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Research Article

PARAMETRIC APPROACH TO LAND EVALUATION FOR IRRIGATION METHODS USING GIS MODEL AT JOLGEH-ROKH PLAIN, IRAN

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ABSTRACT
The objective of this study was assessing land sustainability for surface, sprinkle and drip irrigation methods at Jolgeh-Rokh plain, Iran. The land topographic and physiochemical characteristics evaluated base on parametric method and Geographical Information System (GIS) techniques were used to develop irrigation land suitability map of the studied area. Results showed that 90% of studied area was suitable for surface irrigation while more than 95% of the area was highly suitable for sprinkle and drip irrigation methods. The area classified at suitable rank (S1) for surface irrigation method as well as sprinkle and drip methods. The results also showed the capability of GIS to analyze information across space and time make it proper in evaluating land suitability for irrigation methods.

Keywords: *Sustainability, Topographic, Drip Irrigation, Surface Irrigation*

INTRODUCTION
Limit water resources and growing population make countries to enhance agricultural production per unit of area and increasing water use efficiency via applying new irrigation techniques. Using improper irrigation method results in a high cost and low utilized irrigating process (VatanAra *et al.,* 2011).
Iran located in an arid and semi-arid situation, thus applying high efficiency irrigation methods is necessary for sustainable agricultural production. The first necessity step is to evaluate lands base on soil properties and programing for higher use efficiency and productivity of farmlands.
Land evaluation carry out base on FAO instruction (1976), but different situations need for more specific methods. One of most applied methods suggested by Sys *et al.,* (1991). In Iran, land evaluations more performs based on Sys *et al.,* (1991) which is a parametric method.
Geographical information system (GIS) integrates, stores, edits, analyzes, shares, and displays geographic information and allow users to analyze spatial information, edit data in maps, and present the results of all these operations (Maliene *et al.,* 2011). The integration of land evaluation and GIS can provide an improved basis for addressing spatial land evaluation (Thapa and Murayama, 2008).
Bazzani and Incerti (2002) conducted a land suitability evaluation for surface and drip irrigation systems in Larche-Morocco, by using parametric evaluation systems. Results showed that 19% of area was suitable for surface irrigation while 70% of land was suitable for drip irrigation. The main limiting factors were physical limitations such as the slope and sandy soil texture.
Bienvenue *et al.,* (2003) evaluated the land suitability for surface and drip irrigation in the Thies-Senegal, via parametric evaluation systems. Most of the study area (57.66%) was classified as unsuitable (N2) for surface irrigation. Only 20.24% of the study area proved suitable (S2, 7.73%) or slightly suitable (S3, 12. 51%). For drip irrigation, 45.25% of the area was suitable (S2) while 25.03% was classified as highly suitable (S1) and only a small portion was relatively suitable (N1, 5 .83 %) or unsuitable (N2, 5.83%).
Mbodj *et al.,* (2004) evaluate land suitability for surface and drip irrigation at Tunisian-OuedRmel Catchment using the parametric evaluation. According to the results, land was more suitable for drip irrigation compared to the surface irrigation due to the topographic (slope), soil (depth and texture) and drainage limitations encountered with in the surface irrigation suitability evaluation.
Dagnenet (2013) investigated land suitability at Fogera- Ethiopia and prepared an irrigation suitability map using GIS. He declared that 72 percent of the study area is potentially suitable for irrigation and 28 percent was classified as unsuitable (N) due to drainage limitation, flood hazard, texture and slope factors.

Albaji and Hemadi (2011) evaluated the land suitability for different irrigation systems based on the parametric evaluation approach on the DashtBozorg Plain-Iran. Results revealed that sprinkle and drip irrigation were more effective and efficient than surface irrigation for improving land productivity. In the studied plain the main limiting factors in using surface irrigation was soil calcium carbonate content anddrainage while the only main limiting factor in using sprinkle and/or drip irrigation was the soil calcium carbonate content.

The aim of the present study was comparing the suitability of Jolgeh-Rokh plain, Iran for surface, sprinkle and drip irrigation applying parametric method. Topographic and physiochemical characteristics of land applied for parametric evaluation and results analyzed by GIS application.

MATERIALS AND METHODS

The study was conducted at Jolgeh-Rokh plain, Iran during 2014. The site is a 1022 km^2 plain, located between 35 ° 19′ to 35° 38′ N and 57° 58′ to 59° E with 1925 m altitude.

Minimum and maximum temperatures are -22 and 35 °C respectively with 285 mm annual precipitation.

During the winter, the major precipitation type is snow which is important in feeding underwater. Maximum speed of wind is 28-32 knot/hour and the main wind direction is northwest.

