ORIGINAL ARTICLE

CONTRIBUTION OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) TO THE ANALYSIS OF WASTE DEPOSITS IN THE CITY OF GRAND-BASSAM, IVORY COAST

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ABSTRACT

Introduction: The issue of waste, in the context of environmental preservation, is a real problem in sub-Saharan Africa. Poor waste management leads to soil, water and air pollution and is harmful to human and animal health. **Background**: Solid waste management is one of the main challenges faced by Ivorian cities, including Grand-Bassam. **Objectives:** Thus, the objective of this study is to use GIS to analyze the spatial distribution of solid waste deposits in Grand-Bassam. **Methods:** The data collection operations took place between August 2021 and April 2022 and consisted of criss-crossing the town of Grand-Bassam in order to identify and locate formal and informal dumpsites. The mathematical dimensions including length, width and height or radius of the dumpsites were determined using a ten (10) meter tape measures. The data was imported into QGIS version 2.18 for the production of thematic maps. The characterization of landfill sites is assessed in terms of elevation, hydrography, pedology, geology, fracturing and land use**. Results:** The geographical survey identified 105 waste disposal sites, of which 87 were informal and 18 were formal disposal sites, representing 82.86% and 17.14% respectively. The results of the mapping indicate that 56.32% of the illegal dumpsites are located in the altitudes between 0 m and 7 m. 31.03% and 33.33% of the illegal dumpsites are located on the hydrographic and fracturing networks of the city respectively. The analysis of waste sites in relation to land use shows that these sites are mainly (81.90%) located between the agglomerations. In addition, the town of Grand-Bassam is based on a ferralic aerosol type soil with a coastal sediment type geology. Conclusions: In view of these characteristics and their distribution, these dumpsites cause nuisances both to the environment and to humans. The cartographic information resulting from the present study serves as a reference for the elimination of all illegal dumps in the town of Grand-Bassam.
Keywords: *Mapping, dumps, waste management, Grand-Bassam, GIS*

1. INTRODUCTION

Issues affecting urban waste management and, by extension, urban environmental planning and management are among the most complex that urban managers must address because of their effects on human health and sustainable development [1,2,3]. In Ivory Coast, the government's solid waste management policy is carried out by the National Agency for Waste Management (ANAGED). Indeed, ANAGED delegates to the public service of cleanliness including the collection, transport, recovery and elimination of waste as well as cleaning in the regions and communes of Ivory Coast. In spite of this will of the Ivorian State to clean up the Ivorian cities, the households often resort to the shallows, streets, undeveloped zones and sidewalks to get rid of their waste. These recurrent practices are largely responsible for several environmental and health problems [4-3]. Thus, the management of household waste is one of the greatest difficulties faced by Ivorian cities, particularly the seaside town and UNESCO World Heritage Site, Grand-Bassam. These difficulties are reflected in the accumulation of solid waste and the creation of numerous informal dumpsites, which are beyond the knowledge and control of the municipal authorities. In the current context, knowledge of formal and non-formal dumpsites and their spatial distribution in the city of Grand-Bassam would help the communal authorities to think about the management of these dumpsites. This research uses Geographic Information Systems (GIS) to analyze the spatial distribution of solid waste dumps in Grand-Bassam.

2. MATERIELS AND METHODES

2.1. Study area

This study was conducted in Grand-Bassam, a city located in the southeast of Ivory Coast, in the District of Comoé, more precisely in the region of South Comoé, whose chief town is Aboisso [5]. A historic city with colonial architecture, Grand-Bassam has been a UNESCO World Heritage Site since 2012 [6]. The city of Grand-Bassam is located 43.5 km from Abidjan, Ivory Coast's economic capital between latitude 5°12.000'N and 5°16.800'N and longitude 3°40.800'W and 3°50.40'W (Figure 1). The climate of the area is transitional equatorial. In addition, the Grand-Bassam area is drained by the Comoé River and the Ebrié lagoons and Ouladine. Mangroves are concentrated around these lagoons, thus ensuring several roles of ecological importance.

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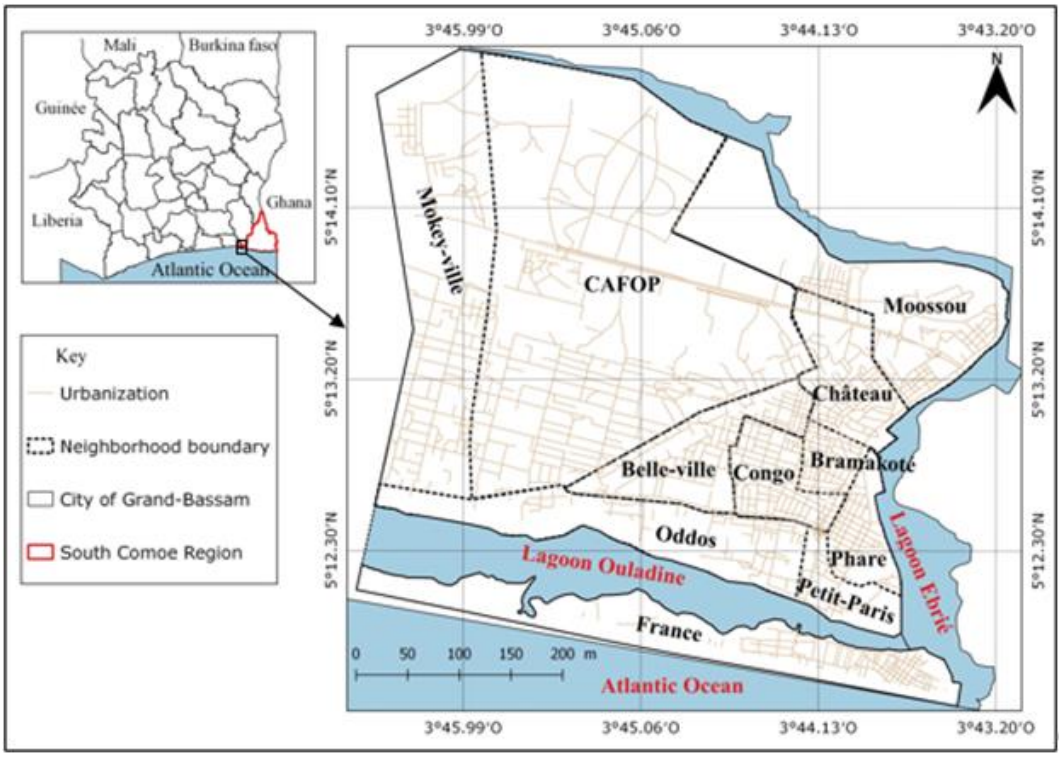

Figure 1: Geographical location of the city of Grand-Bassam (*Source: Téya and al. 2022)*

2.2 Hardware and Data

The equipment used for the geolocation of the dumpster is composed of an observation grid and a GPS device. The planimetric data includes the administrative boundary, the road network, the pedology and the geology in vector format and is produced by the CNTIG (National Center for Remote Sensing and Geographic Information of Ivory Coast) and the SODEMI (Company for the Mining Development of Ivory Coast). A LANDSAT 8 satellite image of 30 m resolution from 2020 in Geo-Tiff format, scene 195-57, downloaded from the USGS website (https://earthexplorer.usgs.gov/) was used for land cover mapping. Downloading the digital terrain model (DTM) from the 30 m resolution SRTM image allowed for the mapping of the hydrographic network, the fracturing network and the relief of the town of Grand-Bassam. As for the data processing tools, they are composed of QGIS, Google Earth pro, ENVI, Geomatica, R. Studio, Statistica and the Excel spreadsheet.

