Land degradation of Taleghan drainage basin, Iran from saline and alkaline marly formations

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ABSTRACT

In Iran fine – grained, saline, alkaline and erodible Tertiary marly formations are exposed in many geological zones and play important role in the formation of present landforms. They also play important role in degradation of water resources and soils as diffuse sources, they are the main sources of suspension loads of many rivers and are endless sources of sediments for sand dunes. These marly formations are present in Zagros, Central Iran, Alborz and Kopeh – Dagh Geological Zones and consists of different geological formations such as Gachsaran, Mishan and Razak Formations(in Zagros), Lower Red and Upper Red Formations(in Central Iran) and Neogene Red Beds(in Albors and Kopeh-Dagh).

In this research, Neogene marly formations of Taleghan Drainage Basin, located in Alborz Geological Zone are investigated for chemical, physical and mechanical characteristics and erosion and sediment yield potential. The studied area is located about 100 kilometers west of Tehran and is one of the subdrainages of sefid-Rood Dam. Runoff and sediment yield were measured using field rainfall simulator.

According to their physical and chemical characteristics, Neogens fine grained Formations of Taleghan Drainage Basin were classified into six subunits: Siltstone (NgSi), Claystone (gy1C), marl(gy1M), haliferous siltstone (NgSiH), haliferous claystone (gy2CH) and gypsiferous claystone (gy1CG). From the view point of salinity and alkalinity, NgSi unit is alkaline and NgsiH, gy2CH, gy1C and gy1CC units are saline and alkaline. The order of the units in respect to sediment and runoff production is as follows: NgsiH>Ngsi>gy2Ch>gy1CC > gy1C.

Keywords: Land degradation, erosion, Taleghan Drainage Basin, Iran

INTRODUCTION

Soil erosion is one of the major land degradation causes in the world. Although a part of soil erosion occurs as a natural phenomenon, but accelerative erosion occurs due to human activities. Physico-chemical characteristics of some geological formations play important role in their erosion and eventually to sediment transport. Therefore, investigation of the effect of physico-chemical characteristics of unconsolidated geological formations on their erodibility and sediment yield is essential and gives insight on their erosion and determination of erosion control measures.

Marls are mostly unconsolidated geological materials which outcrop in many drainage basin of Iran, including Taleghan Drainage Basin and are erodible. Cerda(2002) investigated the effect of parent material and season on water erosion in east of Spain. Yair, etal(1980) and Bryan and Yair (1982) believe that sediment yield of badland marly slopes are much higher than clayey and sandy slopes. They say that erosion rate on marls are very high and they produce the highest amount of sediment concentration and runoff coefficient. Erosion rate of

clay and sand is 10 to 15 times lower than that of marls. Mathys etal.(2003) with calibrating rainfall runoff- erosion model in experimental catchment of Draix in France, quantified erosion of marls. Arnaez etal.(2007) determined the effective factors on runoff and erosion by using rainfall simulator.

Taleghan Drainage Basin is located about 90 km northwest of Tehran, in 36^0 05′ to 36^0 20′ north and 50^0 39′ to 51^0 11′ east (Figure.1), is one of sub-catchments of Sefid-Rood Drainage Basin and is located in southern Alborz Mountain Regions. In 2005 a reservoir dam is built downstream of Taleghan River which provide drinking water of Tehran. Around this dam and in Taleghan Drainage Basin, Neogene marly Formations are present. Due to their sensitivity to erosion and being saline and alkaline, these units play important role in land degradation. Mean annual rainfall in the basin is about 450 mm. Geological formations range in age from pre-Cambrian to Quaternary (Hoseini, 2007).

