sahelian cities of Niger.

$$\text{DPGS}_x = \text{nPGS}_x / \text{TA}_x \quad (1)$$

Where: DPGS_x = density in public green spaces in a city x;

nPGS_x = number of public green spaces in a city x;

TA_x = total area of a city x.

- **Coverage rate in public green spaces (CRPGS) across Nigerien cities**

We proceeded with the calculation of the coverage rate in green spaces in the study area as follows:

$$\text{CRPGS}_x = \text{APGS}_x / \text{TA}_x \times 100 \quad (2)$$

Where: CRPGS_x = coverage rate in public green spaces in a city x;

APGS_x = area of public green spaces in a city x;

TA_x = total area of a city x.

- **Ratio in public green space per inhabitant (RPGS/I) across Nigerien cities**

The below formula was used to calculate the public green space per capita ratio within Niger's largest urban centers.

$$\text{RPGS/I}_x = \text{APGS}_x / \text{EP}_x \quad (3)$$

Where: RPGS/I_x = ratio in public green space per inhabitant in a city x;

APGS_x = area of public green spaces in a city x;

TP_x = total population of a city x. For the well-being of urban dwellers, 10 m² of public green space per capita ratio was recommended by the WHO:

-If $\text{RPGS/I}_x < 10 \text{ m}^2$: the ratio in public green space per inhabitant is not reached;

-If $\text{RPGS/I}_x \geq 10 \text{ m}^2$: the ratio in public green space per inhabitant is reached.

Results

State of public green spaces in sahelian cities of Niger.

The inventory performed within the study area enabled the identification of 228 public green spaces covering an area of 812.95 ha. Niamey city is home to 99 public green spaces, followed by Maradi and Zinder cities with 52 and 42 public green spaces, respectively. With only 35 public green spaces, Tahoua city is ranked as the least green city (**Figure 2**).

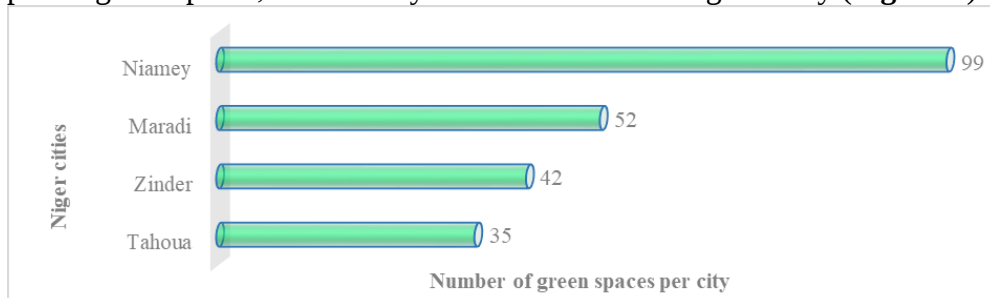


Figure 2: State of public green spaces

Classification of public green spaces in sahelian cities of Niger.

After their identification, the 228 public green spaces (PGS) were classified into eight (8) types such as roadside trees (RT) (**Plate 1, A**), urban woods (UW) (**Plate 1, B**), the green belt (GB) (**Plate 1, C**), memorial green spaces (MGS) (**Plate 1, D**), public gardens (PG) (**Plate 1, E**), parks (P) (**Plate 1, F**), green roundabouts (GR) (**Plate 1, G**), and squares (S) (**Plate 1, H**).

