A Study on Geomorphic Processes and Forms and Groundwater Resources with Using RS-GIS

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Abstract: There are a number of elements impacting the expansion of current groundwater resources, including the role of structural operators viz. faults, seams and gaps, lithological agents among them are the structure of region and topographical elements like the slope and the height of the area in question. Geomorphologic processes and forms are among the most important elements controlling the supply, direction of flow, quality and quantity of groundwater resources and have a serious impact on them. For this reason, in current research, incorporating field studies with remote sensing (RS) we embark providing different maps of affecting factors on groundwater resources and finally incorporating them in Graphic Information System (GIS) which leads to geomorphic map of Saremsaghloo-Gharecharyan map in the Zanjan province. Afterwards, the figures and phenomena obtained are used as a ground for comparison and evaluation of their relationships with groundwater resources in question. According to the conclusions obtained from current research, there is a close relation between geomorphologic phenomena and groundwater resources which shows the possibility of using geomorphologic phenomena for locating groundwater resources. One can mention, according to these facts that plain's north highlands, floodplains, alluvial terraces and alluvial fans are among the most influential elements affecting groundwater resources. On the basis of relation between geomorphologic phenomena and groundwater resources, those regions capable of groundwater resources were diagnosed. After that, a number of suggestions have been putted forward for reinforcing and improving the Saremsaghloo plain, like locating appropriate places for artificial feeding of groundwater resources and constructing underground dams in those areas having groundwater and proper context.
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1. Introduction:

A study on history and birth of geomorphology shows the fact that from the mid-twenties onwards concentration on intrinsic subjects of geomorphology and also its relation with other scientific phenomena leads geomorphology to improve at high speed and using relations between forms, geomorphologic processes and humanistic data, to put the weight on its pragmatic aspects including programs and region constructions. On current time the relation between geomorphology and other disciplines like: ecology, geology, botany, climatology, hydrogeology and agrology yields the possibility of facing all problems of an ecosystem in coherence with other scientific perspectives including geology, rangelands, watershed, desertification, forestry and environment and is an opportunity for geomorphology to play its role.

In current research incorporating remote sensing sciences (RS) and Graphic Information System (GIS) with geomorphology and hydrogeology we embark indentifying and providing different kinds of forms and geomorphologic processes in the plain in question. Afterwards incorporating information and maps obtained and also field operations, we sought identifying relations between groundwater resources and geomorphologic phenomena. Abdi (1379) in his research sough studying sedimentary characteristics of quaternary deposit of Zanjan's plain in order to locating proper places capable of artificial feeding and regards most of the sedimentary environment to be under the kind alluvial fans. And also he regards the amount of decline in groundwater to be approximately 10 m and regards the extent of groundwater aquifer of the plain to be 550 km and the volume of aquifer as 1713 million cubic meters. Afterwards on the basis of existence of aquifer's null volume and surface runoff (which is nearly 200 million cubic meters each year) in Zanjan's plain, he has located the proper place for running the artificial feeding projects.

Mousavi (1382) in his research has sought clarification the impact of distribution of floodwater on Gharecharyan's plain and has gained the conclusion that discharge of wells and subterranean in the area in which floodwater is distributed have had a salient progress and the water permeated due to floodwater distribution lattice is the cause of increasing the groundwater level and is what due to which the amount of discharge of wells and

subterranean has been much more in comparison with other regions.

RAO (2002) has carried out some geomorphologic studies in some parts of the capital and east coasts of India and emphases on immerging filed studies with remote sensing for the aim of clarifying geomorphologic phenomena.

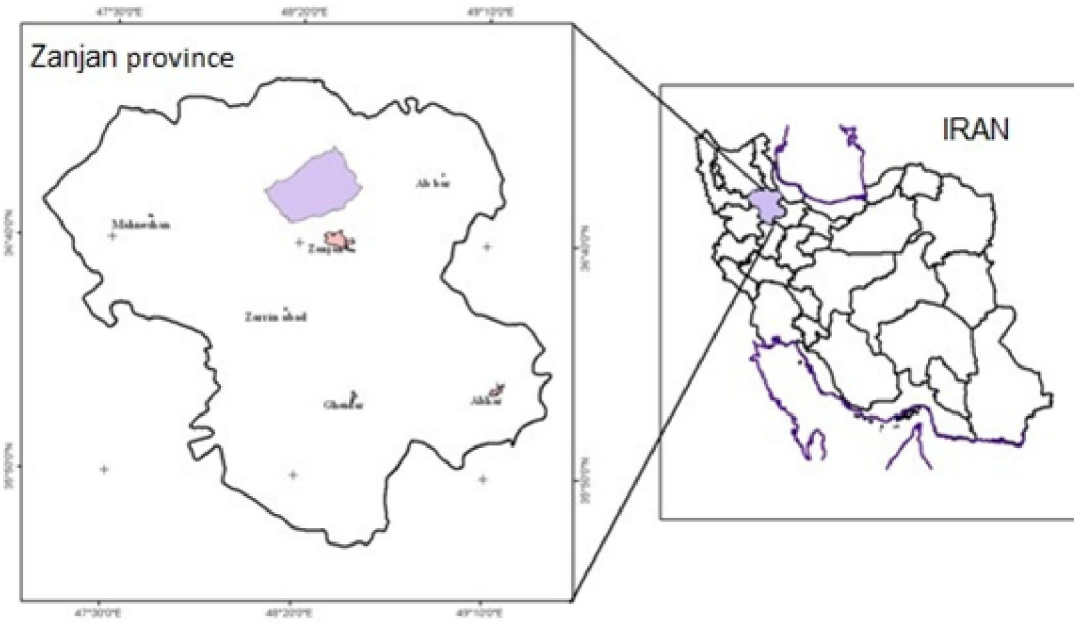
An interesting study on United States highlands has been carried out by Warren (2010) about the impact of groundwater resources on geological, geomorphologic and paleo climate phenomena of the region, the conclusion shows the mutual interaction of all geological phenomena and groundwater resources on the storage and distribution of water in area in question.