2.3 Methods of data collection and processing

The data collection operations took place between August 2021 and April 2022 and consisted of criss-crossing the town of Grand-Bassam in order to identify and locate the formal and informal dumpsites. The mathematical dimensions including length, width and height or radius of the dumpsites were determined using a ten (10) meters measuring tape. Once in the laboratory, the observation and planimetric data were imported into QGIS software version 2.18 for the production of thematic maps. For the LANDSAT 8 image, a pre-processing and then a processing of the said image was carried out. Regarding the pre-processing of the LANDSAT 8 image, it consisted of radiometric and atmospheric corrections. Indeed, the purpose of these corrections was to enhance and/or homogenize the quality of the images [7]. After the pre-processing stage, a supervised classification is performed using the maximum likelihood algorithm. Four (04) classes are retained as a result of the classification namely built-up areas, water bodies, vegetation cover and bare soil and roads. These different classes are confirmed using points surveyed in the field and then imported into the image processing software. The digital terrain model (DTM) derived from the SRTM image was used to extract the hydrographic network and the relief using the spatial analysis tool QGIS version 2.18. The fracture network was derived from the DTM by applying the Sobel directional filter. The spatial analysis of the surface and volume density of informal dumpsites in the neighborhoods of Grand-Bassam was started by first calculating the surface area and volume of each dump identified during the geographical survey. Subsequently, the surface area of each neighborhood of Grand-Bassam was determined using QGIS software.

2.4 Spatial analysis of the density of informal dumpsites

The spatial analysis of the surface and volume density of informal dumpsites in the neighborhoods of Grand-Bassam began by first calculating the surface area and volume of each dump identified during the geographical survey. Subsequently, the surface area of each neighborhood of Grand-Bassam was determined using QGIS software. The surface and volume density of informal dumpsites in the neighborhoods of Grand-Bassam was finally obtained using the Excel spreadsheet by applying the following basic model formulation (Equation 1) [8].

$$Di = \frac{Sd}{Sq} \ (Equation\ 1)$$

With: **Di**: Density by area (m^2/km^2) or density by volume (m^3/km^2) of informal dumpsites; **Sd**: Surface area (m^2) or Volume (m^3) of the informal dumping site identified during the geographical survey; **Sq**: Area of the neighborhood (km^2). Subsequently, IDW (Inverse Distance Weighting) or PID interpolation is applied to the density obtained for the surface areas of informal dumpsites and for the volumes of informal dumpsites using the spatial analysis tool QGIS version 2.18.

3. RESULTS

The characterization of solid waste disposal sites in the city of Grand-Bassam is assessed in terms of altitude, hydrography, soil texture, geology, fracturing, land use, area and volume. This approach provides a screening tool and a means to rank vulnerable potential sites and favorable sites.

3.1. Spatial distribution of formal and informal waste dumps in the city of Grand-Bassam

Waste management as it is currently conducted is unfavorable to the social and economic development of the city of Grand-Bassam. This is due, on the one hand, to the significant increase in population and the change in consumption patterns. Thus, the waste collected in the city of Grand-Bassam is transported in carts to be dumped in the bushes, at informal dumpsites and at the collection points built for this purpose. Figure 2 shows the spatial distribution of formal and informal waste dumps in the town of Grand-Bassam. The geographic survey identified 105 waste disposal sites in the city of Grand-Bassam, of which 87 were informal waste disposal sites and 18 were formal waste disposal sites, i.e. 82.86% and 17.14% respectively. Regarding formal dumpsites, the France and CAFOP districts each have four (4) sites. The Petit-Paris and Belleville neighborhoods have two (02) sites each. The Mokey-ville, Moossou, Oddos, Phare, Congo and Château districts each have one (01) legal deposit site.

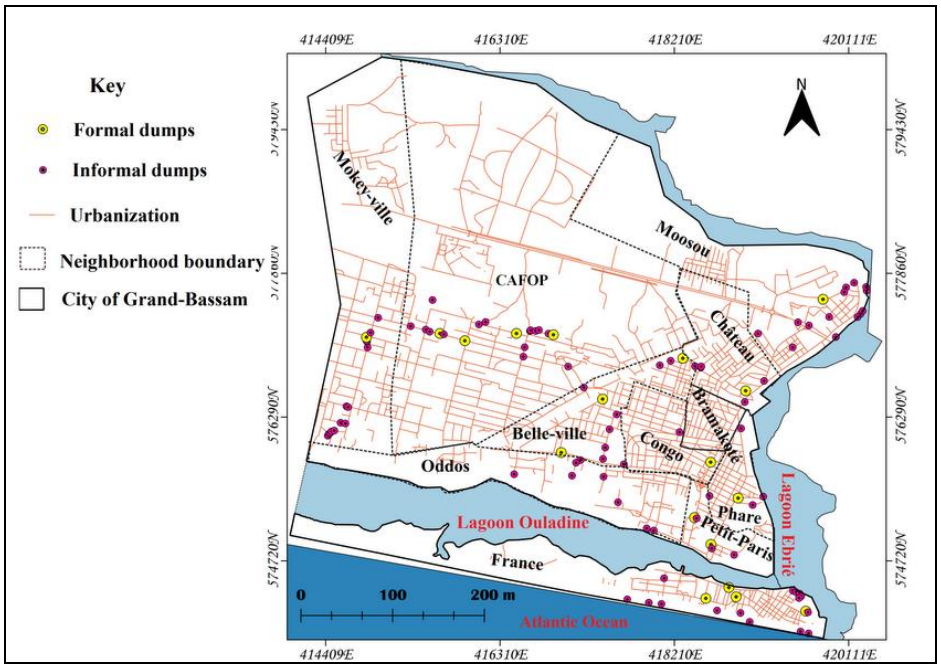

Figure 2: Spatial distribution of formal and informal dumps in the city of Grand-Bassam. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.2. Distribution of waste disposal sites in relation to terrain

Figure 3 presents the location of solid waste dumpsites in the city of Grand-Bassam, according to elevation. Thus, by superimposing these sites on the slope map, 44 informal dumpsites are located between the altitudes of 0 m and 4 m, i.e., 50.57% of the informal dumpsites identified in the city of Grand-Bassam. There are also seven (07) formal dumpsites identified in this altitude range. The analysis also revealed that eight (08) dumpsites, four (04) of which are informal and four (04) formal, are located at altitudes between 5 m and 7 m, i.e., 4.6% of the informal dumpsites identified in the town of Grand-Bassam and 22.22% of the formal dumpsites identified in the town of Grand-Bassam. Also, 39 of the informal dumpsites identified in the city of Grand-Bassam and 7 of the formal dumpsites are identified in areas with altitudes between 8 m and 12 m, i.e., 44.83% and 38.89% respectively. The distribution of waste sites in relation to low altitudes exposes them to drainage by runoff water. These wastes are composed of sand, fermentable materials, paper, plastics, metals, glass and fabrics. This can lead to contamination of the water by these solid wastes and consequently lead to carcinogenic diseases. In addition, most of the waste sites are located in flat and low-lying geographical areas. The landfills that are located in the elevations between 0 m and 7 m (49 informal landfills or 56.32% of the informal landfills) could be subject to site flooding in the event of flooding.

