Geomorphological Mapping of Razzaza–Habbaria Area using Remote Sensing Techniques

Moutaz A. Al-Dabbas* ***Hussain Zaydan Ali*****

*College of Science, University of Baghdad, Postal address: Iraq-Baghdad - Aljaderia - Baghdad University post office - P. O. Box: 47138.
**Ministry of Science and Technology, Baghdad, Iraq

E-mail: profaldabbas@yahoo.com

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Abstract:
Landforms on the earth surface are so expensive to map or monitor. Remote Sensing observations from space platforms provide a synoptic view of terrain on images. Satellite multispectral data have an advantage in that the image data in various bands can be subjected to digital enhancement techniques for highlighting contrasts in objects for improving image interpretability. Geomorphological mapping involves the partitioning of the terrain into conceptual spatial entities based upon criteria. This paper illustrates how geomorphometry and mapping approaches can be used to produce geomorphological information related to the land surface, landforms and geomorphic systems. Remote Sensing application at Razzaza–Habbaria area southwest of Razzaza Lake shows the different geomorphologic units and the land use maps that were delineated from Landsat ETM+ Image. Digital Image unsupervised classification was adopted to delineate the different classes by applying ERDAS 8.4 software. According to this classification five classes were selected and delineated in different colors.

Key words: Geomorphology, Landsat, Remote Sensing, Razzaza-Habbaria.

Introduction:
Geomorphometry is the science of the quantification and analysis of the land surface. It is fundamental to quantitative geomorphology, and is considered a discipline. Various aspects of specific and general geomorphometry have been presented. In general, geomorphometry addresses issues of: 1) sampling attributes of land surfaces; 2) geodesy, digital terrain modeling and the generation of DEMs; 3) DEM error assessment and preprocessing; 4) generation of land-surface parameters, indices, and objects; and 5) geomorphic information production and problem-solving using parameters and objects. Each aspect of geomorphometry represents a research subdiscipline and contributes significantly towards the development of software tools and geospatial technology [1]. The discipline of geomorphology is rich in theory and concepts related to time, processes, systems, and landforms. In other words, the ability to predict the spatial entities resulting from forcing factors, processes and polygenetic evolution is essential. Today, all lands use planning processes in most of the

countries are based on geomorphologic units. Geomorphologic units are dynamic in nature as they are affected by various human activities, including the expansion of cultivated and irrigated lands, industrialization, urbanization and others because it need to monitoring, mapping for land use planning. Geomorphic units are classified on the basis of differential erosion processes [2]. The landscape that surrounds us is essential to our life and activity and thus understanding of its characteristics and processes is important for sustainable development [3]. Formed through long ages by changing climatic conditions, topography and materials, the landscape is complex and includes both resources and hazards to our society. The geomorphologic maps represent the surface, nature and properties of the surface materials and indicate the kind and magnitude of the processes involved.

The Razzaza –Habbaria area is chosen, it is located to the west of Razzaza Lake in Karbala Governorate. This region is characterized by a continental climate is hot, dry summers, cool wet winters, and the wind prevail north-western direction [3]. The generally dry and warm to hot climate dominating most of Iraq have had its influence on the type of Quaternary sediments and soil developed, being generally immature, without profile zonnation, generally with minor mineralogical and chemical alterations compared to source rocks. The main changes have been size degradation of these rocks to gravel, sand, silt and mud by erosional factors and mechanical transportation, rather than by chemical weathering processes [3]. The soils of the Razzaza – Habbaria area in the wadi beds contain surrounded, pink and white colored cobbles and pebbles of limestone and siliceous rocks, mixed with brownish calcareous sand, silt and clay. The areas in between the wadis have a shal1ow or very shallow soil layer, often mixed with or covered by cobbles and pebbles with a dark brown to blackish desert varnish. In shallow depressions such as in Habbaria area, the soils are heavier textured mud, showing typical cracks in the dry summer; sometimes more sandy and silty soils occur. There are gravel crusts, cemented by calcium carbonate. Water erosion, particularly sheet erosion, has transported much material. Aeolian deposits are not extensive in this desert, although in and near some wadis, mixtures of finer grained quartz and somewhat coarser grained limestone and dolomite are occurred. Locally there are small sand dune areas. The soils of the extensive stony areas are called Hamada Soils [4].

The study area is located between latitudes (32' 00" – 33' 00") to the north and longitude (43' 00" – 44' 00") to the east (Figure 1). Razzaza –Habbaria area is covered by recent sediments and sedimentary rocks. The geological formations outcrops have a large extension ranging in age from Miocene (Fatha Fm.) to Quaternary sediments. The common rocks are limestone and clastics with the presence of gypsum rocks [3, 4]. These formations from the oldest to the recent are as follows: -

Tayarat Formation Cretaceous
Um Erdhuma Formation U. Paleocene
Dammam Formation U.-M. Eocene
Euphrates Formation U.-M. Miocene
Nyfayl Zahra Formation M. Miocene
Injana Formation U. Miocene
Quaternary deposits and recent Sediments

In this research, remote sensing and GIS techniques were used to identify landform, geomorphic units and to produce geomorphologic mapping based on land use planning of Razzaza –Habbaria area.

