Geomorphological Facies Zonation, Using GIS and RS and its Application in Natural Resources. (Case Study of Kouhdasht Watershed)

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Abstract. In recent years, the occurrence of water and wind erosion in different parts of country due to the changes of land use from the forest and pasture into the agricultural and also construction of communication lines have increased. The study and research on this phenomenon, the effective factors in creating them and also identification of geomorphology facies types are necessary to prevent the waste of water and soil resources and their damages. In this study, in order to homogenize the studies and prevent the disperse works; we have tried to generate a base map based on geomorphological one. Thematic maps such as lithology and slope erosion facies map were also combined and finally obtained a homogeneous unit map (work units) which has a special place in natural resources studies. Considering the characteristics of each of these homogeneous units, there should be a special planning to protect and restore them. Therefore, considering the nature of this study, it can be a basic platform and be used in other studies. According to researches, 12 geomorphological facies were identified in the region. These facies are in mountain and pediment units; so three types of pediments including erosion, appendage and covered ones were distinguished in pediment unit. Different facies with specific characteristics were determined in each of these types. Finally, considering the natural power (potential) of facies and current status of land use, a management program was suggested.

Key words: Geomorphological map, Geomorphological facies, Management, Natural resources.

Introduction

A special strategy for the utilization of natural resources commensurates with the natural power and the economic and social characteristics of dominant region that is necessary to prevent land degradation and its geographic spread. In other words, protection, restoration and reconstruction of natural areas will be possible when their natural and biological capacity is evaluated with regard to restrictions. So, any attempts to produce excess, especially when it is not consistent with the climate, soil and topography, so successful in economic terms and is not cost effective. Thus, planning for adequate and continuing productivity of land involves the zoning and regionalization method, because weakness and intensity points of natural and environmental factors determine the limitations of land use (Bocco, G., *et al.*, 2005). Therefore, various zoning methods have been innovated and used from the past years to now like the methods evolved synchronously with the progress of science and technology development. Ahmadi (1995) believed that working unit can be considered as a unit of study so that all studies and samples accomplished in that. After facies were identified, he stated that the sequence can be concluded with help of the GIS and then working units obtained. Then, maps of hydrology, soil, vegetation and erosion can be used in GIS environment to distinct the characteristics of each work unit. Bocco *et al*. (2005) expressed that geomorphology science can be used for resource managing in rural areas in underdeveloped countries, especially when the Geographical Information System (GIS) and remote sensing (RS) are used. Verstappen (1983) reported that geomorphological map is a valuable scientific tool and has two theoretical and practical functions. Integrating layer and factor classification of the effective regionalization of erosion hazard using GIS and ILWIS software creates digital models for analysis and classification of data Bocco *et al*. (2005). The importance of geomorphological mapping is dependent to the recent progresses and digital processes, especially geographic information systems Wen westen *et al*., (2001). Definition, description and scientific value of the homogeneous units map have attracted the researchers' attention on the self Fato (1988). Maps of land form units have made the applying geomorphology concepts very easy and understandable. This process is the basis for assessing and mapping the soil because they are considered as a suitable framework for the sampling of soil layers Thoms and Betters (1988). Map of land form units is used as a main input for human resources management program. For example, social organizations, economic and Forest associations in Mexico must submit the management programs in accordance with regulations and law to Ministry of Environment in order to use forest every ten years. Ahmadi Hassan (2002) stated that the proper and efficient management in each region is possible based on the detailed quantitative and qualitative characteristics of plants, knowledge of plant relationships with each other and environmental factors. He investigated Listen Read phonetically the effect rate of environmental factors on the basis of geomorphological units and concluded that there are closely relations between geomorphological facies and plant communities (Giti a., 2001). Today, geomorphology studies are the basis for investigating the renewable natural resources. Since the work field of natural resources is very broad and different sciences such as botany, soil,

hydrology, ecology, and lithology are involved in it, for coordinating and controlling them, mapping that is able to me*et al*l the requirements for starting the studies is essential (Ahmadi h., 1995). As mentioned, there is the necessity of geomorphological mapping and homogeneous units as the main basis of natural resource studies to manage the human and environmental recourses. In this study, in addition to the mapping characteristics of homogeneous facies units, we have tried to show erosive facies consistent with the study area using Geographic Information System (GIS), remote sensing (RS) and frequent field visits.

Methodology

In order to achieve the desired goals in this study which are to determine the natural power of each facies and the current status of land for management programs of the area, we do the following steps that are briefly described.

