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Land capability evaluation and fertility mapping of Hoomand Absard region with emphasis on some soil physiochemical characteristics

Abstract
Problems caused by immethodical and unsuitable using of lands, irregular development of urban areas and therefore reduction in cultivation zones has received widespread attention throughout the world. Using of optimum, capability and suitable methods of land is the main concern of policy markers for the sustainable planning and management most of the cultivation areas. Hence, studies related to land capability evaluation will provide sustainable using agricultural lands. On the other hand the adequacy of soil fertility maps created for variable rate fertilization depends on the variability of the soil properties, sampling design and intensity, interpolation techniques, and mapping protocols. The objectives of this study are to evaluate qualitative land capability and create fertility map of macro nutrients of the Hoomand Absard region (Tehran province) of Iran. This study carried out in an area including 500 ha in the form of semi-detailed surveying level. The various procedures of this investigation are site setting, sampling and land capability evaluation. In studied area, soils were classified in inceptisols order. In the current study, the result of soil analysis of eight soil profiles in three different types of land uses (irrigation farming, dry farming and range) by land capability of different unit samples and field studies were obtained. Results showed that land capability classification different ranges of classes from very suitable (I) to generally unsuitable (VI) were discovered which are variable by particular soil properties such as topsoil, subsoil stoniness, and topography characteristic like slope. Considering the results of distribution map of the pH, EC, CCE, N, P and K, there are relatively good conditions in the studied region.

Keywords: semi-detailed surveying, soil profiles, soil properties, stoniness, unsuitable.

INTRODUCTION

The growing rates of population and consumption and undervaluation of ecosystem services have caused irreversible losses and conservations of prime farm lands, alteration of biogeochemical cycles and pollution of water, air and soil (Rahimi et al., 2009). Proper recognition of land abilities and allocating of them to the best and most profitable and stable revenue operation system has special importance for preventing of ecosystem structure destruction. Sustainability of ecosystem productivity and biodiversity requires quantification of the quality and quantity of natural recourses and their suitability for a range of land uses in planning process of future rural, urban and industrial activities (Kilic et al., 2005).

As land is a limited resource and the competition between land use alternatives is complex, knowledge of physical constraints identified from a land capability assessment, becomes a major consideration in any planning exercise. Building a solution to these constraints or potential problems into the planning phase of a project is generally cheaper than using a band-aid approach afterwards (Salehi et al., 2003).

Land evaluation is formally defined as the assessment of land performance when used for a specified purpose, involving the execution and interpretation of surveys and studies of land forms, soils, vegetation, climate and other aspects of land in order to identify and make a comparison of promising kinds of land use in terms applicable to the objectives of the evaluation (FAO, 1976).

Land evaluation is often carried out in response to recognition of a need for changes in the way in which land is currently being used. The information and recommendations from land evaluation represent only one of multiple inputs into the land use planning process, which often follows land evaluation. In turn, the land use planning process can serve to screen preliminary land use options that should be considered for land evaluation (FAO, 1976).
Land capability assessment is a rational and systematic examination of the ability of land to sustain a specific use and the level of management required to prevent significant long term degradation.

The objectives of land capability assessments are: 1) To assist land managers and land use planners identify areas of land with physical constraints for a range of nominated land uses; and 2) To identify management requirements that will ensure a particular land use can be sustained without causing significant on-site or off-site degradation to land or water quality. To achieve these objectives it is necessary to know the natural characteristics of the land and understand the effects that the proposed land use may have on the land itself and the water derived from it.

Land capability should not be confused with land suitability. Land suitability is the assessment of how suitable a particular site is for a particular use, and depends on land capability and a range of other factors such as proximity to centers of population, land tenure, attractiveness of scenery and consumer demand (Land Capability Assessment Guidelines, 1999).

Detailed soil spatial information is required for many environmental modeling and land management applications (Burrough, 1996; Corwin et al., 1997). As current soil surveys were not designed to provide such detailed soil information (Zhu, 1999), quality of soil maps which increasingly used for land evaluation, land capability and suitability analysis, land use planning and geographic information system (GIS) application and accuracy of procedures used for crop recommendations would be questionable. The most serious limitations of the current soil survey include uncertainty regarding presence of inclusions, lack of mechanism to quantify spatial variability (Rogowski and Wolf 1994). Spatial variability of soil properties results in spatially varying crop yield at the field level. The knowledge of soil variability within the field is fundamental to increase crop production.

