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BADLANDS CREATED BY WATER EROSION IN ZONOUZ VALLEY IN IRAN

Dr. Seyed Esmaeil Asghapour Islamic Azad University, Shahre Rey Branch, Iran

e asghapour 12 @ vahoo. com



Zonouz river is located on 45° degrees and 46' minutes E longitude and 38° degrees 34' minutes N latitude between Aras river and Marand plain. It derives from Soltan-Sanjar mountain in the east and flows to the west. In Cher- Cher area, it joins to Zilbe

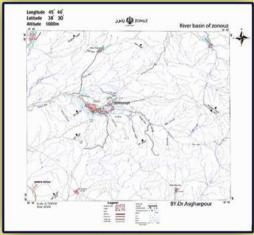
factors that affect on land crosion.

The volume of water varies during the seasons. It reaches to its maximum rate in April and minimum rate in August. In 1980 the average debit of river was 3.4.

After twenty eight years, there is a considerable change in river discharge. The purpose of paper is to show the terraces and alluvial fans before the dam are built on the river. Flow of water in the area plays a major role in creating landforms. Thus, fluvial processes are the geomorphic processes associated with running water and fluvial landforms and landscapes are produced by streams.

Rivers degrade (crode) and aggrade (deposit). Hence, the landscape contains degradational or crosional landforms which are created when rock is removed.

ositional landforms are resulted from the accumulation of sediment. Badland of Zonouz is an example of such an erosional landscape. Resistant material on hills has



Drainage density-the total length of the stream channels that exist in a unit area of a drainage basin. The higher the drainage density, the greater is the erosional efficiency Of the system. The entire drainage basin is likely to slope gently in the direction of the

Zonouz is a small town in east Azerbaijan province N.W of Iran, Situated in a semi-dry veographical region. It is located on 45 degrees and 46 minutes E. Longitude and 38 degrees and 39 minutes. N. Latitude.Its altitude is 1600meters above sea level. Two mountain ranges from north and south part surrounded it. They are connected to the highest mountain of area by name (Sultan Sanjar, its height 3168 meters) in the east Zonouz river which is considered a vital river for the inhabitants of area derives from

the west slopes of this mountain. flows to the west about 25 km (photo 2) The drainage basin of this river is 4630 km. The annual discharge of river which was measured in 2008 was 1.48 cubic meters in comparing to the last two decades its debit

gravel foundation on clay- core . The height of dam 60 meters and the length of crown is

The river irrigates 1600 hectares of farming lands and 400 hectares of orchard gardens Also, fresh water for residents of area are provided by this river. In Marand plain, it joins to Zilbir river and keeps on its running to the west. Near Khoy city, it joins to Aras river which is considered the largest river of Caspian sea (photo 4)

The method which used for preparing this paper based on three scopes

1.Study of area by observations and inquiries for along period of time. 2.GIS method for surveying topographic map of area.





Research method

Evolution of earth's crust and orogenic movements in Iran is not very clear. But in 1988 Termier has pointed out a great intercontinental rift occurred on the continent by name pangea. It was separated into two continents N Laurasia and S. Gondwana.

The geologic data show Iran was on Gondwanaland until the late of Devonian (405,000,000). The Saudi Arabia and Iran platform were separated. Each one created

In the Paleozoic period, a series of vertical orogenic movements happened on Cambrian and caused sudden changes to be created in lithologic layers.

Eftekhar Nezhad an Iranian geologist and geomorphologist believes that on the zonouz region. Also, a lot of orogenic activities have been observed in the mentioned areas since Precambrian. Hubert Rieben, a French geologist, his studies were done on Azerbaijan province of Iran. In 1935, he suggested that limestone sedimentation of Cambrian has lain unconfortably on Devonian depositions.

Rieben also pointed out about Hersinian orogenic movements that have occurred in Iran. He believed that the collision of N. Gondwanaland with European continent resulted to this orogenic movements in Azerbaiyan and Zonouz region. The orogenic movements of late Cretaceous period caused the sediment basins gradually to rise from the sea. This condition was being continued for the Paleocene time. Finally zonouz region like other part of Iran emerged from the sea. The formation of Eocene indicates that area was covered by shallow sea. After passing a long period of time, the tectonic and orogenic movements began and created some faults.