Hasani Shari'at Panahi (1384) has sought clarification the geomorphologic role of characteristics of Haj-Ali-Gholi's north water resources. He also has gained the conclusion that where the alluvial fans have met is the proper place for artificial feeding of groundwater resources in this region. Also he regards highlands of the region to be responsible for water absorption and rainfall and responsible for water supply needed for desert. He regards that these regions being tectonized to be the cause for more absorption of water and springs appearing and groundwater resources feeding. Finally without any point to environmental threats of underground dam's construction, he recommends running such projects in the area.

Current information suggests that there is not extensive and comprehensive research about the impact of geomorphologic phenomena on groundwater resources particularly within our country. Also the history of research and study in this field goes back to recent decades, hence despite existence of studies up to now, it seems that continuing scientific efforts stemming from complicated relations of geomorphic phenomena with groundwater resources, until clarification its different aspects seems to be necessary.

2. The Study Area

Saremsaghloo-Gharecharyan's plain is located in northwest of Iran and is 15 kilometers far from northwest area of Zanjan. This plain is located between geographical lengths 40, 10', 14" to 48, 34', 40" from east and geographical widths 36, 46', 03" to 37, 00', 50" from north (map 1). Saremsaghloo-Gharecharyan's plain is a rectangular plain the area of which is 64197/4 Hectare and is restricted from northeast to Tarom mountains, from Southwest to Zanjanrood river, from southeast to Saremsaghloo river and from northwest to Gharecharyan river. The maximum height of area is 2900 meters in northwest parts of the plain located in Tarom's mountains and its minimum is 1380 meters located near Zanjanrood river. The climate of the region is semi-arid and the average of rainfall within statistical period 1347-1377 equals 340 millimeters. Generally in this plain there are 21 villages, the most important of which is Sohrain village with 2000 persons.

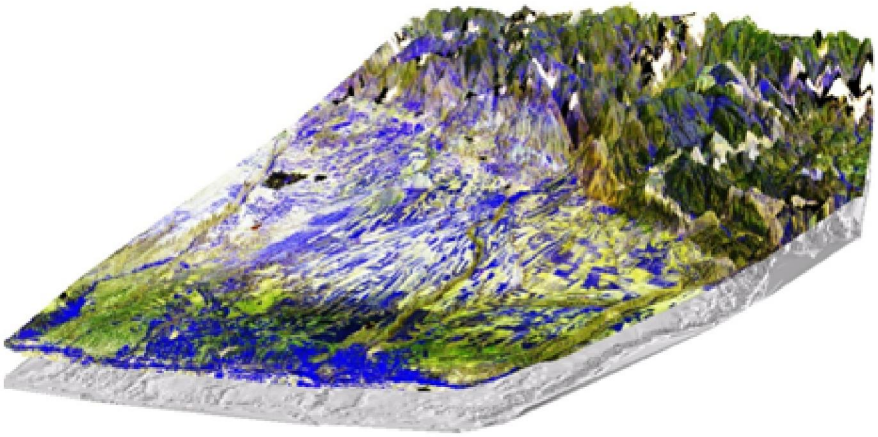


[Figure 1]Location of the study area in Zanjan province & IRAN

3. Material and Method

Research's pattern, is grounded on incorporating information with provided maps and with field information. On first step we embark controlling and to provide maps and information attained from different sources. Also for providing data needed and controlling and correcting geomorphologic map we used Aster satellite (2010). For preparing these pictures, limited map of plain used for satellite cut in I1wis 3.6 software. Afterwards pictures of each band offered for plain and fake colored pictures of these maps have been provided. We used auxiliary Arc Hydro in the environment of ArcGIS 10.1 for correcting canal maps (measure 1: 25000). Using categorical maps provided in aforementioned steps (i.e. topographic maps, slope, geology, lithology, waterways and …) and putting them together with satellites pictures, the primary geomorphologic maps (including forms and geomorphologic processes) has been created.

To put a gloss on topographical situations and plains different figures, fake colored pictures from Aster maps became three dimensional by using Digital Elevation Model (DEM) (figure 2). Then using optical view of maps and putting together geomorphologic maps with them, the limit of forms and processes specified on the map was controlled and corrected.



[Figure 2]Pseudo three-dimensional image of the plain

Also the limit of alluvial fans and alluvials on plain has been specified at high precision. For ultimate controlling provided maps, using DNR Garmin software, this map was conveyed to a GPS system and with satellite navigation systems, the map was corrected via outdoor operations. The final conclusion gained from immerging field information, provided maps and satellite pictures, is geomorphologic picture of the area which consists of forms and different geomorphologic processes in the region. On the second step using collected stats about groundwater resources including wells, springs, subterranean… and running field operations, the location of existing water resources in the plain and their transmittance map was provided and their characterizations were putted under scrutiny. In this step the plains water resources map was provided.
Finally, combining information, maps at hand and providing information bank, the relation between existing geomorphologic phenomena with construction, the amount of supply, direction of flow and groundwater situation… was putted under study, also the most important phenomena and geomorphologic figures influencing groundwater resources was identified.

4. Existing Geomorphologic Units in Area under Study

Phenomena and geomorphologic figures of earth's surface on the one hand is a conclusion of operating constructive forces of inert process, which are named as constructive process and on the other hand these phenomena are under the influence of outer elements, most of which are raised from climate process and factors (Asghari Moghadam 1386). In this section we have studied these phenomena, constructive and Morphotectonic processes and dynamic morpho climate factors in two major sections, and on this ground the geomorphologic map would be offered.

