Graphical Abstract

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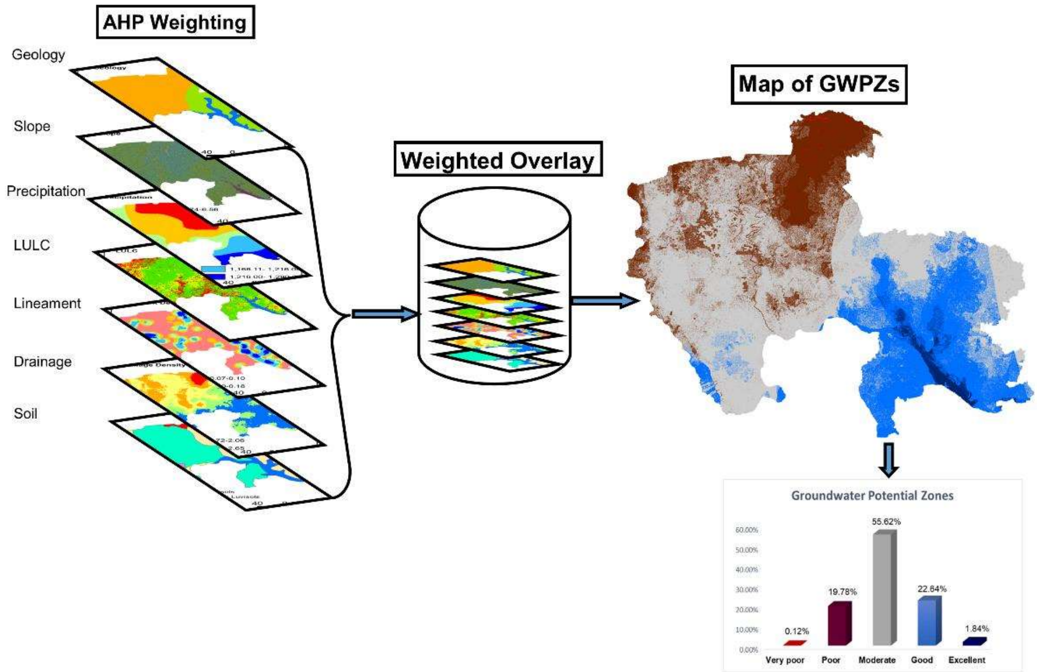

AHP-Geospatial Estimation of Groundwater Potential Zones for Sustainable Agriculture in the Savannah Region of Ghana

Abdul-Karim Wumpini Fuseini

Kwame Nkrumah University of Science and Technology, Faculty of Social Sciences, Department of Geography and Rural Development, Kumasi, Ghana

Corresponding author: wakfuseini@gmail.com

ORCID: https://orcid.org/0000-0001-5228-1041

Abstract

Groundwater is used for approximately half of all irrigation agriculture to support global food production. The impacts of climate change on water resources for sustainable agriculture have led to a rise in groundwater demand for agriculture, particularly in arid and semi-arid regions such as Ghana. However, in the Savanah Region of Ghana, groundwater has not been adequately used in small-large scale agricultural production. The study employed GIS-based Multi-Criteria Decision Making (MCDM) techniques to estimate groundwater potential zones for irrigation agriculture during the dry season in the Savannah Region of Ghana. To determine the groundwater potential zones in the region for irrigation development, the study integrated seven data variables including geology, slope, precipitation, land use and land cover (LULC), lineament density, drainage density, and soil. Based on each thematic layer's characteristics and contribution to groundwater recharge, normalised weights were assigned to them. These were later combined using the weighted overlay analysis technique in ArcGIS to create the map of the groundwater potential zones. The groundwater potential map was classified into five zones according to their groundwater potentiality. The classes were very poor 0.12% (43.09km^2), poor 19.78% (7,051.55km^2), moderate 55.62% (19,830.33km^2), good 22.64% (8,071.57km^2), and excellent 1.84% (654.68km^2) respectively. The map which shows the spatial distribution of the groundwater potential zones of the area will assist stakeholders in groundwater development for irrigation agriculture to supply farming communities with water for sustainable crop cultivation in the Savannah Region, while at the same time serving as reference material for future research studies.

Keywords: Groundwater, groundwater mapping, Savannah Region, irrigation agriculture, sustainable development, analytic hierarchy process

