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Full Length Research Paper

Potential decline in soil quality attributes as a result of land use change in a hillslope in Lordegan, Western Iran

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The aim of the study was to investigate the potential decline in soil quality attributes as a result of land use change in Lordegan area in the Chaharmahal Va Bakhtiari Province, Western Iran. Two of the most important factors associated with soil quality concept are: (1) soil has both inherent and dynamic properties and (2) soil quality assessment must reflect biological, chemical and physical properties. Land use changes, especially cultivation of deforested land may rapidly diminish soil quality. Surface (0 to 30 cm) soil samples were taken from five slope positions (summit, shoulder, backslope, footslope and toeslope) of rangeland and adjacent cultivated land according to randomized complete block design. These results showed that the destroyed, and tillage practices led to an decrease in soil organic matter (SOM), total nitrogen (TN), cation exchange capacity (CEC), extractable manganese (Mn), clay and mean weight diameter (MWD) by 63.04, 61.82, 30.27, 67.71, 59.49 and 10.82%, respectively, while increased soil bulk density (BD) by 21.42%. It could be that rangeland destroyed, land use change and long-term cultivation would decrease soil quality attributes.

Key words: Bulk density, land use, manganese, organic matter, rangeland, soil quality.

INTRODUCTION

Functional capacity of soil could be evaluated by measuring some selected soil physical, chemical and biological properties, also known as soil quality indicators (Shukla et al., 2006). Soil properties that can be changed in a short time by land use dynamic are considered as soil quality indicators (Carter et al., 1997).

Two of the most important factors associated with soil quality concept are: (1) soil has both inherent and dynamic properties and (2) soil quality assessment must reflect biological, chemical and physical properties including aggregate stability, organic matter content, soil depth, water holding capacity, changes in pH values and microbial respiration rate, which changed with different land vegetations (Khormali and Shamsi, 2009).

Assessing soil quality involves measuring physical, chemical, and biological soil properties and using these measured values to detect changes in soil as a result of land use change or management practices (Adolfo et al., 2007).

Deforestation, overgrazing, and conversion of range-lands and forests have resulted in a great decline in the physical, chemical, and biological quality of soil resources in Iran, as well as elsewhere in the world (Nael et al., 2004). Most changes in land use affect the amount of carbon held in vegetation and soil, thereby, either it releasing carbon dioxide (a greenhouse gas) to, or removing it from the atmosphere (Gol, 2008).

Land use change has a great influence on many soil quality attributes mostly through its effect on soil organic matter. Structural stability of soils is affected by land use, which in turn is positively associated with total organic C content (Khormali et al., 2009). Six et al. (2000) reported that cultivation has reduced soil C content and changed the distribution and stability of soil aggregates. Land use

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changes, especially cultivation of deforested land may rapidly diminish soil quality, as ecologically sensitive components of the tropical forest ecosystem are not able to buffer the effects of agricultural practices. As a result, severe deterioration in soil quality may lead to a permanent degradation of land productivity (Islam and Weil, 2000).

Conversion of forest and grasslands into agricultural land is one of the main concerns worldwide in the context of environmental degradation and global climate change (Wali et al., 1999). Mojiri et al. (2011) investigated the effects of land use changes and hillslope position on soil quality attributes. Their results showed that rangeland destroyed, land use changes and long-term cultivation caused decrease of soil organic carbon, organic matter, total nitrogen, available potassium, soil microbial respiration and extractable Fe.

Ayoubi et al. (2011) investigated the assessing impacts of land use change on soil quality indicators in a loessial soil in Golestan Province, Iran. The study showed that forest clearing followed by cultivation of the loessial hilly slopes resulted in the decline of the soil quality attributes, while reforestation improved them in the study area.

Lemenih (2004) investigated the effects of land use changes on soil quality and native flora degradation and restoration in the highlands of Ethiopia. Results showed deforestation and then long-term cultivation caused organic matter and total nitrogen decreased and also changes in soil surface (0 to 10 cm) indicated phosphorous, potassium, available potassium, Ca+Mg, saturation point and cation exchange capacity. The objective of this study was to investigate the effects of landuse change and hillslope position on selected soil quality attributes in Lordegan area.