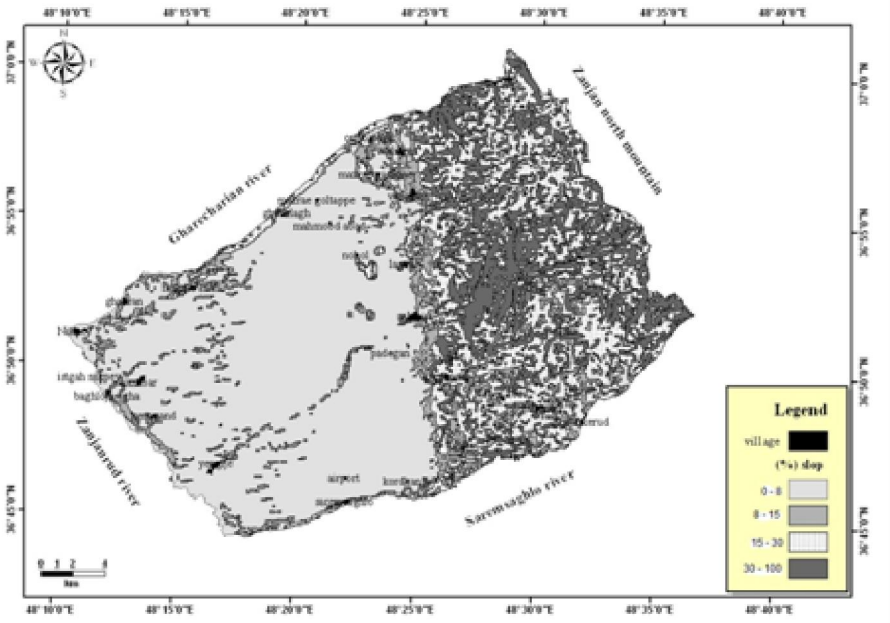
5. Constructive Process

Generally, constructive processes in Saremsaghloo plain have three different morphological aspects.

6. Highland and Mountains Unit

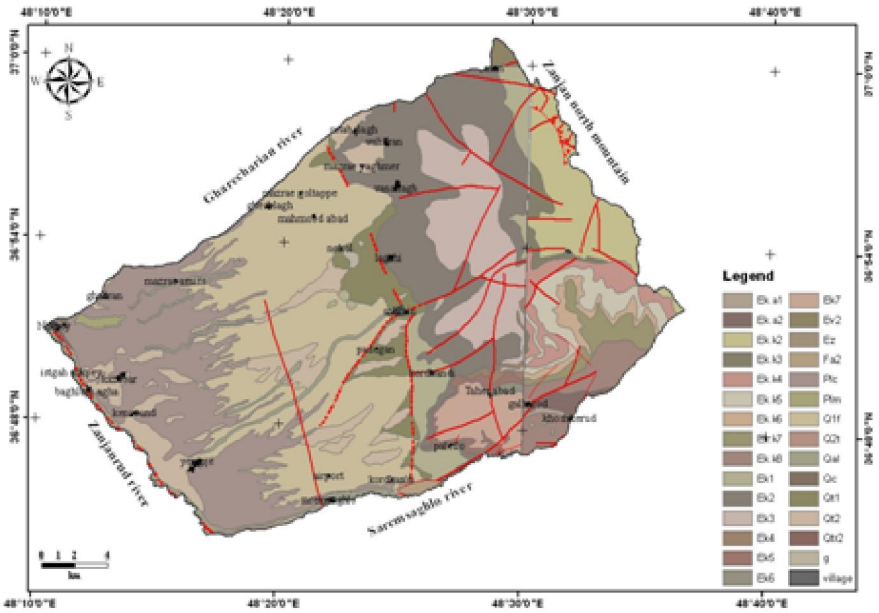
This mountainous area encompasses all north heights of the plain the slope of which is 25 percent ([figure 3]. The highest point of that part is Khairolmasjed mountain (2900 meters from sea). After regular conglomerate sedimentation, the

Eocene sequence of this region includes igneous rocks and tuff sedimentations. These sediments have the thickest height in this mountain. The separator line of these heights go cross flat lands from the north of villages Sohrain, Vanangh, Urtablagh, Legahi, Kordkandi, Golehrud and Valiaryan. Due to abundance of slope and highlands geological situation, lands are predominantly grasslands and agricultural activities are limited. Due to snowy and cold nature of these heights and the direction of the most mountains slopes which are directed toward sun, weathering has influenced them and has caused construction of medium and large debris in these regions [figure 3]. In these areas freezing water, vegetation and decomposition of rocks be means of plants roots and temperature variance yield such weathering.