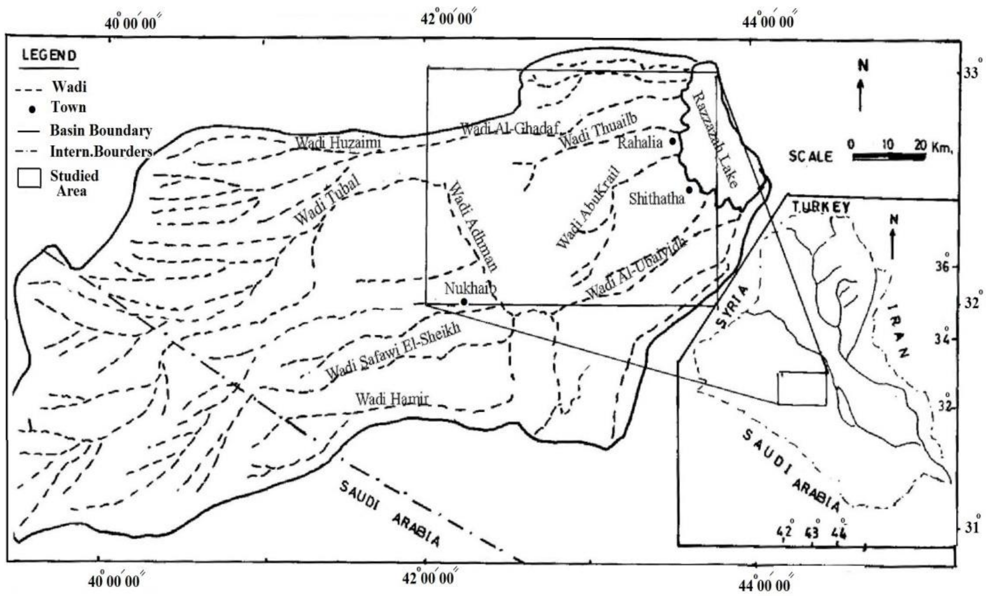

Fig. 1: The Razzaza – Habbaria area location map [3].

Materials and Methods:

Geomorphologic maps have been prepared by digital image classification techniques using enhanced satellite data. Band combination of red, blue and green was used to display the raw images in standard color composites. The spectral band combination for displaying images often varies with different applications. This was necessary for the visual interpretation of the images. A band combination of red, blue and green (RGB) is often used to display images in standard color composites for land use and vegetation mapping. In this study, the images were displayed in a band combination of 4, 3 and 2 is a standard for visual interpretation of vegetation mapping [5-9]. The most significant contribution of remote sensing to geomorphology is the use of passive and active sensors to generate surface elevation data commonly referred to as a DEM.

A variety of techniques can be utilized for digital terrain modeling including image photogrammetry, radar or laser altimetry, and interferometric synthetic aperture radar. Photogrammetric applications of satellite imagery including SPOT and ASTER data are commonly used by scientists. In the case of SPOT imagery, alternate view perspectives from multiple satellite passes enable stereoscopic representations, whereas the ASTER system relies upon forward- and back-looking telescopes to characterize topography through a merged characterization. Similarly, radar imagery and specifically SRTM (Shuttle Radar Topographic Mapping Mission) data are widely used for mapping, as depicted in (Figure 2). The SRTM and ASTER mission objectives were specifically designed to produce a global DEM data product to facilitate Earth science mapping projects. These DEMs have resulted in many new developments and the ability to automate landform mapping based upon the use of geomorphometric parameters/indices. More recently, airborne high resolution, light detection and ranging (LIDAR) systems and terrestrial laser scanning systems can generate millions of 3-D point measurements [1, 4, 5, 6,7 and 10].

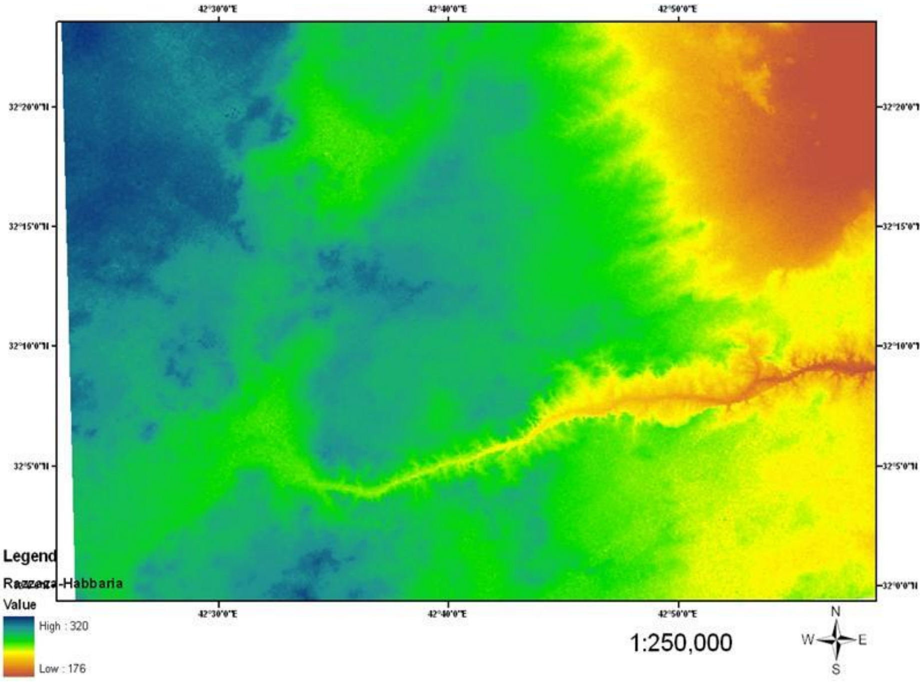

Fig. 2: Shuttle Radar Topographic Mission (SRTM) 3 arc-second DEM for the study area. The 90 m resolution permits relatively accurate geomorphometric characterization of the region [5].

