

Human-induced impacts of land use management on soil properties (case study: high-altitude area of Sahand mountain rangelands, East Azerbaijan-Iran)

Morteza Mofidi^{1*}, Ahmad Alijanpour², Esmail Sheidai Karkaj³, Mehdi Rashtbari⁴, Javad Motamedi⁵

1. Graduated MSc. in Range Management, Department of Natural Resources, Tehran University, Iran.

2. Assistant professor, Department of Natural Resources, University of Urmia, Iran.

3. Ph.D student. in Rangeland Management, Department of Natural Resources, Gorgan University, Iran.

4. Graduated MSc. in Soil Biology and Biotechnology, Tehran University, Iran.

5. Assistant professor, Department of Natural Resources, University of Urmia, Iran.

**Corresponding author email:* Mofidi.morteza@gmail.com

ABSTRACT: Dry cultivation and overgrazing are widely recognized as the degradation primary causes of high land rangelands in semi-arid regions of Iran. The objective of this study was to quantitatively evaluate the magnitude of changes in soil properties due to long time of dry cultivation with Wheat (DCW), dry cultivation with Medicago (DCM), recently abandoned cultivation (RAC), and finally grazing Land (GL) in an ecosystem of the semi-arid high lands in Sahand Mountain, Iran. In order to this, after sampling of surface soil in each four sites, soil parameters such as pH, EC, bulk density (BD), soil organic matter (SOM), total nitrogen (TN), available K, P, soil moisture (SM) and soil particles (clay, silt and sand) were measured in laboratory. ANOVA analysis showed that the historical conversion of land-use from native vegetation (GL) to dry cultivation resulted in sharp declines in SOM, TN, P, K, and EC and increase in pH. Cultivation abandoned (RAC) have decreased of SOM, TN, P, K, EC, SM but pH and BD have increased in RAC comparing with both cultivation land. Cultivation of Medicago has promoted soil quality indices such as nutrient elements and physical properties compared to the wheat cultivation. The results address the importance of grazing land for maintaining soil quality properties on the landscape. From the perspective of soil resource management and environmental conservation, a viable option for these fragile high-altitude rangelands would be to stop conversion of rangeland to dry cultivation and adopt moderate grazing intensity practices to limit overgrazing. Also, the abandoned dry cultivated areas should be converted back into native rangeland.

Keywords: land use, dry cultivation, abandoned land, soil properties, Sahand area.

INTRODUCTION

The complex integration of the primary natural resources including soil, water and vegetation, is vital for maintaining terrestrial ecosystem functions and productivity (Islam and Weil, 2000). Land use/land cover changes (LULCC) are affected by human-induced activities and growth, socio-economic factors, expansion of the forests, grazing, agricultural activities government policies, and environmental factors such as drought (Gol et al., 2010).

Socio-economic changes in rural especially mountainous region are mainly influenced by land-based economies closely related to the structure and function of landscape because agriculture, forestry and mining still constitute major economic activities (Gol et al., 2010). Global land use has significantly changed in the past

decades. Historically, the driving force for most land use changes is population growth (Ramankutty et al., 2002), and in most parts of the world, agriculture is the primary cause of land use change. Much of the pressure on convert rangeland, agricultural uses comes from increasing population growth and developmental demands (FAO, 2001). The intensity of land-use changes in response to world population growth and its consequences for the quality of life, the environment, global climate and world peace obligate in-depth studies of these transformations (Shoshany and Goldshleger, 2002). Land use change, mainly through conversion of natural vegetation to cropland and or grazing, may influence many natural phenomena and ecological processes (Turner, 1989), leading to a remarkable change in soil properties. Also leaving agricultural lands after a period of cultivation indeed increase these terrible consequences. Various studies have conducted around land use changes and management on soil properties. But low information is available around mountain areas in Iran (Nael et al., 2004). Especially around various crops cultivation effects on soil has conducted and there is in vast gap. But inversly in other parts of the word it was studied in vast And effects of land use change on soil nutrients have been reported elsewhere. For example, Lemenih and Itanna (2004) found significantly lower soil carbon (C) and total nitrogen (N) stocks in cropland soils than the soil C and total N stocks under the natural vegetation in the south central part of Ethiopia. Even though it is generally known that land use strongly affects soil aggregation (John et al., 2005; Ashagrie et al., 2007), the temporal dimension of this impact remains unknown. Blank and Fosberg (1989) stated that when grasslands are tilled for crop production, and during years of subsequent tillage, mineralization of SOM causes significant reduction in soil organic carbon (SOC). Also, it was reported by Mubarak *et al.* (2005) that cultivation in semi-arid tropics (for more than 50 years) is known to decrease SOC by 59%.

The effects of land abandonment on land quality may be positive or negative depending on the soils and climatic conditions of the area (Kosmas et al., 2000). Soils under favorable climatic conditions that sustain plant cover may improve with time by accumulating organic materials, increasing floral and faunal activity, improving soil structure, increasing infiltration capacity, and therefore, decreasing erosion potential (Trimble, 1990). Also on the contrary, it is widely reported that organic matter content and soil aggregate stability are greatly enhanced in most of the soils converting from arable to abandoned pasture (Kosmas et al., 2000). Martinez-Fernandez et al., (1995) have reported a positive effect of land abandonment after a period of over 10 years in which characteristics of abandoned soils approached those seen before cultivation. The abandonment of this area resulted in improvement of soil characteristics such as the organic matter content, water retention capacity, aggregation and structural stability. Unger (1997) reported a deterioration of soil fertility under cropping and concluded that the soils under various types of agricultural land uses contained less organic matter content, total nitrogen, exchangeable bases and cation exchange capacity (CEC) than similar soils under natural vegetation.