1.1 Introduction

Groundwater is considered one of the most vital resources, and the greatest available freshwater found below the surface of the earth in the pore cracks and fissures of rock and sediments (Díaz-Alcaide & Martínez-Santos, 2019; Naghibi et al., 2015). In contrast to about 0.3% of surface water in the form of lakes, marshes, reservoirs, and rivers, around 30% of the planet's freshwater is hidden and reserved as groundwater (Senanayake et al., 2016). The principal source of groundwater, which percolates in the aquifer through the soil pores, especially in the dry savannah, is rainwater. According to the IPCC (2021), groundwater recharge has increased due to rising precipitation intensities. This resource is increasingly relied on for several uses including irrigation agriculture due to the rapid growth of the world population and changing climates (Arulbalaji et al., 2019; IPCC, 2021). Approximately half of all irrigated agricultural production in the world is sourced from groundwater (GWP, 2013). Globally, agricultural and industrial crops as well as livestock are grown using around 70% of the world's groundwater withdrawals, while 30% of all irrigation water utilized worldwide is derived from underground sources (FAO, 2022). This contributes to economic growth, ecological balance and improved livelihoods in groundwater irrigation environments. In many places of the world, including Ghana, ensuring food security requires the sustainable development of groundwater due to a changing climate. Though a preferred choice of drinking water in remote areas of Ghana (Osiakwan et al., 2022), groundwater is also used for small-scale cultivation (Adam & Appiah-Adjei, 2019). With increasing intensities and fluctuations of climatic variables such as rainfall and droughts, coupled with rising demand for food and water, there is a need to double the rate of food production and water supply. The single cropping season in the Savannah ecological zones of Ghana do not seem to present the opportunity to meet the increasing food demand. Meanwhile, agriculture is the mainstay of inhabitants of the area (GSS, 2021). Thus, an alternative source of water (groundwater) needs to be explored for such a development. This could help improve farmers productivity and livelihoods throughout the year. To make groundwater irrigation development decisions by stakeholders such as the Regional Authorities, the Government of Ghana, and the external investors, there is the need to understand the groundwater potential of the region. However, there is a paucity of knowledge regarding the potential areas of groundwater in the Savannah Region. Hence, the study seeks to bridge this knowledge gap by using geospatial techniques (geographic information system and remote sensing) to estimate the groundwater potential of the Savannah Region such that stakeholders including the Ministry of Agriculture can be guided by the findings of the study.

Geospatial technologies (GIS and remote sensing) have been used widely in natural resources assessment including mapping of groundwater potential zones in diverse locations across the globe (Arulbalaji et al., 2019; Asante et al., 2022, 2022; Aslan & Çelik, 2021; Das et al., 2019; Díaz-Alcaide & Martínez-Santos, 2019; Owolabi et al., 2020). Due to the pricy and time-consuming nature of traditional methods which are often done through ground surveys for identifying, delineating and mapping groundwater potential zones (Israil et al., 2006), GIS and remote sensing techniques have emerged as cost-effective tools for groundwater potential mapping in recent times (Adiat et al., 2012; Arulbalaji et al., 2019). The literature reveals that GIS and remote sensing techniques for groundwater exploration are very cost-effective and; thus recommended for such activities, particularly before detailed and expensive land-based surveys are conducted (Arulbalaji et al., 2019). The groundwater potential zones of this study were defined using a blend of Analytical Hierarchy Process (AHP) which is a multi-criteria decision-making technique and geospatial approaches. In 1980, Thomas Saaty invented the AHP model, a useful tool for addressing complicated decision-making, which has been adopted in groundwater-related disciplines (Arulbalaji et al., 2019; Kpiebaya et al., 2022; Owolabi et al., 2020). The method is helpful for decomposing complex decisions into a series of pair-wise comparisons and then integrating the findings. The AHP tool is also an appropriate method for assessing the consistency of the outcome, which reduces subjectivity in the decision-making process. Therefore, the objective of the study is to estimate the groundwater potential of the Savannah Region using the AHP method to guide policy makings with regard to groundwater resource planning and management.

2. Methodological Approach

2.1 Study Area

The Savannah Region is one of the sixteen regions of Ghana located within the guinea savannah agroecological zone. It is the largest in landmass among all the regions in Ghana with an area of about 46,922 km^2, or nearly 1/5 of Ghana's total geographical area. The Upper West Region anchors the region on the north, the Bono and Bono East Regions on the south, the North-East and Northern Regions on the west, and the Republic of Cote d'Ivoire on the west. Approximately 2.69 million hectares of land in the region are used for agriculture (farming and animal rearing). Additionally, it possesses roughly 1.67 million hectares of land ostensibly suitable for growing a variety of crops, including maize, rice, millet, sorghum, yam, cassava, soybeans, and groundnuts. The area has two major inland rivers (the White and the Black Volta; tributaries of the Volta Lake in Ghana) that serve as the major drainage channels of the region. The region, according to GSS (2021), has about 653,266 inhabitants of whom about 70.4 per cent live in rural areas whilst the remaining 29.6 per cent live in urban centres. The majority of these people are smallholder farmers who rely heavily on rainfed agriculture for survival. Meanwhile, the region has a unimodal rainfall regime and receives an annual rainfall of between 1000-1500mm. This presents economic challenges to the people of the area, especially during the dry season. The increasing demand for water - for domestic and agricultural purposes - is becoming an issue of concern for development authorities in the area leading to the construction of smaller surface dams for some communities. However, most of these dams are not able to withstand the intensity of the dry season's weather; thus, becoming ephemeral. **Figure 1** is the map of the Savannah Region showing the major rivers and elevation of the area.