- Positioning the region and existing phenomena such as geomorphology facies, residential areas and establishments in the region using the topographic maps (1:50000 and 1:250000) and Landsat satellite images (TM with the requirement combined bands) and matching them with the region through field visits.
- Collecting data and information of meteorology, climatology, geology, geomorphology, vegetation, soil, hydrology and socio economic issues based on the determined work units.
- Identifying and determining the dominant processes of land degradation through the field visits according to the sub-criteria and criteria derived from the analysis of FAO-UNEP and ICD procedures associated with the criteria and sub-factors consistent with the study area in each facies.
- Determining the appropriate criteria and sub-factors for the evaluation of land degradation process in each studied working units.
- Zoning the geomorphologic facies using Geographic Information System software ILWIS.
- Determining the limiting factors and sub-factors (human - environment) and providing the management programs for each geomorphological facies.
- Suggesting and providing an appropriate method with area for the project accomplishment.

Study Area

Kouhdasht catchment (aquiferous basin) located in western Lorestan extends from 33º, 15' to 33º, 38' northern latitude and 47º, 27' to 47º, 49' eastern longitude. The area vastitude is about 456 km/Sq which is located in central part of Zagros, and it is composed of the two parts including mountain and plain. The highest point of this area is 1936 meters above sea level in the northern part of the Catchment and lowest point is 1140 meters. The rainfall regime of the region is Mediterranean, i.e. conforming the dry season to summer and precipitation is observed in winter (Fig. 1).

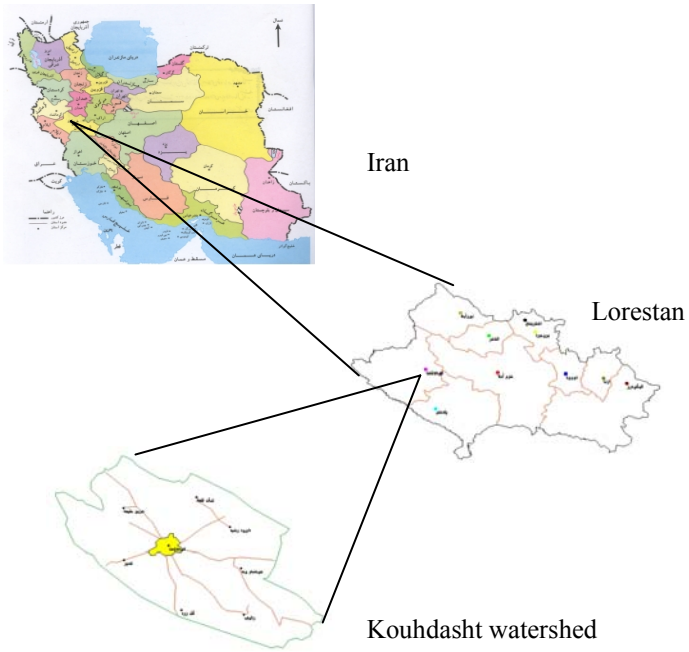

Fig. 1. Lorestan Province Position, Kouhdasht Township and Kouhdasht Watershed

Slope Map

GIS capabilities were used for generating the slope map. First, 100-meter contour lines and then 20-meter contour lines in some parts were digitized from topo-sheet (topographic map) using ILWIS software. Then, these data were processed at the same environment, and Digital Elevation Model (DEM) of the region was generated. Subsequently, the slope map was drawn using DEM in terms of percentage. In this process, the slope map of Catchment (aquiferous basin) was classified into four classes (Fig. 2).