On the Quaternary, some alluvial terraces have lain on the upper- level surfaces in comparing to the base- level. These are the evidence of water erosion that occurred in the zonouz valley. Alluvial deposits in the upper part of river are coarse- grained size



Geomorphology of Zonouz

east and plain land in the west.map2 concerns to the topographic area of zonouz. Map 3 is an aspect map which affects on hydrologic processes and land erosion .Different kinds of erosion occur on the aspect of slopes and have caused various morphologic landscape

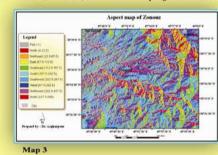
Topographic features of area can be divided into two parts: Mountainous area in the

to be created .Map 4 based on slope of the area which plays a major role on drainage system of river. Therefore, erosion acts severely when the slopes are steeper. Map 5 shows the height of area from east to the west are decreased. The region is divided from the lowest part 1215 meters to the highest point 3200 meters. The mountains and hills have given a specific landscape to the area. The most water sources of area are provided

Gradient(slope)of valley, the volume of water and form of valley play a major role on land degradation , when a gradient is more, the flow of water is very turbulent , by contrast the lower portion of river has very low gradients. Map 4 shows that deep and mountain has different structure .Old and young terraces were formed in the west part of river .Also the sediments of Quaternary are observed here .Red and green gypsiferous marl have formed the Badland of Zonouz Jocated in south part of the city Map 6 based on satellite images for collecting data via an appropriate imaging system



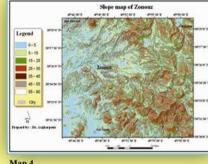
for basic maps .For this purpose, topographic map of Tabriz was provided based on 1:25000 scale It was necessary that study of area must be separated .Distance of contour-lines are 10 meters. The main river, Water channels tributaries of rivers, main roads urban area ,rural area ,and distribution of springs are needed to be extracted by



Aspect is the major factor which affects on hydrologic processes and land erosion Aspects of slope are influenced by variety of vegetation and snow melting.

increases on the mountainous area. Soil layers on aspect of slopes are heated to higher temperature and temperature is changed by elevation .Different kinds of erosion occur on the aspect of slopes .It causes different morphologic forms to appear .Therefore ,It is necessary that the aspect map of region is provided in order to be understood that how

Aspect map of Zonouz was provided by using digital elevation model (DEM) which based on GIS . The aspect map of Zonous is classified into eight states. North, northeast east southeast south, southwest ,west ,northwest and flat area .It indicates that south



The study of land erosion and slopes based on geomorphologic processes. The slopes of mountains in this area have made not only a beautiful landscape in the nature ,but also

significant and complicated geomorphologic forms of the area. Steep slopes, velocity and volume of water are the main agents on land erosion .So ,mechanical erosion acts severely when the slopes are steeper. The steeper slopes

decrease the water penetration, consequently ,soil formation will be limited. The slope map was provided by using the Digital Elevation Method (DEM)with the

particularity of 20 meters pixels by seven classes. The distance of gradient levels are 10 degrees. Therefore ,the gradient of region was classified from the lowest elevation to the highest. The gradient of region shows 0 degree to 80 degrees.



Digital Elevation Model (DEM) which is used for showing elevation of places on the map .It generally shows a series of elevations on the earth, s surface .The model indicates that the elevation-rate based on a triangular grid. Some definitions can develop the scope of DEM. Therefore, it includes any kind of digital demonstration of places on the earth such as TIN or contour-lines on the map must be changed into digital forms in order to

So, a three-deminsional model should be provided by 20 meter pixels by seven classes. The distances of elevation levels have been 300 meters .The region has been divided from the lowest part of elevation 1215 meters to the highest elevation 3200 meters. A vast part of area was located between 1215 to 2000 meters from the sea level .It implies that the area is severely eroded by Zonouz river basin.

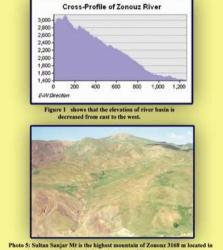


being in direct contact with the object or scene itself

Geographers who use this method normally collect data via an appropriate imaging system ,interpret that spatial information, and display and communicate the results on a

For this research, a sophisticated satellite image was used. Sophisticated satellite image ETM consists 8 spectral bands.7 color bands for identifying place separation of 30 meters, and a panchromatic band for distinguishing place separation of 15 meters .Also ,satellite image helps us to identify the realm of regional studies, separating the

Briefly ,the results which obtained from remote sensing and GIS for study of land

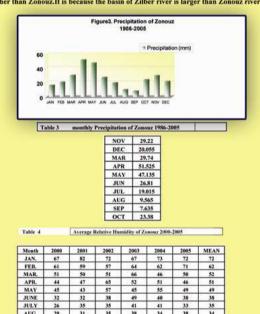


Effect of climate on erosion

It is significant to know that the rate of precipitation affects on the flowing of river .Land erosion depends on the precipitation and current of river. The land is eroded