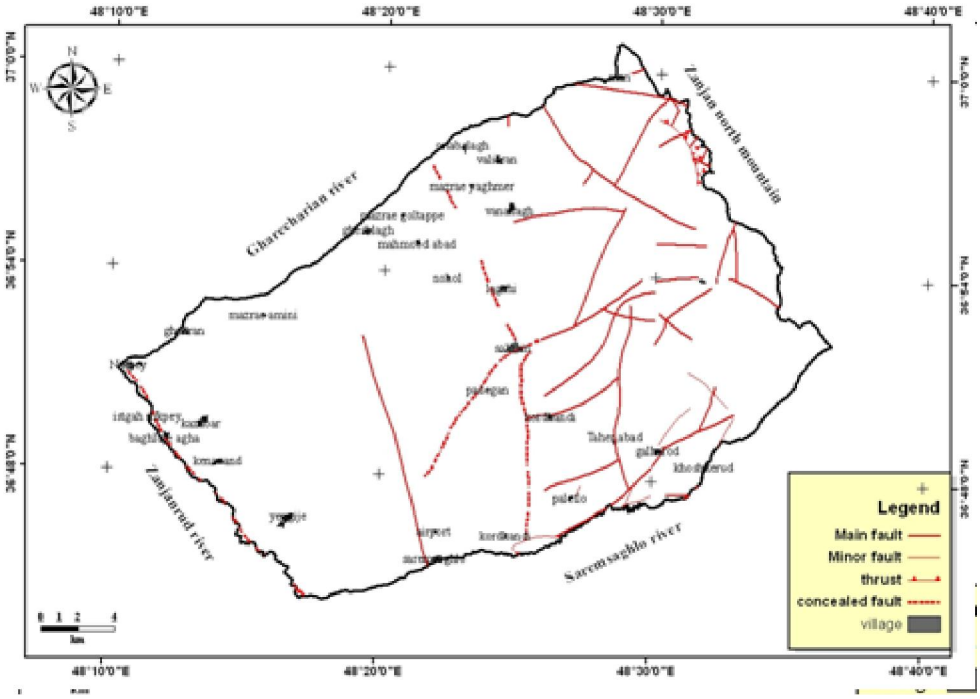


[Figure 3] Slope

The plain due to the fact that is the source of three important rivers under study viz. Saremsaghloo in west, Sohrain in the center and Gharecharyan in west and is the reason for birth of residential areas in plain (located between two rivers), is of great importance. Generally this plain consists of wrinkled failed fault units, Eocene sandstone and andezite lava and tuff which due to some features like relatively high physical resistance and elevated topographic face, floodway profile are often "V" like and are generally headlands.

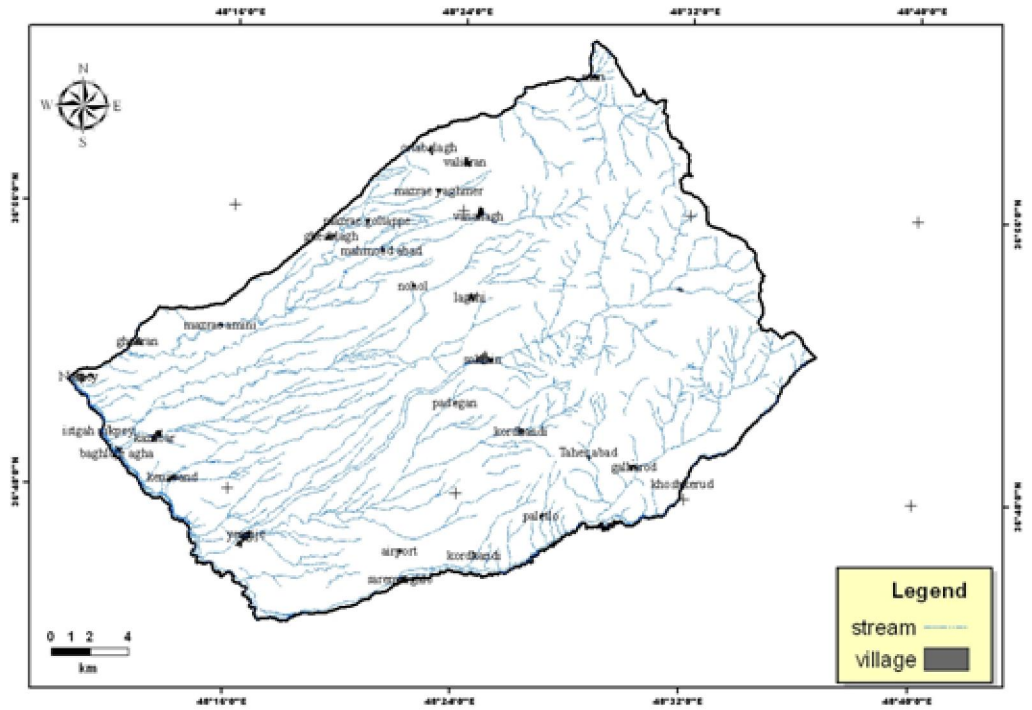


[Figure 4]Geological

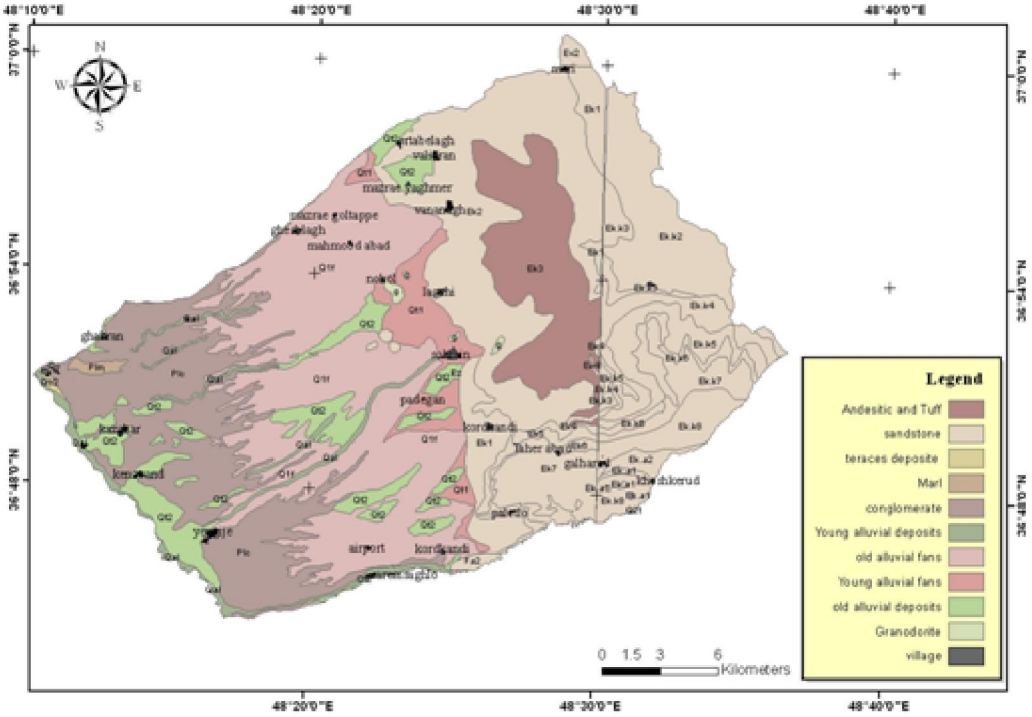


[Figure 5]Tectonic

Another feature of this area is low permeability coefficient and existence of abundant springs particularly in northwest parts. It seems that this area due to existence of numerous faults and including shear fractures, layered surface and non-resistant minerals which are easily weathered, allows penetration of water to lower layers. Block debris and sometimes grained debris (in comparison with their physical and chemical features) are found in hillsides dominated Saremsaghloo, Sohrain and Gharecharyan rivers. Appearing hillside debris is among clear characteristics of this region.



