

Applied remote sensing technique, and GIS to choose suitable Geopark in south east Iraq

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Abstract

Sentinel satellite images are enhanced using Erdas-2014 and analyzed by GIS techniques to distinguish the main geological features in the study area. The enhancement process and correct satellite image with Topography, Geomorphology, and Lithology characterize for landscape classify. GIS method environmental, geological, hydrological, and topographic analysis to identified and assess the suitable location of Geopark in the eastern masian area. This study shows the east misan area has many suitable sites that can be developed as Geopark. By GIS method can choose the suitable Geopark that achieves the basic requirements set by UNESCO for the establishment of Geopark. It includes The existence of wildlife or watery Presence of geological, geophysical, or hydrological factors Hydrogeology is of importance in the region, and high Geodiversity, the area is of importance to ecotourism, The presence of archaeological sites in the region.

Keywords: Geopark, geosite, geo diversity, geo heritage.

INTRODUCTION

Geopark is a unified area that advances the protection and use of geological heritage in a sustainable way, and promotes the economic well-being of the people who live there (Mc Keever & Zouros, 2005). There are global geoparks and national geoparks. It must have clearly defined boundaries and a sufficient area to allow for true territorial economic development, primarily through tourism. Geological sites must be of particular importance in terms of their scientific quality, rarity, aesthetic appeal and education value. Sites can not only be to geology but also to archaeology, ecology, history and culture (Martini, G., & Zouros, N. 2009)and ((UNESCO, 2007). The declaration of a site as a Geopark is a recognition granted to regions that have geological heritage, but may also be of archaeological, ecological, historical or cultural interest that contribute to the sustainable development of the territories. For these reasons UNESCO Global Geoparks are mechanisms of international cooperation that help places considered as heritage to reach great value and seek conservation backed one another in conjunction with local communities to propose awareness of it (Carrión-Mero, P. et al 2020). Geological parks are an important factor in local development, and their importance stems from the fact that many regions of the world have become vulnerable to damage, which threatens them with natural disasters. Therefore, the interest in these parks is a protection for the planet and for humans. The relationship between the requirements of the economy and sustainable development made interest in these parks a necessary condition to create the necessary balance for the continuation of life. However, IUCN, Biosphere Reserves, World Heritage Sites, Ramsar Wetlands and Marine Reserves are the five international designations for protected areas (Schaaf, T., & Rodrigues, D. C. 2016). According to the International Union for Conservation of Nature (IUCN) a protected area can be defined as “Geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values (Dudley, 2008) UNESCO Global Geopark are unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development (UNESCO, 2021). The main benefit of Geopark (Protection, conservation, Education, scientific research, local economic development) (Moreira, J. C., 2021).

In this study the Remote sensing images and GIS Method are processed to classify Landscape based on the Topography, Geomorphology, and Lithology chanceries. the study is very important to Improve the infrastructure of rural areas through the development of geotourism by building roads, creating and improving accommodation, supplying remote areas with electricity

and drinking water, creating adequate spaces to sell local products. development of museums and cultural/information centers. Making an inventory of geosites of outstanding value in the area. Creating and maintaining dynamic GIS database. reinforcement and raising awareness among policies and the general public in the area, especially local communities, about importance of protecting geological heritage and the benefits derived from its use through the creation of geoparks for local socio-economic sustainable development. Building the capacity of the local population in the field of geo heritage and geo-conservation including the organization of conferences seminars, symposia, training courses and workshops focusing on the non-professional community. The result show Telal. Al.band is best site to be geological park its characters high geodiversity and have prerequisite to any Geopark proposal.

Aim of study

- 1- Remote sensing technique, and GIS as An important and low-cost tool to landscape reclassification.
- 2- Identifying suitable area to be Geopark.

Location of study

The study area is located in the South - Eastern part of Iraq between (32°50'9.71"N), (46°35'53.90"E), and (31°47'3.45"N), (47°52'33.30"E) covered an area equivalent to (13415 Km²). The geographical location it located on the Iraqi-Iranian borders. about 336 km to the south of Baghdad city, and 200 km to the north of Basrah city as show in fig. (1-1)

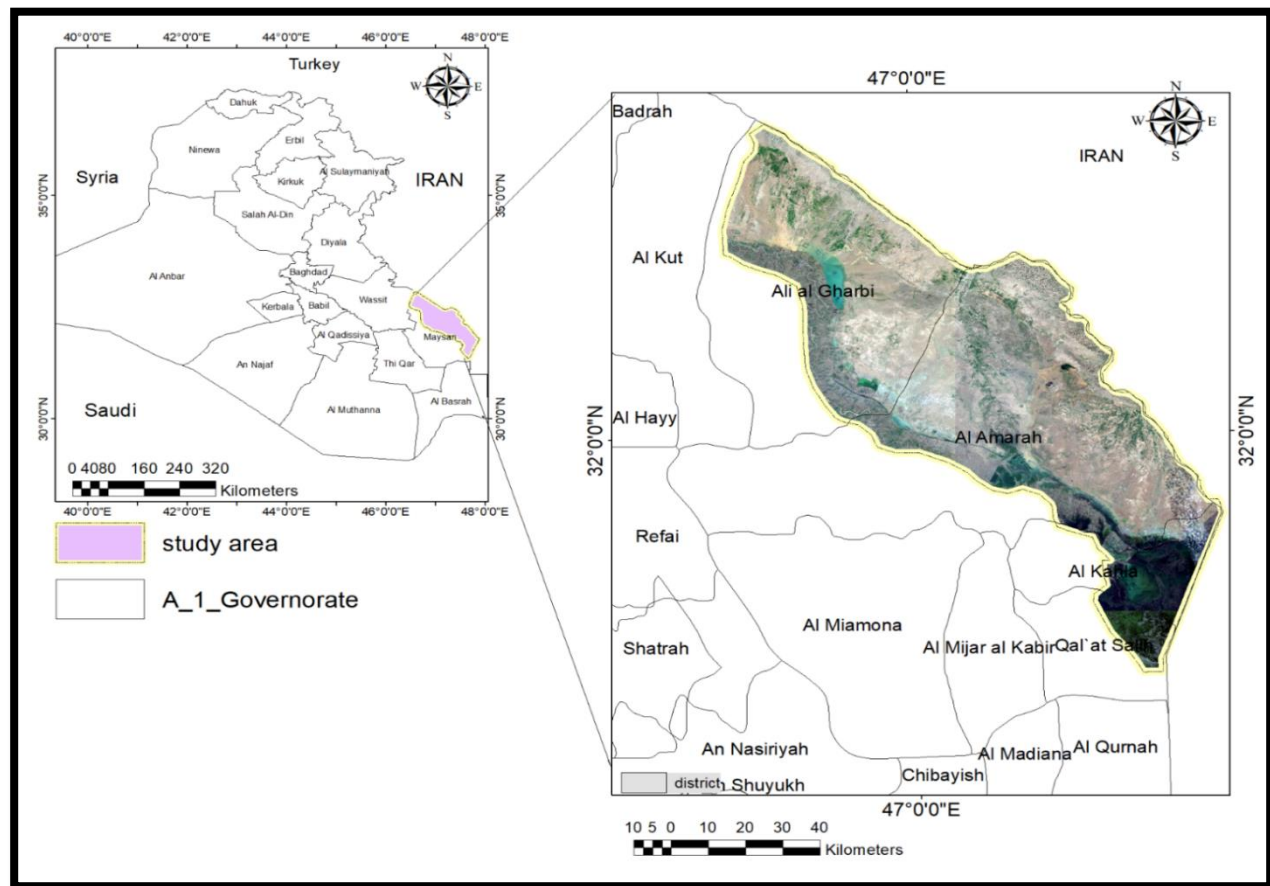


Figure (1-1) location of area study

General Geological of study area: -

Geological sitting: -

According to the geological map of Iraq 4 edition (2012) the study area is covered by Tertiary Formations and Quaternary deposits. Many of strata from Pliocene to Paleocene are distributed within study area; they are representing by Bai- Hassan, Mukdadiya, Injana, and Fatha. Slope sediments represent by rock fragments with fine clastis and depression fill sediments represent by silt and mud are the main Quaternary deposits towards the Mesopotamian plain from the foothills along the Iraqi-Iranian border on the east. Fig (1.2).

