Maps of spatial relationships between slopes and some land uses in the Sarsank district using remote sensing and geographic information systems

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Abstract

The research aims to reveal the spatial relationship between the slopes and some land uses in the Sarsank region using remote sensing and geographic information systems techniques, and the research has relied on the digital elevation model (DEM) to derive the geomorphological information of the slopes of the study area, as well as the wave classification of the space visual (Landsat8) for the purpose of obtaining the most important uses of the land in the area and calculating its area and percentages and knowing its relationship with the slope, and showed through the classification of the space visual of the study area the small residential areas agricultural compared to pastoral areas is due to the conversion of many of the lands of the region that are difficult to exploit for residential and agricultural uses into pastoral land because of the obstacles that the slopes pose to their exploitation for residential and agricultural uses.

Keywords: *Regression, Yonk Classification, Human Settlements, Land Uses, GIS.*

Introduction

The study of land slopes has occupied the attention of geomorphologies as it is one of the most widespread terrestrial manifestations in nature and one of the most important geomorphological systems because it is a system that is very sensitive to any environmental variables .The slope systems and the nature of the weathering and erosion factors prevailing in them are an influential factor in determining the land system and the extent to which this system is optimally usable, as the nature of the slopes contributes to determining the possibility of the planned land to benefit from it in order to achieve development, and through the study of slopes can identify lands exposed to erosion and that have the ability to develop investment such as places of human settlements and determine the optimal path of the main roads depending on the data of the slope classifications. The Digital Elevation Model (DEM) was relied upon to derive geomorphological information for the slopes of the study area, as well as the wave classification of space visualization (Landsat8) for the purpose of obtaining the most important uses of the Earth in the Sarsnik region, calculating its area and percentages, and knowing its relationship with the slope.

1. The problem of study.

The main research problem is the following question (Is there a relationship between slopes and some land uses in Sarsank district? and what is the feasibility of using GIS software in achieving the objectives of the current study)

2. Hypothesis of Research

The research assumes that there is a relationship between the slopes and some land uses in the area of Sarsank and for the purpose of clarifying this relationship the process of matching the slope according to the classification of Yonk being one of the most realistic, appropriate and representative classifications of the slopes of the study area with land uses, and modern geographical techniques are one of the most efficient scientific means due to their availability of effort, time and accuracy in extrapolating accurate information about the land slopes in terms of formal characteristics and classification and their reflections on the natural and human sides.

3. Importance of Research

The importance of the research comes from the fact that it highlights one of the important topics in geomorphology if not the most important originally, as the regressive characteristics have a prominent role in the implementation of many different development projects, as well as the importance of this study in highlighting the role of modern geographical technologies represented by remote sensing and geographic information systems in the study of the spatial relationship between slopes and some land uses.

The area is of a mountainous nature and is characterized by its varying slopes, which gives the researcher the opportunity to study and analyze.

4. Objective of the study

The research aims to prepare maps of the spatial relationships between slopes and some land uses in the Sarsank district using remote sensing and GIS techniques.

5. Methodology of study

The study relied on the analytical approach and the quantitative approach that depends on quantitative measurement, that is, on quantitative variables using the language of numbers so that the results of the study are accurate, and the cartographic approach in drawing all the maps of the current study as well as the descriptive approach.

6. Boundaries of study area

The study area is located in the northern part of Iraq, within the Amadiya district of Dohuk Governorate, bordered to the east by the center of the Amadiya district, to the northwest by Sindi district, to the west by its corner, while to the south by Nineveh Governorate and to the southeast by Erbil Governorate.

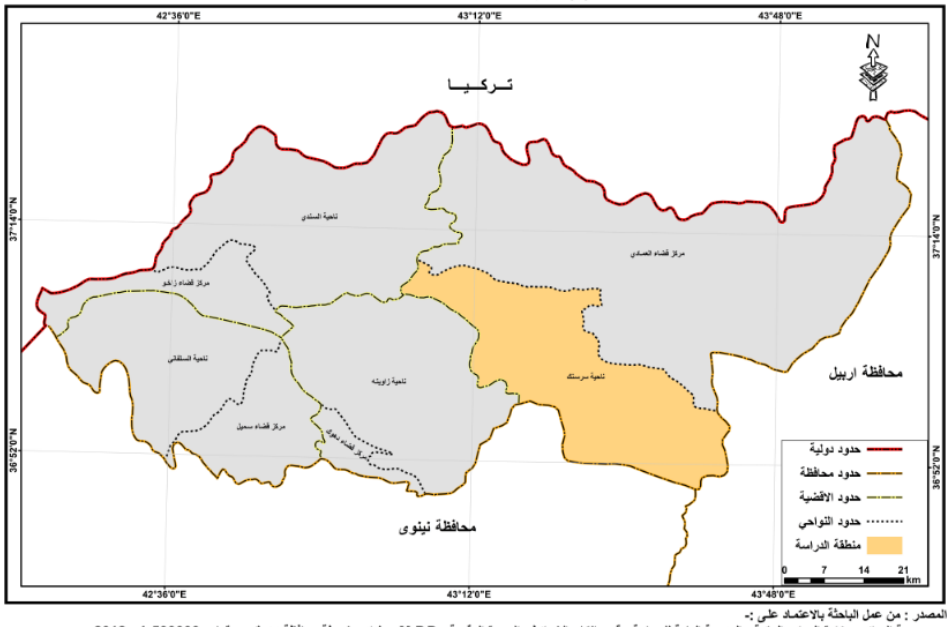
And the area extends astronomically between my circles. Width (40" 49' 36º and (7" 11'37º) North, longitudes (51" 3'43º and (34" 42' 43º) East, map (1), and the area of the study area is about (940.12) km2.

