A Qualitative Land Suitability Assessment in Gypsiferous Soils of Kerman Province, Iran

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Abstract: The suitability is the aptitude of a given type of land to support a defined use. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for a defined use.This research was performed to study of properties of gypsiferous soils and land suitabilityevaluation for agronomic productions in the study area. At first, the land maps were studied, then 35 farmlandswere chosen, they had gypsic horizon and were scattered in the total plain. Then one profile in each farm wasdescribed and catch the samples from all horizons. The total gypsum characteristics, using agriculturalinstruments and applying of different inputs were studied. Land characteristics for example: salinity, acidity, Sodium Absorption Ratio (SAR), Cation Exchange Capacity (CEC), gypsum content, calcium carbonatecontent, texture and climate were used to classification of land suitability and land utilization types such aswheat, barely, alfalfa, maize, sugarbeet and potato were studied. meanwhile, plant and climate tables weregathered by sys and givi. The results show that the maximum and average of soil gypsum was 31% and 12%respectively. it is one of the most limitation for crop production. According to key to soil taxonomy(2006), thegypsic and cambic horizons were classified in aridisols and entisols. Parent materials, climate, microrelief (topography), physiography and pendant shapes effect the gypsum formation in the studied area. Investigationand qualitative reviewing of lands show that land suitability have a range of changes in classes from S2 to S3for wheat with the limitations of gypsum in soils and texture, from S2 to S3 for barley with the limitations ofgypsum in soils and texture, from S2 to N2 and S3 to N2 for potato with the limitations of soil acidity andgypsum, and S2 to N1 with the limitation of soil`s texture for sugarbeet, from S2 to N2 and S3 to N2 for alfalfawith the limitations of soil`s acidity and gypsum and topography and from S2 to N2 for onion with thelimitations of soil`s gypsum and acidity, respectively. researches show that the average of yield in differentproduction in gypsic and non- gypsiferous soils are different.

Key words: Land suitability; Land utilization types; Gypsiferous soils; Kerman

INTRODUCTION

Decisions on land use have always been part of the evolution of human society. In the past, land use changes often came about by gradual evolution, as the result of many separate decisions taken by individuals. In the more crowded and complex world of the present they are frequently brought about by the process of land use planning. Such planning takes place in all parts of the world, including both developing and developed countries. It may be concerned with putting environmental resources to new kinds of productive use. The need for land use planning is frequently brought about, however, by changing needs and pressures, involving competing uses for the same land.

The function of land use planning is to guide decisions on land use in such a way that the resources of the environment are put to the most beneficial use for man, whiles at the same time conserving those resources for the future. This planning must be based on an understanding both of the natural environment and of the kinds of land use envisaged. There have been many examples of damage to natural resources and of unsuccessful land use enterprises through failure to take account of the mutual relationships between land and the uses to which it is put. It is a function of land evaluation to bring about such understanding and to present planners with comparisons of the most promising kinds of land use.

Land evaluation is concerned with the assessment of land performance when used for specified purposes. It involves the execution and interpretation of basic surveys of climate, soils, vegetation and other aspects of land in terms of the requirements of alternative forms of land use. To be of value in planning, the range of land uses considered has to be limited to those which are relevant within the physical, economic and social context of the area considered, and the comparisons must incorporate economic considerations.

Land evaluation is concerned with the assessment of land performance for specific land utilization purposes and provides a rational basis for taking land use decisions based on analysis of relations between the land use and land, giving estimates of required inputs and predicted outputs.(FAO, 1985; Sys et al, 1991).

Gypsiferous soils are soils that contain sufficient quantities of gypsum (calcium sulphate) to interfere with plant growth. Soils with gypsum of pedogenic origin are found in regions with ustic, xeric and aridic moisture regimes (Nettleton *et al.,* 1982). They are well represented in dry areas where sources for the calcium sulphate exist. They do not usually occur under wet climates. In most cases the gypsum is associated with other salts of calcium and salts of sodium and magnesium.

Gypsiferous soils are very variable and there are many factors that affect their properties in relation to plant growth. Gypsiferous soils can be productive and managed profitably if they are first studied properly. The effect of the chemical properties of gypsiferous and calcareous soils on the growth of plants, both natural vegetation and crops, and their mineral contents have been investigated by numerous authors. In the first American system of soil classification gypsiferous soils are not separated from other soils. The soils of the dry areas are classified as Red Desert Soils equivalent to Argids, Calciorthids and Camborthids of the modern American system. The first system was elaborated from the classification of (Marbut, 1967) after some redefinition. It was revised several times subsequently.