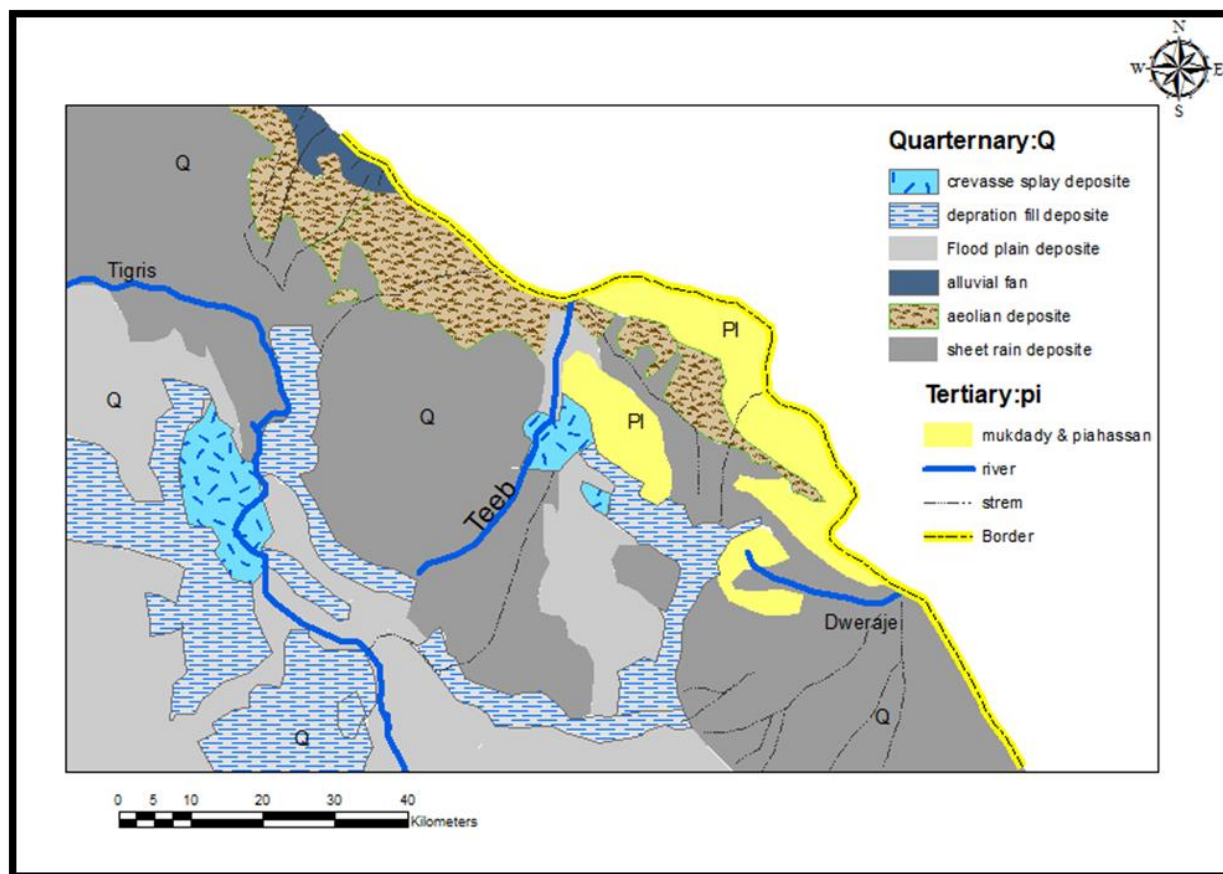


Figure. (1.2): Geological map of one geosite area modified by (geological map of Iraq, Sissakian, & Fouad, 2015), (Geological map of Amara, GEOSURV, 1995), and (Geological map of Ali AL-Garbi GEOSURV 1993).

Geomorphologically, the study area is considered as an enormous aggregation geomorphologic unit, dominated by the structural, fluvial, lacustrine, and Aeolian landforms. Marine and estuarine features are also a presence, but these are limited to the extreme south-eastern regions of the study area. The geomorphic units of the study area are classified depending on their origin, geomorphic position, and lithology. Some units have different geomorphic features, with some details given their order and importance (Yacoub, 2011). The geomorphological map of Iraq was prepared by (Hamza, 1997). He classified the geomorphic units of Iraq into eight units, based on tectonic forces and geomorphic activities. through the field survey we can observed some of geomorphology feature as sand dunse (Barkhane) ,custa ,marshes ,hilles ,vally and river terraces. Thus, the the stratigraphic unit of study area in table (1-1). The geomorphologic units of the study area are summarized hereunder in Table (1-2)

Summarized the stratigraphic unit of study area in table (1-1)

Age	Unite	Lithology
Late Miocene-Pliocene	Upper Bakhtiary (Bai Hassan) Formation	Conglomerate, sandstone and red claystone. In Dokan area it consist of limestone conglomerate (Karim and Taha , 2012)
Upper Miocene- Early Pliocene	Lower Bakhtiary (Mukdadyia) Formation	Very thick alternation of red claystone and Pebbly sandstone
Upper Miocene	Upper Fars (Injana) Formation	Very thick alternation of red claystone and sandstone Age
Lower and Middle Miocene	Lower Fars (Fatha) Formation	Very thick alternation of Gypsum (or anhydrite), Salt, marly limestone in the basin center while it may contain fossiliferous and oolitic limestone, sandstone and red claystone
Quaternary deposits	flood plain, depression fill, and Aeolian deposits	boulder, gravel, and sand silt and clay deposits

Table (1-2), The geomorphological unites of the study area

Unite	Orgin	Force
Fold ,and fracture	Structure orgin	Tectonic activity
Alluvial fan	Fluvial origin	Tectonic and climatic activity
Flood plain	Fluvial origin	Erosion and Deposition processes
Marshes,	Fluvial origin	Erosion and Deposition processes
Shallow depression	Fluvial origin	Aeolian activity
River terraces	Fluvial origin	Erosion and Deposition processes
Sand dunes	Aeolian	Aeolian activity

Methodology: -

GIS methods and spatial data analysis are used for choose suitable area to be geological park (Geopark). By use the landscape classification and. choose five landscape as potential Geopark fig.(1-15). Terrain analysis used to choose suitable area to be geological park show in table (1-5) and figure (1-16). This object consists number of technique as follow:

1- The satellite image resolution enhancement technique for sentinel 2 MSI image, geometric correction, and extraction of the study area

2- landscape classification

Landscape classification based on the Topogrphological as fig (1-3), Geomorphology as fig (1-4), and Lithology chancerics as fig (1-5) show as follow:

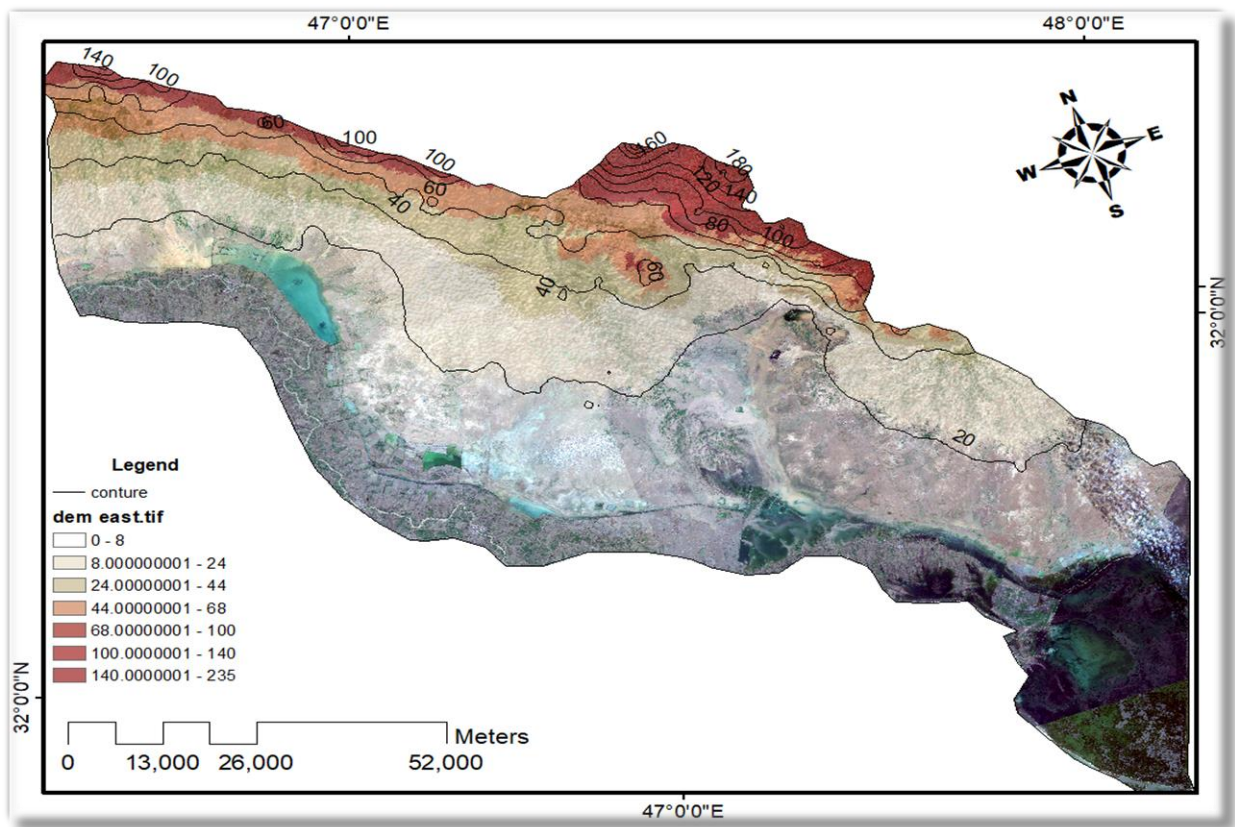


Figure (1-3) Topographic map

Table (1-2) Topography characteristics of land scape

NO	Land scape	Elevation	Topography surface
1	Hills	(50-180) m	Hard land (complicated surface)
2	Alluvial fans	(20-50) m	Less hard (clastic)
3	Plain	(0-20) m	Easy land (flat)

