Sources and Processes of Salt Accumulation in Segzi Valley of Isfahan, IRAN

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Abstract

Salinity and alkalinity are the major problems in soils of arid regions. Wind erosion also creates land degradation in drylands through loss of crops, pollution and jeopardised sustainability. Concentrations of soluble salts, through their high osmotic pressures, affect plant growth by restricting the uptake of water by the roots. In this study, factors influencing salt accumulation in Segzi valley of Isfahan were investigated. Because of the vicinity of the study area to irrigated farms and the city of Isfahan, wind erosion is also one of the most important agriculturally related problems in the area. Thirteen soil mapping units, which were different in their surface characteristics and salt accumulation, separated in an area of 43000 ha. In these soil-mapping units, 25 pedons were described in the field and 16 pedons selected for laboratory analyses. Physical and chemical soil properties including texture, percentage of stable aggregates in wet sieving, EC, SAR, soluble cations and anions, pH, percentage of calcium carbonate, gypsum and organic matter were determined by routine procedures. Factors such as moist subsoil, increase of EC and SAR toward the soil surface, redoximorphic features and salt efflorescence indicates that high water table is the major source of salt accumulation in these soils. Because of excessive pumping, water table has dropped lower in recent years. Wind also plays an important role in distribution of salts in the area as indicated by aeolian deposits, ripple marks and nebkas. Textural discontinuity in soils and human activity in the area also influence salt distribution but factors such as topography, soil parent material and surface runoff are less important in the area. Halite, gypsum and mirabilite were major evaporites identified in saturated extracts by XRD. Crusted soils had stable aggregates during wet sieving as compared to non-crusted soils. Because of high salinity and susceptibility of soils to wind erosion, open mining for gypsum, sand and clay is not recommended and special care must be taken to preserve surface crust in the area. Further investigation should be done to find tolerant plants to wind erosion and salty-gypsiferous soils with impermeable subsurface horizons.

Key words*:* Isfahan; Salt accumulation, Wind erosion,

Introduction

Saline and sodic soils occupy about 15 percent of Iran. Although they are extensive, little research has been done about factors influencing salt accumulation in these soils. Salinization is the process by which water-soluble salts accumulate in the soil. Since few plants grow well on saline soils; therefore, salinization often restricts options for cropping in a given land area. About 10 million ha of irrigated lands have to be taken out of production because of salinity problems (Rhoades and Loveday, 1990). The released salts are transported away from their source of origin through surface or groundwater streams. Saline soils also facilitate desertification processes due to their unfavorable properties. Abu-Sharar et al. (1987) have mentioned in saline and sodic soils, reducing of hydraulic conductivity is corrolated with aggregate dispersion.

Wind erosion can be a major threat to soil productivity if care is not taken to protect the soil surface with an appropriate soil cover. World Bank (1984) mentioned that the dominant man induced causes of land degradation in the drylands are salinity and alkalinity problems, poor farming practices, population pressure, overgrazing, soil erosion, deforestation, and the use of livestock manure and crop residue for fuel as energy resource of the rural households. Therefore, evaluation of salinity hazards can help to prevent irrevocable damage of soil quality. The objective of this study is to determine sources and processes of salt accumulation in Segzi valley of Isfahan, Iran.

Materials and Methods

The area under investigation is about 43000 ha. It is located between 51° 56' 29" and 52° 7' 30" E and 32° 52' 18" and 32° 23' 50" N in eastern part of Isfahan, Iran. Because of the vicinity of the study area to irrigated farms, airport and the city of Isfahan and also main road of Isfahan toYazd, salinity and wind erosion are two major important problems in the region. This area is characterized by a dry climate with high temperature. The mean annual rainfall and air temperature is about 100mm and 14.7ºC, respectively with an altitude of 1500m above the sea level. The soil moisture and temperature regimes in the area are aridic and thermic respectively. The dominant wind direction is from the east to the west in this region. Total of 25 pedons were excavated in 13 selected mapping units, which were different in topsoil properties and salt accumulation. After describing the pedons in the field, 16 pedons representing soils and including secondary carbonates, gypsum and salts were selected for laboratory analyses. Physical and chemical soil properties including texture, percentage of stable aggregates (MWD) in wet sieving, ECe, soluble cations and anions, pH, percentage of calcium carbonate, gypsum and organic matter were determined by routine procedures. Sodium adsorption ratio (SAR) of saturated extracts was calculated by following equation:

$$SAR = [Na^{+}]/([Ca^{2+} + Mg^{2+}]/2)^{1/2}$$

Results and Discussion

Results show that all soils in the region are considered as saline-sodic soils based on their pH, SAR and ECe values and classified as Gypsic Aquisalids, Gypsic Haplosalids and Typic Haplosalids subgroups according to soil taxonomy (Soil Survey Staff, 1999). In all pedons studied, ECe and SAR increase toward the soil surface (Fig.1). This increase indicate that high water table was the major source for salt accumulation in the soils.

Soil morphology is also an indicator of seasonal changes of the shallow water table. In most subsurface horizons, redoximorphic features present that water table has been near the soil surface but because of excessive pumping and artificial drainage, water table has dropped lower in recent years. In spite of artificial drainage, water table approaches to the surface by decreasing the slope in the area. Therefore, the overall salt accumulation increases toward the center of the playa. A dark layer has been observed in some subsurface horizons. This layer consists of about threefold organic matter in comparison with surface horizons. This can suggest that high water table and moist subsoil have prevented the decomposition of soil organic matter. Khademi (1997) believed that this study area was a part of the post-Tethyan sea environment that covered by shallow lagoons in the late Tertiary. The Gavkhouni swamp located 50 Km east of the area studied is considered to be the remnant of such lagoons. Palynological investigations by Ayoubi (2002) on Segzi paleosols also showed

different aquatic species and a lot of macrofossil shells of Gastropods. All of these documents confirm the existence of a swampy environment in the past conditions of the area.

Evaporation of water raised by capillary movement could leave considerable amounts of salts on the soil surface. From the top to the bottom of soils, the order of salt follows soluble salts, gypsum and calcite. This succession shows that because of evaporation of water table, more soluble salts accumulate near the soil surface whereas less soluble salts gather in subsoil horizons. Salt efflorescence and puffy grounds in the region presents the growth of salt crystals under crust in the soil surface.

In a few soils studied, a cemented horizon containing high soluble salts has been distinguished. Since this horizon slakes in water and also is a root-limiting layer, petrosalic (zm as suffix symbol) is suggested as a new horizon in Soil Taxonomy. Chemical analyses show high gypsum and salinity contents in wind deposited materials. Also, halite, gypsum and mirabilite were major evaporites identified in soils and wind deposits by XRD (Fig. 2). Therefore, wind plays an important role in distribution of salts in the area as also indicated by ripple marks and nebkas. Textural discontinuity in soils is another indicator for wind activity, which is an important factor in formation of salic and gypsic horizons. This property reduces the rate of water movement and causes salt accumulation between horizon boundary.

Calculated mean weight diameter shows that crusted soils have stable aggregates during wet sieving as compared to non-crusted soils. This can suggest that special care must be taken to preserve crust, desert pavement and also poor native vegetation in the area. To protect the soil surface, open mining and over-exploitation of gypsum, sand and clay is not recommended. These activities in addition to soil and climate conditions have created a favorable environment for wind erosion. With respect to results obtained in different positions of the area, other factors such as topography, soil parent material and surface runoff are less important in salt accumulation. Further investigation should be done to find tolerant plants to wind erosion as well as salty-gypsiferous soils with impermeable subsurface horizons because planting of Halloxilon and Atriplex species has not been successful in last decades probably because of low porosity and heavy texture in the soils.

Conclusion

High water table and wind activity is two major factors in salt accumulation and distribution in Segzi valley. Textural discontinuity in soils and human activity in the area also influence salt distribution but factors such as topography, soil parent material and surface runoff are less important in the area. Further investigations should be done to find plants adaptable with soil and climate conditions in the area. Better management of land and vegetation cover in the region can reduce wind erosion, thus preventing salt accumulation in soils further a way from Segzi. Because of high salinity and susceptibility of soils to wind erosion, open mining for gypsum, sand and clay is not recommended and special care must be taken to preserve surface crust in the region.