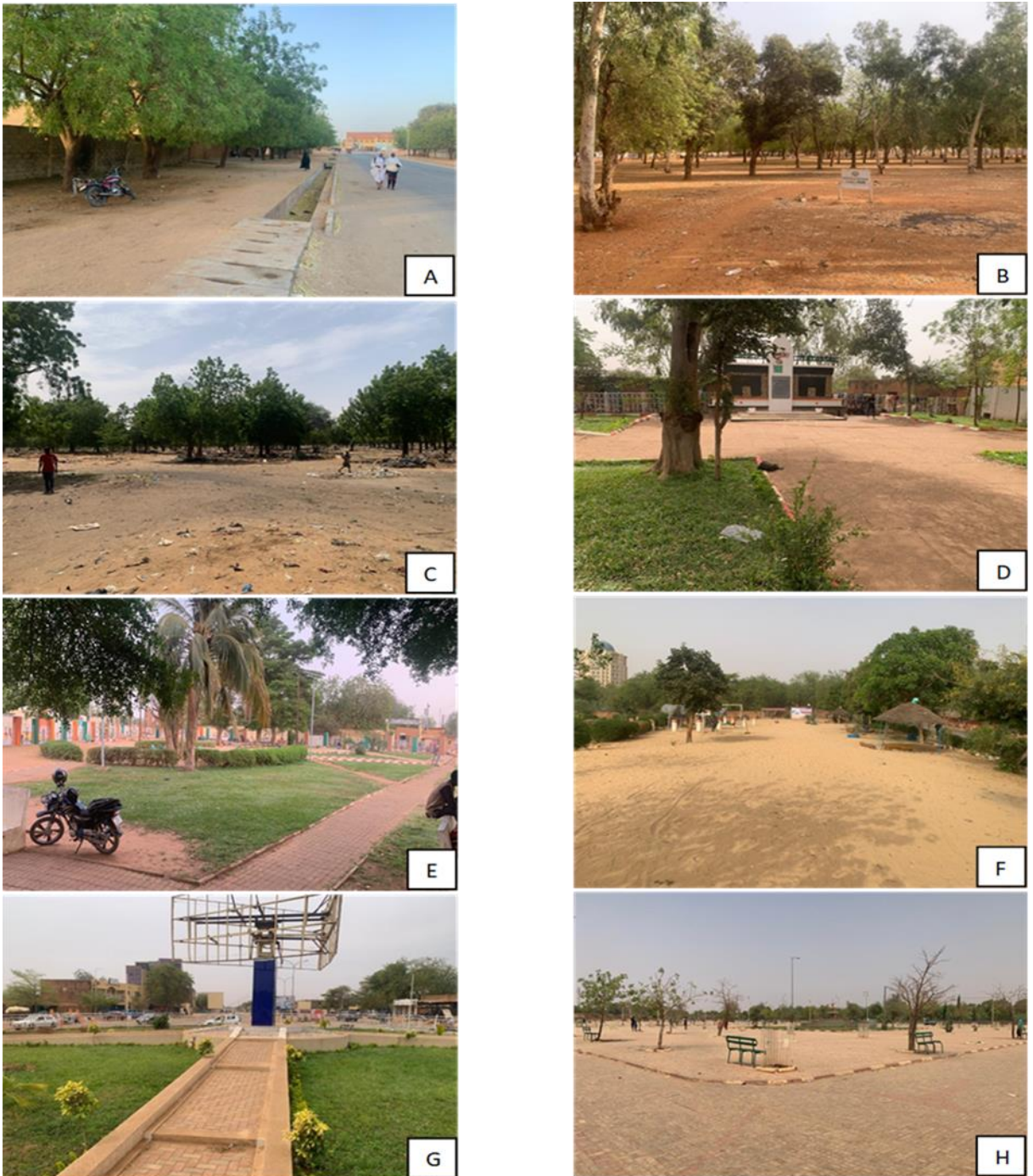


Plate 1: Public green spaces types across metropolitan areas of Niger

Among all public green spaces types, roadside trees (81.14%) represent the predominant type within these four cities compared to the green belt accounting for only 0.44% (**Figure 3**).

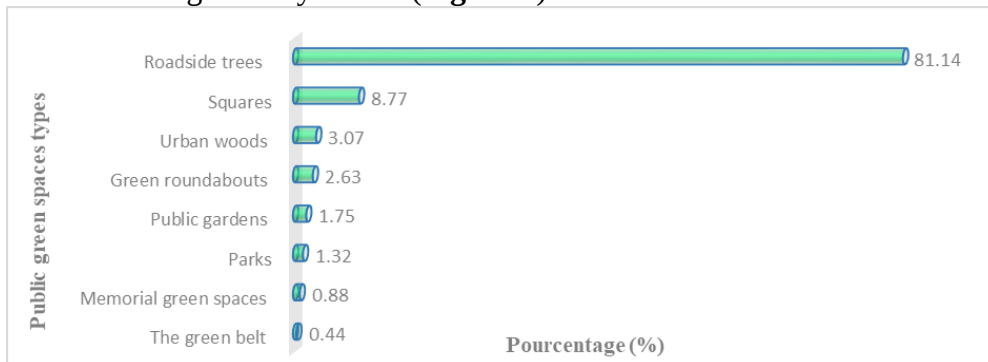


Figure 3: Dominant public green spaces types in the study area

Classification of public green spaces per city

Niamey city is the most diversified in terms of green spaces, as it contains all types of public green spaces documented in the study area. The poor richness of green spaces was observed in Zinder city which hosts only two types of public green spaces (**Plate 2**).



