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Evaluation of the Two Methods of Surface and Drip Irrigation Based on the Parametric System

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ABSTRACT

The purpose of the present study is in fact the comparison of the two methods of surface and drip irrigation based on the parametric approach. This study was conducted in an area of 3200 hectares in Shoushtar's Shirinab located in Khouzestan province, in the south-west of Iran. Land properties (slope, drainage etc.) and physical and chemical properties of soil (lime, salinity and alkalinity etc.) were selected for the parametric approach and after the analysis based on GIS, the evaluation was done. The results showed that 83.6% of the lands under study were considered suitable for surface irrigation and 90.8% of the lands were suitable for drip irrigation and 2.6% of the lands were unsuitable for both types of irrigation. An approach of water irrigation, as compared with another, can increase land's productivity but it should be noted that the main limiting factors showing the irrigation approach of an area are the soil texture, salinity, and alkalinity, GIS, drainage, calcium carbonate, topography, and the slope of land. The study also showed that GIS had an important role in evaluating the land suitability for different methods of irrigation.
Key words: Drip and Surface Irrigation, GIS Technique, Land Evaluation, Parametric System.

INTRODUCTION

The limitation of water, soil, and an increasing growth in population had driven the world's countries to increasing agricultural products and optimal use. Granted the increase in population and the standards of living, the demand for food has increased. As such, it is essential to recognize all of the parameters which are effective in food production. Since water and soil are among the most important factors, recognizing the potentialities and land limitations and also providing water are the most salient elements of production. Because of the water shortage in most areas, it is essential to use irrigation approaches for the agricultural products so as to save the water resources and have the benefits of the other constant approaches of water, irrigation of the lands which have some irregular topography. Through the use of these methods of irrigation and the amount of some fixed water (in proportion to approach of surface or gravitational irrigation), one can multiply the amount of hydro cultivation as a result of high quality of the approach. Even, it is possible to produce more crops through using less water. Drip irrigation approach is more beneficial than that of surface irrigation because of the following:

-It effectively prevents surface flow of water and soil erosion in steep lands or the ones having sharp topography.
-It can correctly irrigate lands or soils, texture and different properties such as layers.
-It can irrigate the lands with limited depth which cannot be leveled.
-surface irrigation approach was not fruitful in low-land soils or some of products with short roots and also in primary irrigation in which irrigation should occur in a low level and in a short period of time while drip irrigation can be used in a best way possible.

Land suitability according to FAO framework depends sharply on the quality of land which has some parameters like erosion, usable water, dangers of silt removal and slopes and all of them have their own measurable qualities. In fact, land qualities are measurable parameters, easy to be estimated and they are the practical results of land properties. Some of these qualities are the angle and length of the slope, soil texture etc. and they can be used to study land suitability for irrigational purposes [1]. Sys et al (1991) proposed the parametric evaluation approach for irrigational methods which was based on the physical and chemical properties of soil. The measurable factors of land suitability for irrigation are divided up into four categories: physical properties of soil which has a relationship with the water present in soil such as texture, structure, depth, calcium carbonate and chalk, chemical properties of soil which has a relationship with salinity and alkalinity such as soluble materials and exchangeable sodium, drainage properties, environmental factors such as slope [2]. Dengize (2006) compared different methods of irrigation including surface and drip irrigation in the farm located in southern Ankara. He used GIS and data analysis

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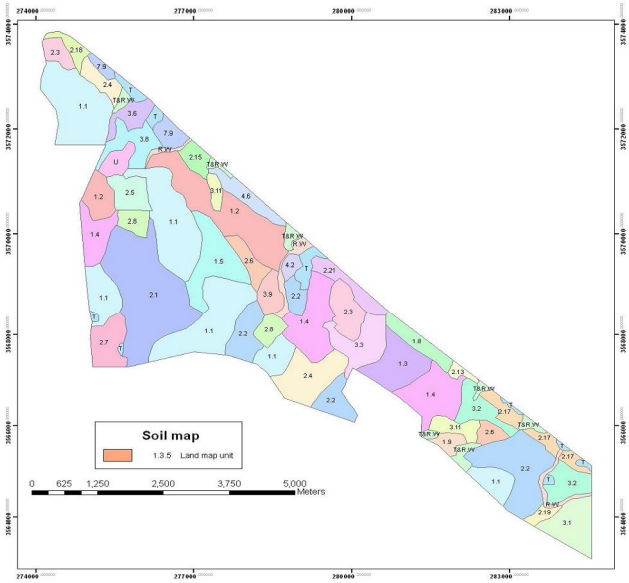
and provided the related maps. Through the analysis of physical properties of soil, topography, salinity, alkalinity, and drainage he showed that 31.1% of the land of that area was suitable for surface irrigation and 51.2% of the land was suitable for drip irrigation. Therefore, drip irrigation was suitable and drip irrigation was more suitable than surface irrigation for more than half the area under study. Also, using GIS for parametric evaluation was considered important in irrigation methods, and in addition to saving time in analyzing data, it was possible to update the data [3]. Naseri et al (2009) studied the quality of soil for different methods of irrigation in Lali's plain (a city in Khouzestan) and focused on the soil texture, soil depth, lime, soil salinity, drainage, and slope. The result of their study showed that 1732 hectares (48.5%) of the lands were suitable for the three types of irrigation, drip, surface, and rain, while 384 hectares (10.8%) of the lands were unsuitable for surface irrigation and there were not unsuitable lands for rain and drip irrigation in this area. The purpose of this study is to evaluate land suitability for the two methods of irrigation, drip and surface, in Shoushtar's Shirin ab located in Khouzestan [4].