Much work has focused on the effects of land use change and consideration to consequences of cultivation abandonment is low. Also the studies show that it is important to understand effects of spatial changes of land use/land cover on soil properties to disclose the implications for land use planning and management. In this study the effects of land use changes on soil quality attributes in Sahand mountainous area has been investigated.

In this area we know roughly where land use changes occur and we also know that land use changes affect soil chemical and physical properties. Such changes have been fairly well-documented but a systematic global scale link between land cover change and soil fertility change has to our knowledge - not been made. In the Sahand area, appreciable mountainous areas have been converted to cropland. Attempts to estimate changes in soil quality of these areas were greatly lacking. Therefore, the aim of this study was to evaluate the effects conversion of native rangelands to cultivation land on some soil quality attributes. High altitude croplands put ecological sustainability of the land resources at risk in Sahand mountain area of Iran. Therefore, it is thought that assessment of organic matter and physical properties of soil upon conversion of natural rangelands for croplands is very important to distinguish early variations in soil quality. The objective of this study was to quantify effects of changes in land-use type on organic matter and physical properties of soil in a Sahand highland region of East Azerbaijan province Iran.

In this study we hypothesize primarily that, different soil properties react towards land use managements change and second that with abounding cultivation lands it lead to deteriorate or recover soil quality. To test these hypothesizes we measured soil parameters such as pH, electrical conductivity (EC), bulk density (BD), soil organic matter (SOM), total nitrogen (TN), available K, P, soil moisture (SM), mean soil weight diameter of the soil aggregates (MWD) and soil particles (clay, silt and sand) in four sites including cultivation with various crops such Medicago and wheat, rangeland grazing area and abounded cultivation land. The main objective of our study was therefore to gain insight into the impact of land use change on soil properties.

MATERIALS AND METHODS

Study site

This study was conducted on the Sahand Mountains area in 33 km far from the east of Maragha city, East Azerbaijan province, North West of Iran. This area Situated approximately 37°25' N and 46°31' E (Figure 1). The region is characterized by semi-arid climate. According to the nearest climatologic station recorded data (33 Km further from), the long-term mean annual rainfall is 322.4 mm and generally has cool and snowy winters. Maximum and minimum monthly mean rainfall occurs in April and August with 64.6 and 1.6 mm respectively. Also mean annual temperature is 12.5^oc (Iranian weather organization web site, 2012). Based on soil analysis, soil is very uniform throughout the study area and the soil texture of the area is clay loam and its type was classified as "Aridisol" (according to USA soil classification). Current geological maps demonstrate that the geology of the study area is dominated by sedimentary rocks of Pliocene to Quaternary ages. The sedimentary sequence consists predominately of Tuff, poorly indurated clay stone with bon beds (Geological survey of Iran, 1975). The herbaceous layer of selected study area is consisted of cool-season grasses *Agropyron trichophorum*, *Festuca ovina*, *Cirsium arvence*, *Artemisia aucheri*, *Bromus tomentolus* with scattered *Thymus* spp. and *Asragalus* spp. shrubs. The area has been grazed mainly by sheep and goat which had not been subject to pesticide or fertilizer application. These rangelands are located in Boulouk Abad watershed that its drainage stream network flow in west on Urmia Lake. Four various site were distinguished in this representative rangeland area for evaluating grazing intensity on soil properties.

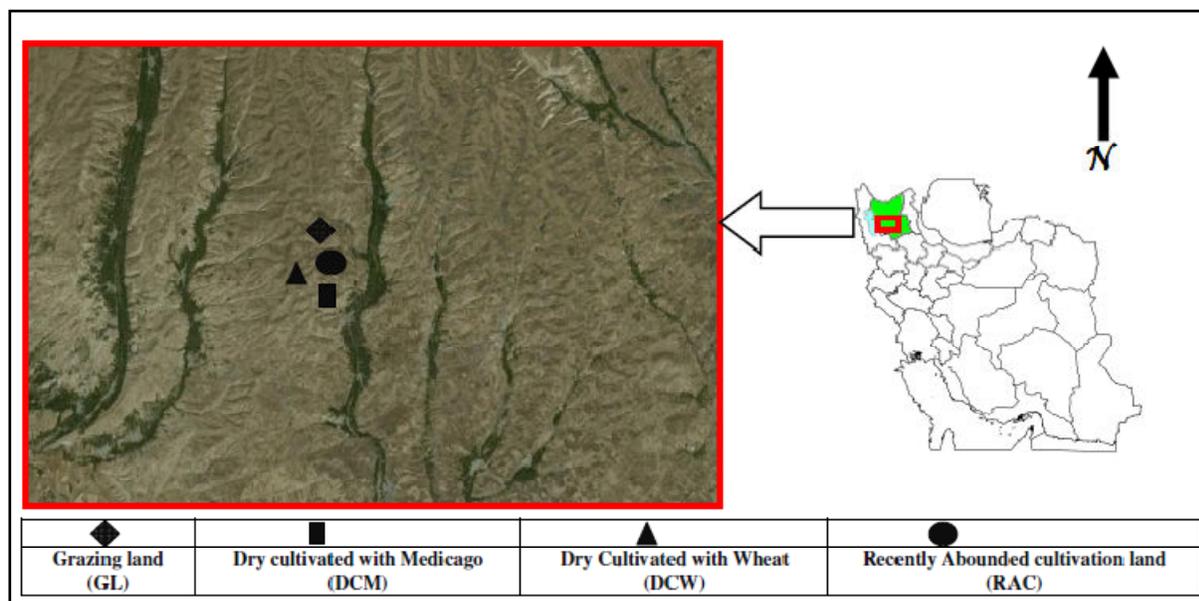
Four sites including rangeland site, cultivated land with Medicago, cultivated with wheat as dry cultivation and abounded cultivation site. Their historically land uses were consistent in the recent decades. Sites, which have been converted from rangeland to dry land at a defined point of time in history and have been used continuously ever since, were selected.