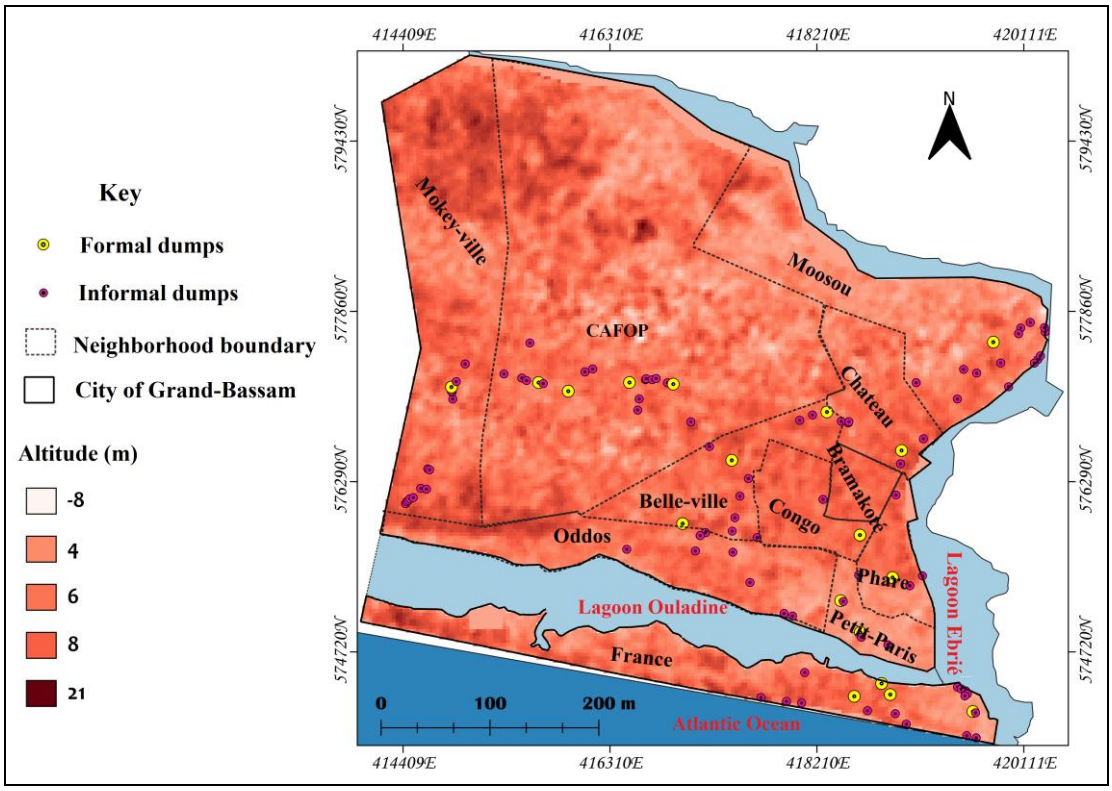

Figure 3: Distribution of waste disposal sites in relation to terrain. ***(Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.3. Distribution of waste disposal sites in relation to hydrography

The location of solid waste disposal sites in the city of Grand-Bassam in relation to hydrography is presented in figure 4. Indeed, 27 informal waste disposal sites are located on waterbeds, i.e., 31.03% of informal dumpsites identified in the city of Grand-Bassam. As for the formal dumpsites, three (3) of them, i.e., 16.67% of the identified formal dumpsites, are also located on the hydrographic network of the city of Grand-Bassam. The waste found on these sites prevents the normal flow of water towards the outlets. As a result, the populations near these areas are exposed to flooding and odors. In addition, small quantities of waste such as bottles of water, juice, milk and oil, plastic bags and disposable cups and utensils are drained into the outlets of these waterways, which are mostly the Ebrié and Ouladine lagoons and the Comoé River. All this contributes to the degradation of the natural environment but also to the occupation of the ecological niches of these waters with multiple harmful consequences for their flora and fauna.

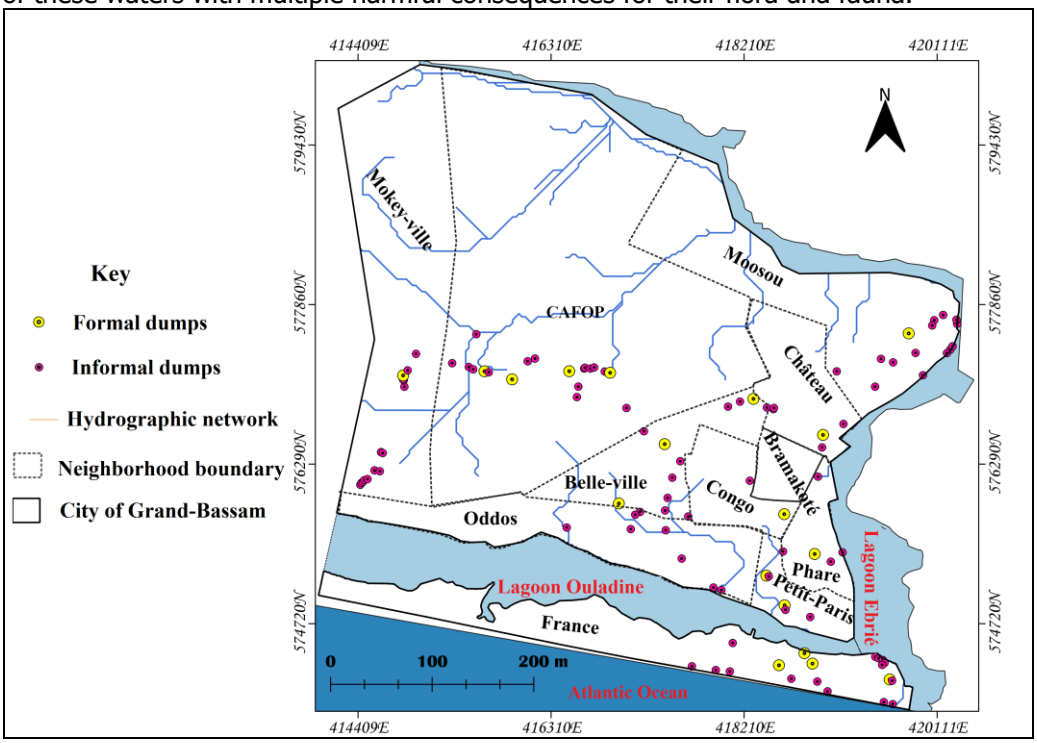

Figure 4: Distribution of waste disposal sites in relation to hydrography. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.4. Distribution of waste disposal sites in relation to soil texture

The superimposition of the waste sites on the soil layer made it possible to characterize the latter according to the texture of the soil as shown in figure 5. Indeed, the city of Grand-Bassam is based on a ferralic aerosol type of soil. In fact, aerosols are sandy soils that are at least 120 cm thick. They have a low clay content and a low percentage of coarse elements. Analysis of the location of the sites according to soil texture shows that all the waste sites in the city of Grand-Bassam are located on permeable soil, which can facilitate the infiltration of leachate and the various minerals contained in the waste, which oxidizes very easily in contact with water. As a consequence, the contamination of the water table which could then represent dangers for the animal and human health.

