Locate suitable areas for implementation of surface and pressurized irrigation using (GIS) (case study: Izeh plain)

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Abstract: Successful pressurized irrigation system accomplishment in a region is related to factors such as climatic conditions, water quality, topography condition, soil specifications, production variety and socio-economic factors. The purpose of this study was to compare three methods of irrigation, according to the story's parametric evaluation method. The study on land of Izeh the semi-detailed soil studies Underlying area & extract eight factors slope, texture, depth, salinity, drainage, salinity, alkalinity, water and wind speed, using geographic information systems (GIS) maps of land suitability for surface irrigation, drip and sprinkler were prepared. The final determination of these parameters, and after taking into account the relevant Rating irrigation capability index (Ci) is calculated and areas suitable for different irrigation methods were extracted. The results showed that in plain of Izeh the drip irrigation for 7451 hec (67%) of land was highly suitable (S1), for surface irrigation 6300 hectares (57%) is very appropriate. Also, there are no region suitable for sprinker irrigation. In comparison irrigation systems because of the capability index for drip irrigation was higher then other irrigation system so this system was selected as the most suitable. The most important limiting factors in the area were water quality (salinity), soil texture and soil depth.

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Key words: surface irrigation, drip irrigation, sprinkler irrigation, land evaluation, parametric method, GIS

1. Introduction

Food security and stability in the world greatly depend on the management of natural resources. Due to the depletion of water resources and increases in population, the extent of irrigated area per capita has been declining and irrigated lands nowadays have produced 40% of the food supply (Hargreaves and Mekley. 1998). Consequently, available water resources will not be able to meet various demands in the near future and this will inevitably result in the seeking of newer lands for irrigation in order to achieve sustainable global food security. Land suitability, by definition, is the natural capability of a given 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.

According to FAO methodology (1976) land suitability is strongly related to "land qualities" including erosion resistance, water availability, and flood hazards which are in themselves immeasurable qualities. Since these qualities are derived from "land characteristics", such as slope angle and length, rainfall and soil texture which are measurable or estimable, it is advantageous to use the latter indicators in the land suitability studies, and then use the land parameters for determining the land suitability for irrigation purposes. Sys et al. (1991) suggested a parametric evaluation system for irrigation methods which was primarily based upon physical and chemical soil properties.

DENGIZ (2006) also compared different irrigation methods including surface and drip irrigation in the pilot fields of Central Research Institute, Lkizce research farm located in Southern Ankara. He concluded that the drip irrigation method increased the land suitability by 38% compared to the surface irrigation method.

GIZACHEW and NDAO (2008) evaluated the land suitability for surface (gravity) and drip (localized) irrigation in the Enderta District, Tigray, Ethiopia, using Sys's parametric evaluation systems. Drip irrigation can be a good method of irrigation in this region, if it is managed properly (best design, filters, etc.)

BROU and WOLDEGIORGIS (2009) performed a land suitability evaluation for two types of irrigation i.e., surface irrigation and drip irrigation, in the Kilte Awulaelo District – Tigrayregion – Ethiopia using the suggested parametric evaluation. As the study area is composed of heterogeneous physiographic features, dominantly from undulating to steep scarp, the drip irrigation suitability gave more irrigable areas compared to the surface irrigation practice, due to the topographic (slope), soil (depth and texture), surface stoniness and drainage limitations worked out in the surface irrigation suitability evaluation.

ALBAJI et al. (2009a) compared the suitability of land for surface and drip irrigation methods according to a parametric evaluation system in the plains west of the city of Shush, in the southwest Iran. The results indicated that a larger amount of the land (30,100 ha – 71.8%) can be classified as more suitable for drip irrigation than surface irrigation.

Different ways such as quantitative, qualitative and drawing is for locating. Among them, the parametric-story method has been used in this research. In this way, to each of the selected parameters to the select of the system given Points. And according to story method the Index of irrigation is determined. With determine of this index and according of table (10) Land suitability is determined for each system. The aim of this research is using of remote sensing and GIS techniques for locating implementation of pressure irrigation systems and surface. This study was performed with Taking into account characteristics of the soil, air, and water quality of ize- plain and with using of Parametric-method.