The performance of plants grown on shallow soils depends to a large extent on their root system, the gypsum content, the fertility level of the topsoil, and the water availability during the growing season. In particular the presence of a hard impervious gypsic layer has a strong effect on crop production under irrigation.

Percolating water dissolves gypsum and salts and stagnates at the top of the gypsic layer creating a perched water-table, often resulting in an accumulation of gypsum and salts. The resulting high water-table may rise to the soil surface leaving salts and gypsum. Under these conditions, the performance of crops will be affected by both gypsum and salinity. Gypsiferous soils have been cultivated under dry farming systems for centuries mainly with cereal crops and small-grain legumes. Because of population pressure and recent technological developments in the use of underground waters some gypsiferous soils are now irrigated. Under irrigation, new problems have arisen through the introduction of high-yielding crops especially those least tolerant of gypsum.

The intensive leaching of nutrients, calcium solubilization from gypsum, and the removal of exchangeable potassium and magnesium affect the productivity of gypsiferous soils. the influence of the gypsum concentration in soils is comparable to that of calcium carbonate, except gypsum is more soluble and may cause dissolution pockets and successive development of a characteristic microrelief if the soils are irrigated. The general indices in Table 1 are suggested where soils and crops information are very limited.

Table 1: Rating index on the basis of average gypsum content on the upper 100 cm of the soil or to a limiting layer (Sys and Verheye 1972, Barzanji 1973).

Gypsum content(%)	Gypsum indices
Up to 0.3	0.9
0.3-10	1.0
10-25	0.85
25-50	0.60

Smith and Robertson (1962) observe that yields of annual and perennial crops are depressed when grown onsoils where the gypsum content of the root zone is higher than 25 percent. Thus, Barzanji (1973) suggested thefollowing parameters for annual crops where the indices were calculated according to the weighted average ofthe gypsum content of the upper 40 cm of the soil profile (Table 2). For perennial crops the weighted average ofthe gypsum content was calculated for the upper 100 cm of the soil, if no gypsic layer is present. If there is agypsic layer the weighted average is calculated for soil above the gypsic layer only

Table 2: Gypsum indices for annual crops with shallow root system according to their gypsum tolerance (Barzanji, 1973).

	I	II	III
Gypsum(%)	Crops that tolerate a high level of $CaSO_4$	Crops that tolerate some $CaSO_4$	Crops sensitive to $CaSO_4$
up to 0.3	1	1	1
0.3-10	1.1	1	0.75
10-25	0.8	0.7	0.5
>25	0.5	0.4	0.3

The above classification adopted by Barzanji was based on limited data, field observations, and informationgiven by Smith and Robertson (1962). In more recent studies, many annual and perennial crops are found toperform well in highly gypsiferous soils; and the depth of the gypsic layer and the degree of its cementationdetermine to a large extent the irrigability of that type of soil.Studies on gypsiferous soils don`t have long antiquity and their background is returned to the second half ofthe twentieth century. These soils are considered among the unsuitable or with acute proportion soilsagriculturally. A large amount of gypsum in soils have considerable extent in arid and semi-arid regions of theworld. gypsiferous soils extent has been estimated about 85 million hectares in the world and these lands extenthas been reported about 73 million hectares in the Middle East which 9.8 million hectares of that has beenreported in Islamic Repulbic of Iran that about 124500 hectares of these lands are placedinKerman. Accordingto the features of these soils, their potentials are different for different applications. Suchsoilsidentify, is not only valuable from the viewpoint of soil resources evaluation, but also awareness of theirformation mechanismand evolution procedure can be effective in applicationprogrammings,environment protect, and soilpreservation and etc. Basically, when the gypsum amount in soil is poor, its existence is proper for plants growth, but the yield of crop production is decreased by increasing gypsum percent because of imbalance in nutrientelements absorption by plants roots. One of the product increase methods in surface unit and/ or in the otherwords optimum use of lands is identifying production capacity of each land and choosing proper applicationwith that,s production capacity. Identifying the lands proportion evaluation is a proper solution for acquiring thisgoal. Nowadays, the formation of gypsiferous soils, evaluation of these lands and presenting specialmanagement and proper agricultural garden shift for these lands are among considerable subjects. These soilsformation and extent part of under farm lands of Bardsir area that in some points have had many destructiveeffects on soil`s function and features.