[Figure 6] Network Water

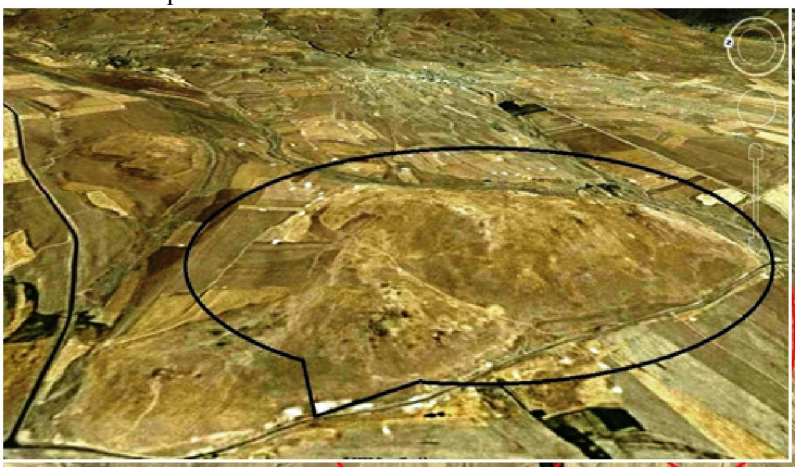


[Figure 7] Lithology

7. Foothill Areas and Low Height Hills

This field includes hills and rocks which consist of granodiorite and granite intrusive formations which are scattered in middle parts of the plain (in lower parts of plain between Vanangh and Sohrain villages) and in lower parts of plain and near north parts of area under study. The difference between the height of these hills in comparison with nearby villages reaches 500 meters (picture 1) (map 8). Among restricting causes of penetrating water in stone layers and construction of aquifers with high capacity one can mention non-existence of gaps and sufficient slits

between stones, independency of spaces, being slits and gaps filled with fine grained material (particularly in Granodiorite stones), are erosion kicked of earth by chattels and the most important one, one could mention the slope hills. Some important causes for penetration of water in some parts of these hills, ignoring chattels graze one must mention average or even appropriate shield of this region.



(Picture 1) Hills intrusive granodiorite containing structures on satellite images

8. Nearly Smooth and low Height Region

A large part of plain's lands (nearly 40 Percentage), includes smooth and low lands the slope of which are 1-10 percents. Generally morphologic face of this area can be divided into three parts under study in three different categories under the names: floodplains, alluvial terraces, watercourses, old outbreak platform and alluvial fans.

9. Floodwater plains and Alluvial Terraces

There areas are the result of sedimentation of Sahrin, Gharechariyan and Zanjanrud rivers in their strand within continuous years. Around those areas, there has been created a lot of rural residential areas, among them one could mention Saremsaghloo, Gharecharyan, Ghaheran and Gheshlagh.
[Picture 2]

10. Floodwaters and Old Outbreak Platforms

The old platforms, includes those parts of plants which during the past years were path for pass of seasonal flows which are extracted from mountains. These lands include soil containing low amount of sand (maximally 15 percents) which has been deposited after passing through the rivers. The slope of these areas are between 1- 5 percents and their border slope might raise to 8 percents. These lands height variance is less than 5 meters.

11. Alluvial Fans

Alluvial fans due to their pregnancy and their access to surface and underground resources in their domain, are interesting to geomorphologs from agricultural point of view. Morphologic face of this part consists of alluvial fans includes regions with spalls which are immediately visible when one exists these highlands and high mountains. In fact, there is another kind of aggregation of materials in common parts of high slopes with low slopes which impart low slopes with accumulated water flood and the primary sedimentation of rivers the most of which are constructed from coarse grained stuffs, exists in these lands. Existing spalls of this kind of lands they did not passed through a long distance are generally embowed. Slope of these lands are generally 5-10 percents. A considerable area of Saremsaghloo plain, contain composite alluvial fans with slope less than 5 percentages (picture 3) (map 8). According to these reasons studying alluvial fans are of great importance.

- These lands are among the most capable of lands for agriculture.
- Due to high amount of penetrability of fans sedimentations, these lands are proper areas for groundwater resources feeding projects.
- Iran's alluvial fans due to their good capacity of water storage, which are generally residential, are extracted by subterranean (Pashayi, 1381).