Plate 2: Public green spaces types per city

Morphology of public green spaces

The inventoried public green spaces revealed significant morphological differences in concerned cities. Thus, linear shape (81.14%) dominates the urban forests' spatial configuration, followed by trapezoidal (9.65%), rectangular (5.26%), circular (3.07%), and triangular shapes (0.88%) (**Figure 4**).

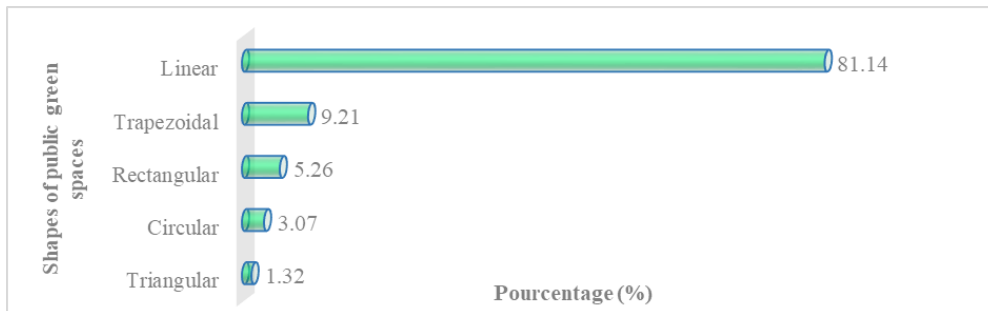


Figure 4: Public green spaces' shapes

Size of public green spaces

Public green spaces' size considerably varies from 0.19 ha for squares to 705.16 ha for the green belt (**Figure 5**). With an average area of 18.48 ha, this research pointed out the prevalence of small-sized green spaces in Niamey (NY), Maradi (MI), Tahoua (TA), and Zinder (ZR) cities (**Photos 1 and 2**).

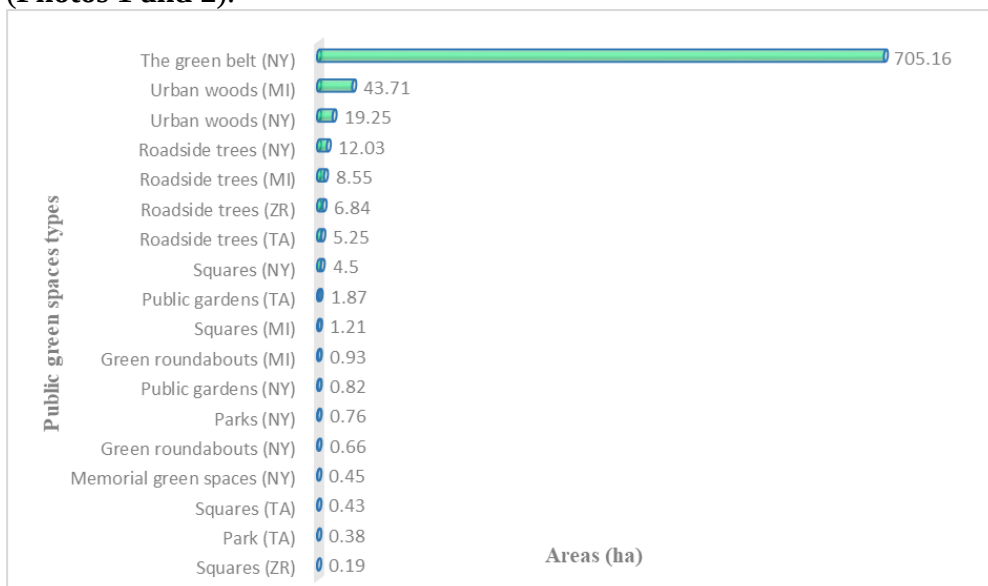


Figure 5: Size of public green spaces



Photo 1: Square in Niamey city



Photo 2: Square in Tahoua city

Presence of amenities in public green spaces

Surveys performed across Sahelian cities of Niger showed that polygonal green spaces are equipped with seats/benches (present in 29.63% of public green spaces), lighting (present in 22.22% of public green spaces), trash cans (present in 14.81% of public green spaces), restrooms (present in 6.17% of public green spaces), monuments (present in 4.94% of public green spaces), fountains (present in 3.70% of public green spaces), and snack bars/restaurants (present in 2.47% of public green spaces) (**Figure 6**). Nevertheless, 16.05% of public green spaces lack any amenities (**Plate 3**).