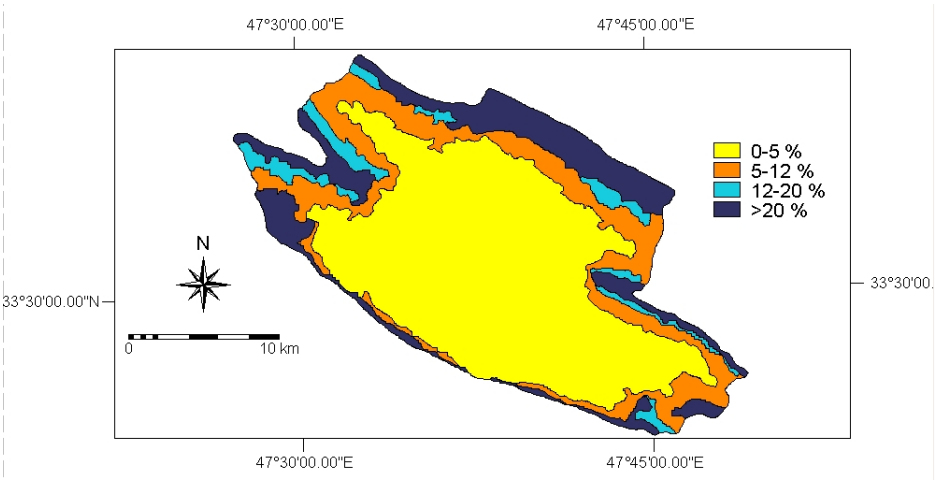

Fig. 2. Slope Map of Kouhdasht

Lithology Unit Map

The area geological maps were used for drawing the lithology map. First, the lithology units of the catchment were digitized using geo-sheet (geology map sheet), then by visiting the field, the lithology map, especially the units were controlled and corrected. At this stage, seven lithology units including Cu, Am, Tz, KN, As-Sb, Gs and QT were determined in the desired area. Meanwhile, the share of QT units was several times more than other units (Fig. 3)

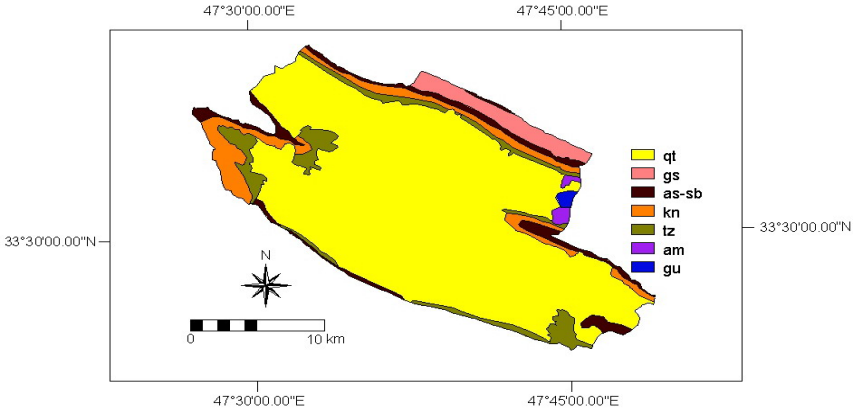

Fig. 3. The Map of Lithology Units in Kouhdasht

Erosion Facies Map

To generate the erosion facies map, a preliminary map was prepared using 1:50000 aerial photos. Then, the obtained facies boundary with visiting the field and matching the color combination made in ILWIS environment were carefully digitized and revised using Landsat TM satellite images. Thus, erosion facies maps of this catchment including six facies (severe stream erosion, regular range, stone outcrops, surface erosion, residential areas and stream erosion) were generated. According to the studies, mountain and pediment units in the region have been identified; so, the pediment unit includes three types such as erosion pediment, appendage pediment and covered pediment. Mountain unit which is located above the conical (Kenic) line is including three facies of regular hillside with the water erosion, rill wash erosion and rock mass facies. Pediment unit in the region includes the erosion, appendage and covered pediments. Each of the types mentioned above has different facies which are shown in geomorphology map (Fig. 4).

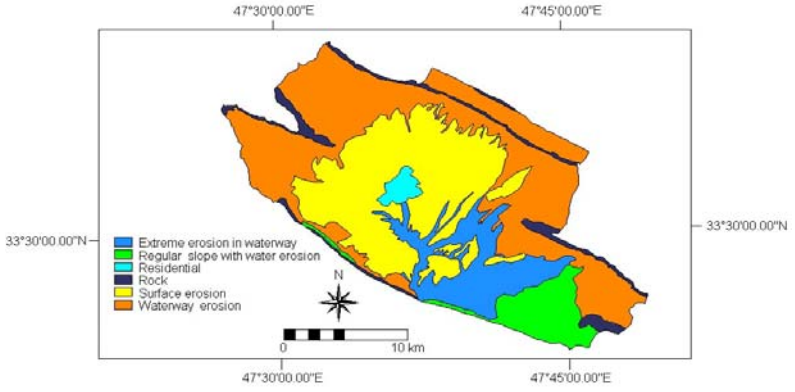

Fig. 4. Erosion Facies Map in Kouhdasht

Homogeneous Unit Map

With combining the basic maps such as geological formations, slope and erosional facies map, a new map called homogeneous unit map will be obtained that is very important in the natural resource studies. Considering the characteristics of each of these homogeneous units, a special planning should be presented to protect and restore them. Due to the nature of this study, they have been used only as a platform and base of the studies (Fig. 5).