MATERIALS AND METHODS

The present study was conducted in Shoushtar's Shirin Ab located in Khouzestan. Its area covers 3200 hectares. The area under study is located in 40 km north-west and west of Shoushtar, with geographical coordinates of 267000 to 284000 east longitude and 3563000 to 3590000 north latitude. The annual average amount of rain is about 331.9 mm and the annual average amount of temperature is 24 degrees centigrade and the annual amount of moisture is 47.3%. The temperature regime of the area is hyperthermic and moisture regime of the area under study is in the Ustic class. In terms of climate, it is located in a warm climate and it is dry for 205 days. The water needed for agriculture in this area is provided mostly from the wells dug in the area under study. Based on the soil studies carried out in a precise semi-detailed manner (Iran's Water and Soil Engineering Co.) in the area under study, the following have been provided: two physiographical units including fan-shaped lands having stones and upper terraces (plateau) and also five different types of recognized soil provided to determine the properties of soil based on the tests done on the profiles. Map 1 show the lands which have been provided through GIS. Different parameters such as soil texture, soil depth, lime, electrical conductor, drainage, and slope were provided an information bank and through putting these layers in ARCGIS, the maps to evaluate the lands for drip and surface irrigation have been provided [5].



(Fig. 1) The map of land Units

To evaluate the land suitability for different methods of irrigation, parametric evaluation presented by Sys et al (1991) has been applied. In this method, soil properties were graded and through using them, the capability index for irrigation was calculated based on the following equation:

$$Ci = A*B/100*C/100*D/100*E/100*F/100$$

In this equation, A, B, C, D, E, and F show the degrees of soil texture, soil depth, lime, salinity and alkalinity, drainage and slope [6].

(Table 1) The classes of suitability for capability index of irrigation

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

(Table 2) Some Ci and the suitability classes for surface and drip irrigation

Land map unit(LMU)	Surface irrigation		Drip irrigation	
	Ci	Suitability	Ci	Suitability
1.1	76.18	S2	79.10	S2
1.2	71.52	S2	78.30	S2
1.3	52.19	S3	61.76	S2
1.4	69.01	S2	75.20	S2
1.5	62.28	S2	68.85	S2
1.8	71.20	S2	77.90	S2
1.9	57.41	S3	62.88	S2
2.1	66.56	S2	68.85	S2
2.2	66.41	S2	68.67	S2
2.3	66.79	S2	69.12	S2
2.4	63.50	S2	69.39	S2
2.5	66.48	S2	68.76	S2
2.6	62.11	S2	67.68	S2
2.7	66.33	S2	68.58	S2
2.8	62.48	S2	68.13	S2
2.13	62.48	S2	68.13	S2
2.15	39.05	N1	47.94	S3
2.17	49.69	S3	60.91	S2
2.18	58.69	S3	60.64	S2
2.19	65.64	S2	67.77	S2
2.21	66.87	S2	69.21	S2
3.1	66.25	S2	68.49	S2
3.2	62.62	S2	68.31	S2
3.3	62.84	S2	68.58	S2
3.6	33.51	N1	34.70	N1
3.8	62.91	S2	68.67	S2
3.9	65.72	S2	67.86	S2
3.11	65.64	S2	67.77	S2
4.2	34.28	N1	35.60	N1
4.6	56.57	S3	62.61	S2
7.9	33.90	N1	35.15	N1