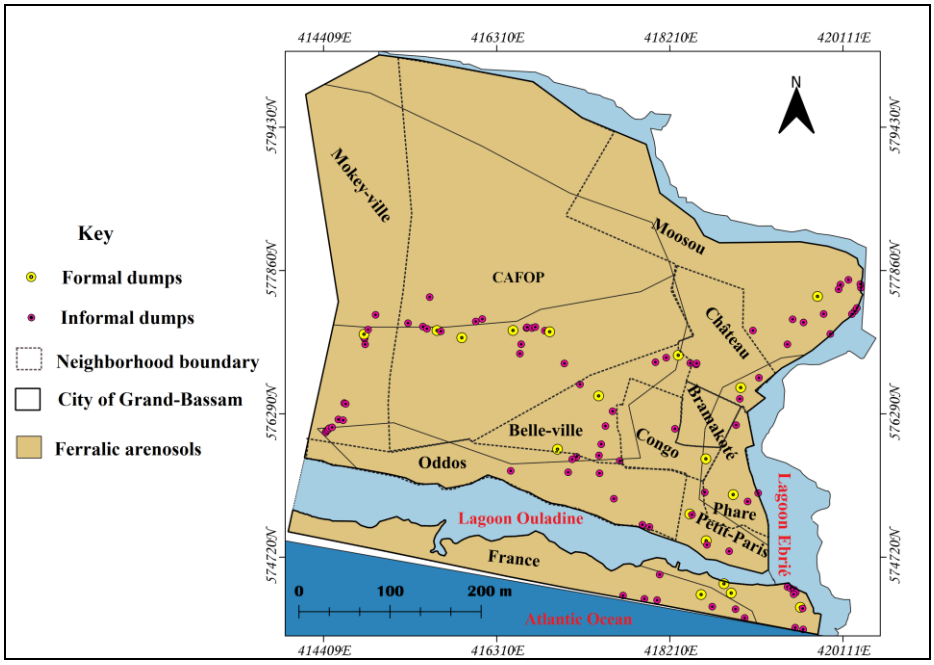

Figure 5: Distribution of waste disposal sites in relation to the soil texture. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.5. Distribution of waste disposal sites in relation to geology

Figure 6 shows the location of solid waste disposal sites in the city of Grand-Bassam, according to the geology. Thus, by superimposing these sites on the geological map, it appears that all the waste sites of the city of Grand-Bassam are located in the sedimentary basin area, precisely on coastal sediments. The contact of plastic waste associated with biodegradable waste in these coastal sediments can lead to the progressive pollution of the soil, subsequently of the groundwater and of the fauna, flora and living environment through the development of diseases.

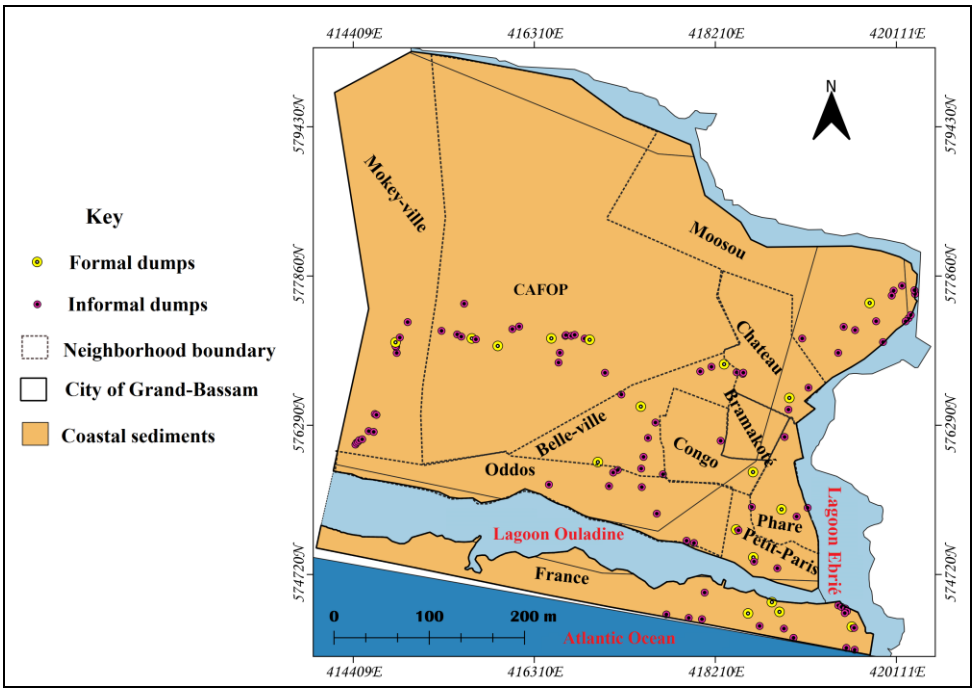

Figure 6: Distribution of waste disposal sites in relation to site geology. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.6. Distribution of waste disposal sites in relation to the fracking network

Figure 7 shows the location of solid waste disposal sites in the town of Grand-Bassam, according to the fracking network. Thus, by superimposing these sites on the map of fracturing, 29 sites of informal dumps or 33.33% are located on the fracturing network of the city of Grand-Bassam against 12 sites or 66.67% for formal dumpsites. Plastic waste associated with biodegradable waste undergoes chemical, biological and physical processes generating liquid flows called leachate. These liquids charged bacteriologically with both mineral and organic substances will reach the groundwater through the various fracture networks on which the dumps are located.

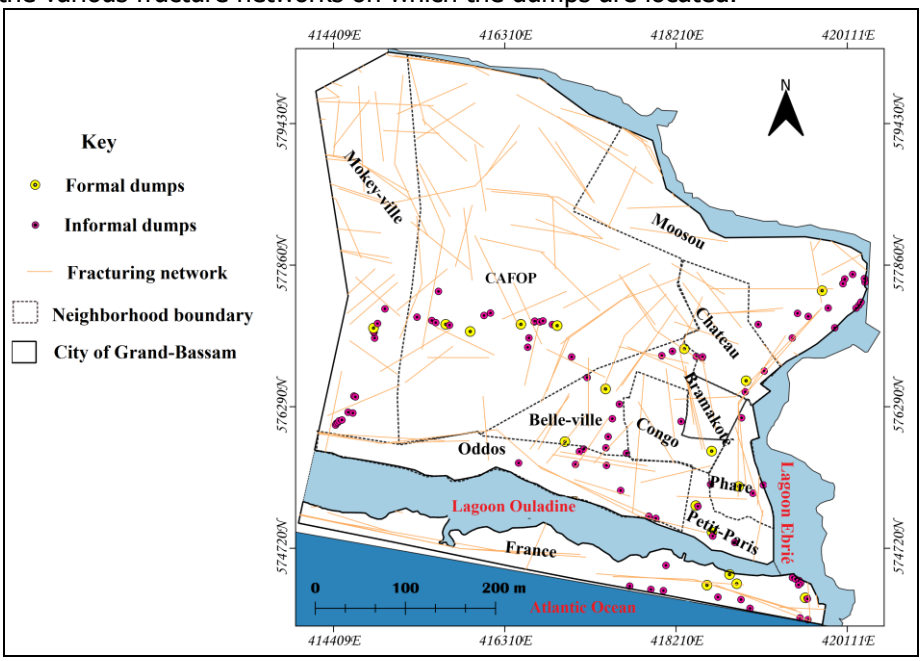

Figure 7: Distribution of waste disposal sites in relation to the fracking network. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.7. Distribution of waste disposal sites in relation to land use

Waste sites superimposed on the land use layer in the city of Grand-Bassam, this study was used to characterize informal sites in relation to key land use elements (Figure 8). From the examination of the figure, it appears that 71 informal dumpsites (or 81.61% of informal sites) are located between settlements. Fifteen of the formal dumpsites, or 83.33% of the formal dumpsites, are located between settlements. Analysis of the location of household waste sites in relation to land use shows that these sites are mainly (81.90%) located between settlements. Thus, the waste located in the settlements could lead to soil acidification and by infiltration of leachate from the waste, contamination of private wells and in the long term the water table.