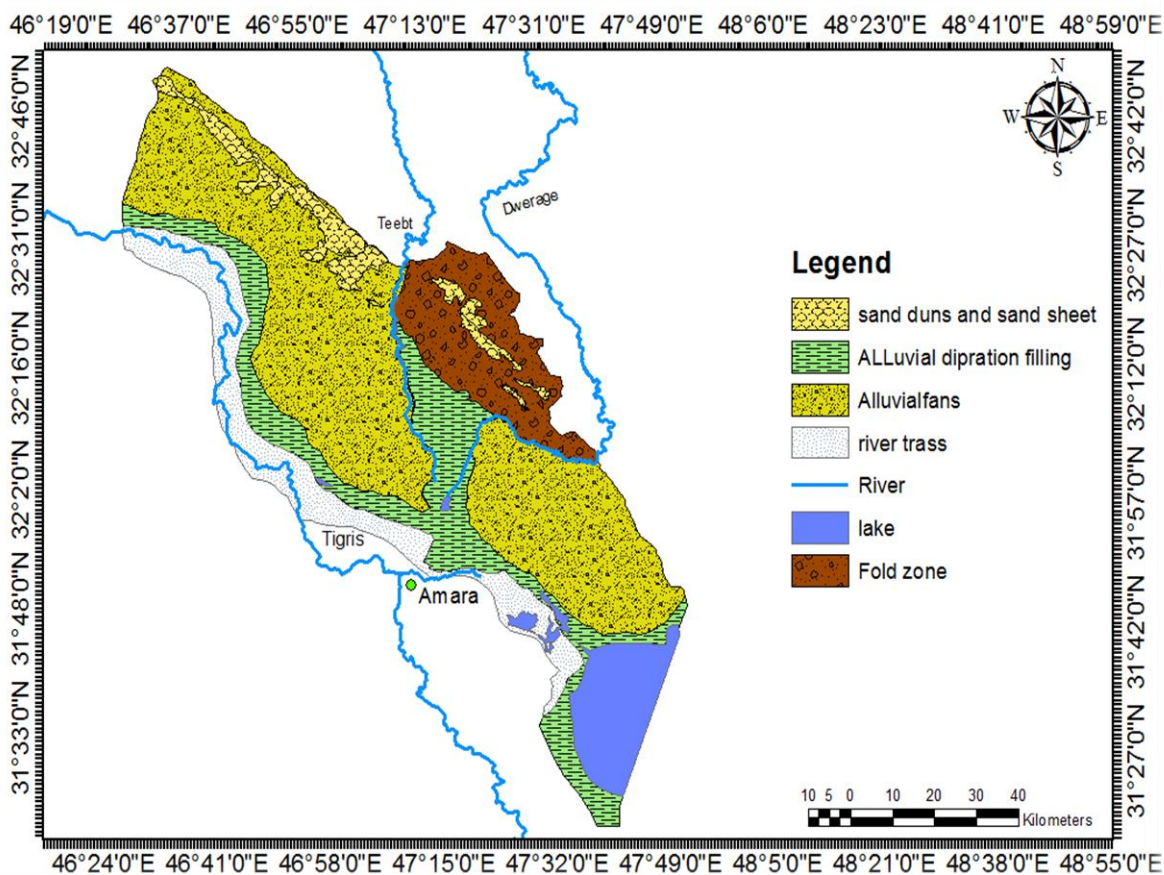


Figure (1-4), The Lithological map

Table (1-3) The Topographic characteristics of landscapes

NO	Land scape	lithology	Age	Origin
1	Folded zone	Conglomerate, Gravel	Tertiary	Flooded and fluvial
2	Sand dunes and sand sheet	Sand, silt, clay	Quaternary	Aeolian
3	Alluvial depression filling	Fine sand, siltstone, and clay	Quaternary	Fluvial

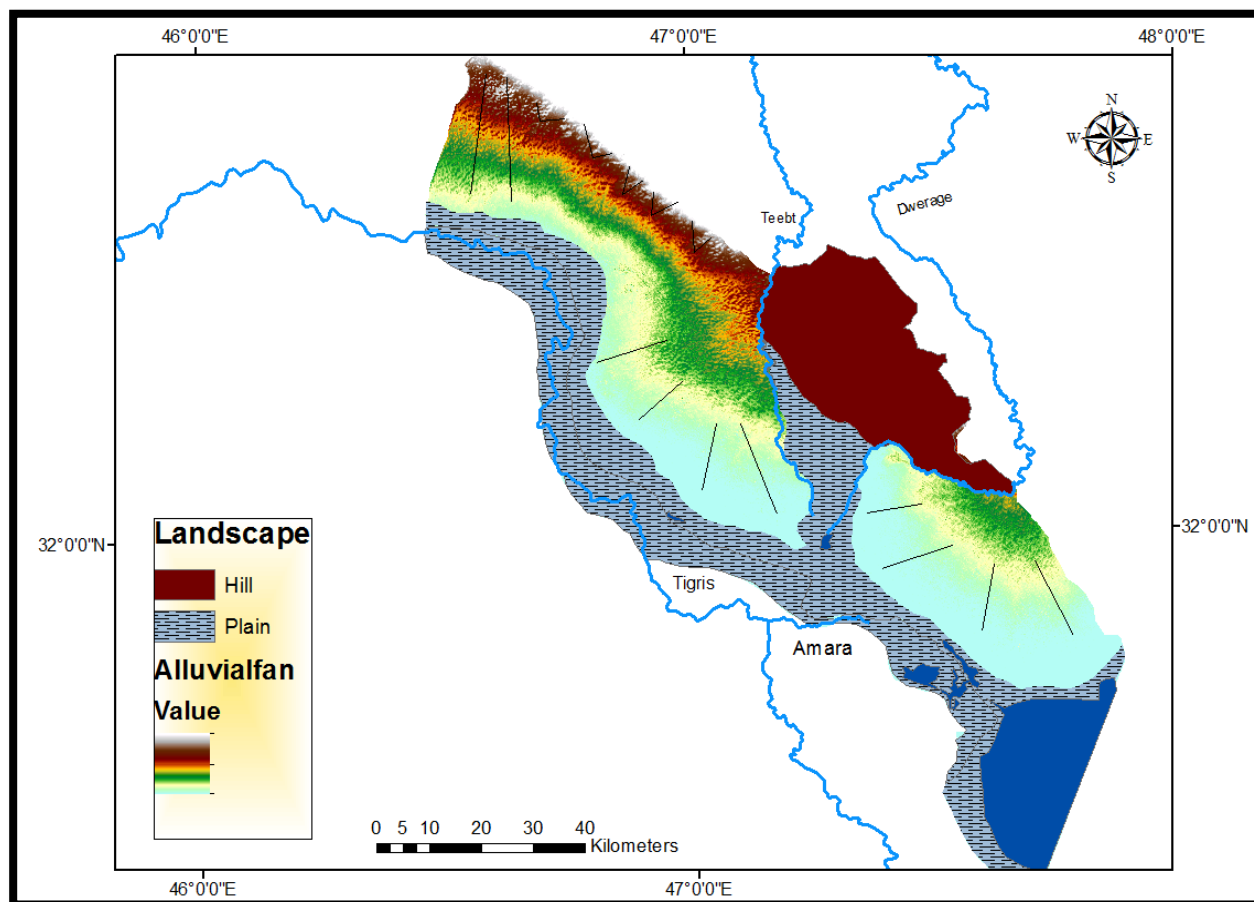


Figure (1-5) geomorphological landscapes

Table (1-4) The Geomorphological landscapes characteristics of landscapes

NO	geomorphological land scape	Geological formation	Origin
1	Hill	Mukdadiya and Bai Hassan	structural
2	Plain	Quaternary deposits	Deposition
3	Alluvial fan	Injana ,fataha and Quaternary deposition	Structural and deposition

Terrain analysis

It's have some techniques show as fellow:-

slope, aspect, curvature, and Terrain Ruggedness are techniques useful for geological heritage, and land scape studies (Dhakal, A. S., Amada, T., & Aniya, M. 2000) and (Misagh, N. *1, Ashouri, M.2016) show as figures (1-6),(1-7) , (1-8) ,and (1-9).

