International Journal of Agricultural Management and Development (IJAMAD)
Available online on: www.ijamad.iaurasht.ac.ir
ISSN: 2159-5852 (Print)
ISSN:2159-5860 (Online)

Comparison of Different Irrigation Methods Based On the Parametric Evaluation Approach in Chikan and Mourzian Subbasin, Iran

Masoud Masoudi [1], Abdollah Ebrahimi [2] and Parviz Jokar [2]*

Received: 14 December 2016,
Accepted: 18 June 2018

Abstract

Increasing world population has led to product more foods and crops, while agricultural lands have been decreased. Then, it is necessary to use the maximum potential of these lands which product maximum yield without any damage. To reach this objective, land suitability evaluation is the most important way that can reach-this objective. The main objective of this research was to compare different irrigation methods based on a parametric evaluation system in an area of 100 ha in the Chikan and Mourzian Subbasin of the Fars province, in the south of Iran. After preparing land unit map, 10 points were selected for sampling. Soil properties were evaluated and analyzed. Suitability maps for drop and gravity irrigation were generated using GIS technique. The result revealed land suitability of 71.9 ha (71.9%) of the case study was classified as permanently not suitable (N2) and 28.1 ha (28.1%) currently not suitable (N1) for gravity irrigation. On the other hand, land suitability of 47.3 ha (47.3%) of the case study was classified as permanently not suitability (N2), 28.5 ha (28.5%) currently not suitable (N1) and 24.3 ha (24.3%) marginally suitable (S3) for drop irrigation. The limiting factor for drop irrigation was slope and for gravity irrigation were slope and drainage.

Keywords:
drop irrigation, gravity irrigation, land suitability

[1] Associate Professor, Department of Natural Resources and Environmental Engineering, Shiraz University, Shiraz , Iran
[2] Department of Natural Resources and Environmental Engineering, Shiraz University, Shiraz, Iran
* Corresponding author's email: masoudi@shirazu.ac.ir

INTRODUCTION

Human have used natural resources to supply daily and early requirement without consideration their capability in different regions of the world. The result of this way is irreparable damage to natural resource. For preventing more damage, land suitability should be determined for everywhere. Reports shows continuous use of agriculture land in past decades, regardless of land evaluation has caused much more degradation than provide the resources (FAO, 2007). So, precise land evaluation based on ecological capability is essential to solve this problem. Land evaluation is a process of evaluating land performance over time according to the specific types of utilization (Lee & Yeh, 2009; Martin & Saha, 2009; Sonneveld et al., 2010). The principle objective of agriculture land suitability evaluation is to assess the potential and limitation of the land for crop production (Pan & Pan, 2012). Land evaluation methodologies have changed from subjective and qualitative assessments to specific and quantification assessment (Elsheik et al., 2010; Nwer, 2006). On the other hand, land is a comprehensive system resulting from the interaction of biological, physical and anthropogenic activity operating over different scales of time and space, therefore choice of proper model for land evaluation is very important (O'Neill, 1989).

Fifteen percent of agricultural lands are irrigated but it product 50 percent of agricultural crop and world food. This shows the importance of irrigation in agriculture. In Iran, agriculture consumes 92 percent of all water supplies per year and more than 60 percent of the ratio waste because of disuse of advance technology. Consequences of this low efficiency are obvious: the rise in water table, evaporation of water from the soil surface, and accumulation of salts in the top soil. Therefore the irrigation systems have to be reached to a stage that this low efficiency becomes more. The best suggestion for the irrigated areas that quality of irrigation water is not bad is using of drip and sprinkler methods (Masoudi, 2010). Therefore the main objective of this research is the implementation and comparison of a parametric evaluation model (Sys et al., 1991) for two different irrigation methods of surface (gravity) and drip (localized) irrigation in order to better planning management of Irrigated Lands.

Several studies have done in comparison of different irrigation methods based on the parametric evaluation approach. Briza et al. (2001) applied a parametric system to evaluate land suitability for both surface and drip irrigation in the Ben Slimane province, Morocco. The largest part of the agricultural areas was classified as marginally suitable. Bazzani and Incerti (2002) also provided a land suitability evaluation for surface and drip irrigation systems in the province of Larche, Morocco, by using parametric evaluation systems. The results showed a large difference between applying the two irrigation methods.

Bienvenue et al. (2003) evaluated the land suitability for surface (gravity) and drip (localized) irrigation in Senegal using Sys's parametric evaluation systems. Regarding the surface irrigation, there was no area classified as highly suitable (S1). For drip (localized) irrigation, a good portion (25.03%) of the area was classified as highly suitable (S1).