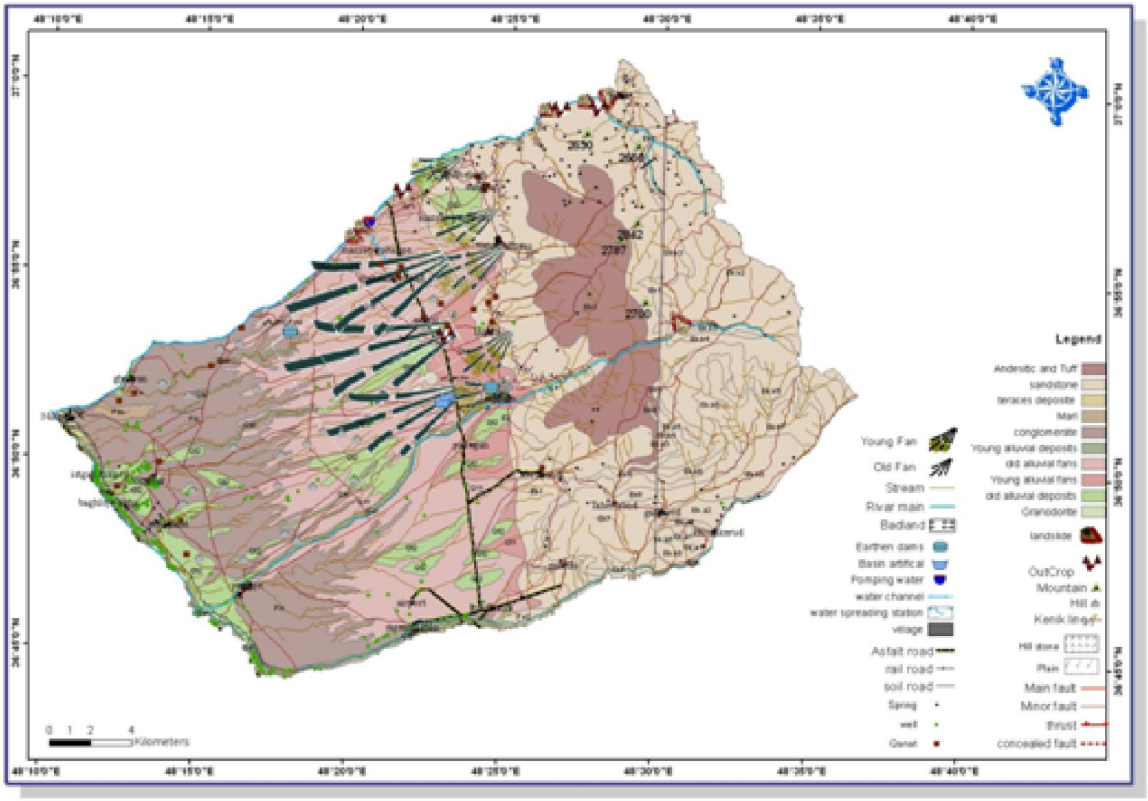
Morphodynamic Processes Influencing the Area

On current time due to situations pertaining to climate, the most important erosion element from northeast to the lowest points of the plain near the Zanjanrood river contain these processes: snow ablation, processes raised from weathering, trill of rivers and breakup.

(Picture 2) Rainfed and irrigated agriculture in the alluvial fan plains

12. Snow Ablation

According to aggregated information and stats from the area, one can see the highest depth of snow in highlands with heights more than 2000 meters in north parts of the plain. Within the winter season, except some low parts, the plain is covered with snow. The snow shield near 5 months of the year endures as a thick part in the surface of the plains and hills of mountains. These snow shields penetrating the slits and gaps of stones and afterward freezing and melting, causes stones destruction from different aspects and shapes them as angled (Tavangar, Kleimani 1387). Now the phenomenon snow ablation most occurs in the middle north heights of the plain and in the hills overlooking the rivers in the plain.



[Figure 8] Geomorphology of Saremsaqhloo Plain

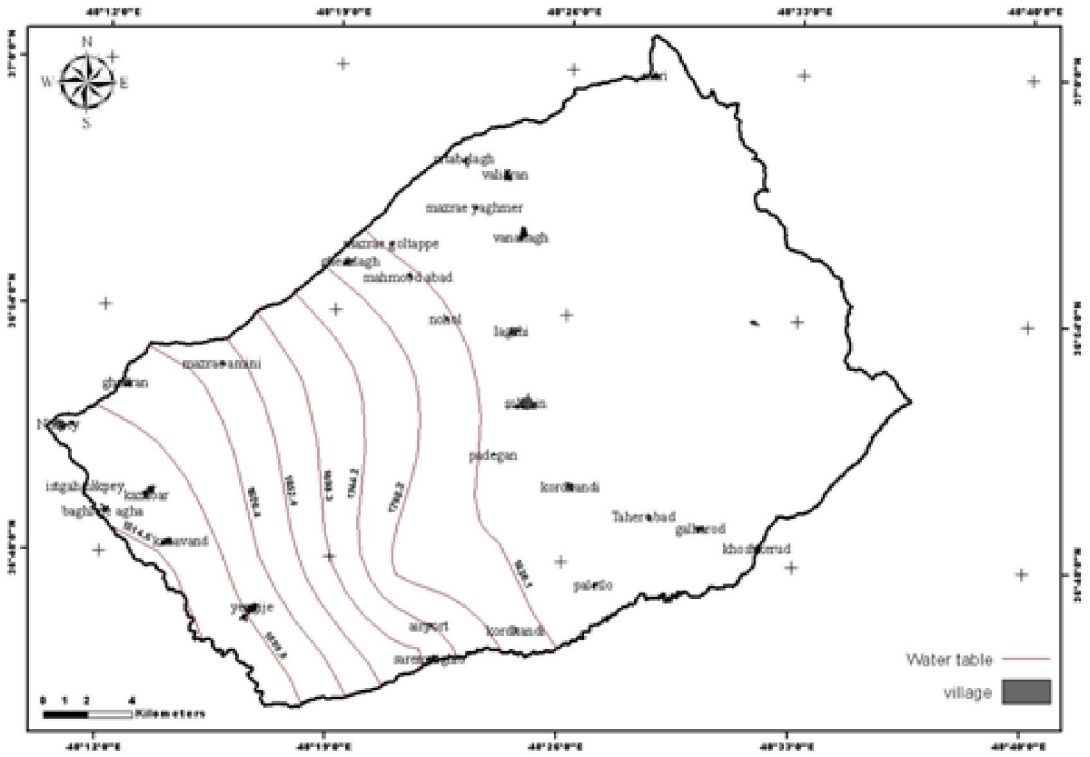
13. Phenomenon Raised From Weathering and Breakup

