Identification of Municipal Solid Waste Landfill Sites using the GIS and AHP Multicriteria decision analysis: A case of the urban municipality of Dédougou (Burkina Faso)

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Abstract

Sustainable management of municipal solid waste is a major challenge for developing countries, where rapid population growth and accelerated urbanization are increasing waste production and pressure on landfill sites. Selecting suitable landfill sites is a complex task that requires consideration of multiple environmental, geological, topographical and anthropogenic factors in order to minimize impacts on public health and the environment. This study focuses on the urban commune of Dédougou and proposes an approach combining GIS and the Analytic Hierarchy Process (AHP) to identify optimal municipal waste landfill sites. The data used includes groundwater depth, distance from built-up areas, distance from watercourses, slope, altitude, land use and cover, soil types, geological formations, and distance from road networks. Each factor was standardized, weighted according to Thomas L. Saaty's 1977 AHP scale, and integrated into the GIS to produce a landfill suitability map. The results indicate a classification of areas into five categories: very unfavorable (9.29%), unfavorable (23.55%), moderately favorable (27.25%), favorable (39.88%) and very favorable (0.06%). The weightings assigned reveal that groundwater depth (0.386), proximity to built-up areas (0.232) and distance from watercourses (0.131) are the most influential factors. The final map shows that suitable and very suitable sites are mainly located on the northern and north-western outskirts of the urban commune of Dédougou, while the central areas are largely unsuitable for landfills.

Keywords: Municipal Solid Waste management; Landfill site selection; Geographic Information System; Analytic Hierarchy Process; Dédougou (Burkina Faso)

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Introduction

One of the most common and serious problems facing developing countries is the lack of adequate space for waste disposal (Iskender, 2025; Armanuos et al., 2023)located in the middle of the Nile Delta in Egypt, suffers from random selection of sites for solid waste disposal, resulting in significant environmental challenges. The aim of this study is to determine optimal landfill locations within Al-Gharbia Governorate and validate the existing landfill sites. Four techniques of multi-criteria decision-making (MCDM. Rapid population growth, economic development and industrialisation have created numerous problems related to municipal solid waste management (MSWM) in developing countries (Yildirim et al., 2018). There is a direct correlation between population and the amount of waste (Othman et al., 2021).

The use of landfills has been hailed in the context of municipal solid waste management as an essential solution to open dumping and incineration (Oyedele et al., 2022). However, the process of disposing of municipal solid waste by landfill or sanitary landfill is one of the most common practices in various countries around the world. But selecting landfill sites and choosing the best site is not an easy process, as the identification and selection process involves strict rules and regulations (Abdel-razzaq et al., 2024). Selecting suitable landfill sites is challenging because it involves integrating numerous criteria into waste management and sustainability models without harming the environment (Oyedele et al., 2022). Municipal solid waste (MSW) management is essential to public health and quality of life in urban and rural environments (Ali et al., 2023). For urban planners, it is essential to carefully select landfills that have minimal impact on the environment (Antony et al., 2024).

Numerous studies have focused on the optimal selection of landfill sites using multi-criteria decision-making methods in conjunction with geographic information systems (Alkaradaghi et al., 2019). The use of multi-criteria decision-making (MCDA) approaches, which combine geographic information systems (GIS) and multi-criteria evaluation techniques such as the analytic hierarchy process (AHP), is currently considered a better approach (Asefa et al., 2021)a capital city of Harari regional state located in the eastern part of Ethiopia, covers an area of 19.5 km2 and has a total population of 270 000. Despite the fastest population growth of the city, it doesn't have a landfill site to accommodate the waste generated and open dumping is in full practice. As an integral part of a solid waste management plan, the construction of a landfill has been suggested by the city municipality. However, the multi-dimensional and conflicting aspect of landfill sitting, which involves environmental, social, technical, and economic considerations, challenges the location of a suitable landfill site. In the current study, we have applied geographic information system (GIS. GIS and MCDA software have improved the effectiveness and efficiency of selecting suitable sites; these are decision-making tools that help select appropriate sites for landfill disposal (Abdel-razzaq et al., 2024).

The overall objective of this study is to select suitable sites for the establishment of household waste landfills in Dédougou, by combining a Geographic Information System (GIS) with the Analytic Hierarchy Process (AHP). To achieve this objective, the study focuses on the following specific objectives:

- To identify and map the decision-making factors;
- To standardize and normalize the suitability criteria for landfill sites;
- To use the Analytic Hierarchy Process (AHP) to determine the relative importance of each criterion;
- Integrate the weighted criteria into a GIS-based multi-criteria evaluation model to generate a landfill suitability map.

Materials and Methods

Study area

The municipality of Dédougou is located in the province of Mouhoun and is one of seven municipalities that make up the province. The city of Dédougou is the capital of the municipality of the same name, the province of Mouhoun and the Boucle du Mouhoun region. It is located 230 km west of the political capital Ouagadougou and 176 km from Bobo-Dioulasso, the economic capital. Dédougou is connected to Ouagadougou by National Road Nº. 14 and to Bobo-Dioulasso by National Road Nº. 10. The access roads to both towns are paved and in good condition. The municipality of Dédougou covers an area of 1,352.56 km² or approximately 19.68% of the total area of Mouhoun Province. The municipality of Dédougou (Figure 1) shares its borders with the following municipalities:

- to the east with the municipality of Douroula;
- in the west, the municipalities of Sanaba and Bourasso;
- in the north, the municipalities of Sono and Gassan;
- in the south, the municipalities of Ouarkoye and Kona;
- to the south-east with the municipality of Safané.

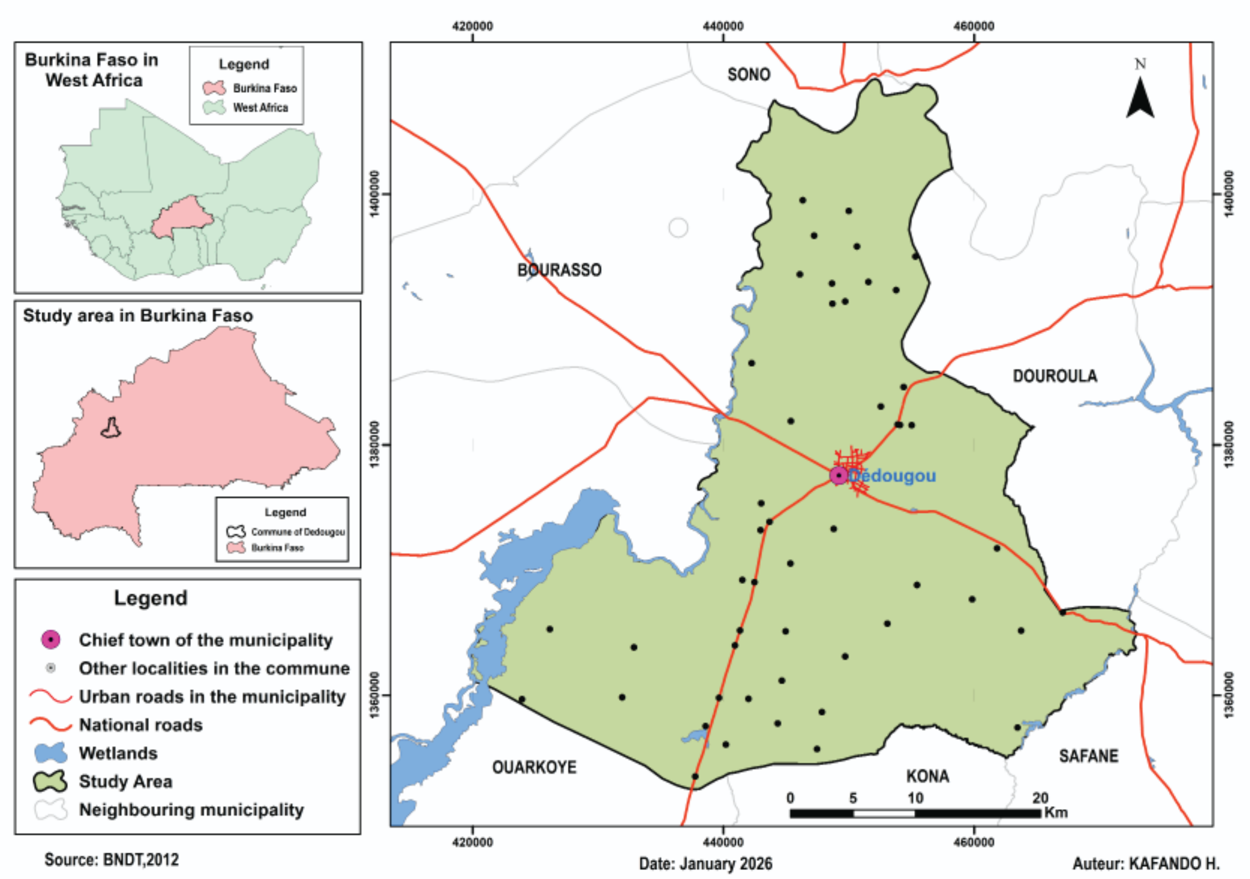

Figure 1. Study area Urban municipality of Dédougou

Data used in this study

The selection of potential sites for the establishment of a municipal landfill in the urban commune of Dédougou is based on the integration of several data sets. The main data used (Table 1) concern groundwater table, built-up areas, watercourse, types of soil, geological formations, land use/land cover, slope, roads, and, altitude factors that influence the location of landfill sites. These data were obtained from institutional sources, geomatics processing and field studies.