2. Material and Methods

Study area in plain IZEH an area of 11080 hec in the North East of Ahwaz, The provincial capital of Khuzestan & Between the geographical coordinates 45°49' to 49 °59' East & 31° 46' to 31°57' north latitude. This area is a temperate sub-humid areas. Mean annual temperature of 24 ° C, The mean annual precipitation and evaporation pan 9/655 and 1685 respectively have been reported (Soil reported Izeh, 2011).

Figure 1. Range map of the study area

The most important step is finding the potential of an irrigation system for each zone using parametric method, A score for each of the important factors in choosing the system. Because determining the scores of the relevant standards is done, In the current study and previous studies conducted by various authorities & Also getting experts and experienced teachers, range of influence of each factor on irrigation systems specified & The classification has been made & finally, in each category, and each of irrigation systems have been Rate. These tables are actually patterns and tips that provides analyze different conditions a study provides irrigation from different perspectives.

The application of irrigated agriculture has been common in the study area. Currently, the irrigation systems used by farmlands in the region are furrow irrigation, basin irrigation and border irrigation schemes. Over much of the Izeh Plain, the use of surface irrigation systems has been applied specifically for field crops to meet the water demand of both summer and winter crops. The groups of soils that had similar properties and were located in a same physiographic unit were categorized as soil series and were classified to form a soil family as per the Keys to Soil Taxonomy. Ultimately, seven soil series were selected for the surface, sprinkler and drip irrigation land suitability.

In order to obtain the average soil texture, salinity for the upper 150cm of soil surface, the profile was subdivided into 6 equal sections and weighting factors of 2, 1.75, 1.5, 1.25, 1 and 0.75 were used for each section, respectively (Sys et al.1991). For the evaluation of land suitability for surface sprinkler and drip irrigation, the parametric evaluation system was used (Sys et al. 1991). This method is based on morphology, physical and chemical properties of soil. Eight parameters including slope, drainage properties, electrical conductivity of soil solution, soil texture, soil depth, wind speed and electrical conductivity and alkalinity of water were also considered and rates were assigned to each as per the related tables (Sys et al. (1991) and IAO (2005) for surface and drip irrigation and Albaji (2010) for sprinkler irrigation), thus, the capability index for irrigation (Ci) was developed as shown in the equation below:

$$Ci = A * \frac{B}{100} \cdot \frac{C}{100} \cdot \frac{D}{100} \cdot \frac{E}{100} \cdot \frac{F}{100} \cdot \frac{G}{100} \cdot \frac{H}{100}$$

where A, B, C, D, E, F,G and H are soil texture rating, soil depth rating, electrical conductivity rating, drainage rating and slope, wind speed and electrical conductivity and alkalinity of water rating, respectively. In Table 1 the ranges of capability index and the corresponding suitability classes are shown.

Table 1. Suitability Classes for the Irrigation Capability Indices (Ci) Classes

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

Parametric models, using a grading factor in the formula (1) determines. These eight layers was then space on the final layers (maps of land suitability for surface irrigation, sprinkler and drip) to provide.

3. Results and Discussion

The study area to 11,080 hec of land that was available soil information is limited. According to the Materials and Methods,is calculated earned every region of the study area for pressurized irrigation systems and surface. In general, land evaluation systems to provide for useful information and recommendations for decision-making about the per unit land (soil) of what type of irrigation system is used. At this stage, after grading land restrictions for irrigation systems and all these factors determine the needs of irrigation systems, the land property obtained through studies and surveys, Matched and based on separated land appropriate and inappropriate surface for each of the systems, sprinkler and drip. The Ci values and suitability classes of surface, sprinkler and drip irrigation for each land unit are shown in Table 2. Also, the distribution of surface, sprinkler and drip irrigation suitability is shown in Table 3.

Table 2. The Ci values and suitability classes of surface, sprinkler and drip irrigation for each land unit

Land Unit Code	Surface Irrigation		Drip Irrigation		Sprinkler Irrigation	
	(Ci) (%)	Suitability Classes	(Ci) (%)	Suitability Classes	(Ci) (%)	Suitability Classes
1	25	N_{2sq}	33.2	N_{1s}	21.8	N_{2sq}
2	85.5	S_1	95	S_1	73	S_{2sqb}
3	73.1	S_{2sq}	90	S_1	69	S_{2qbs}
4	90	S_1	95	S_1	76.5	S_{2qb}
5	61.5	S_{2sqt}	81	S_1	59	S_{3sqb}
6	85.5	S_1	90	S_1	73	S_{2sqb}
7	90	S_1	95	S_1	76.5	S_{2qb}

n: Salinity (ECe); w: Drainage; s: Heavy soil texture; c:The limiting factors for drip irrigation; q: water quality and b: wind speed

In order to verify the possible effects of different management practices, the land suitability for sprinkler and drip irrigation was evaluated (Tables 2 and 3). For surface irrigation, soil series coded 2,4,6,7 (6300ha–57%) was highly suitable (S1) while soil series coded 5 and 3 (2484 ha–23.41%) were classified as moder- ately suitable (S2). Further, soil series coded 1 (18.28ha–16.5%) were classified as permanently not suitable (N2) for sprinkler irrigation.