14. Physical weathering phenomena in different parts of the plain, occurs in different ways: alternating melting and freezing in the fracture space between stones, heating and cooling the stones and differential expansion and contraction of rock minerals and rocks destruction in transit or being exposed to water flow. According to observations and field studies, chemical weathering and also dissolution action, is to be found in marl organization. Marl sedimentations and Gypsum marls of red color with Pleio Pleistocene age are the result of ablation of Quaternary polio which chiefly is made of not hard conglomerate and is located un-conformal and in some points with conformal discontinuity on trench on red neogene floors. These constructions are easily seen in hills with steep slopes toward northwest of Gharecharyan river, and also they are easily seen in Trenches related water pipelines. Aforementioned marls include south and southwest borders in which the works of badlands ditch erosion are observable.

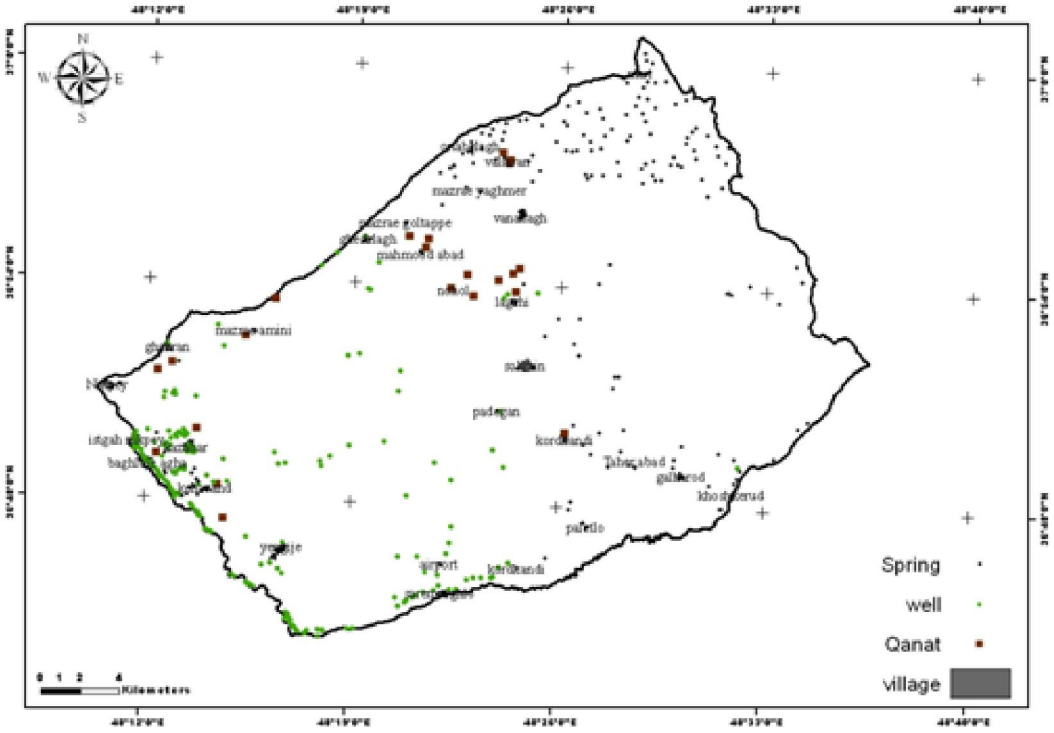
15. Underground Waters

For determining the direction and the amount of underground water and feeding role of existing geomorphologic phenomena in the plain, we embark investigating stats and the situation of pisometric wells, exploiting existing wells and also underground alignment map for the plain has been provided.

There are nearly 23 pisometric wells in Sarmsaghloo plain under study. Using these stats, by interpolation in Surfer software, the underground "the depth" map of the groundwater levels has been provided (figures 9 &10). According to the log of existing pisometric wells, the variance domain of stagnation nearly follows up topography such that in highlands nearly they are deeper than topographic level and in lowlands they are closer to earth's surface, such that near Zanjanrood, depth of water table surface are very close to earth's surface and is nearly less than 10 meters. The depth of water table surface in plain is between 20 to 66 meters, such that approximately in middle parts of the plain, the surface of water is nearly 33 meters.



[Figure 9] Lines deep groundwater



[Figure 10] Position of operational wells, qanats and springs

16. Tapping Wells, Spring, Subterranean

Tipper sources of underground waters, includes spring, subterranean and wells. Springs are often located in highlands and subterranean and wells are dugout in alluvials. Generally in Saremsaghloo plain until 1384, 228 wells were legally registered. It seems that the number of tapping wells is more than the aforementioned. Majority of these wells are dugout near Zanjanrood river or near downstream of flood station of Gharecharyan.

In Saremsaghloo plain until 1389 there was nearly 362 registered wells the density of which are more seen in north highlands of the plain and in tuff constructions and Eocene sandstone of Sazand (Karaj constructions) and sometimes in alluvial sedimentations and conglomerate sedimentations. Also in Saremsaghloo plain until 1384, nearly 22 aqueducts have been registered.

