Full Length Research Paper

Comparison of site selection of suitable lands for performance of pressurized irrigation by geography information system (GIS) in Kerman Plain, Southeast of Iran

Ali Neshat

Department Of Water Engineering, Faculty Of Engineering, Islamic Azad University, Kerman Branch, Kerman, Iran.

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The different parameters such as water, soil and climate have an important effect in the decision making and performance of pressurized irrigation systems. The underground and surface water resources in per region have no unique quality and quantity. The Kerman Plain, which has about 7500 km², is located in the Kerman Province. The irrigation of this plain is done with using the underground water resources which are facing drop in the water level, due to over exploitation. Accordingly, the pressurized irrigation is suggested in order to the prevention of drop the loss trend and increasing irrigation efficiency. The aim of this research is to identify suitable lands for performance of pressurized irrigation system, with the help of remote sensing techniques and geography information system (GIS), in Kerman plain of southeast of Iran. In this research, 2 methods of site selection: logical overlay method – Boolean method- and Arithmetic overlay - proportion percent method are compared and evaluated. On the basis of Boolean site selection model 5% of desert lands for performance of sprinkle irrigation and 25% of lands for drip irrigation and on the basis of arithmetic overlay 15% of lands for performance of sprinkle irrigation and 20% of them for performance of drip irrigation reasonably were recognized. The comparison of these 2 methods with considering the condition of regions showed that arithmetic overlay site selection model is more suitable for recognizing the suitable zones for performance of pressurized irrigation systems.

Key words: Pressurized irrigation, geography information system (GIS), boolean model, proportion percent model, site selection.

INTRODUCTION

The limitation of water sources and ever-increasing population, has tended the world countries to increase of the agricultural products in unit of area and optimized productivity from water and soil sources by new methods irrigation for increasing irrigation efficiency and efficiency of used water.

*Corresponding author. E-mail: a.neshat896@gmail.com
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The quality of water, the climate of region, the situation of topography, characteristics of soil region, the quantity of water irrigation and kind of crops are the most important and effective factors in determination of various pressurized irrigation systems. Arba Minch University (2004) made a case by case study on the basis of Arabia CHAMOO in the area of irrigation proportion by geography information system (GIS).


Mamanpoosh and Tofangsaz (2009) did site selection of zones which have the ability of pressurized irrigation by assistance of geography information system for Barkhar desert in Esfahan.


Albaji et al. (2009) evaluated the soil characteristics for different irrigation systems in Laly desert.

The aim of this research is to do a suitable site selection for performance of pressurized irrigation systems by remote sensing techniques with GIS. Considering the characteristics of soil and water, soil texture, electrical conduction, thickness of bicarbonate, the slope of region, climate, the conditions of water quality, the proportion lands, the ability of lands which is Kerman desert with the comparison and evaluation of logical overlay - Boolean- and arithmetic overlay, the proportion percent that contribute to present the best overlay model.

MATERIALS AND METHODS

The process of site selection by GIS includes recognition steps, the collection of input data, determination of effective factors, compiling and preparing of data, the preparation of maps, weighting to maps, combination of maps and preparation of output maps. The province of Kerman, which has about 184,400 km² area, is located on the southern east of Iran, and it is the most extensive province of Iran. The geography position of this province is from 54°, 22' to 59°, 45' eastern latitude, and from 26°, 22' to a little more than 32' northern longitudes. The evaluations of statistical wind speed are shown in a long-term period which demonstrates that the moderate of strong winds in forecast station of Kerman region have 5.1, 2.4, 2.5, and 3.5 km/h speed in the spring, summer, fall and winter respectively, which illustrates that proportional tranquility is dominated in the region.

The majority of agriculture products are pistachio which is more compressed in northern desert, Zerand, Rafsanjan, and Sirjan. After collecting data which are related to condition of soil texture, types of lands, proportion of lands, and lands ability, maps that are related to soil texture, soil ability, and proportion of lands of region are prepared by GIS. Booth B, Mitchell A., 2011, Cuenca RH 1989.

In order to evaluate the quality of water irrigation, the results of chemical analytic of water resources on the basis of last excising statistics in 2008 were used. Electrical conduction, thickness of bicarbonate, sodium, and chloride were the evaluated parameters.