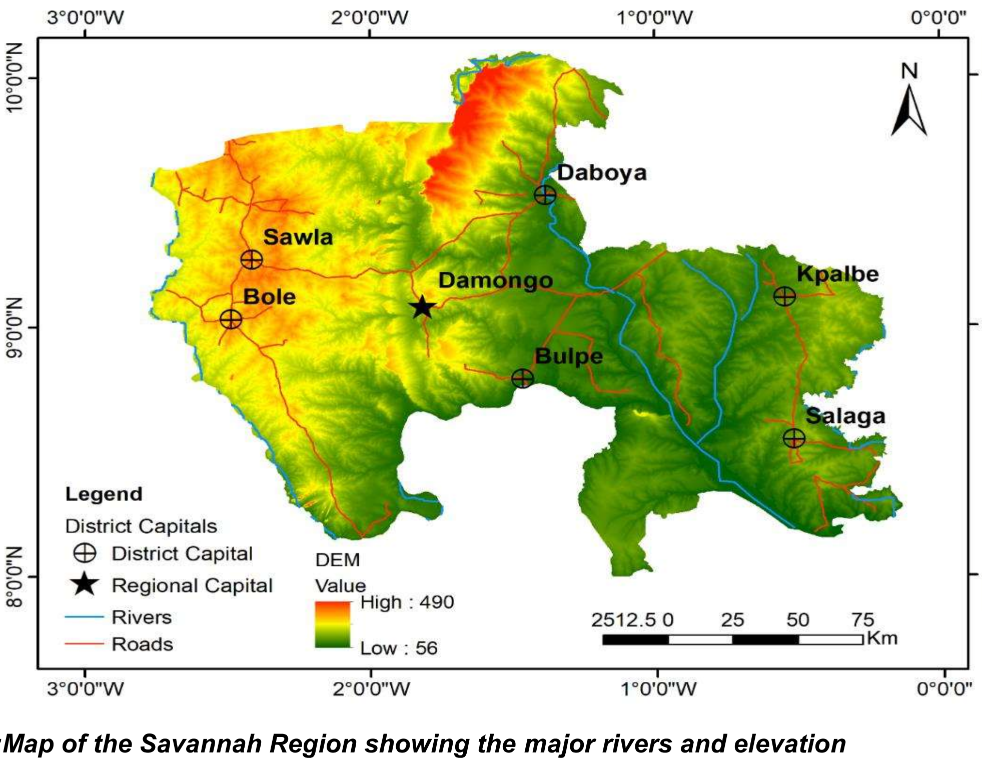

Figure 1:Map of the Savannah Region showing the major rivers and elevation

Author's construct (2022)

2.2 Materials and Methods

In this study, geospatial techniques were used to define the groundwater potential zones of the Savannah Region. A total of 7 thematic layers of information about the region, including geology, slope, precipitation, land use/land cover (LULC), lineament density, drainage density, and soil were selected using knowledge-based experience and understanding. Though there are varieties of factors including geology, geomorphology, land use/land cover (LULC), drainage density, lineaments, rainfall, soil, roughness, slope, curvature, topographic position index, and topographic wetness index used for groundwater potential mapping and modelling (Arulbalaji et al., 2019), this study selected only seven of the factors. These factors were selected based on previous studies that have applied those variables for groundwater potential mapping (Abebrese et al., 2022; Kpiebaya et al., 2022; Nasir et al., 2018; Osiakwan et al., 2022; Tolche, 2021)

The data used for this study were obtained from secondary sources and, the software used for the remotely sensed image pre-processing and geospatial analysis were ENVI 5.3 and ArcGIS 10.8. For the creation of LULC of the region, the ENVI software was used for colour compositing and classification. The study area map was derived from the Shuttle Radar Topographic Mission (SRTM-30m resolution) data using the regional boundary shapefile. The SRTM data was obtained from the United States Geological Survey (USGS) EarthExplorer.

From SRTM data, the slope, lineament, and drainage densities were produced. Line density in the spatial analyst tool of ArcGIS software was used to prepare the density from the drainage and lineament. The soil data were acquired from the Food and Agriculture Organization of the United Nations (FAO-UN) data catalogue whilst the geology data was downloaded from the USGS World Geologic Maps portal. The precipitation data was also obtained from the Climate Research Unit of the University of East Anglia portal for 2021 in NetCDF format. This was imported into ArcGIS using the NetCDF tool under the multi-dimension tools of the software. The average annual precipitation was converted into point vector data and later, the spatial distribution of the precipitation was produced using the kriging interpolation tool. The flowchart of the methodology used to map the groundwater potential zones is presented in **Figure 2**.

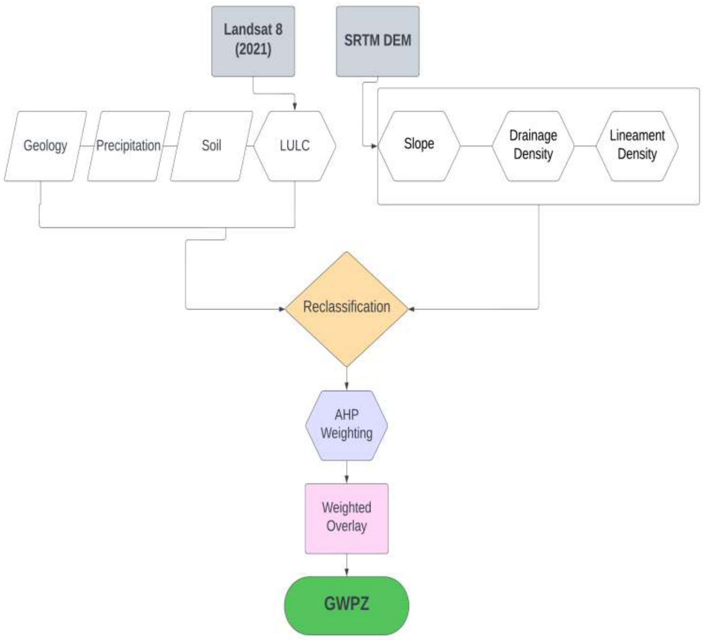

Figure 2: Flowchart of the methodology

Author's construct (2022)