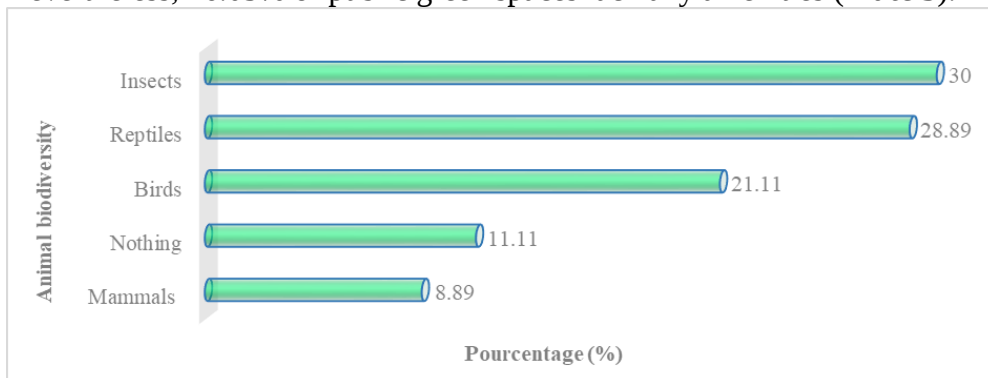


Figure 6: Existing amenities within public green spaces



Plate 3: Public green spaces amenities

The ability of public green spaces to support urban wildlife

Results highlighted the public green spaces ability to maintain urban fauna in densely built areas (**Figure 7**). Indeed, these natural areas act as refuge for a wide variety of wildlife, notably insects (Present in 30% of public green spaces), reptiles (Present in 28.89% public of green spaces), birds (Present in 21.11% of public green spaces), and mammals (Present in 8.89% of public green spaces) (**Photo 3**). However, due to their critical condition, 11.11% of these public green spaces do not harbor any animal biodiversity.

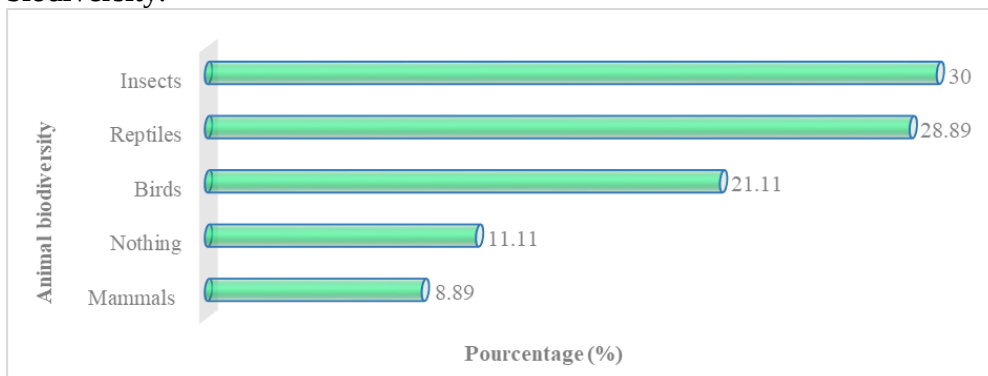


Figure 7: Ability of public green spaces to support urban fauna



Photo 3: Image of a rat captured in urban woods (Andoumé) of Maradi city

Availability of public green spaces across sahelian cities of Niger Density in public green spaces

Maradi city recorded the highest density in public green spaces (0.70 green spaces/km²), while Tahoua city underscores the lowest density (0.04 green spaces/km²) (**Figure 8**).