Table 1. Spatial data used for the selection of landfill sites in the urban municipality of Dédougou

N	Data	Acquisition
1	Groundwater depth	DGRE/DEIE, 2025
2	Built-up Areas	BNDT, 2012
3	Watercourse	BNDT, 2012
4	Types of soil	BUNASOLS, 2023
5	Geological formations	BUMIGEB, 2012
6	Land use/Land cover	Sentinel-2, 2025
7	Slope	STRM (NASA,2000)
8	Roads	BNDT, 2014
9	Altitude	STRM (NASA,2000)

Flowchart

To ensure a systematic and transparent selection of suitable municipal solid waste landfill sites, a structured methodological framework was developed. The approach integrates spatial analysis within a GIS environment and the Analytic Hierarchy Process (AHP) for multi-criteria decision-making. The framework includes the identification of the decision criteria based on literature review, local environmental context, following by criteria standardization, weighting, and overlay analysis. The Figure 2 present the overall methodological workflow adopted in this study.

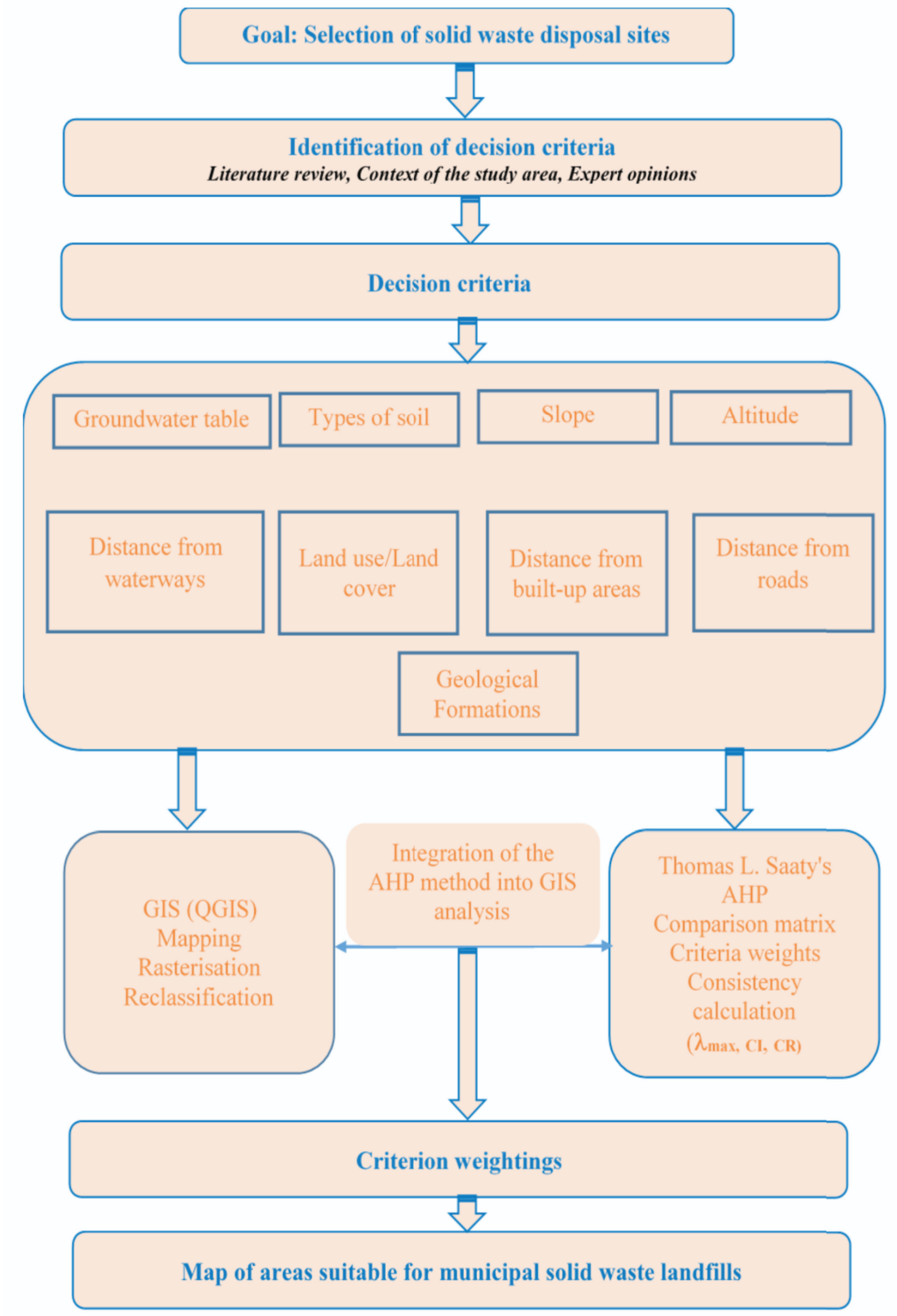

Figure 2. AHP-GIS integrated methodological workflow

Methods for integrating GIS and the AHP method

This study adopts an integrated framework combining Geographic Information Systems (GIS) and the Analytic Hierarchy Process (AHP) to identify suitable sites for the establishment of landfill sites. The selection of decision criteria was based on a depth review of the literature on GIS-based multi-criteria analysis for the selection of landfill sites. Furthermore, the choice of criteria takes into account the environmental and socio-economic conditions specific to the study area. The Table 2 presents the selected criteria, along with their justification and corresponding references.

Table 2. Selected criteria, justification and corresponding references

Criteria	Description/justification	Reference
Groundwater	Assess the distance from groundwater tables to prevent leachate from contaminating drinking water. Sites should be located sufficiently far from groundwater sources to ensure public health and environmental safety;	(Sisay et al., 2025; Mukomberanwa et al., 2025; Degefu & Asefa, 2024)
Built-up Areas	Avoid densely populated areas to minimize health risks, odor nuisance, and social conflicts. Sites located away from built-up areas are preferable to ensure social acceptance and operational safety;	(Degefu & Asefa, 2024; Kalisha & Munthali, 2024; Oluwanimifise & Anyaeche, 2024),
Watercourse	Maintain a safe distance from rivers, streams, or drainage channels to prevent contamination of surface water from runoff, and leachate. Buffer zones are essential for environmental protection ;	(Moumane et al., 2025; Mohammed, 2019; Audu et al., 2020; Aladenika, 2020)
Types of soil	Soils with low to moderate permeability should be selected in order to reduce the risk of leachate infiltration and ensure the geotechnical stability of landfills. Clay-rich soils are generally preferred due to their low permeability and high water-holding capacity;	(Elkhrachy et al., 2023; Salmana et al., 2024; Ali et al., 2023)
Geological formations	Geological characteristics must be taken into account to ensure the site's stability, its resistance to landslides, and its suitability for waste storage. Solid, low-permeability formations are preferred in order to minimize environmental risks;	(Soyaslan, 2025; Oguzhan et al., 2024; Armanuos et al., 2023)located in the middle of the Nile Delta in Egypt, suffers from random selection of sites for solid waste disposal, resulting in significant environmental challenges. The aim of this study is to determine optimal landfill locations within Al-Gharbia Governorate and validate the existing landfill sites. Four techniques of multi-criteria decision-making (MCDM
Land use/Land cover	Avoid sensitive areas (forests, wetlands, fertile farmland) and prioritize degraded or low-yield land in order to minimize environmental and social impacts. Land use planning ensures sustainable site selection;	(Moumane et al., 2025; Okin et al., 2024; Bhusal et al., 2023 ; Tafti et al., 2026)
Slope	Preference is given to gently sloping areas in order to minimize soil erosion, rapid surface runoff and construction difficulties. Steep slopes increase environmental and technical risks, as well as costs;	(Kalisha & Munthali, 2024; Degefu & Asefa, 2024)
Distance from roads	Assess the proximity of roads to ensure accessibility whilst minimizing traffic in residential areas. An optimal distance helps to reduce operating costs and environmental impact;	(Audu et al., 2020; Khalifa, 2015)
Altitude	Moderate elevations are generally preferred in order to avoid flood-prone areas, facilitate construction and ensure accessibility. Extremely low or high elevations can increase risks or costs.	(Tafti et al., 2026; Bhusal et al., 2023)

Decision criteria mapping

a. Distance from roads

Distance from roads is an essential criterion when choosing a landfill site. It affects accessibility for waste transport while minimizing the impact on residential areas. This factor (Figure 3) therefore helps to identify sites that are both accessible and safe (Molla, 2024; Rimal & Gurung, 2026).