2.3 The AHP-Geospatial Analysis

The Analytic Hierarchy Process is one of the widely used multi-criteria decision-making techniques across several disciplines including geospatial analysis (Arulbalaji et al., 2019; Mallick et al., 2019; Owolabi et al., 2020). The Technique was developed by Professor Saaty in 1981 to aid in complex decision-making by integrating several factors (choices). In this study, a total of seven (7) groundwater influencing factors were used for the assessment. The free web-based model of the AHP model developed by Goepel (2018) was used to assign weights to each of the seven factors. The parameter that contributes to groundwater recharge the most, is given the highest weight. Thus, a high weight shows a parameter with a greater impact, and a low weight shows a parameter with little impact on groundwater potential. Each criterion's weight was determined using Saaty's scale of relative relevance values (1-9). Additionally, the weights were assigned taking into account the study of prior research and field experience. According to Saaty's scale of relative importance, a value of 9 indicates extreme importance, 8 indicates between extreme and very strong importance, 7 indicates very strong importance, 6 indicates between strong and very strong importance, 5 indicates strong importance, 4 indicates between moderate and strong importance, 3 indicates moderate importance, 2 indicates between equal and moderate importance, and 1 indicates equal importance. A pair-wise comparison matrix has been used to compare all of the parameters to determine their individual influence on groundwater development (**Table 1**).

Table 1: Pairwise Comparison Matrix of the factors Influencing Groundwater Potentiality

	Geology	Slope	Precipitation	LULC	Lineament	Drainage	Soil
Geology	1	1	2	3	2	1	2
Slope	1	1	2	2	2	1	3
Precipitation	1/2	1/2	1	1	2	1/2	2
LULC	1/3	1/2	1	1	1	1/2	1
Lineament	1/2	1/2	1/2	1	1	1/2	2
Drainage	1	1	2	2	2	1	5
Soil	1/2	1/3	1/2	1	1/2	1/5	1

The subclasses of the parameters were reclassified in ArcGIS using the natural breaks classification technique to assign the suitability class ratings. On a scale from 1 to 5, higher suitability class ranges were ranked and assigned values based on their relative impact on groundwater recharge with 5 being the range with very high impact and 1 being the range with very low impact (**Table 2**).

Table 2: Parameter Weightings

Variable	Unit	Class	Suitability class ranges	Suitability class ratings	Weight (%)
Geology	Level	Water	Very High	5	20.5
		Ordovician Cambrian	Moderate	3	
		Precambrian	Very Low	1	
Slope	%	<0.93	Very High	5	20.1
		0.93-2.14	High	4	
		2.14-3.74	Moderate	3	
		3.74-6.56	Low	2	
		>6.56	Very Low	1	
Precipitation	mm/year	1,059.09- 1,099.00	Very Low	1	11.9
		1,099.00 - 1,129.83	Low	2	
		1,129.83 - 1,166.11	Moderate	3	
		1,166.11- 1,216.00	High	4	
		1,216.00- 1,290.37	Very High	5	
LULC	Level	Water	Very High	5	9.1
		Vegetation	High	4	
		Agriculture	Moderate	3	
		Settlement/Bare land	Very Low	1	
Lineament density	km/km^2	0-01	Very Low	1	9.7
		0.01-0.04	Low	2	
		0.04-0.07	Moderate	3	
		0.07-0.10	High	4	
		0.10-0.18	Very High	5	
Drainage density	km/Km^2	2.06-2.65	Very Low	1	22.0
		1.72-2.06	Low	2	
		1.52-1.72	Moderate	3	
		1.33-1.52	High	4	
		0.62-1.33	Very High	5	
Soil	Level	Cambisols	High	4	6.7
		Acrisols	Low	2	
		Luvisols	Moderate	3	
		Gleysols	Moderate	3	
		Lithosols	Very High	5	
		Plinthosols	Moderate	3	
		Water	Very High	5	

