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The Analysis of the Geomorphometric and Landforms of Sarhan Basin, in Jordan

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ABSTRACT

The main goal of this paper is to study the general morphometric characteristics of the Sarhan Basin (SB) in Jordan, and classify its Landforms. It relied on data from the Shuttle Radar Topography Mission (SRTM) for preparing the digital elevation model (DEM), then geographical information system (GIS) was used to evaluate major linear, relief, and aerial aspects of morphometric parameters. For landforms classification, we applied the topographic position index (TPI). TPI values are dependent upon the cell size, Shape, and the standard deviation (SD) of the TPI. In this study, we used cycle type with neighborhood cell size: 3000m and (SD) 11.9. By using TPI, the study area classified into aslope position index having six classes; valley, lower slope, flat slope, middle slope, upper slope and ridge, with valley and ridge the vast majority of landforms constitute 86% of all six landforms classes.

Keywords: Landform, Digital Elevation Model (DEM), Sarhan Basin, Topographic Position Index (TPI), Slope Position Index (SPI).

1. Introduction

Morphometric analysis of a watershed provides a quantitative description of the drainage system, which is an important aspect of the characterization of watersheds (Strahler, 1964). Over the last three decades, Geographical Information Systems (GIS) and digital elevation models (DEMs) have been widely used in hydrology and drainage basin analysis: (Akawwi, 2013; Kuldeep and Upasana, 2012; Vogt, et al, 2003, Zeiler, 1999). The drainage network which is represented by a network of connected line features can be derived automatically from a digital elevation model (DEM), (Bloch, et al, 2004; Zandbergen, 2008; Sreedevi, et al, 2009; Lipng Yang, et al, 2011; Tamll, et al, 2011; Vitmal, et al, 2012; Magesh, et al, 2012; Abubaker et al., 2012; Farr et al., 2013 and Waikar, et al, 2014). Landform patterns have been referred to as relief forms (Dikau, 1989; Dikau et al., 1995 and De Reu, et al, 2013). Derivation of landform units can be carried out using various approaches, including the classification of morphometric parameters, filter techniques, cluster analysis, and multivariate statistics (Maune, 2001; De Reu.J et al, 2013). In this paper (TPI) methodology is applied and it is based on (DEM), (Weiss, 2001; Jenness, 2006).

2. Study Area

The Jordan's drainage system consists of three main flow directions; one of them basins group drains rainfall through valleys from the western highlands towards the eastern desert depressions and mudflats such as; Sarhan, Azraq, and Al- Jafer basins. (Ministry of Water and Irrigation the Hashemite Kingdom of Jordan and German Technical Cooperation - GTZ, 2004). The (SB) is a part of the central plateau, which is bordered on the west by high slopes that rise westward to the mountain and ridge, and falls to the flat areas in the eastern zone. (SB) is a closed basin along the southeastern Jordanian borders with drains converging into low-lying zone of salt lakes and mudflats in Saudi Arabia. Its area within Jordan is 17431 km². Its elevations ranges from 1037 m in the southwest, and falling to

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about 555 m along the Jordan/Saudi Arabia border, then declining to 500 m inside Saudi Arabia, where the low-lying mudflats are located. figure 1. The Basin consists of five major valleys within Jordan: The wadi of Hadraj, Fakk, El-Garra, Bayir, Husseida and Qattafi (Topographic map, Royal Jordanian Geographic Center, 1995). The valleys have well-defined wide beds (U-shaped valley) with fluvial sands, gravel, and drain the limestone cover (Rijam/Shallala) in the west, while Wadi Qattafi is draining the basalts in the North into the Rijam limestone cover at the southeastern part of the basin. Structurally, Bender divided the structural framework of Jordan into the following structural elements: 1. Arabian Nubian Shield (ANS) in the south; 2. Block-Faulted areas in the east; 3. Unwarping in north and east; 4) Wadi Araba-Dead Sea Transform Fault in the western part Groups of faults cut Jordan as normal faults or horst and grabens with northeast direction; faults with directions N-S, N-NE, E-W, NE-SW. Unwarping in north and east re represented by folding as Ajlun dome, synclines as Ramtha syncline and depressions as sarhan, Jafer and Azraq (Bender, 1974). The Jordan – Dead Sea Rift Valley, affects the geological structures in the area and the dominant tectonic features are the north – east Sarhan fault system, and the west-east Siwaqa and Salawan faults, figure 2 the main faults that affected the study area.

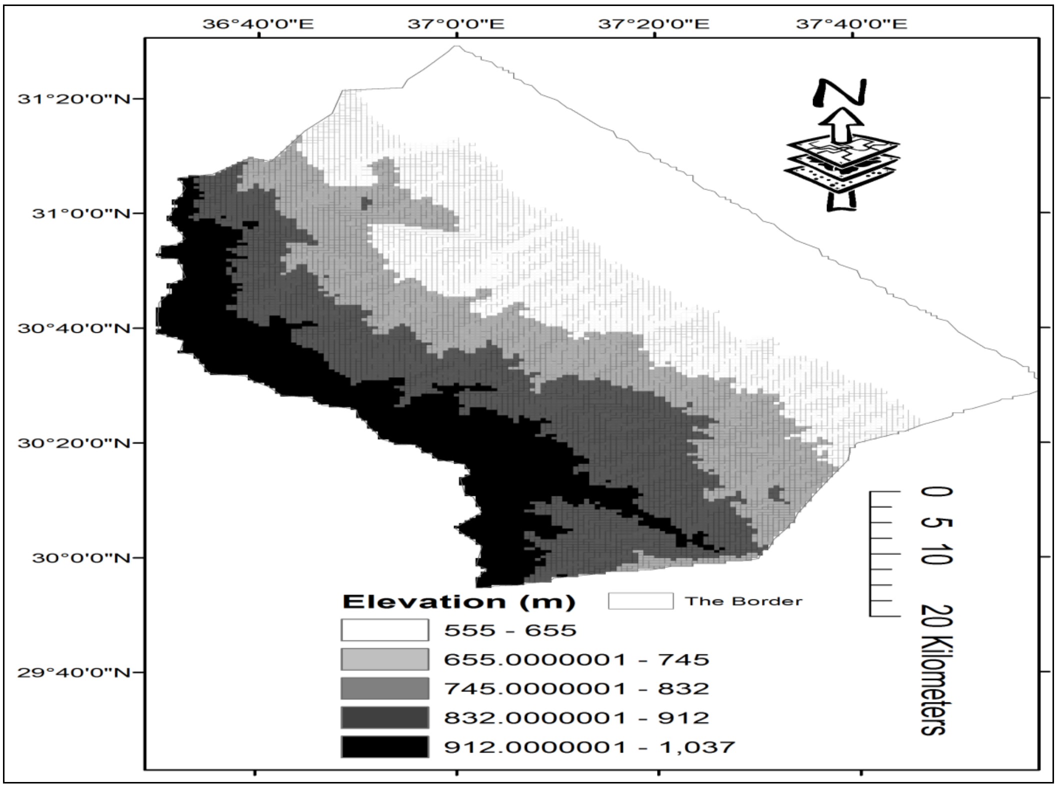

Figure 1. ASTER DEM (30 m resolution) of the study area.