Soil test-based fertility management is an effective tool for increasing productivity of agricultural soils that have a high degree of spatial variability. However, major constraints impede wide scale adoption of soil testing in most developing countries. Under this context, GIS-based soil fertility mapping has appeared as a promising alternative (Iftikar et al., 2010). Use of such maps as a decision support tool for nutrient management will not only be helpful for adopting a rational approach compared to farmer practices or blanket use of state recommended fertilization, but will also reduce the necessity for elaborate plot-by-plot soil testing activities. However, information pertaining to such use of GIS-based fertility maps has been meager in Asian country such as India and etc (Sen and Majumdar, 2006). The objectives of this study are to evaluate qualitative land capability, create fertility map of macro nutrients and distribution map of some important soil parameters of the Hoomand Absard region (Tehran province) of Iran.

Materials and Methods

The area under investigation is about 500 ha. It is located in the Absard county from Damavand city in Tehran province, Iran (35º27´40´´ to 35º38´48´´ northern latitudes and 52º 5´25´´ to 52º6´34´´ eastern longitudes, 2000-2100 m below sea level) (Fig.1). Mean annual precipitation in this region is 331 mm, and mean annual air temperature is 10.5 ºC. Soil moisture and temperature regimes, calculated according to the Newhall Simulation Model (Newhall and Berdanier, 1996), were xeric and mesic, respectively. Eight pedons and 44 surface sample were dug, described and sampled according to standard methods (USDA-NRCS, 2002), and classified based on Keys to Soil Taxonomy (Soil Survey Staff, 2010).

All analyses were performed on air-dried soil samples, which were passed through 2 mm sieve (Pansu and Gautheyrou, 2006). Routine analyses, such as percentage of gravel, clay, silt, sand, organic carbon, pH, EC, CCE, available P, K and total N were performed on all samples according to standard methods (Sparks, 1996; Pansu and Gautheyrou, 2006; Carter and Gregorich, 2008). Site characteristics including topography, wetness and etc were determined base on field observation.

The first stage in the land capability evaluation (assessment) is the development of assessment criteria, typically including the following steps: 1-Identifying the site's key land features and 2-Developing the Land Capability ratings. To complete the land capability evaluation, the assessor will assign a rating to each land feature. The features with the poorest rating are those that are the most constraining. As the land capability rating increases so does the associated risk and, with it, the degree of difficulty for satisfying environmental protection. All land features associated with the particular land use are assessed together. The final overall land capability evaluation is that rating which relates to the most constraining feature(s).