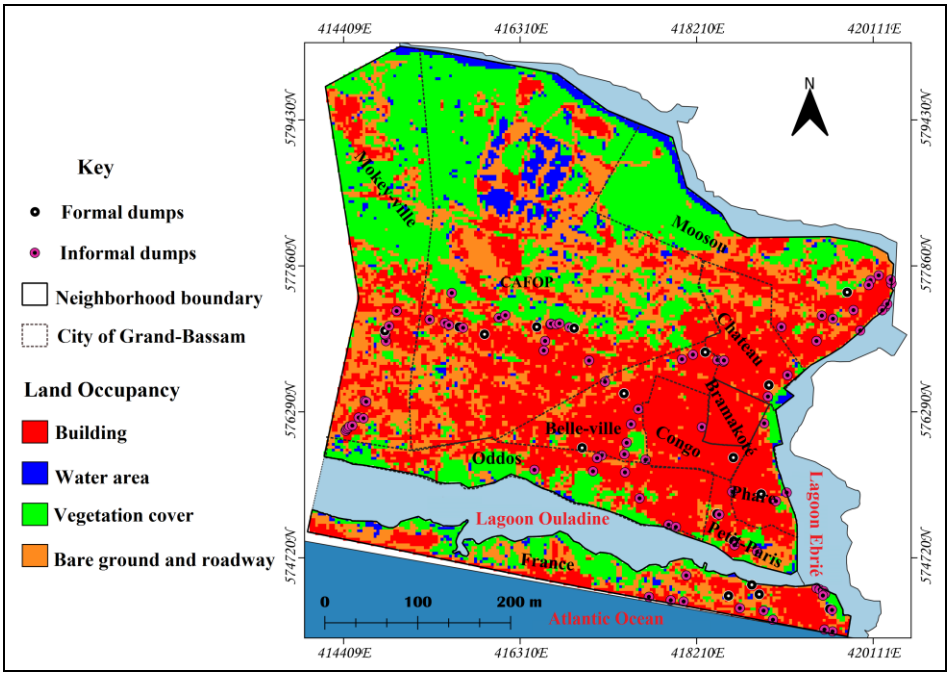

Figure 8: Distribution of waste disposal sites in relation to land use. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.8. Distribution of waste disposal sites in relation to the stormwater drainage system

The location of solid waste disposal sites in the city of Grand-Bassam in relation to with the stormwater drainage network is presented in figure 9. Indeed, 26 informal dumpsites are located along the storm water drainage channels of the city of Grand-Bassam, i.e., 29.89% of the informal dumpsites identified in the city of Grand-Bassam. As for the formal dumpsites, nine (9) of them, i.e., 50% of the formal dumpsites identified, are also located along the storm water drainage channels of the city of Grand-Bassam. Like the majority of waste dumping sites encountered in the city of Grand-Bassam, the frequency of collection of waste deposited along the drainage channels is not always regular. This waste, of various kinds, is likely to end up in the said canals, either through the wind or rainwater runoff. As a result, the city's canals are clogged, preventing the evacuation of runoff water. All this favors the occurrence of floods in the surrounding neighborhoods.

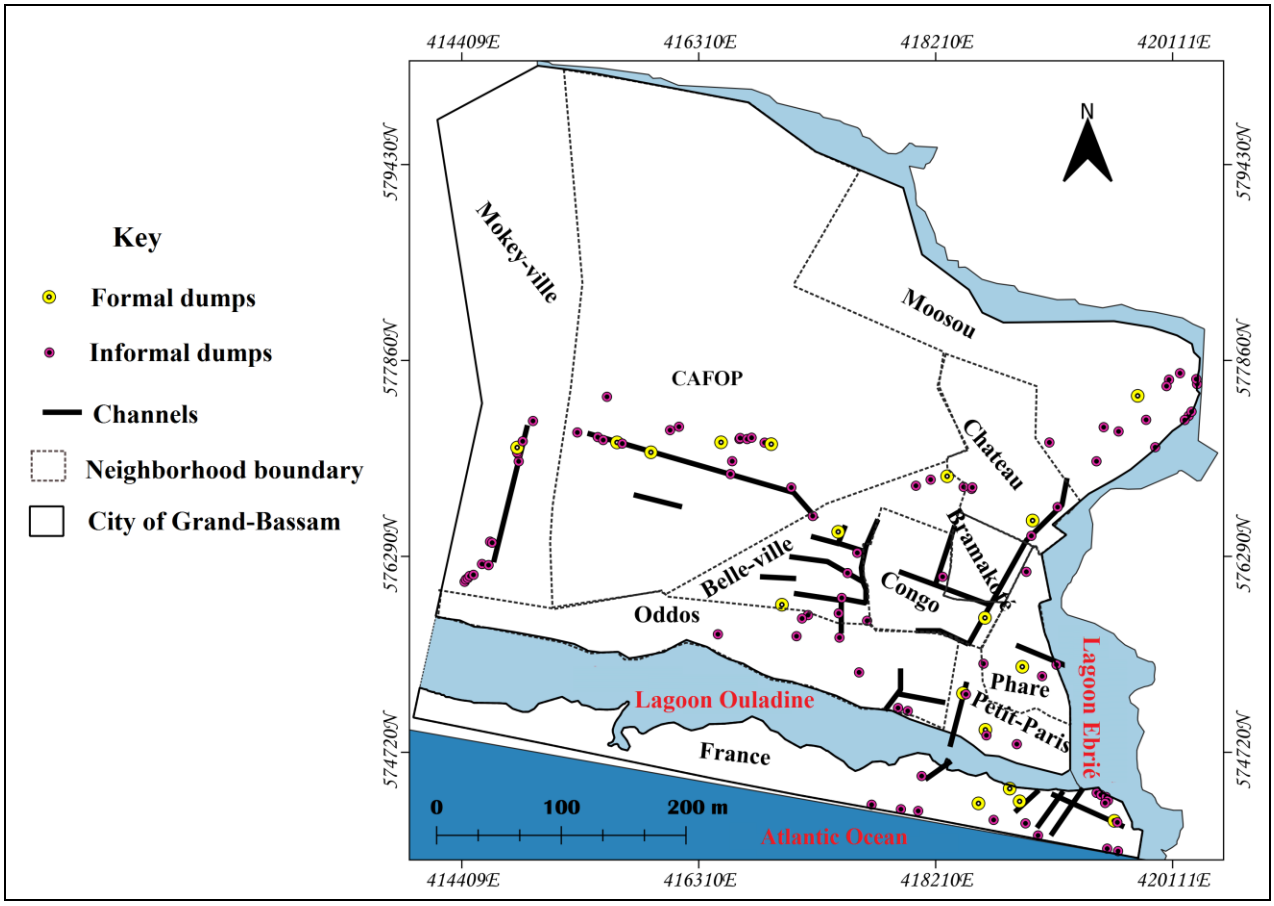

Figure 9: Distribution of Waste Disposal Sites in Relation to the Storm Drainage System. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.9. Distribution of waste disposal sites in relation to area