Soil Sampling

Sampling within each area was conducted using a systematic randomized method. On each site, 1 composite (combined mixed) samples per each transects. Totally 8 mixed soil samples from each sites, yielding a total of 32 composite soil samples for the study (4 site × 8 replications) were obtained. The mixed samples were homogenized, and oven dried at 105^oc for 24 h. prior to soil analysis, samples were crushed to pass through a screen (2 mm-opening).

samples were taken every 20 m along 8 diagonal transects of 60 m long to a depth of 30 cm, with

Figure 1. location of study sites in Iran



Laboratory analysis

The Samples were analyzed in the laboratory of the department of Natural Resources, Tehran University. The particle-size distribution fractions of the 2 mm fraction were determined by the Bouyoucos hydrometer method (Gee and Bauder, 1986). EC and pH was determined in 1:1 suspension with distilled water (Sparks, 1996, McLean, 1982). The organic carbon (OC) was determined according to the Nelson and Sommers, 1982 method, and The percent of soil organic matter (SOM) was calculated by multiplying the percent organic carbon by a factor of 1.724, following the standard practice that organic matter is composed of 58% carbon (Brady, 1985) and total N using the Kjeldahl procedure (Bremmer and Mulvaney, 1982). Available phosphorus (P), exchangeable potassium (K), and sodium (Na) were analyzed according to Sparks *et al.* (1996). Soil Bulk density was determined by the clod method (Blake, 1965); and soil moisture content (SM) was determined gravimetrically (Gardner, 1965). The wet sieving technique of Yoder, (1936) was used for the determination of the mean soil weight diameter of the soil aggregates (MWD).

Statistical analysis

Data were tested for normality before analysis using the Anderson Darling test (Steel and Torrie, 1980) and homogeneity of variance (Levene's test) for above condition at 5% probability level. Data analysis was performed using one-way ANOVA analysis of variance and multivariate analysis of variance (MANOVA) and comparison of means was accomplished by the Duncan's multiple range tests for the comparison and grouping the data of different management sites with regard to soil properties at 5% probability level ($P < 0.05$). Statistical analysis of each of the measured variables was conducted with SPSS program ver. 15.

RESULTS

This investigation was conducted to understand the changes of soil functions, resulting from exploitive management and changes in land-use type, using some soil quality properties of the mountainous area in Sahand Mountain area.

Multivariate analyses

Results showed firstly that there were differences between all four sites in relation to soil physical and chemical properties (Wilks' $\lambda = 0.000$, $P < 0.01$). All of soil physical and chemical properties were found to have been affected by land use managements in the region (Table 1). We also analyzed the land use changes on soil chemical properties using ANOVA and found remarkable changes in land use area. These data showed that, there are significant differences among sites with different management histories considering to soil chemical physical properties in study area (Table 1).

Table 1. soil properties in study sites and Mean \pm SD

Properties	Grazing land (GL)	Dry cultivated with Medicago (DCM)	Dry Cultivated with Wheat (DCW)	Recently Abounded cultivation land (RAC)
pH	0.09c \pm 7.07	0.04b \pm 7.42	0.05a \pm 8.20	0.03a \pm 8.27
EC _e (dS/m)	0.01a \pm 0.52	0.02a \pm 0.52	0.02b \pm 0.28	0.00c \pm 0.21
Organic matter (%)	0.07a \pm 2.40	0.13b \pm 2.06	0.02c \pm 0.84	0.007d \pm 0.07
Nitrogen (%)	0.00b \pm 0.13	0.00a \pm 0.17	0.00c \pm 0.05	0.00d \pm 0.04
Phosphorous (ppm)	0.91b \pm 21.46	0.68a \pm 25.55	0.32c \pm 7.38	0.19d \pm 5.14
Potassium (ppm)	3.18b \pm 245.80	7.58a \pm 273.69	4.40c \pm 124.91	4.88d \pm 96.67
BD(gr/cm ³)	0.06b \pm 1.04	0.08b \pm 1.15	0.07b \pm 1.22	0.10a \pm 1.52
SM (%)	0.85a \pm 21.61	0.68a \pm 20.79	0.51c \pm 5.67	0.44b \pm 8.49
Sand (%)	0.61d \pm 69.06	0.35c \pm 71.52	0.59b \pm 73.99	0.60a \pm 75.77
Clay (%)	0.28a \pm 12.60	0.35b \pm 11.34	0.52b \pm 10.84	0.39c \pm 8.40
Silt (%)	0.61a \pm 18.33	0.48ab \pm 17.13	0.28c \pm 15.16	0.75bc \pm 15.82
MWD (mm)	2.2 \pm 0.11a	1.7 \pm 0.13b	0.9 \pm 0.09d	1.2 \pm 0.1c

The means differ if they have a different letter in $p < 0.05$.