MATERIALS AND METHODS

The Study Area:

The land investigated in research located in Bardsir (kerman province) and has the area of 3000 hectares between latitudes of 47   29′30″ and 52   29′30″ N and between longitudes of 56   45′00″ and 56   52′30″ E at west south of Kerman city. The average heights are 1980 meters from sea level. (fig.1).

Sampling:

Based on Soil Taxonomy (2006), this region has soils in Aridisols and Entisols orders. Using GPS deviceand base map, profiles location defined and profiles excavated and described using presented methods in “FieldBook Describing and Sampling Soils”(1998). To perform experimental studies, 59 bulk soil samples preparedand air dried and after being ground passed through standard sieve size of 2mm. The soil texture was defined viahydrometric method and after calibration in saturated paste the pH and Electrical Conductivity (EC) were measured, calcium carbonate content measured via Calcimetery methods, gypsum measured via Acetone, cationexchange capacity measured via Bower method.

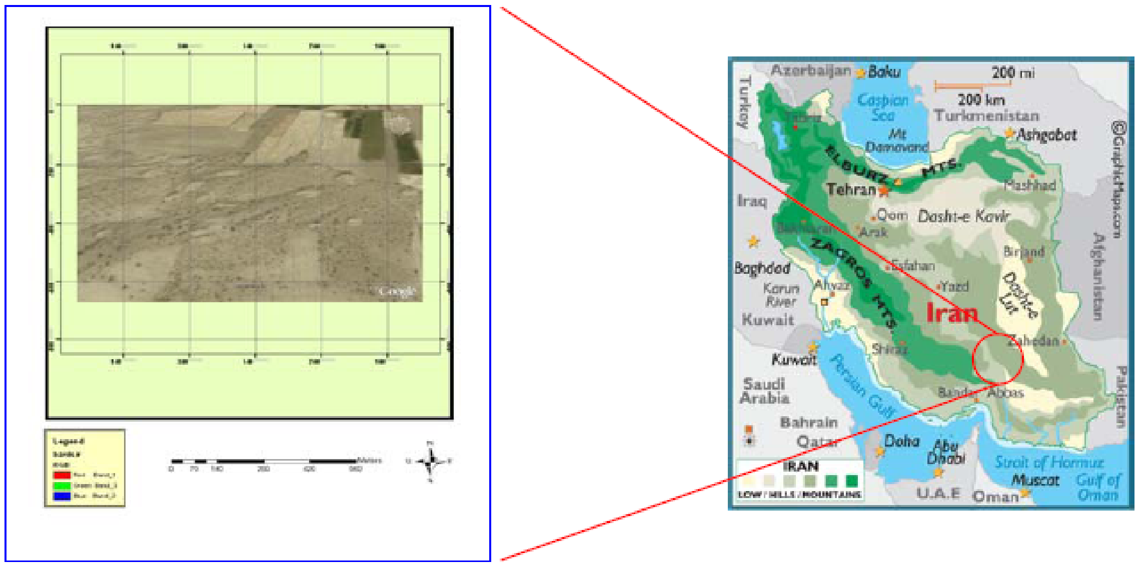

Fig.1: Location of the study area.

In this study, 59 points (35 profiles and 24 drills) were studied in the kind of profile and drill (alternatively).Profiles were sampled and described according to key to soil taxonomy (2006) guide upto family level. Landsuitability evaluation were performed according to the land quality for special agricultural plants(FAO, 1990).Land suitability classes were calculated by parametric method and herbaceous needs were extracted from tableswhich were collected by sys using harmony and correction with area conditions(Sys et al., 1991).

RESULTS AND DISCUSSION

On the basis of performed pedology studies in selected lands, diagnostic horizons of Gypsic and Cambicwere segregated and categorized according to key to soil taxonomy in *aridisols* and *entisols* orders and *XericHaplogypsids* and *Xeric Haplocambids* and *Xeric torrifluvents* great groups and totally 19 different soil unitswere segregated. Climatic suitability categorizing in study area was performed on the basis of parametric
method and according to ranges of limitations.