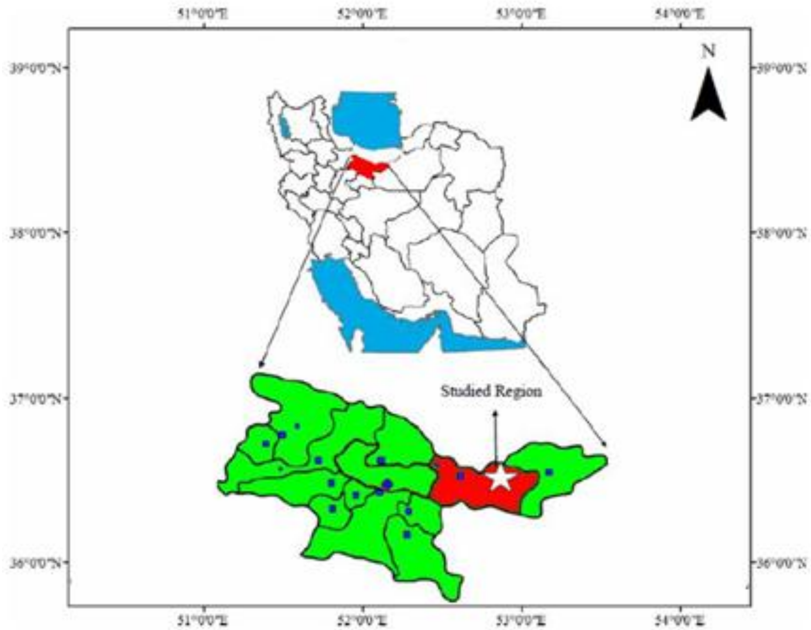

Figure 1- Map of studied region in Tehran province, Iran

RESULTS

Morphological, physical, and chemical characteristics were considerably different in the studied soils. Table 1 and 2 shows some of the physico-chemical characteristics including PSD, pH, EC, OC, CCE, and available P, K and total N in the studied pedons and surface samples. In the studied pedons, pH of the saturated extracted was around slightly alkaline (8.3-8.6), which the Bk1 horizon of pedon No. 8 had lower values (Table 1). The organic carbon content showed a considerable variation from 0.46 % in Ap horizon of pedon No.1 to 2.53 % in Bk2 horizon of pedon No.2. The measured Electrical Conductivity (EC) ranged from 0.34 to 0.9 dS m^{-1}. The calcium carbonate equivalent (CCE) in studied pedons was between 1.8 % (Ap horizon of pedon No. 6) to 12.1% (Ap horizon of pedon No. 1) (Table 1). The available P content showed a variation from 4.1 $mgkg^{-1}$ in Bk2 horizon of pedon No.8 to 71.4 $mgkg^{-1}$ in Ap horizon of pedon No.1. The highest content of exchangeable K was observed in the pedon No. 1 (886 mg kg^{-1}), followed by pedon No. 5 (304 mg kg^{-1}). Minimum and maximum amounts of total N in the studied soils were 0.03 and 0.15 % for the first. Highest amounts of total Nitrogen were observed at the surface horizons in different land uses in accordance with organic carbon distribution.

Table 1- Some physico-chemical properties of the studied pedons

Horizon	Depth(cm)	pH	EC(dS/m)	CCE(%)	OM(%)	Sand(%)	Clay(%)	Silt(%)	Tex.	N(%)	P(ppm)	K(ppm)
Pedon No.1- Fine, mixed, superactive, mesic, Typic Calcixerepts												
Ap	0-15	8.5	0.9	3.7	2.53	22	39	39	C.L	0.15	71.4	886
Bw	15-35	8.5	0.82	2.4	2.26	20	41	39	C	0.13	22.9	826
Bk	35-100	8.5	0.69	12.1	0.76	20	45	35	C	0.04	9.6	356
Pedon No.2- Fine, mixed, active, mesic, Typic Calcixerepts												
A	0-14	8.6	0.4	10.2	1.22	19	49	32	C	0.07	13.9	592
Bk1	14-32	8.6	0.34	9.5	0.88	20	52	28	C	0.05	6.8	452
Bk2	31-70	8.5	0.63	10.6	0.46	27	49	24	C	0.03	4.4	322
Pedon No.3- Fine, mixed, superactive, mesic, Typic Haploxerepts												
Ap	0-20	8.6	0.76	2.9	1.72	28	29	43	C.L	0.1	53.4	610
Bw1	20-40	8.5	0.39	2.6	1.17	27	35	38	C.L	0.07	35.8	478
Bw2	40-75	8.5	0.38	2.5	1.2	27	38	35	C.L	0.07	35	480
Pedon No.4- Fine loamy, mixed, superactive, mesic, Typic Haploxerepts												
A	0-13	8.5	0.36	2.6	0.98	21	33	46	C.L	0.06	25.8	360
Bw	13-46	8.5	0.34	2.6	0.83	22	31	47	C.L	0.05	24	368
Pedon No.5- Fine, mixed, superactive, mesic, Typic Haploxerepts												
Ap	0-15	8.5	0.42	2.6	1.1	23	26	47	C.L	0.06	21.4	304
Bw1	15-40	8.5	0.53	2.4	0.71	24	39	37	C.L	0.04	32.5	474
Bw2	40-75	8.4	0.58	2.3	0.6	26	34	40	C.L	0.04	35.6	436
Pedon No.6- Fine, mixed, active, mesic, Typic Haploxerepts												
Ap	0-15	8.5	0.57	2.9	0.91	23	27	50	C.L	0.05	21.1	304
Bw1	15-35	8.4	0.45	1.8	0.62	22	42	36	C	0.04	21.6	396
Bw2	35-80	8.3	0.39	1.3	0.51	20	42	38	C	0.04	27.6	443
Pedon No.7- Fine loamy, mixed, superactive, mesic, Typic Haploxerepts												
Ap	0-15	8.5	0.47	3.2	1.22	37	24	39	C.L	0.07	17.6	322
Bw1	15-40	8.6	0.44	3.8	0.62	34	32	34	C.L	0.04	10.5	364
Bw2	40-100	8.5	0.41	4.2	0.77	32	30	38	C.L	0.04	16.4	352
Pedon No.8- Fine, mixed, active, mesic, Typic Calcixerepts												
A	0-18	8.4	0.35	9.5	1.1	21	47	32	C	0.06	12.1	554
Bk1	18-42	8.3	0.41	9.1	0.79	25	49	26	C	0.04	5.2	435
Bk2	42-75	8.5	0.63	10.4	0.49	26	47	27	C	0.03	4.1	315