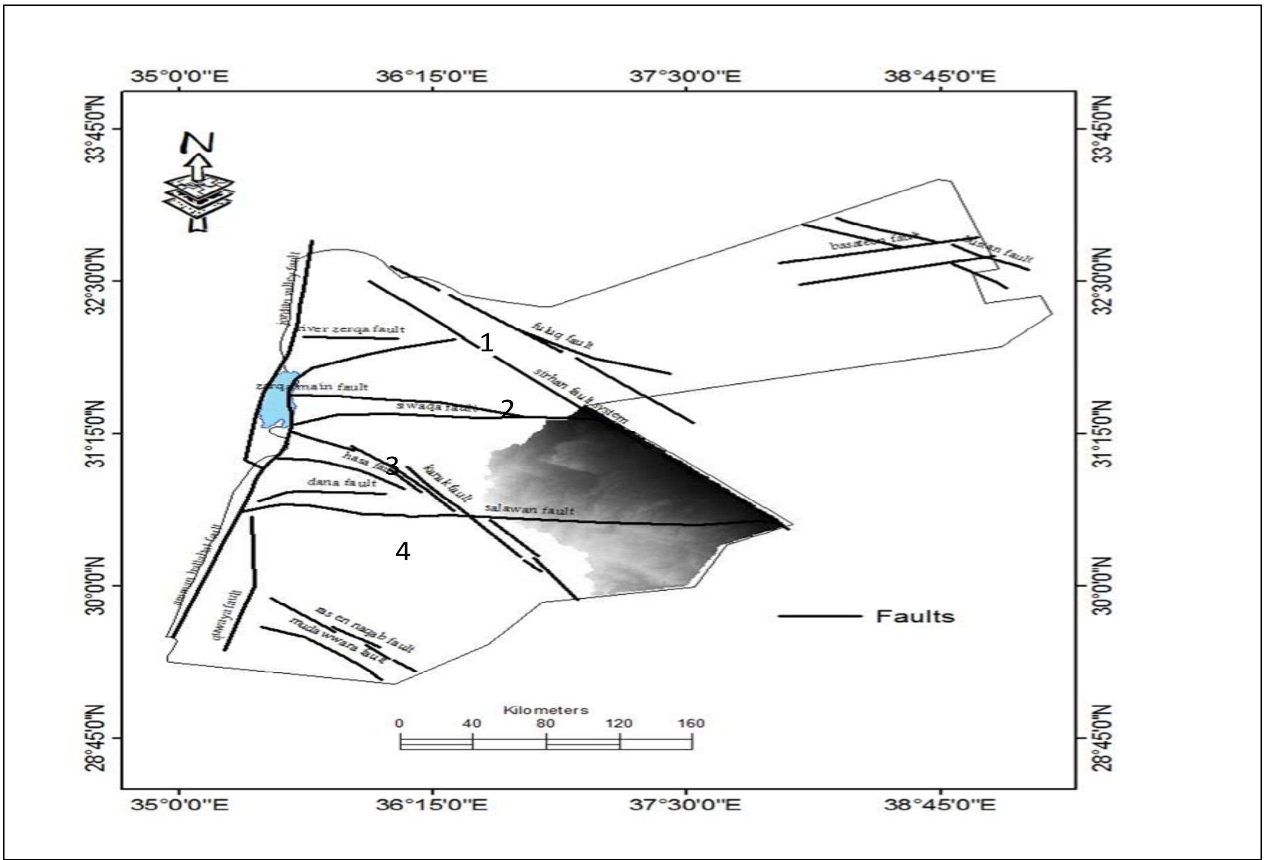

Figure 2. Structural map of Jordan, showing the dominate faults that affects the study area; 1.Sarhan.2.Zarqa mmain.3.Swaqqa.4.Hasa and Salawan faults.

With respect to the climate of the study area; most of its area is classified as a hyper arid land; the annual rainfall in the catchment area ranges from less than 50 mm in the eastern (a hyper arid land) part to more than 100 mm in the western and southwestern highlands, and the maximum temperature exceeds 39Cº in summer; due to the solar radiation, which average up to 9 hours.(SR): The areas solar radiation which is reflects and affected by; the latitude, distance from the sun, time of year, elevation, slope and aspect are all major factors in determining the amount of energy, Figure 3. (1) Showed that the differences between the maximum (693) and the minimum (655) value is (38) in the basin which is not significant (ARC GIS, Solar Radiation). On the other hand, Figure 3. (2) Shoeds the Graph of solar radiation; which represents a line of sight analysis that returns what areas of a surface are and are not visible to an observer at a given point of that surface. Sarhan area showed that only less than 1% is not visible.

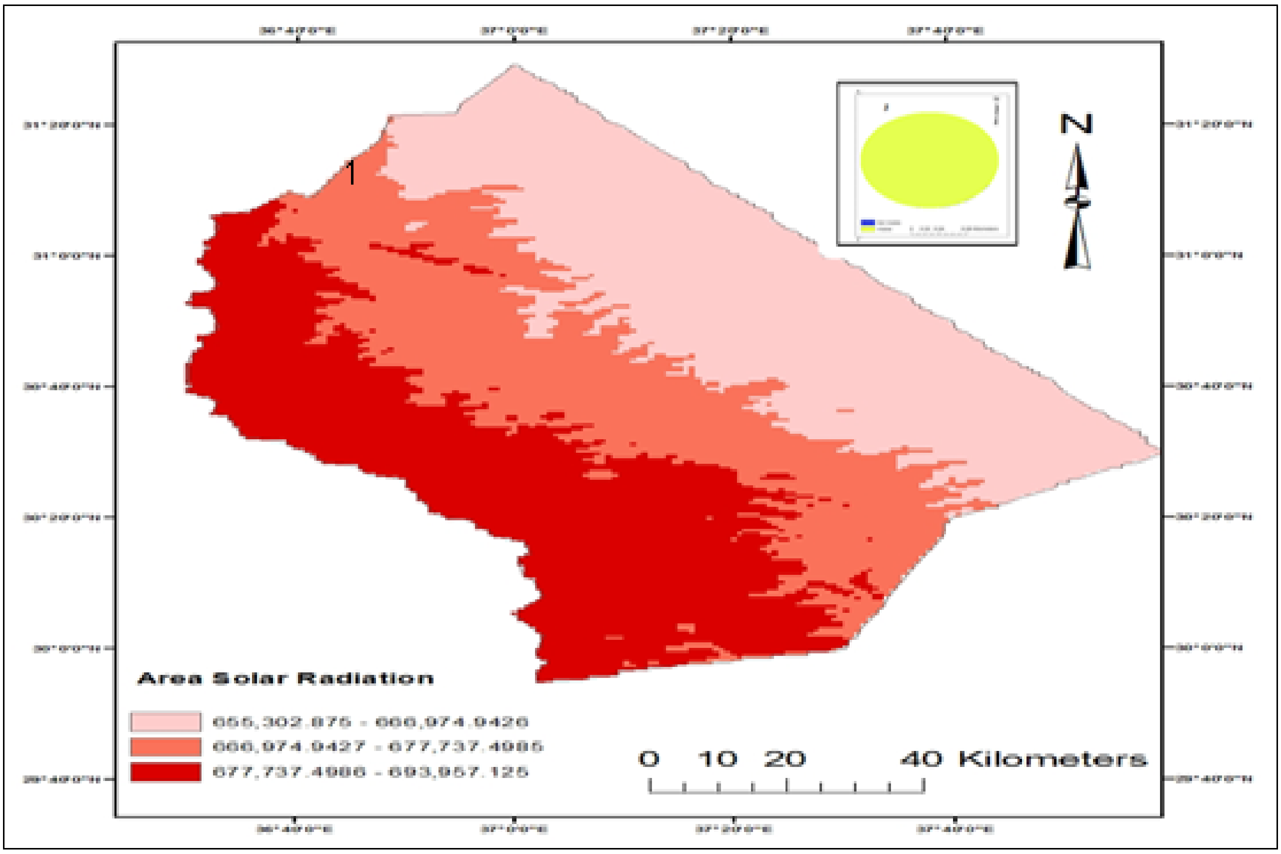

Figure. 3 (1-2) Annual mean area Solar Radiation of 2015 watt per square meter (W/m^2), and the graph of solar radiation.