2.4 Results and Discussion

2.4.1 Geology

Geology is one of the important factors that determine the availability of groundwater in an area. The location of aquifers, confining units, and their outcrops are determined by geological factors. The composition of morphological layers, which affect groundwater flow, recharge, and discharge, is dictated by geological factors; thus, contributes to determining the quantity and rate of infiltration, as well as surface runoff and groundwater quality (Alsharhan & Rizk, 2020). The data for the analysis of the geological formation of the study area was obtained from the USGS World Geologic Maps portal. The results showed two major geologic formations including Precambrian and Ordovician in the study (**Figure 3a**). The Precambrian formation occupies more than half of the study area. While the Precambrian geology in Ghana is mostly characterised by metamorphic rocks such as mafic gneiss, quartzite, schist, phyllite, quartzite, shale, and sandstone rocks, the Ordovician geology is characterised by sheer, thin-bedded quartzitic sandstones with siltstones and mudstones, along with coarse-grained, feldspathic sandstones (Dapaah-Siakwan & Gyau-Boakye, 2000; Persits et al., 1997). In comparison with the Precambrian geologic formation, the Ordovician geology of upper voltaian sandstone is argued to possess significant amounts of groundwater. This makes the southeastern area of the Savannah Region highly favourable for groundwater recharge. Though the Precambrian also contain some levels of groundwater, this water forms through secondary permeability means such as rock fractures, joints and faults (Dapaah-Siakwan & Gyau-Boakye, 2000), making the north-western part of the region less favourable for groundwater development.

2.4.2 Slope

The slope, which expresses how steep the ground surface is, is an important topographical feature and influencing factor of groundwater. Slope provides crucial details on the types of geology and geodynamic processes at work at the regional level (Arulbalaji et al., 2019; B. Das et al., 2019). The slope has a significant impact on the surface runoff and infiltration rate of a region. Steeper slopes allow for little infiltration during rainfall while gentle slopes allow significant infiltration. Thus, the rapid flow of water along steep slopes reduces the groundwater recharge of an area. In this case, the water has less time to settle down and recharge the saturated zone (De Reu et al., 2013). The slope of the Savannah Region is shown in **Figure 3b**. The slope values were reclassified into five classes ranging from very low (<0.93%) to very steep (>6.56%) sloping areas. Steeper slopes are identified in the northwestern part of the region while lower slopes are identified in the south-eastern side of the study area. For steeper slopes, lesser weights were assigned and vice versa. This suggests that the southeastern section of the Savannah Region experiences more infiltration than runoff, whilst the northern part experiences higher runoff than infiltration.

2.4.3 Precipitation

The primary water source in the hydrological cycle and the most important determining factor for a region's groundwater is precipitation which includes rainfall. The study used the 2021 rainfall data for the analysis. Studies revealed that areas that receive more rain during the year have a higher probability of groundwater whilst areas that receive less rainfall are less likely to have good groundwater zones (Adam & Appiah-Adjei, 2019; B. Das et al., 2019; Owolabi et al., 2020). The amount and length of rainfall have an impact on infiltration. Whereas less intensive and extended duration rain influences high infiltration than runoff, greater intensity and short duration rain instigates less infiltration and more surface runoff (Arulbalaji et al., 2019). In the Savannah Region, rainfall varies from 1,059 to 1,200mm per year (**Figure 3c**). Using the ordinary kriging interpolation approach, a map of the spatial distribution of rainfall was created. The rainfall values were reclassified (**Table 2**) into Very Low (1,059.09-1,099.00 mm), Low (1,099.00-1,129.83 mm), Moderate (1,129.83-1,166.11 mm), High (1,166.11-1,216.00 mm), and Very High (1,216.00-1,290.37 mm). From the result (**Figure 3c**), the south-eastern area of the Savannah Region appears to receive more precipitation than the north-western zone of the Region. This makes the southeastern zones more favourable for groundwater development for domestic and agricultural uses.

2.4.4 LULC

LULC provides guidance on groundwater requirements as well as critical data on infiltration, soil moisture, groundwater, surface water, etc. (Arulbalaji et al., 2019). There are different types of land uses in the Savannah Region. However, the study examined only four including built-up/bare lands, farmlands, vegetation and water (**Figure 3d**). For the land use/cover classification, the Landsat 8 OLI data for 2021 was acquired from USGS with less than 10% cloud cover. The data was downloaded between February and April 2021. This was to ensure that the data acquired will meet the 10% cloud cover requirement.

Among all the classes, vegetation predominates over the others. This was followed by built-up/bare lands, farmlands, and water. The north-western area of the Savannah Region has more vegetation which is attributable to the presence of the Mole National Park. The restrictions imposed by the Park's management authority and the Ghana Wildlife Division of the Forestry Commission limit anthropogenic activities in the area. Thus, preserving its vegetation cover. Built-up/bare lands appear to be the second largest land use/cover in the area due to the availability of bare lands, particularly during the dry season due to the prevalence of bush burning in the area. In comparison to built-up/bare lands, LULC types like vegetation and farmlands store a significant proportion of water for infiltration (Arulbalaji et al., 2019; Rajaveni et al., 2017; Ghosh et al., 2015). The vegetation, farmland, and water are given higher weights whilst built-up/bare land is a lower weight (**Table 2**).