Mbodj et al. (2004) performed a land suitability evaluation for two types of irrigation, i.e., surface irrigation and drip irrigation, in the Tunisian Oued Rmel Catchment using the suggested parametric evaluation. They found that the drip irrigation suitability gave more irrigable areas compared to the surface irrigation practice.

Barberis and Minelli (2005) provided land suitability classification for both surface and drip irrigation systems in Shouyang county, Shanxi province, China. The results indicated that due to the unusual morphology, the area suitable for the surface irrigation (34%) is smaller than the land that could be used for the drip irrigation (62%).

Dengiz (2006) also compared different irrigation methods including surface and drip irrigation in the pilot fields of İkizce central research institute, located in south of Ankara, Turkey. This researcher has concluded that the drip irrigation method increased the land suitability by 38% compared to the surface irrigation method.

Liu et al. (2006) evaluated the land suitability for surface and drip irrigation in the Danling County, Sichuan province, China, using a Sys's parametric evaluation system. Drip irrigation was everywhere more suitable than surface irrigation due to the minor environmental impact that it caused. Albaji et al. (2007) carried out a land suitability evaluation for surface and drip irrigation in the Shavoor plain, in Iran. The results showed that 41% of the area was suitable for surface irrigation; 50% of the area was highly recommended for drip irrigation. Due to soil salinity and drainage problem the rest was not considered suitable for either irrigation method.

Albaji et al. (2010) investigated different irrigation methods based upon a parametric evaluation system in an area of 29,300 ha in the Abbas Plain Located in the Elam province, in the West of Iran. The results demonstrated that by applying sprinkler irrigation instead of surface and drip irrigation methods, the arability of 21,250 ha (72.53%) in the Abbas Plain will improve.

Gholami and Delavari (2012) evaluated the land suitability for drip and surface irrigation methods at Shirin Abad, Shoushtar that located in the province of Khouzestan. The results of parametric evaluation system showed that 83.6 percent of land is suitable for surface irrigation and 90.8 percent is suitable for drip irrigation and 6.2% of the land is unsuitable for both irrigation methods and factor of restrictions were introduced in salinity and soil alkalinity.

Fatapour and Eslami (2014) investigated comparison of suitability of two methods of sprinkler and drip irrigation based on the parametric method in Kouhdasht Plain located in Lorestan Province, in the west of Iran. The results showed that all of arable lands were considered suitable for drip irrigation and classified as class S1.

Bagherzadeh and Paymard (2015) investigated land capability for different types of irrigation systems including surface, drip, and sprinkler practices by parametric and fuzzy approaches to evaluate the capability of cultivated lands on 6131 km^2 of the Mashhad Plain, Khorasan Razavi Province, northeast Iran. Results showed that the land capability indices were in higher classes (S1 to S2) by drip and sprinkler irrigation compared to the surface irrigation system and the soil texture was detected as the most limiting factor for using the surface irrigation system. With respect to current soil and climate conditions in the study area, the most efficient irrigation systems are drip and sprinkler practices.

Albaji et al. (2016) evaluated a suitable irrigation plan based upon a parametric evaluation system for an area of 1325 ha in the Ghaleh Madreseh Pain, Iran. The obtained results showed that sprinkler and drip irrigation were highly appropriate methods for 682.3 ha (51.5%) of the study area. Moreover, through applying sprinkler instead of surface and drip irrigation methods, the arability of 1170, 7 ha (88.4%) of Ghaleh Madreseh Plain would improve for sprinkler irrigation.

The main objective of this research was to evaluate and compare land suitability for gravity and drop irrigation methods based on the parametric evaluation system for Chikan and Mourzian Subbasin, Iran.

METHODOLOGY

This research was conducted in an area of 100 ha in the Chikan and Mourzian Subbasin of the Fars province, in the south of Iran (Figure1). The case study is located 300 31' N to 300 31' 30'' N and 520 2' 30'' E to 520 3' 30'' E. The elevation ranges between 1600-2000 meters, average annual precipitation is 770.8 mm, average annual evaporation is 2174.2 mm and the current land use is dry land farming.

Sys et al. (1991) suggested a parametric evaluation system for irrigation method based on physical and chemical soil properties. In their proposed system there are six parameters and has been shown in the equation below:

$$C_i = A \times B/100 \times C/100 \times D/100 \times E/100 \times F/100$$

where A, B, C, D, E and F are soil texture rating, soil depth rating, calcium carbonate content rating, electrical conductivity rating, drainage rating and slope rating, respectively.