3. Data and Methodology:

For Morphometric Analysis: (DEM) of the study area produced by NASA and made available in Tiff format with a 30 meter ground resolution downloaded from the University of Maryland at this website http://glcf.umd.edu/data/landsat, and then we rectified the data into the Jordan Transvers Mercator (JTM) projection to ensure uniform cell size. Arc GIS software was used for creating the linear, relief, and areal aspects, Arc GIS Hydro Surface water is a conceptual design implementation of an Arc-GIS geo-database model.

For landform classification: topographic position index (TPI) technique has been used; (TPI) measures the difference between elevation at the central point (z0) and the average elevation (_z) around it within a predetermined radius (R) (Weiss, 2001; Tagil & Jenness 2008); describing higher and lower areas; which classify the landscape into different morphological classes (Jenness 2005); Positive TPI values indicate that the central point is located higher than its average surroundings, while negative values indicate a position lower than the average. The range of TPI depends on elevation differences and radius values (Drăguţ, and Blaschke, 2006) large radius values mainly reveal major landscape units, while smaller values highlight smaller features, such as minor valleys and ridges. (Weiss, 2001; Jenness;2010;2006). TPI calculated by formula (1):

$$TPI_t = z_0 - \frac{\sum_{1-n} z_n}{n}$$

Where:

Z0 = elevation of the model point under evaluation Z = elevation of grid within the local window

N = the total number of surrounding points employed in the evaluation. TPI values Classified as:

- Zero or near-zero areas that are flat or have a near continuous slope.
- Large positive: the central pixel is, on average, much higher than the surrounding areas on top of a ridge or hill)
- Large negative: the central pixel is, on average, much lower than the surrounding areas (the bottom of a valley or is a gulley) (Jenness, 2001;2004;2007).

4. Results and Discussion

4.1 Morphometric Analysis:

The morphometric analysis of the (SB) was conducted from ASTER-GDEM data with a 30 m spatial resolution. The lengths of the streams, areas of the watershed were measured by using ArcGIS software, and stream ordering was generated using Strahler stream ordering (Strahler, 1956), and Arc Hydro Tool for ArcGIS-10.1 software. The linear aspects were studied using the methods of (Horton, 1945; Chorley 1972), the aerial aspects using those of Schumm, 1956; Strahler 1956; Miller 1953; Horton, 1932), and the relief aspects employing the techniques of (Horton, 1945; Schumm,1954). The Drainage Density and Frequency Distribution Analysis of the watershed area done using the Spatial Analyst Tool in ArcGIS-10.1 software.

4.1.1- Sarhan basin Geometry:

The total area of Sarhan Basin is 17431 km², with 6th stream orders; the total number of streams is 4133 from the first to the sixth order, and the total length of the stream 3182 km.

4.2.1 –Sarhan basin Relief:

Contour map has been created by using the Surface Analysis Tool in ArcGIS-10.1 then computed the basin relief by area see table 1. Relief is the elevation between the highest and lowest points, (Schumm, 1956). The relief decreases gradually from west to east. Although the study area can be described as hilly level in nature, and it can be divided according to elevation into three categories: The first one where the elevation ranges from 555- 745 m, in the eastern part that formed 46.4% of the study area, the second category is where the elevation ranged from 745 to 912 m and formed 37.7%. The third category with an elevation of more than > 912m formed 16%. The relief - within the study area is 382 m; the elevation according to area is presented in table 1.

4.3.1. Sarhan basin Slope:

Slope map with flow direction and flow accumulation play a critical role in hydrological modeling, it's considered one of the most important terrain parameter which is understood by observing the horizontal spacing of the contours. In general, closely spaced contours represent steeper slopes and sparse contours exhibit gentler slopes, (Strahler, 1956; Schumm, 1956). Slopes in the study area have been shown in figure 4. Only 10% can be classified as Cliffs, sloping steeply >10º.While as most of area is, about 44% is flat and hills with slopes less than < 2º. The average slope by area is presented in table 1.

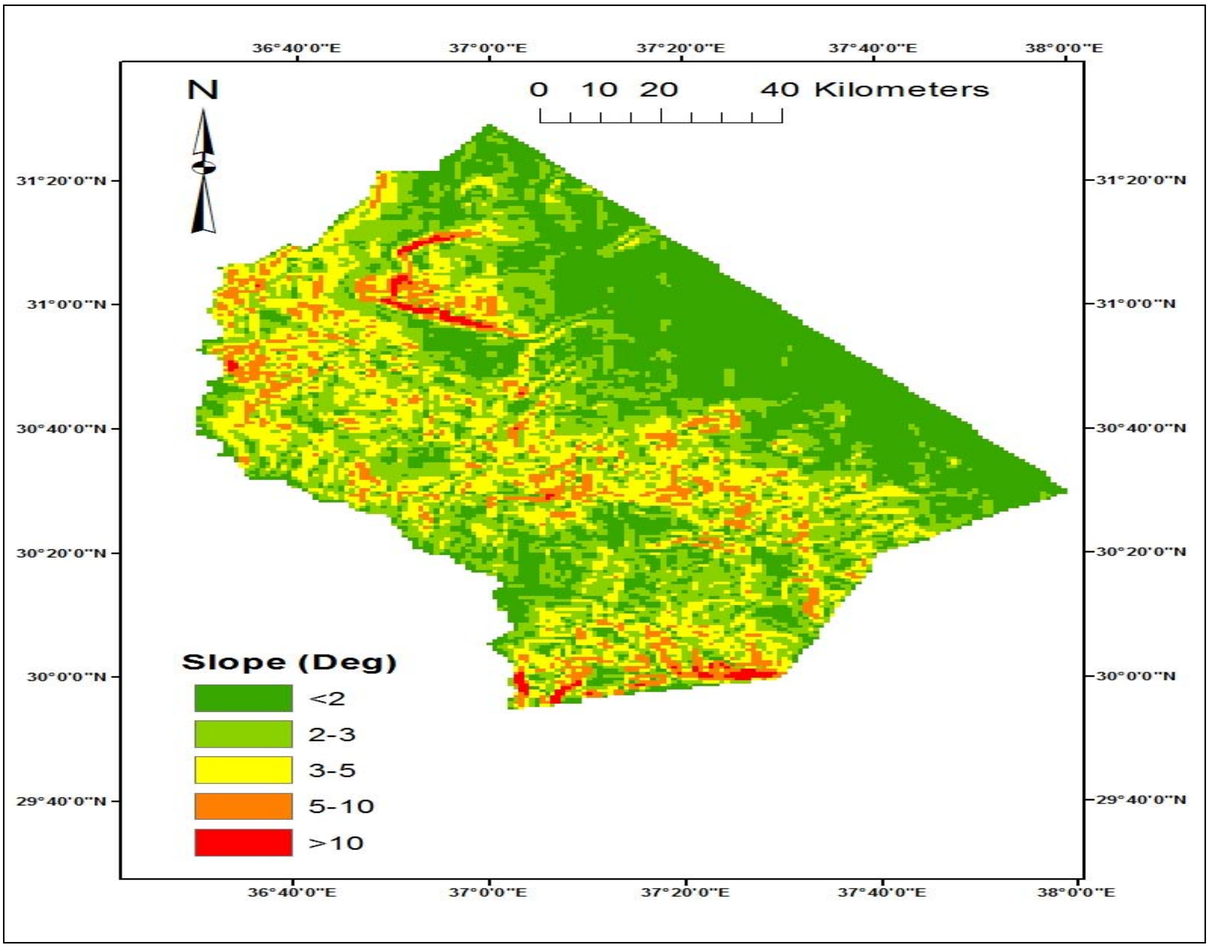

Figure.4 Slope map of the (SB).