The position of region slope is another important and effective factor in operating site selection of pressurized irrigation system that is prepared by digital elevation model (DEM) map and GIS technology (Mamanpoosh and Tofangsaz, 2009; Nikpoor, 2011). After gathering required data including state of soil texture, the ability of soil lands, the lands proportion, the condition of slope, the evaluation of water quality, the maps are classified into 2 groups: the logical Boolean model, and the proportion percent. The various methods and models are used in site selection which involves Boolean model, Fussy, and indexes overlay. In this research, Boolean site selection model and arithmetic overlay is used. In this, Boolean site selection model- Binary- the logical combination of map value is in 2 cases: Yes and No. It means that belonging to a series by ONE and not belonging to a series by ZERO is expressed.

However, the conclusion of arithmetic overlay method is a suitability map which is set on the basis of well-proportioned degree, and includes a variety of colors. This method is used when the severe effectiveness of each factor is to be determined. However, the impact of all factors should be considered the same in Boolean. In this research, to evaluate water quality, on the basis of the model mentioned, water sources of pressurized irrigation systems with limitations, such as electrical conductions and calcium bicarbonate -H CO3– should be determined. Moreover, pistachio consists of the majority of cultivated field in Kerman Plain, and the number and limitations which are related to sensitivity of salty are not mentioned in this table considering the conditions of pressurized irrigation plans which are performed in the province. In the evaluation of the soil water of the province and considering high the electrical conduction in this region, the borders and limitations on the basis of Boolean method are E.C (µmos/cm)< = 8000 and Bicarbonate (meq/lit)< = 6 suitable value: (1). Also, E.C(µmos/cm)> 8000 and Bicarbonate(meq/lit)> 6 is considered not suitable value: (0).

The limiting factors in the sprinkle irrigation system were water quality, sodium, chloride, and electrical conductions. The borders were determined by site selection Boolean model: E.C(µmos/cm)< = 25, and Sodium (meq/lit)< = 9, and Chlorine (meq/lit)< = 9 is considered suitable value: (1) Moreover, E.C (µmos/cm) = 2500, Sodium (meq/lit) > 9 and Chlorine (meq/lit) > 9 is considered not suitable value: (0).

The interpolation of maps for site selection of pressurized irrigation systems -sprinkle and drip- is prepared. The interpolation is done on E.C, HCO3, parameters in drip irrigation system and in the sprinkle irrigation is done on the E.C sodium and chloride factors. The topography conditions of region showed that the spline method is used for interpolation.

The soil texture is the other limiting factor in performing pressurized irrigation system. The suitable and not suitable value of soil texture is shown on the basis of Boolean model. Fine coarse texture with E.C (µmos/cm)< = 8000 and Bicarbonate (meq/lit)< = 6 suitable value: (1). Also, E.C(µmos/cm)> 8000 and Bicarbonate(meq/lit)> 6 is considered not suitable value: (0).

After evaluation of effective factors in selection of pressurized irrigation system such as climate condition, topography, the characteristics of soil, the quality of irrigation water in selection of pressurized irrigation system, the layers of separate data are prepared separately for per parameters. Also, then with considering standards and numerical limitation which are in these parameters, interpolation was done. Consequently, weighting the map was done by two logical overlay method –Boolean-, and arithmetic overlay.
RESULTS

The result of logical overlay Boolean is a (0, 1) function: 1: suitable and 0: Not suitable, so just two colors are shown in the output Raster with the labels of (0, 1). However, the result of arithmetic overlay is a suitability map which has set on the basis of suitable degree, and include a variety of colors when a series of conditions is described for explanation of projects, logical overlay is used. A series of conditions means that for each condition, an amount is determined. Two groups of maps are prepared in this research:

The maps which are related to logical overlay (site selection Boolean model). The maps which are related to arithmetic overlay (proportion percent) without considering the percent affection which means the effect ion of all parameters consider the same.

After evaluation of effective factors in selection of pressurized irrigation system such as climate condition, topography, the characteristics of soil, the quality of irrigation water in selection of pressurized irrigation system, the layers of separate data are prepared separately for per parameters.

