

REVIEW ARTICLE

MAPPING OF AVAILABLE LAND FOR URBAN AGRICULTURE IN THE CITY OF PORTO-NOVO, BENIN

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ABSTRACT

In recent years, the city of Porto-Novo has experienced significant population growth and urban development. This growth has resulted in a decrease in the availability of agricultural land within the city. The aim of this research is to identify and map the areas available for urban agriculture in Porto-Novo. The methodological approach used is structured around the identification of the data used: data collection, data processing, and results analysis. It also takes into account the use of a Geographic Information System (GIS) to identify and map the areas available for urban agriculture in the city of Porto-Novo. In total, 65 people were surveyed. The results of this study identified the following types of areas suitable for agriculture: marshy land; uncultivated land; bare soil; house foundations; balconies; terraces; and fish ponds. GIS was used to map these available agricultural areas within the city using manual scanning. This technique involves visually identifying areas unsuitable for agriculture on a recent image. These approaches used for spatialization made it possible to determine the area of available space of approximately 959 hectares in Porto-Novo.

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INTRODUCTION

According to the Food and Agriculture Organization of the United Nations (FAO, p. 16), the world population is expected to reach 9.6 billion by 2050. It will therefore be difficult for the agricultural sector to adequately meet the food needs of this population. Furthermore, 60% of humanity lives in urban areas, and projections for 2050 indicate this figure will reach 80%, with an additional 3 billion inhabitants worldwide. The development of urban agriculture (UA) is thus considered one of the keys to ensuring humanity's food security (C. Dumat *et al.*, 2016, p. 1). In cities and metropolitan areas of developing countries, urban production can be significantly higher. In Africa, self-sufficiency levels can reach 60 to 70%. The FAO generally considers an average rate of 15% globally, with significant disparities (C. Bernhard, 2022, p. 16). Urban agriculture can also be characterized by various functions: food production, economic and social development (creation of jobs for people reintegrating into the workforce), environmental benefits, educational and recreational activities, landscape design, and urban planning (C. Bernhard, 2022, p. 12). It is becoming increasingly important on the public policy agenda, but it is also generating enthusiasm among a wide range of stakeholders for local initiatives that advocate for a return to closer ties between city and nature, between city and agriculture, and between city and food (P. Scheromm *et al.*, 2014, p. 1).

Introducing agriculture into the city is a way to rebuild connections and also to foster mutual exchange regarding the needs of some and the economic realities of others (P. Mayol *et al.*, 2019, p. 58). Urban agriculture, previously considered a marginal activity in Benin and relegated to the background of agricultural development, contributes significantly to food security (V. Assogba Miguel, 1999, p. 15). A sustainable city would thus be one capable of managing its complex interactions with both nearby and distant spaces, in order to limit negative effects and enhance positive ones (L. Granchamp-Florentino, 2016, p. 141). In planning, Geographic Information Systems (GIS) remain a preferred tool (W. Atakpama *et al.*, 2021, p. 1). GIS contribute to improving our understanding of the overall functioning of ecosystems and inform decision-making through their capacity to store, analyze, and represent spatial information (Z. Koumoi, 2023, p. 56). GIS is a crucial tool for establishing and monitoring urban agriculture. The city of Porto-Novo offers numerous advantages that could be conducive to the development of urban agriculture. Located in southern Benin, the city of Porto-Novo lies between 6°27' and 6°30' north latitude and between 2°34' and 2°40' east longitude. It is bordered to the north by the municipalities of Akpro-Missrété and Avrankou, to the south by the Porto-Novo Lagoon, to the east by the municipality of Adjara, and to the west by the municipality of Agouégués. The figure below shows a map of the location of the municipality of Porto-Novo.