Land evaluated base on parametric model (Sys and Verheye, 1974). Base on this model the factors affecting soil suitability for irrigation purposes can be divided into four groups: soil physical, chemical and drainage traits and land qualitative characteristics such as slope.

Irrigation capacity estimated using following equation:

$$Ci = \prod_{i=1}^{n} Xi^{\frac{1}{n}} \times \sqrt{\frac{\prod_{i=1}^{n} Xi}{100^n}}$$

Where:

Xi included: X1: rating of soil texture, X2: rating of soil depth, X3: rating of soil calcium carbonate content, X4: rating of soil electrical conductivity, X5: rating of soil drainage, X6: rating of soil slope, X7: rating of soil gypsum content and X8: rating of wind speed (used for Sprinkle irrigation only). The ranges of capability index and the consistent suitability classes are shown at table 1.

Table 1: Suitability classes for the irrigation capability indices (Ci) classes

Capability index	Definition	Ci class
>80	Highly suitable	S1
60-79	Moderately suitable	S2
45-59	Marginally suitable	S3
30-44	Currently not suitable	N1
<29	Permanently not suitable	N2

Ten soil series were derived from the semi-detailed soil study of the area. In order to prepare land suitability maps for different irrigation methods all the soil characteristics data, were analyzed and incorporated in the map using ArcGIS software.

RESULTS AND DISCUSSION

Results of land evaluating for surface, sprinkle and drip irrigation showed at table 2.

Table 2: Capability indexes (Ci) and suitability classes of surface, sprinkle and drip irrigation for each soil series

Codes of soil series	Surface irrigation		Sprinkle irrigation		Drip irrigation	
	Capability index (Ci)	Sustainability class	Capability index (Ci)	Sustainability class	Capability index (Ci)	Sustainability class
1	67.17	S_2	71.38	S_2	78.33	S_2
2	55.03	S3	66.58	S_2	72.93	S_2
3	61.15	S_2	61.98	S_2	67.75	S_2
4	53.51	S3	58.03	S_2	63.31	S_2
5	70.58	S_2	71.25	S_2	78.19	S_2
6	7.13	S_2	76.7	S_2	84.34	S_1
7	70.58	S_2	71.25	S_2	78.19	S_2
8	70.58	S_2	71.25	S_2	78.19	S_2
9	61.15	S_2	61.98	S_2	67.75	S_2
10	63.58	S_2	64.37	S_2	70.44	S_2

As revealed in table 2, soil series coded 2 and 4 showed marginal suitability (S3) in respect of surface irrigation. Other soil series was moderate suitable (S2) for surface irrigation.

The obtained results showed that replacing surface irrigation with sprinkle and drip irrigation is suitable for the studied plain. There was no high suitable soil series in respect of surface irrigation. Land suitability map for surface irrigation showed that soil series coded 2 and 4 located in center of plain. The east and west of plain is suitable for surface irrigation. The suitability decreased by the center of plain (figure 1).

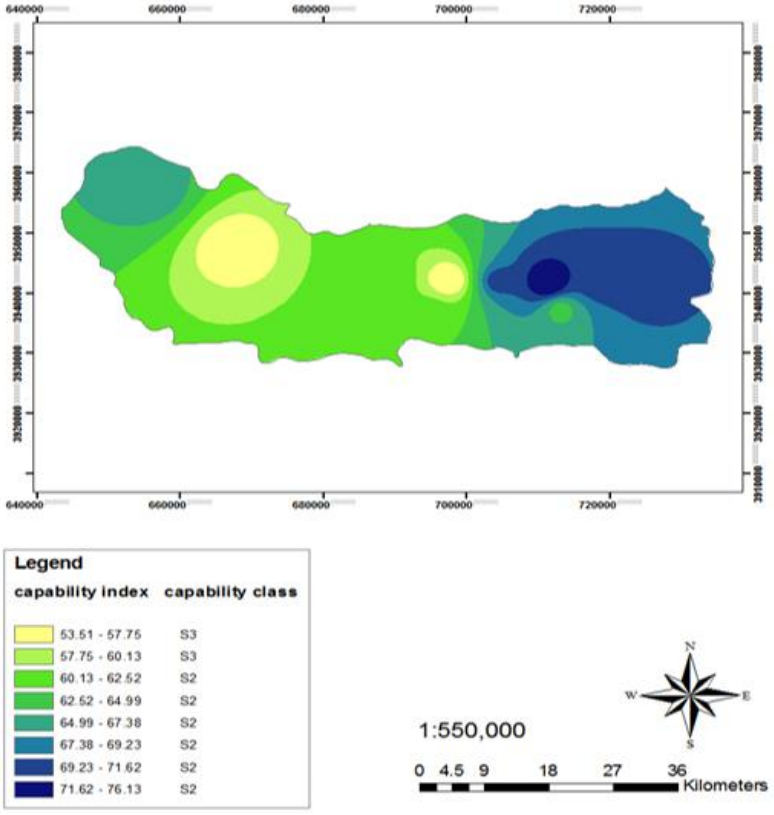

Figure 1: Land suitability map for surface irrigation

All soil series classified as moderately suitable in respect of sprinkle irrigation method (table 2). The most important limiting factors were soil texture and wind speed in respect of sprinkle irrigation method. Soil suitability was high at east and west of plain and decreased by the center of Jolgeh-Rokh in respect of sprinkle irrigation (figure 2).