Figure 10 presents the distribution of waste disposal sites in relation to the surface area occupied in the city of Grand-Bassam. Thus, the evaluation of the surface areas of the informal dumpsites identified during the geographic survey in the city of Grand-Bassam indicates that these informal dumpsites range from 01 to 2000 m^2. The figure shows that 15 informal dumpsites (or 17.25% of the informal dumpsites identified) have an area of between 01 and 10 m^2. As for the informal dumpsites with an area between 10 and 100 m^2, they amount to 33, or 37.93% of the informal dumpsites identified in the city of Grand-Bassam. In addition, 20 of the informal dumpsites identified in the city (or 22.99% of the informal dumpsites identified) have an area between 100 and 200 m^2. Informal dumpsites with an area of between 200 and 500 square meters represent 12.64% of all informal dumpsites identified in the city of Grand-Bassam (11 informal dumpsites). The largest informal dumpsites in terms of surface area identified in the city of Grand-Bassam vary from 500 to 2000 m^2 and are eight (8) in number informal dumpsites, i.e. 09.20% of the informal dumpsites identified in the city of Grand-Bassam. The majority of the large dumpsites identified are located in the France and Phare districts of Grand-Bassam. Also, the evaluation of the surface area of the garbage bins identified during the geographic survey in the city of Grand-Bassam indicates that these garbage bins vary from 0.9 to 12.7 m^2. Large metal garbage bins, with an estimated surface area of 12.7 m^2, represent 44.44% of the garbage bins found in the city of Grand-Bassam. Medium-

sized metal bins, with an estimated surface area of 3.51 m^2, represent 11.12% of all garbage bins found in the city. Small high-density polyethylene (HDPE) bins, with an estimated surface area of 0.9 m^2, account for 44.44% of the garbage bins found in the city of Grand-Bassam.

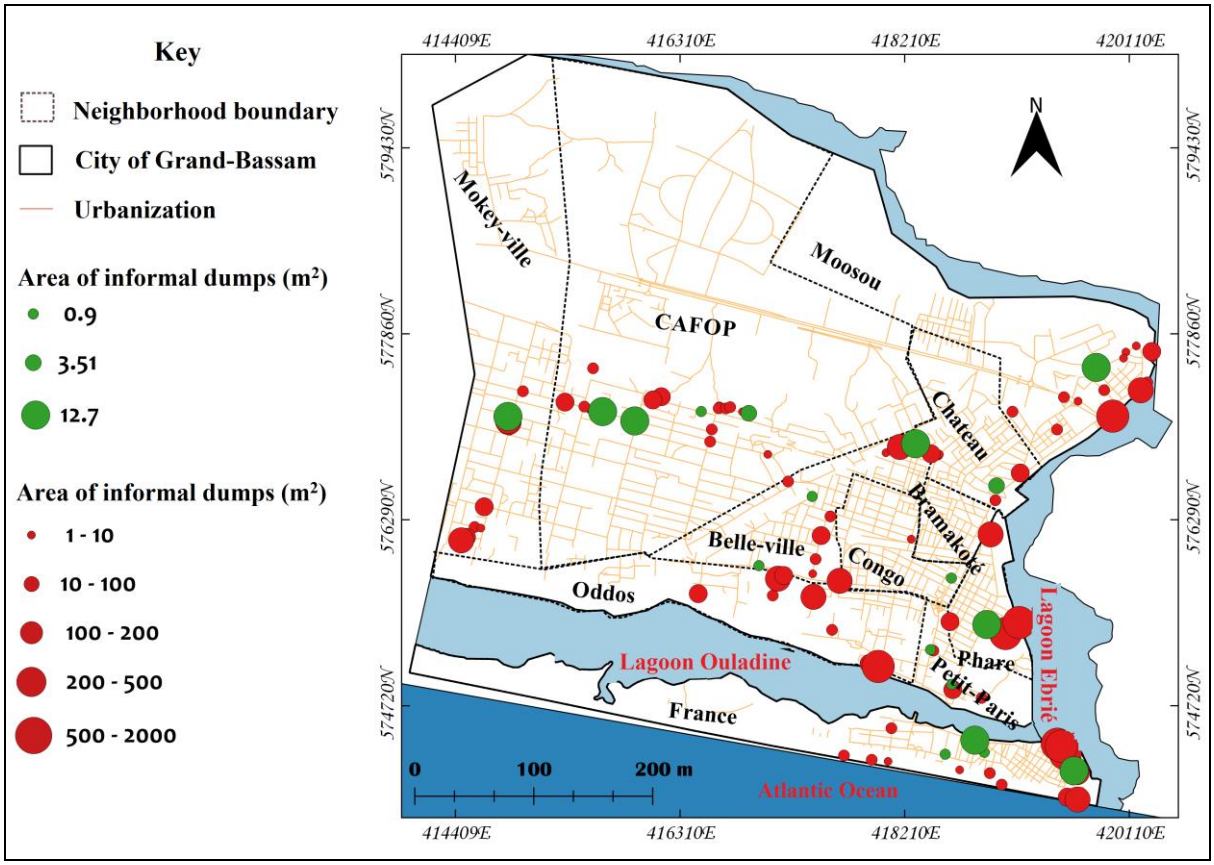

Figure 10: Distribution of waste disposal sites in relation to surface area. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al,. 2022).*

3.10. Distribution of waste disposal sites in relation to volume

Figure 11 presents the distribution of waste disposal sites in relation to the volume occupied in the city of Grand-Bassam. Thus, the evaluation of the volumes of informal dumpsites identified during the geographic survey in the city of Grand-Bassam indicates that these informal dumpsites vary from 0.1 to 3500 m^3. The figure shows that 10 informal dumpsites (or 11.49% of the informal dumpsites identified) have a volume of between 0.1 and 01 m^3. As for the informal dumpsites with a volume between 01 and 10 m^3, they amount to 19 or 21.84% of the informal dumpsites identified in the city of Grand-Bassam. In addition, 34 of the informal dumpsites identified in the city (i.e. 39.08% of the informal dumpsites identified) have a volume of between 10 and 100 m^3. As for the informal dumpsites with a volume between 100 and 1000 m^3, they represent 21.84% of all informal dumpsites identified in the city of Grand-Bassam (i.e. 19 informal dumpsites). The largest informal dumpsites in terms of volume identified in the city of Grand-Bassam ranging from 100 to 3500 m^2 and are five (05) informal dumpsites, representing 05.75% of informal dumpsites identified in the city of Grand-Bassam. The majority of the large dumpsites identified are located in France, Oddos and Phare districts of Grand-Bassam (Figure 12). Also, the evaluation of the volumes of garbage bins identified during the geographic survey in the city of Grand-Bassam indicates that these bins ranging from 0.9 to 14.01 m^3. Large metal garbage bins, whose volume is estimated at 14.01 m^3, represent 44.44% of the garbage bins found in the city of Grand-Bassam. Medium-sized metal bins, whose volume is estimated at 4.56 m^3, represent 11.12% of all the garbage bins found in the city. Small high-density polyethylene (HDPE) bins, with an estimated surface area of 0.9 m^3, account for 44.44% of the garbage bins found in the city of Grand-Bassam.