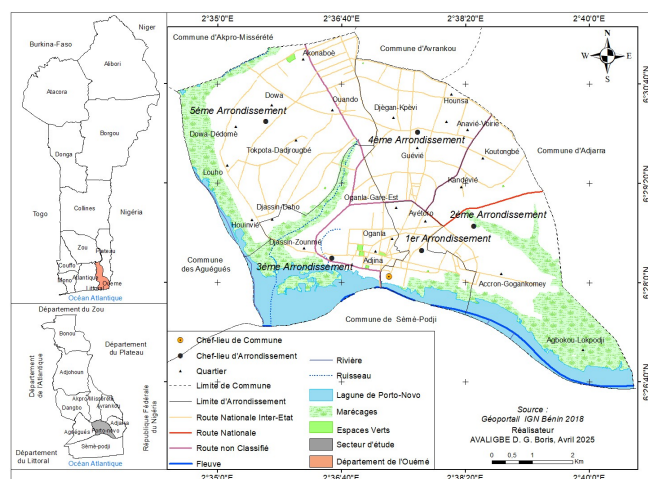


Figure 1. Geographical and administrative situation of the Municipality of Porto-Novo

METHODOLOGICAL

The methods used to collect information included documentary research and field surveys in the Commune of Porto-Novo. This data was supplemented by information gathered through field investigations. The sampling was carried out taking into account the specific characteristics of the city of Porto-Novo and the diversity of urban agricultural practices. The Municipality of Porto-Novo comprises five (5) districts, but the survey was conducted in four (4) districts selected based on relevant criteria related to urban agriculture. The districts selected for the survey are: the 1st, 2nd, 3rd, and 5th districts. The choice of these districts is based on the following criteria:

- A significant number of farming households ;
- Availability of usable agricultural land;
- Diversity of agricultural practices.

The main categories of people surveyed were urban farmers, municipal officials, and institutional actors involved in managing agricultural activities. The selection of interviewees was based on the following criteria:

- The minimum age of 18 years to ensure that people with proven experience in the agricultural field are interviewed;
- Agricultural experience is essential for collecting data based on real-world practices;
- Basic knowledge of agriculture, in order to avoid interviewing people who have no direct link to the sector.

The sample size was determined using the formula of Beau and Marien (2003), which is as follows:

$$n = \frac{N \times 400}{N + 400}$$
 where n = the sample size and N = the total number of agricultural households. The city of Porto-Novo has 214 households (RGPH 4).

$$n = \frac{214 \times 400}{214 + 400} = 139.41$$
, for a total of 139 people surveyed for this study.

However, to better represent the producers, taking into account available resources, 65 people were surveyed. Table I shows the distribution of respondents. Analysis of Table III reveals

that 60 people were interviewed in four of the five districts of the Porto-Novo municipality. In addition, five officials from the Porto-Novo municipality were interviewed: two agents from the DDAEP (Departmental Directorate of Agriculture, Livestock and Fisheries), two agents from the Porto-Novo municipal unit, and one agent from the town hall. In total, 65 people were interviewed for this research. Analysis of this figure reveals that the surveyed farming households in the city of Porto-Novo are more concentrated in marshy areas.

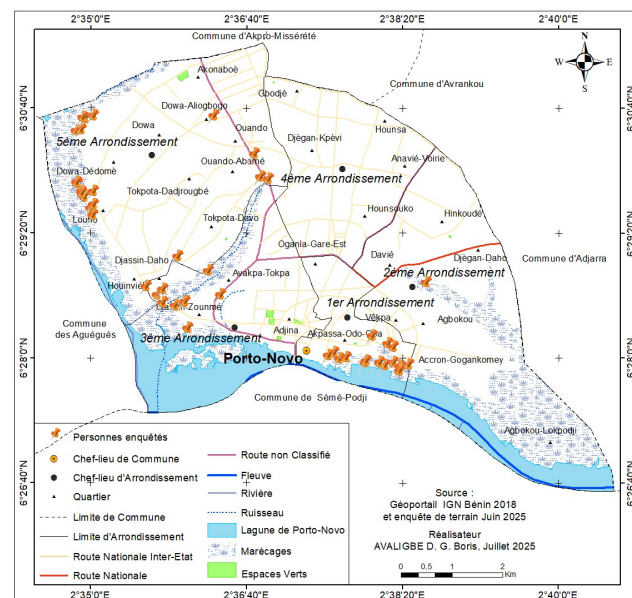


Figure 2. Distribution of respondents

They are located near agricultural sites. The fieldwork was conducted using data collection tools such as a questionnaire, an interview guide, an observation grid, and a camera.