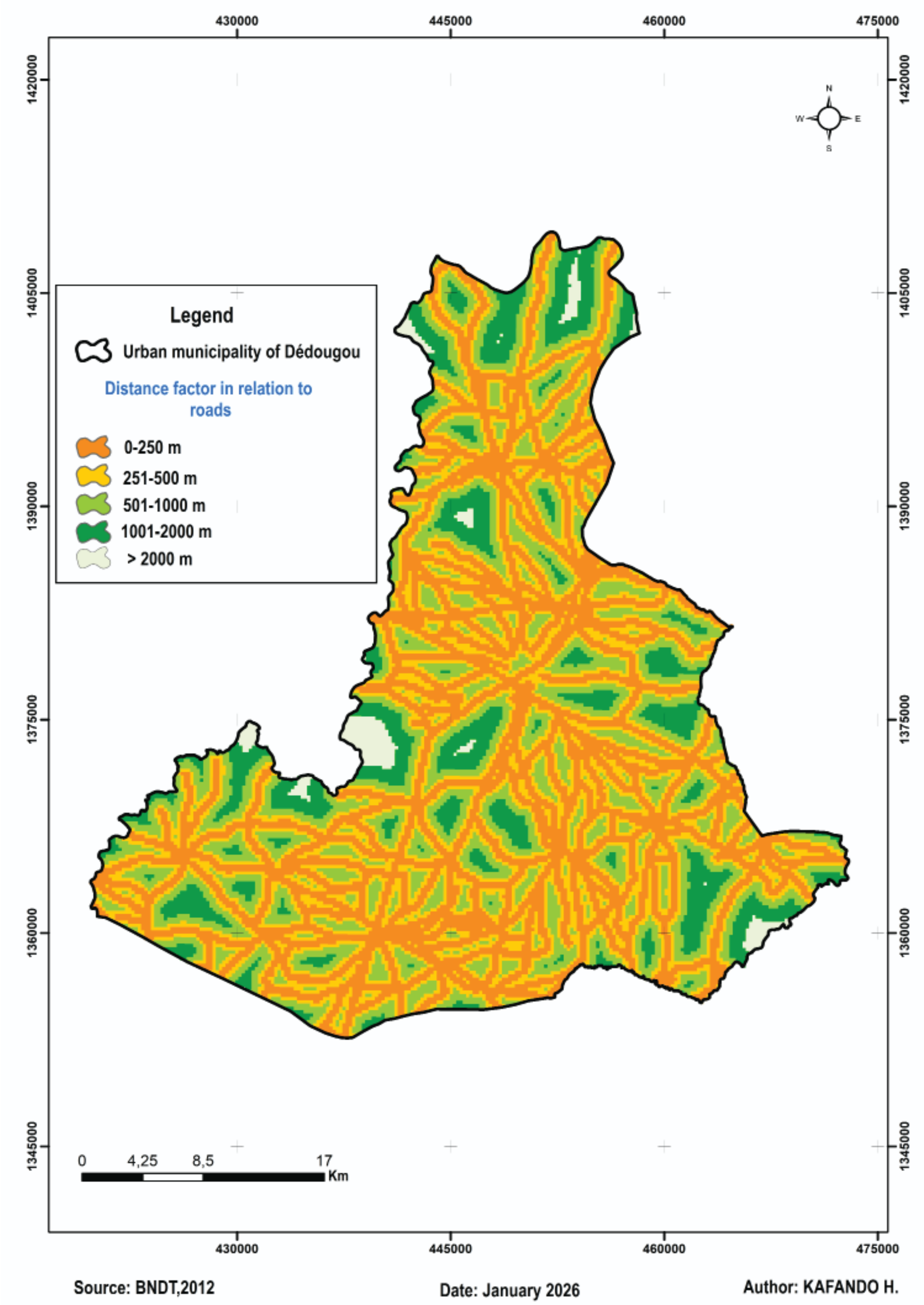

Figure 3. Distance from roads map in the urban municipality of Dédougou

b. Distance from watercourses

Distance from waterways is an essential criterion in choosing a landfill site. It helps protect water resources from contamination and maintain safety buffer zones along rivers and streams. This factor (Figure 4) thus minimizes environmental and health impacts (Chandel et al., 2024; S. Kumar et al., 2024; Tella et al., 2025).

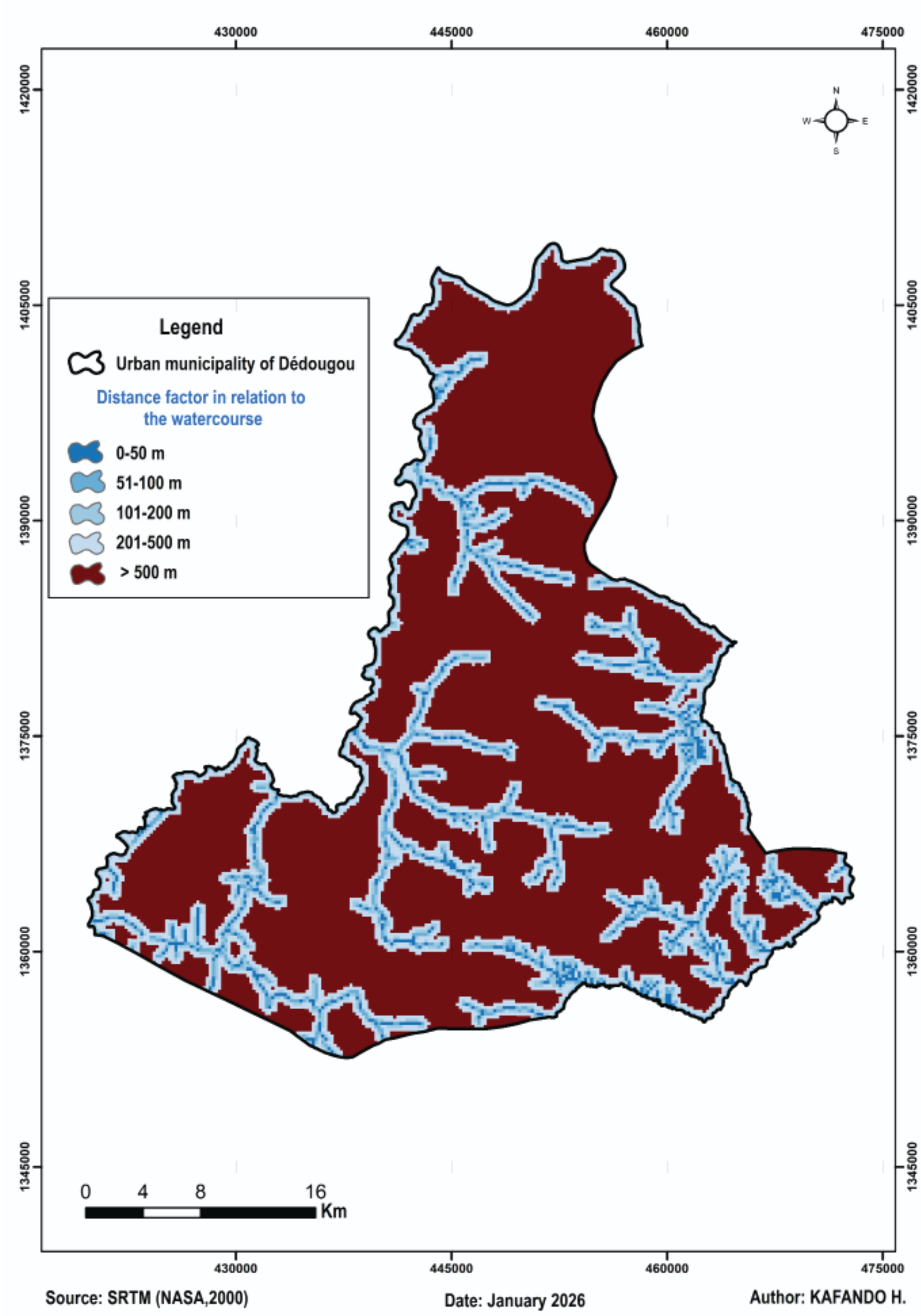

Figure 4. Distance from watercourses map in the urban municipality of Dédougou

c. Geological formations

Geological formations (Figure 5) influence the stability of a landfill site and the infiltration of waste into the soil. Permeable rocks or sediments can increase the risk of groundwater contamination, while impermeable formations offer better protection for the environment. This factor is therefore essential to ensure site safety and minimize impacts on soil and water resources (Alam et al., 2024; Wang et al., 2025).