Table 3. Distribution of surface, sprinkler and drip irrigation suitability

Suitability	Surface Irrigation			Sprinkler Irrigation			Drip Irrigation		
	Land Unit	Area(ha)	Ratio (%)	Land Unit	Area(ha)	Ratio (%)	Land Unit	Area(ha)	Ratio (%)
S1	2,4,6,7	6300	56.86	-	-	-	2,3,4,5,6,7	8784.5	79.27
S2	3,5	2484.16	22.41	2,3,4,6,7	7451.02	67.24	-	-	-
S3	-	-	-	5	1333.48	12.03	-	-	-
N1	-	-	-	-	-	-	1	1828.24	16.5
N2	1	1828.24	16.5	1	1828.24	16.5	-	-	-
Miscellaneous land	467.81		4.22	467.81		4.22	467.81 4.22		
Total	11080.54		100	11080.54		100	11080.54 100		

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As shown in Table 2 for drip irrigation, the soil series coded 2,3,4,5,6,7 (8785ha – 79%) were highly suitable (S1; Land having no, or insignificant limitations for irrigation); soil series coded 1 (1828 ha –16.5%) were classified as currently not-suitable (N1; land having severe limitations for irrigation). There was no permanently not suitable land (N2; land that have so severe limitations for irrigation) in this plain. For sprinkler irrigation, soil series coded 2, 3, 4,6,7 (7451 ha – 67.24 %) were classified as moder- ately suitable (S2). Further, only soil series coded 5 (1333 ha – 12.03 %) were found to be marginally suitable (S3). only soil series coded 1 (1828.24 ha- 16.5 %) was classified as permanently not-suitable (N2) for sprinkler irrigation. The code first in a series of soils because of soil depth limitation for any irrigation method was not suitable. The highest wind speed and quality of irrigation water in the region limit the impact of these restrictions on drip irrigation was lower.

In order to develop land suitability maps for different irrigation methods, all the data for soil characteristics were analyzed and incorporated in the map using ArcGIS 9.2 software. The analysis of the suitability irrigation map for surface irrigation (Figure 2) the highly suitable area can be observed in the part of the cultivated zone in this plain (located in the center) due to deep soil, good drainage, texture, salinity and appropriate slope of the area. Regarding sprinkler irrigation, (Figure 3) indicates that there was no highly suitable land in this plain. Regarding drip irrigation, (Figure 4) there was many highly suitable land in this plain. As seen from the map, the largest part of the cultivated area in this plain was evaluated as suitable for drip irrigation because of the least limiting factors.

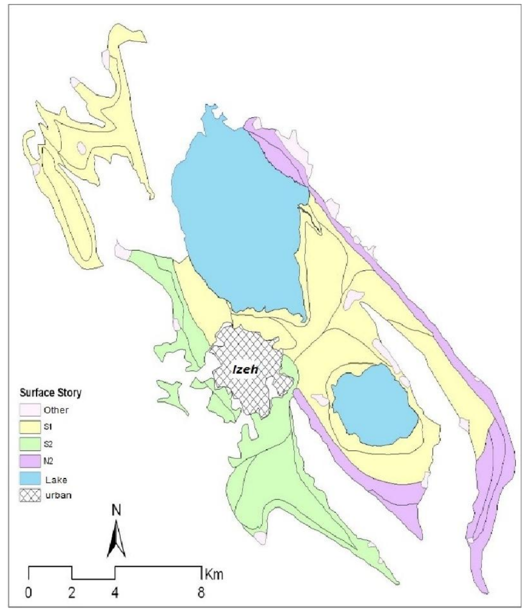

Figure 2. Map locations suitable for surface irrigation

In soil series coded 2, 3, 4,5, 6, 7 applying drip irrigation systems was more suitable than surface and sprinkler irrigation systems. A map indicating the most suitable irrigation systems is shown in Figure 5. As seen from this map, the largest part of this plain was suitable for drip irrigation systems and some parts of this area were suitable for surface irrigation systems. The results of Tables 3 and 4 indicated that by applying drip irrigation instead of surface and sprinkler irrigation methods, the land suitability of 8785 ha (79%) of the Izeh Plain could be improved substantially.