RESULTS

Typology of available areas for urban agriculture in the city of Porto-Novo: Table II presents the types of perimeter available for urban agriculture in the city of Porto-Novo. Analysis of Table II reveals seven types of agricultural areas in Porto-Novo, including marshland, uncultivated land, bare soil, slabs, balconies, terraces, and fish ponds. The study focuses primarily on three types: marshland, uncultivated land, and bare soil, due to their level of cultivation and their potential for spatial development. The other, less cultivated areas nevertheless represent opportunities to strengthen urban agriculture and contribute to food security.

Marshy lands in the Commune of Porto-Novo: A marsh is a type of aquatic ecosystem and one of the most common and diverse wetlands. According to 89% of respondents, a marsh is characterized by an area of shallow water, usually stagnant or with very slow flow, and is typically covered with aquatic vegetation such as reeds, grasses, and shrubs. These areas generally form in depressions in the ground where water accumulates, either naturally or as a result of human intervention, such as the construction of dams or the alteration of natural drainage. According to 87% of respondents, marshy areas used for agriculture offer the advantage of relatively easy access to the water table, generally located between 1 and 2 meters deep. This constant availability of water, even during the dry season, significantly reduces supply constraints and

allows farmers to practice agriculture year-round. Farmers thus take advantage of this natural asset, notably by creating ponds to facilitate water supply and maintain agricultural activities throughout the year.

The soils of marshy areas possess a natural fertility favorable to plant production, particularly for market garden and food crops. According to 88% of respondents, this fertility is linked to constant moisture, the continuous decomposition of organic matter, and the natural accumulation of nutrients, thus reducing the need for chemical fertilizers. However, 67% of producers use animal manure to enrich the soil, stimulate crop growth, and improve yields. Photo 1 illustrates vegetable cultivation on raised beds in a marshy area of the municipality of Porto-Novo.



Photo 1. Vegetable cultivation on raised beds in a marshy area in Gbédji

Photo 1 shows a vegetable crop grown on raised beds in a marshy area. This crop is planted in black soil, rich in organic matter, which is typical of marshy soils. This type of soil, rich in organic matter, has high natural fertility and retains moisture, making it a favorable environment for growing food and vegetable crops. These marshy soils undergo a natural decomposition process. According to 79% of respondents, this soil allows for improved production on naturally rich soil without the need for chemical fertilizers. Figure 3 shows the marshy areas of the city of Porto-Novo.

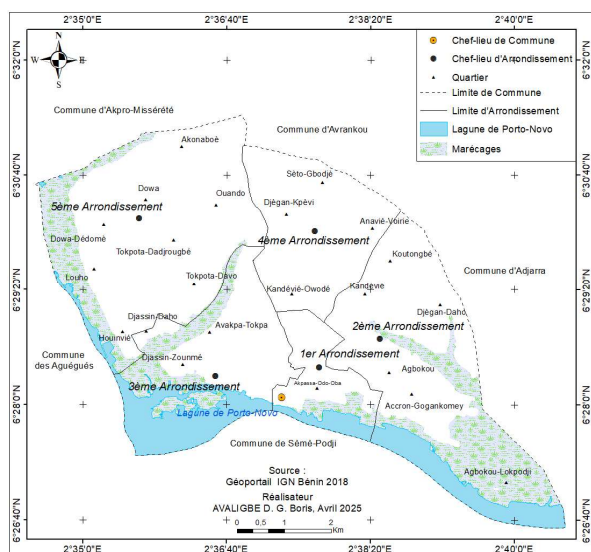


Figure 3. Marshy lands in the city of Porto-Novo

Analysis of Figure 3 shows the significant presence of marshland within the city, covering a large area of the municipality. This marshland borders the city from southeast

to northwest and is located in Districts 1, 2, 3, and 5. The availability of marshland across this entire area represents potential for the development of urban agriculture. This land offers more available areas for agricultural practice within the city.