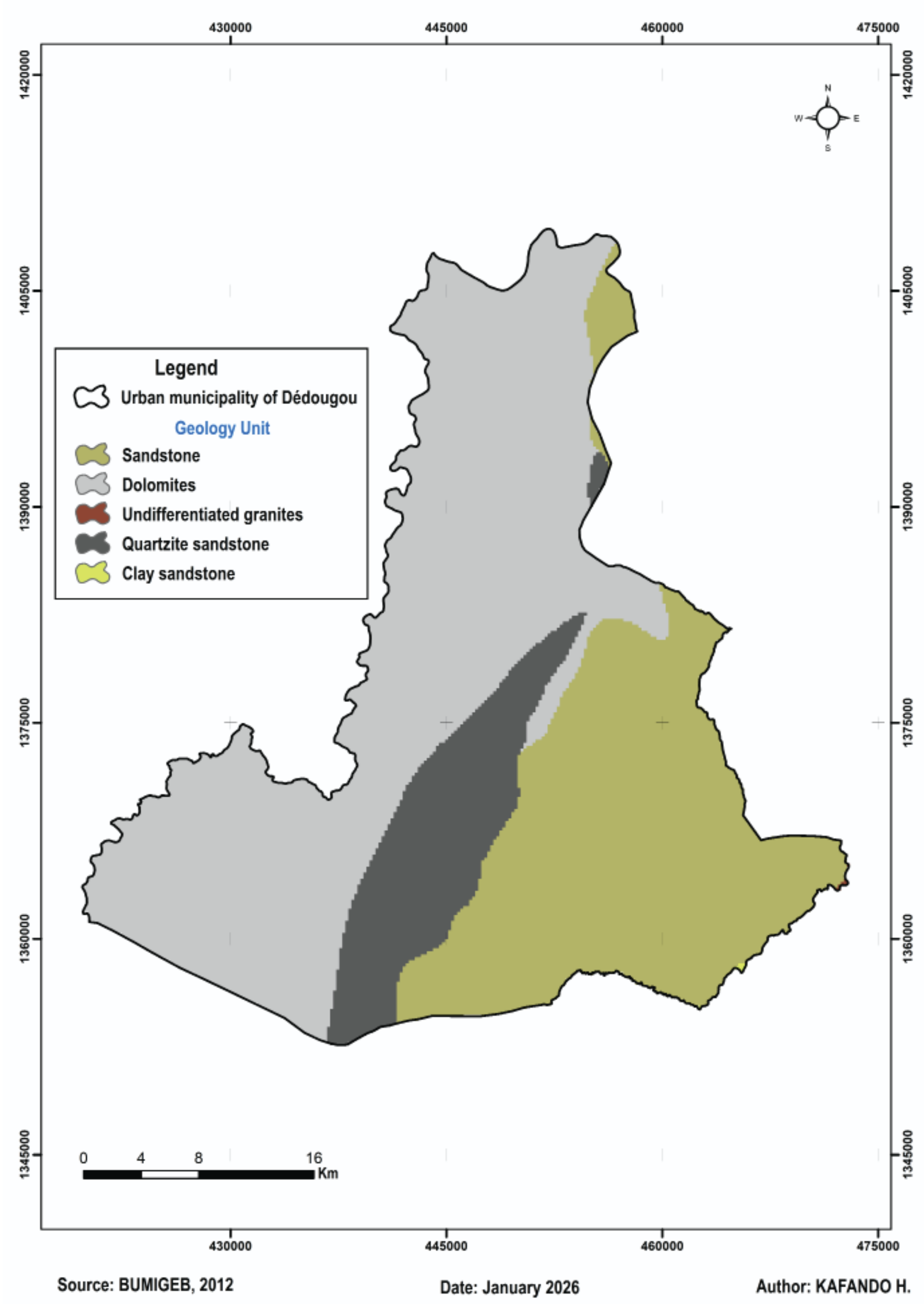

Figure 5. Geological formations map in the urban municipality of Dédougou

d. Altitude

The factor altitude (Figure 6) influences natural drainage and the risk of flooding at the site. Sites located at higher altitudes are less prone to flooding and allow surface water to drain away by gravity, reducing environmental and health risks. This factor therefore contributes to the safety and sustainability of the landfill site (Gebremichael et al., 2025"mendeley":{"formattedCitation":"(Gebremichael et al., 2025; Copăcean & Cojocariu, 2025).

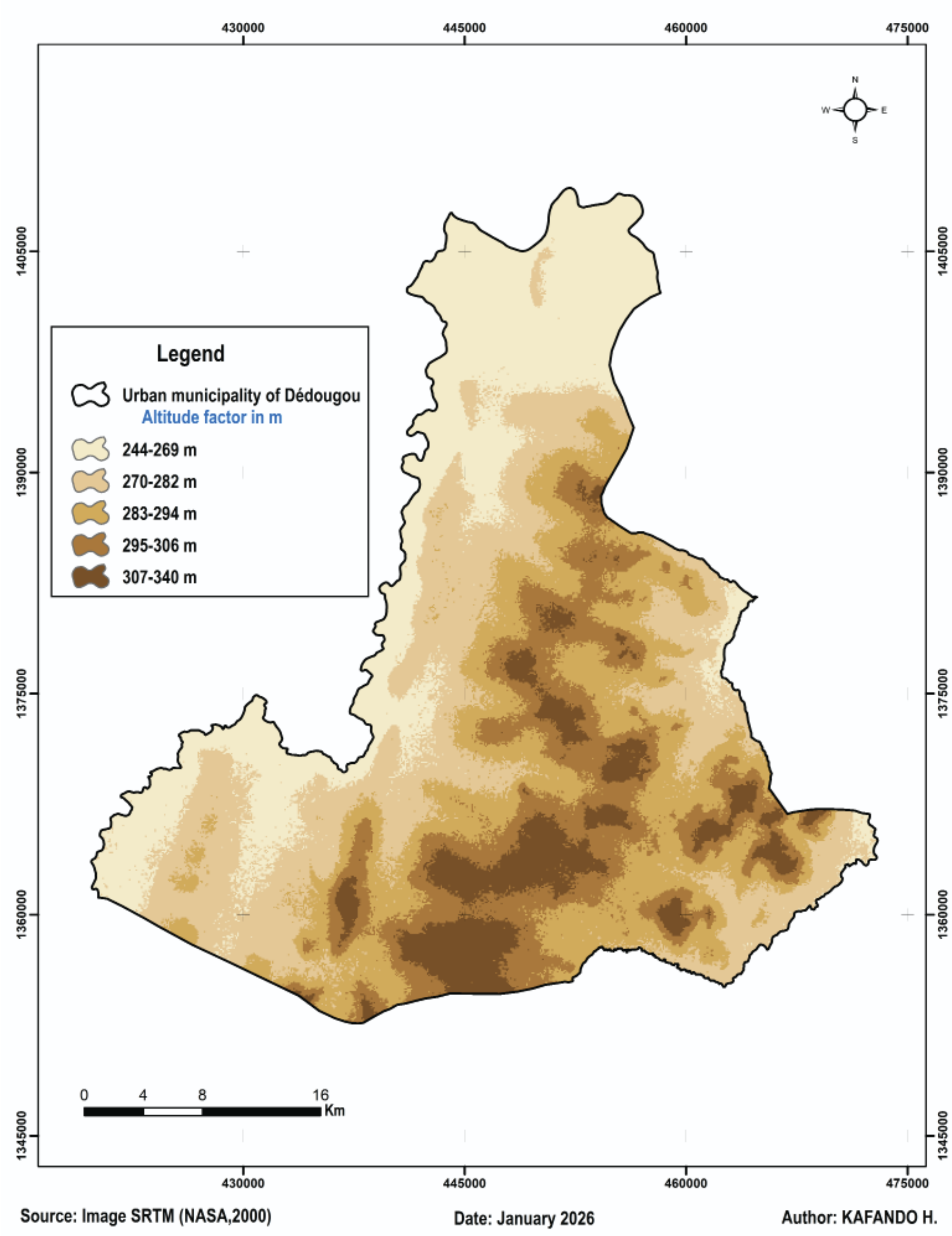

Figure 6. Altitude map in the urban municipality of Dédougou

e. Slope

The factor slope (Figure 7) influences site stability and surface water drainage. Steep slopes can cause erosion and rapid leachate runoff, while gentle slopes can lead to water accumulation and soil saturation. This factor is therefore crucial to ensuring safety, sustainability and effective waste management in landfills (Inegbedion & Orobosa, 2023; Sisay et al., 2025; Chandel et al., 2024).