Chemical properties

The Duncan tests were performed to determine the differences between sites means at $P < 0.05$. The soils on study area were moderately alkaline (average $\text{pH} = 7.2$) (Table 1). Both DCV and RAC sites have on average, 24% higher pH than the two GL and DCM sites soil. The lowest pH belongs to the DCM site with 7.07. SOM percent ranged from 0.07 to 2.40 %; the largest differences occurred among sites, in RAC with 0.07 percent while the highest amount of SOM is related to DCM with 2.40 percent ($P < 0.05$). The greatest change in organic matter content was measured in soils formed on volcanic lava. Dry cultivation of Whet resulted a sharply reduction in concentration of SOC. The abandonment of the land has greatly increased soil organic matter content and soil aggregate stability, especially for the soils formed on lava, as compared to the soils under the existing cultivation practices. Soil total N differed even more among the sites soils ($P < 0.05$). Total N was higher in the DCM soils than in the other different sites ($P < 0.05$). The obtained data indicated that exchangeable potassium and phosphorous was lower in the abandoned soils than in soils under cultivation formed on the same parent material (Table 1). The highest average amount of exchangeable K was measured in DCM soils.

Physical properties

Table 1 shows the effects of land use management on changes of soil Physical properties including BD, SM, MWD and soil particles. There was a significant amount of variation in soil moisture (SM) among the agricultural sites. The amounts of soil moisture in both DCM and GL significantly were greater than other two sites (Table 1). The grazing site and DCM were 3- to 4-times wetter than the DCW and RAC ($P < 0.05$). Textural analysis showed that we found that samples collected from GL and DCM lands gave the lowest silt and highest clay values. The highest MWD was measured in soils GL. Increasing years of cultivation abounding resulted in increasing MWD. All the soils under cultivation had an average aggregate size ranging from 1.2 mm to 2.2 mm. Changes in soil bulk density (BD) were not statistically significant among three GL, DCW and DCW sites ($P < 0.05$), but slightly increased under RAC compared to other sites.

DISCUSSION

The findings of this study demonstrated that land-use change from rangeland to agriculture could have significant impacts on soil properties. Also there were some changes in soil quality in RAC site after abounding the cultivation lands.

Chemical properties

Land use management significantly had affected soil chemical properties. Soil pH increased with land use changing from grazing land to cultivation. But the rate of this decline is low in DCM relative to other two changed lands. The decline in pH values in the GL and DCM as compared with DCW and RAC can possibly be related to more root biomass, high amounts of soil organic matter, dense root systems (Jeddi and Chaieb, 2010) and more active microorganism metabolism in the rhizosphere (David et al., 2004). Hinsinger et al. (2003) stated that the organic acids secreted from the roots and release of CO_2 from roots and microorganisms could lead to the decrease in pH. Content of SOC was significantly lower in cultivated land compared to rangeland lands. Across all sites, conversion of grazing land to DCM showed no significant effects on SM. It was reduced by 44%, 40% for the 0-30 cm, soil depths, respectively.

Annual Soil tillage in DCW and bare surface of RAC site improve to SOC reduction and consequently pH increases. In contrast, Blank and Fosberg (1989) stated that when grasslands are tilled for crop production, and during years of subsequent tillage, mineralization of SOM causes significant reduction in soil organic carbon (SOC). Also, it was reported by Mubarak et al. (2005) that cultivation in semi-arid tropics (for more than 50 years) is known to decrease SOC by 59%.

The soils of the ROC and DCW were moderately alkaline (average $\text{pH} = 8.2$ and 8.27 , respectively), while the two other site soils (GL and DCM) were slightly acid (average $\text{pH} = 7.07$ and 7.42 , respectively) (Table 1). The acidity of the GL soils was slightly lower than that of the DCM soils (at the 0.05 level). This is mainly attributed to SOM distribution of the GL soils in the landscape. Reduction of soil pH due to GL could result from high native vegetation biomass or dense root system and high soil organic matter accumulation, due to more active microorganism metabolism in the rhizosphere and metabolism of hyperactive microorganisms in rhizosphere (David et al., 2004), organic acids secretion from the roots and large amounts of CO_2 released from roots and micro-organisms (Hinsinger et al., 2003), increased leaching and decreases in carbonate calcium equivalent (CCE)

percent. With increasing organic matter content, more mineral and organic acids are produced with carbonic acid being the most abundant. Although this is a weak acid, its continuous production in soil with high root density causes lime dissolution and leaching from soil. Dissolving the CaCO_3 causes pH reduction (Al-Seekh, *et al.*, 2009). Grazing soils have more dense grasses cover, more organic matter and available water, more plant roots and better aeration than grazed soils with less cover (Mesdaghi, 2007). Excessive grazing that degrades the vegetation has a negative effect on soil physical properties and soil fertility (Mikola, *et al.*, 2001).

Increasing of EC in the GL and DCM sites could be related to increasing soil cation exchange capability (Abdallah *et al.*, 2008). In these two sites due to increasing vegetation canopy cover percentage and denser vegetation cover in native rangeland and high rooting system of Medicago, organic matter is enhanced and pH is lowered. Improvement in soil structure, a decrease in runoff and increased water infiltration could cause a reduction in CCE in the surface soil depths due to dissolving by pH reduction. Abounding of RAC site and non establishment of native vegetation result in increasing of runoff and dissolving the cations may lead to declining in EC. Also similarly this condition has been happened in DCW site with land tillage along slope direction and non-covering of land in most days of the year.