Unexploited land and bare soils in the city of Porto-Novo:

The municipality of Porto-Novo is among the most urbanized cities in Benin, and today presents an image comparable to major African cities. Urban development in this city leaves very little open space; undeveloped areas are becoming increasingly rare. However, a city, despite all its urban functions, must also fulfill other important roles: an agricultural one. Uncultivated land in major cities around the world is now being cultivated, often forming small urban gardens. Porto-Novo is, in fact, highly saturated, and the remaining small empty spaces are often found on the outskirts, in areas somewhat further from the city center. The field survey allowed not only observation but also the collection of information on the management of vacant land in the city of Porto-Novo. Small, unused vacant spaces can be seen throughout the city, often marked with signs indicating "Property of the City of Porto-Novo" or "Domain of the Diocese of Porto-Novo".

Respondents believe that developing properties owned by the Porto-Novo municipality will be a valuable asset to the development of urban agriculture in the city. They also emphasized the importance of municipal authorities developing vacant land within the city, as this undeveloped land is highly sought after for expanding market gardening activities. Producers further pointed out that vacant land within the city limits is more suitable than marshy land, provided the issue of water access on the plateau is resolved. Uncultivated land and bare soil offer potential for sustainable development of small urban gardens. The following photo shows an uncultivated plot of bare soil in Danto.



Photo 2. Unexploited bare soil in Danto *Filming location: DGB Avaligbé July 2025*

Photo 2 shows an unused plot of bare land in the heart of the Danto neighborhood, illustrating a type of area not commonly found in the urban zone of Porto-Novo. Although this space is currently undeveloped, it represents potential for the development of urban agriculture. Indeed, such spaces, often reserved for future construction, could be temporarily converted into urban gardens or vegetable growing areas. Such a use of bare land would also prevent the accumulation of waste in cities. Figure 4 shows unused land in the 5th Arrondissement of the Municipality of Porto-Novo.

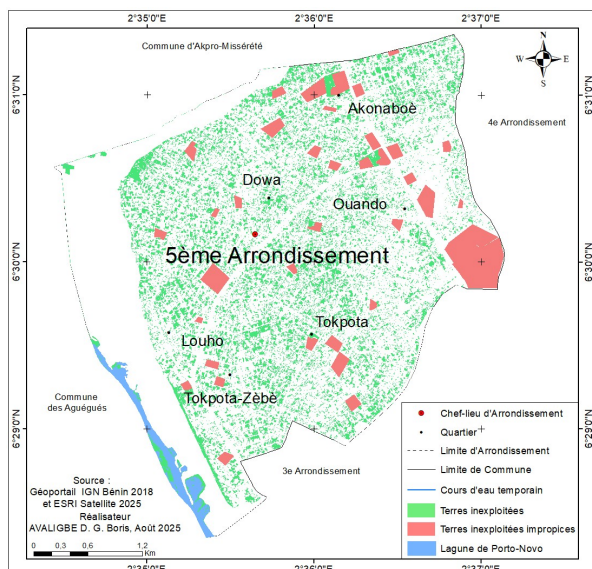
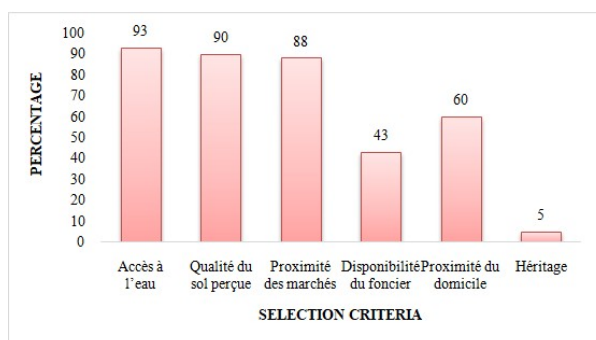


