

# International conference on Land and water Degradation

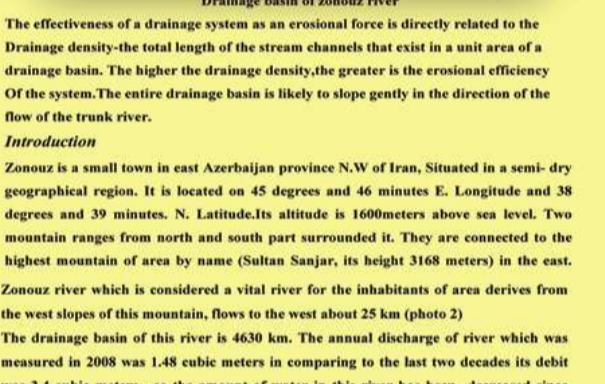
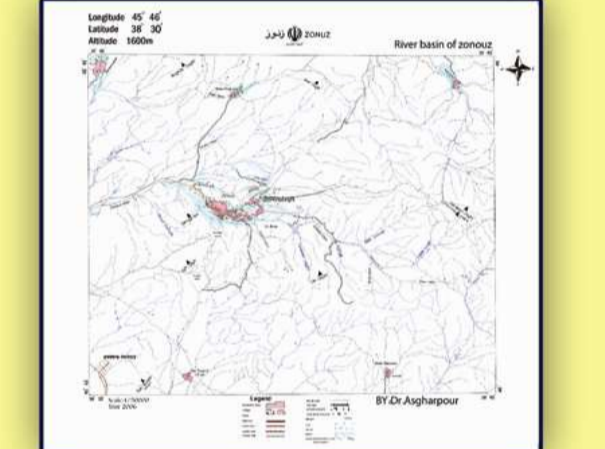
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## BADLANDS CREATED BY WATER EROSION IN ZONOOUZ VALLEY IN IRAN

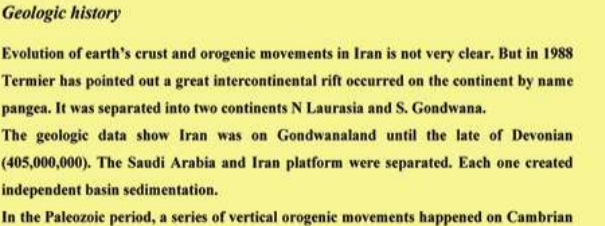
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**Abstract:**  
This study focuses on the badlands created by water erosion in Zonoouz valley. Zonoouz is a small Iranian town in the East Azerbaijan province N.W. of Iran. It is located between two mountain ranges and has very cold and snowy weather in winter and cool summers. River terraces and alluvial fans which were built by Zonoouz river are considerably important in that area.  
Zonoouz river is located on 45° degrees and 46' minutes E longitude and 38° degrees 35' minutes N latitude between Aras river and Marand plain. It derives from Sultan-Sanjar mountain in the east and flows to the west. In Cher-Cher area, it joins to Zillber river and finally enters to the Caspian sea. This paper based on GIS methods, topographic map 1:50,000 and geologic map 1:100,000 scale in order to find out, the elevations, hydrographic layers, lithologic layers and orogenic movements which have affected on degradation of zonoouz valley.  
The amount of rainfall, type of soil, gradient of land and speed of water are the main factors that affect on land erosion.  
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 process associated with running water and fluvial landforms and landscapes are produced by streams.  
Rivers degrade (erode) and aggrade (deposit). Hence, the landscape contains degradational or erosional landforms which are created when rock is removed. Depositional landforms are resulted from the accumulation of sediment. Badland of Zonoouz is an example of such an erosional landscape. Resistant material on hills has given a beautiful shape to the hills (Photo 1).  
Key words: erosion, landform, landscape, aggradation, degradation, fluvial.



**Map 1: Geologic of Julla**  
Topographic features of area can be divided into two parts: Mountainous area in the east and plain land in the west. map 2 concerns to the topographic area of zonoouz. 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 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 by these mountains.  
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 narrow valleys are placed in the east, while wide valleys are placed in the west. Each 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 Zonoouz, located in south part of the city. Map 6 based on satellite images for collecting data via an appropriate imaging system.



**Map 2: Drainage basin of Zonoouz river**  
The effectiveness of a drainage system as an erosional force is directly related to the 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 flow of the trunk river.  
**Introduction**  
Zonoouz is a small town in east Azerbaijan province N.W of Iran, Situated in a semi-dry geographical region. It is located on 45 degrees and 46 minutes E. Longitude and 38 degrees and 39 minutes N. Latitude. Its altitude is 1600 meters 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. Zonoouz 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 was 3.4 cubic meters, so the amount of water in this river has been decreased since 1985.  
In 2004, a reservoir dam was built on this river. The dam was established on a sand-gravel foundation on clay-core. The height of dam 60 meters and the length of crown is 177.5 meters (photo 3).  
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 Zillber river and keeps on its running to the west. Near Khoy city, it joins to Qator Sue makes a large river, then it changes its course to the north, finally enters into Aras river which is considered the largest river of Caspian sea (photo 4)



**Photo 5:** Sultan Sanjar Mt is the highest mountain of Zonoouz 3168 m located in the east, and considered the main source of Zonoouz river