Table 1. Elevation (m) and slope by degree.

Elevation class	Elevation (m)	Area (%)	Slope class	Slope degree	Area (%)
1	555-655	26.66514	1	>2	44
2	655-745	19.84396	2	2-3	17
3	745-832	17.81309	3	3-5	14
4	832-912	19.92427	4	5-10	6
5	912-1037	15.75354	5	>10	4
	Total	100%			100%

Besides, the Slope aspect identifies the steepest down slope direction from each cell to its neighbors. It showed that from the figure 5 about 73% of the slope aspect is towards the directions of north-east, and east. While the hillshade map as shown in figure 5 was generated from an elevation dataset, with grid cell values on a scale ranging from 0 to 255, according to how directly the grid cell faces the sun. A value of 0 means that no sunlight is hitting that grid cell (not facing the sun, or shadowed behind another topographic feature). The hillshade map helped to identify the main landforms in the study area; Ridge, hills, valleys, flat areas. (Jeennes, 2004; Jeennes, 2007).

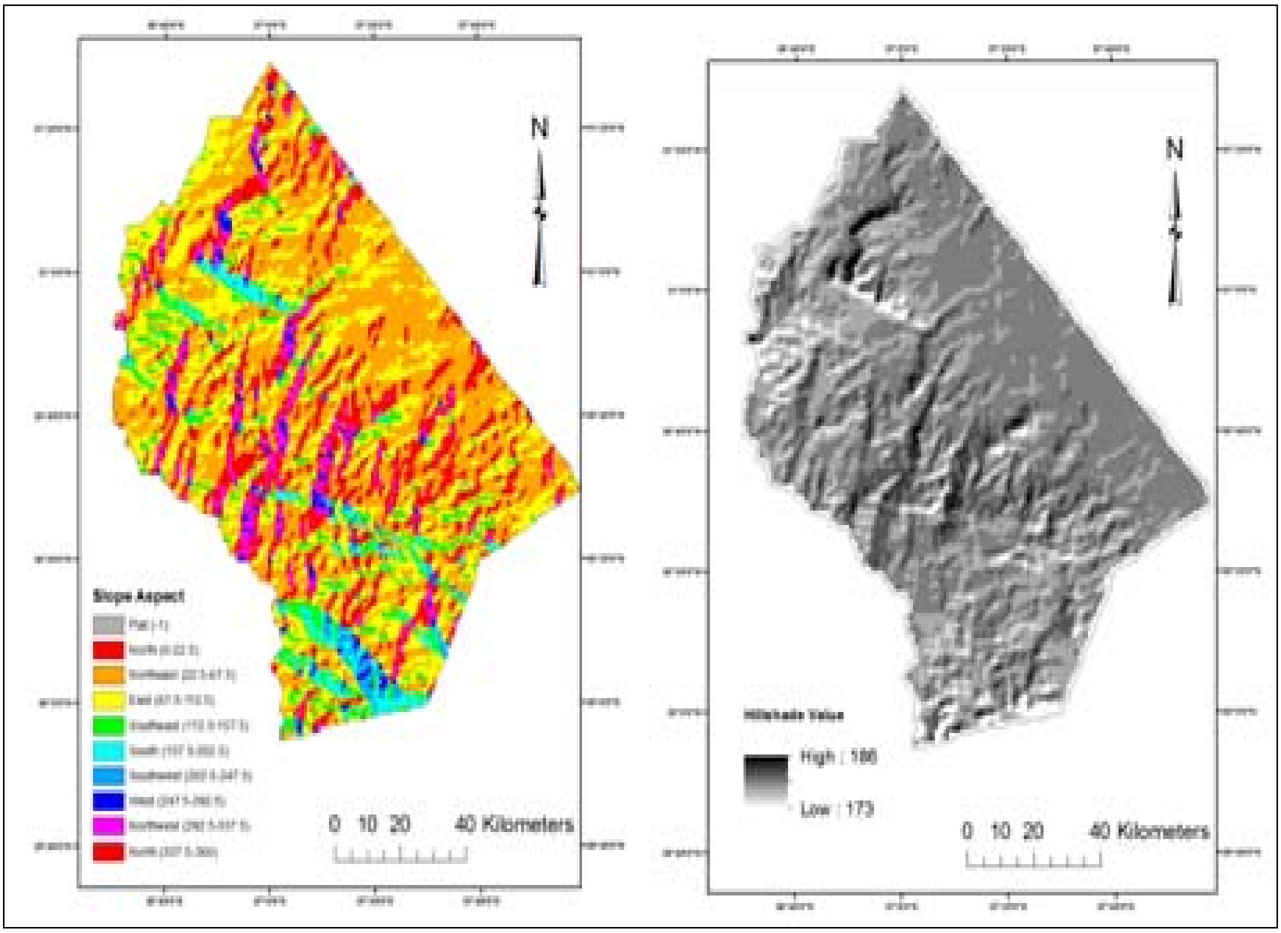

Figure 5. Slope aspect and hillshaded of (SB).

4.4.1. Drainage Network

The drainage network, which drains from the west north of the basin to western part laying in Saudi Arabia. Following is an analyses of characteristic; stream order, number, length, frequency, drainage density, and bifurcation Ratio.

- Stream Order

Strahler's stream order law (Strahler, 1952) has been applied, where the smallest, unbranched streams are designated as a first 1st order, the confluence of two first 1st order channels gives a channel segments of the second 2nd order and so on. The total drainage basin boundary and major river system are delineated from SRTM DEM. It was found that this drainage basin is a sixth 6th stream order. The analyses of morphometric parameters were carried out for the entire asixth 6th order basin, detailed in figure 6 and table 2.

- Stream Number

The total number of stream segments present in each order is the stream number. In this study, all of the basin streams in the 6th stream order is counted and tabulated for the analysis. The total number of stream segments is 4133; we found that stream number decreases as the stream order increases in all the sub basins. The study reveals that the development of first 1st order streams is at its greatest in the higher western zone and least in the eastern zone as most of this area is classified as flat.

-Stream length

The total length of the streams from the first to the six order are 3182km. The data implies that the total length of stream increases with the decrease of the stream order. The basin consists of only one sixth-order stream with a maximum stream length of 53 km and is considered as major stream (W. Bayir) in the study area.

- Drainage (Stream) frequency

Stream frequency gives the number of stream per unit area. **Formula** (2) Fs **= N/A,** Where **N** = Total number of streams from all orders, and **A** = Total area of the basin, or sub-basin. (Horton, 1945). We found that the total drainage frequency of the study area is 0.24 km^2 and the drainage frequency decreases from the west and north to the east and south. In the southeastern part of the study area the stream frequency is 0.003 km^2. As drainage frequency relate to the geological characteristics, elevation, and climate; the part of the basin with hills has higher stream frequency, while the parts of alluvial, and flat of basin has minimum stream frequency,

- Drainage density (Dd)

Drainage density or average length of streams within the basin per unit of area (Horton, 1932). Drainage density was calculated by using Spatial Analyst Tool in ArcGIS-10. **Formula** (3) ***(Dd) = L_k/A_k*** Where, **L_k** is the total length of the channel included from all orders. And, **A_k** is the total basin area. Drainage density in the study area 0.18 km/km^2. Drainage density is an important aspect in the morphometric analysis of a drainage basin as it can be correlated to the dynamic nature of the stream and the area of the basin, (Schumm, 1954). Drainage density reflects the landuse and affects infiltration and the basin response time between precipitation and discharge, besides the geology, climate (hyper arid land), and It reflects the landuse which is completely bare land. Drainage basin with a high (Dd) indicates that a large proportion of the precipitation runs off. On the other hand, a low drainage density indicates the most rainfall infiltrates the ground and few channels are required to carry the runoff (Horton, 1932).