Figure 4. Undeveloped land in the 5th Arrondissement of the Commune of Porto-Novo

Figure 4 shows the uncultivated land in the 5th Arrondissement of the Commune of Porto-Novo. This figure reveals that the 5th Arrondissement of Porto-Novo has several uncultivated plots and bare soils suitable for agricultural activities. Among these available uncultivated lands are areas with non-agricultural uses, such as administrative spaces and grassy public squares, empty spaces in markets, sports fields, and other areas. Although uncultivated, these spaces are unsuitable for agricultural activities.

Criteria for selecting available areas for urban agriculture in the city of Porto-Novo: The development of urban agriculture in the city of Porto-Novo depends not only on agricultural policies and funding, but also on the criteria for selecting areas designated for production. Figure 5 presents the main criteria for selecting agricultural zones in the city of Porto-Novo.



Source: Field results, May 2025

Figure 5. Selection criteria for agricultural areas in Porto-Novo

Analysis of Figure 5 shows that six criteria are taken into account in the choice of agricultural areas in Porto-Novo. The main criteria are access to water (93%), soil quality (90%) and proximity to markets (88%), while heritage is the least cited (5%). Thus, the choice of agricultural spaces is based primarily on the availability of water, soil fertility and accessibility to markets.

Classification of selection criteria for available urban agriculture areas in the city of Porto-Novo: The criteria for selecting perimeters are necessary for choosing a location

intended for agricultural activity. Figure 13 shows the ranking of agricultural perimeter selection criteria according to their frequency in first position. Analysis of the figure reveals the agricultural perimeter selection criteria cited at least once as the primary selection criterion. Respondents ranked these criteria, which influenced their choice of location. According to the figure, access to water is the most frequently cited primary criterion for selecting agricultural perimeters. It is noted that access to water is a basic need for producers, making it the most important criterion for choosing their perimeters in the city of Porto-Novo.

Spatial mapping of available areas for urban agriculture in the city of Porto-Novo: The city of Porto-Novo has areas suitable for urban agriculture, despite their limited availability. These spaces are used for agricultural sites intended for market gardening and other production.



Source: Field results, May 2025

Figure 6. Ranking of agricultural perimeter selection criteria according to their frequency in 1st position

Spatialization of agricultural sites in the city of Porto-Novo: The city of Porto-Novo has very little arable land suitable for agricultural sites. However, it does possess some advantages for establishing such sites; the marshy areas provide suitable locations for agricultural development. The following figure shows the distribution of agricultural sites within the city of Porto-Novo.

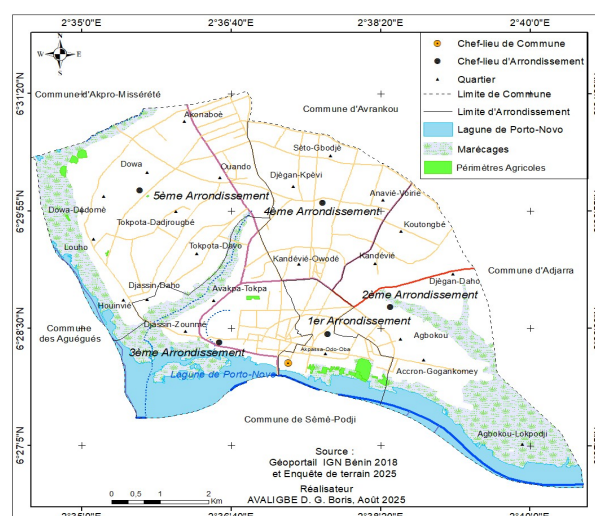


Figure 7. Distribution of agricultural sites in the city of Porto-Novo

The figure shows the agricultural sites in the city of Porto-Novo. Analysis of the figure reveals that the number of

available sites within the city is very limited. These sites are mostly located in marshy areas, likely due to the availability of agricultural land, proximity to the lagoon, and other advantages these areas offer for farming. It is also noted that very few areas are currently being cultivated across all suitable spaces. Agricultural sites should occupy more of the available marshy land to improve production.