MATERIALS AND METHODS

Study area and field work

Two adjacent sites were selected, considering the natural rangeland and cultivated land on a hillslope located in Lordegan area in the southern of Chaharmahal va Bakhtiari Province (west of Iran) (30° 55'N, 49°55'E to 31° 26'N, 50° 34'E). The elevation of this area is 1700 m Above Sea Level (ASL). This area is at Zagros Mountain. Lordegan has a variety climate so that there are cold, hot, humid and temperate regions in this area (Lordegan City Governor, 2011). This study was done in cold region. Surface (0 to 30 cm) soil samples were taken from five slope positions (summit, shoulder, backslope, footslope and toeslope) of rangeland and adjacent cultivated land according to randomized complete block design. Soil samples were air dried in a green house at a temperature between 25 and 30°C and passed through a 2 mm mesh sieve for preparation of fine soil samples (Mojiri and Jalalian, 2011).

Laboratory analyses

The percentages of clay and sand were determined by the Bouyoucos hydrometer method (Gee and Bauder, 1986). Total nitrogen (TN) was measured by Kjeldahl method and soil organic matter (OM) was measured by Walkley and Black method (ASA, 1982). Cation exchange capacity (CEC) was measured by sodium acetate at pH 8.2 (Chapman, 1965). Extractable manganese (Mn) was measured by DTPA method (APHA, 1998). Soil bulk density (BD) was estimated using paraffin method (Blake and Hartge, 1986). The mean weight diameter (MWD) was determined by Kemper and Rosenau method (1986) (Figure 1).

Statistical analysis

Descriptive statistical analysis including mean comparison using Duncan's multiple range test (DMRT) was conducted using SPSS software.

RESULTS AND DISCUSSION

The effects of land use change and hillslope position are shown in Table 1 and Figures 2 to 5.

Particle size distribution

Maximum clay (%) equal to 37 was related to rangeland in summit position, and minimum clay equal to 31 was related to cultivated land in backslope, footslope and toeslope positions. Particle size distribution showed that the percentage of clay in cultivation decreased and percentage of clay diminished from 37% in rangeland to 31% in cultivation. This is in line with findings of Hajabbasi et al. (2007).

Organic matter (OM)

Maximum OM (%) equal to 2.678 was related to rangeland in toeslope position, and minimum OM equal to 0.912 was related to cultivated land in shoulder position.

Rangeland destroyed and land use change in different slope positions caused a decrease of soil OM content. This is in line with findings of Gol (2008) and Islam and Weil (2000). Cultivation is the most important factor that it is effective in acceleration reduction soil organic matter. Increased erosion is another factor that it is effective in acceleration reduction soil organic matter in soil surface (Mojiri et al., 2011).

Gol et al. (2010) expressed significant difference ($p<0.05$) in soil organic matter (SOM) between the forest and the other Land use/land cover (LULC) will lead to a reduction in the nutrient and soil organic carbon content. The conversion of native forest (NF) and native rangeland (NR) into cultivated area (CA) is known to deteriorate soil properties, especially reduces SOM and changes the distribution and stability of soil aggregates.