Results and Discussion:

Satellite remote sensing collects multispectral, multiresolution and multitemporal data, and turns them into information valuable for understanding, monitoring land processes and land cover datasets. Remote Sensing application at Razzaza–Habbaria area southwest of Razzaza Lake (Figure 3 and Table 1) shows the different geomorphologic units maps (Figure 3-B) that were delineated from Landsat ETM+ Image(Figure 3-A), for Razzaza – Habbaria area on the south western side of Razzaza Lake. Digital Image classification for wadi Habbaria flood plain area (Faidat) was studied. As known there are two methods of digital image classification, supervised, and unsupervised classifications, the most suitable classifications which carried out in wadi Habbaria flood plain area (Faidat) is the unsupervised classification to delineate the different classes by applying ERDAS 8.4 software. ISODATA (Iterative Self Organizing Data Analysis Technique) was applied to classify the Landsat image. According to this classification five classes were selected and delineated in different colors (Figure 4). Brownish color, represent the higher topographical situated parts, mainly composed of desert sand and line gravels mixed with gypsiferous soil in small patches . Yellowish color, represent the most eroded area in the steep slope parts affected by showers of rainfall water, there are coarse deposited materials of pebbles and gravels in the flat regions and these regions are more permeable for the limited showers of rainfall. Reddish color, this class represents the course soil material mixed with small rock eroded deposits (rock cuttings or breccias) and pebbles with natural vegetation after rainy season from geomorphological point of view called valley filling deposits.

1- Blush color, this class area composed of medium to fine soil materials (with silty clay loam and sandy clay loam texture) this area is the most cultivated with wheat and barley.

2- Greenish color, this class mostly with fine soil texture (silty clay and clay loam) with more moist to wet soil (depressions deposits)

Finally, the Landsat Image shown in Figure 5 is with edge enhancement to recognize the Faidat Habbaria and the three alluvial fans of Mudaisses Shabwan and Abu Ghar valleys. The Sabkha areas were recognized within the blue color inside the Faidat Habbaria (Figure 5), and to the south of Obaied valley the area between Shabwan and Obaied and the area between Shabwan and Abu Ghar all of these Sabkha area are to the west of Faidat Habbaria the dark black color represent the highest elevations in the study area and the escarpment with the reddish brown color.

Many geomorphologic features were considered within Faidat Habbaria or Nukhaib depression. This Faidat or depression is a collective area for all around valleys, where all the valleys' flow direction in the studied area are toward this depression such as Tabal valley Mudaisses Abu Ghar, Shabwan, Duwakhla, this depression bounded from the south by Obaied valley of North – south direction. The sediment of Faidat Habbaria is composed of clayey, silty, fine sand deposits in the centre with gravelly on the edges of the depression. There is a positive relation between this depression and Obaidat, Ghader Sheikh and Tabal valleys' faults from the west boundary of the depression and Shinan, Adma and Zarka faults from the east boundary. The water erosion considered to be of importance in the area, such as the Sheet Erosion that affected the soil surface and covered the plateaus in the area, while the Rill Erosion is considered very active in all parts of the study area, depends on the rock hardness. However, all the sedimentological processes play a great role in the area, such as the weathering, transportation and deposition processes, therefore many erosional features may recognized with the area, such as the Erosional plains with rock fragment within its sediments, with some geomorphologic features such as Mesa and Butt.

The main valleys within Faidat Habbaria or Nukhaib depression were classified to:

1- Consequent primary valleys such as Obaied, Tabal, Mudaisses, Abu Ghar, Shabwan and Duwakhla

2- Subsequent valleys such valleys depend on the hardness of the outcropped rock beds or they are elongated within the low hardness and friable rocks beds, such as the drainage valley of the main valleys of Duwakhla, & Mudaisses.

3- Resequent valleys which are constructed randomly in all directions depending on the local slope of the area.

4- Obsequent valleys which are those valleys that flow in opposite direction to the main valleys' flow directions. i.e., against the general slop of the rock beds.

Also, there are many other geomorphological features such as:

- The Escarpments with slopes more than 40 degrees. There are two types of Escarpments, Fault Scarps and Erosional Scarps that may found within the Obaied valley with north-south direction and southwest of Tabal valley.
- Bad land, which may represent a plateau divided by deep valleys with steep slopes.
- Pediment, that exists in area restricted between the mountainous regions, river valley and the plains with low slope of 1 to 7 degrees with general slope not more than 2.5 degrees, the pediments recognized

within the northern and western parts of the study area

- Hamad which is those area with out sand and distributed on vast areas, recognized on the eastern part of Habbaria area.
- Sareer which is desert plain composed of gravels and rock fragment that affected by the deflation processes which recognized to the east of Habbaria composed of chert and other silicate minerals.

There are also the depositional geomorphology features such as Flood Plains, River Terraces, Alluvial Fans or Bajadas and Valley Deposits. Moreover, the Karistified features such as sinkholes (Dolin, solution sinks and collapse sinks) some of the collapse sinkholes may joint each other to form gradational large sinks called (Uvula) that range in depth from 3-70m, as shown in the Geomorphologic maps for the study area of Razzaza – Habbaria that were constructed from the different satellite images (Figures 6 -14).

The results of the mapping are summarized in a generalized manner as quantitative data are tabulated in Table 1. Results at the reconnaissance level quantitatively describe the geographic distribution of major landforms and dominant land cover as indicated in Figure 3-A and B.

Table-1: Digital image classification and field description of the different units in map (Figure 3-B) obtained from Satellite Image (Figure 3-A) of South western Razzaza Lake.