Finally, the separation of suitable and not suitable sites was done by Boolean logic in which the logical combination of a map is in Yes and No form (in zero and one form: zero shows not suitable regions and one is considered for suitable regions).

By combining of layer information's of soil texture, the ability of soil the slope of region, and the water quality with standards and especial limitations of sprinkle irrigation a map was prepared (Figure 4). Also by combining the layers information's which include soil texture the ability of soil the slope of region the water quality with standards and especial limitations of drip irrigation a map was drawn (Figure 4). These maps were drawn by logical Boolean (logical overlay) and proportion percent (arithmetic overlay).

Kerman desert has about 7,500 km$^2$ area, and 4,000 km$^2$ out of this area consists of proportion lands which have ability, and potential of irrigation: about 55% of them. After preparation and combination of data which are related to soil texture, the ability of lands proportion, the slope of lands, water quality and use of standards, and limitation in when design of drip irrigation is considered is prepared (Figures 1, 2 and 3).

After preparation and combination of data which are related to soil texture, the ability of lands proportion, the slope of lands, water quality and use of standards, and limitation in when design of sprinkle irrigation is considered for sprinkle irrigation by Boolean and arithmetic overlay were recognized (Figures 4, 5, 6 and 7). The conclusion of Boolean method showed 25% of desert lands are suitable for performing of drip irrigation system, and 5% of them are suitable for...
performing of sprinkle irrigation in the desert of Kerman. However, the arithmetic overlay method showed that 20% of desert lands are suitable for performing of drip irrigation and 15% of them can be used for sprinkle irrigation in the Kerman plain.

To sum up, the comparison of results and condition of the region showed that arithmetic overlay method is more suitable for recognizing and finding suitable locations to perform pressurized irrigation plans in Kerman Plain. It is noticeable that the logical overlay model, Boolean, because of simple logic and calculation, has fast and simple performance, but with considering the effect of other parameters on site selection process, this model cannot be used as a suitable model for combination of maps. Because not only the weight of all parameters is considered the same and equal in this model but also the possibility of classification of per parameter in separate classes for weighting per classification is impossible.

The unsuitable and untalented land for performance of drip irrigation includes about 80% of plain lands that 20% out of the unsuitable lands is located in Derakhtegan and Khenaman - section. The limiting factors in these regions involve the condition of topography and improper slope of land and kind of land region. The lands of this region include mountains and hills that have severe limitation because of having rocks out crop which is without soil. Fourthly percent of unsuitable lands are located in some

**Figure 2.** The condition of soil texture in Kerman Plain.
Figure 3. The classification of soil texture in the sprinkle irrigation with Boolean method.

Figure 4. The classification of soil texture in the sprinkle irrigation with proportion % method.
Figure 5. The proportion classification of Lands with Boolean.

Figure 6. The classification of proportion Lands with proportion percent.
parts of Baghin and Kabootarkhan region. The limiting factors in these regions include the improper quality of water because of having high electrical conduction (E.C > 8000) and thickness of bicarbonate of calcium (HCO₃ > 6). Also the kind of these regions includes the gravel fan colluviums and type and severity of them is because of many gravels and not keeping of moisture. Some lands of these regions belong to mountains and hills.

Type and severity of their limitation because of rocks out crop that have not soil and proper slope (slope> 10%). 20% of unsuitable lands of plain is located in some parts of Mahan region and Sare Asiabe Farsangi limiting factors in this regions are unqualified water and the improper condition of slope (slope > 10%). the unsuitable and untalented lands for performance of sprinkle irrigation include about 85% of lands of plan and 45% out of them are located in Baghin, Kabootarkhan, Khenaman and Derakhtegan and the soil texture is the most important problem.

Forty percent of unsuitable and untalented lands for performance of irrigation system in Kerman plain is located in some ports of Zangiaabad, Ekhtiar Abad, Sare Asiabe Farsangi, Mahan and Ghenaghestan which have the limiting factor of water quality, the high ratio of sodium, chlorine or the high ratio of E.C.

DISCUSSION

The remote sensing techniques, GIS, and its analytic functions are applied and effective devices in site selection. There are different ways and models in quantitative, qualitative and drawing form for site selection. The potentials and abilities of a site is different according to concepts.