Table 2- Some physico-chemical properties of the studied surface sample

No	pH	EC(dS/m)	CCE(%)	OM(%)	Sand	Clay	Silt	Tex.	N(%)	P(ppm)	K(ppm)
1	8.5	10.8	4.5	2.93	25	32	43	C.L	0.17	63.3	724
2	8.5	1.36	3	4.14	23	39	38	C.L	0.24	145	1500
3	8.4	1.25	3.1	4.48	22	40	38	C.L	0.26	160	1320
4	8.5	1.03	4.2	3.28	22	37	41	C.L	0.19	87.7	968
5	8.5	0.93	9.1	1.14	23	47	30	C	0.06	27.7	660
6	8.6	0.62	5.8	1.29	17	51	32	C	0.07	23.8	714
7	8.7	0.47	4.8	1.29	19	48	33	C	0.07	20.3	585
8	8.7	0.39	8.6	1.03	16	47	37	C	0.06	22.5	766
9	8.6	0.35	2.4	1.03	25	33	42	C.L	0.06	30.5	416
10	8.4	0.94	3.7	1.79	27	33	40	C.L	0.1	15.2	435
11	8.3	1.23	3.1	3.1	22	34	44	C.L	0.18	43.9	1140
12	8.3	1.2	3	2.76	20	38	42	C.L	0.16	44	1045
13	8.4	0.83	13	1.48	16	50	34	C	0.09	35.1	804
14	8.3	1.41	2.8	1.74	29	28	43	C.L	0.1	27.8	440
15	8.2	1.34	2.4	1.43	29	32	39	C.L	0.08	30.6	504
16	8.6	0.75	3.7	1.74	26	38	36	C.L	0.1	26.9	606
17	8.2	1	2.5	1.55	28	36	36	C.L	0.09	26.9	575
18	8	1.2	2	1.38	30	34	36	C.L	0.08	26.4	536
19	8.5	0.52	2.4	1.38	31	30	39	C.L	0.08	28.9	586
20	8.6	0.37	2.4	1	17	48	35	C	0.06	33.3	578
21	8.5	0.9	2.4	1.27	23	38	39	C.L	0.07	48.4	528
22	8.7	0.38	2.4	1.07	19	37	44	Si.C.L	0.06	29.6	440
23	8.1	1.55	2.4	3.57	19	34	48	Si.C.L	0.21	23	825
24	8.7	0.47	2.4	0.97	32	31	37	C.L	0.05	30.4	436
25	8.4	0.55	2.2	1.05	31	32	37	C.L	0.06	28.2	458
26	8.1	1.3	2.4	1.55	27	37	36	C.L	0.09	27.3	591
27	8.2	0.71	2.3	1.22	30	29	41	C.L	0.07	32.6	586
28	8.5	0.42	2.4	1.08	32	30	38	C.L	0.06	34.2	395
29	8.6	0.45	2.3	1.24	21	36	43	C.L	0.07	40.5	492
30	8.6	0.35	3.4	0.74	26	38	36	C.L	0.04	23.4	360
31	8.5	0.38	3	0.69	21	36	43	C.L	0.04	25.6	392
32	8.6	0.67	2.4	0.76	23	38	39	C.L	0.04	28.9	384