In this study, 12 geomorphological facies were identified in the region (Fig. 5). These facies are located in the mountain and pediment Units. In the pediment unit, three types including erosion, appendage and covered pediments have been recognized. In each of these types, various facies were identified. They have been given briefly in (Table 1).

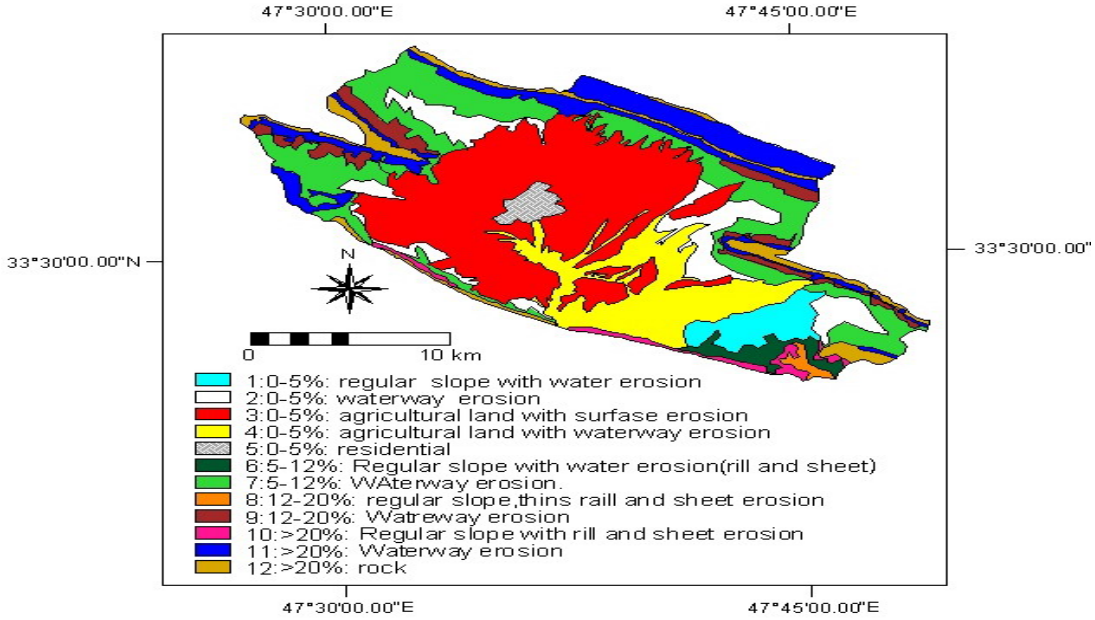

Fig. 5. Coordinated Unit Map of Kouhdasht

Results and Discussion

After determining the land surface units and mapping the geomorphological facies, each facies was assessed separately. The evaluation results through the frequent field visits of facies were compared with the available facts. In each of these types, various facies were identified and the percentage of area is shown in Chart 1.

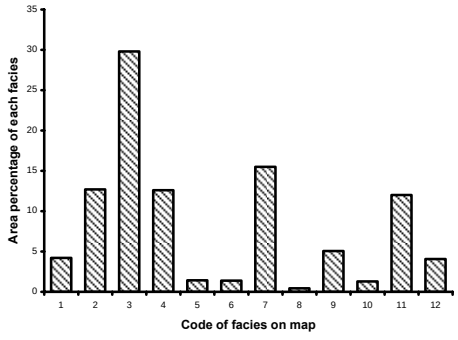

Chart 1. Area Percentage of Each Facies

Table 1. Units, Types and Geomorphological Facies

Code & Geomorphological Faces				Code & Type Name		Code & Geomorphological Unit Name	
Slope Percentage	Code on the Map	Name	Code	Types Name	Code	Unite Name	Code
>20	12	Rock	1-1-1	Asmari - Shahbazan	1-1	Mountain	1
	10	Regular slope with water erosion	1-2-1	Talezang	2-1		
	11	Waterway erosion	2-2-1	Gachsaran along with Kashkan			
12-20	8	Regular slope with water erosion	1-1-2	Erosion pediment	1-2		
	9	Waterway erosion	2-1-2				
5-12	6	Regular slope with water erosion	1-2-2	Appendage pediment	2-2		
	7	Waterway erosion	2-2-2				
0-5	1	Regular slope with water erosion	1-3-2	covered pediment	3-2	pediment	2
	2	Waterway erosion	2-3-2				
	3	Agricultural land with surface erosion	3-3-2				
	4	Intense Waterway erosion	4-3-2				
	5	Residential Area	5-3-2				