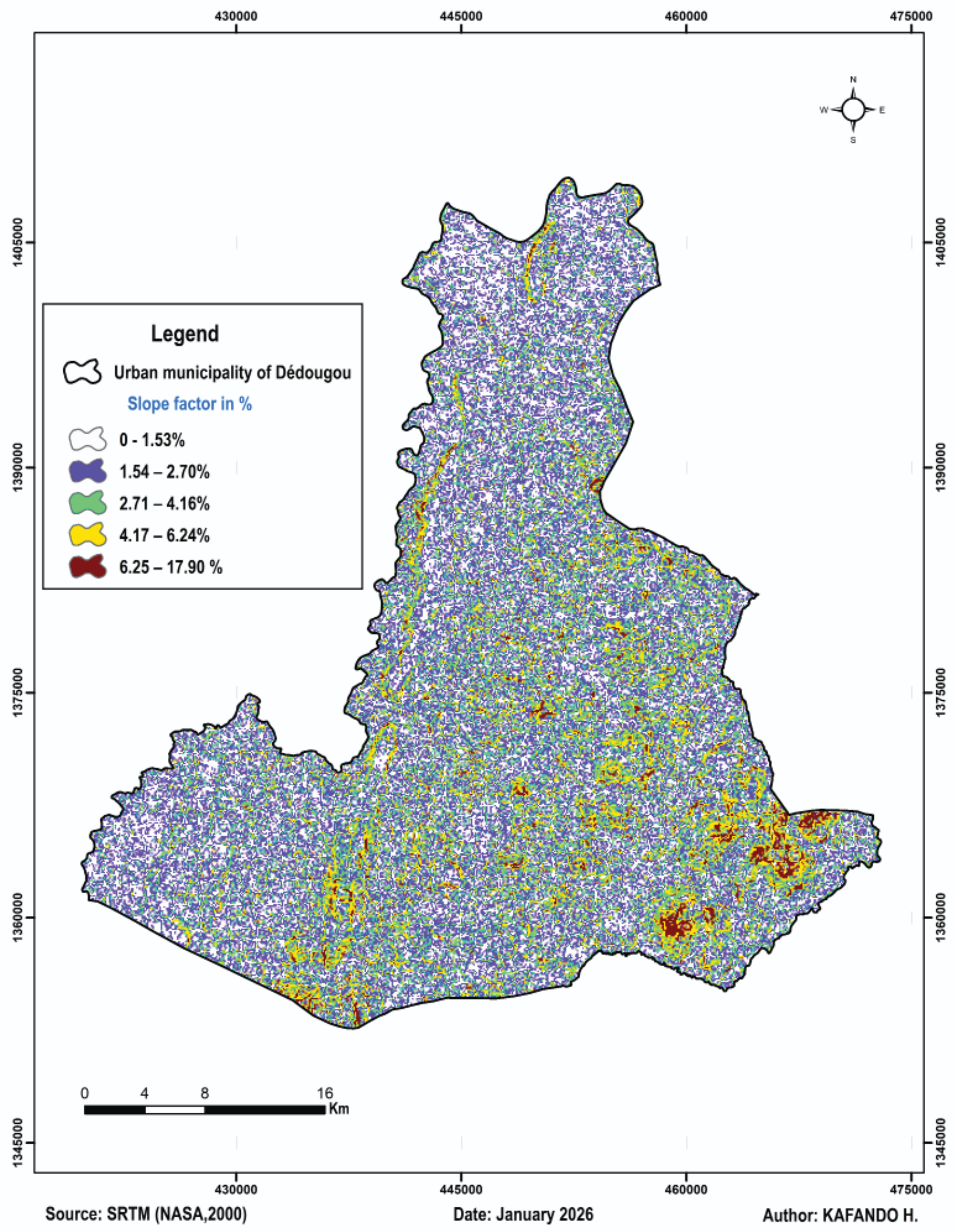

Figure 7. Slope map in the urban municipality of Dédougou

f. Soil type

The soil types (Figure 8) influence the stability, drainage and leachate containment of a landfill site. Clay soils, which are less permeable, help prevent leachate from seeping into groundwater, while sandy or highly permeable soils increase the risk of contamination. This factor is therefore essential for environmental protection and the long-term safety of the site (Kalisha & Munthali, 2024; Wamyil et al., 2026).

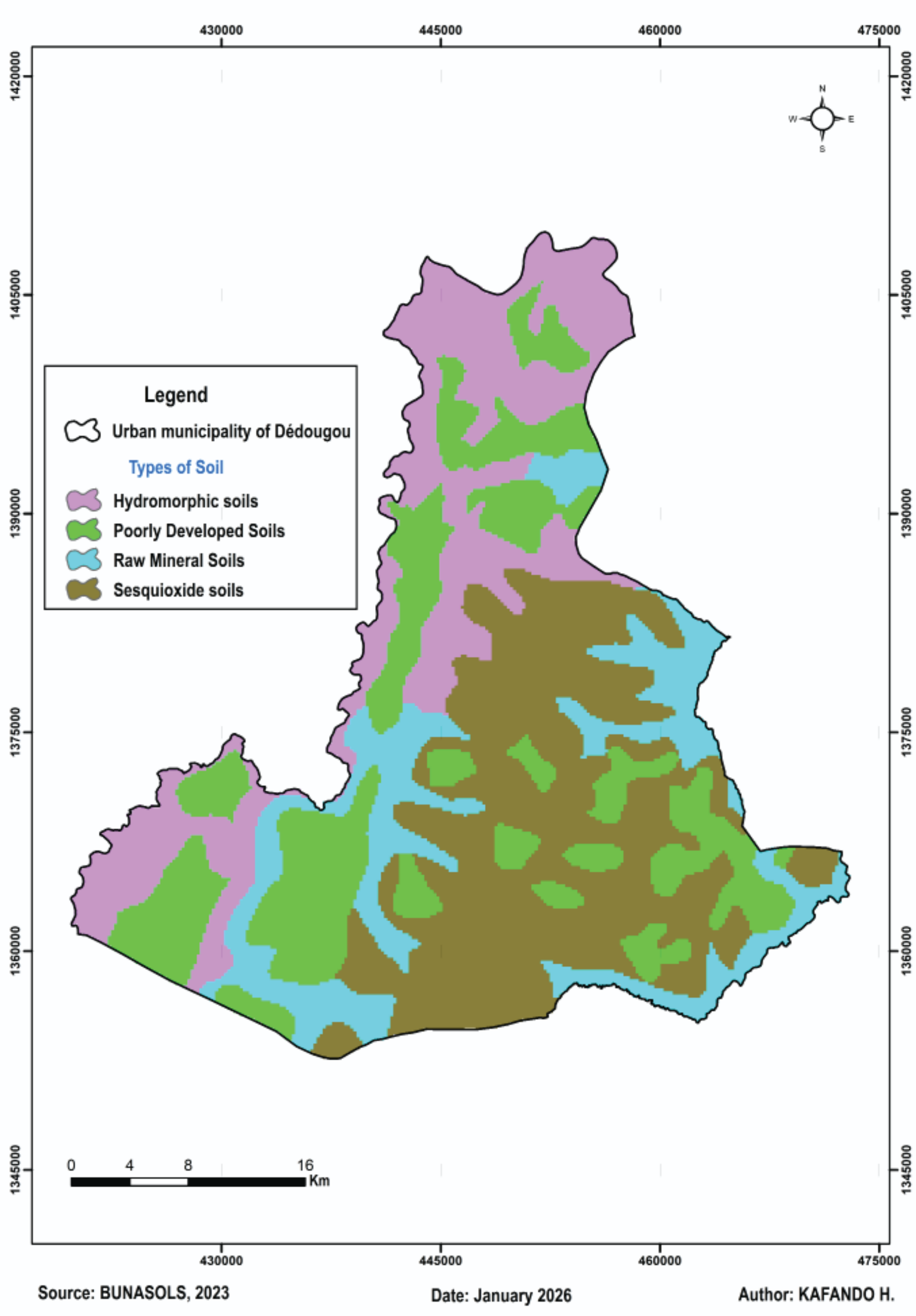

Figure 8. Soil type map in the urban municipality of Dédougou

g. Build up area

Distance from urban areas (Figure 9) is an essential criterion in landfill site selection, as it minimizes health risks, odours, and other nuisances affecting nearby populations (A. Kumar et al., 2024). Maintaining sufficient distance from inhabited areas also helps to reduce social conflicts. In addition, increasing this distance helps to limit conflicts associated with the Not In My Backyard (NIMBY) syndrome, where local communities oppose the siting of waste facilities near their living areas (Holm et al., 2021; Bao et al., 2023) . Furthermore, environmental regulations and planning guidelines recommend buffer distances between landfill sites and residential areas to ensure public health and environmental protection (UNEP & UNITAR, 2013; WHO, 2024).