First: Classification of land uses and land cover in the study area

Surveying, inventorying and classifying land uses and land cover is an essential step in the process of planning and evaluating land uses, comparing alternatives and choosing the optimal and sustainable use of land with a view to achieving development The classification of land uses consists in the inventory of all types of land uses that include used and unused land by classifying them into categories, grades and levels indicating their types and areas, thus being an important tool for the establishment of a broad database that is useful in the assessments and planning of available and potential resources for any area, supported by remote sensing techniques, which are one of the important means used today in surveying land

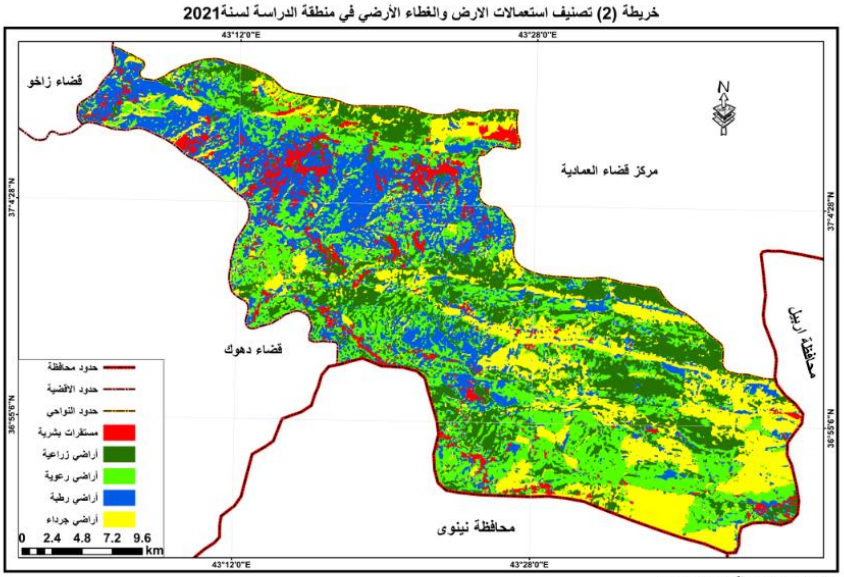
cover and land uses of both rural and urban quality because of the characteristics of it has a great speed, comprehensiveness and frequency of time in providing a realistic and vivid picture of the problems suffered by land uses in the studied areas and through the huge amount of information they provide and at different scales commensurate with the desired goal of the survey .The space visualization of the study area has been classified and the researcher has adopted the wave classification of the Earth's uses on the space visualization of the Landsat-8 satellite based on the Ecological Landuse .Classification in order to represent the reality of the Earth's uses in the study area and for the purpose of knowing the impact of the declines on the distribution of these uses Map (2), Table (1).

خريطة (1) موقع منطقة الدراسة من محافظة دهوك



المصدر : من عمل الباحثة بالاعتماد على :-
- جمهورية العراق ، وزارة الموارد المائية ، المديرية العامة للمساحة ، قسم إنتاج الخرائط ، الوحدة الرقمية ، M.P.D ، بغداد ، خريطة محافظة دهوك ، بمقياس 1:500000 ، 2012 .

خريطة (2) تصنيف استعمالات الارض والغطاء الأرضي في منطقة الدراسة لسنة2021



المصدر : من عمل الباحثة بالاعتماد على :-
- المرئية الفضائية للقمر الصناعي (Landsat 8) الباند(2،3، 4) ، وباستعمال برنامج (Arc GIS 10.4.1)

Table (1) Classification of land cover and land uses in Sarsang district

percentage%	Area / km2	Classification type	s
5.72	**53.82**	human settlements	**1**
20.70	**194.59**	agricultural land	**2**
27.07	**254.49**	grazing land	**3**
24.42	**229.55**	wetlands	**4**
22.09	**207.67**	barren lands	**5**
100	**940.12**	**Total**	

Source: From the researcher's work based on map (2) and using the Arc GIS 10.4.1 program.