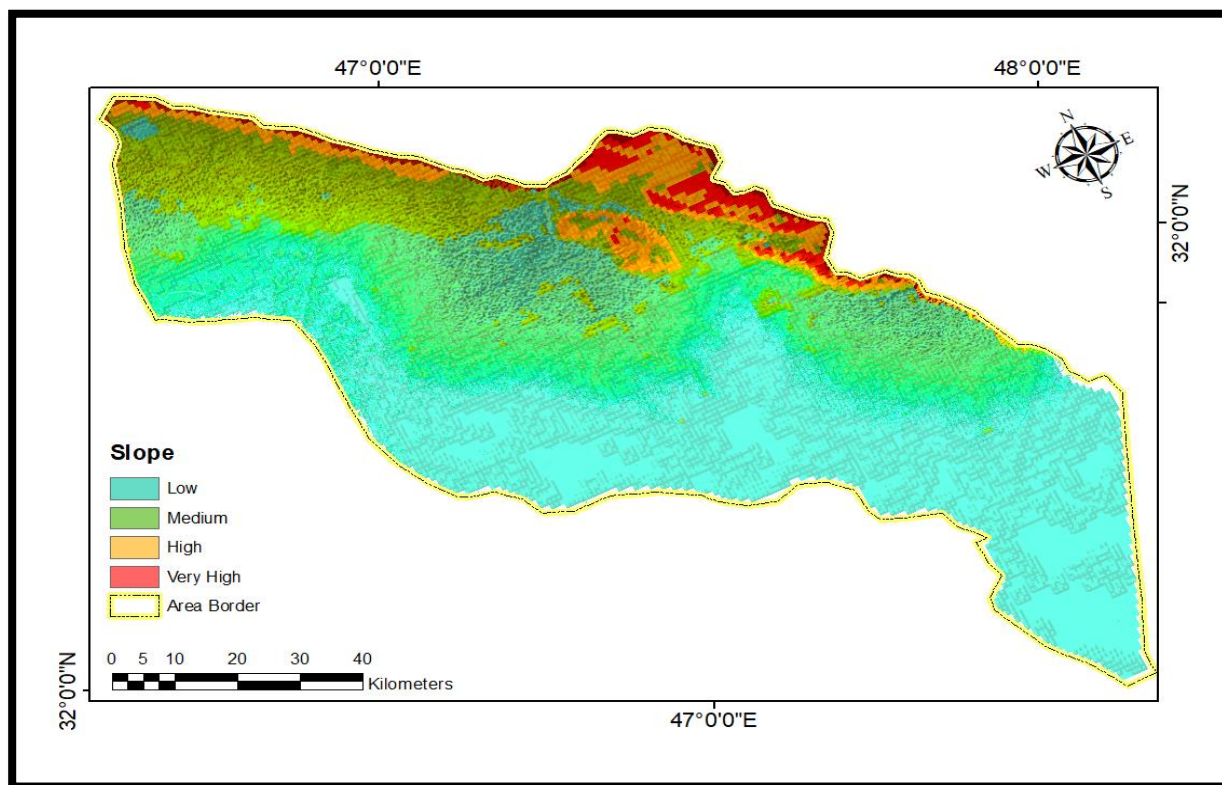


Figure (1-6) Slope Map

The high and very high slopes are ranging (22-60) (60-100) and, focus on the northern regions of the region, due to the geographical situation: it's close to the Hamrin-Mogul mountain range, and the geological situation: hardness rocks area, and it is within the foothill zone. The moderate slope ranging (5-22) focuses on the Mesopotamia zone and less hard rocks