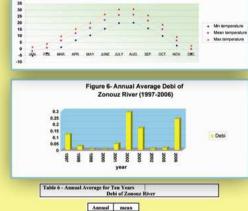
precipitation of this area reaches 250-300 millimeters .The maximum temperature is 30.7 centigrade in July and minimum temperature -5 centigrade in January. The relative humidity reaches to the highest point 72 percent in January and December .The precipitation-rate ,relative humidity and temperature are shown by table 3,4, and 5

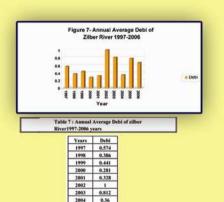
Table 6 shows the average annual debit of Zonouz river since 1997-2006.Its discharge reached to 0.289 in 2002. Table 7 concerns to annual average discharge of Zilber. Its debit was one cubic meter per second in 2002.In comparison ,the discharge of these two rivers which are located at the same area .We understand that the debit of Zilber is higher than Zonouz.It is because the basin of Zilber river is larger than Zonouz river.











Water erosion in Zonouz valley

Erosion is displacement of solids (Soil, mud, rock and other particles) usually by the agents of currents such as wind, water, ice, humans. Two kind of erosions were recognized in this area. Water erosion, and weathering, weathering and erosion are geological processes that act together to shape the surface of earth. The rate of erosion can be estimated by the amount of sediment (Particles and dissolved material) carried by zonouz river varies widely depending upon climate, topography, rock type and

Streams are the most important sculptors of terrestrial landscapes. The erosion of hills slope comes flowing water as the principal creator of landforms and landscapes, so water plays a major role in modifying the surface hills. The ancient Latin word for river was fluvius from which is derived the term fluvial to denote running water. Thus fluvial processes are the geomorphic processes associated with running water, and fluvial landforms and landscapes are pronounced by streams. The rivers degrade (erode) and aggrade (deposit). Hence, the landscape contains degradational or erosional landforms Created when rock is removed, and aggradational or depositional landforms, resulting from accumulation of sediment. zonouz valley is essentially an erosional landscapes.

History of erosion

"Allah sends down the water from the clouds ,water courses flow (with water)according to their measure and torrent bears along the swelling foam"(Thunder, verse 17,Qur an)

Hydrologic cycle: water evaporates from surface of oceans makes clouds, condensation of water in clouds make precipitation on the land and back again to the oceans. This does, so it carries the products of weathering with it.

Rainfall comes in different forms. from the steady, gentle rain to the violent heavy down pour associated with spring thunderstorm, during drizzle, the soil generally is able to absorb all or most of the water because its infiltration capacity (the rate at which it is able to absorb water from the surface) is not exceeded. But when rail falls at higher intensities, it may saturate the soil and exceed the infiltration capacity, resulting in run off many small, temporary streamlets form and with such run off comes erosion.

Large, heavy raindrops dislodge soil particles in a process called splash erosion. If the exposed soil lies on a slope, splash erosion results in down slope transfer of soil. The steeper the slope the faster this degradation proceeds. If the rate of erosion, over a long term, exceeds the rate of soil formation, the slope will lose its soil cover and suffer denudation wherever vegetation cover is dense, erosion is generally slight. But where natural vegetation is removed to make way for agriculture or perhaps decimated by overgrazing, accelerated erosion

Rain that is not absorbed by the soil run off as sheet flow, sheet flow is a thin layer of water that moves down slope without being confined to channels. This thin film of water can cause considerable erosion as it removes fine grained surface materials such sheet erosion is an important degradational process in certain areas. Especially in bare slope which is unable to absorb water rapidly. Continued run off causes initiation and growth of small channels called rills that may merge into larger brooks or creeks, and these in both water and sediment become part of the river system that is in the process of

Drainage basins of zonouz are separated by Sultan saniar mount, Gharannok Darreh, Adineh, Diraghah, Gerd Ovol, Gebla Daghi, water from the western slope of sultan sanjar flows into the zunoz river, water on the eastern slope of this mountain flows into

To determine the erosional activity of zonouz river based on quantity of sediment that passes a cross-section of the zonouz river near its mouth another set of measurement identifies every stream segment of the network and the sedimentary load carried by carried out of it at the mouth of its trunk river. But this is not always become true. These are conditions that influence the rate of erosion. Obviously, the amount of precipitation is a factor. The more water available, the more erosion can take place. But the cover of vegetation also plays an important role because it inhibits erosion. The relief slopes are less steep. Water moves slowly, and erosion is less active than in a basin where relief is high. Another factor is the underlying lithology. Soft sedimentary and weak metamorphic rocks are degraded much more rapidly than hard crystalline rocks. We must also consider human impact to be a factor influencing on erosion rates of zonouz