33	8.7	0.7	2	0.83	24	36	40	C.L	0.05	29.1	356
34	8.7	0.38	2.4	0.77	28	31	41	C.L	0.04	28.5	300
35	8.5	0.44	2.4	1.02	27	30	43	C.L	0.06	28	310
36	8.5	0.92	2.4	1.53	24	34	42	C.L	0.09	41.4	714
37	8.5	1.81	2.8	3.07	23	33	44	C.L	0.18	85.6	990
38	8.6	0.76	5.2	2.84	27	33	40	C.L	0.16	59.1	750
39	8.5	0.89	3.1	2.34	26	27	47	C.L	0.13	51	640
40	8.5	0.78	1.9	2.43	22	36	42	C.L	0.14	88.9	842
41	8.5	0.75	2	1.98	25	35	40	C.L	0.11	54.6	754
42	8.5	0.6	2.2	1.12	29	26	45	C.L	0.06	33.3	404
43	8.6	0.35	3.4	0.74	26	38	36	C.L	0.04	23.4	360
44	8.6	0.67	2.4	0.76	23	38	39	C.L	0.04	28.9	384

DISCUSSION

With regarding to results obtained from description of soil profiles and physical and chemical analysis of soil samples (Table 1), soils were classified as Inceptisols (Typic Calcixerepts and Typic Haploxerepts) on the basis of soil taxonomy system (Soil Survey Staff, 2010). Soil characteristic such as stoniness and topography characteristic such as slope were the limiting factors in the study area.

Based on results of land capability classification different ranges of classes from very suitable (I) to generally unsuitable (VI) were discovered which are variable by particular soil properties such as topsoil, subsoil stoniness, and topography characteristic like slope (Table 3). In the current study, the result of soil analysis of eight soil profiles in three different types of land uses (irrigation farming, dry farming, and range) by land capability of different unit samples and field studies were obtained. For irrigation farming on the basis of land capability we are only allowed to apply the system for Class I and II and class III in particular circumstances. According to our results and comparing mapping of current land use and land capabilities maps concluded that a large area in the region irrigated agriculture carrying our while it will lead to a low yields for farmers. Considering land capabilities for rainfed agriculture besides soil and terrain constraints, concerns with climatological features of the area are added that totally restrict proper land use. Rainfed cultivation requires a minimum rainfall about 300 mm in 10 years, with trust level of 8 years. Therefore, rainfed farming in this area produce a low profit. Applying rangeland system as main land use does not have a high limit but due to lower profitability and efficiency, irrigated agriculture and rainfed are much preferred.

Considering the results of distribution map of the pH, the minimum and maximum of the parameter is 8 and 8.7, respectively. The results indicated no significance differences in soil pH where range of soil pH is high, thus lead to some limits including nutrient availability. Acidity classification showed that rangeland areas have lower pH than other parts (Figure 2). The minimum observed salinity according to distribution maps is 0.35 and the maximum is about 1.8 dS m^{-1}. Due to this fact that salinity less than 4 in the Iran has no limit for a number of different crops, it can be concluded that there is no restriction by salinity in the study area (Figure 2). According to produced distribution maps, the minimum and maximum of lime is 1.9% and 10%, respectively. Moreover, based on the classification results in the studied region about 1.9-3% organic matter was observed in the northern part of land which indicates that the area is suitable. More restriction found in the southern part where apple orchards are dominated historically. It is noteworthy that based on available resources and considering limits by lime, the value of this parameter in the studied soils is tolerable for most plants (Figure 3). According to the results of soil fertility the least amount of total nitrogen is 0.04% and the maximum is about 0.25%. Also, based on nitrogen levels areas with nitrogen for about 0.04 to 0.07%, the amount of nitrogen is in poorer condition than other areas and considering areas with nitrogen deficiency (less than 0.05%) which is much lower than threshold we need to apply Nitrogen fertilizers. However, there are areas that due to long-term cultivation and proper tillage have high organic matter content, located in the northern part of the studied field that consequently increased their organic matter and nitrogen comparing to other areas (Figure 3). The minimum amount of phosphorus and potassium according to the distribution maps is 15 and 300 respectively and the maximum ranged about 150 and 1100 mg/kg. With respect to Olsen standard range for phosphorus and standard range for potassium, the studied area has high P and K content and in the area under cultivation till 1 to 2 next years there is no need to apply phosphate and potassium fertilizers (Figure 4).

