Stream Network Delineation and Watershed Segmentation  
Of Wadi Al-Khur Basin in the South of Iraq  
by Using the (GIS)  
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Abstract  
The studied area (Wadi Al-Khur Basin) is located between Al-Anbar and Al-Najaf governorates within Iraqi Southern Desert. The geographic coordinates is longitude (32° 10' 00" – 31° 20' 00") N and latitude (44° 20' 00" - 43° 30' 30") E. The research results are based on the calculation for the Digital Elevation Model with resolution (60) meters, which is analysis by using the Geographic Information System (GIS) version (10.1), which is determining the physical hydrology properties: calculating the basin watershed and area (2950) meters, stream slop gradient (2-5) m/Km, The streams follow a branching drainage pattern called Dendritic. The stream flow direction is (northeast), and the main stream order is the fourth order.  

It is clearly, that the Iraqi desert region is under the water shortage due to the scarcity and the effect of the climate (decline in rainfall and increase of temperatures degrees). The physical hydrology properties are important to evaluate the hydrology condition of the Wadi AlKhur basin.
1-1 Introduction:
The hydrology is a multidisciplinary subject that deals with the occurrence, storage, and distribution of surface water on the earth, (Philip B. Bedient, 2008). In recent years, the scarcity and the drought were impacting the region. To understand the hydrological condition of the basin, it’s necessary to determine the physiographic properties of the area that is best representing the hydrological processes. The hydrology employs a spatial distribution of the catchment and numerical integration of the mass conservation. The geospatial dataset provides a digital elevation model (DEM) data and derivative products including streams, watersheds, drainage network topology, slope, and flow direction for runoff routing through a network of the basin.

1-2 Location and area:
The (Wadi Al-Khur Basin) area is (2950) Km². The studied is located between Al-Anbar and Al-Najaf governorates within Iraqi Southern Desert. It is extends from the east by Tar Alnajaf (Abu-Jir Fault), from west Saudi Arabia borders, from north Al-Anbar governorate and from south Bahr Al-Najaf. There is a several villages in the area like: Al-Ezeyah, Taqtaqana and Al-Rehaymmah.

The geographic coordinates is longitude (32° 10' 00" – 31° 20' 00") N and latitude (44° 20' 00" - 43° 00' 30") E. The lowest elevation in the basin is (15) meters a.s.l. and highest elevation reaches (530) meters a.s.l., (Figures, 1-1).

Figure (1-1) Location Map of Studied Area

1-3 Objectives:
For the reason that seasonal streams are extremely important in the region makes studying their hydrology physical properties becomes as a requirement. This research will be including:
1. Determining the hydrology physical properties by using the (GIS) technique (Watershed, Basin and Sub-Basins extend and Drawing the streams features).
2. Determining the spatial streams network analysis (Streams slop gradient, Stream orders and Streams flow directions)
3. Apply the evaluation of the Wadi Al-Khur basin.

1-4 **Topography:**

The studied area is located between the western and the southern desert of Iraq where the land surface rises gradually from south-west to north-east (50m every 10-15 Km.) (Sissakian et al, 1994). The terrain is declining toward the Mesopotamian basin. The even surface has thin soil cover especially in the eastern parts of the studied area. The main topographic features are some positive features like mesas, valleys, canyons, cliffs and karsts, large parts of it are dry or as in the western part of studied area. Wadi Al-Khur is the major feature within the studied area which is deep and (V) shaped in most of the area, (Figure 1-2)

Figure (1-2) Studied Area Topographic Map

1-5 **Methods of research:**

1. Collecting available hydrological information’s about the studied area.
2. Preparing (DEM) Digital Elevation Model which is represent the land surface in sufficient details (resolution 60m) for hydrologic analysis.
3. Processing the information’s to the GIS program to extract all topographic and topologic drainage network and watershed properties relevant to the hydrologic surface model which is representing the output data.