By classifying the satellite visuals of the study area, it was found that human settlements occupied an area of (53.82 km2) and a percentage of (5.72) of the total area of the study area, while agricultural land uses occupied an area of (194.59 km2) and a percentage of (20.70) of the total area of the study area. It occupied an area of (254.49 km2), or (27.07) of the total area of the study area, while the uses of wet land occupied an area of (229.55 km2), or by (24.42) of the total area of the study area, and the uses of the barren land occupied an area of (207.67 km2), with a percentage of (22.09) of the total area of the study area. As for the transportation routes, they extended for varying distances, with a total length of 281 km. The roads are affected by the presence of mountain slopes, such as the slopes of Jabal Kara, Matin, Jumanki and Kiri Rabtixi, which affect their straightness and prevent them from taking straight paths. It was shown through the results of the table (1) The smallness of the residential and agricultural areas compared to the pastoral areas, due to the conversion of many of the lands of the region that are difficult to exploit for residential and agricultural uses into pastoral lands because of the obstacles posed by the slopes It prevents its use for residential and agricultural uses.

Second: The distribution of human settlements

Regressions affect the distribution of the population in different geographical environments and this varies from one region to another and from one place to another depending on the spatial importance provided by the location of these settlements in terms of the morphology of the landscape and natural resources, as there is an inverse relationship between the degree of regression and the distribution of human settlements, as the distribution and pattern of settlements are affected And its size with a large degree of surface slope, and for the purpose of clarifying this relationship, a map of human settlements was derived through the classification of satellite visuals and matching this map with the regression map of the study area according to the classification of Young, Map (3), Table (2), which are as follows:

1. The lands of the sloping category, whose slope angles range between (0˚-2˚), the residential area was (2.12 km2) and a percentage (3.94) of the residential areas within the study area, which is a small percentage, because this category includes the plain lands, but it has invested in Agriculture, especially demographic agriculture.

2. Lands of the sloping category, whose slope angles range between (2˚-5˚), have formed an area of (12.54 km2), or 23.30 of the total area for residential use.

3. The lands whose slope angles range between (5˚-10˚) recorded the highest residential investment rate as it amounted to (18.73 km2) and a percentage of (34.80) of the residential

areas within the study area, due to the suitability of this regressive category to the housing conditions and ease of use.

4. The lands whose slope angles range between (10˚-18˚), as the residential area constitutes (12.75 km2) and a percentage of (23.69) of the residential areas within the study area, and thus constitutes the second highest percentage of residential use within the region and these areas have been exploited In a way that adapts to the nature of its slopes, and its investment came due to the increase in the population, so that they can exploit the less sloped lands in the agricultural field.

5. The lands whose slope angles range between (18˚-30˚) the residential area was (6.46 km2) and (12.00) of the residential areas within the study area.

6. The lands of the regressive category, whose slope angles range between (30˚-45˚), the residential area was (1.14 km2) and a ratio of (2.12) of the residential areas within the study area, as human settlements began to decline in their sizes with the increase of the slope angles due to their ruggedness It is difficult to use in residential use.

7. The lands with a sloping category more than (45˚) had a residential area of (0.08 km2) and a percentage of (0.15) of the total residential areas within the study area, which is a small percentage, due to the complexity of its terrain and the difficulty and costs of its residential exploitation. It is clear from the foregoing that there is an inverse relationship between the degree of slope and the distribution of human settlements, as the increase in the number of settlements and their large size are related to areas with a slight slope, either areas with a severe slope are characterized by the absence of settlements due to the severity of their gradient and its freezing cold and the accumulation of snow, which constitutes an obstacle to the movement of the population and this led to leave the steep slopes and resort to the light slopes, and this is what was seen during field work.

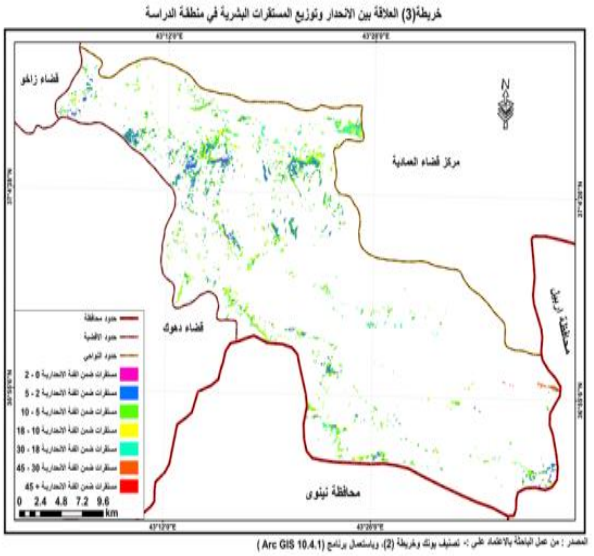


Table (2) The relationship between the regression and the human settlements of Sarsang district

percentage%	Occupied area / km2	sloping angles	s
3.94	**2.12**	Flat ground 0˚-2˚	**1**
23.30	**12.54**	Simple slope 2˚- 5˚	**2**
34.80	**18.73**	Slope 5˚-10˚	**3**
23.69	**12.75**	Moderate terrain 10˚-18˚	**4**
12.00	**6.46**	Steep terrain 18˚-30˚	**5**
2.12	**1.14**	Very steep terrain 30˚- 45˚	**6**
0.15	**0.08**	Cliff land 45˚+	**7**
100	**53.82**	**Total**	