The result analysis of available land use in each geomorphologic facies showed that the environmental factors including the quantitative restrictions of the area water and soil source influence only 1,854 hectares that is approximately 4 percent of the catchment area. Thus, the environmental restrictions are less effective in creating a variety of water erosion and land degradation. In other geomorphological facies, human factor, inappropriate use and excessive pressure on the natural resource were identified as the main causes of water resources, soil and vegetation degradation. So, from 45,600 ha of study area, about 95 percent of the land more or less is faced with the regressive degradation process. In this study, it was found that the using type in facies 1 and 7 was not according to the current status of land, and in the other facies, uncontrolled and inappropriate exploitation was the main cause of erosion intensification. Due to the natural structure of the study area and limiting factors (environmental and human), management strategies were presented to manage the resources and combat the erosion. These strategies are summarized in Table 2. As a result, the destruction and erosion factors caused a major heterogeneity in the type. Each of these changes made due to the climatic factors and human represents a type of erosion and destruction system that have created 12-fold facies in the region. Considering that land degradation expands in the study area with a considerable speed, so the application of geomorphological techniques for understanding the current situation and resource management can be considered as the standard method. So other professionals can use the geomorphological maps as the work basis. This approach makes the work of other professionals easier because they will do their work within the boundary of the unit, types and facies.

Managerial schedule	The limiting factors	Using Type	Slope %	Type Name	Facies Name	Facies Code
-	Water and soil limitations (Environmental)	-	>20	Asmari - Shahbazan	Rocky Outcrops	12
Implementation of range management projects, grazed livestock, pasture and preserve balance	Vegetation &bush destruction and deforestation (Human)	Degraded pasture	>20	Talezang	Regular hillside along with narrow cracks	10
Implementation of forestry projects, preventing cutting down trees following replacing fossil fuels	Vegetation &bush destruction and deforestation (Human)	Forest and pasture	>20	Gachsaran - Kashkan	Rill wash erosion	11
Implementation of forestry projects, preventing cutting down trees following replacing fossil fuels	Vegetation &bush destruction and deforestation (Human)	Forest and pasture	12-20	Erosion plain	Regular hillside along with water erosion	8
range management preventing cutting down trees, Provide forage for livestock pastures excess capacity, replacing fossil fuels	Vegetation &bush destruction, deforestation, water sources destruction and soil erosion (Human)	Degraded pasture	12-20	Erosion plain	Rill wash erosion	9
range management preventing cutting down trees, Provide forage for livestock pastures excess capacity, replacing fossil fuels	Vegetation &bush destruction, deforestation and excessive livestock grazing (Human)	Forest and pasture	5-12	Appendage	Water regular hillside	6
Implementation of forestry projects, preventing agricultural activities	Land degradation, loss of groundwater table level due to pumping, and forest and grassland conversion to agriculture and ... (human)	Forest with farming sub-stratum	5-12	Appendage	Rill wash erosion	7
Water flood spreading,aquifer feeding, preventing agricultural activities under forest trees.	Land degradation, natural areas converted to agricultural and urban (human)	Forest with farming sub-stratum	0-5	covered pediment	Regular hillside	1
Improving the agricultural models and utilization of appropriate system with Aquifer capacity	Water resource damage, pumping, and waterbed decrease (Human)	Agriculture	0-5	covered pediment	Rill wash erosion	2
Reform of agricultural Patterns and strengthen of agricultural soils through fertilization	Water resource damage, pumping, and waterbed decrease (Human)	Agriculture	0-5	covered pediment	Agricultural land, along with surface erosion	3
Mechanical and biological operations in the upper plains, flood control, the use of periodic patterns of culture, promotion of soil	Degradation of water resources, the effect of pumping, severe soil degradation and erosion due to inappropriate user, soil sensitivity to erosion (Human & environmental)	Agriculture	0-5	covered pediment	Severe Rill wash erosion	4
Urban management	Population boom and…. (Human)	Urban	0-5	covered pediment	Residential Area	5

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