Vegetation cover strongly influences soil nitrogen content. Soils having good plant cover, aerial biomass and high root biomass usually have more organic matter and nitrogen (Foth *et al.*, 1997). Therefore, where vegetation is native, it is expected to resulting in an increase in nitrogen compared with the cultivated sites. But inversely we found high amount of N in DCM. It is related to N-mineralization of this crop as categorizing in leguminous family in soil which increases soil N. Mortenson, *et al.*, 2004 also found that Inter-seeding yellow-flowering alfalfa into rangelands has the potential to enhance all of these factors: increase soil carbon storage, enhance production, and increase forage quality. Soil organic carbon was increased by 4, 8, and 17% in the 1998, 1987, and 1965 inter-seeded pastures, respectively. Nitrogen fixation by the legume also led to increased soil nitrogen levels, hence increased nitrogen (protein) content of the native forages. This pointed out the practice of inter-seeding adaptive cultivars of legumes into native rangeland may help to mitigate the elevated atmospheric carbon dioxide and N levels and at the same time enhance soil quality and sustainability.

Decrease in soil chemical properties including, SOM, N, P and K, in two sites of RAC and DCW, as seen in this study, are mainly related to differences in the soil structure, with a low-developed litter layer and soil tillage. Moreover, the higher SOM, N, P and K content in the DCM might reflect the higher biological activities of soil microorganisms, and this higher microbial activity might increase the N, C and other soil contents (Lavado *et al.*, 1996; Han *et al.*, 2008).

Annual crop lands involving conventional tillage in DCW results in a substantial loss of soil organic matter and soil physical condition (Milne, *et al.*, 2004, Sparling, *et al.*, 1992). This is probably due to tillage-induced breakdown of organic material (Fenton, *et al.*, 1999). Ghani, *et al.*, (2007) reported that grass land maintained the greatest SOC compared to arable cropping. Many studies reported that TN in pastoral soils was greater than cropped soils of similar types (e.g Ghani *et al.*, 2007, Tilman, *et al.*, 2001). Cleik (2005) reported 45% reduction in SOM when pasture was converted to cultivation while Xiao-gang *et al.* (2007) reported 26-42% lower SOC and 10-18% lower TN. Several studies have investigated soil physical quality under pastoral grazing (e.g. Menneer, *et al.*, 2001).

Conversely, the organic carbon and total N contents of the soil were significantly lower in the croplands of wheat compared to the grazing sites, which is likely the consequence of the reduced amount of organic material being returned to the soil system, and high rates of oxidation of soil organic matter due to tillage, and loss of organic matter by water erosion (Dalal and Chan, 2001; Jaiyeoba, 2003). Cultivation promotes SOC loss due to exposing micro-aggregate organic carbon to microbial decomposition by changing the moisture and temperature regimes (Reicosky and Forcella, 1998). Initial and rapid loss of nutrients and SOC decay occur mainly due to plant uptake and organic matter oxidation (Ross, 1993).

The other difference we measured chemical properties among the various land use managements was lower levels of K and P and N in GL. The rate of nutrient cycling would have been higher with abounded land than Cultivation lands, which possibly accounted for it being higher than these two management categories. It is possibly related to low species composition and cover of land in RAC.

The increase of soil organic matter and nutrient content which accompanies GL, can be a result of increase in the amount of plant litter on the one hand and a decrease in soil compaction on the other hand, which obviously result in favorable living conditions for those organisms vital for the incorporation of the humus into the soil (Liu *et al.*, 1997; Jeddi and Chaieb, 2010). Consequently, soil nutrient content, and hence soil fertility significantly affected. Grazing land caused phosphorous levels to increase in the layer of soil compared with cultivated sites. This is likely

due to the fact that rangeland vegetation exploits phosphorous from lower depths so when vegetation cover and biomass (Azarnivand & Zare Chahoki, 2011).

Abounding of cultivated lands also decreased the mean K, P and N concentration in the soil layer compared to the DCM and DCW sites. This is likely due to an increase in potassium transfer by runoff to the down slopes. The decreases in K, P and N amount is also likely due to the decreased vegetation and litter cover and declined soil quality in the RAC. Since increasing of pH results in lower potassium levels (Foth *et al.*, 1997; Somda *et al.*, 1997) the higher pH levels in the RAC likely contributed to a decrease in potassium content.

Physical properties

Our results clearly demonstrate soil physical properties are influenced by the land-use change from rangeland to cultivation. There is some evidence that the abandonment of agriculture and the subsequent regeneration of forest may return C storage to pre-agricultural. Amounts of Bulk density were significantly higher in the agricultural sites compared to regenerating sites (Table 1).

Based on result of the current study, bulk density and water content were reduced significantly in RAC, compared with the other land use. Lower bulk densities and a lower water content, as a result of increased animal trampling and non covering of land; have been observed in other studies. Our results were therefore consistent with previous research. In other sites such DCM, DCW and GL increasing of plant inputs of organic matter to the soil resulted in lower soil bulk densities and higher moisture content (Ilan *et al.*, 2008).

Van Haveren (1983), found that the soil texture and moisture at the time of grazing and as well as the level of organic matter in the soil surface determine the degree of soil compaction. Soil compaction decreases the infiltration rate while increases the runoff and sedimentation and therefore soil erosion.