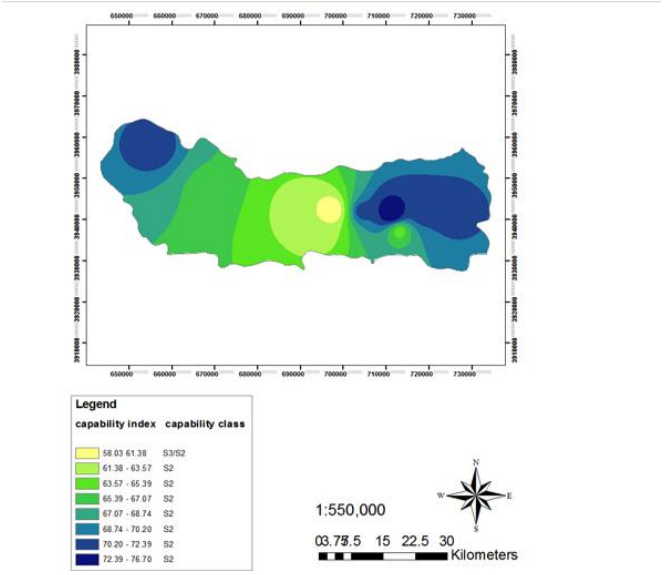

Figure 2: Land suitability map for sprinkle irrigation

Soil series coded 6 was highly suitable in respect of drip irrigation (table 2). Other land series was moderately suitable in respect of drip irrigation. The main limiting factor for drip irrigation was soil texture. Soil series coded 6 which classified as S1, located at east and west of the plain (figure 3).

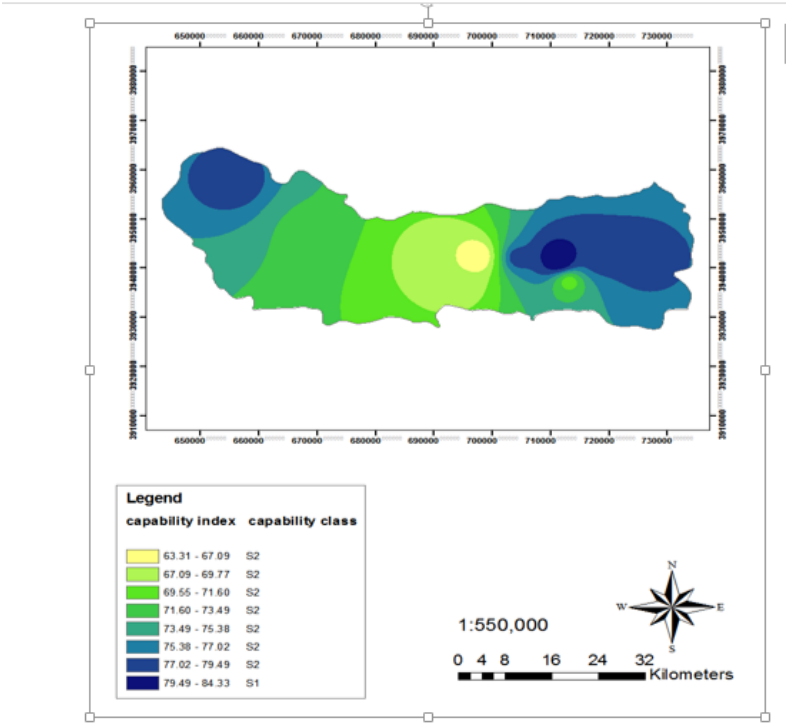

Figure 3: Land suitability map for drip irrigation

Conclusion

Comparing the suitability evaluation of different irrigation methods revealed that the application of drip irrigation was more effective and efficient than the other irrigation methods and it improved the land suitability for irrigation purposes. Mean of capability index was 64.94, 67.48 and 73.94 for surface, sprinkle and drip irrigation methods respectively, which show that the studied areas are suitable for all irrigation methods but replacing surface irrigation with sprinkle and drip irrigation methods is appropriate in the studied plain.

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