In Table 1 the range of capability index (C_i) and in Table 2 to7 the factors and their classes are seen. At first, land unit map was prepared by overlaying three maps: elevation, slope and

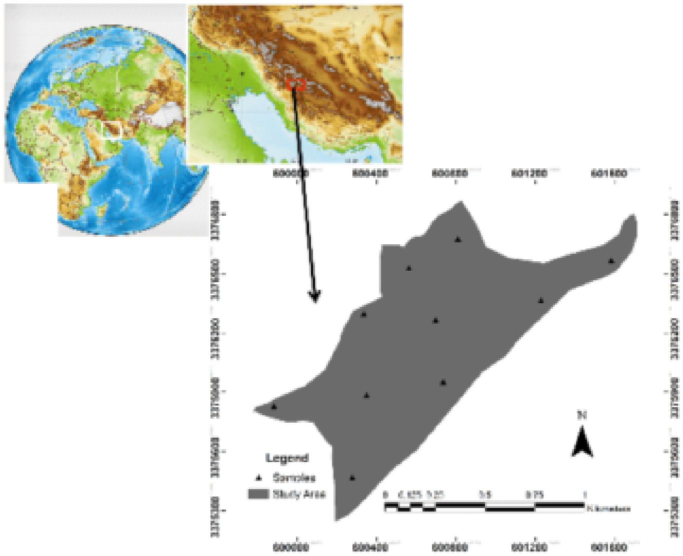

Figure 1. Location of study area with field samples

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

Capability index	Definition	Symbol
> 80	Highly Suitable	S_1
60–80	Moderately Suitable	S_2
45–59	Marginally Suitable	S_3
30–44	Currently Not Suitable	N_1
< 29	Permanently Not Suitable	N_2

Table 2
Soil Depth Rating

Soil depth [cm]	Rating for gravity irrigation	Rating for drop irrigation
< 20	30	30
20–50	60	70
50–80	80	90
80–100	90	100
> 100	100	100

aspect maps. After that according to the land unit map ten points were selected for sampling (Figure1). The factors are measured and the values were allocated to each of them. When the factors were valued the Capability index for irrigation were calculated and the numerical values of the Capability index were allocated for corresponding suitability classes

RESULTS

There is a freshwater river in center of case study and any irrigation system is not seen. Figures 2 and 3 show land suitability maps for different irrigation methods. In Table 8 for drop irrigation results revealed the most part about 47.3 ha (47.3%) (2, 4, 6, 10) are classified as permanently not suitable (N_2), 28.8 ha (28.8%) (1, 3, 5, 8) currently not suitable (N_1) and 24.4 ha (24.4%) (7, 9) marginally suitable (S3).Then about 75.8 ha of all are classified as not suitable. The average capability index (C_i) for drop irrigation is 38.28 that is classified as currently not suitable.

Land suitability for gravity irrigation is similar to drop irrigation with a little difference. 71.9 ha (71.9%) (2, 4, 5, 6, 8, 9, 10) are classified as permanently not suitable (N_2), 28.1 ha (28.1%) (1, 3, 7) currently not suitable (N_1) and there