It is clear from Table (3) that the total number of urban population in the study area for the year 2022 was about (18,718) people, while the total number of rural population reached about (7,558) people, while the total population of the study area (urban / rural) reached about (26,276). breeze.

Table (3) Population of the study area for the year 2022

Total			countryside			civilize			side	s
Total	female	male	Total	female	male	Total	female	male		
26,276	13,108	13,168	7,558	3,760	3,798	18,718	9,348	9,370	Sarsang	1

Source: From the researcher's work based on the Kurdistan Region Statistics General Authority, unpublished data for the year 2022.

Third: Use of the land in agricultural activity

The concept of agricultural land uses is a broad concept and contains many opinions, but everyone agrees that it is the interactive relationship between man and the geographical theater in which man exercises his activities, which is the land and the use of land is a function of the variables (land, water, air and man) and the product of their interaction is called land uses

The agricultural activity is one of the important activities in the study area, despite the small areas exploited in agriculture, due to the presence of large slopes in most of the topography of the region, as well as the mixed and rocky soils and the severity of water erosion in the slope areas.

In order to clarify the relationship between land regressions and agricultural activity, the regression map according to the classification of Young was matched with the map of the classification of land cover in order to identify the impact of regression on the distribution of agricultural lands and to arrive at the places of distribution of these lands according to the regressive categories, map (4), table (4), which is as follows:

1. Lands of the sloping category whose slope angles range between (0˚-2˚) occupied an area of (1.79 km2) and a percentage (0.92) of the total agricultural lands within the study area. This category includes plain lands and valleys that invested in agriculture, especially permaculture.

2. The lands of the regressive category whose slope angles range between (2˚-5˚) constitute an area of (9.3 km2), or 4.78 of the total agricultural area in the study area.

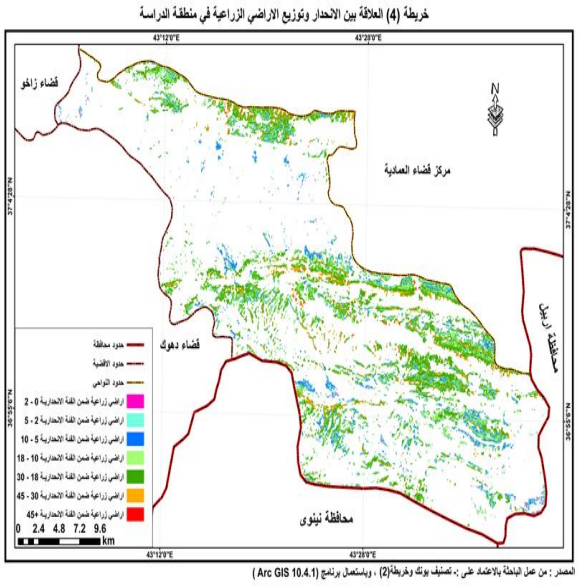
3. The lands whose slope angles range between (5˚-10˚) has reached an area of (26.59 km2) and a percentage of (13.66) of the total agricultural lands in the study area.

4. The lands whose slope angles range between (10˚-18˚) formed an area of (63.78 km2) and a percentage of (32.78) of the total area of agricultural lands in the study area, and thus constitute the second largest agricultural area in the region.

5. The lands whose slope angles range between (18˚-30˚) occupied an area of (72.25 km2) and a percentage of (37.13) of the total area of agricultural lands in the region, which is the highest percentage, as it was invested by relying on contour agriculture and terraces.

6. The lands of the regressive category, whose slope angles range between (30˚-45˚), the agricultural area in which was (19.9 km2) and a percentage of (10.23) of the total agricultural lands within the study area, and thus the agricultural lands began to decline compared with the other regressive categories, and the reason for This is due to its ruggedness and the difficulty of expanding its agricultural activity.

7. The lands with a regressive category more than (45˚) recorded the lowest areas, as their area reached (0.98 km2) and (0.50) of the total agricultural areas. Map (4), Table (4). Agricultural activity almost disappears within the study area due to the nature of this Its steep slopes.



Source: From the researcher's work based on map (4) and using the ArcGIS 10.4.1 program.