(Table 3) Suitability classes for different land map units

Suitability	Surface irrigation			Drip irrigation		
	Land map unit LMU	Area ha	Ratio %	Land map unit LMU	Area ha	Ratio %
S1	-	-	-	-	-	-
S2	1.1,1.2,1.4,1.5 1.8,2.1,2.2,2.3 2.4,2.5,2.6,2.7 2.8,2.13,2.19 2.21,3.1,3.2,3.3 3.8,3.9,3.11	2687.2	83.6	1.1,1.2,1.3,1.4,1.5 1.8,1.9,2.1,2.2,2.3 2.4,2.5,2.6,2.7,2.8 2.13,2.17,2.18,2.19 2.21,3.1,3.2,3.3,3.8 3.9,3.11,4.6	2919.2	90.8
S3	1.3,1.9,2.17,2.18,4.6	232.0	7.2	2.15	25.2	0.8
N1	2.15,3.6,4.2,7.9	108.6	3.4	3.6,4.2,7.9	83.4	2.6
N2	-	-	-	-	-	-
Mis Land	R.W,T,U	186.6	5.8	R.W,T,U	186.6	5.8
Total		3214.4	100.0		3214.4	100.0

RESULTS AND DISCOSSION

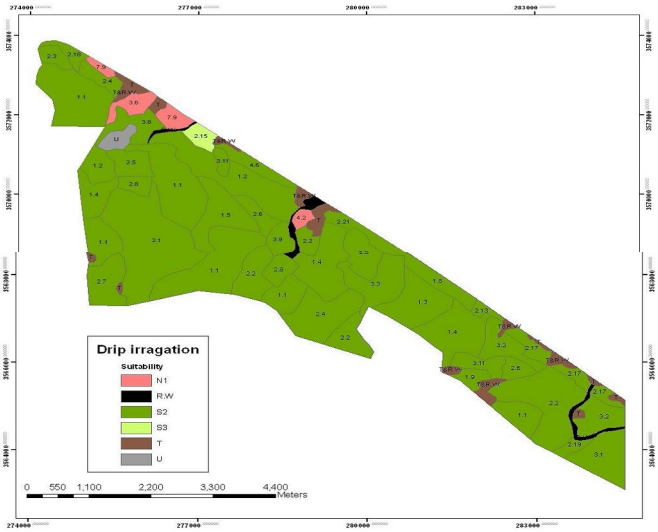
Irrigation capability index (Ci) was calculated for all land units and through using Table 1. land suitability has been determined for that unit and presented with a related sign on the map. These signs contain S1 (completely suitable), S2 (fairly suitable), S3 (partly suitable), N1 (unsuitable in present conditions), and N2 (permanently unsuitable).

In the area under study, 31 land units have been isolated forming 94.2% of the lands and 5.8% of the lands were parts of residential areas and roads which were separated as lands [7].

In evaluating the land suitability for surface irrigation based on parametric approach, it was determined that units 1.1, 1.2, 1.3, 1.4, 1.5, 1.8, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.13, 2.19, 2.21, 3.1, 3.2, .3.3, 3.8, 3.9, and 3.11, had S2 suitability which were 2687 hectares (83.6%), and units 1.3, 1.9, 2.17, 2.18, and 4.6 had S3 suitability which were 232 hectares (7.2%), and units 2.15, 3.6, 4.2, and 7.9 had N1 suitability which were 108.6 hectares (3.4), and there were no S1 and N2 in the area. (Table 3).

Also, in evaluating the land suitability for drip irrigation based on parametric approach, it was determined that units 1.1, 1.2, 1.3, 1.4, 1.5, 1.8, 1.9, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.13, 2.17, 2.18, 2.19, 2.21, 3.1, 3.2, 3.3, 3.8, 3.9, 3.11, and 4.6 had S2 suitability which were approximately 2919.2 hectares (90.8%), and unit 2.15 had S3 suitability which was 25.2 hectares (2.6%), and there were no S1 and N2. The map No. 2 shows land suitability for surface irrigation and the map No. 3 shows land suitability for drip irrigation.

(Fig. 2) Land suitability for surface irrigation



(Fig. 3) Land suitability for drip irrigation

CONCLUSION

Based on the results obtained, it was known that using the approach of drip irrigation instead of surface irrigation in some units is suitable. Units 1.3, 1.9, 2.17, 2.18, and 4.6 had suitability S3 in evaluating surface irrigation while they had S2 suitability for drip irrigation. Also, unit 2.15 had N1 suitability in evaluation surface irrigation while it had S3 suitability in evaluating drip irrigation. The factors slope, lime were limiting elements in surface irrigation while lime was the limiting element in drip irrigation [8]. Also, using GIS had an important role in analyzing the data.

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