Land Use: The following figure shows the land use of the city of Porto-Novo. The figure shows that the city of Porto-Novo is dominated by buildings and human settlements, and by marshy vegetation on the outskirts of the city center. This clearly demonstrates the presence of spaces suitable for urban agriculture.

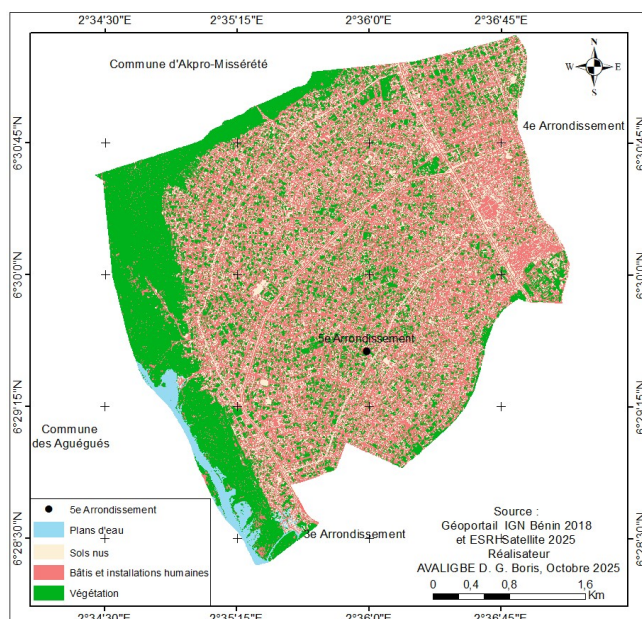


Figure 8. Land use in the city of Porto-Novo

Spatial mapping of unused areas for urban agriculture in the city of Porto-Novo: The city of Porto-Novo is primarily a residential area and reflects the image of a city experiencing rapid urban growth. The following figure shows the spatial distribution of available land not currently used for urban agriculture within the city of Porto-Novo. The figure shows a significant availability of land suitable for urban agriculture in the city of Porto-Novo, particularly in the west where vast marshy areas predominate. Some vacant and unused plots are also scattered within residential areas, offering opportunities for developing small gardens and vegetable patches. Plate 1 illustrates some of these vacant spaces currently being used for agricultural purposes. Figure 1 shows that even small vacant spaces in Louho and Danto can be used for market gardening, banana cultivation, and permaculture. These farms, despite their small size, contribute to the local supply of fresh produce and bring production closer to consumers. Permaculture also illustrates the possibility of achieving quality production with limited space. Thus, the development of urban agriculture does not necessarily require vast agricultural areas. Furthermore, some vacant spaces in educational and administrative buildings are also being developed to boost agricultural production within the city. Plate 2 presents agricultural areas developed within certain administrative and educational establishments in Porto-Novo. The sites of ATDA and Lycée Béhanzin illustrate the production of market garden produce, cassava and maize on areas that were initially



Plate 1 :Some empty spaces used for agriculture in Porto-Novo Filming location :DGB Avaligbé, August 2025

undeveloped. These initiatives contribute to local food security while promoting agricultural skills among learners. Spatial analysis reveals several areas suitable for urban agriculture: marshy land, bare soil, concrete slabs, terraces, balconies, and fish ponds. Favorable climatic conditions and the growing demand for market garden produce and food crops represent significant opportunities for this activity. The existence of agricultural support structures also strengthens the potential for urban agriculture development in Porto-Novo. However, irrigation difficulties, the high cost of inputs, theft, vandalism, stray animals, poor sales, and weak institutional support limit its progress.