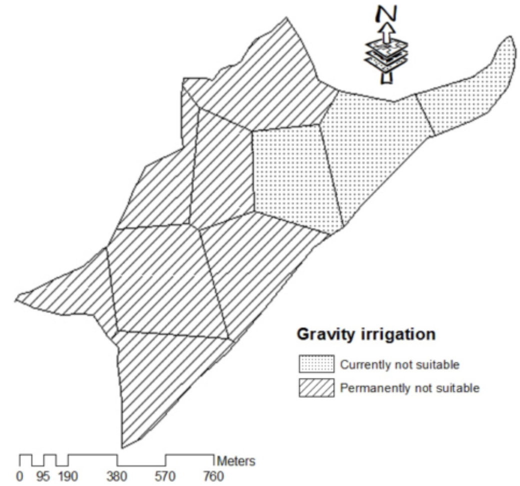

Figure 2. Land suitability map for gravity irrigation

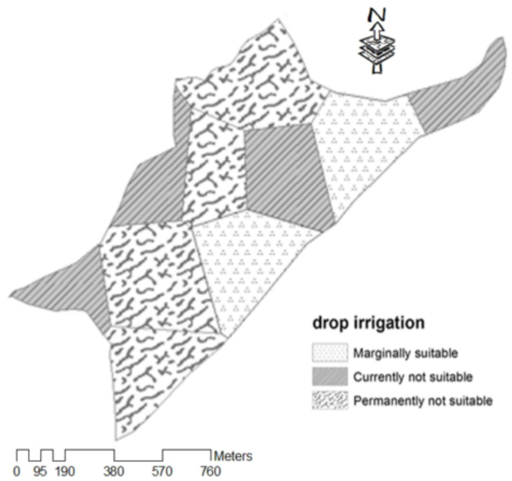

Figure 3. Land suitability map for drop irrigation

are no land units with marginally suitable (S_3) class. Therefore all of the case study land units are classified as not suitable. The average capability index (C_i) for gravity irrigation is about 24.28 and it means this area are classified as permanently not suitable (N_2).

In Table 9, for drop irrigation the highest value of capability index (C_i) is 49.25 that is marginally suitable (S_3), but this class has a little area that is related to land unit 7. On the other hand, the lowest value is 24.32 that is permanently not suitable (N_2) and this class is related to land unit 6.

For gravity irrigation, the highest value of capability index (C_i) is 34.84 that is classified as currently not suitable (N_1) and this allocates to land unit 7. The lowest value is 14.36 that is classified as permanently not suitable (N_2) and it is related to land unit 6. By combination of above results, land unit 7 is the best suitability and has no limiting factor but land unit 6 is the worst suitability and there is a limiting factor in land unit 6 like slope.

Table 10 shows, comparison of capability index (C_i) for gravity and drop irrigation in case study. Drop irrigation is more suitable than gravity irrigation in all land units. Then between tow irrigation methods, drop irrigation is better. Finally

Table 3
Textural Class Rating

Tex.	Rating for drop irrigation					Rating for drop irrigation				
	Fine gravel (%)			Coarse gravel (%)		Fine gravel (%)			Coarse gravel (%)	
	<15	15-40	40-75	15-40	40-75	<15	15-40	40-75	15-40	40-75
Clay Loam (CL)	100	90	80	80	50	100	90	80	80	50
Silty Loam (SiL)	100	90	80	80	50	100	90	80	80	50
Sandy Clay Loam (SCL)	95	85	75	75	45	95	85	75	75	45
Loam (L)	90	80	70	70	45	90	80	70	70	45
Silty Loam (SiL)	90	80	70	70	45	90	80	70	70	45
Silty (Si)	90	80	70	70	45	90	80	70	70	45
Silty Clay (SiC)	85	95	80	80	40	85	95	80	80	40
Clay (C)	85	95	80	80	40	85	95	80	80	40
Sandy Clay (SC)	80	90	75	75	35	95	90	85	80	35
Sandy Loam (SL)	75	65	60	60	35	95	85	80	75	35
loamy Sand (LS)	55	50	45	45	25	85	75	55	60	35
Sandy (S)	30	25	25	25	25	70	65	50	35	35

Table 4
$CaCO_3$ Status Rating

CaCO3 [%]	Rating for gravity irrigation	Rating for drop irrigation
<0.3	90	90
0.3–10	95	95
10–25	100	95
25–50	90	80
>50	80	70

Table 5
Elecrto-Conductivity Rating

EC [ds m–1]	Rating for drop irrigation		Rating for drop irrigation	
	C, SiC, S, SC textures	Other textures	C, SiC, S, SC textures	Other textures
< 4	100	100	100	100
4–8	90	95	95	95
8–16	80	50	85	50
16–30	70	35	75	35
> 30	60	20	65	20

C – clay; SiC – silty clay; S – sand; SC – sandy clay

it is considerable that both irrigation methods have low capability index (C_i) and weak suitability class. The most area of case study are classified as not suitable and no irrigation methods are suggested.

DISCUSSION AND CONCLUSION

The policy of expanding irrigated agriculture is one main cause of soil salinity in Iran. Lack of proper water management, has resulted in low water use efficiency. A combination of 60% conveyance efficiency and 50% application efficiency, leading to an overall efficiency of 30%, is usually reported in official reports (Masoudi, 2010). Drop and sprinkler methods of applying water will work best for increasing

Table 6
Drainage Classes Rating

Drainage classes	Rating for drop irrigation		Rating for drop irrigation	
	C, SiC, SC textures	Other textures	C, SiC, SC textures	Other textures
Well drained	100	100	100	100
Moderately drained	80	90	100	100
Imperfectly drained	70	80	80	90
Poorly drained	60	65	70	80
Very poorly drained	40	65	50	65
Drainage status not known	70	80	70	80