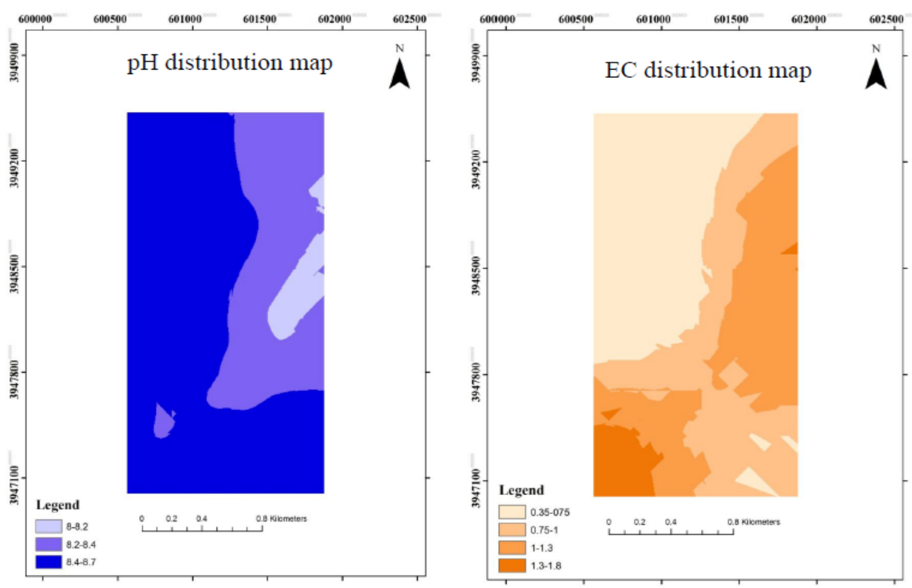

Figure 2- Map of pH and EC level in Studied Hoomand soils

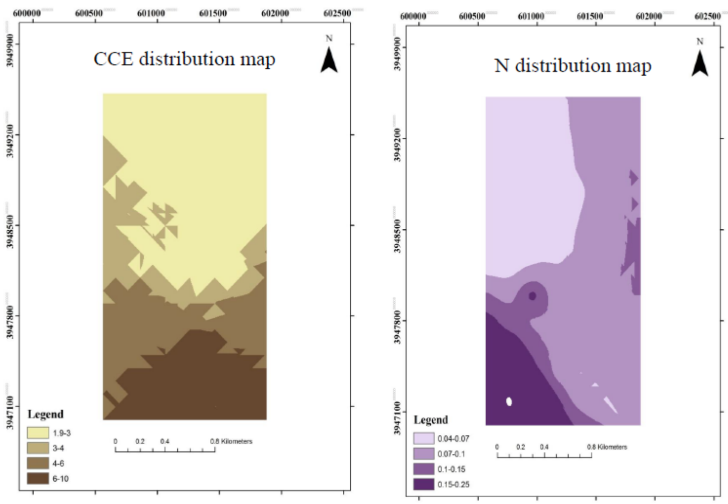

Figure 3- Map of CCE and N level in Studied Hoomand soils

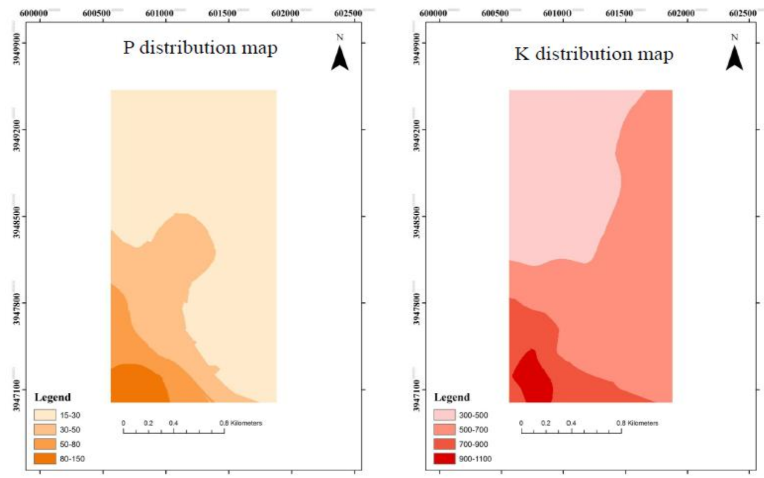

Figure 4- Map of P and K level in Studied Hoomand soils

CONCLUSION

Evolving technologies (e.g. data processing), as well as increased awareness of the important influence of a wider range of factors (e.g. institutional, social and environmental) on the sustainable use of land and the livelihood of land users, has in the past triggered enhancements to existing approaches. In recent years, some specialized software has been developed for land evaluation goals that the common aspect of them is the generation of an environment for patterning and modeling of evaluation methods. In order to ensure a precise and accurate assessment there is a need for accurate data on soil science, meteorology, economic, and social problems, therefore it is highly recommended action taken to obtain information, especially in the quantitative evaluation notice that the real products (farmers turnover) are different, thus it is necessary to measure different levels of performance values and management in the experimental plots that contribute to get correct numbers and statistics rather than values obtained through interviews with farmers.

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REFERENCES

1. Carter, M.R., and Gregorich, E.G. 2008. Soil Sampling and Methods of Analysis. 2nd Ed. Canadian Society of Soil Science. 1224p.
2. FAO, 1976. A framework for land evaluation. FAO Soils Bulletin 32
3. Iftikar, W., Chattopadhayay, G.N., Majumdar, K.. and Sulewski. G.D. 2010. Use of Village- Level Soil Fertility Maps as a Fertilizer Decision Support Tool in the Red and Lateritic Soil Zone of India. Better Crops, 94: 10-12.
4. Kilic, S., Evrendilek, F., Senol, S. and Celik, I. 2005, Developing a suitability index for land uses and agricultural land covers: A case study in Turkey. Environ. Mon and Assess. 102: 323-335.