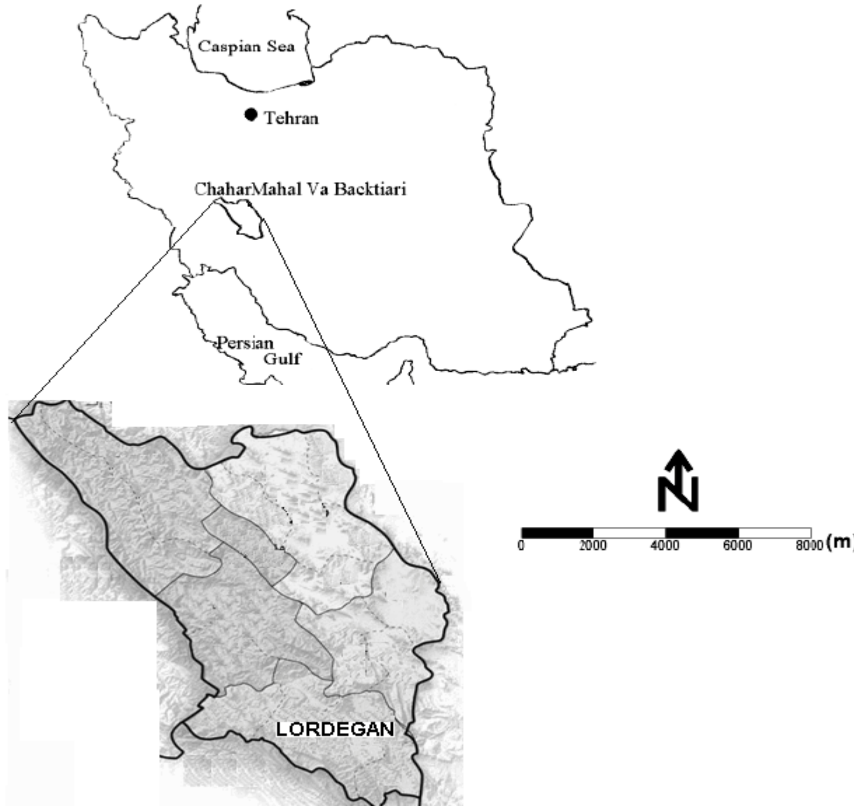

Figure 1. Study area.

Table 1. Effects of the land use and hillslope position on some physicochemical properties of soil.

Land use	Position	Clay (%)	Sand (%)	OM (%)	TN (%)	CEC (Cmol kg^{-1})	Mn (ppm)	BD (g/cm^3)	MWD (mm)
R[+]	SU[a]	37[a]	27[a]	2.534[a*]	0.283[a]	28.67[a]	3.498[a]	1.10[a]	1.18[a]
C		33[d]	29[d]	0.956[e]	0.108[e]	20.19[d]	1.211[f]	1.30[b]	0.51[b]
R	SH	36[a]	26[a]	2.489[a]	0.219[b]	28.58[a]	3.103[b]	1.12[a]	1.16[a]
C		33[d]	28[d]	0.912[f]	0.101[f]	19.93[e]	1.002[g]	1.36[c]	0.47[c]
R	BS	34[b]	26[a]	2.491[a]	0.228[b]	28.41[a]	3.113[c]	1.12[a]	1.16[a]
C		31[e]	28[d]	0.920[f]	0.103[f]	19.96[e]	1.006[g]	1.35[c]	0.49[c]
R	FS	34[b]	29[b]	2.526[a]	0.234[b]	28.49[b]	3.090[d]	1.10[a]	1.17[a]
C		31[e]	30[e]	0.967[g]	0.149[g]	21.01[f]	1.271[h]	1.31[b]	0.51[b]
R	TS	32[c]	31[c]	2.678[b]	0.296[c]	29.13[b]	3.872[e]	1.09[a]	1.19[a]
C		31[e]	32[e]	1.283[h]	0.165[h]	21.95[f]	1.521[i]	1.29[b]	0.57[d]

[+]R = Rangeland and C = cultivated; [a]SU = summit , SH = shoulder; BS = backslope; FS = footslope and TS = toeslope; *Means whithin a column followed by the same letter are not significantly different at (P<0.05) according to the DMR test.

Total nitrogen (TN)

Maximum TN (%) equal to 0.296 was related to rangeland in toeslope position, and minimum TN equal to 0.101 was related to cultivated land in shoulder position. Rangeland destroyed and land use change in different slope positions caused a decrease of soil total nitrogen (N) content. In investigating the effect of land use

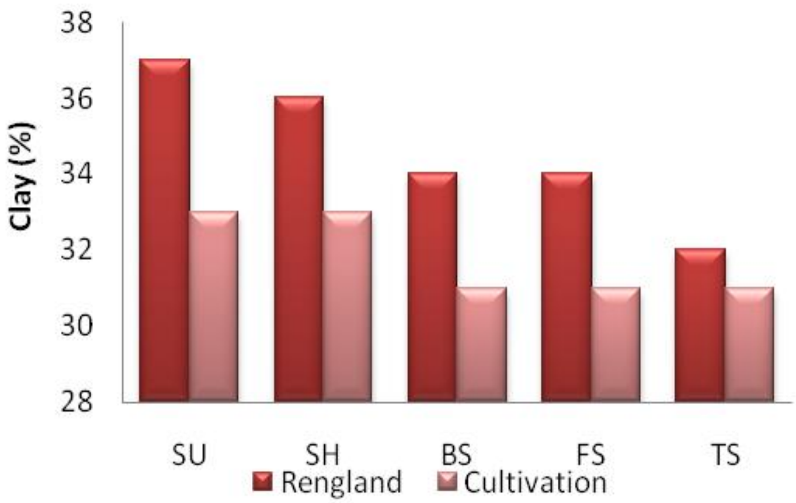

Figure 2. Clay in the two land uses on different slope position.