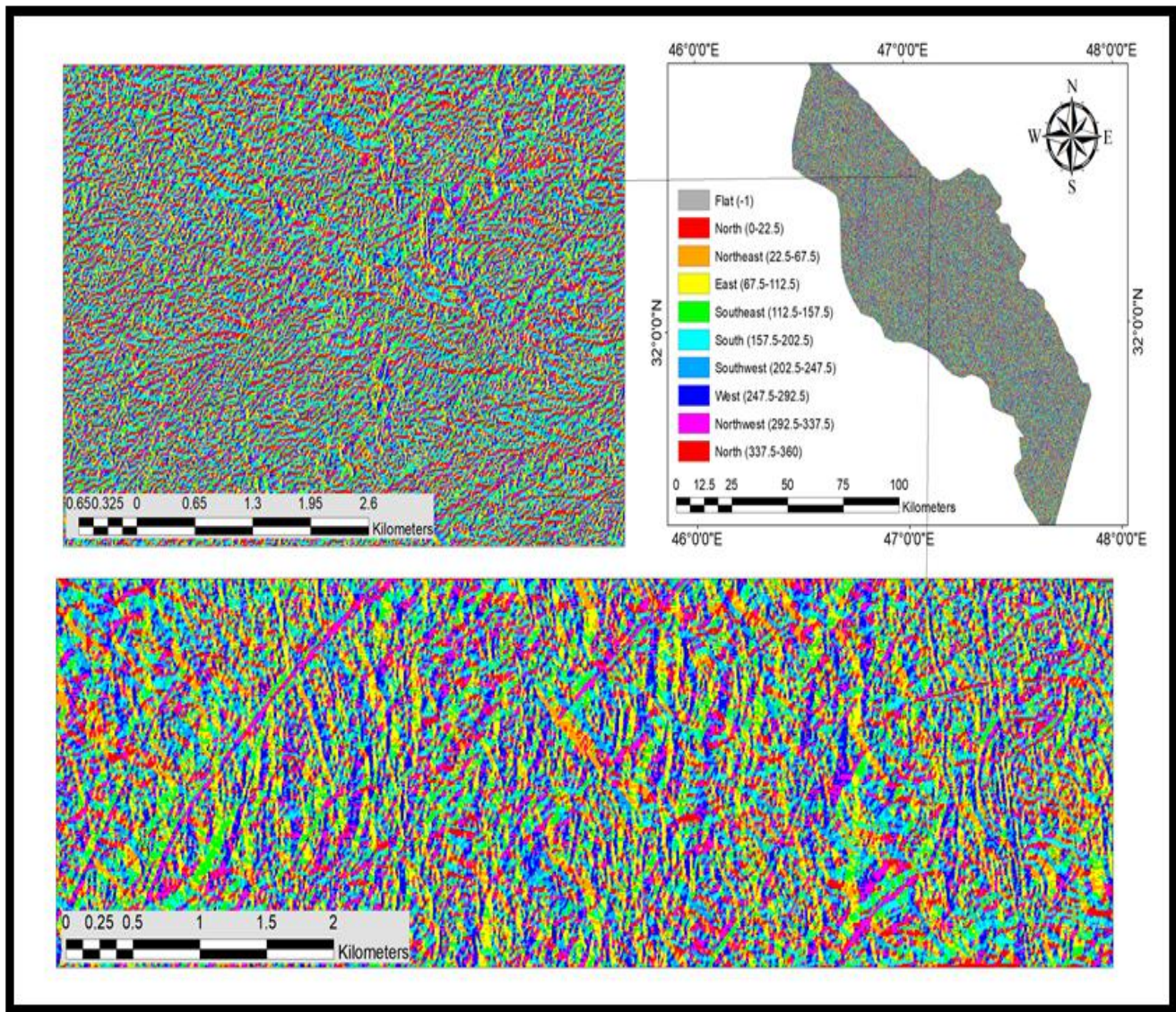


Figure (1-7) Aspect map

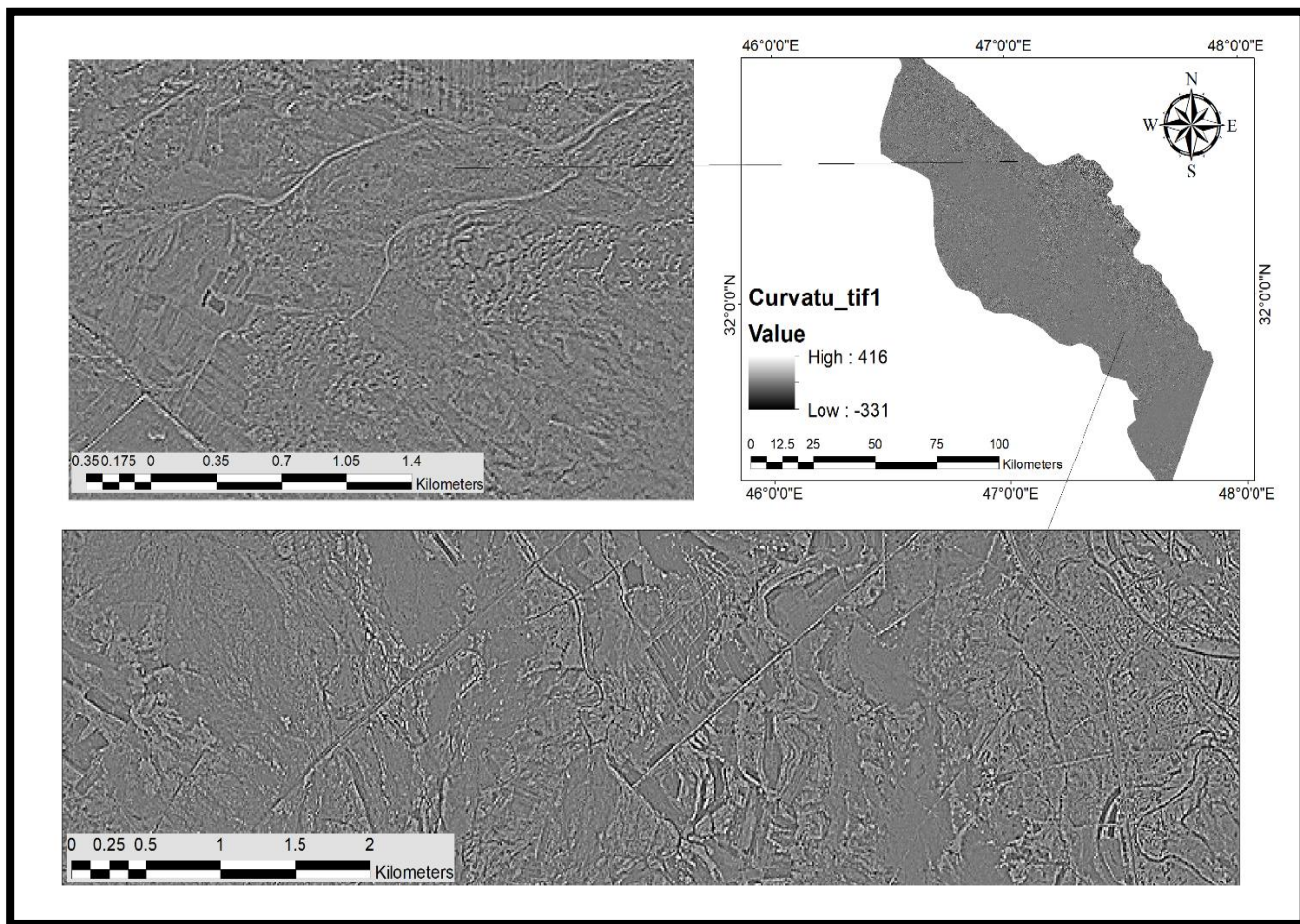


Figure (1-8) curvature map

Terrain Ruggedness index and Roughness: is defined as the variability or irregularity in elevation (highs and lows) within a sampled terrain unit (Smith, M. W. (2014), and used to study geological feature (oil exploration) .in this study used this technique to identified the type of geodiversity in study area show in figure (1-9)

The terrain ruggedness index (TRI) is calculated as follows (Riley et al, 1999):

$$TRI = Y [\sum (x_{ij} - x_{00})^2]^{1/2}$$

where x_{ij} is the height of each neighboring cell.

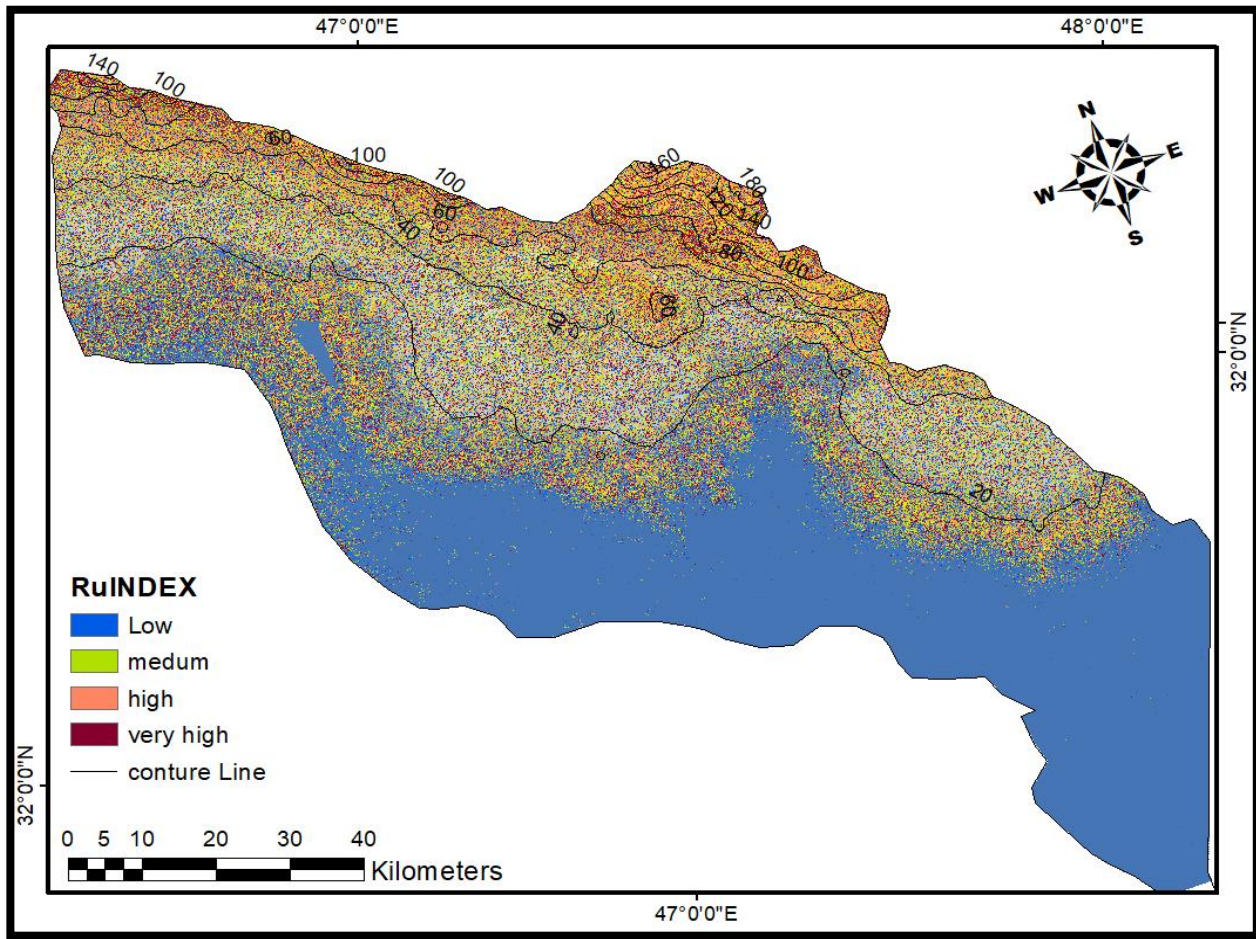


Figure (1-9) Terrain Ruggedness Index and roughness

The very high value and high between elevation (60-180) m, the moderate value between (20-60) m, and low value (0-20) m.

- Watershed and main stream: - The technique shows the sub-basin and drainage pattern in the study area are affected by structure of area
- Stream power index SPI; used to describe potential channel erosion and landscape processes (Moore et al., 1991) calculated based upon slope and contributing area. SPI approximates locations where gullies might be more likely to form on the land- scape. Wilson and Gallant, 2000):

$$SPI = \ln([FlowAccum Raster] + 0.001) * ((Slope Raster]/100) + 0.001))$$

So, by this technique can be identified the gullies erosion areas are caused soil erosion and weakness in the region. show in figure (1-11)

- Topography wetness index: used to describe the spatial soil moisture pattern, landslide susceptibility studies and assess hydrogeology process (Chen, C. Y., & Yu, F. C. (2011)