Month	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	
JAN	47	82	72	47	73	72	73	72	72	71	82	71	82	72	82	82	71	82	71	82
FEB	41	59	57	64	64	62	63	71	82	72	82	71	82	72	82	82	71	82	71	82
MAR	51	59	51	66	66	66	66	70	52	52	52	52	52	52	52	52	52	52	52	52
APR	44	47	49	53	51	49	51	49	51	49	51	49	51	49	51	49	51	49	51	49
MAY	45	43	47	45	45	45	45	49	49	49	49	49	49	49	49	49	49	49	49	49
JUN	32	32	38	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49	49
JULY	26	35	35	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
AUG	29	31	35	38	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34	34
SEPT	37	33	31	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
OCT	52	48	47	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
NOV	41	43	43	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45
DEC	78	71	72	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75	75
Annual	49	50	51	54	52	50	51	52	51	52	51	52	51	52	51	52	51	52	51	52

Month	2000	2001	2002	2003	2004	2005	MEAN
JAN	67	82	72	47	73	72	73
FEB	41	59	57	64	64	62	71
MAR	51	59	51	66	66	66	70
APR	44	47	49	53	51	49	51
MAY	45	43	47	45	45	45	49
JUN	32	32	38	49	49	49	49
JULY	26	35	35	41	41	41	41
AUG	29	31	35	38	34	34	34
SEPT	37	33	31	43	43	43	43
OCT	52	48	47	45	45	45	45
NOV	41	43	43	45	45	45	45
DEC	78	71	72	75	75	75	75
Annual	49	50	51	54	52	50	51

Month	min temp	max temp	mean temp	max temp
JAN	-5.1	-1.6	1.6	1.6
FEB	-3.2	0.8	4.3	4.3
MAR	1.5	6.4	10	10
APR	4.8	13	14.7	14.7
MAY	10.5	19.3	20.3	20.3
JUNE	15.8	23.4	24.8	24.8
JULY	19.9	26.1	26.7	26.7
AUG	20.2	26.3	26.7	26.7
SEPT	16	21.9	24.2	24.2
OCT	10	18.1	19	19
NOV	5.6	13.5	14.6	14.6
DEC	-3.7	-0.2	2.8	2.8



Year	Debit
1997	0.519
1998	0.328
1999	0.385
2000	0.391
2001	0.446
2002	0.289
2003	0.188
2004	0.309
2005	0.815
2006	0.739

Two main faults were recognized on the zonoouz river bed. They have extended NW to SE and NE to S.W direction. Also a minor fault extended east to west direction (see geologic map 1).  
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 zonoouz valley. Alluvial deposits in the upper part of river are coarse-grained size sediments whereas fine-grained deposits are accumulated in the lower part of river.

**Geomorphology of Zonoouz**  
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**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 more when there is much rain.  
The climate of Zonoouz is influenced by Siberia and Mediterranean climate. The annual precipitation of this area reaches 250-300 millimeters. The maximum temperature is 36.7 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 respectively.

Table 6 shows the average annual debit of Zonoouz river since 1997-2006. Its discharge reached to 0.289 in 2002. Table 7 concerns to annual average discharge of Zillber. 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 Zillber is higher than Zonoouz. It is because the basin of Zillber river is larger than Zonoouz river.

**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 unceasing circulation of water ensures the continuation of fluvial erosion because the water that falls on the elevated landmasses will always flow back toward sea level as it does, so it carries the products of weathering with it.

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 often results.

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 as silt and clay. This 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 turn coalesce into more permanent streams. This water carries sediment with it, and both water and sediment become part of the river system that is in the process of shaping the regional landscape.

**History of erosion**  
Allah sends down the water from the clouds, water courses flow (with water) according to their measure and current hours along the swelling foam (Thausder, verse 17, Qur an).

**Drainage basin of Zonoouz river**  
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**Research method**  
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.  
3. Library resources.

**Aspect map of Zonoouz** was provided by using digital elevation model (DEM) which based on GIS. The aspect map of Zonoouz is classified into eight states. North, northeast, east, southeast, south, southwest, west, northwest and flat area. It indicates that south and southwest slopes receive the most amount of the sun, s heat

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**Slope map of Zonoouz**  
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 play a major role on drainage system of river. Therefore, the slopes have been the significant and complicated geomorphologic forms of the area.  
Slope, slope 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.

**Three-dimensional map of Zonoouz**  
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 determine the elevation of places.  
So, a three-dimensional 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 Zonoouz river basin.

**Evolution of earth's crust and orogenic movements in Iran** is not very clear. But in 1988 Terrier has pointed out a great intercontinental rift occurred on the continent by name panges. 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 independent basin sedimentation.  
In the Paleozoic period, a series of vertical orogenic movements happened on Cambrian and caused sudden changes to be created in lithologic layers.  
Eftekar Neshad an Iranian geologist and geomorphologist believes that on the paleozoic period, a series of erosions occurred in west Elborz mountain in Tabriz and zonoouz 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 unconformably on Devonian depositions.  
Rieben also pointed out how Hersinian orogenic movements that have occurred in Iran. He believed that the collision of N. Gondwanaland with European continent resulted in this orogenic movements in Azerbaijan and Zonoouz 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 zonoouz 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.

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