5. Newhall, F., and C. R. Berdanier. 1996. Calculation of soil moisture regimes from the climatic record. Natural Resources Conservation Service, Soil Survey Investigation Report No. 46.
6. Pansu, M., and J. Gautheyrou. 2006. Handbook of Soil Analysis: Mineralogical, Organic and Inorganic Methods. Springer, pp. 995.
7. Rahimi Lake, H., Taghizadeh Mehrjardi, R., Akbarzadeh, A. and Ramezanpour, H. 1999. Qualitative and quantitative land suitability evaluation for Olive (*Olea europaea* L.) production in Roodbar region, Iran. Agricultural Journal, 4(2): 52-62.
8. Rogowski, A.S and Wolf, J.K. 1994. Incorporation variability into soil map unit delineations. Soil Sci. Soc. Am. J. 58: 163-174.
9. Salehi, M. H., M. K. Eghbal and H. Khademi. 2003. Comparison of soil variability in a detailed and a reconnaissance soil map in central Iran. Geoderma. 111: 45-56.
10. Sen P, and Majumdar K. 2006. Spatial variability in soil physico-chemical properties and nutrient status in an intensively cultivated village of West Bengal. Proceedings of the Fifth International Conference of the Asian Federation for Information Technology in Agriculture, Macmillan (India), Bangalore, India; 653-660.
11. Soil Survey Staff. 2010. Keys to Soil Taxonomy, United States Department of Agriculture. 11nd ed. Natural Resources Conservation Service.
12. Sparks, D.L. 1996. Method of soil Analysis, Part 3. Chemical Methods, American Society of Agronomy, pp. 1390.
13. USDA-NRCS. 2002. Field Book for Describing and Sampling Soils, Version 2.0, National Soil Survey Center, pp. 228.
14. Zhu, A.X. 1999. Fuzzy inference of soil patterns: implications for watershed modeling . p. 135-149. In: D.L Crowin et al. (ed.) Application of GIS, remote sensing, geostatiscal and solute transport modeling to the assessment of nonpoint source pollution in the Vadous zone. Geophys. Monogr. 108, AM. Geophys. Union, Washington, DC.