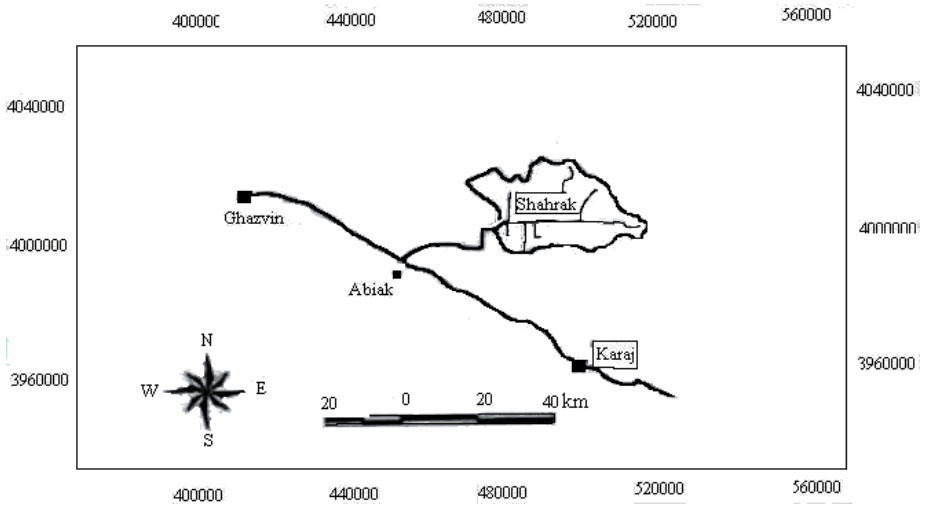

Figure 1: Location of the Taleghan Drainage Basin

MATERIALS AND METHODS

For investigating marly formations and their effect on land degradation of the area, the following studies have been performed: The inventory map of marly formations in Taleghan Drainage Basin is prepared. Then the map of homogenous units is prepared by overlying geologic, elevation, slope and erosion features maps of the area in GIS environment. Each homogenous unit is sampled and in each homogenous unit, runoff and sediment yield are measured using field rainfall simulator. The samples are analyzed in the laboratory for physical and chemical characteristics, including grain- size distribution, clay mineralogy, electrical conductivity, the amounts of gypsum, So_4^{--} , Ca^{++}, Mg^{++}, Co_3^{--}, $H\text{-}Co_3$, Cl^- and pH. The Neogene Marls are then separated into different units according to their physical and chemical characteristics. Then the dispersion and salinity and alkalinity of different marly units were studied and they were analyzed for clay-mineral types using XRD.

The rainfall simulator was applied on different marly units using two rainfall intensities of 30 and 60 millimeters per hour which is in accordance with the climatical characteristics of the area. Finally regression analysis were performed between the amount of runoff and sediment

as dependent variables and physico-chemical characteristics of marly units as independent variables.

RESULTS

The results have shown that there are six different fine grained units in the studied drainage basin which are: Siltstone (NgSi), Claystone (gy1C), marl(gy1M), haliferous siltstone (NgSiH), haliferous claystone (gy2CH) and gipsiferous claystone (gy1CG) (Figure 2). From the view point of salinity and alkalinity, NgSi unit is alkaline and NgSiH, gy2CH, gy1C and gy1CG units are saline and alkaline. From the view point of dispersion, gy2CH unit is dispersive and NgSiH, NgSi, gy1C and gy1CG units are medium to dispersive. In unit gy2CH illite (%45), chlorite (%30) and montmorillonite (%20-25) are present. In units NgSiH, NgSi, gy1CG, gy1C units, illite and cholorite (>%40) are present.

Duncan Method shows that NgSiH unit has produced the highest amounts of runoff and sediment at %5 significance level. Then the order of decreasing of runoff and sediment at %5 significance level is as follows in the other marly units: $NgSi, gy_2CH, gy_1CG$ and finally gy_2C .