Table (4) The relationship between the regression and the distribution of agricultural land in Sarsang district

percentage%	Occupied area / km2	sloping angles	s
0.92	**1.79**	Flat ground 0˚-2˚	**1**
4.78	**9.3**	Simple slope 2˚- 5˚	**2**
13.66	**26.59**	Slope 5˚-10˚	**3**
32.78	**63.78**	Moderate terrain 10˚-18˚	**4**
37.13	**72.25**	Steep terrain 18˚-30˚	**5**
10.23	**19.9**	Very steep terrain 30˚- 45˚	**6**
0.50	**0.98**	Cliff land 45˚+	**7**
100	**194.59**	**Total**	

Source: From the researcher's work based on map (4), and using the ArcGIS 10.4.1 program.

Fourth: Land uses in pastoral activity

The natural pastures are of great importance in the production of pastures, medicinal and aromatic plants and fuelwood. The lands of the pastures are the main place for raising herds of livestock and contribute to maintaining the quality of the environment and providing possibilities for tourism and recreational activities (1), and may give the land appearance represented by the presence of wide plains and undulating lands at the feet of The mountain ranges and hills with the availability of rain characteristics of a pastoral character is widespread in the study area, in addition to that the areas with large slopes that are difficult to exploit in agricultural and residential activity are suitable for exploitation in the pastoral field. For the purpose of knowing the interrelationship between the land slopes and the pastoral activity, the regression map according to the classification of Young was

matched with the map of the classification of the land cover in order to identify the impact of the regression on the distribution of pastoral lands and to arrive at the places of distribution of these lands according to the regressive categories, map (5), table (5)) It is as follows:

1. The lands of the sloping category, whose slope angles range between (0˚-2˚), the area of pastures is (2.34 km2) and a percentage (0.92) of the percentage of pastures in the region, which is a small area due to the exploitation of these lands in residential and agricultural activities.

2. Lands of sloping category whose slope angles range between (2˚-5˚) constitute an area of (52.63 km2) and a percentage of (20.68) of the total percentage of pastures in the study area.

3. The lands whose slope angles range between (5˚-10˚) recorded an area of (20.58 km2) and a percentage of (8.08) of the total pastoral lands in the study area.

4. The lands whose slope angles range between (10˚-18˚) formed an area of (93.95 km2) with a ratio of (36.92), which constitutes the highest percentage of pastoral activity and the most exploited in terms of pastoral lands.

5. The lands whose slope angles range between (18˚-30˚) occupied an area of (70.67 km2) and a percentage of (27.77) of the total pastoral lands in the study area, and thus constitute the second highest percentage of pastoral activity in the region.

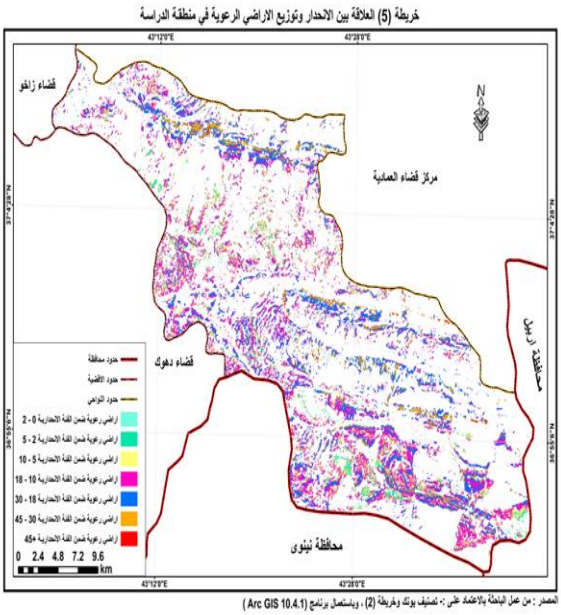
6. The lands of the regressive category, whose slope angles range between (30˚-45˚), the grazing area was (18.55 km2) and a percentage of (7.29) of the total grazing lands in the study area.

7. The lands with a sloping category more than (45˚) occupied an area of about (1.49 km2) and a percentage of (0.58) of the total pastoral lands and the area of the grazing lands may decrease, due to its complex surface and difficult access.

Table (5) The relationship between the slope and the distribution of pastoral land in Sarsang district

percentage%	Occupied area / km2	sloping angles	s
0.92	**2.34**	Flat ground 0˚-2˚	**1**
5.84	**14.86**	Simple slope 2˚- 5˚	**2**
20.68	**52.63**	Slope 5˚-10˚	**3**
36.92	**93.95**	Moderate terrain 10˚-18˚	**4**
27.77	**70.67**	Steep terrain 18˚-30˚	**5**
7.29	**18.55**	Very steep terrain 30˚- 45˚	**6**
0.58	**1.49**	Cliff land 45˚+	**7**
100	**254.49**	**Total**	

Source: From the researcher's work based on map (5), and using the ArcGIS 10.4.1 program.