%	Unit No	Physiographic From	Cross-sectional from	Drainage form	Gully form & Erosion form	Vegetation and land use
2.53	1	Basin	Flat,concave 1%	Sub parallel & Artificial	Saucer deposition	Orchard (date palm)
3.28	2	Basin	Almost flat 1-2%	Dendritic & Sub parallel	u-shaped	Abandoned land with spot land and crop
6.06	3	Depression flood plain	Level 1%	Freely pattern & sub parallel	Slightly sheet erosion	Cultivated with salt Affected land
14.8	4	Pediment	Undulating 2-3%	Multi basinal & collinear	u-v shaped & with rill erosion	Grass land & crop land
40.6	5	Plateau	Undulating 2-6%	Gullied and dendritic	v-shaped & channel erosion	Pasture land and scattered vegetation
7.9	6	Valley	Related with stream action	Surface stream	v-u shaped & channel erosion	Partly cultivated
8.4	7	Pediment	Undulating 2%	Radial and sub dendritic	Slightly eroded phase	Grass land & crop land
12.6	8	High basin & terraces	Almost flat < 2%	Dendritic & sub parallel	Slightly eroded phase	Mixed land & quarries &gravel pits
2.4	9	Alluvial plain with alluvial fans	Almost flat 1-2%	Parallel & divergent	Slightly sheet Erosion	Pasture land & grass land
1.7	10	Depressed plain(lowland)	Flat or concave relict	Low dendritic and radial	Fluviatile deposits	Crop land and date palm

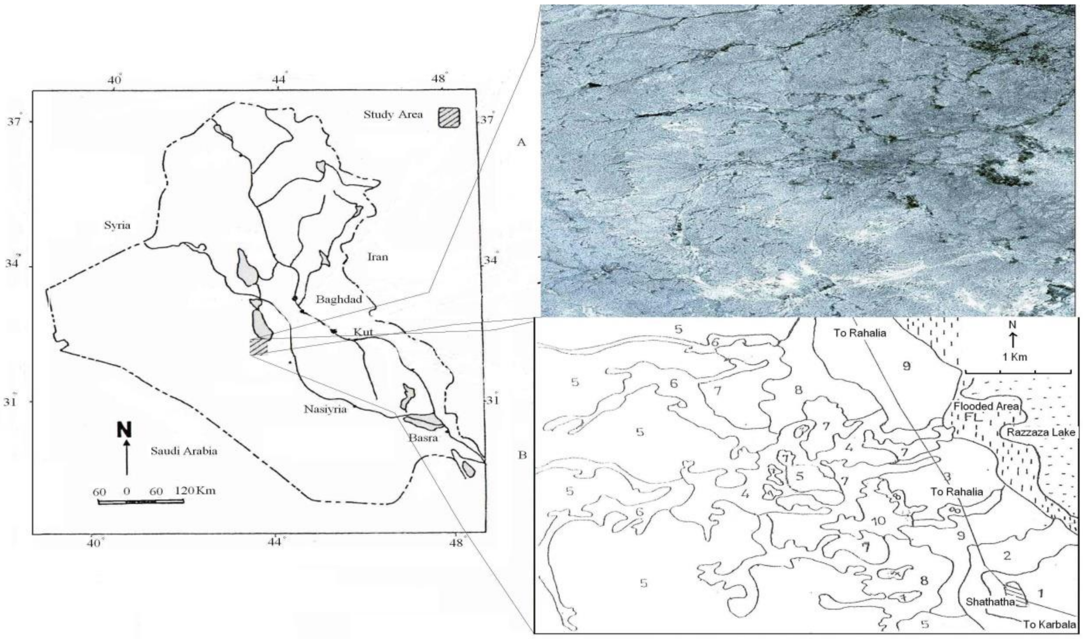

Fig. 3: Geomorphologic map Obtained from Land Sat Image of Southwestern Razzaza Lake, A- Corrected Landsat Image ETM+ merged with 15 meter resolution for Razzaza –Habbaria Area. B-Different Land cover units delineated from classified Land sat ETM+ Image [3].

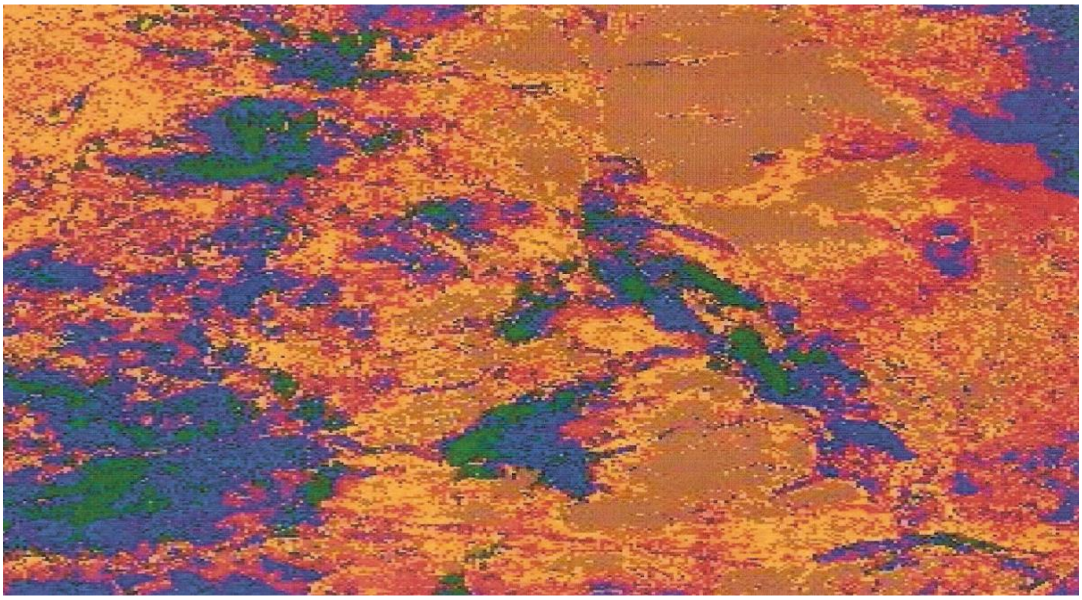

Fig. 4: Landsat ETM+ image with unsupervised classification (ISODATA) for wadi Habbaria flood plain area (Faidat), using ERDAS 8.2 version software [5].