- Bifurcation Ratio (Rb)

The bifurcation ratio is the ratio of the number of stream of a given order Nu to the number of streams of the next higher order **Formula** (4) **Nu+1**, (Schumm, 1956).

Rb = Nu/Nu+1

The bifurcation ratio as an index of relief, lithology and structure, (Rb) of flat basin region is comparatively lower than that of the hilly area, (Rb) is of fundamental importance in the drainage basin analysis as it is the foremost parameter to link the hydrological regime of a watershed under topological and climatic conditions, the mean bifurcation ratio is 0.18 for our entire study area, and we found that the bifurcation ratio for the 1st 2nd, and 3rd order stream is higher than the other ratio. higher values reflect the high dissection in the upland area. According to (Horton, 1945) bifurcation ratio having a low value of about 2 to 3 is that of a flat region. The mean bifurcation ratio is 0.01 in the eastern part of the basin, but the western part has a mean bifurcation ratio of 0.43.

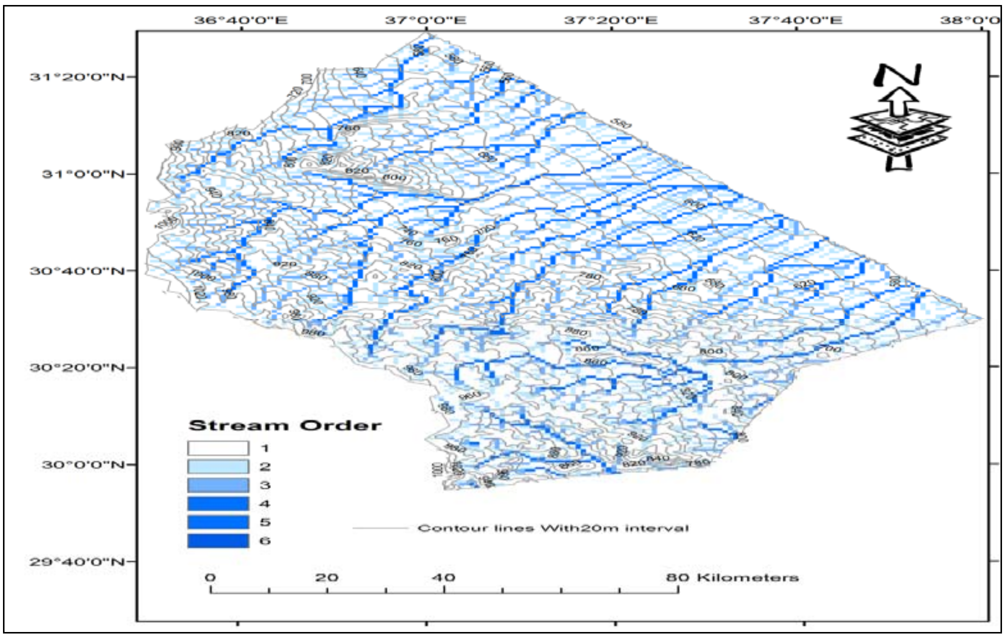

Figure 6. Contour map, and drainage Map.

Table 2. Stream order, number, bifurcation ratios, drainage density, stream frequency in the Sarhan Watershed and the main sub-basins.

Stream order	Stream number/per/km²	Birfuction ratios	Drainage Density	Stream frequency	Sub-basin ID	Sub-basin (percentage) from the study area
1st	1032	1.6	2.4	5/km²	1	12%
2nd	645	1.6	1.6	1.8/ km²	2	10%
3rd	412	3.5	0.8	1.2/ km²	3	60%
5th	11	11	0.02	.01/ km²	4	9%
6th	1	1	0.03	.002/ km²	5	10%
Total	2218					

4.5.1 The basin shape

The main shape Parameters of (SB) are the elongation ratio, and Circularity Ratio.

The total area of sarhan basin in Jordan 17431 km²; divided in to five sub-basins and the main sub-basin are (1). W.Husseida (2). W. Bayir (3). Qattafi (4). W. El-Garra, (5). W. Haddraj. See figure 7 and table 2

- Elongation Ratio

The elongation ratio is calculated by dividing the diameter of a circle with equal area as the basin by the maximum length of the basin, measured from its outlet to its boundary using formula (5) (Schumm, 1956).

$$Rc= D/L$$

Where

Rc = elongate ratio.

D = diameter of a circle with equal area as the basin.

L = maximum length of the basin parallel to the principal drainage lines. The value of elongation ratio in the study area varies from 0.72 in highly elongated shape for the sub-basins ID 1 and 3 to 0.23 in the nearly circular shape for the sub-basin ID 2. What distinguishes the basins in arid land is the high elongation ratio due to the flash floods and bare land.

- Circularity Ratio

Circularity ratio is defined by (Miller, 1953), as the ratio of the area of the basin to the area of the circle having same circumference as the basin perimeter using formula (6) Rc =A/Ac

Where

R, = circularity ratio.

A = basin area.

A, = area of a circle with equal perimeter as the basin.

circularity ratio in the study area is influenced mainly by the climate conditions (flashfloods),bare land. (RC) value varies from less than 0.30 to 0.62, which indicates strongly elongated (Schumm, 1956).We found that the circularity ratio value for the sub basins that takes the ID 2 and 4 the highest values of circularity ratio 0.5 - 0.45.

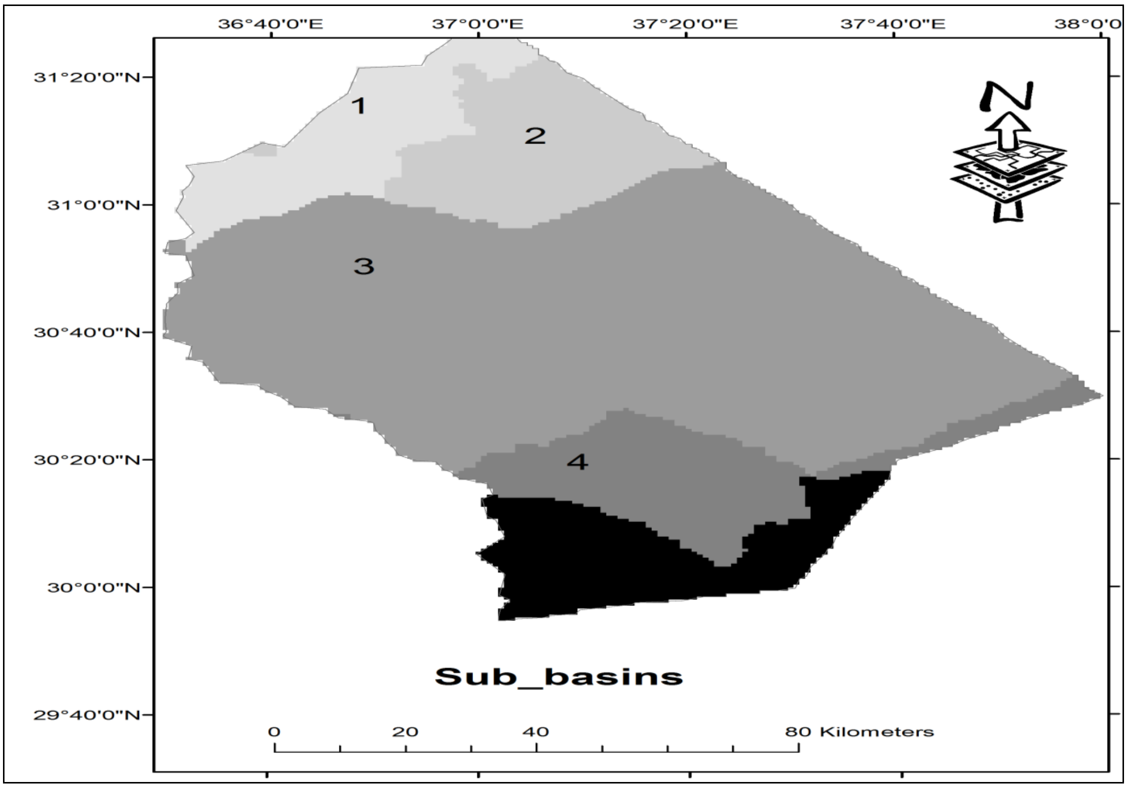

Figure 7. Sub-basins in Sarhan basin.