2.4.5 Lineament density

Lineaments are weak surfaces with linear or curvilinear features such as fractures, joints, and faults. that structurally control groundwater infiltration (Mallick et al., 2019). Their comparatively linear alignments on the satellite picture make it easy to discriminate (Arulbalaji et al., 2019). The faulting and fracture zones dictate higher porosity and permeability which are generally associated with lineaments (Yeh et al., 2016). The lineaments were extracted using the ArcGIS curvature tool which was later used for line detection and digitizing for the lineament density. **Figure 3e** shows the lineament density map that was created using ArcGIS software's line density feature. After carefully analysing the results, the data were divided into five classes including Very Low (0.02-0.47 km/km^2), Low (0.47-0.73 km/km^2), Moderate (0.73-0.96 km/km^2), High (0.96-1.21 km/km^2), and Very High (1.21-1.72 km/km^2). Studies suggest that areas with higher lineament density are associated with higher groundwater potential whilst areas with lower lineament density are associated with lower groundwater potential (Yeh et al., 2016; Arulbalaji et al., 2019; Mallick et al., 2019; Owolabi et al., 2020). Therefore, higher weights were assigned to higher lineament density values and vice versa in this study.

2.4.6 Drainage density

Drainage density, which represents the ratio of total lengths of channel networks per unit area, is indicated to have a significant influence on groundwater availability (Arulbalaji et al., 2019; Owolabi et al., 2020). The drainage system is lithology-dependent and serves as a significant determinant of infiltration rate. Permeability has an opposite relationship with drainage density. As a result, it plays a crucial role in defining the groundwater potential zone. A drainage basin's drainage density is calculated by dividing the sum of the lengths of its rivers by the area of the drainage basin (Yeh et al., 2016). Low infiltration due to high drainage density makes the north-western part of the Savannah Region less favourable for groundwater development. Low drainage density in the southeastern side of the region translates to high infiltration, which raises the groundwater potential of the area. The drainage density (**Figure 3f**) of the study was reclassified into very poor (0.62-1.33 km/km^2), poor (1.33-1.52 km/km^2), moderate (1.52-1.72 km/km^2), good (1.72-2.06 km/km^2), and excellent (2.06-2.65 km/km^2). In this study, lower drainage density values were assigned higher rates whilst higher drainage density values were assigned lower values.