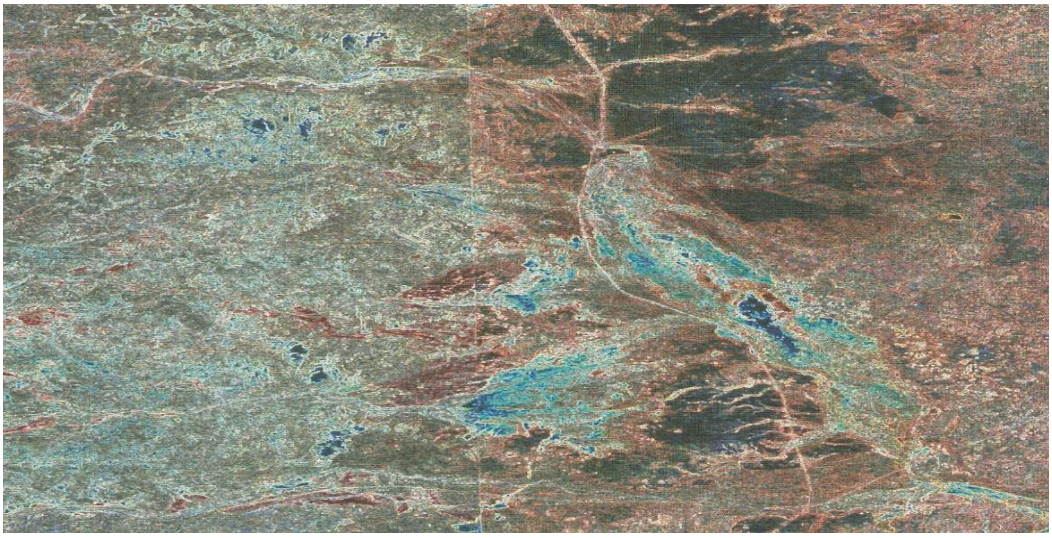

Fig. 5: Edge Enhancement land sat + ETM image for Habbaria flood plain area (Faidat) [5].

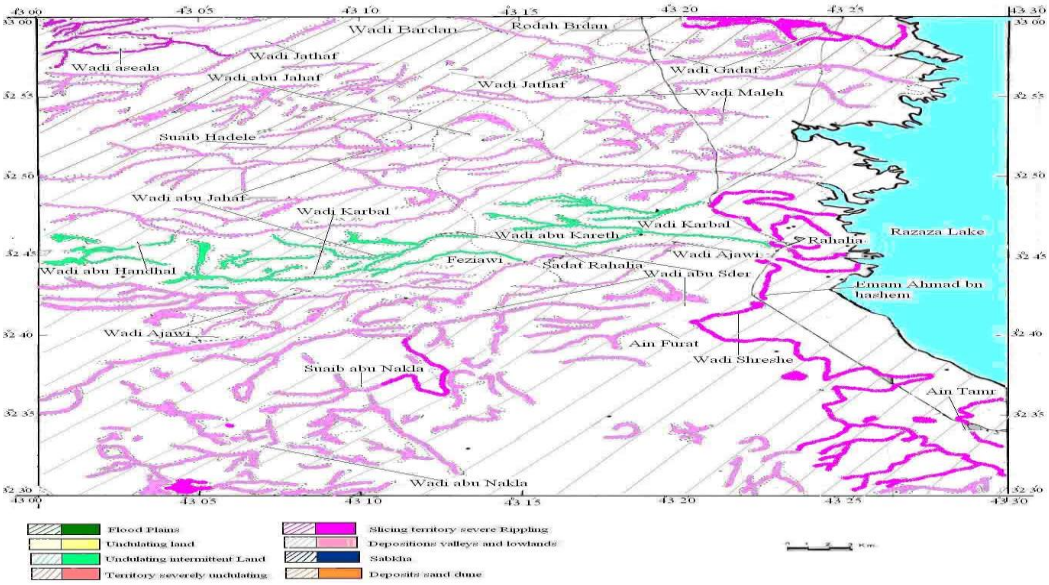

Fig. 6: Geomorphologic Map Wadi Abu Nakla.

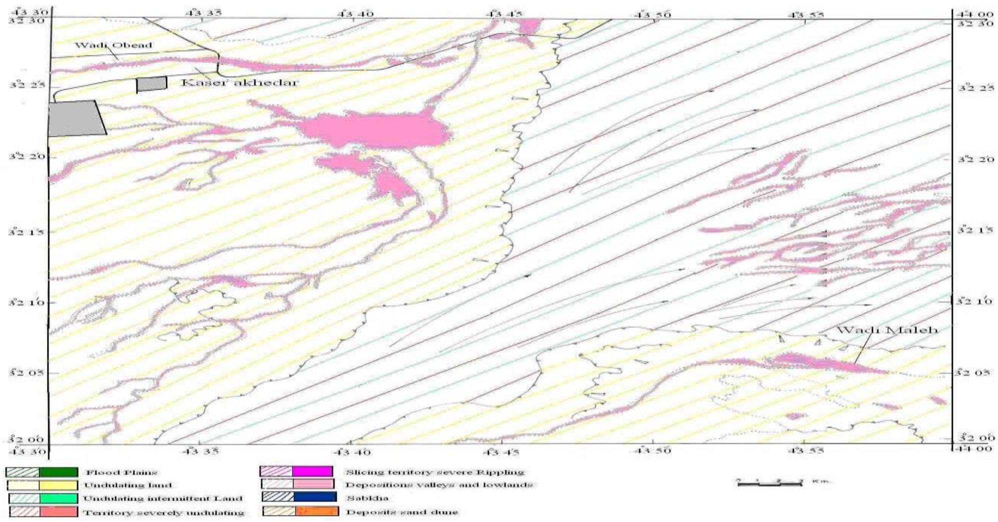

Fig. 7: Geomorphologic Map of Ukhader.