المصدر : من عمل الباحثة بالاعتماد على :- تصنيف يونك وخريطة (2) ، وباستعمال برنامج (Arc GIS 10.4.1)

Fifthly, wetlands

Wetlands are transitional lands between terrestrial and aquatic systems, where water is near the surface or the land is covered with shallow water. For the purpose of clarifying the relationship between regressions and wetlands, the regression map according to the Young classification was matched with the map of the land cover classification in order to identify the effect of regression on the distribution of wetlands and to arrive at the places where these lands are distributed according to regression categories, map (6), table (6), which is as follows:

1. The lands of the sloping category whose slope angles range between (0˚-2˚) occupied an area of (4.94 km2) and by (2.15) of the total agricultural lands in the study area, and this category includes plain lands and small plains.

2. The lands of the sloping category whose slope angles range between (2˚-5˚) constitute an area of (3.32 km2) and a ratio of (1.44) of the total wet area in the study area.

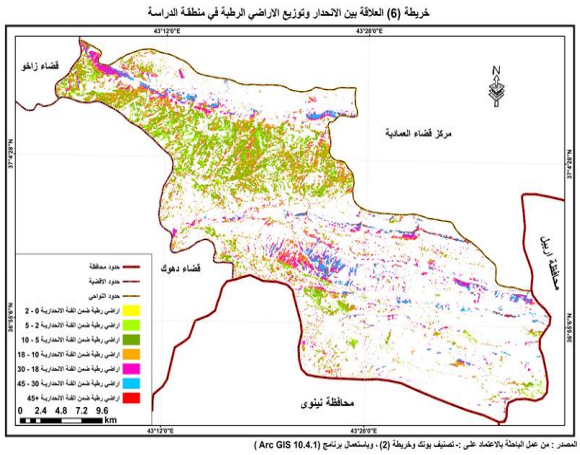
3. The lands whose slope angles range between (5˚-10˚) recorded an area of about (145.55 km2) and a percentage of (63.41) of the total area of wetlands in the study area, which constitutes the highest percentage of wetlands in the region.

4. The lands whose slope angles range between (10˚-18˚), which constituted an area of (5.34 km2) and a percentage of (2.33) of the total area of wet lands in the region.

5. The lands whose slope angles range between (18˚-30˚) occupied an area of (23.55 km2) with a percentage of (10.26) of the total wetlands in the study area. These lands may be distributed on the mountain slopes within the grooved erosion areas resulting from rain erosion.

6. The lands of the sloping category, whose slope angles range between (30˚-45˚), where the wet area was (43.65 km2) with a ratio of (19.02), which constitutes the second highest percentage of wet areas in the region and extends with the extension of the mountain slopes of each of the Kara, Matin and Warkin mountains And Sidra.

7. Lands with a sloping category more than (45˚) recorded the lowest areas, with an area of (3.2 km2) and a percentage of (1.39) of the total wet areas in the region. The mountain peaks are represented by Jabal Kara and Matin.



المصدر : من عمل الباحثة بالاعتماد على :- تصنيف يونك وخريطة (2) ، وباستعمال برنامج (Arc GIS 10.4.1)

Table (6) the relationship between the slope and the distribution of wetlands in Sarsang district

percentage%	Occupied area / km2	sloping angles	s
2.15	**4.94**	Flat ground 0˚-2˚	**1**
1.44	**3.32**	Simple slope 2˚- 5˚	**2**
63.41	**145.55**	Slope 5˚-10˚	**3**
2.33	**5.34**	Moderate terrain 10˚-18˚	**4**
10.26	**23.55**	Steep terrain 18˚-30˚	**5**
19.02	**43.65**	Very steep terrain 30˚- 45˚	**6**
1.39	**3.2**	Cliff land 45˚+	**7**
100	**229.55**	**Total**	

Source: From the researcher's work based on map (6), and using the ArcGIS 10.4.1 program.

Sixth: Barren lands

It is represented by rocky lands devoid of vegetation cover and lands with shallow soils scattered in the upper slopes within the mountainous and hilly lands, as these parts were exposed to active erosion represented by laminar and gully erosion. (Young) with a map of the classification of land cover in order to identify the effect of regression on the distribution of barren lands and to arrive at the places where these lands are distributed according to regression categories, map (7), table (7), which are as follows:

1. The lands of the sloping category, whose slope angles range between (0˚-2˚), recorded the lowest areas as they reached (0.82 km2) and a percentage of (0.39) of the total barren lands in the study area. This category includes the plain lands.

2. The lands of the regressive category whose slope angles range between (2˚-5˚) constitute an area of (5.44 km2), or a percentage of (2.62), of the total barren area in the study area.

3. The lands whose slope angles range between (5˚-10˚) recorded an area of (22.73 km2) and a percentage of (10.95) of the total area of barren lands in the study area.

4. The lands whose slope angles range between (10˚-18˚), as they formed an area of about (60.44 km2) and a percentage of (29.1) of the total area of barren lands in the region, which constitutes the second highest percentage of barren areas in the study area.