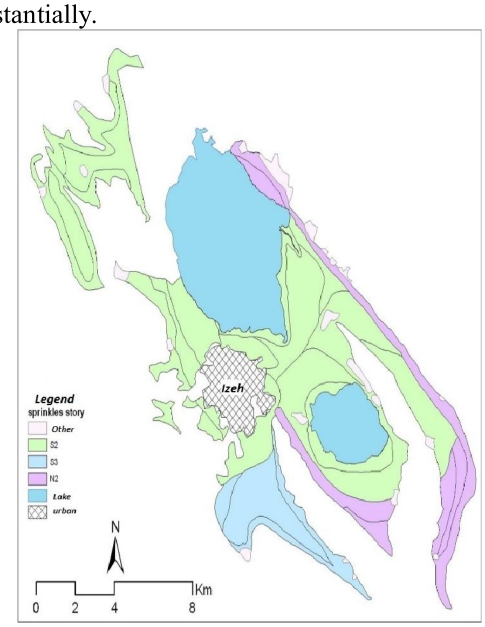

Figure 3. Map locations suitable for sprinklers irrigation

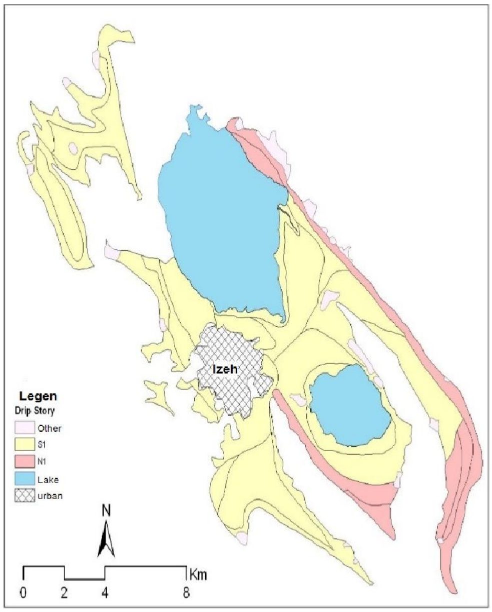

Figure 4. Map locations suitable for drip irrigation

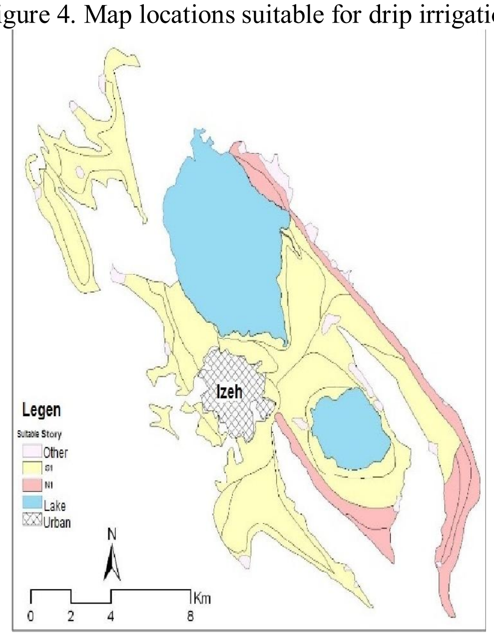

Figure 5. Map the best fit irrigation systems

4.Conclusions

In this study, we have decided that 3 irrigation system taking into account different characteristics of soil, wind speed, water and land are analyzed and compared. As a result of these studies priority irrigation system to irrigate the area are as follows: drip irrigation, surface irrigation, sprinkler irrigation. In general, soil and water quality parameters to limit the implementation of Irrigation systems. By comparing the results of the appropriateness of the best systems in the plains Izeh with similar studies in the plain of Shavoor by vatanara (1389), the best system for plain Shavoor was recognized.

Sprinkler system, drip irrigation system is the best system due to water shortages in arid and semi-arid climates. By examining other technical conditions, economic and social This method can be used for Sustainable water and optimization management.

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