C – clay; SiC – silty clay; S – sand; SC – sandy clay

Table 7
Slope Rating

Slope classes [%]	Rating for drop irrigation		Rating for drop irrigation	
	Non-Terraced	Terraced	Non-Terraced	Terraced
0–1	100	100	100	100
1–3	95	95	100	100
3–5	90	95	100	100
5–8	80	95	90	100
8–16	70	85	80	90
16–30	50	70	60	70
>30	30	50	40	50

C – clay; SiC – silty clay; S – sand; SC – sandy clay

Table 8
Distribution of Area in Methods of Gravity and Drop Irrigation

Suitability	Drop irrigation			Drop irrigation		
	Land unit	Area(ha)	Ratio (%)	Land unit	Area(ha)	Ratio (%)
N_2	2,4,6,10	47.3	47.3	2,4,5,6,8,9,10	71.9	71.9
N_1	1,3,5,8	28.5	28.5	1,3,7	28.1	28.1
S_3	7,9	24.2	24.2	------	0	0
total	10	100	100	10	100	100

water use efficiency. This aim needs land capability evaluation for such irrigation methods. So, classification of land capability using physical and chemical land properties is a prerequisite process for uses management. The land capability evaluation involves multi factors, which are in different scales ranging from nominal to ratio. Geospatial technologies have been utilized for handling such a complex phenomenon for long (Jokar et al., 2015).

The main objective of this work was the implementation and comparison of different irrigation methods based on a parametric evaluation system in order to better planning for water management. Soil properties including soil texture, soil depth, calcium carbonate content, electrical conductivity, drainage and slope were evaluated and analyzed based on the model. This model is evaluated to two kinds of irrigation in-

Table 9

Ci Values and Suitability Classes in Gravity and Drop Irrigation for Each Land Units

Class of land unit	Drop irrigation		Gravity irrigation	
	C_i	Suitability class	C_i	Suitability
1	43.78	N_1	31.36	N_1
2	27.65	N_2	20.16	N_2
3	43.78	N_1	29.79	N_2
4	26.88	N_2	20.16	N_2
5	36.48	N_1	25.2	N_2
6	24.32	N_2	14.36	N_2
7	49.25	S_3	35.84	N_1
8	36.48	N_1	25.2	N_2
9	48.64	S_3	23.94	N_2
10	25.54	N_2	16.8	N_2

Table 10

The Most Suitable Land Units for Drop and Gravity Irrigation Methods Regarding to Capability Index for Different Irrigation Methods

Codes of land unit	Maximum (Ci)	Suitability class	The most suitable irrigation method	Limiting factor
1	43.78	N1	Drop	----
2	27.65	N2	Drop	Slope
3	43.78	N1	Drop	----
4	26.88	N2	Drop	Slope, $CaCO_3$%
5	36.48	N1	Drop	Slope
6	24.32	N2	Drop	Slope
7	49.25	S3	Drop	----
8	36.48	N1	Drop	Slope
9	48.64	S3	Drop	----
10	25.54	N2	Drop	Slope, depth

cluding "drop and gravity". Suitability maps for drop and gravity irrigation showed all parts of the study is not suitable for gravity irrigation because of slope limitation but using drop irrigation decrease this limitation and other kinds of problems and make some parts of study area marginally suitable for irrigated agriculture. Overall, the results showed study area does not have good conditions for irrigations. Of course these results may be related to process of evaluation which is so strictly. On the other hand, results of Gholami and Delavari (2012); Fatapour and Eslami (2014) using the parametric evaluation (Sys et al., 1991) showed that their study areas are in suitable conditions for irrigation, showing almost good ecological condition for cultivation. Also, such areas will be the area needing immediate attention for remedial measures for reclamation and conservation for each type of degradation like those measures mentioned by Masoudi and Jokar (2017) and Masoudi et al. (2017).

ACKNOWLEDGEMENTS

The authors are thankful to those governmental offices of Iran, for providing the data, maps and reports for the present work.

REFERENCES

Albaji, M. Landi, A. Boroomand Nasab, S. & Moravej, K. (2007). Land Suitability Evaluation for Surface and Drip Irrigation in Shavoor Plain. *Iran Journal of Applied Sciences, 8*(4), 654-659.

Albaji, M., Boroomand, N.S., Naseri, A.A., & Jafari, S. (2010). Comparison of different irrigation methods based on the parametric evaluation approach in Abbas plain, Iran. *Journal of Irrigation and Drainage Engineering, 136* (2), 131–136.