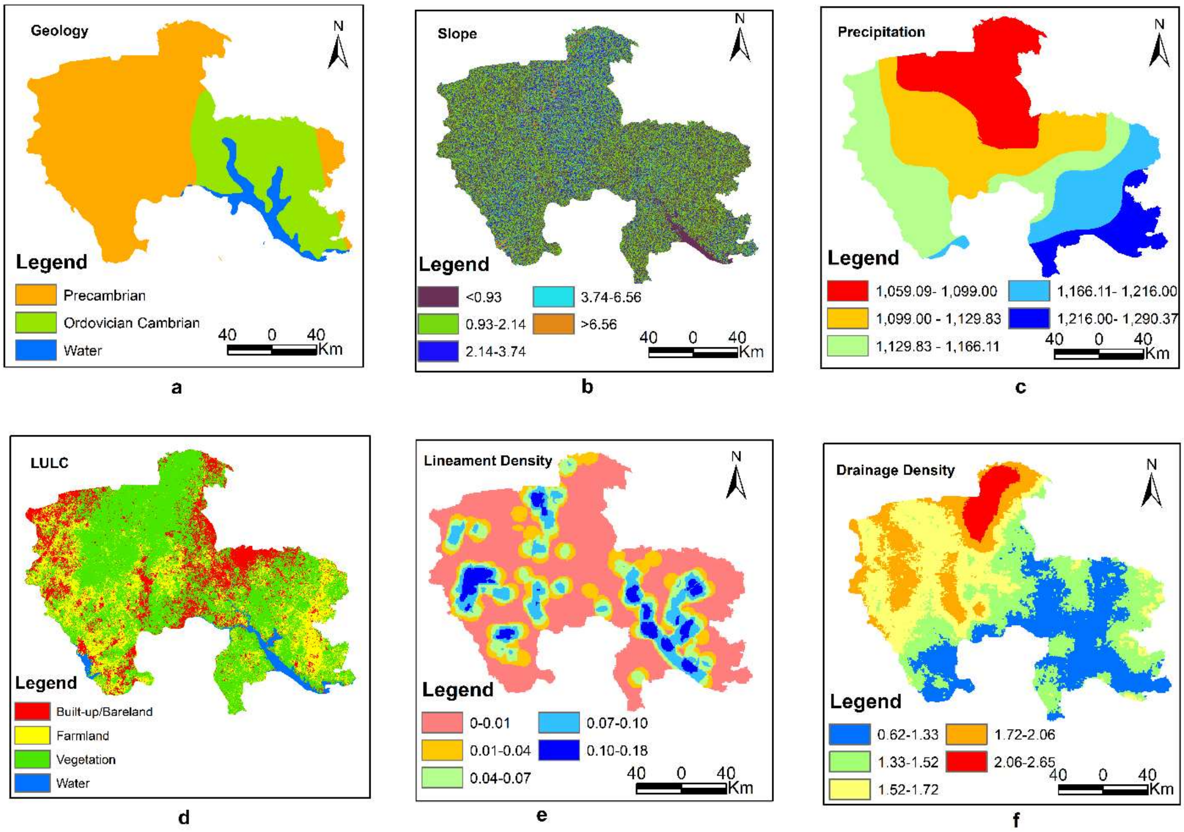

Figure 3a-g: Maps of the Various Parameters

2.4.7 Soil

Soil is another parameter that determines the rate of infiltration of water underground. A review of the literature suggests that soil types significantly affect the volume of water seeping into soil layers which consequently affects the groundwater recharge of an area (Arulbalaji et al., 2019; Das et al., 2019; Das, 2017; Yeh et al., 2016). In the study area, a total of six soil types were identified. These include eutric cambisols, ferric acrisols, ferric luvisols, gleyic luvisols, lithosols and plinthic luvisols. After considering the type of soil and its capacity to retain water, weights are intuitively assigned to each soil component. Soils such as lithosols or rigosols are associated with high water-holding capacity and; thus, have a high probability of groundwater development. However, acrisols have lesser water-holding capacity; hence, has little impact on groundwater recharge. This accounts for the reasons for rating lithosols very high and acrisols low (**Figure 4**). As presented in **Figure 4**, ferric and plinthic luvisols are the predominant soil types in the Savannah Region

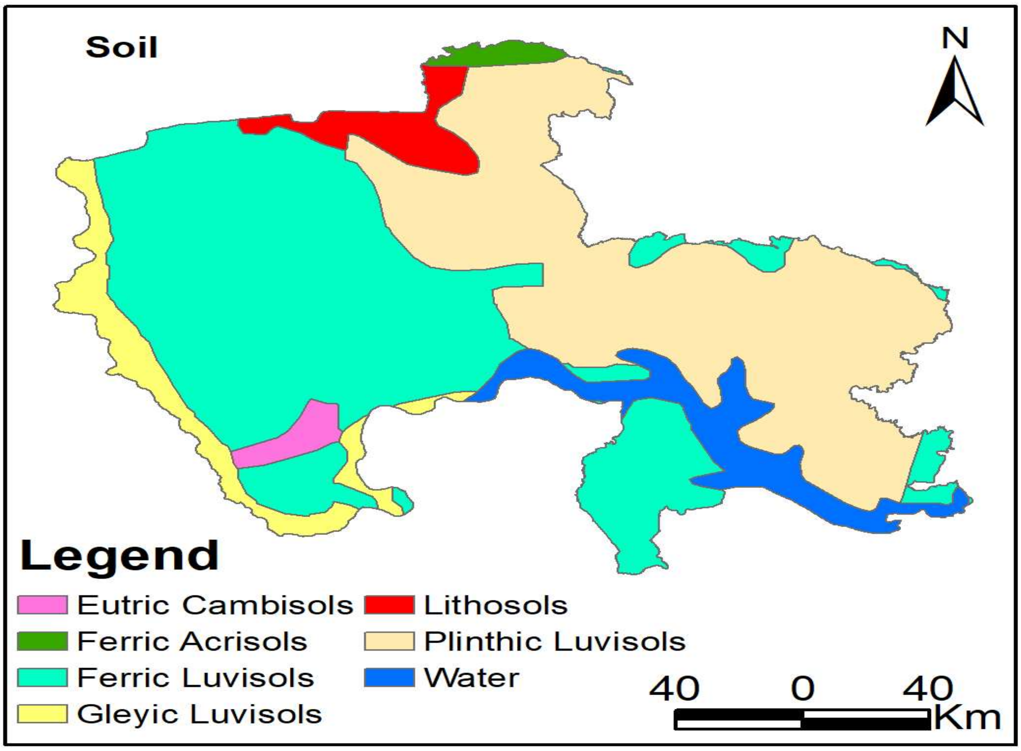

Figure 4: Soil Map of the study area

2.4.8 Criteria Influence on groundwater development

The study determined the amount of influence each parameter has on groundwater recharge using the AHP technique. The results in Table 3 indicate that drainage density has the highest (22.0%) influence on groundwater development in the Savannah Region. This is followed by geology (20.5%), Slope (20.1%), and Precipitation (11.9%). The rates of influence were used in this study to undertake the weighted overlay analysis in ArcGIS to estimate the final groundwater potential zone map. The consistency ratio computed from the weights or rates of influence was 0.01983, equivalent to 2.0%. This implies that the weights assigned to the parameters were consistent since the ratio estimated was less than 10%.

Table 3: Parameter weights and rate of influence on groundwater recharge

Criterion	Weights	Influence
Geology	0.205	20.5%
Slope	0.201	20.1%
Precipitation	0.119	11.9%
LULC	0.091	9.1%
Lineament density	0.097	9.7%
Drainage density	0.220	22.0%
Soil	0.067	6.7%
Sum	1.00	100.0%
Consistency Ratio	**0.01983**	**2.0%**