The main functions of Zonouz river can be grouped into three stages:erosion (degradation) transportation (transfer) and deposition (aggradation). Zonouz river flows rapidly, even wildly in mountainous areas in the eastern part of Zonouz and many tributaries join to it in the eastern part and rush down slope in deep valleys, it

resembling a v-shape. Near Sildrim in Charaza area. Zonouz river is the most important and efficient of all agents of erosion, continuously

modifying its valley and changing the landscape. So, stream power , velocity of river and idient of slopes are the most significant factors on erosion

A .Streampower or stream capacity refers the maximum load of sediment that a stream

can carry with a given discharge or volume of water. It is obvious that a stream with a large discharge has a larger capacity than a smaller stream. B . The velocity of a stream ,therefore, is a critical factor in its ability to erode and

transport. As a rule ,water velocity is greatest in the middle of the channel .But near the bank and on the river bottom the velocity is slowest because friction between water and rock slows the water s motion. C. The gradient or slope, is the key factor in a stream s velocity whereas, a wide

Water erosion is a land erosion that takes place by running of water and rainfall. Three

Splash erosion is the detachment and airborne movement of small soil particles caused by the impact of raindrops on soil. Sheet erosion is the detachment of soil particles by raindrop impact and their removal down slope by water flowing over land. Once the rate of falling rain faster than

Rill erosion refers to the development of small ephemeral concentrated flow paths,

which function as both sediment source and sediment delivery systems for erosion on The rill bed surface changes as soil erodes, which in turn alters the hydraulics of the

flow velocity, depth, width, hydraulic roughness, local bed slope, friction slope, and detachment rate time and space variable functions the rill evolutionary process. There are four processes in transportation when a river transports its load:

Traction: refers to the sliding or rolling of particles along the river bed. Saltation: indicates the speed of the water lifts these fragments off the river bottom Suspension: In this stage, very fine sediment ground down to sit and clay sized particles

Solution: On this process, some rock material dissolved in stream water and is carried down river in solution.

Erosion, transportation and deposition are three phases of a single activity which occur in this river. The larger materials are carried in the upper part of river where stream Frosion (degradation) is the main activity of river which occurs in the upper parts

whereas deposition (aggradation) takes place in the lower parts of the river. Rainfall, weathering and type of soil are three factors that have caused the badland of

Zonouz was formed. (photo 1....)

It should be mentioned that water erosion on the bare slopes are extremely more intensive than gentle and vegetated slopes.

6the-9th september 2009 in magdeburg, Germany

Soil creep appears to result from the alternate freezing and thawing of soil particles or

from alternate periods of wetting and drying

Fall, or the downslope rolling of pieces of rock that have come loosened by weathering Landslide, soilcreep and fall movements accur in Zonouz valley. Soil creep appears to

result from the alternate freezing and thawing of soil particles or from alternate periods of wetting and drying.Fall,or the downslope rolling of pieces of rock that have come loosened by weathering occurs on andesite rocky wall of Zonouz valley. Water erosion which occurs in Zonouz valley can be seen in three ways: hydraulic action, abrasion and corrosion:

1. Hydraulic action: It refers the work of water, as it dislodges and drags away rock aterial from the valley floor and sides.

2. Abrasion refers to the erosive actionof boulders, pebbles and small grains of sediment as they are carried along the river valley. 3. Corrosionis theleast important form of erosion by river. It is the process by

which certain rocks and minerals are dissolved by water. Three significant factors should be considered in studying of Zonouz river.

1. drainage basin, the region occupied by a complete stream system formed by the

trunk river and its tributaries (as known as watershed). 2.channels: the rain that is not absorbed by the soil runs off as sheet flow. Sheet flow is a thin layer of water that moves down slope without being confined to

channels. It removes fine- grained surface materials 3. Alluvial fan:a fan- shaped deposit consisting of alluvial material located where a

mountain stream emerges onto a plain. The larger materials that river can not move are remained in upper parts of river, where as smaller grains such as pebble, grovel, sandstone silt sand carried to the

lower part.Zonouz river which derives from SultanSanjar mountain in the east. It passes through a deep valley.