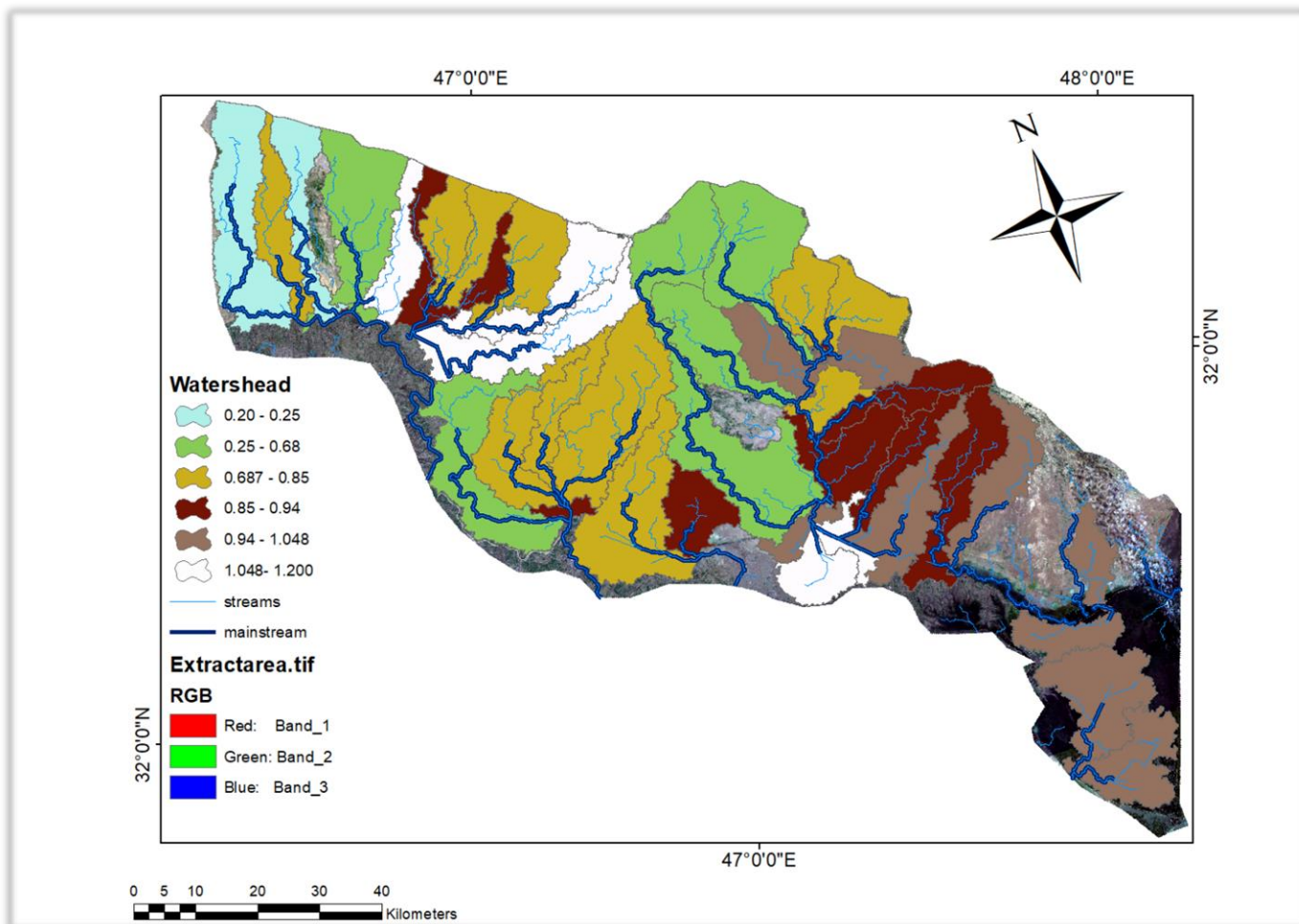
$$\ln(A_s/\tan\beta)$$

In this case high value of TWI focused in the lower area and near stream divided. show in figure (1-12)

- Normalized difference vegetation index (NDVI): it is used to predict ground vegetation biomass .and it is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation. Negative values of NDVI (values approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Lastly, low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests and calculate by equation (Weier, J., & Herring, D. (2000). in this case select five geopoint show as figure (1-13)

$$NDVI = (NIR - VIS)/(NIR + VIS)$$

- Built-up index: - The normalized difference built-up index (NDBI) has been useful for mapping urban built up areas using sentinel image (show in figure (1-14)



Figures (1-10) watershed and streams

The distribution of watershed and different Types of Drainage Patterns as result affected by surface and subsurface structure.