1. **1-6 THE TOP SOIL:**

Water comes into the soil largely by percolation of rainfall. The basic characteristic that sets soil classification is that it is generic, which mean it is organized on the basis of observable soil characteristics, (Tom L. McKnight, 2008). The top soil within studied area region is classed as Aridisols (Dry Soil). The distribution of the various soils in Iraq is deferent through the region. This difference is due to the low and high latitudes. The dry soil is much more common in the western desert, Figure (1-3). The top soil thickness in the studied area is about (0.3 – 1) meters. It is
characteristics clearly associated with a dry climate and a scarcity of penetrating moisture. It is diminished largely through evapotranspiration.

Generally, the dominant soil classification in the area is clayey loam (Sand fraction 39%, Silt fraction 37%, and Clay fraction 24%) according to the (USDA) soil textural classification. The soil Available Water Capacity (AWC) is (50 mm). (HWSD-FAO, 2012), Table (1-1).

Table (1-1) Soil Properties of the Studied Area

<table>
<thead>
<tr>
<th>Month</th>
<th>Temp.(C)</th>
<th>Rainfall(mm)</th>
<th>EAppan(mm)</th>
<th>RH%</th>
<th>Sunshine(hrs.)</th>
<th>Wind Speed(m/s)</th>
</tr>
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<tbody>
<tr>
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<td>10.0</td>
<td>20.0</td>
<td>81.3</td>
<td>68.0</td>
<td>6.5</td>
<td>1.3</td>
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<td>Fe</td>
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<td>14.0</td>
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<td>58.0</td>
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<td>1.8</td>
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<td>Ma</td>
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<td>50.0</td>
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<td>2.1</td>
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<tr>
<td>Ap</td>
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<td>280.0</td>
<td>42.0</td>
<td>8.5</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Ma</td>
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<td>5.1</td>
<td>398.0</td>
<td>31.0</td>
<td>9.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Ju</td>
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<td>11.0</td>
<td>2.9</td>
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<tr>
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<td>0</td>
<td>583.0</td>
<td>22.0</td>
<td>11.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Au</td>
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<td>0</td>
<td>532.0</td>
<td>23.0</td>
<td>11.0</td>
<td>2.4</td>
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<td>10.0</td>
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<td>8.5</td>
<td>1.5</td>
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<td>57.0</td>
<td>7.3</td>
<td>1.3</td>
</tr>
<tr>
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<td>86.6</td>
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<tr>
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<td>97.0</td>
<td>3592.0</td>
<td>42.0</td>
<td>8.8</td>
<td>1.96</td>
</tr>
</tbody>
</table>

2. 1-6 THE CLIMATE:

The climatic information’s were provided from the General Commission of Meteorological and Seismic Monitoring (IMO, 2011). The climate records of the studied area are under the conditions of sub arid to arid areas in general, (Al-Kubaisy, 2004). This climatic data records indicate that the average annual rainfall is (97.6 mm), the average annual temperature is (24.4 °C), the total depth amount of (E Apan) is (3592 mm/year), the relative humidity is (42.8 %), the average annual sunshine is (8.85 hrs.) and the average annual wind speed is (1.96 m/s), Table (1-2).

Table (1-2) The values of the averages monthly for the climate elements for the period (1962-2011), (Iraqi meteorological organization, 2011).
2-1 **The Digital Elevations Model:**

The digital elevation model is the most useful types of geospatial data. The terrain attributes such as slope and drainage direction are derived from (DEM). A model of terrain traditionally relies on contours of equal elevation that define watershed boundaries, streams slope and orders. Within a GIS representation of terrain can be accomplished with contours, gridded elevations. The raster of DEM consists of an array of numbers representing the spatial distribution of elevations.( Philip B.,2008).

Digital elevation data are acquired through a GIS technique that relies on aerial satellite photography to produce a stereographic image. The interpolation of the elevation from the contours results in a regularly sampled grid of elevations, which are used to apply watershed drainage areas, Figure (2-1).