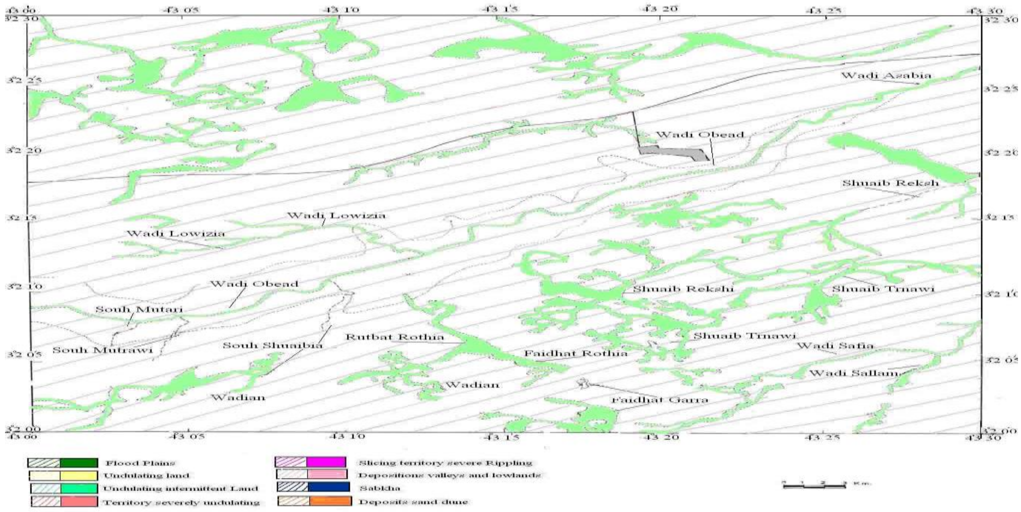

Fig. 8: Geomorphologic Map of Shuaib Trnawi.

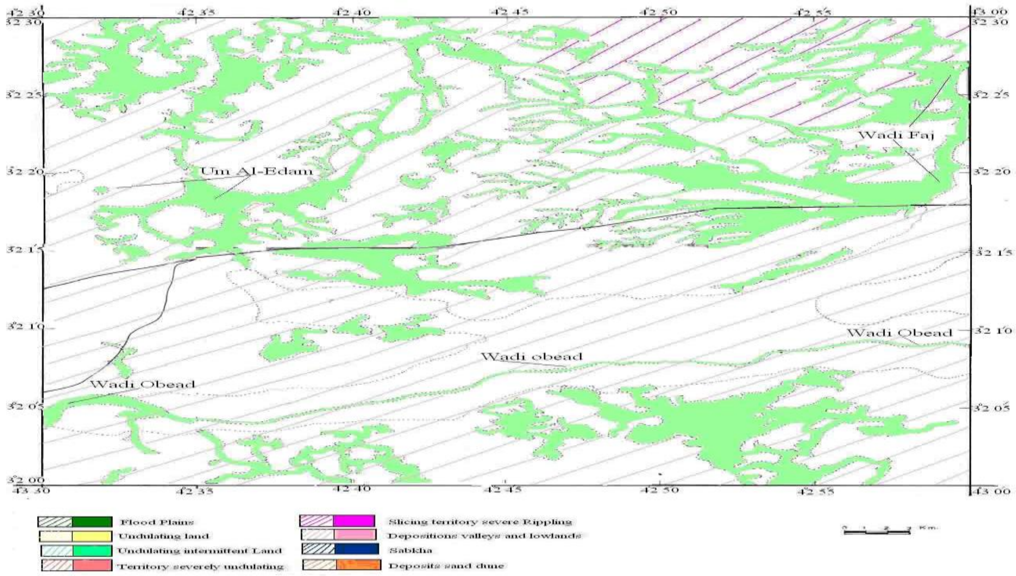

Fig. 9: Geomorphologic Map of Um Al-Edam.

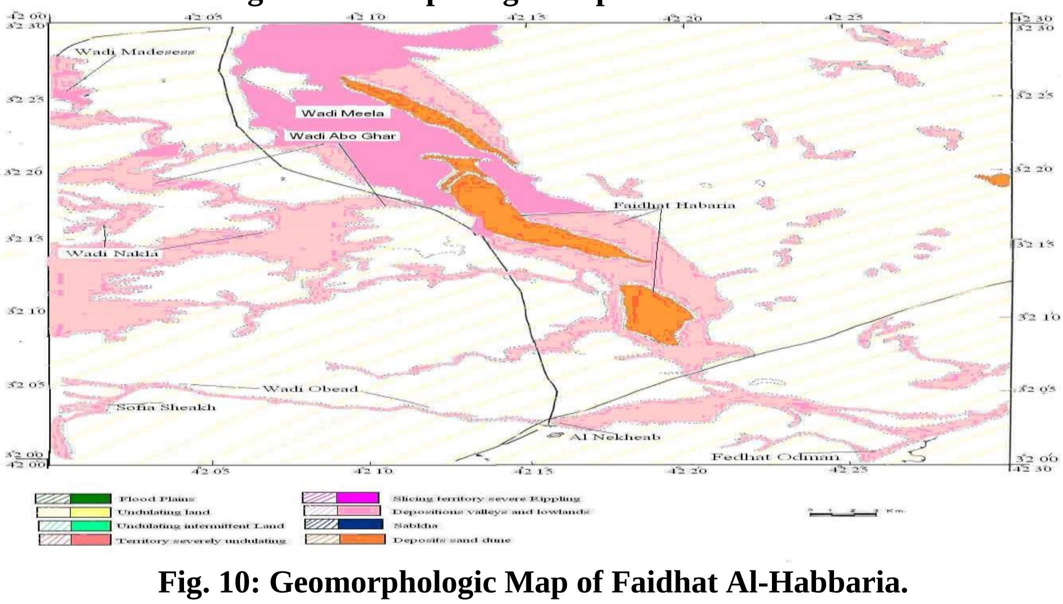

Fig. 10: Geomorphologic Map of Faidhat Al-Habbaria.