2.4.8 Groundwater Potential Zones of the Savannah Region

Groundwater is an important source of water supply to both rural and urban environments in arid and semi-arid regions. Groundwater is a replenishable resource that supports domestic, agricultural and industrial uses. This resource has been impacted by climate change due to anthropogenic footprints on planet earth. Arulbalaji et al. (2019) noted that, recently, the recharge of this priceless life-sustaining resource has been greatly diminished as a result of different anthropogenic activities and imbalanced development. Meanwhile, the resource has helped other countries boost their agricultural productivity, contributing significantly to food security efforts. Henceforth, the planning and sustainable development of a region depend heavily on having a better grasp of the groundwater potential of the area. Such details are necessary for the planning and construction of the required infrastructure that will enhance the processes of groundwater development and optimum utilisation. According to the hydrological parameters of the Savannah Region (**Figure 5**), excellent and good groundwater exist in the southeast. The findings of the study reveal that more than half (55.62%), representing a total area of about 19,830.33 km^2, is moderately good for groundwater development. Areas with good and excellent groundwater potential zones were estimated at 22.64% and 1.84%, translating to a total area of 8,071.57 km^2 and 654.68 km^2 respectively. However, about 0.12% and 19.78%, representing an area of 43.09 km^2 and 7051.55 km2 of the entire study area have (very) poor groundwater potential zones. Cumulatively, the study established that about 24.48% of the study area can be used for groundwater development while 19.9% is not conducive to groundwater recharge. Generally, zones with excellent and good groundwater potential are associated with areas with high rainfall, high drainage density, high lineament density, high vegetation cover, and low slopes (lowlands/valleys) which also have strong infiltration potential. The findings of the study are consistent with the study by Arulbalaji et al. (2019). Therefore, the south-eastern areas that include Salaga, Kpalbe, and Buipe could be explored further by stakeholders to develop irrigation schemes for farmers in those areas. This will enhance the sustainable agricultural production of the area and provide livelihood support systems for farmers during the dry season.

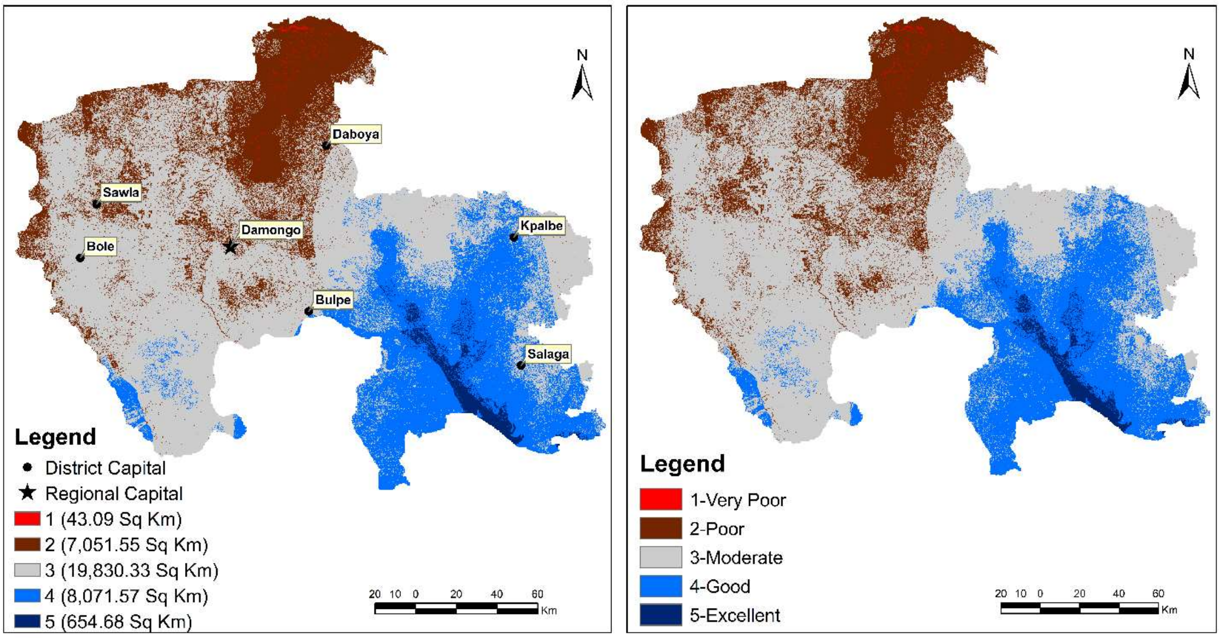

Figure 5: Map of groundwater potential zones of the Savannah Region

2.5 Conclusion

The study has attempted to estimate groundwater potential zones of the Savannah Region of Ghana using geospatial techniques and the Analytic Hierarchy Process (AHP) method. It is necessary to assess the groundwater resource in the area to assist prospective groundwater development agencies, farmers, and the local government in making effective groundwater development planning, management, and investment decisions. The study offers insights into groundwater availability in the Savannah Region for effective planning and management for domestic, industrial and agricultural applications. The parameters that were used in the estimation of the groundwater potential of the region included geology, slope, precipitation, LULC, lineament density, drainage density, and soil. The groundwater potential zones were created using the weighted overlay approach in ArcGIS. The resulting map was classified into five zones ranging from excellent to very poor potential areas. Over 55% of the Savannah Region has moderate groundwater potential. While 19.9% of the region is poorly suitable for groundwater development, about 24.48% of it has favourable potential for groundwater development. This implies that the resource, when adequately harnessed, will propel the region's agricultural production to support the expanding population of Ghana.

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