4.2. Landforms classification:

4.2.1 Generate Topographic Position Index (TPI). TPI algorithm was used to classify the landforms in the Sarhan Depression (Basin); this new methodology compares the elevation of each cell in a study area DEM to the mean elevation of a specified neighborhood around that cell. Since the creations of the Topographic Position Index algorithm (TPI) by (Weiss, 2001; Jenees,2006) the geomorphological is performed using TPI with different neighborhood cell size and type of radius size to classify the landscape into aslope position index (Jenness, 2007; Tagil and Jenness, 2008; Jenness, 2010; Seif,2014A; Seif,2014B; De Reu, et al,2013; Azita, et al, 2014; Ivan, et al,2011; Naydenova and Stamenov,2013; Camize and Poscdien,2015). In the Sarhan Depression, a radius of 3 km was applied to determine the Slope Position Index using the TPI extension v. 1.3a. for ARC View 3x. Available at: http://www.jennessent.com/arcview/tpi.htm. TPI values as shown in figure 7. Classified into two main categories: Positive values ranged between 3.8 to 64.5 these positive values indicate that the cell is higher than its neighbors, and negative values ranging between -3.8_-64.5 which indicates that the cell is lower than its neighbors (Jenness, 2005; Jenness,2008). Figure 8. TPI, classified into 6 classes of values; each value and its slope at each point identity landescap.

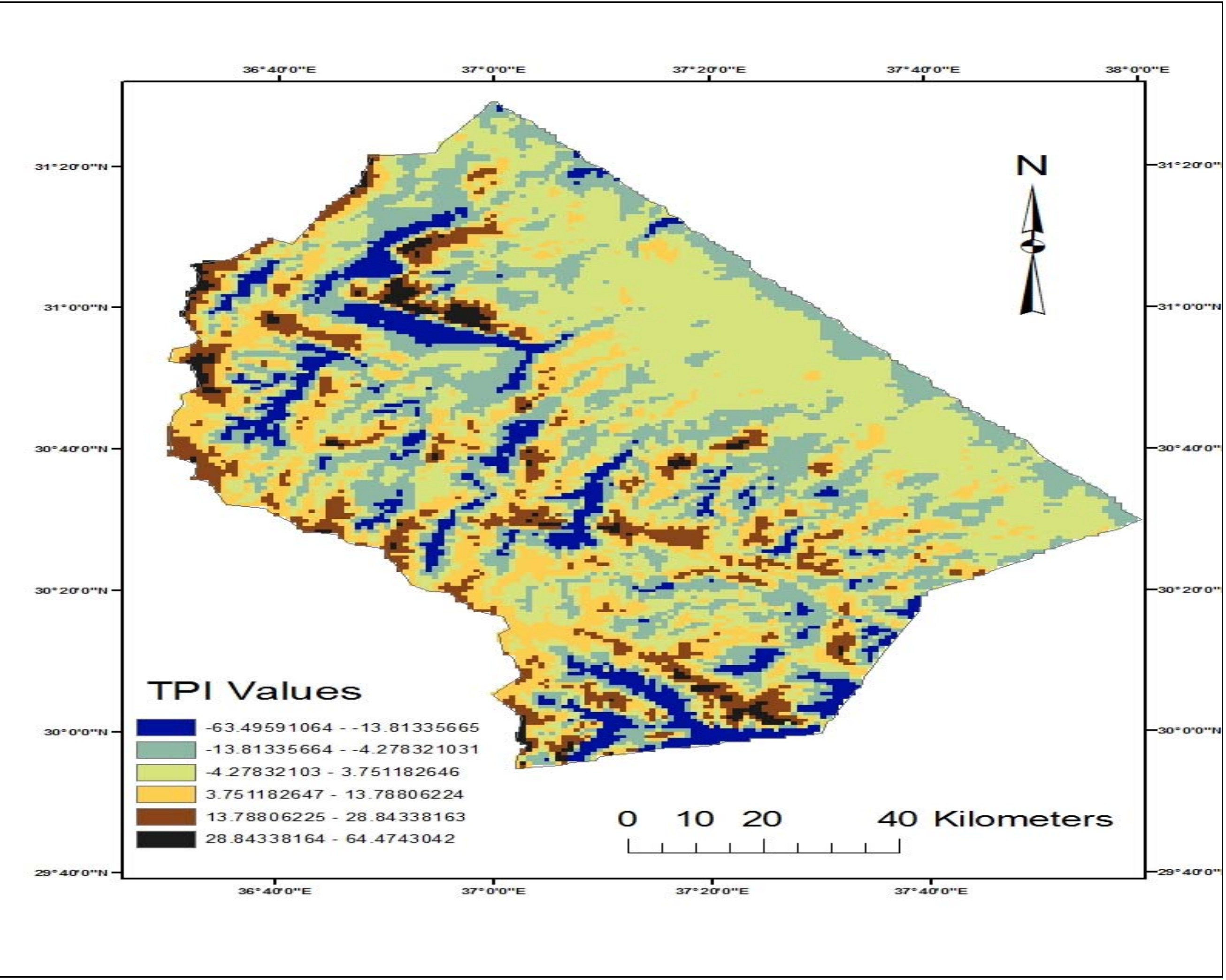

Figure. 8 TPI values, circle type, with a radius of 3km and SD. 11.22.

Table. 3 Landforms and TPI values

Land forms classes	TPI values
Valley (U-shaped valley/Spread water), deeply incised streams	-63.5_-13.8
Lower slope, shallow valleys, faults	-13.3_-4.3
Flat slope	-4.3-3.8
Middle slope	3.8-13.8
Upper slope, small hills	13.8-28.8
Mountain tops, high ridges	28.83-64.5

4.2.2. Generate Slope Position Index (SPI):

TPI values were used to classify the landscape into Slope Position classes. This classification is based on how extreme the TPI values are and by the slope at each point. Actually high TPI values are defined as ridges and hills, while the negative values represent locations that are assigned with values lower than their surroundings and are classified as faulty areas, flat mud and U-shaped beds valleys for the main streams (Hadraj, Fakk, El-Garra, Bayir, Husseida and Qattafi). The flat areas are calculated with values less than zero. Almost 63% of the basin has a TPI value less than zero, and falls under the classification of aflat valleys areas. The TPI is used for the differentiating of the main landform classes such as in Figure 8. The main landform classes for the study area are “ridge and valleys”. In this study the TPI value plus standard Deviation were used to classify the landforms according the SPI figure 8 and 9. Displays the results.