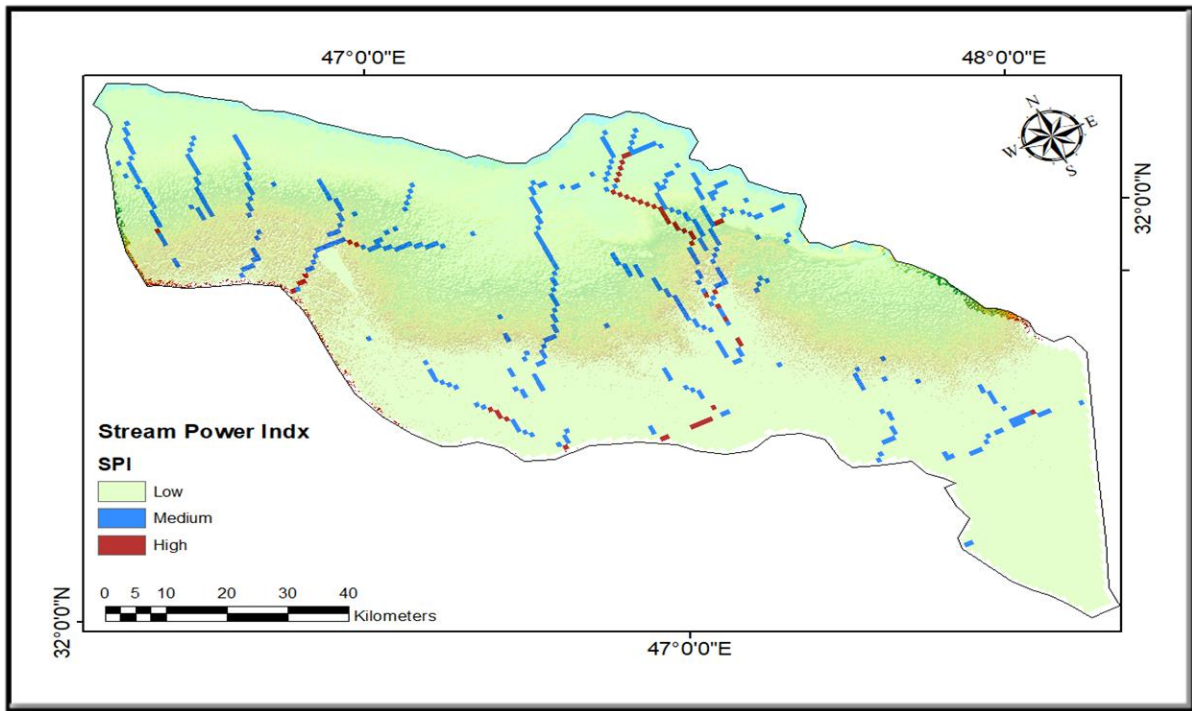


Figure (1-11) SPI

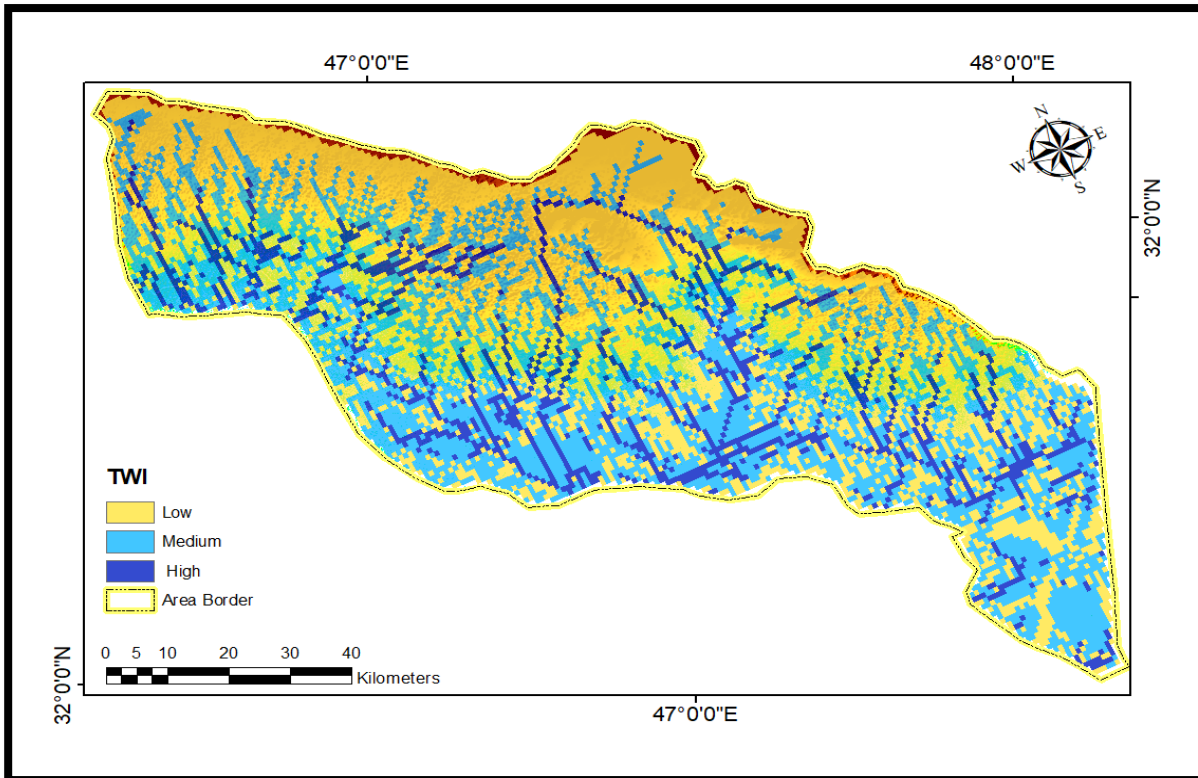


Figure (1-12) Topography wetness index

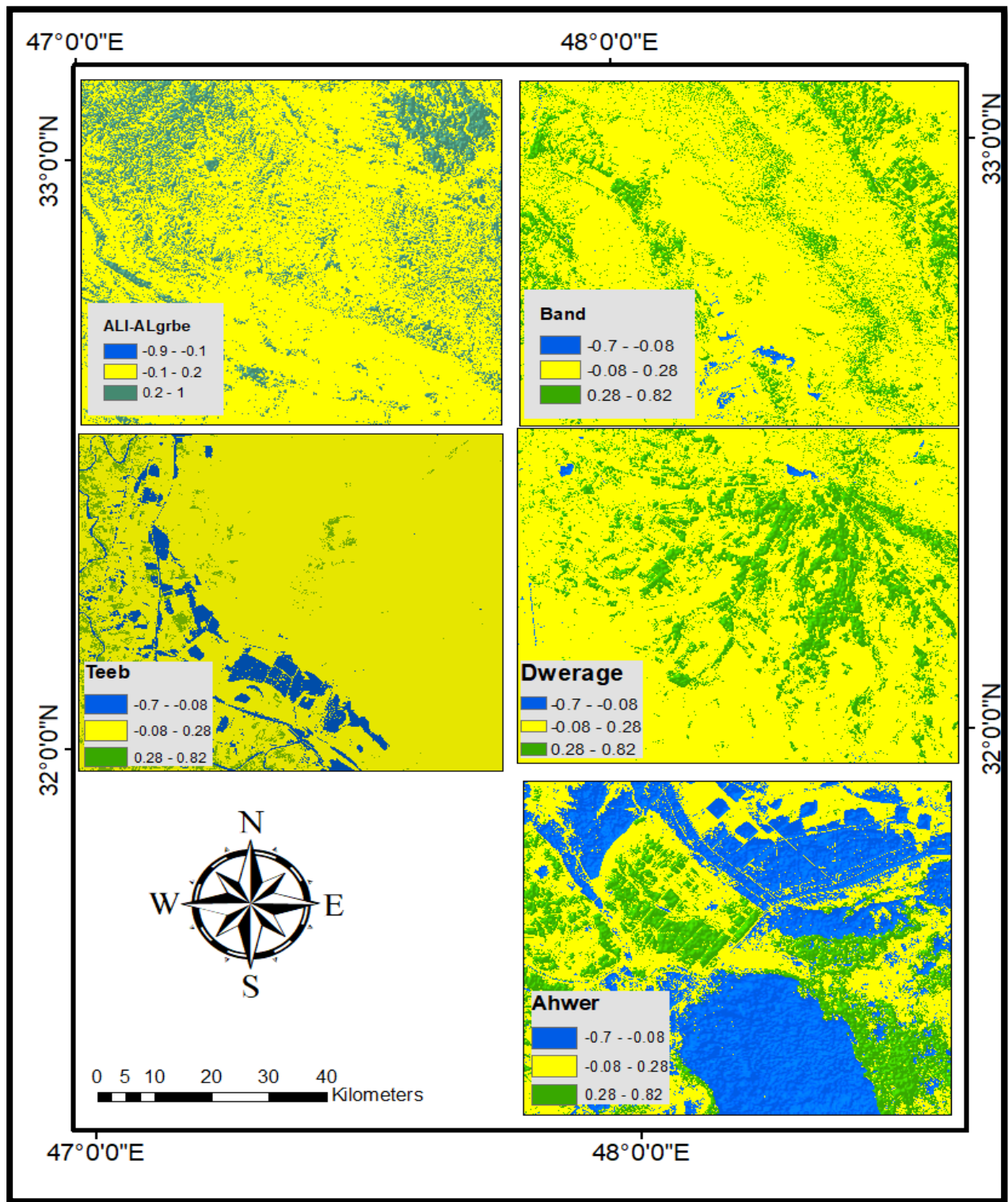


Figure (1-13) NDVI index

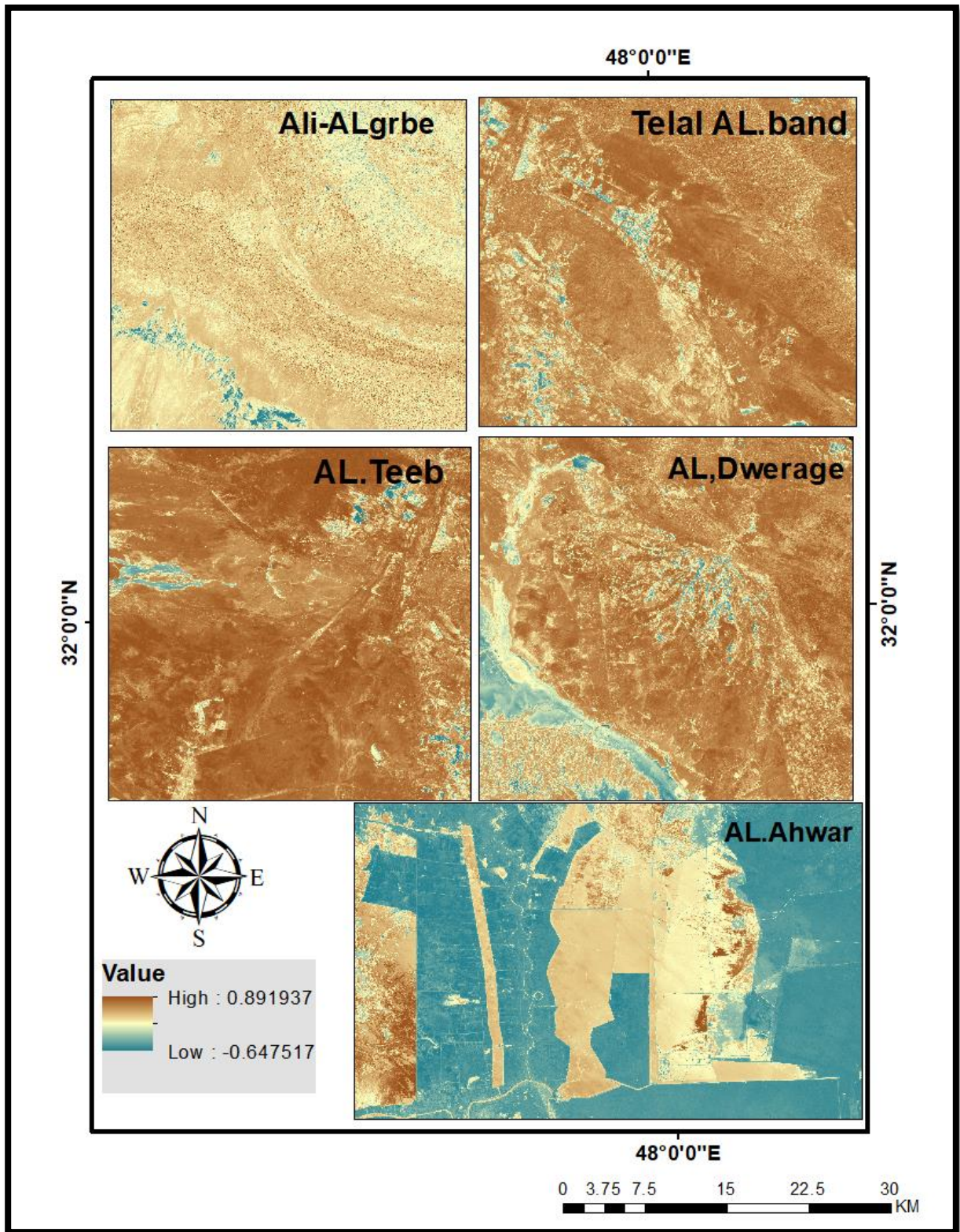


Figure (1-14) Bare soil index

Result and conclusion:

1- Landscape classification to five areas, are (Al. Teeb, Ali- ALgrbe, ALDwerage, Telal al band, and Al. ahwar) as potential Geopark show figure(1-15).