5. The lands whose slope angles range between (18˚-30˚) recorded an area of (77.41 km2) and a percentage of (37.28) of the total area of barren lands in the study area, and it occupies the first rank among the other regressive categories in the region.

6. The lands of the sloping category, whose slope angles range between (30˚-45˚), the area of the barren lands was (34.14 km2), with a percentage of (16.44) of the total barren lands in the study area and distributed with the extension of the mountainous slopes of each of the mountains of Kara, Matin, Warkin, Sidra and Khoshka and Keri Rapteksy.

7. The lands with a sloping category more than (45˚) have an area of (6.69 km2) and a percentage of (3.22) of the total barren areas. This is due to the nature of its large slopes and the nature of its highly complex terrain, as it spreads in the form of narrow bands on some mountain peaks represented by Jabal Kara and solid.

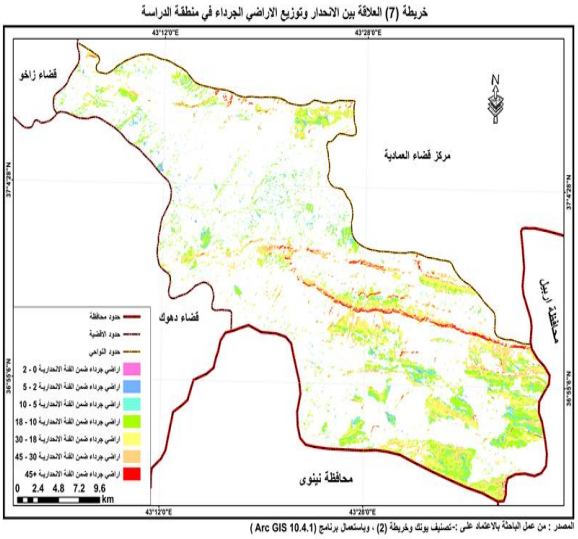
Table (7): The relationship between the slope and the distribution of the barren land in Sarsang district

percentage %	Occupied area / km2	sloping angles	s
0.39	**0.82**	Flat ground 0˚-2˚	**1**
2.62	**5.44**	Simple slope 2˚- 5˚	**2**
10.95	**22.73**	Slope 5˚-10˚	**3**
29.1	**60.44**	Moderate terrain 10˚-18˚	**4**
37.28	**77.41**	Steep terrain 18˚-30˚	**5**
16.44	**34.14**	Very steep terrain 30˚- 45˚	**6**
3.22	**6.69**	Cliff land 45˚+	**7**
100	**207.67**	**Total**	

Source: From the researcher's work based on map (7), and using the ArcGIS 10.4.1 program.

Seventh: Uses of the land in the field of transportation

Land uses for transportation purposes are considered essential in any region, as they are the feeding arteries that connect the various parts of the study area and their uses. When considering the construction of any road, a thorough study should be made of the nature of the slopes of the study area and their rock formations in order to avoid the risks and obstacles that obstruct the road. For the purpose of clarifying the relationship between the slopes and the main roads, the regression map according to the classification of Young was matched with the map of the classification of the land cover in order to identify the effect of the slope on the distribution of the main roads and to reach the places of distribution of these roads according to the regression categories, map (8), table (8), which are as follows:



1. The lands of the sloping category whose slope angles range between (0˚-2˚), the distance in which is (7.17 km) and at a rate of (2.55) of the total road distances in the study area, and this category includes the plain lands.

2. Lands of sloping category whose slope angles range between (2˚-5˚) constitute a distance of (46.09 km), or 16.4, of the total road distances in the study area.

2. The lands whose slope angles range between (5˚-10˚) recorded a distance of about (91.87 km) with a percentage of (32.69) and thus it occupies the second place in the longest distance of the extended roads within the regression categories in the study area.

3. The lands whose slope angles range between (10˚-18˚), as they formed a distance of about (96.88 km) and by (34.48), which constitutes the longest distance of the extended roads within the sloping categories in the study area.

4. The lands whose slope angles range between (18˚-30˚) recorded a distance of (35.62 km)

with a percentage of (12.68) of the total road distances in the study area.

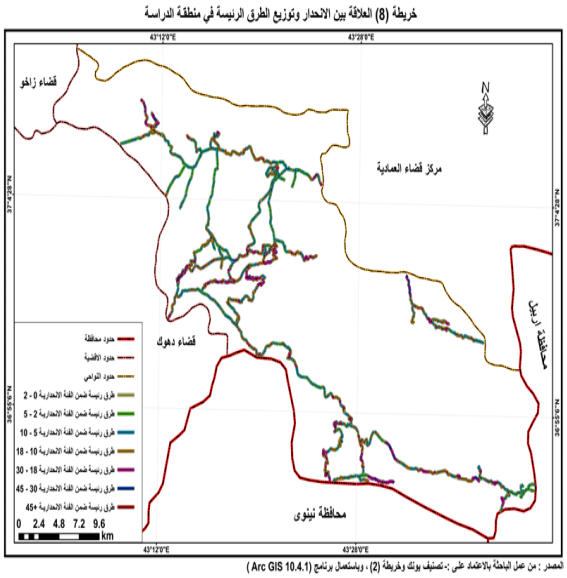
5. The lands of the sloping category whose slope angles range between (30˚-45˚), the distance of which was (3.28 km) and by (1.17), which is a small percentage compared to the other sloping categories. This is due to the rugged topography and its hard rocks, which leads to the difficulty of investing those lands to extend the roads.