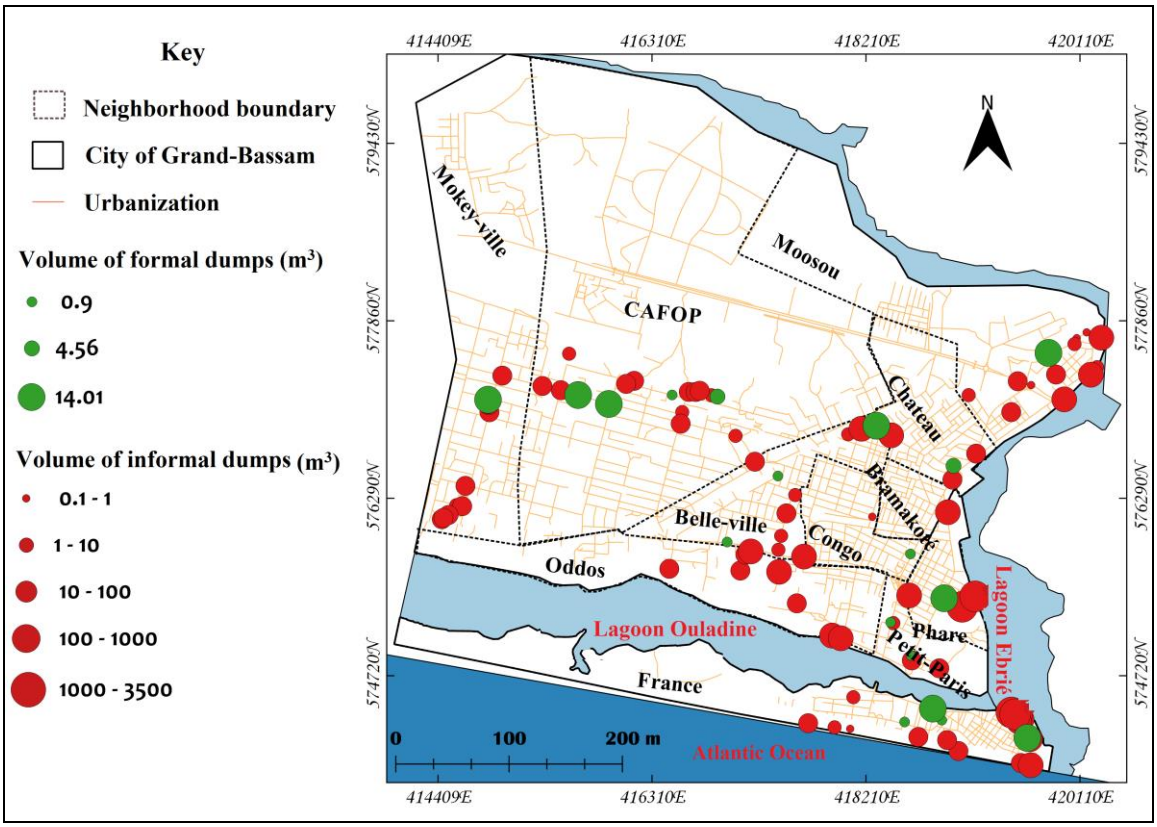

Figure 11: Distribution of waste disposal sites in relation to volume occupied. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al,. 2022).*

Figure 12: Informal dumps in the France (A) and Phare (B) neighborhoods of Grand-Bassam

(Spirce: *Teya et al., August 2021)*

3.11. Density analysis of the impact of informal dumps on the city of Grand-Bassam

3.11.1. Density of impact of informal dumps in relation to area

Figure 13 shows the density of the impact of informal dumps in the city's neighborhoods of Grand-Bassam in relation to the surface. Indeed, this density range from 0.08 and 2000 m^2/km^2. The density of the impact of informal dumpsites in the city of Grand-Bassam is not the same in the different districts. Thus, the Mokey-ville and CAFOP neighborhoods are the least impacted with a density ranging from 0.08 to 9.99 m^2/km^2. The Moossou, Château and Belleville neighborhoods are moderately impacted by informal dumpsites with an impact density ranging from 10 to 99.99 m^2/km^2. In addition, the Congo, Oddos and French neighborhoods are heavily impacted by the informal dumpsites identified in the city of Grand-Bassam with an impact density ranging from 100 to 499 m^2/km^2. As for the Bramakoté, Petit-Paris and Phare neighborhoods, they are very strongly impacted by the informal dumpsites recorded in the city of Grand-Bassam with an impact density ranging from 500 to 2000 m^2/km^2.

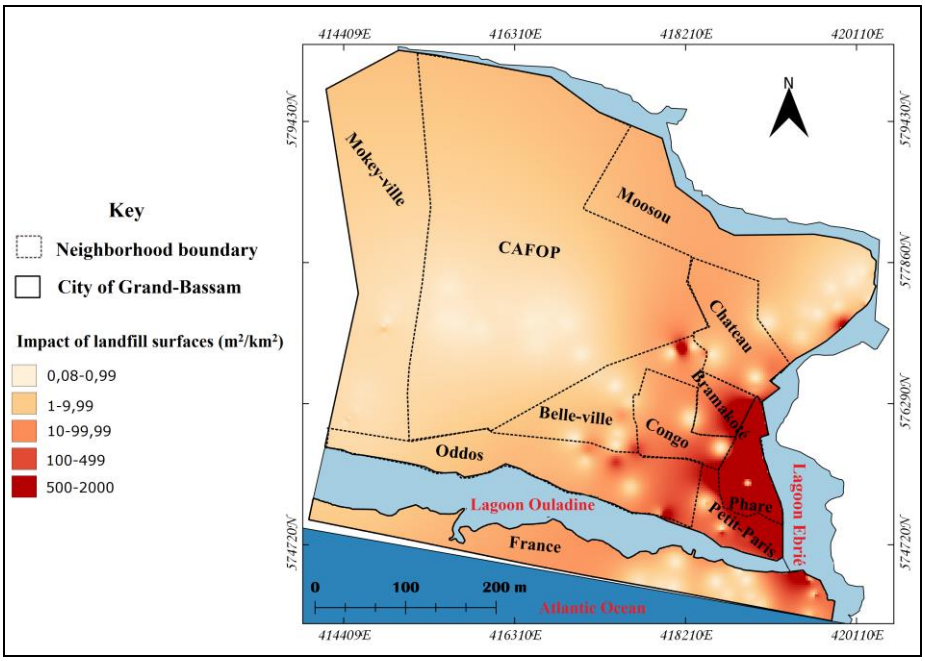

Figure 13: Density of informal dumpsites in the city of Grand-Bassam in relation to the surface area of the neighborhoods. (***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

3.11.2. Density of impact of informal dumps in relation to volume

Figure 14 shows the density of the impact of informal dumps in the city's neighborhoods of Grand-Bassam in relation to volume. Indeed, this density varies between 0.05 and 6000 m^3/km^2. Like the surface density, the density of the impact of informal dumpsites in relation to volume in the city of Grand-Bassam is not the same in the different districts. Thus, the Mokey-ville and CAFOP neighborhoods are the least impacted with a volume density rage from 0.05 to 9.99 m^3/km^2. The Moossou, Château and Belleville neighborhoods are moderately impacted by informal dumpsites, with an impact volume density ranging from 10 to 99.99 m^3/km^2. In addition, the Congo, Oddos and French neighborhoods are heavily impacted by the informal dumpsites identified in the city of Grand-Bassam with an impact density ranging from 100 to 499 m^3/km^2. As for the Bramakoté, Petit-Paris and Phare districts, they are very strongly impacted by the informal dumpsites recorded in the city of Grand-Bassam with an impact density ranging from 500 to 6000 m^3/km^2. Considering the surface and volume density, the districts of Mokey-ville and CAFOP are the least impacted and the districts of Bramakoté, Petit-Paris and Phare are the most impacted by the informal dumps recorded in the city of Grand-Bassam.