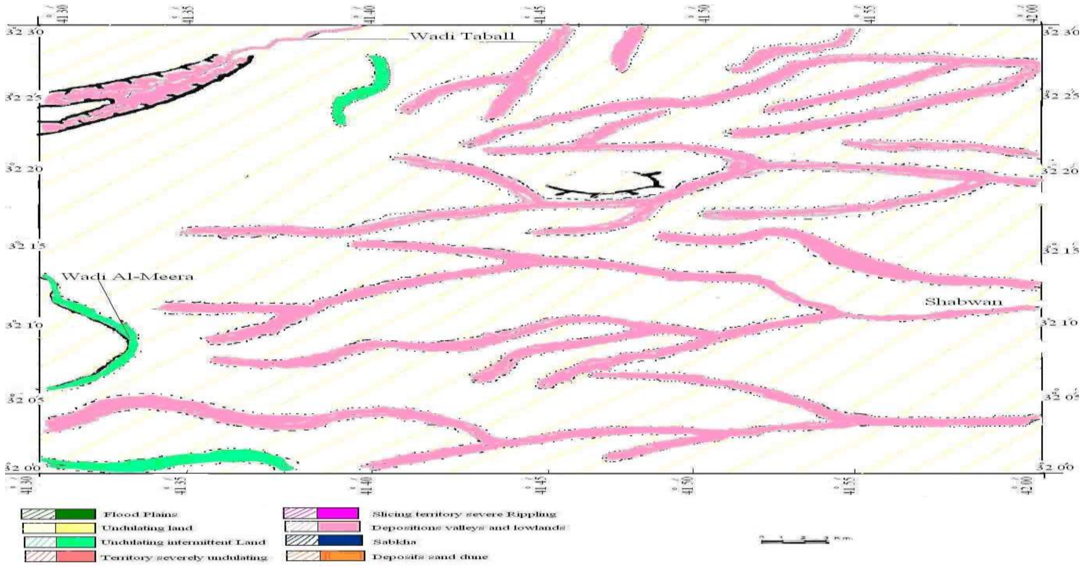

Fig. 11: Geomorphologic Map of wadi Al-Meera.

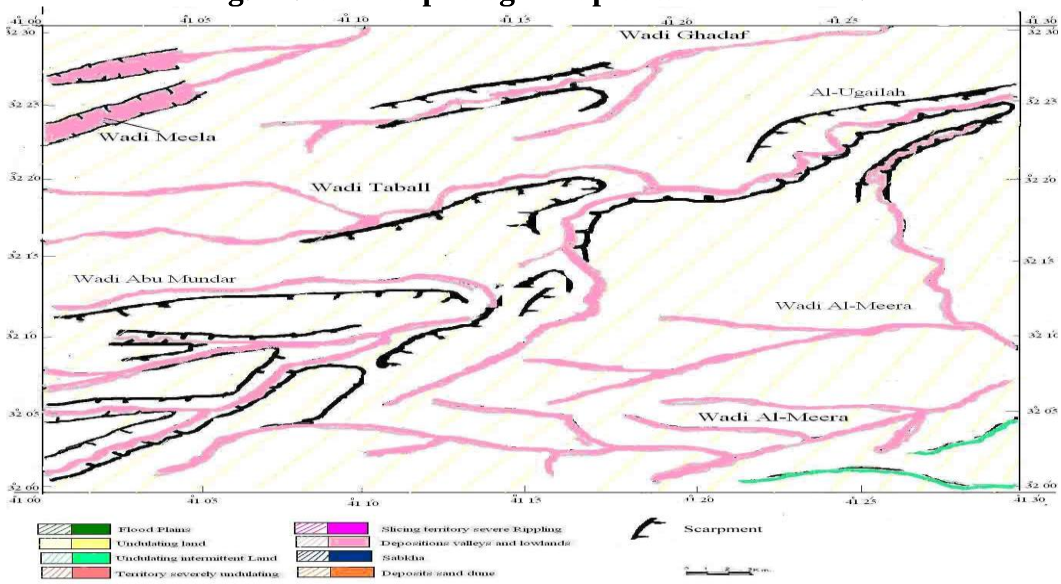

Fig. 12: Geomorphologic Map of Wadi Taball.

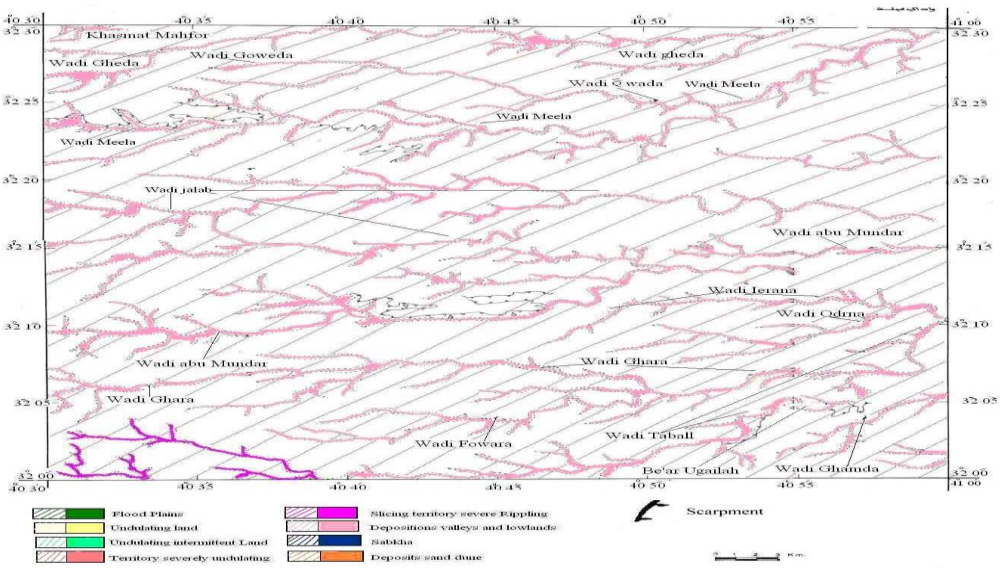

Figure 13: Geomorphologic Map of Meela.