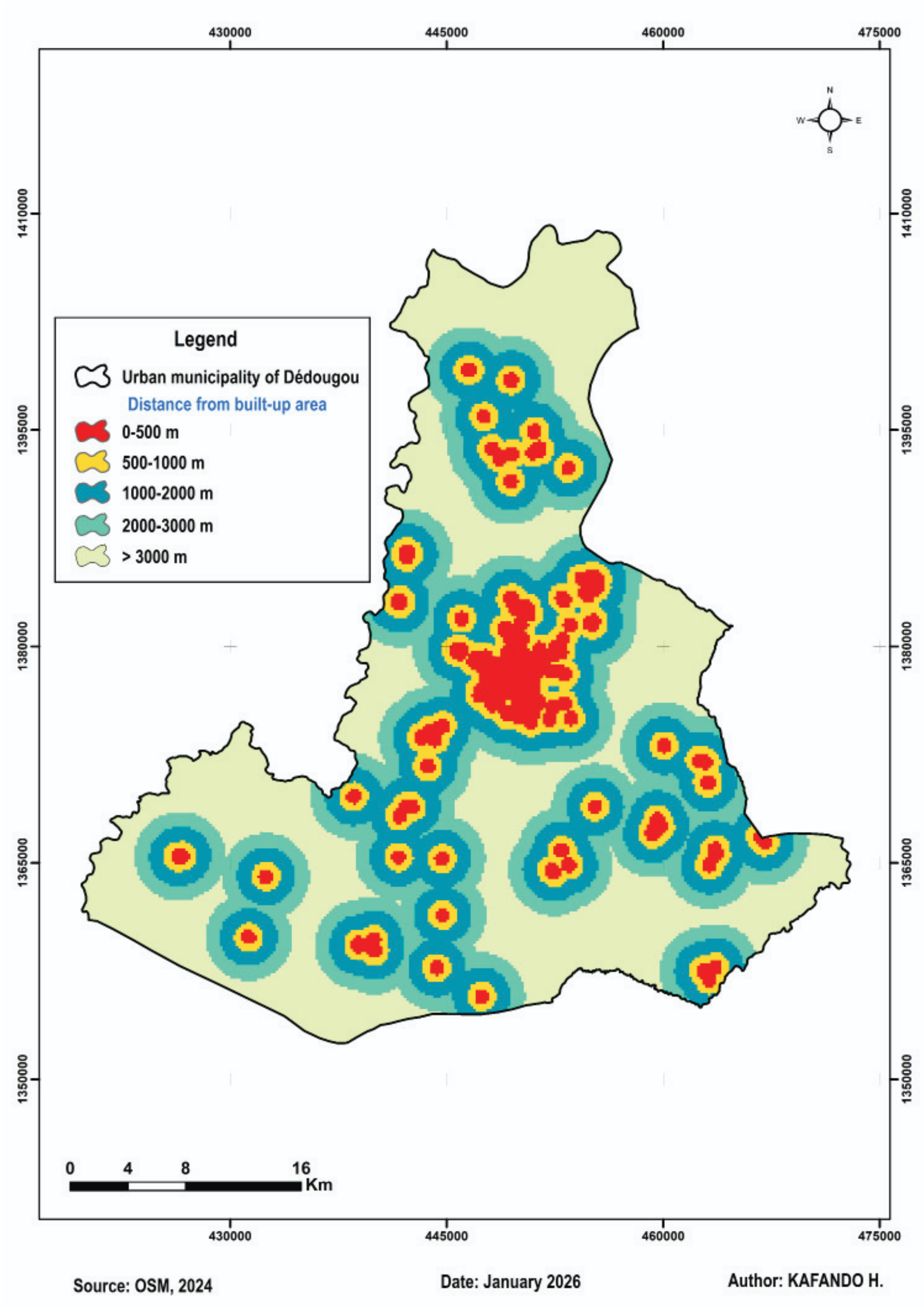

Figure 9. Distance from urban areas map in the urban municipality of Dédougou

h. Land use/Land cover

Land use and land cover (Figure 10) influence the choice of landfill sites based on human activities and vegetation cover. Densely populated or cultivated areas are generally avoided in order to reduce social and environmental impacts, while underused or undeveloped land is preferred. This factor thus contributes to balancing accessibility, safety and environmental protection (Tafti et al., 2026; Sisay et al., 2025; S. Kumar et al., 2024; Chandel et al., 2024).

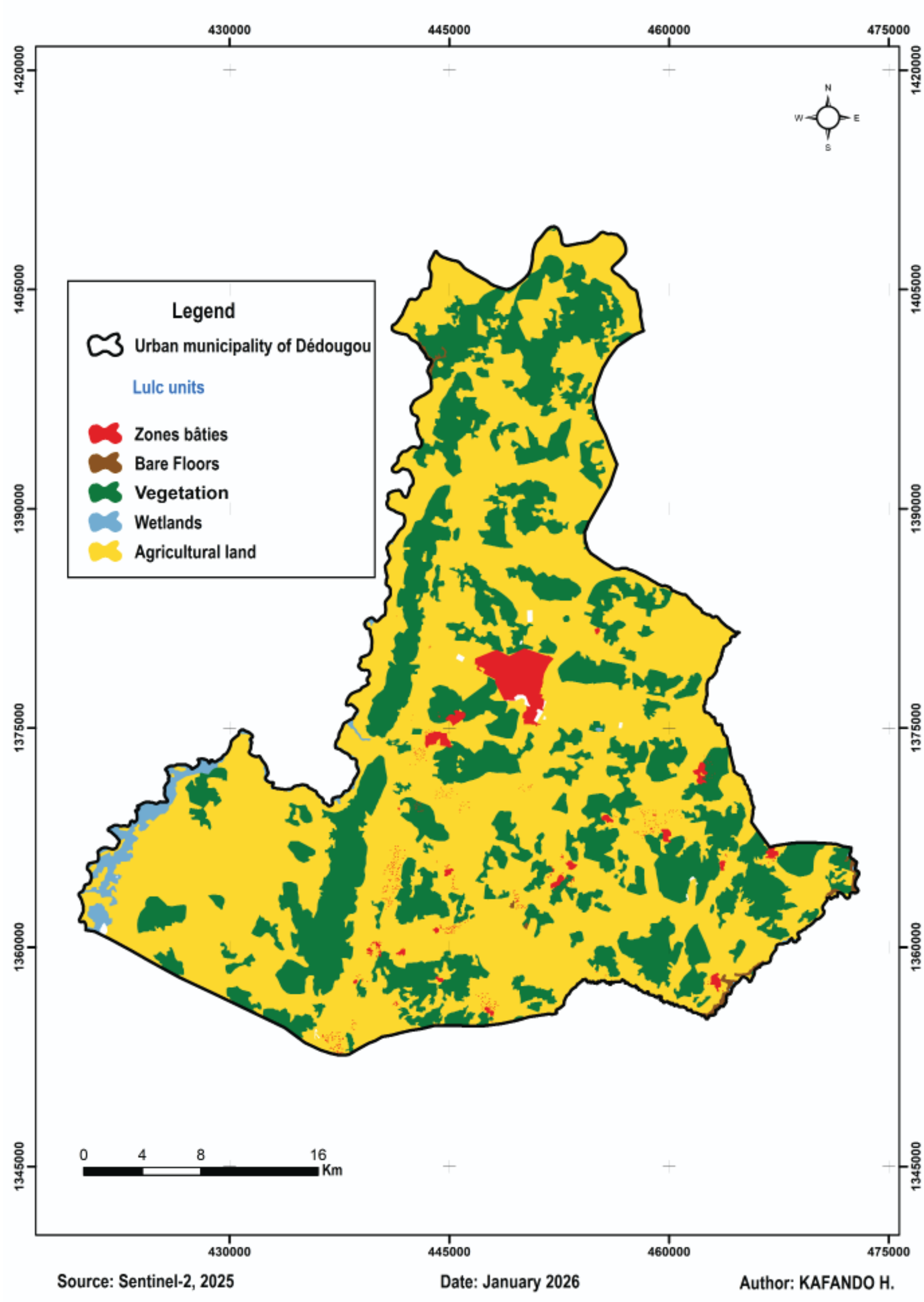

Figure 10. Land use/Land cover map in the urban municipality of Dédougou

i. Groundwater depth

The groundwater depth (Figure 11) is a determining factor in the selection of waste disposal sites, as it determines the vulnerability of groundwater to pollution (Sisay et al., 2025; Al-Fares, 2024; Armanuos et al., 2023)located in the middle of the Nile Delta in Egypt, suffers from random selection of sites for solid waste disposal, resulting in significant environmental challenges. The aim of this study is to determine optimal landfill locations within Al-Gharbia Governorate and validate the existing landfill sites. Four techniques of multi-criteria decision-making (MCDM. Highlighting areas with shallow groundwater level that are more vulnerable to contamination and therefore less suitable for landfill site selection.