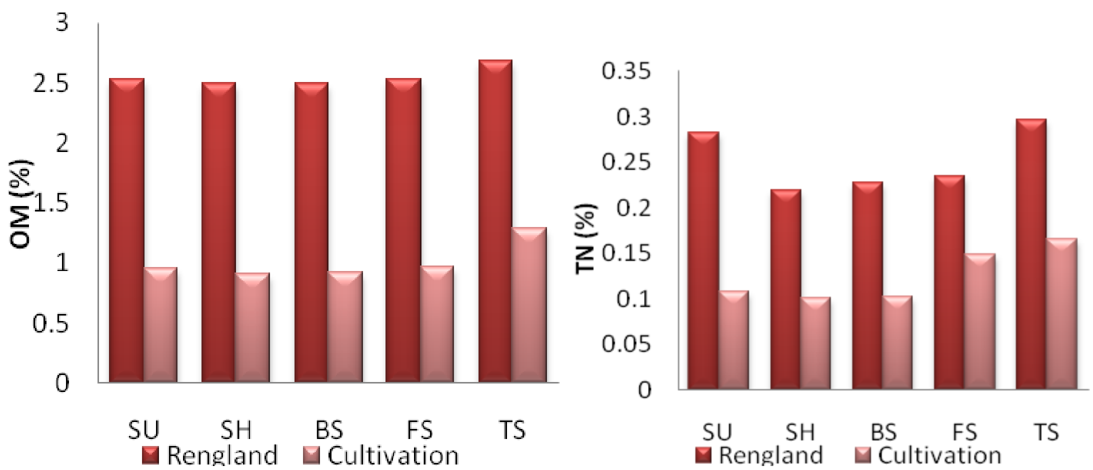

Figure 3. OM and TN in the two land uses on different slope position.

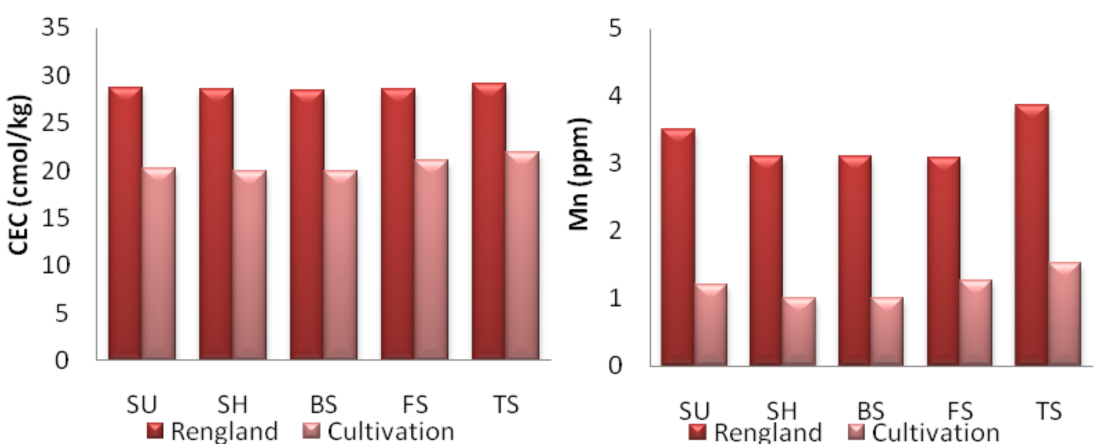

Figure 4. CEC and Mn in the two land uses on different slope position.