17. Incorporating Underground Water Maps with Geomorphologic Maps

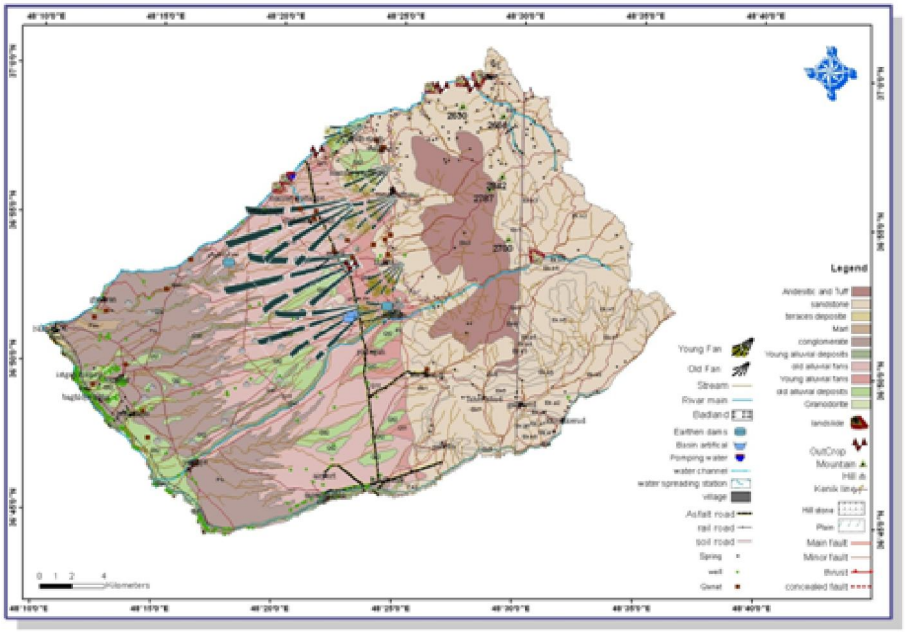
Afterwards to get a grip on the influence of geomorphologic on underground water resources, we embark incorporating underground water resource maps with geomorphologic maps and their impact on these resources was putted under study [figure 11]. The conclusions obtained from putting together maps, shows the relation between geomorphologic phenomena and underground water resources in Saremsaghloo plain.

There is a close relation between topographic figures, geomorphology and hydrological systems in Saremsaghloo plain. For example from 362 springs registered, only 92 springs are located in low slope and prairie-like areas, and also their distribution is seen in the northern highlands and tuff construction and sandstones formation constitution (Karaj constitutions) and sometimes distribution is seen alluvial, conglomerate sedimentations. Among all springs, 24 springs are in locations including alluvial constitutions, 24 springs are located in pliocene conglomerate constitutions, 26 springs located in andesitic and the others are located in Eocene sandstone constitutions. Also in a quantitative estimation of tectonical activities and existence of springs in GIS environment, we see from 362 existing wells in the plain, 248 wells springs are located near active faults in northern and northwest parts of the plain. This fact shows that water transmission are influenced by lineaments faults. It seems that these faults one can assume one of them as a feeding source of plains aquifers.

Also from 21 existing subterranean sequences in the plain, nearly 14 subterranean are in the domain of alluvial fans and the others are located in conglomerate constitutions of the plain. Water source of these subterranean are gained from the top of

alluvial fans i.e. the original wells have been drilled at the apex of the cone which consists of much more coarse and much bigger than sand texture and are also combined together. The conclusion is on the ground of more penetrability of materials in northern wells, the water quickly moves downwards toward the alluvial fans. It is noteworthy that the quality of water in original wells is very high, while in downhill near the zone of alluvial fans, the average diameter of the particles decreases and the level of underground water increases while the quality would reduce.

Scrutinizing alignment map of underground water plain, shows that maximum level of water tables underground aquifers is located in borders of northern heights of the region (Trailhead of alluvial fan) and its heights is more than 50 meters, whilst near the borders of Zanjanrood's alluvial, the water table level of aquifers is less than 10 meters. Henceforth the transmission of underground waters take place from high points to low ones i.e. in Saremsaghloo plain, the flow direction is from northern highlands to the center and south parts of the plain. This fact stems from the very thickness of alluvials which would decline as we get away from highlands and hence the level of water tables would increase. So Zanjanrood river which is located in valley of the plain, plays the role plain's drainage and discharging water of upstream watercourses.



[Figure 11] Overlay layers of geomorphology and groundwater.

18. Conclusion

According to conclusions at hand, the role of geomorphologic factors, are threefold:

19. Overall Flow Direction of Underground water and Water Level of the Plain

According to the depth map of underground water level, the mail flow of underground water of Saremsaghloo plain is from northeast to southwest i.e. it is from northern highlands to Zanjanrood river. This shows the fact that Zanjanrood in this land plays the role of drainage aquifers and vacates the underground water from the land. Also according to the log of pisometric wells provided, the range of water level invariance follows the topography by and large such that in highlands, generally they are located in a major depth and in low lands, like the domain of Saremsaghloo, Sohrain, Gharecharyan and particularly they are more close to earth. According to conclusions at hand, geomorphologic phenomena are among influencing agents on underground water resources of Saremsaghloo plain. Such that high mountains, influencing fall average and existing alluvials constitutions in middle parts of the plain on the form of alluvial fans and floodwater plains and drainage with diverse lithology in different parts plays the main role in nutrition, supplying, water direction and underground water quality.

20. Suggestions

Due to existing potentials in some number of plains points, including surface water resources like floodwater flows and occurance of appropriate alluvial material, there are number of artificial feeding plans and enriching underground resources are among those activities which are attractive to

practitioners. Running artificial feeding plans like infiltration basins in east and distributing flooding of Gharecharyan confirms this claim. The conclusions gained from running the plan of flooding distribution in Gharecharyan shows the capability of plain for running similar plans. According to alluvial material with proper thickness, northern alluvial fans of the plain and occurrence of surface resources of water, running artificial feeding plans and reinforcing underground resources are among the most important tasks the practitioners of the plain must pay attention to. These conditions, justifies running projects for artificial feeding of this plain. Successful instances which have been implemented, such as artificial feeding project of basins down to Sohrain village and also the great project of distributing flooding of Gharecharyan among recent decades, is a good guide for continuing these projects in order to boosting agriculture towards enduring development of the plain.

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