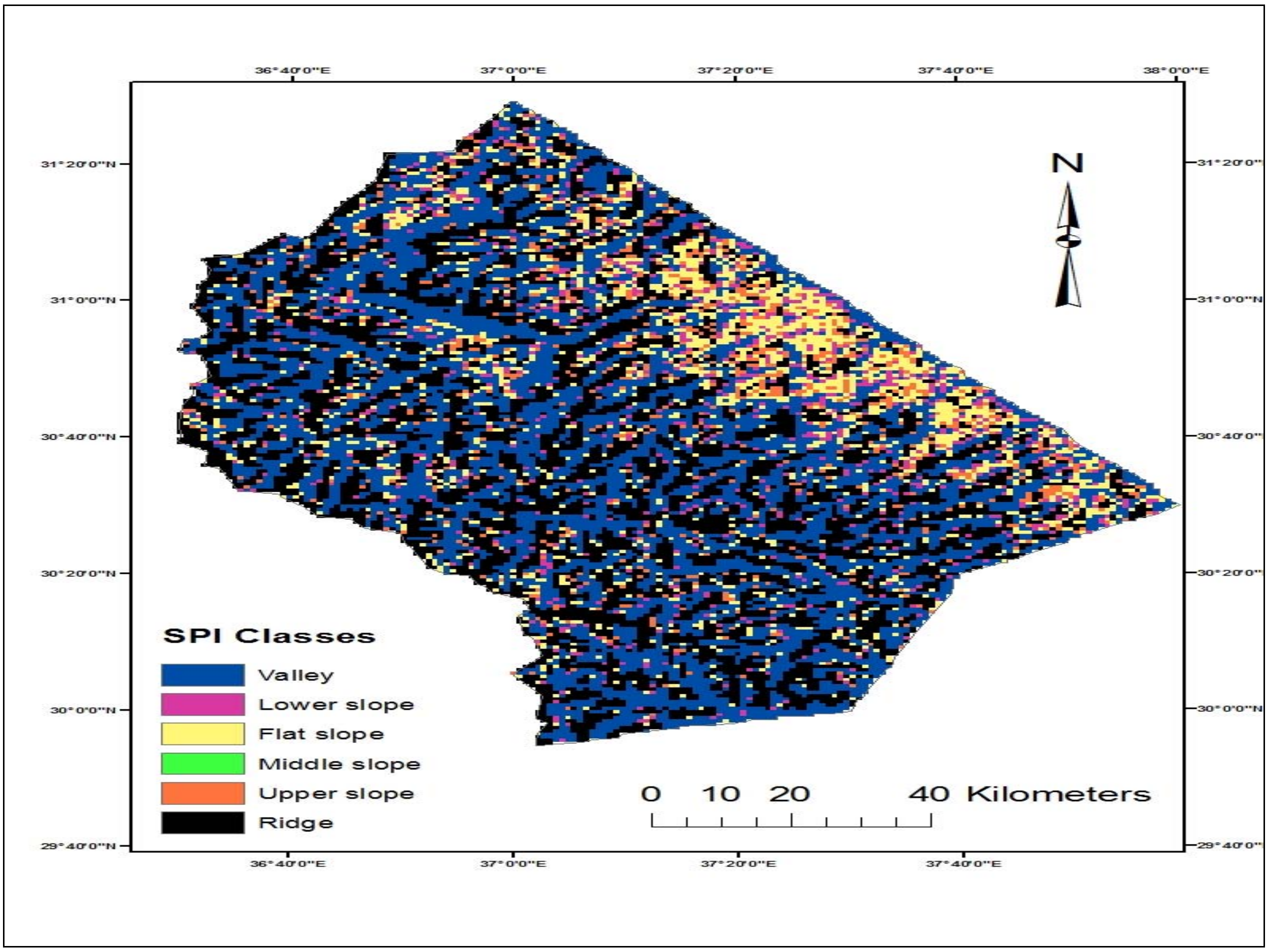

Figure 9. Slope Position classification based on SD (11.22), and circle type, Radius in the Neighbourhood of 3km size.

Figure 10. Landforms by area classified by Slope Position Index.

5. Conclusions

GIS and DEM have been widely used in topographic and morphometric analysis. Algorithms of Jenness were applied to classify the landforms of (SB) according to (SPI).

The main results of the study can be summarized into the following 6 Points;

1. The Sarhan Basin has an area of 17431 km², with the total length of drainage inclusive of all order streams equaling is 3182 km, with 6- stream order stream.

2. The relief of the area in Jordan, which was studied, ranged from 555 m to 1037 m.

3. The total number of streams is 4133.

4. The relief map shows that the elevation gradient is moves from the northeast to the southwest.

5. TPI values are between -63.4 to +64.5.

6. Finally, by using (TPI) the results showed that the dominated landforms are (Valley/ Ridge) which formed 86% of all six landforms classes, and the patterns of the landforms reflect the topographic, and the structure system; that controlling the ultimate landscape.

REFERENCES

Abubaker, T., Azra E.A. and Mohammed, C. (2012). Selecting suitable drainage pattern to minimize flooding in sangere village using GIS and remote Sensing. Global J. Geol. Sci. DOI: 10.4314/ gjgs.v10i2.1.

Akawwi, E. (2013). Geomorphology using Geographic Information System and Globel Mapper, American Journal of Environmental Science, 9 (5): 398-409, Science Publication.

Azita.A., Zawawi, M. S, Noor, Janatun, N. (2014). Landform Classification for Site Evaluation and Forest Planning: Integration between Scientific Approach and Traditional Concept, Sains Malaysiana 43(3) 349–358.

Bender, F. (1975).Geology of the Arabian Peninsula, United State Government prining office. Washington.

Bloch, T., Ulrich Kamp, Jeffrey Olsenholler (2004). Using ASTER and SRTM DEMs for studying geomorphology and glaciation in high mountain areas. New Strategies for European Remote Sensing, (ed.),119-127.

Dikau,R. Heidlberg, Earl E. Brabb, Robert, K. Mark,Richard J. & Park, P. (1995). Morphometric landform analysis of new mexico, Z.Geomorph.N.F,P109-126,Berlin-stuttgart.

Dikau, R. (1989). The application of a digital relief model to landform analysis in geomorphology. In: Raper, J. (Ed.), Three-dimensional Applications in Geographical Information Systems. Taylor & Francis, London, pp. 51–77.

De Reu,J., Jean Bourgeois, Machteld Bats, Ann Zwertvaegher, Vanessa Gelorini,Philippe De Smedt Wei Chu, Marc Antrop, Philippe De Maeyer, Peter Finke,Marc Van Meirvenne, Jacques Verniers, Philippe Crombé, 2013, Application of the topographic position index to heterogeneous landscapes, Geomorphology 186 (2013) 39–49.

Drăguţ,L., and Blaschke,T. (2006). Automated classification of landform elements using object-based image analysis, Geomorphology,81 (3), 330–344.

Farr, G., Rosen P. A., Caro E., Crippen R., Duren, D., Hensley, S., Kobrick, M., Paller, M., Rodriguez, E., Roth, L., Seal, D., Shaffer, S., Shimada,J., & Umland, J. (2013). The Shuttle Radar Topography Mission, available at web site http://www2.jpl.nasa.gov/srtm/SRTM_paper.pdfpp1-49.

Horton, R.E. (1932). "Drainage Basin Characteristics", Transactions, American Geophysical Union, 13, 350-61.

Horton R.E., (1945). Erosional development of streams and their drainage basins: hydrophysical approach to quantitative morphology. Geological Society of America Bulletin, 56, 275–370.

Jenness, J. (2006). Topographic Position Index (tpi_jen.avx) extension for ArcView 3.x, v. 1.3a. Jenness Enterprises. Available at: http://www.jennessent.com/arcview/tpi.htm.