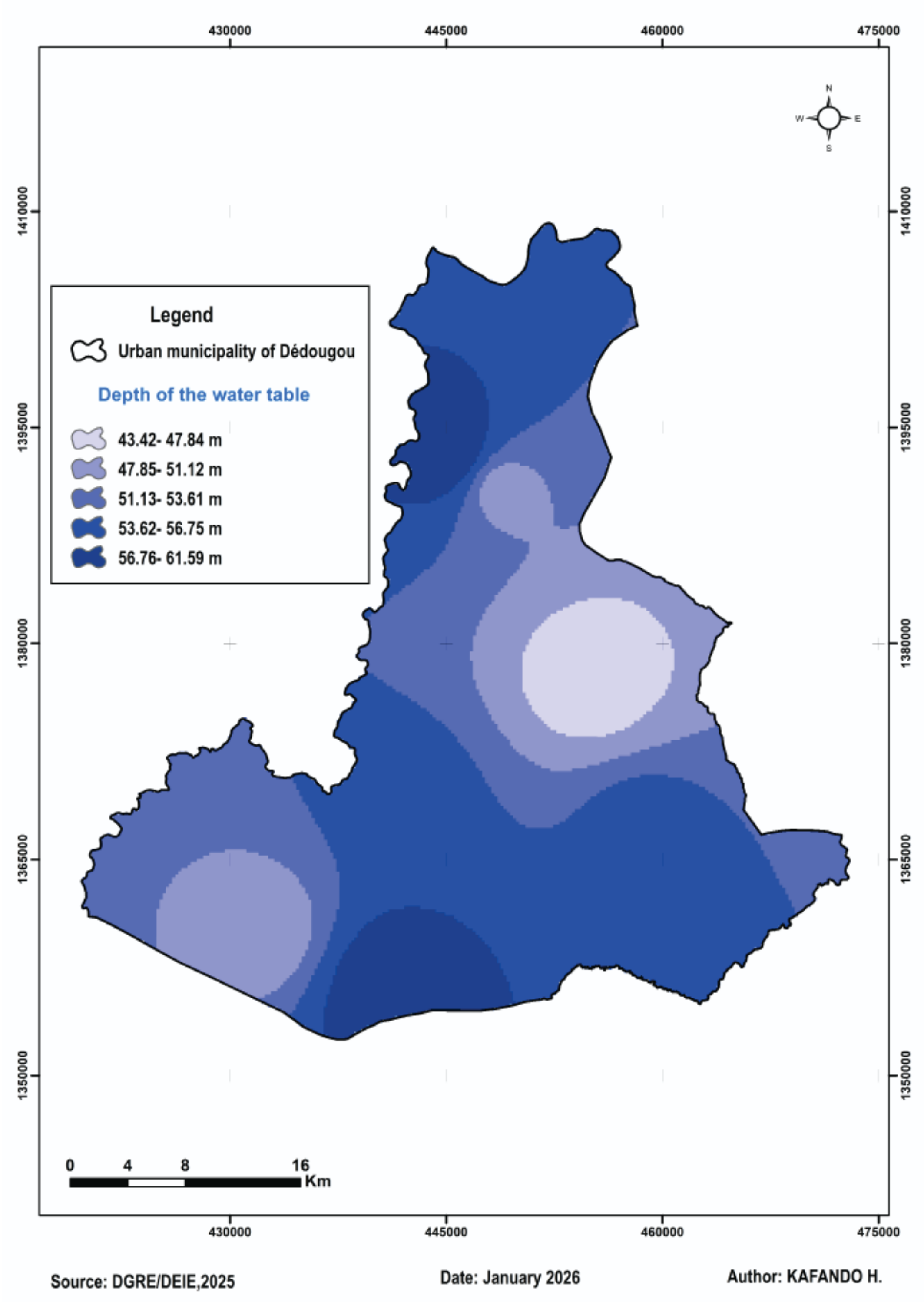

Figure 11. Spatial distribution of groundwater depth (m) in the urban municipality of Dédougou

Standardization and normalization of decision criteria

Before integrating the decision criteria into the weighted superimposition analysis, all spatial layers were normalized to ensure comparability and consistency within the multi-criteria evaluation framework. As the selected criteria were in different units of measurement (m, %, etc.), a reclassification process was applied to convert them to a common suitability scale ranging from 1, which means very low suitability, to 5, which means very high suitability. The normalization system adopted in this study is presented in Table 3.

Table 3. Standardization and normalization of decision criteria

Criteria selected	Sub-criteria	Units	Aptitude classes	Aptitude score
Distance from roads	0-250	m	Very low	1
	251-500		Low	2
	501-1000		Medium	3
	1001-2000		High	4
	> 2000		Very high	5
Distance from watercourse	0-50	m	Very low	1
	51-100		Low	2
	101-200		Medium	3
	201-500		High	4
	> 500		Very high	5
Land use/land cover	Built-up areas	Occupation unit	Very low	1
	Wetlands		Very low	1
	Agricultural land		Low	2
	Vegetation		Medium	3
	Bare floors		Very high	5
Slope	0-1.53	%	Very low	1
	1.54-2.70		Low	2
	2.71-4.16		Medium	3
	4.17-6.24		High	4
	6.25-17.90		Very high	5
Altitude	244-269	m	Very low	1
	270-282		Low	2
	283-294		Medium	3
	295-306		High	4
	307-340		Very high	5
Types of soil	Hydromorphic soils	Soils unit	Very low	1
	Slightly evolved soils		Low	2
	Raw mineral soils		Medium	3
	Sesquioxide soils		Very High	5
Distance from urban areas	0-500	m	Very low	1
	501-1000		Low	2
	1001-2000		Medium	3
	2001-3000		High	4
	> 3000		Very high	5
Geological formations	Dolomites	Geological units	Very low	1
	Sandstone		Low	2
	Quartzite sandstone		Medium	3
	Clay sandstone		High	4
	Undifferentiated granites		Very high	5
Groundwater depth	43.42- 47.84	m	Very low	1
	47.85- 51.12		Low	2
	51.13- 53.61		Medium	3
	53.62- 56.75		High	4
	56.76- 61.59		Very high	5

Source: Authors

Analytic Hierarchy Process scale (Thomas L. Saaty 1980)

The Analytic Hierarchy Process developed by Saaty L. Thomas, employs a fundamental scale of pairwise comparison to assess the relative important between two criteria. The table 4 present the fundamental AHP scale.

Table 4. AHP Scale

Value	Meaning
1	Equal importance
3	Moderate importance
5	High importance
7	Very high importance
9	Absolute importance
2.4.6	Intermediate value

Results

Pairwise comparison matrix

The Table 5 is our pairwise comparison matrix for comparing the importance of each decision criterion. The values in this table are based on Saaty's scale. Where 1 = equal importance and 9 = absolute importance of one criterion over another.

Table 5. Pairwise comparison matrix of decision criteria

Criteria	Gt	Ba	Wc	St	Gf	Lulc	Sl	R	Al
Gt	1	3	5	7	7	9	9	9	9
Ba	1/3	1	3	5	5	7	7	7	7
Wc	1/5	1/3	1	3	3	5	5	5	5
St	1/7	1/5	1/3	1	3	3	3	3	3
Gf	1/7	1/5	1/3	1/3	1	3	3	3	3
Lulc	1/9	1/7	1/5	1/3	1/3	1	2	2	2
Sl	1/9	1/7	1/5	1/3	1/3	1/2	1	2	2
R	1/9	1/7	1/5	1/3	1/3	1/2	1/2	1	2
Al	1/9	1/7	1/5	1/3	1/3	1/2	1/2	1/2	1

Legend of the table: R = Roads, Wc = Watercourse, Lulc = Land use/land cover, Sl =Slope, Al =Altitude, St=Soil type, Ba = Built-up area, Gf = Geological formations, G t= Groundwater table.

Criterion weighting and justification

The decision criteria were weighted using the Analytic Hierarchy Process (AHP) following a structured and transparent procedure. The pairwise comparison matrix for this study was developed by the authors based on an in-depth analysis of the scientific literature on landfill site selection using GIS-AHP methods.

Initially, the relative importance of each criterion was determined by analyzing previous studies conducted in similar environmental and socio-economic contexts (Sisay et al., 2025; Elkhrachy et al., 2023; Armanuos et al., 2023)located in the middle of the Nile Delta in Egypt, suffers from random selection of sites for solid waste disposal, resulting in significant environmental challenges. The aim of this study is to determine optimal landfill locations within Al-Gharbia Governorate and validate the existing landfill sites. Four techniques of multi-criteria decision-making (MCDM. Particular attention was given to both the frequency of use of each criterion and the level of importance attributed to it in these studies. Criteria consistently identified as critical for environmental protection and public health, such as groundwater depth, distance from built-up areas, and distance from watercourses, were therefore assigned higher relative importance.

Secondly, based on this literature review, pairwise comparisons between the criteria were performed using Saaty's fundamental scale (Saaty, 1980). To ensure transparency and reproducibility, the assignment of pairwise comparison values followed a structured decision rule. Criteria directly related to environmental protection and public health (e.g., groundwater, watercourses, built-up areas) were systematically assigned higher importance values (5-9), whereas criteria with a secondary influence (e.g. altitude, roads) were assigned moderate to low values (1-5). These judgments were guided by both the frequency of occurrence and the relative importance of criteria reported in previous studies conducted in comparable contexts. Each comparison reflects a reasoned judgment regarding the relative importance of one criterion over another within the specific context of Dédougou. For example, groundwater protection was considered significantly more important than accessibility factors due to the high risk of groundwater contamination in the absence of adequately engineered landfill systems.

Thirdly, the pairwise comparison matrix was normalized and the criterion weights were derived from the principal eigenvector. To assess the reliability of the judgments, the Consistency Ratio (CR) was calculated. The obtained value (CR = 0.055) is below the acceptable threshold of 0.1 indicating a satisfactory level of consistency in the comparisons.

The resulting weights (Table 6) reflect a logical prioritization of environmental protection criteria over technical and accessibility factors. Groundwater depth (0.386) received the highest weight due to its critical role in preventing contamination. Distance from built-up areas (0.232) and distance from watercourses (0.131) were also assigned high weights, as they directly influence risks to public health and environmental safety. In contrast, criteria such as altitude (0.022) and distance from roads (0.026) were assigned lower weights, as their impact is considered secondary within the specific geographical context of the study area. The final weights assigned to each criterion are presented in Table 6.