The watershed or basin area is an important physiographic property that determine the volume of runoff to be expected from a given rainfall event that falls over the area, (Philip B. Bedient, 2008). The watershed area is (2950 Km²) within the studied area. It is calculated by clipping the studied area boundary from the watershed of Wadi Al-Khur layer using the (GIS) technique. The performance of a water distribution system depends on variations in ground surface elevation, Figure (2-1).

2-2 **Watershed of the studied area:**

![Figure (2-1) DEM of the Studied Area](image)

The watershed divide is the loci of points (the ridge line) that is separate to two adjacent watersheds, which then drain into two different outlets, (Philip B. Bedient, 2008). The calculation of the studied area watershed image is based on outlet points. It is divided into several surface sub-basins. The main channel was
plotted from elevation vs. horizontal distance that is indicator of channels gradient, Figure (2-2).

**3-1 The stream network analysis:**

The streams network within the watershed is delineated from the catchment area. The network is containing short exterior links which represent valley side indentation or gully outlets (John G. Lyon, 2003).

**3-2 The streams order:**

In every drainage basin, small streams come together to form large ones and small valleys join more extensive ones. The stream order is devised to describe the arrangement of the network system. The first order stream is the smallest unit in the system which is one without tributaries. Where two first order streams is formed the second order stream. This unifying principle is applied through higher orders. The network ordering is used to find the catchment area at the upstream and downstream end of each link. This is used to calculate the direct drainage area, respectively, for each link in the network system within Wadi Al-Khur basin.

The predictable relationships are that the average stream length, watershed area, increases regularly with increasing order, average stream gradient decreases with increasing order, Figure (3-1).

**3-3 The flow directions:**

The flow direction is used to follow each link from its upstream end to its downstream end. Its generally flow towards (Northeast), Figure (3-2).
3-4 **The Streams gradients:**

The stream gradients are (2-5 m/Km), and mean slope is higher for the more turbid streams. Its indicate of the less amount of time required for water to travel from the higher most distant point of the watershed to the mouth of the primary stream , the velocity of flowing water inside the stream will be higher towards the higher order stream thus, the less amount of water will be infiltrated to the ground. Figure (3-3).

![Image](image_url)

**Figure (3-3) The Basin and Sub-basin gradient in the studied area.**

5. **THE DRAINAGE TYPE IS DEPENDENT ON LOCAL LANDFORMS AND THE TYPES OF ROCK AND SOIL PRESENT. THE STREAMS FOLLOW A BRANCHING DRAINAGE PATTERN CALLED DENDRITIC, FROM THE GREEK WORD DENDROS, MEANING “TREE.”**

DENDRITIC DRAINAGE PATTERNS ARE IRREGULAR WITH TRIBUTARIES AT VARIOUS ANGLES FROM THE MAIN STREAM (TREE TRUNK), (MCGRAW, 2008).

4-1 **Discussion and Conclusion:**

The computer program GIS version (10.1) is developed to assist the rapid parameterization of hydrologic surface models using DEMs. Its able to process limited resolution DEM data of low and high relief terrain to provide results that are both valid and consistent with the topographic characteristics to the land surface.

The studied watershed included flat areas and depressions along the valley bottom, and flat areas near drainage divides. The depression is artifacts of the DEM and have been removed by rising the elevation of the raster cells within the depression to the elevation of the lowest outlet points on the outside edge of the depressions.

The Wadi Al-Khur basin network parameters show reasonable results. These include: stream slop gradient (2-5) m/Km, The streams follow a branching drainage pattern called *Dendritic*. The stream flow direction is (northeast), and the main stream order is the fourth order. The soil classed as a clayey loam with Available
Water Capacity (AWC) of (50) mm, that mean the ground infiltration is very low and the expected seasonal water runoff is sufficient due to the climate parameters.

The advantage of DEM analysis in hydrology GIS methods is combines the subdivision of the Wadi Al-khur basin considering the direction of water flow with the watershed of the area. This is advantageous for modeling surface water of the Wadi.

5-1 References:
4. ESRI, Copyright © 1999-2011, GIS v10.1, 380 New York Street, Redlands, CA 92373-8100, USA.