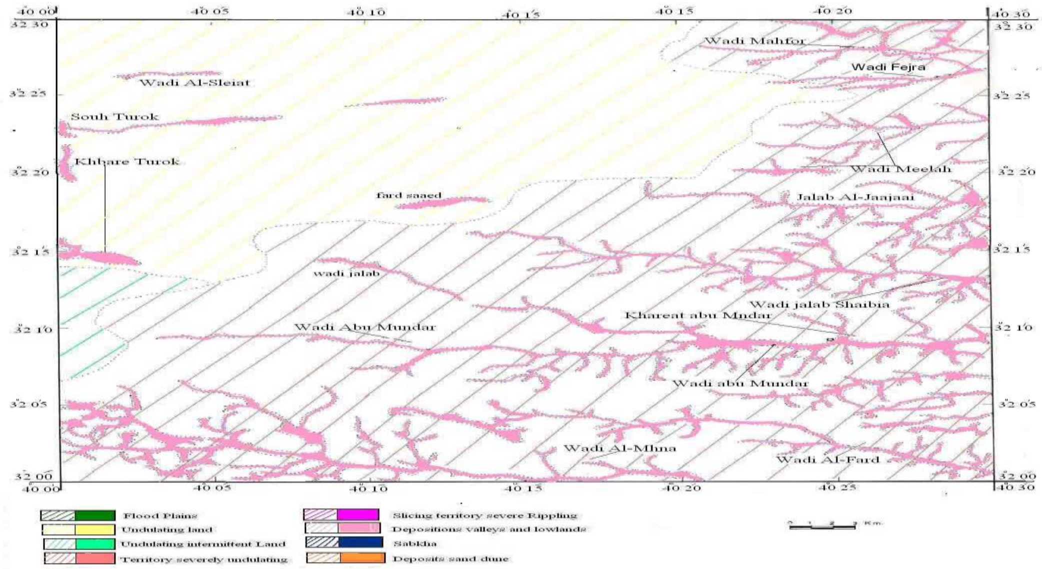

Figure 14: Geomorphologic Map of Wadi Abu Mundar.

Conclusions:

Geomorphologic maps are needed at a variety of scales due to the surface materials, topography constrain, numerous chemical, biological, meteorological and lithospheric processes. Numerous multi-scale topographic effects influence forcing factors and environmental change. Consequently, geomorphologic maps are essential for assessing and managing natural resources and promoting sustainability. Given this objective, numerous advancements in geospatial technologies have occurred. Standard location information and land-surface measurement technologies permit a wealth of information to be generated regarding the spatio-temporal nature of planetary surfaces. Access to information has increased dramatically, greatly facilitating analysis and mapping efforts. Cartography is experiencing an important change with the introduction of computer systems and digital images (GIS, satellite images). In particular in Earth Sciences, Geomorphologic mapping begins to benefit from the digitalization of information. Identification of landforms using key interpretation features such as image tone, texture, association and terrain shadow was demonstrated.

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الخرائط الجيومورفولوجية لمنطقة الرزازة-هبارية باستخدام تقانات التحسس النائي

معتزعبد الستار الدباس* **حسين زيدان علي ****

*كلية العلوم، جامعة بغداد
**وزا رة العلوم والتكنلوجيا، بغداد، العراق

الخلاصة:

أن إنتاج الخرائط و مراقبة ألإشكال ألارضية على سطح ألأرض تكون ذات تكلفة عالية. إن المراقبة باستخدام التحسس النائي من مركبة فضائية تزودنا بصورة لمشهد شمولي للأرض. إن بيانات الأقمار الاصطناعية المتعددة القنوات لها فائدة بحيث إن بيانات الصورة في الحزم المختلفة يمكن تعريضها إلى تقانات التحسس النائي الرقمية لغرض إظهار التباين في الأجسام لغرض تحسين قدرة التفسير للصورة. تتضمن عملية إنتاج الخرائط الجيومورفولوجية تقسيم ألأرض إلى حقائق مكانية مستندين على معايير باستخدام تقانات تصنيف الصورة الرقمية لبيانات الأقمار الاصطناعية. يوضح هذا البحث كيف إن مقتربات مثل الجيومورفولوجي و إنتاج الخرائط يمكن أن تستخدم للحصول على معلومات جيومورفولوجية لها علاقة مع سطح ألأرض و ألإشكال ألأرضية و ألأنظمة الجيومورفية باستخدام تقانات تصنيف الصورة الرقمية لبيانات الأقمار الاصطناعية. بينت تطبيقات التحسس النائي في منطقة ألرزازة-الهبارية جنوب غرب بحيرة الرزازة وجود عدة وحدات جيومورفولوجية مختلفة، و التي تم تحديدها من صور لاندسات المتحسس ألغرضي المحسن. تم اتخاذ تصنيف الصورة الرقمية غير المراقب لتحديد أصناف مختلفة بتطبيق برمجيات ايرداس النسخة 8.4 . بموجب هذا التصنيف تم اختيار خمسة أصناف و تم تحديدها بألوان مختلفة.

الكلمات المفتاحية: جيومورفولوجي ، لاندسات ، تحسس نائي ، رزازة- هبارية.