The movement of materials related to the speed of river. Cobble, gravel, boulder can be transported when the velocity of river is exceeded. Fine- grained material like siltstone, mudstone are transported when velocity of river decreases.

The main agents which affect on the erosion of Zonouz valley are as follow 1. Steep of mountain slopes 2. Composition of soil 3. kind of soil 4. Human's effects 5. Variety of relief and rugged 6, bare slopes of mountain 7, shape of mountain The high rocky cliff is located on the left side of zonouz river which extended to the

The cliff is made of granite stone. It is an impermeable stone. The erosion can be seen here in the form of fall movements. Free fall, or the down slope rolling of pieces of rock that have become loosened by weathering. Such rock fragments and boulders usually do not go far, ending at the base of cliff. The accumulation of rock fragments, large and small, at the foot of the slope. Rockslides and falling of stones are a constant hazard for the gardeners (photo 6).



river. The downslope rolling of pieces of rock have become loosened by weathering. In the left bank of river near Sildrim, the landslide has occurred since 1955 and are being continued for today. Three principal type of weathering are as follow

1. Mechanical weathering also called physical weathering, takes place when rocks are broken down without any change in the chemical nature of the rocks. Mechanical weathering can be seen in three states: Frost action, frost creep and frost

2. Chemical weathering it involves the change in the composition of rocks, often leading to a breakdown in its form. Type of chemical weathering are:

3. Biological weathering It is through the break down of rocks and the accumulation of a layer of minerals that plants can grow plants whose roots contribute to the

4. Human activity contributes to various forms of weathering in a number of ways:

2- by exploiting of mines

3- by farming

Conclusion I. Seasonal flooding of this river based on local torrential rain that occurs or

the mountain area ,consequently it has resulted to the land degradation. 2. Overgrazing of area by herds can be considered soil erosion. 3. The bare slope of mountain and loose soil are exposed to be eroded more

4. In the upper course of river, erosion is vertical that is because the water is being

pulled downwards by gravity. This forms deep V-shaped valley. 5. In the lower course of river, erosion is lateral ,this forms a wide river channel

6. The higher-gradient slopes are eroded more than the lower-gradient ones. 7. Northern or southern slopes have different erosional forms. 8. There are two kind of precipitations: cyclonic precipitation and convective

9. The coarse-grained size sediments were observed in the upper part of river

,whereas fine-sediments accumulated in the lower part. 10. Seasonal and alternating movement of livestock between two regions as 11. Three kind of erosions were recognized landslide, fall movement and

creep.Erosion in the form of physical weathering which occurs on the andesite

12. Landslide happens when the upper layer of soil is permeable but the lower layer of soil is impermeable. 13. Erosion in the west part of region is more than the east ,it is because

rocky wall in the left side of river (photo 5).

vegetation of western slopes are fairly poor. 14. Construction of road for exploiting the Kaoline mines in Zonouz has intensified

15. The massive lithologic layers and steeper slopes which dominate on a vast 16. Man-made erosion ; such as farming can speed up the erosion process.

Strategies and methods which should be exerted in controlling of water erosion in Zonouz region.

water from flooding bordering land.

2. The flood course must be directed toward the main channel. 3. Flood storages should be constructed by cooperation of people and local

4. Flood mitigation reservoirs are needed to be established. 6. Dikes must be built across the river.

9. Construction of dams ,reservoirs ,river embankments are essentially needed to

10. Terraces should be built on the hillside in controlling land erosion

erosion.

12. Parallel grooves should be made on the surface of slopes in the opposite side

 Asgharpour, seyed Esmaeil. Thesis: study on subsistence & nature of Zonouz valley, Tehran university, Iran 1977.
 Willett, Son D. Tectoole, climate and landscape evolution geological society of American special paper 2006.

3- Geological survey of Iran: Geologic map of Julfa county, Scale 1: 100.0000 4- Geographic surverying organization of Army forces, Iran, 2006,
5- General department for surfacial waters of Tabriz province. Data based on rivers 2006.
6-Holy Qur an Ansariyan publications, Islamic republic of Iran, Thunder (RAD)page 229, verset 7, 1993

7- Rieben, Hubert, geologic of Azarbaijan, Iran 1946 8-Jensen, John R. Remote sensing of environment : an earth resource perspective published by Prentice

management of Iran ,s Geomorphologic and Environmental data 2008 10- Muller, peter, o Physical geography of global environmental, John wiley & sons. Inc 2996. 11- Meteorology department of Tabriz, a report on rain fall in zonouz weather station, 200 12- Meteorology organization of Islamic republic of Iran, data on temperature, rain fall and humidity in