The indexes should be combined with standards on the basis of the performance in order to evaluate the potential of site. These indexes and standards are difference according to application, but all of them are centralized for selection of site. The using of these indexes requires the correct and complete information from the site, and achieving these information's needs on extensive and comprehensive researchers.

The Kerman plain has about 7,500 km² area and the well-proportioned and irrigation able lands include around 4,000 km² of this area, which is about 55%. 25% of plain lands are reasonably recognized for drip irrigation (Naseri et al., 2009; Omidvari and Sepahvand, 2005). The
Planning and Budget Organization (1997). The unsuitable and untalented lands for performing of drip irrigation are categorized into three zones:

The first zone

This zone covers the Derakhtegan region and parts of Khenaman, which have totally 1,380 km² areas and include 20% of plain. The limiting factors in these regions are:

1). The condition of topography and slope. On the basis of the map of slope region, the slope is more than 10% in these regions and according to Boolean logic; these regions were not reasonably recognized for the drip irrigation.
2). The lands of these regions belong to mountains and hills on the view of lands type. According to the proportion degrees of lands and limitations of these lands are severe because there is severe rocks out crop there, and they belong to N2(r) lands on the view of the proportion lands classification.

The second zone

The region covers some parts of Baghin, Kabootarkhan, Ekhtiarabad, and Zangiabad, and it involves 35% of unsuitable lands of plain. The limiting factors in these regions involve:

1). The quality of water: The limitation of these region is EC > 8000 and HCO₃ > 6 in some parts.
2). The ability of lands: The lands of this region belong to 1.3 and 8.1 lands. The 8.1 lands include the grovel colluvium on the view of lands type and many gravel colluviums, and the lack of keeping moisture are the reasons of kind and severe of limitation. They belong to s₄ (gw) lands on the view of lands classification, and 1.3 lands. The rocks out crop which have not soil are the reasons of their limitation and kind, and they belong to N₄(r) lands on the view of lands classification.
3). The unsuitable slope condition (slope > 10)

With paying attention to the lands slope, KABOOTAPKLHAN has unsuitable land.

The third zone

This region includes some parts of MAHAN and SARA ASIAB, which cover about 18% of plain lands. The limiting factors of these regions are:

1). The unsuitable slope in the Mahan region (slope > 10).
2). The unqualified water of some parts of Sarasiabefarsaci, and 5% of plain lands are reasonably recognized for sprinkle irrigation, so 95% of them are not suitable and talented.

On the view of existing limitation for performing of sprinkle irrigation in the Kerman plain, the lands are categorized into two zones:

The first zone

This region, which has about 3,650 km² covers BAGHIN, KABOOTARKHAN, KHENAMAN, and DERAKHTEGAN or it includes 48% of lands plain. The problem of these regions is soil texture.

The second zone

This region, which includes 47% of plain lands, covers some parts of Zangiabad, Ekhtiarabad, Sarasiabe Farasangi, Mahan, and Ghenaghestan, and it has the limiting factor of water quality high sodium, chlorine or high ratio EC.

Conclusions

1). The comparison of two methods: logical overlay and arithmetic overlay with the circumstances of the regions showed that the site selection arithmetic overlay model – the proportion percent- for recognizing the suitable lands in order to perform pressurized irrigation system is more suitable. On the basis of this method, 15% of desert lands for performing of sprinkle system and 20% of them for drip irrigation reasonably were recognized.
2). Principal management and correct programming and optimistic exploitation from the sources required exact and up to date from that site. In this direction, GIS plays an important role in achieving predetermined aims such as optimistic investment; for they have the ability of analysis of location, combination and digestion of map data, table data, reporting in according to standards format and decrease of cost.
3). The suitable site selection for performing of pressurized irrigation plans by study of all quantitative and qualified factors of water, soil, climate, and the topography of region which were done by GIS and satellite image that has high quality that finally with making analytic site selection and by related logical contribute to appropriate comprehension from region is a necessary issue in all regions. Because with existing limitation in sources of agriculture section the regions which have more adoption for performing of pressurized irrigation system should be determined so that to prevent to go to waste the sources of soil and water.

Conflict of Interests

The author(s) have not declared any conflict of interests.
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