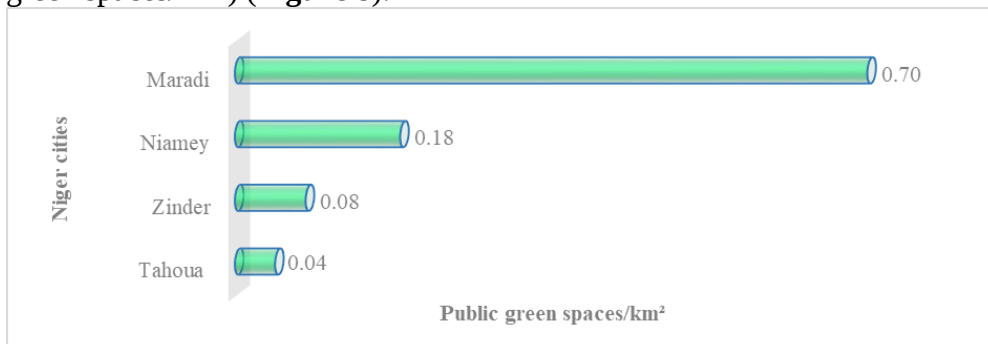


Figure 8: Public green spaces density

Coverage rate in public green spaces

The highest coverage rate in public green spaces (1.37% of territorial coverage) was found in Niamey city (**Figure 9**). An analysis of this Figure globally shows a low coverage rate of public green spaces across these Nigerien metropolises.

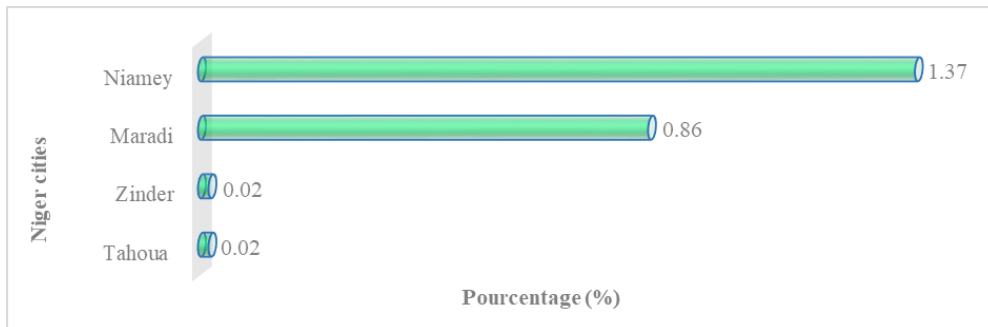


Figure 9: Coverage rate in public green spaces

Public green space per inhabitant ratio

In terms of public green spaces availability, the highest ratio estimated at 4.95 m² of public green space per capita was discovered in Niamey city. Nevertheless, Zinder city presents the lowest public green space per capita ratio (0.23 m² of public green space per capita) (**Figure 10**).

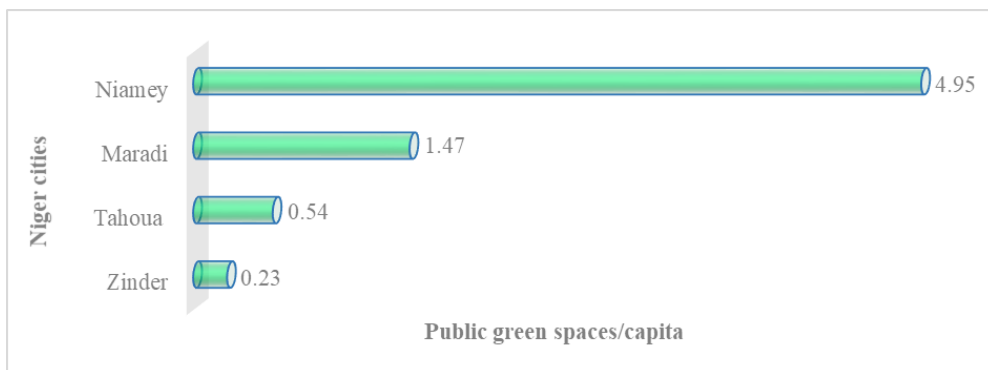


Figure 10: Public green space per inhabitant ratio

Level of Maintenance of Public Green Spaces

Based on surveys conducted in public green spaces, results highlighted that 38.64% of these spaces lack maintenance and 31.82% are moderately maintained (**Figure 11**). Well-maintained public green spaces consist of only 29.55% (**Plate 4**).