The investigation of runoff and sediment production trend with time have shown that $NgSiH$ and $NgSi$ quickly reach the saturation and their runoff and sediment production remains constant afterward. But gy_1CG and gy_1C units have low suspended sediment production at the early times(first and second 10 minutes), after that sediment production increase greatly, especially in the third 10 minutes due to saturation of clay minerals. Factor analyses have shown that among twenty one physical, chemical and mechanical parameters. the amounts of silt, Mg, Cl, clay, electrical conductivity(EC), plasticity Index(PI) and K show %87.6 of the variations in the data. Regression analyses using multi-variate statistical method have shown that the most effective factors in runoff production are EC, clay, PI and in sediment production are Mg, clay, salt and PI. The regression equation characteristics as independent variables is as follows:

R= 94.63+4.36EC-6.1Cl-1.1 Clay+.87PI

In which:
R= runoff(mm)
Ec= Electrical conductivity(millimohs)
Cl= The amount of cholorine (milliequivalent/liter)
Clay=The amount of clay(%)
PI= Plastisity Index(%)

The regression equation between sediment production as dependent variable and physico-chemical characteristics as independent variables is as follow:

Qs= 35.38-9.4Mg+14.9Cl+2.4*10-2Silt+.-0.67PI

In which:
Qs= The amount of produced sediment(g/lit)
Mg= The amount of Magnesium (milliequivalent/liter)
Cl= The amount of cholorine (milliequivalent/liter)
Silt= The amount of silt(%)
PI= Plastisity Index(%)

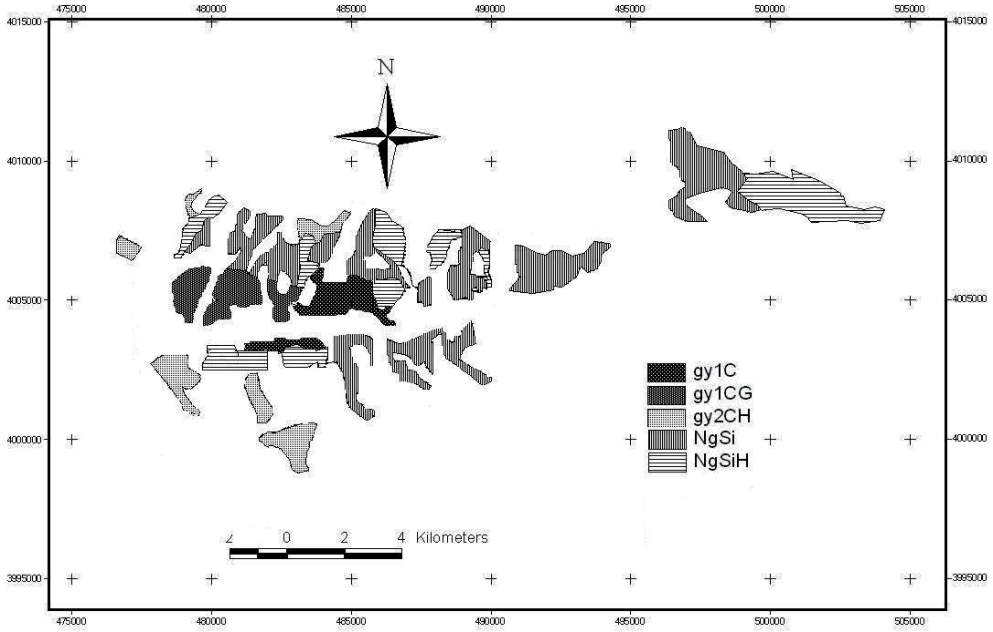

Figure 2: Map of fine grained units of Taleghan Drainage basin

DISCUSSION AND CONCLUSION

The saline and alkaline units of $NgSiH, gy_2CH$ and gy_1CG play important role in degradation of surface and underground water, soils and vegetation covers, especially when these units are located in the vicinity of the drainages and are under channel erosion. Unproper land uses and over-grazing have intensified land degradation due to the presence of these units. Different restoration measures are proposed for preventing land degradation due to the presence of marly formations in the studied area and similar areas which are as follows: Preparation of inventory map of marly formations and saline and alkaline units for determination of physical and chemical properties and determination of the extent of land degradation due to presence of these formations and units, preserving the range lands consisting of these units from over- grazing such that the rangelands restore naturally and preventing unproper land uses on these units such as construction of roads and industrial complexes and mining activities.

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