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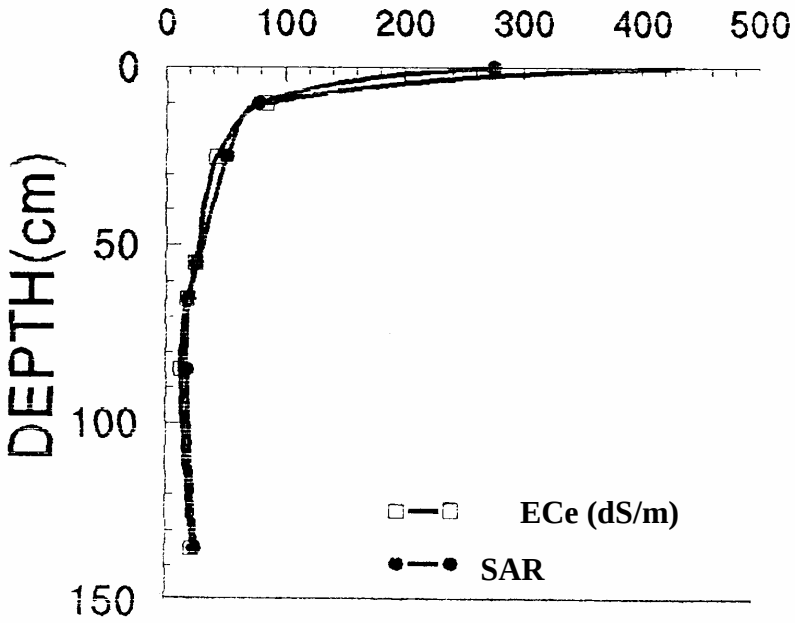

Fig.1. Increase of ECe and SAR toward the soil surface in pedons studied.

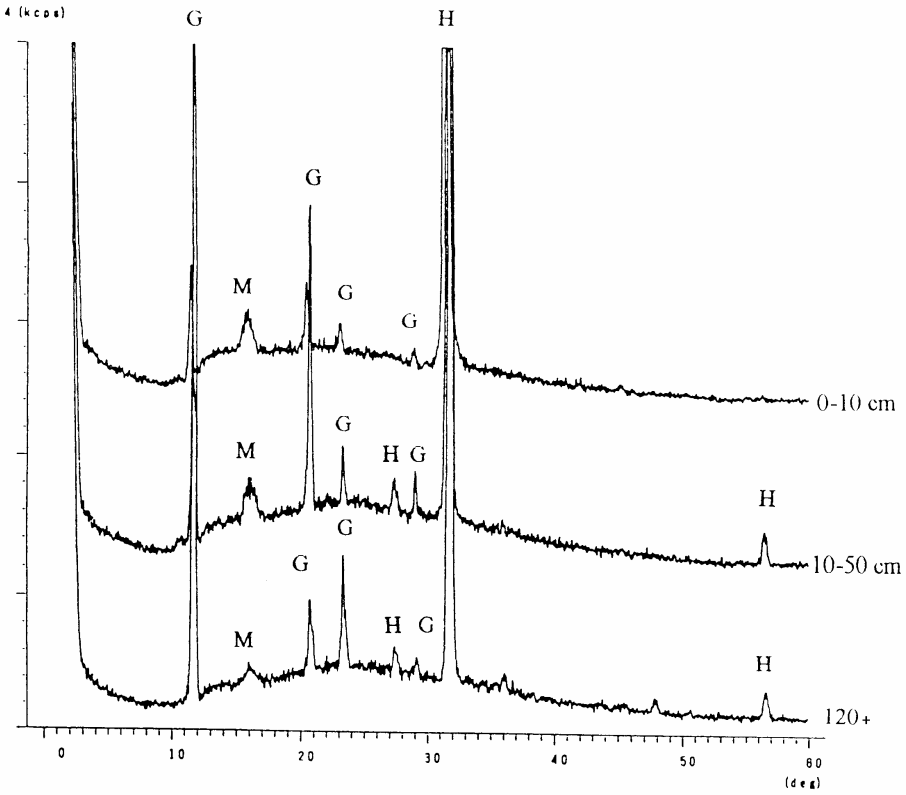

Fig.2. Evaporite minerals identified by XRD in saturated extracts of different depth of pedons (H: Halite, M: mirabilite, G: Gypsum).