Table 6. Weight of each Criteria

Nº	Criteria	Weighting of criteria
1	Groundwater depth	0.386
2	Buil up area	0.232
3	Watercourse	0.131
4	Types of soil	0.077
5	Geological formations	0.059
6	Land use/Land cover	0.035
7	Slope	0.030
8	Roads	0.026
9	Altitude	0.022
Total		1

Consistency calculation

a. Maximum eigenvalue (λ_{max})

The maximum eigenvalue was calculated to verify the consistency of the decision criteria judgements. The calculation formula is:

$$\boldsymbol{\lambda}\mathbf{max} = Aij\,\frac{\text{wi}}{\text{wj}}$$

A is the pairwise comparison matrix (Table 6)

Wi is the weight of criterion i

Wj is the number of criteria

The maximum eigenvalue calculated for our study λmax is equal to: 9.643

b. Consistency index (CI)

To validate the judgements, we calculated the consistency index. The calculation formula is :

$$CI = \frac{(\lambda\text{max}-\text{n})}{(n-1)}$$

CI=0.080

CI=is the consistency index

c. Consistency ratio (CR)

To verify the validity and acceptability of the matrix, we calculated the consistency ratio.

$$CR = \frac{CI}{AI}$$

CR= **0.055**

CR=is the random index

Integration of the AHP method into GIS analysis

a. Standardization of criteria

Each decision factor has been reclassified (Table 7) into five levels. This reclassification allows for compatibility of the factors to be aggregated in the GIS software.

Table 7. Reclassification of decision factors for landfill site selection

Reclassified value	Site suitability
1	Very unfavorable site
2	Unfavorable site
3	Moderately unfavorable site
4	Favorable site
5	Very favorable site

b. Weighting of factors in the GIS

The final map is obtained by the weighted sum of the factors. The following equation is used to determine suitable sites for municipal solid waste disposal in the urban municipality of Dédougou

Sites suitable = ("Groundwater depth* 0.386) + ("Built-up area" * 0.232) + ("watercourse" * 0.131) + ("Soils type" * 0.077) + ("Geological formations" * 0.059) + ("Land use/Land cover" * 0.035) + ("Slope" * 0.030) + ("Roads" * 0.026) + ("Altitude" * 0.022)

c. Map of sites suitable for municipal waste disposal

The Figure 12 shows the spatial distribution of areas suitable for the establishment of municipal solid waste landfills in the urban municipality of Dédougou.

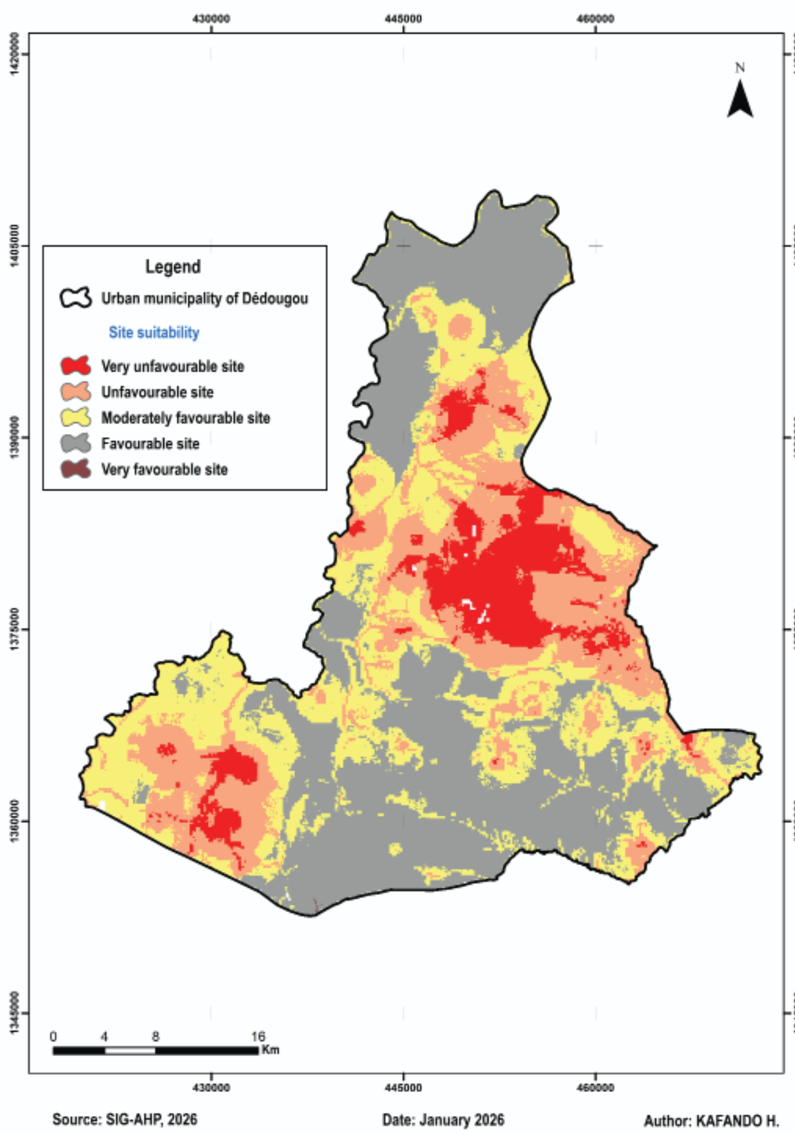

Figure 12. Sites suitable for municipal waste disposal

Discussion

Analysis of the results of mapping the suitability of municipal solid waste landfill sites in the urban commune of Dédougou, produced by combining GIS and the AHP method, shows that the study area is structured into five levels of suitability, with a clear spatial differentiation between central urban areas and peripheral zones. This result highlights the strong influence of urbanization and environmental constraints on site selection. The resulting map shows that the most suitable areas are mainly located in the peripheral zones, while central areas are largely unsuitable due to high population density and land use constraints. This spatial pattern confirms findings from previous studies, particularly those conducted in Hossana and Gimba Town in Ethiopia (Wanore et al., 2023; Sisay et al., 2025), where suitable landfill sites were also identified in peripheral areas. However, unlike some studies that report large continuous suitable zones, the results in Dédougou indicate a more fragmented distribution of suitable areas. This difference can be explained by the spatial organization of the municipality, where land use is increasingly constrained by agricultural activities and scattered settlements, limiting the availability of large homogeneous zones. Similarly, the classification into five suitability classes is consistent with the study conducted in the Najran region of Saudi Arabia (Elkhrachy et al., 2023). Nevertheless, the relative importance of certain criteria appears to differ, particularly regarding topographic factors. While slope was identified as a key determinant in studies such as that conducted in Turkey (Soyaslan, 2025), its influence in Dédougou seems to be less significant, which can be attributed to the relatively low topographic variability of the study area. The weighting of criteria using the AHP method played a central role in the results obtained. Although this method has been criticized for its subjectivity, the consistency of the spatial distribution observed in this study suggests that the weighting remains coherent with local environmental realities. This finding is in line with the study conducted in Nepal (Subedi, 2025).

However, the present study did not incorporate advanced approaches such as Fuzzy AHP, which could reduce uncertainties related to pairwise comparisons. Future research could therefore integrate such methods, as suggested by recent reviews (S. Kumar et al., 2024), to improve the robustness of decision-making. Finally, the mapping produced confirms that locating landfill sites away from densely populated areas is essential for minimizing health and environmental risks. However, these results remain theoretical and require field validation to assess their practical feasibility. In addition, the integration of temporal dynamics, such as urban growth and future waste production trends, would significantly improve long-term planning and sustainability of landfill site selection. The mapping produced for solid waste disposal sites in the urban municipality of Dédougou confirms that the most suitable areas are located on the outskirts of inhabited areas, which is important for minimizing health risks. However, additional field validation is necessary to confirm the practical feasibility of the proposed sites. In addition, the integration of temporal data in this case projections of urban growth and future trends in waste production should be considered in future studies in order to anticipate long-term needs.

Conclusion

This study addressed the crucial issue of sustainable solid waste management by identifying potential sites suitable for waste disposal in the urban municipality of Dédougou. The final map shows that 0.06 km² of the municipal territory is highly suitable and 536.08 km² is suitable for municipal solid waste disposal. These sites are located on the outskirts of the municipality, mainly to the north and north-west. 124.98 km² of the municipality are very unfavourable areas and 316.63 km² are unfavourable. They are located in the centre of the municipal territory. Moderately favourable areas, covering 27.25 km², occupy the areas above the favourable areas. Thanks to the GIS-AHP approach. We have transformed the complex issue of solid waste into a valuable decision-making tool. The multi-criteria GIS-AHP approach has proven effective in integrating both natural constraints (topography, waterways, soil) and anthropogenic constraints (proximity to roads, built-up areas and land use). Ultimately, the GIS-AHP approach applied to solid waste in the municipality of Dédougou provides an operational tool for sustainable waste planning and management.

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