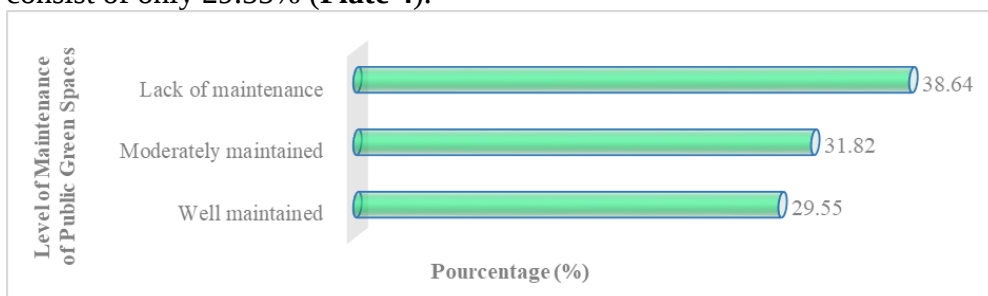


Figure 11: Public green spaces' maintenance level



Plate 4: Maintenance level of certain public green spaces

Threats of degradation identification

An analysis of Figure 12 reveals that 33.33% of public green spaces are in good condition, 31.48% were turned into urban dumps, 22.22% are weakly maintained, 7.41% are used for commercial activities, 3.70% are facing illegal logging, and 1.85% present erosion signs (**Plate 5**).

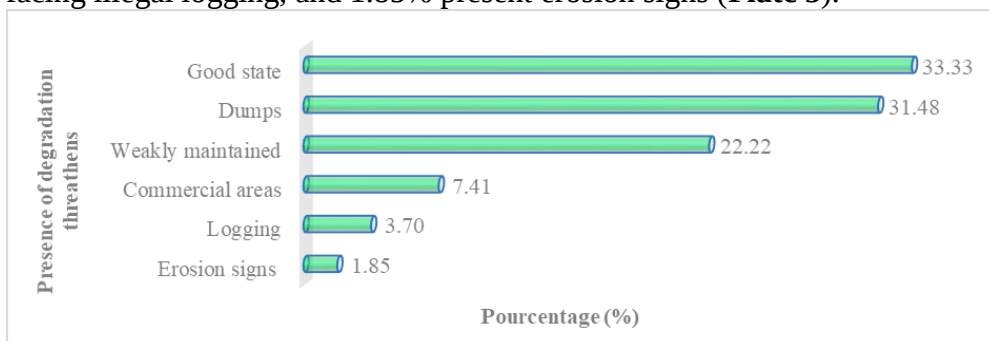


Figure 12: Identified degradation threatens in the study area



Plate 5: Threats of degradation facing public green spaces

Discussion

Diversity and current state of public green spaces in Sahelian Cities of Niger

In total, 228 public green spaces including 99 in Niamey city, 52 in Maradi city, 42 in Zinder city and 35 in Tahoua city were recorded. This richness doubled that reported by Amontcha et al. (2017) whose findings mentioned a list of 114 public green spaces identified in the southern cities of Benin. The superiority of these Sahelian cities of Niger in terms of public green spaces number could be linked to their disadvantageous climatic conditions obliging municipalities to prioritize green areas in urban development plans.

Public green spaces inventory reveals the prevalence of roadside trees (81.14%) among all green spaces types of the study area. Similar results were found by Agbani et al. (2021) where roadside trees represent 62.86% of inventoried green spaces. This widespread of roadside trees in African cities could be due to their least requirement in terms of maintenance and space compared to other types.

Niamey city is clearly distinguished from other cities by its urban forests abundance since it contains the all eight types of public green areas.

In the Democratic Republic of Congo, Useni et al. (2018) warned about this phenomenon, where public green spaces are unequally distributed across municipalities of Lubumbashi. This uneven distribution of green heritage may be attributed to the lack of local authorities' interest in the development of green spaces within other cities because only Niamey city benefits from funding for the development of public green spaces.

Concerning morphological characteristic of public green spaces inventoried across Nigerien cities, linear shape accounting for 81.14% of identified shapes is predominant. Analogous results were reported in the city of Cotonou by Agbani et al. (2021). The prevalence of linear shape could be explained by the fact that roadside trees are primarily concentrated in urban areas due to their negligible cost and maintenance requirements.

This study revealed that small public green spaces are the most represented in municipal districts of Niger's largest cities. Tchibozo-Kekele et al. (2024) highlighted similar findings in municipal districts of Abomey-Calavi. In the Republic of Niger, the research carried out by Meyer (2018) brought in light that natural areas were fragmented by municipal authorities in collaboration with the Ministry of Urban Planning. The aforementioned fragmentation of public spaces planned for future creation of green spaces may certainly lead to the predominance of these small-sized public green spaces currently observed within Sahelian cities of Niger.