DISCUSSION

This research analyzed the development of urban agriculture, the types of available plots, and their spatial distribution in the city of Porto-Novo. The results identified and mapped several areas suitable for agriculture, including marshy land, uncultivated land, bare soil, slabs, balconies, terraces, and fish ponds. In the city of Porto-Novo, marshy, uncultivated land and bare soil cover an area of 959 hectares, despite significant urbanization. Agricultural areas are primarily concentrated in the marshy zones, while suitable spaces in the city center are more dispersed and often occupied by garbage dumps. The study also highlights fish ponds as a type of exploitable land, representing an innovative agricultural production technique according to the farmers surveyed. The use of GIS tools and ESRI Satellite imagery was a major contribution to spatially representing available areas and visualizing their distribution. The technique used to identify areas available for agriculture demonstrates the meticulous attention to detail applied to this research. This technique surpassed those used by other authors who have conducted similar studies, such as W. Atakpama *et al.* (2021, p. 207), who carried out a similar study on the city of Lomé and its suburbs, identifying the areas of agricultural and potential plots. However, the method used for this research is similar to the work carried out by FAO (2017, p. 18), which showed that overlaying cartographic data and Sentinel-2 satellite imagery allows for the identification and classification of agricultural plots at the municipal level. In the research conducted in the municipality of Hollands Kroon in the Netherlands, the integration of satellite imagery and cadastral data made it possible to map more than 27,000 agricultural plots. A. Daugeilh (2017, p. 14) adds that urban agriculture promotes local consumption by reducing the distances between production and consumption sites, thus

Table I. Distribution of respondents

Boroughs	Neighborhoods surveyed	Number of people surveyed	Rate %
1st Arrondissement	AccronGogankome (6 households); Gbékon (8 agricultural households); Gbédji (8 farming households)	22	37
2nd Arrondissement	Agbokou I (22 households); Agbokou II (6 households); GuéviéDjéganto (6 households);	01	2
3rd Arrondissement	Djassin Daho (3 households); DjassinZoume (3 households)	14	23
5th Arrondissement	Akonaboè (13 households); Dowa (35 households); Ouando (13 households); Tokpota I (11 households)	23	38
Total	13 districts	60	100

Source: INSta D2013, field surveys, April 2025

Table II. Types of perimeter available for urban agriculture in the city of Porto-Novo

Types of perimeter available	Number	Percentage of respondents who gave this answer (%)
Undeveloped land	58	96.66
Bare ground	24	40
Marshy lands	59	98.33
House slab	35	58.33
Balcony	05	8.33
Fish pond	01	1.66
Terrace	07	11.66

Source: Field investigations, April 2025

contributing to food security and the local economy. E. Siborurema (2019, p. 17) highlights the importance of utilizing available urban spaces, such as rooftops and vacant lots, to develop urban agriculture. However, A. Roy (2013, p. 7) warns of the need for more rigorous urban planning to prevent infrastructure expansion from compromising spaces dedicated to agriculture and livestock farming.

CONCLUSION

This study made it possible to identify and map the areas favorable to urban agriculture in the city of Porto-Novo based on field surveys and GIS. The main areas identified are marshy land, unexploited land and bare soil, with additional potential for slabs, terraces, balconies and fish ponds. Marshy lands appear to be the most favorable due to water availability and soil fertility. Access to water, soil quality, and proximity to markets are the main criteria producers use to choose their land. Despite this potential, urban agriculture still faces challenges such as insufficient irrigation, the cost of inputs, theft, land pressure, and weak institutional support. Therefore, integrating urban agriculture into urban planning and monitoring agricultural areas using GIS (Geographic Information Systems) is essential. Sustainable management of these areas would contribute to strengthening food security, producer incomes, and the resilience of the city of Porto-Novo.

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