In addition, these results could be related to the former larger amount of living and decaying plant roots, fungal hyphae and especially casts of earthworms and termites that would have been rapidly destroyed by cultivation. These results confirm earlier observations that macro-aggregates are dynamic in nature, the size distribution of macro-aggregates being affected by the change in land use and management in tropical conditions (Spaccini *et al.*, 2001; Ashagrie *et al.*, 2007). A greater shift in MWD from large macro-aggregates with cultivation also induced significant reduction in MWD. The MWD values indicated that cultivation reduced the aggregate stability by 1.6 times for DCW but that by 3.14 times reductions for soils of RAC lands (Table 1). The greater reduction of MWD values observed for soils of RAC and DCW could be attributed to rapid removal of crops following the crop cultivation. The reduction in the proportion of macro-aggregate fractions following cultivation was also reported by other workers, however, this trend of changes could appear in both tropic and sub humid conditions, but in greater extent in tropical condition after short-term cultivation of virgin soils (Spaccini *et al.*, 2001; Adesodun *et al.*, 2007).

Exchangeable K could affect aggregate stability and therefore soil erodibility (Imeson, 1995). The highest average amount of exchangeable K was measured in DCM soils. This can be attributed to the restricted leaching of cations occurring in these soils due to the almost impermeable underlying bedrock. This value is not expected to have any significant effect on clay dispersion and reduction of aggregate stability (Hillel, 1980). As Lavee *et al.* (1991), and Imeson (1995) pointed out, below a rainfall of about 300 mm/year, soil degradation is related more to the dynamics of sodium than to organic matter content, while organic matter dynamics dominate over sodium effects where annual rainfall exceeds about 600 mm. Since organic matter is central to the formation and stabilization of soil aggregates (Tisdall *et al.*, 1982), there is normally a close correlation between soil organic matter content and water stable aggregation (Haynes, *et al.*, 1996). Increase in MWD could possibly be due to the production of binding carbohydrates which are not water extractable (Haynes, *et al.*, 1991).

However, in the soils, a significantly large proportion of the soil was retained as micro-aggregate. Since small aggregates sized was found to be a useful indicator for soil degradation (Whalen and Chang, 2002). Cultivation in the Sahand soils of two natural ecosystems disintegrated the large aggregates into smaller aggregates, resulting in higher proportion of small aggregates. This could be attributed to the breakdown of aggregates due to cultivation, different annual organic matter input and the enmeshing effects of roots and associated micro and macro organisms.

Cultivation of mountain rangeland and subsequent short-term tillage practices resulted in losses of soil organic C, N and P, largely due to the removal of nutrient-rich fine particle fractions (clay). We measured greater SOM in the regenerating and GL and DCM sites compared to the DCW, and the greatest amount K soil in DCM. This may be attributed to frequent disturbance of these soils by occasionally removing rock fragments and boulders

to aid mechanical cultivation. The removal of boulders from the fields is mainly achieved by using tractor resulting in mixing of the A-horizon with subsurface soil materials. The existence of easily weathered the partial weathering of the consolidated rock and the adsorption of water, permitting root penetration from the growing plants along fracture planes of the bedrock. Therefore, plant roots can penetrate deeper than just through the shallow soil, and the organic matter is more uniformly distributed in deeper layers. Measurements of organic matter in sub-surface layers of selected sites showed that the highest content was measured in soils formed on shale means 0.78%, followed by soils.

Based on the reports of reductions in soil aggregate stability and their relationship to SOM content, when land is cultivated after land use change, there is no detailed study in the Sahand region in Iran with semi-arid condition on the dynamics of nutrient elements and carbohydrates and their distribution in different aggregate fractions. (Emadi *et al.*, 2009). Then degradation of the highland soils with the restricted depth by cultivation seriously impaired soil properties and especially reduced the chemical quality. Marked changes in the particle size distribution and the increase in bulk density for the cultivated soil were apparently related to the effects of accelerated wind and water erosion due to cultivation and subsequent tillage practices. Cultivated croplands had a short growth period and low vegetative and root biomass. Thus, ground surfaces were left bare and directly exposed to strong wind and water erosion.

The results were consistent in terms of particle size distribution of the trapped soils in highlands of southern Mediterranean Conversion of grassland into agricultural land is of considerable concern worldwide in the context of environmental degradation and global climate change Upon conversion of the land to arable agriculture, loss of soil organic matter (SOM) occurs, and Elliott (1986) and Grupta and Germida (1988) reported that cultivation of pasture soils has resulted in 25–50% decrease in soil organic carbon.

CONCLUSION

Overgrazing, deforestation, and increase in the agricultural activity have intensified pressures on high-altitude fragile ecosystems. In conclusion, the results showed that the cultivation of the pastures degraded the soil physical properties, leaving soils more susceptible to the erosion. This suggests that land disturbances should be strictly avoided in the rangelands with the limited soil depth in the Sahand highlands. Additionally, semi-arid climate and inclined topography prevailing in the mountainous area of Sahand render abounded ecosystems vulnerable and unable to recover from incompatible changes in land use type. The present paper has shown the importance of the impact of human intervention regarding land use/ cover and conservation practice changes on soil quality and effects of different management systems on agricultural and natural ecosystems in an agricultural area of fundamental concern in the Sahand Mountain area. The changes of soil particle size distribution and the loss of SOC can be regarded as viable indications of water erosion. Differences in soil MWD among land management practices and their suggested that MWD may be used as a valuable indicator of soil ecological stress or restoration processes. Deterioration of soil properties resulting from indiscriminate cultivation followed by wind erosion processes might occur in short periods of time in the semi-arid, erosion-prone sandy land ecosystems. To conserve soils and rehabilitate regional eco-environment, the sandy rangelands should not be converted to cultivated but be managed with proper fencing in a rotation grazing system. Also, the degraded farmland should be converted back into grasslands or forests. Chemical properties, especially SOM which is the most important indicator of soil chemical properties, had a very important role in soil sensitivity to destructive factors. This is because SOM content affects the main soil physical, chemical, and biological properties. It is, therefore, a valuable indicator in soil quality studies. The abandonment of the land may lead to deteriorating or improving conditions of plant cover depending on the soil and climate characteristics of the area. Soil fertility status may slightly increase after abandonment. Degradation and desertification of this land is ultimately an irreversible process. The changes in land cover and consequently in soil erosion are primarily associated with human activities and hangs in landscape utilization. We expect that a decision of land use management plan is need to prevent of land soil deterioration. However, the global climate changes may offset these effects at least partially. The complex interaction of evolving factors will be a subject of our further study.