In addition to their significant ecological benefits, public green spaces also beautify urban areas (Mili et al., 2019; Wijesinghe and Thorn, 2021; Chkird et al., 2024; Moussa et al., 2024). Investigations performed in Sahelian cities of Niger confirmed their attractiveness due to the presence of various types of amenities. Agbani et al. (2021) found such a result in the city of Cotonou, Benin.

This study proved that public green spaces are haven for urban fauna in metropolises of Niger. This green spaces' role as a reservoir for urban fauna has been revealed by several studies (Du Toit et al., 2018; Lombart et al., 2018; Tristan, 2018). However, this wildlife conservation potential depends on the state of plant composition and maintenance of these natural environments. In the city of Lubumbashi, Democratic Republic of the Congo, Mashagiro et al. (2024) showed that the maintenance state of urban green spaces and their plant composition have a great influence on the abundance and diversity of macro fauna.

Availability and current state of public green spaces in Sahelian Cities of Niger

The highest density in public green spaces which is 0.70 green spaces per km² was observed in Maradi city. This could be linked to its small size enabling a better coverage compared to other largest urban centers.

Niamey city detains the highest public green spaces' coverage rate (1.37%). According to officials in charge of green spaces management in Maradi, Tahoua, and Zinder cities, as the administrative capital of Niger, the city of Niamey holds funds intended for the gradual creation of public green spaces and their management.

A standard of 10 m² of public green space per capita was recommended by the WHO for citizens' well-being, while Niamey city recorded a moderate ratio of 4.95 m² of green space per capita. Despite its low rate, this ratio is high compared to those documented by numerous authors such as Polorigni et al. (2014) in Lomé city highlighting a ratio of 0.75 m² green space per capita, Amontcha et al. (2017) in Porto-Novo city, who mentioned a ratio of 0.27 m² green space per capita, Agbani et al. (2021) in Cotonou city underscoring a ratio of 0.12 m² green space per capita, and Gherraz (2021) in Constantine city whose findings emphasized a ratio of 1.17 m² green space per inhabitant. A vast green belt present in the city of Niamey may probably increase this ratio, which is greatly influenced by the size of vegetated areas. Nevertheless, the ratio of 20 m² green space per capita reported by Polorigni et al. (2014) in Paris and New York megacities is much higher than that we found in this populated West African city. Many African researchers highlighted the lack of sufficient financial resources to encourage African municipalities developing and managing more public green spaces.

This research revealed a poor maintenance level of almost all public green spaces in these studied Sahelian cities of Niger. Our findings reported that only 29.55% of public green spaces are well maintained by municipalities. As mentioned by Ngahane (2015), local authorities do not consider urban forestry as a priority in their political and strategic decisions.

Our investigations carried out in Niamey, Maradi, Tahoua, and Zinder cities, brought in light that 32.69% of public green spaces were converted into urban dumps, 23.08% are poorly maintained, 7.69% have been used for commercial activities, and 1.92% were exposed to water erosion. Kouakou et al. (2018) alerted about the conversion of public green spaces into dump grounds, tires burning places, and spaces intended for commercial activities in Abidjan district, Ivory Coast. Public green spaces are also converted into urban dumps in the city of Kinshasa, Democratic republic of Congo as reported by Kassay (2010). This deliberate destruction of public green infrastructures could be due on one hand to the fact that green spaces management offices are not fully fulfilling their duties and on the other hand, to a lack of civism from a portion of urban dwellers, acting to these precious patrimony detriment.

Conclusion

This scientific investigation provided an overview of public green spaces in Sahelian cities of Niger. Indeed, these natural areas are not fairly distributed within the study area. The study displayed the existence of eight types of public green spaces, with roadside trees representing the dominant type in these Nigerien cities. This research also reported variations in public green spaces' characteristics regarding various aspects, such as the shape, the size, the presence of amenities, the degradation threatens, the biodiversity supporting capacity, and the level of maintenance. Although Niamey city dominated other cities in terms of the coverage rate and ratio in public green space per capita, the city of Maradi holds the highest density in public green spaces. This study globally revealed the scarcity of public green spaces in these four metropolitan areas due to their low ratio of green space per capita. Consequently, as a considerable quantity of undeveloped public areas exist, municipal authorities must proceed with a gradual creation of new green spaces. This will therefore contribute to the welfare of urban dwellers, lacking adaptation means within these Sahelian cities especially in this context of global warming.

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