6. Lands with a sloping category more than (45˚) recorded the lowest distances as it reached (0.09 km) and a percentage (0.03) of the total road total distance, due to the nature of its large slopes and the nature of its highly complex terrain.

Table (8) the relationship between the regression and the distribution of transport routes for Sarsang district

percentage%	Occupied area / km2	sloping angles	s
2.55	**7.17**	Flat ground 0˚-2˚	**1**
16.4	**46.09**	Simple slope 2˚- 5˚	**2**
32.69	**91.87**	Slope 5˚-10˚	**3**
34.48	**96.88**	Moderate terrain 10˚-18˚	**4**
12.68	**35.62**	Steep terrain 18˚-30˚	**5**
1.17	**3.28**	Very steep terrain 30˚- 45˚	**6**
0.03	**0.09**	Cliff land 45˚+	**7**
100	**281**	**Total**	

Source: From the researcher's work based on map (8), and using the ArcGIS 10.4.1 program.



Conclusions

1. It became clear by classifying the satellite visuals of the study area that human settlements occupied an area of about (53.90 km2), which is equivalent to (5.73) of the total area of the study area, while agricultural land uses occupied an area of (194.82 km²), which is equivalent to (20.72) of The total area of the study area, while the pasture lands occupied an area of (254.62 km2), which is equivalent to (27.08) of the total area of the study area, while the uses of wet land occupied an area of (229.08 km²), which is equivalent to (24.37) of the total area of the study area and occupied The barren land uses an area of (207.70 km2), which is equivalent to (22.1) of the total area of the study area. As for the transportation methods, they extended for varying distances, with a total length of (281 km).

2. It was found that there is an inverse relationship between the degree of slope and the distribution of human settlements, as the increase in the number of settlements and their large size are related to areas with a slight slope, either areas with a severe slope are characterized by the absence of settlements due

to the severity of their gradient and its freezing cold and the accumulation of snow, which constitutes an obstacle to the movement of the population and this led To leave the steep slopes and resort to the light slopes, and this is what was seen during field work.

3. By classifying the satellite visualization of the study area, it was found that the residential and agricultural spaces are small compared to the pastoral spaces, due to the conversion of many lands of the region that are difficult to exploit for residential and agricultural uses into pastoral lands because of the obstacles that the slopes pose to prevent their use for residential and agricultural uses.

4. The study revealed when matching the regression map according to Young's classification with the map of agricultural land uses that the lands whose slope angles range between (18˚-30˚) occupied an area of (72.25 km2) and a percentage of (37.13) of the total area of agricultural lands in the region It thus constitutes the highest percentage, as it was invested by relying on contour farming and terraces.

5. When matching the regression map according to Young's classification with the map of wetland uses, it was found that lands with a regression category of more than (45˚) recorded the lowest areas, as their area reached (3.2 km2) and a percentage of (1.39) of the total wet areas in the region. This is due to the nature of its large slopes and the nature of its highly complex terrain, as it spreads in the form of narrow bands on some mountain peaks represented by Jabal Kara and Mutin.

Recommendations

1. The necessity of paying attention to the afforestation and cultivation of mountain slopes by following the method of contour plowing and planting terraces because it provides protection for the slopes as well as benefiting from them in providing herbs to reduce the processes of soil encroachment and rockfall.

2. Choosing the most suitable lands within the appropriate sloping categories for establishing human settlements to reduce the material costs resulting from settling the steep areas.

3. The necessity of keeping human settlements away from the slopes that are characterized by their steep slope, in order to preserve them from the dangers of precipitation and rockslide.

4. The work of fenders and side walls (concrete, wood and mesh) on the sides of the roads, in addition to digging tunnels, making cement walls and barriers that prevent and limiting the fall of rock masses, and filling joints and cracks with cement materials to prevent rainwater from reaching and penetrating in them, especially the areas supervising the roads. human settlements.

5. The need to take advantage of steep lands that are difficult to exploit for residential and agricultural uses by converting them into pastoral lands, regulating grazing activity, eliminating overgrazing and providing weeds through planting slopes, and this helps reduce the risks of land degradation and soil erosion.

6. Working on making use of the barren lands in proportion to the type of their surface and the nature of the rocks in the area.

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