Jenness, J. (2008). Surface Tools (surf_tools.avx) extension for ArcView 3.x, v. 1.6a. Jenness Enterprises. Available at: http://www.jennessent.com/arcview/surface_tools.htm.

Jenness, J.(2010a). Topographic Position Index (tpi_jen.avx) extension for ArcView 3.x, v. 1.3a. Jenness Enterprises. http://www.jennessent.com/arcview/tpi.htm.

Jenness, J. S. (2004b). Calculating landscape surface area from digital elevation models. Wildlife Society Bulletin, 32(3), 829-839.

Jenness, J. S. (2005c). Topographic Position Index (tpi_jen.avx) extension for ArcView 3.x Jenness Enterprises. Available at: http://www.jennessent.com/arcview/tpi.htm.

Jenness,J.(2008). TPI Poster, Topography Position Index TPI Landform Slope Classification Standardization Neighborhood Statistics GIS Analyst.

Jenness, J.(2007). Some Thoughts on Analyzing Topographic Habitat Characteristics, http://www.jennessent.com 3020 N. Schevene Blvd. (928) 607-4638, p 14-15.

Kuldeep P., Upasana P. (2011). Uantitative Morphometric Analysis of a Watershed of Yamuna Basin, India using ASTER (DEM) Data and GIS. International Journal of Geomatics and Geosciences, 2(1), 248-269.

Lipng Yang, Xingmin Meng, and Xiaoqiang (2011) SRTM DEM and its application advances, International Journal of Remote Sensing, 32 (14), 3875–3896.

Magesh N.S., Chandrasekar N. and Kaliraj S. (2012) A GIS based Automated Extraction Tool for the Analysis of Basin Morphometry, onfring International Journal of Industrial Engineering and Management Science, 2 (1), 32-35.

Maune, D. F. (2001). Digital elevation model technologies and applications: the DEM users–

manual. The American Society for Photogrammetry and Remote Sensing (ASPRS) Bethesda, Maryland. P. 539.

Miller, V. C. (1953). A quantitative geomorphic study of drainage basin characteristics in the Clinch.

Mountain area Virginia and Tennessee. **Tech. Rept.** 3, Dept. of Geol., Columbia Univ., New York.

Ministry of Water and Irrigation the Hashemite Kingdom of Jordan and German Technical Cooperation - GTZ (2004). Surface Water Resources. Main Report, the national water masterplan, PP1-47.

Naydenova, V., and Stamenov, S.(2013) landform classification using ASTER GDEM and optical high resolution satellite images of Sofia city district,, Bulgarian Academy of Sciences. Space Research and Technology Institute. Aerospace Research in Bulgaria, Sofia. 25,183-192.

Royal Jordanian Geographic Center, Topographic map scale 1:25000. 1995.

Schumm, S.A (1954). The relation of Drainage Basin Relief to Sediment Loss. International Association of Scientific Hydrology, 36, 216-219.

Schumm, S.A (1956). Evolution of Drainage Systems & Slopes in Badlands at Perth Anboy, New Jersey. Bulletin of the Geological Society of America, 67, pp 597-646.

Seif, A., (2014a). Landform Classification by Slope Position classes, Bulletin of Environment. Pharmacology and Life Sciences, 3 (11), 62-69.

Seif, A. (2014 b). Using Topography Position Index for Landform Classification(Case study: Grain Mountain), Bulletin of Environment. Pharmacology and Life Sciences,(Bull. Env. Pharmacol. Life Sci), 3(11), 33-39.

Seif, A.(2014c). Using Topography Position Index and Relationship between Land Use AP and Geology for Determination of Quaternary Landform in Zagros Mountain, Bulletin of Environment. Pharmacology and Life Sciences, 3 (11), 70-85.

Seif A., Mokarram, M.(2014). GIS-Based Automated Landform Classification in Zagros mountain (case study: Grain mountain). Bulletin of Environment, Pharmacology and Life Sciences. 3 (3), 20-33.

Seif, A. Mokarram, M.(2013).Using Wood Method for Landform Classification – a Case study on Zardkooh Mountain, Iran. Indian Journal Of Natural Sciences,4 (21),1415-1420.

Sreedevi, P. D., Owais, S. Khan, H. and Ahmed S. (2009). Morphometric Analysis of a Watershed of South India Using SRTM Data and GIS. Journal Society of India, 73, 543-552.

Strahler, A.N. (1964). Quantitative geomorphology of drainage basin and channel network, Handbook of Applied Hydrology. 39-76.

Strahler, A.N. (1956), "Quantitative Slope Analysis", Bulletin of the Geological

Society of America, 67, 571-596.

Tagil,S, and Jenness,J.(2008). GIS-based automated landform classification and topographic, landcover and geologic attributes of lanforms around the Yazoern polje, Turkey. Journal of Applied Sciences, 8 (6):910-921.

Tamll, S, M., Sarfaraz, A., d, and. Rashid, S.M. (2011). Analysis of the Geomorphometric Parameters in High Altitude Glaciered Terrain using SRTM DEM data in Central Himalaya, India. ARPN Journal of Science and Technology. 1(1), PP. 22-27.

Vimal, S., Nagesh Kumar D. and Jaya, I. (2012). Extraction of Drainage Pattern from ASTER and SRTM Data for aRiver Basin using GIS Tools, International Conference on Environment, Energy and Biotechnology,33, 120-129.

Vogt, J.V., R. Colombo and F. Bertol (2003). Deriving drainage networks and catchment boundaries: A new methodology combining digital elevation data and environmental characteristics. Geomorphology, 53: 281 - 298. DOI: 10.1016/ S0169-555X(02) 00319-7

Waikar M.L., and Aditya P. (2014). Morphometric Analysis of a Drainage Basin Using Geographical Information System: A Case study. International Journal of Multidisciplinary and Current Research, 179-184.

Weiss, A. (2001). Topographic Positions and Landforms Analysis (Conference Poster). ESRI International User Conference. San Diego, CA, pp. 9-13.

Zandbergen, P.(2008). Applications of Shuttle Radar Topography Mission Elevation Data, Geography Compass 2/5 (2008): 1404–1431, 10.1111/j.1749-8198..00154.x.

Zeiler, M. (1999). Modeling our World: The ESRI Guide to Geodatabase Design. 1st Edn., ESRI, Inc., Redlands, ISBN-10: 1879102625, pp: 199.

تحليل البيانات والقياسات الجيومترية لحوض سرحان في الأردن

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ملخص

تهدف الدراسة إلى تحليل المواصفات الجيومترية العامة لحوض سرحان في الأردن وتصنيف التضاريس الظاهرة فيه. وتعتمد الدراسة على استخدام تقنية الرادار (SRTM) ونموذج الارتفاع الرقمي (DEM) ونظام المعلومات الجغرافي (GIS) لتحديد العوامل الجغرافية في المنطقة. ولتصنيف تضاريس السطح تم تطبيق مؤشر الموقع الطبوغرافي (TPI) حيث يعتمد هذا المؤشر على تحديد حجم وشكل والانحراف المعياري للموقع. وتم اعتماد قياس الخلية المجاورة 3000م وانحراف معياري 11.9. وبناءً على ذلك تم تصنيف المنطقة حسب الميل إلى: وادي، منحدر منخفض، منحدر مستو، منحدر متوسط، منحدر عال، وقمة؛ حيث شكل الوادي والقمة الأغلبية العظمى بنسبة 86%.

لكلمات الدالـة: تضاريس، نموذج الارتفاع الرقمي (DEM)، وادي سرحان، مؤشر الموقع الطبوغرافي (TPI).

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