REFERENCES

- Adesodun JK, Adeyemi EF, Oyegoke CO. 2007. Distribution of nutrient elements within water stable aggregates of two tropical agro-ecological soils under different land uses. *Soil & Tillage Research* 92, 190–197.

- Ashagrie Y, Zech W, Guggenberger G, Mamo T. 2007. Soil aggregation, and total and particulate organic matter following conversion of native forests to continuous cultivation in Ethiopia. *Soil & Tillage Research* 94, 101–108.
- Blake GR. 1965. Bulk Density, Methods of Soils Analysis. Physical and Mineralogical Properties. American Society of Agronomy, pp. 374–390.
- Blank RR, Fosberg MA. 1989. Cultivated and adjacent virgin soils in northcentral South Dakota: I. Chemical and physical comparisons. *Soil Sci. Soc. Am. J.*, 53: 1484-1490.
- Brady NC. 1985. The Nature and Properties of Soils, 8th (eds) Eurasia Publishing House, New Delhi.
- Bremmer JM, Mulvaney CS. 1982. Total nitrogen. In: Page, A.L., et al. (Eds.), *Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties*. ASA Monograph, vol. 9, pp. 595–624.
- Cleik I. 2005. Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. *Soil Till. Res.*, 38: 270-277.
- Dalal RC, Chan KY. 2001. Soil organic carbon in rainfed cropping systems of the Australian cereal belt. *Aust. J. Soil Res.* 39, 435–464.
- Drewry JJ, Paton RJ. 2005. Soil physical quality under cattle grazing of a winter-fed brassica crop. *Aust. J. Soil Res.*, 43: 525-531.
- Emadi M, Baghernejad M, Memarian HR. 2009. Effect of land-use change on soil fertility characteristics within water-stable aggregates of two cultivated soils in northern Iran, *Land Use Policy* 26, 452–457.
- FAO (United Nations [UN] Food and Agriculture Organization). 2001. *Global Forest Resources Assessment 2000*. FAO Forestry Paper #140. UN FAO, Rome, Italy. 482pp.
- Fenton TE, Brown JR, Mausbach MJ. 1999. Effects of long-term cropping on organic matter content of soils: Implications for soil quality. In: Lal R (ed) *Soil quality and soil erosion*. CRC Press, Boca Raton, Fla., pp. 95–124.
- Gardner WG. 1965. Water content. In: Black, C.A. (Ed.), *Methods of Soil Analysis, No. 9*. American Society of Agronomy, Madison, pp. 82–127.
- Gee GW, Bauder J W. 1986. Particle size analysis. In: Klute, A. _Ed., *Methods of Soil Analyses, Part 2, 2nd edn*. Agronomy Monograph 9. ASA and SSSA, Madison WI, pp. 383–411.
- Ghani A , Dexter M, Carran R A, Theobald P W. 2007. Dissolved organic nitrogen and carbon in pastoral soils: the New Zealand experience. *Eur. J. Soil Sci.*, 58: 832-843.
- Göl C, Çakir M, Edis S, Yilmaz H. 2010. The effects of land use/land cover change and demographic processes (1950 - 2008) on soil properties in the Gökçay catchment, Turkey. *Afr. J. Agric. Res.*, 4(13): 1670-1677.
- Haynes R J, Swift RS, Stephen RC. 1991. Influence of mixed cropping rotations (pasturearable) on organic matter content, water stable aggregation and clod porosity in a group of soils. *Soil Till. Res.*, 19: 77-87.
- Haynes RJ, Beare MH. 1996. Aggregation and organic matter storage in meso thermal, humid soils. In: Carter MR, Stewart BA (eds) *Advances in soil science. Structure and organic matter storage in agricultural soils*. CRC Press, Boca Raton, Fla., pp: 213–262.
- Hillel D. 1980. Movement of solutes and soil salinity. In: Hillel, D. _Ed., *Fundamentals of Soil Physics*. Academic Press, New York, pp. 233–257.
- Imeson A. 1995. The physical, chemical and biological degradation of the soil. In: Fantechi, E., Denis, D.P., Balabanis, P., Rubio, J.I. Eds., *Desertification in a European Context: Physical and Socio-Economic Aspects*. European Commission, Directorate-General Science, Research and Development, EUR 151415EN, pp. 153–168.
- Islam KR, Weil RR. 2000. Land use effects on soil quality in a tropical forest ecosystem of Bangladesh. *Agric. Ecosyst. Environ.*, 79: 9-16.
- Jaiyeoba I A. 2003. Changes in soil properties due to continuous cultivation in Nigerian semiarid Savannah. *Soil Till. Res.* 70, 91–98.
- Kosmas C, Gerontidis St, Marathianou M. 2000. The effect of land use change on soils and vegetation over various lithological formations on Lesvos (Greece). *Catena*, 40, 51–68 .
- Lavee H, Imeson AC, Parientes S, Benjamini Y. 1991. The response of soils to simulated rainfall along a climatological gradient in the arid and semi-arid region. *Catena Supplement* 19, 19–37.
- Lemenih M, Itanna F. 2004. Soil carbon stock and turnovers in various vegetation types and arable lands along an elevation gradient in southern Ethiopia. *Geoderma* 123, 177–188.
- Martinez-Fernandez J, Lopez-Bermudez F, Romezo-Diaz A. 1995. Land use and soil-vegetation relationships in a Mediterranean ecosystem: El Ardal Murcia, Spain. *Catena* 25, 153–167.
- McLean E. 1982. Soil pH and lime requirement. In: Page, A.L. _Ed., *Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties*. Agron. 9. ASA, SSSA. Madison, WI, USA, pp. 199–223.
- Menneer J, Legard S, McLary C, Silvester W. 2001. What impact does dairy cow pugging have on clover N fixation and long-term farm production? *Procee. New Zealand Grass land Association*, 63: 63-67.
- Milne RM, Haynes RJ. 2004. Comparative effects of annual and permanent dairy pastures on soil physical properties in the Tsitsikamma region of South Africa. *Soil Use Manag.*, 20: 81-88.
- Mortenson MC, Schuman GE, Ingram LJ. 2004. Carbon sequestration in rangelands inter seeded with yellow-flowering Alfalfa (*Medicago sativa* ssp. *falcata*). *Envi. Mana.* 33: 475-481.
- Mubarak AR, Elshami OME, Azhari AA. 2005. Long and short –term effects of conventional tillage on a Vertisol properties under sugarcane plantation. *Soil Till. Res.*, 84: 1-6.
- Nael M, Khademi H, Hajabbasi MA. 2004. Response of soil quality indicators and their spatial variability to land degradation in central Iran. *Appl. Soil Ecol.*, 27: 221-232.
- Nelson DW, Sommers LE. 1982. Total carbon, organic carbon, and organic matter. In: Page, A.L., et al. _Eds., *Methods of Soil Analysis, Part 2, 2nd edn*. Agronomy Monograph 9. ASA and SSSA, Madison, WI, pp. 539–579.
- Ramankutty N, Foley JA, Olejniczak NJ. 2002. People on the land: changes in global population and croplands during the 20th century. *Ambio* 31 (3), 251–257.
- Reicosky DC, Forcella F. 1998. Cover crop and Soil quality interactions in agroecosystem. *J. Soil Water Conserv.* 53 (3), 224–229.
- Ross SM (1993) Organic matter in tropical soils: current conditions, concerns and prospects for conservation. *Progress in Physiographic and Geography* 17, 265–305.
- Shoshany M, Goldshleger N. 2002. Land-use and population density changes in Israel-1950 to 1990: analysis of regional and local trends. *Land Use Policy*, 19. 123–133
- Spaccini R, Zena A, Igwe CA, Mbagwu JSC, Piccolo A. 2001. Carbohydrates in water-stable aggregates and particle size fractions of forested and cultivated soils in two contrasting tropical ecosystems. *Biogeochemistry* 53, 1–22.