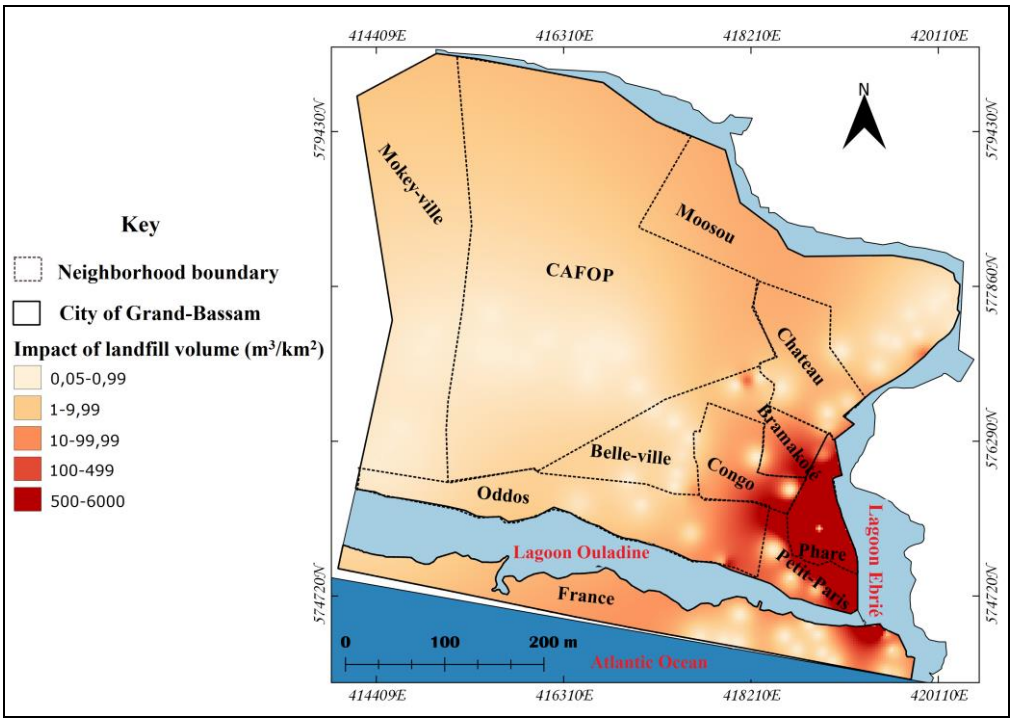

Figure 14: Volume density of informal dumps in the city of Grand-Bassam in relation to the area of the neighborhoods ***Source:*** *Field surveys, 2021;* ***Realization:*** *Téya and al., 2022).*

4. DISCUSSION

The study of the spatial distribution of waste dumping sites revealed the existence of several waste dumping sites in the city of Grand-Bassam. A total of 87 informal dumping sites were identified and 18 formal dumping points. The majority of the formal dumping sites built for the regrouping of waste are for the most part difficult to access because of the impassability of the roads. These results on the characterization of collection points and their spatial distribution are similar to those obtained by Allagbé (2019) [9] in the city of Porto-Novo in Benin, with the difference that the number of informal dumpsites is reduced. The number of informal dumpsites (87 out of a total of 105) represents 82.86% of all dumpsites identified in the city of Grand-Bassam. The alarming number of informal dumpsites in the city of Grand-Bassam could be explained by population density, the presence of undeveloped areas, poor occupation or anarchic urbanization, and lack of civic-mindedness. The results obtained corroborate those of previous work [10,11,12]. Indeed, these authors indicate that there is a correlation between anarchic urbanization and the proliferation of waste in urban areas. In addition to the identified dumpsites, there is, almost everywhere, garbage along the roads and gutters. This state of affairs was also observed by other authors [13,14]. In addition, the lack of coverage of the space by pre-collection structures, which results in part in the proliferation of informal dumpsites, could have a negative impact on the living environment. This aspect was raised by [15,16] in Rabat, Morocco and Conakry, Guinea, respectively. During their investigations, these authors noted that the proliferation of waste in urban areas creates an unhealthy environment characterized by air, soil and subsoil pollution and the deterioration of the living conditions of the population. Similarly, in the practical guide on the management of household waste and technical landfill sites in the countries of the South [17], shows that these dumps not only constitute a threat to human health and the environment but also cause the pollution of drinking water reserves by pathogenic microorganisms, which can cause epidemics. Kahonou (2020) [18] also reveals that most diseases are caused or influenced by environmental factors such as the proliferation of uncontrolled garbage dumps. Also, the United Nations Environment Program (UNEP) argues in 2013 that the main environmental diseases in developing countries are diarrhea (94% environmental causes), malaria (42%) and Acute Respiratory Infection (ARI) (42%). He further states that these three diseases account for 60% of the known environmental impacts on health in Africa. The analysis of the density of the impact of informal dumpsites on the city of Grand-Bassam indicates that whether it is the surface and/or volume density, the districts of Bramakoté, Petit-Paris and Phare are the most impacted by the informal dumpsites recorded in the city of Grand-Bassam. This hinders the economic and social development of the communities but also exposes the inhabitants of these districts to diseases, particularly malaria. In fact, studies conducted by Koné (2019) [19] on the health risks associated with household waste in the commune of Anyama (Ivory Coast) reveal that the neighborhoods with the highest rates of uncontrolled dumping have the highest malaria prevalence rates.

5. CONCLUSION

The waste disposal site mapping results for Grand-Bassam town indicate a lack of adequate transit depots in the surrounding neighborhoods, with informal dumps comprising 82.86% of identified waste disposal sites. Of the informal dumps, 56.32% were located at altitudes ranging between 0 m and 7 m, while 31.03% were situated on the city's hydrographic network, and 33.33% on the fracturing network compared to formal dumps' 66.67%. The majority (81.90%) of these dumpsites were found to be located between the settlements, posing a threat to both the environment and human health. The informal dumpsites had the greatest impact on the Bramakoté, Petit-Paris, and Phare districts, with Mokey-ville and CAFOP being the least impacted based on surface and volume density. To address this issue, it is crucial to conduct cleaning sessions to remove all informal dumps and deposits around and inside the city. The municipality can involve the general population, including civilians and the military, who are often called upon to clean up the city during official visits by political figures.

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