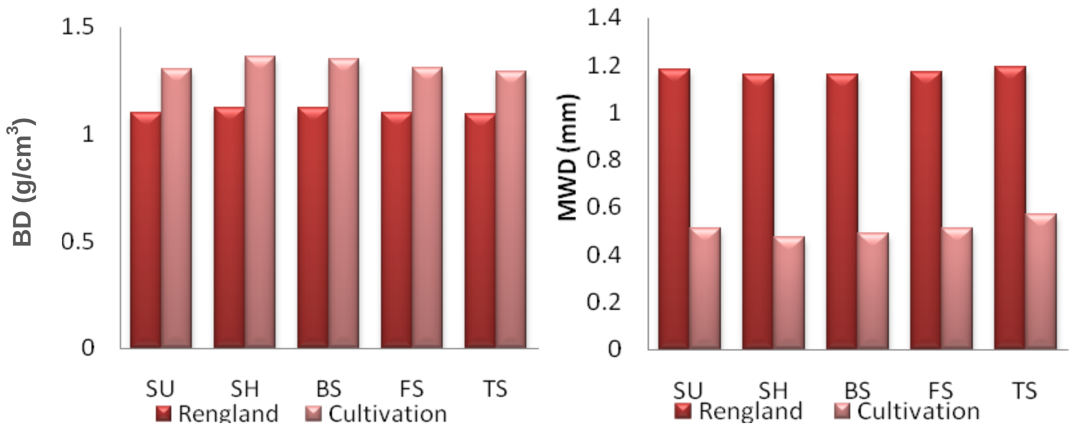

Figure 5. BD and MWD in the two land uses on different slope position.

changes on soil quality attribute Islam and Weil (2000) and Lemenih (2004) found the same results about that the deforestation and land use changes caused a decrease of total nitrogen (TN).

The lower levels of C_{org} and TN in cultivated soils may have resulted from a combination of lower C inputs because of less biomass C return on harvested land and greater C losses because of aggregate disruption, increased aeration by tillage, crop residue burning, accelerated water erosion and livestock grazing (Islam and Weil, 2000).

Cation exchange capacity (CEC)

Maximum CEC (cmol kg^{-1}) equal to 29.13 was related to rangeland in toeslope position, and minimum CEC equal to 19.93 was related to cultivated land in shoulder position. Rangeland destroyed and land use change in different slope positions caused a decrease of soil cation exchange capacity content. In investigating the effect of land use changes on soil quality attribute Lemenih (2004) found the same results about that the deforestation and land use changes caused a decrease of CEC. Decrease in CEC reflects the textural and OM changes in deforestation (Khormali et al., 2009).

Extractable manganese (Mn)

Maximum Mn (ppm) equal to 3.872 was related to rangeland in toeslope position, and minimum Mn equal to 1.002 was related to cultivated land in shoulder position. Rangeland destroyed and land use change in different slope positions caused a decrease of soil extractable Mn content.

Bulk density (BD)

Maximum BD (g/cm^3) equal to 1.36 was related to cultivated land in shoulder position, and minimum BD equal to 1.09 was related to rangeland in toeslope position. Rangeland destroyed and land use change in different slope positions caused an increase of soil bulk density. This is in line with the findings of Khormali et al. (2009) and Islam and Weil (2000). Increased BD is related with the loss of organic matter and soil compaction due to tillage practices in the deforested land (Khormali et al., 2009).

Mean weight diameter (MWD)

Maximum MWD (mm) equal to 1.19 was related to rangeland in toeslope position, and minimum MWD equal to 0.47 was related to cultivated land in shoulder position. Rangeland destroyed and land use change in different slope positions caused a decrease of MWD. This is in line with finding of Khormali et al. (2009) and Hajabbasi et al. (2007).

Two important factors have role in aggregation and aggregate sustainability: (i) Presented agglutinate particles (cation and organic matter). (ii) Time impact these factors. The activity of these factors is more limit, aggregation and aggregate stability are less (Hajabbasi et al., 2007). Accordinge to Table 1 and Figures 2 to 5, best soil quality attributes were related to rangeland in toeslope position. Rangeland destroyed, land use change and long-term cultivation caused decreased of soil quality attributes specially in shoulder position.

Conclusion

The capacity of soil to function can be reflected by measured soil physical, chemical and biological properties, also known as soil quality indicators. Land use change has a great influence on many soil quality attributes. This research showed rangeland destroyed, land use change and long-term cultivation caused decrease of OM, TN, CEC, Mn and MWD but it caused an increase of BD.

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