2- Terrain analysis in this case use (slope, aspect, couverture, and Ruggedness index) techniques to assess the Geodiversity in study area, and use (NDVI, PI, WT, BS) techniques to assess the Biodiversity, existence of water life, active community, and natural hazard. Show in table (1-5).

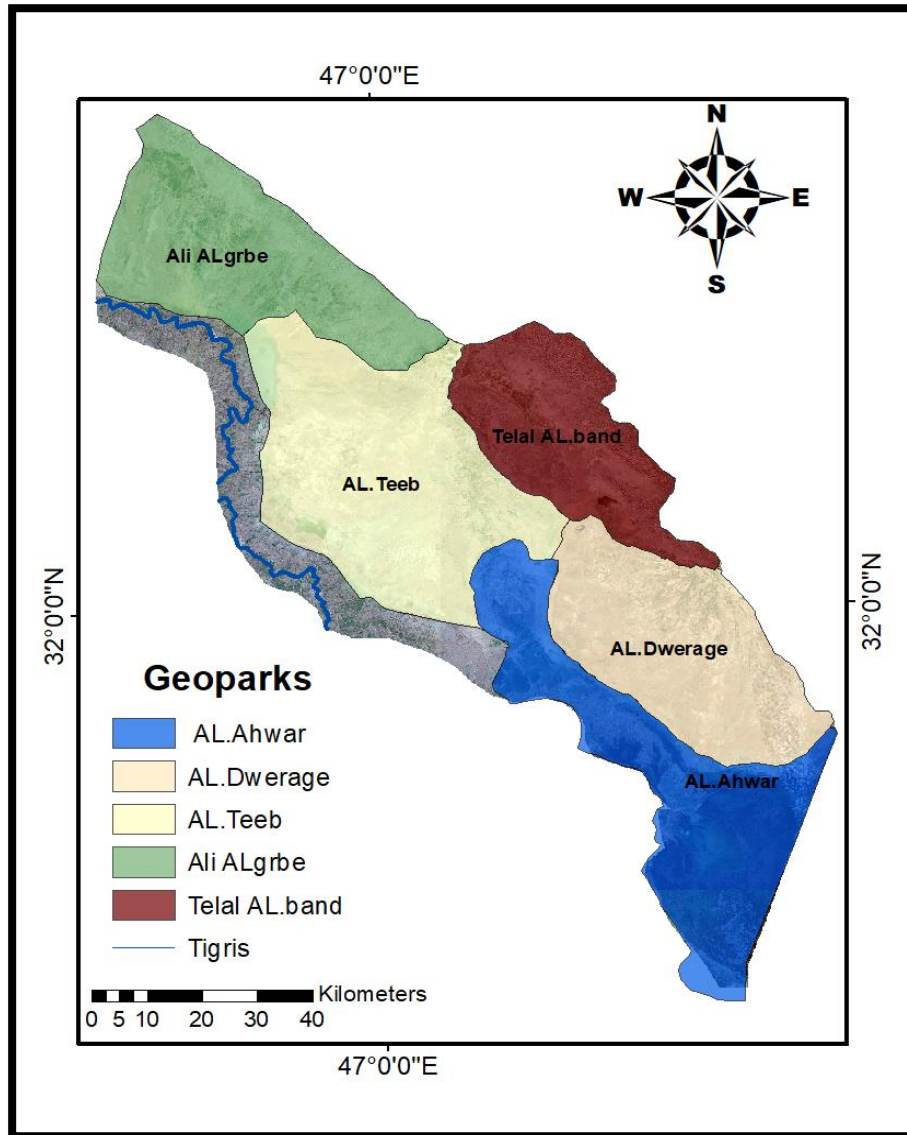


Figure (1-15) The potential Landscapes areas map

Table (1-5) Evaluation of suitable geological park (Geopark)

<i>Name</i>	Geodiversity	Biodiversity	Geological complicated	Hydrology Characters	Archology	Economic geology	Natural hazard
Telal. Al.band	High	Moderate	high	Streams, valley, and natural spring	yes	Oil field, Quarries, Ground water well	Flooding Desertification Earthquake
Al.dweraje	Medium	Moderate	Moderate	Streams, valley	no	Oil field, Quarries	Desertification Earthquake
Al.Teeb	Medium	Low	Moderate	Streams, valley	no	Quarries, Ground water well	Flooding Desertification
Al.ahwar	low	High	Low	Life water	yes	Oil field	Flooding Earthquake
Ali.algrbe	Medium	High	Moderate	Valley and stream	no	Quarries, Ground water well	Flooding Desertification Earthquake

So Telal. Al.band is best site to be geological park its characters high geodiversity and have prerequisite to any Geopark proposal, are Clearly defined boundaries , large enough area for it to serve local economic area is (1172Km²), and cultural development (particularly through tourism, The existence of wild life or watery, The presence of archaeological sites in the region, Presence of geological, geophysical, or hydrological factors Hydrogeology of importance in the region, the area be of importance to ecotourism (unsc02016) fig. (1-16).

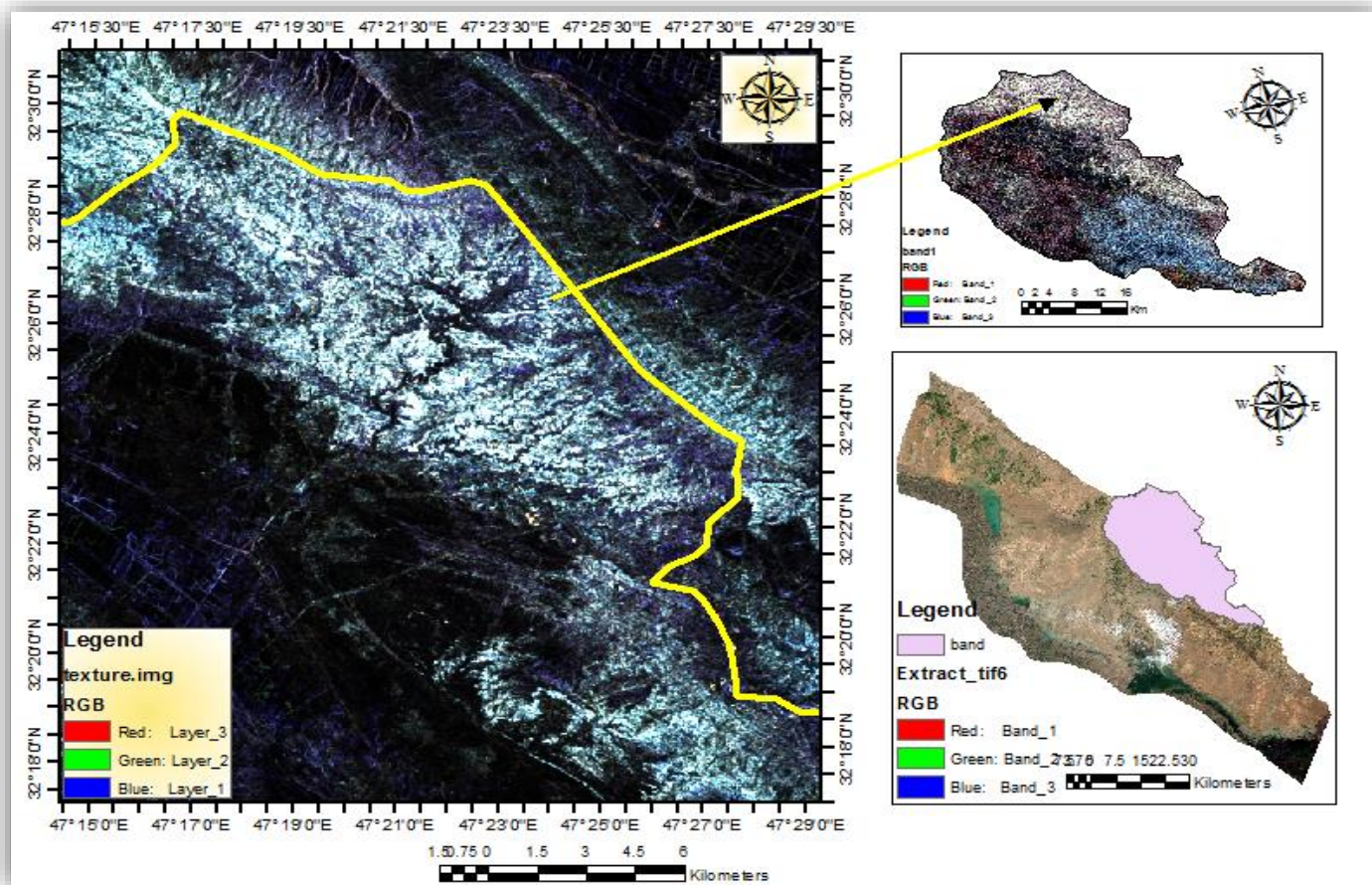


Figure (1-16) Telal al band Geopark

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