- Sparks DL. 1996. Methods of soil analysis. Part 3. Chemical Methods. Soil Science Society American, Inc. American Society of agronomy, Inc. Madison, Wisconsin, USA.
- Sparling GP, Shepherd TG, Shepherd HA. 1992. Changes in soil organic carbon, microbial C and aggregate stability under continuous maize and cereal cropping and after restoration to pasture in soils from the Manawalu region, New Zealand. *Soil Till. Res.*, 24: 225-241.
- Steel RGD, Torrie JH. 1980. Principles and Procedures of Statistics. McGraw-Hill, New York.
- Tilman D, Reich P, Knops J, Wedin D, Mielke T, Lehman C. 2001. Diversity and productivity in a long-term grassland experiment. *Sci.*, 294: 843-845.
- Tisdall JM, Oades JM. 1982. Organic matter and water stable aggregates in soils. *J. Soil Sci.*, 33: 141-163.
- Trimble SW. 1990. Geomorphic effects of vegetation cover and management: some time and space considerations in prediction of erosion and sediment yield. In: Thornes, J.B. Ed., *Vegetation and Erosion Processes and Environments*. Wiley, pp. 55-66.
- Turner MG. 1989. Landscape ecology: the effect of pattern and process. *Ann. Rev. Ecol. Syst.* 20, 171-197.
- Twerdoff DA, Chanasyk DS, Mapfumo E, Naeth NA, Baron VS. 1999. Impacts of forage grazing and cultivation on near-surface relative compaction. *Canad. J. Soil Sci.*, 79: 465-471.
- Unger PW. 1997. Management-induced aggregation and organic carbon concentrations in the surface layer of a Torrertic Paleustoll. *Soil and Tillage Research* 42, 185-208.
- Whalen JK, Chang C. 2002. Macroaggregate characteristics in cultivated soils after 25 annual manure applications. *Soil Science Society of American Journal* 66, 1637-1647.
- Xiao-gang L, Feng-min Li, Bhupinderpal-Singh RZ, Zheng-yan Z. 2007. Soil management changes organic carbon pools in alpine pastoral land soils. *Soil Till. Res.*, 93: 186-196.
- Yoder RE. 1936. A direct method of aggregate analysis and a study of the physical nature of erosion losses. *J. Am. Soc. Agron.* 28, 337-351.