Results show that, climate for wheat, barley, potato and onion productions is in S1 class. the climate has nolimitation for wheat, barley, potato and onion. But climate was categorized for sugarbeet production in S2 classand with the limitation of temprature the coldest month of growth season and alfalfa production is in S2 classand with the limitation of temprature during the growth season. According to the results of Climatic suitability
categorizing, area climate is proper for wheat, barley , potato and onion plants productions and qualitativereviewing of lands show that range of changes in classes is from S2 to S3 for wheat with the limitations ofgypsum in soils and texture, from S2 to S3 for barley with the limitations of gypsum in soils and texture, from
S2 to N2 and S3 to N2 for potato with the limitations of soil acidity and gypsum, and S2 to N1 with thelimitation of soil`s texture for sugarbeet, from S2 to N2 and S3 to N2 for alfalfa with the limitations of soil`sacidity and gypsum and topography and from S2 to N2 for onion with the limitations of soil`s gypsum and

acidity, respectively. Soil texture is majorly light in surface and bottom levels of gypsiferous soils and watertransformation is performed rapidly in these soils, but absorption and maintenance capacity of water andnutrients is very low and these soils have problem in the view of providing nutrients which need soil texturereform and increasing of organic matter in surface soil. Meanwhile surface and subsoil texture is majorlyweighty in not gypsiferous soils and water transformation is done slowly and don`t have many problems innutrients and water absorption and maintenance and also have more organic mattere in their surface soil(Tomanian, 1998).

Reviewing of nutrients condition of gypsi- and not gypsiferous soil`s in different levels show that accordingto the soil physical conditions especially soil texture, gypsiferous soils are less fertiliezer than non- gypsiferoussoils in the view of nutrients, that existence of surface level with specified thickness which majorly doesn`t haveany gypsum but there are specified amounts of gypsum from the second depth to lower depthsmakes thenecessity of lands reformation more serious. So, the usage management of agricultural qualities especiallydifferent chemical fertilizers must be used with attention and especial conditions(Syedjalali, 2000; Mahmodi, 1998).

Reviewing of products function in gypsi- and non- gypsiferous soils show that gypsiferous soils weight inaverage are at least one ton in hectare lower than non- gypsiferous soils, which is considerable in the level of5000 hectares of gypsiferous soils in Bardsir area(Barzanji and Salien, 1980; Hess, 1976).

According to the performed studies about optimum use of these resources, the following casesare suggested:

1- Choosing proper production according to the physical and chemical conditions of area`s soils and climate.

2- It is better to evaluate all the features of gypsiferous soils and different respects of these soils in order tooptimum use of production resources.

3- Gypsiferous soils have limitations in the view of nutrients, so, performing correct fertilization can beeffective.

4- Farmer`s education and their awareness of gypsiferous soil`s features can be effective in the improvement ofproduction condition.

Conclusion:

Gypsiferous soils have been cultivated for centuries under traditional rotational rainfed farming systems inwhich wheat or barley is followed by leguminous grain crops or by fallow. Under rainfed farming conditions,

yields depend mainly on rainfall and are usually low to moderate. Soil chemical properties are in a dynamicequilibrium. Gypsum and other salts are leached in the rainy season to deeper horizons and returned to thesurface horizons during summer by capillary rise. When gypsiferous soils are irrigated changes in their chemicalproperties take place involving further movement of gypsum salts and nutrients.The improvement in the productivity of gypsiferous soils under rainfed conditions is currently approachedby several methods depending upon the soil properties.

Soil terracing has been practised for many centuries on the deep hilly soils of the Murcia area of Spain toprevent erosion. Fruit orchards have been planted including peaches, pears, olives and other crops.Supplementary irrigation has been used to increase productivity where water resources areavailable.

Harrowing the land after harvesting and before the rainy season is a common practice to improve the infiltration of water and conserve soil moisture.

The organic matter of soils can be increased by replacing fallow by small-grain leguminous crops in thewheat-fallow rotations. This was practised in Syria and Iraq, especially in areas where the annual precipitationranges between 250 to 450 mm. Akramov (1981) discusses the positive effect of manure on convertingunproductive gypsiferous soils into productive ones.

Subsoiling can be undertaken to break the cemented gypsic subsoil. This improves root penetration andreduces susceptibility to drought, especially in the case of fruit and forest trees. It improves crop establishmentand has been practised by many farmers in Algeria, Syria and other countries for planting pistachio, almond,etc., in soils with a hard calcareous crust. Caution should be exercised not to mix the topsoil and subsoil. Theformer usually contains less gypsum and has a higher organic matter than the latter.*Fertilization* is very beneficial in increasing productivity. It has become a general practice under rainfedconditions to apply nitrogen and phosphorus to cereals. The rate of applied nitrogen fertilizers depends on theannual precipitation; N is generally applied where rainfall exceeds 260 mm annually. Phosphorus fertilizers arevery effective in Cereals are grown satisfactorily on soils with less than 30 cm depth and less than 25 percent gypsumcontent, especially if precipitation is adequate, ranging between 250 and 350 mm. Under higher rainfall thesetypes of soils are satisfactory for many varieties of grape vines.

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