Albaji, M., Golabi, M., Hooshmand, A.R., & Ahmadee, M. (2016). Investigation of Surface, Sprinkler and Drip Irrigation Methods Using GIS. *Jordan Journal of Agricultural Sciences, 12,* 211-222.

Bagherzadeh, A., & Paymard, P. (2015). Assessment of land capability for different irrigation systems by parametric and fuzzy approaches in the Mashhad Plain, northeast Iran. *Soil and Water Research, 10,* 90–98.

Barberis, A., & Minelli, S. (2005). Land evaluation in the Shouyang county, Shanxi province, China. In: 25th Course Professional Master. Geomatics and Natural Resources Evaluation. Istituto Agronomico Per L‟Oltremare. 8th November 2004–23 June 2005, Vol. 19, IAO, Florence, Italy, pp. 56–94.

Bazzani, F., & Incerti, F. (2002). Land evaluation in the province of larache, Morocco. In: 22nd Course Professional Master. Geometric and Natural Resources Evaluation. Istituto Agronomico Per L‟Oltremare. 12 November 2001–21 June 2002, Vol. 17, IAO, Florence, Italy, pp. 29–48.

Bienvenue, J.S. Ngardeta, M. & Mamadou, K. (2003). Land Evaluation in the Province of Thies, Senegal. 23rd Course Professional Master. Geometric and Natural Resources Evaluation.8th Nov 2002-20 June 2003. IAO, Florence, Italy.

Briza, Y. Dileonardo, F. & Spisni, A. (2001). Land Evaluation in the Province of Ben Slimane, Morocco. 21st Course Professional Master. Remote Sensing and Natural Resource Evaluation .10 Nov 2000 - 22 June 2001. IAO, Florence, Italy.

Dengiz, O. (2006). A comparison of different irrigation methods based on the parametric evaluation approach. *Turkish Journal of Agriculture and Forestry, 30*, 21–29.

Elsheik, A.R., Ahmad, N., Shariff, A., Balasundra, S., & Yahaya, S. (2010). An agricultural investment map based on geographic information system and multi-criteria method. *Journal of Applied Sciences, 10,* 1596–1602.

FAO (2007). Land evaluation towards a revised framework. Food and Agriculture Organization of the United Nations, Rome, Italy.

Fatapour, E., & Eslami, H. (2014). Locating suitable areas for pressurized irrigation systems using GIS. *Bulletin of Environment, Pharmacology and Life Sciences, 3*, 153-156.

Gholami, A., & Delavari, A. (2012). Evaluation of the two methods of surface and drip irrigation based on the parametric system. *Journal of Basic and Applied Scientific Research, 2*(6), 5988-5992.

Jokar, P., Masoud, M., Fallah Shamsi, S.R., & Afzali, S.F. (2015). Developing a model for ecological capability evaluation of ecotourism (A case study: Jahrom Township, Iran). *International Journal of Scientific Research in Environmental Sciences, 3*(1), 1-8.

Lee, T.M., & Yeh, H.C. (2009). Applying remote sensing techniques to monitor shifting wetland vegetation: A case study of Danshui River estuary mangrove communities, Taiwan. *Ecological Engineering, 35*, 487–496.

Liu, W., Qin, Y. & Vital, L. (2006). Land Evaluation in Danling county, Sichuan province, China. 26th Course Professional Master. Geometric and Natural Resources Evaluation. 7th Nov 2005–23rd Jun 2006. IAO, Florence, Italy.

Martin, D., & Saha, S.K. (2009). Land evaluation by integrating remote sensing and GIS for cropping system analysis in a watershed. *Current Science, 96*, 1-10.

Masoudi, M. (2010). Risk assessment and remedial measures of land degradation, In Parts of Southern Iran. Lambert Academic Publishing (LAP), Germany, 220 p.

Masoudi, M., & Jokar, P. (2017). A new model for desertification assessment using Geographic Information System (GIS) − A case study, Runiz Basin, Iran. *Polish Journal of Ecology, 65,*

236–246.
Masoudi, M., Jokar, P., & Sadeghi, M. (2017). Land use planning using a quantitative model and Geographic Information System (GIS) in Darab County, Iran. *Journal of Materials and Environmental Sciences, 8*, 2975-2985.
Mbodj, C., Mahjoub, I., & Sghaiev, N. (2004). Land evaluation in the Oued Rmel Catchment, Tunisia. In: 24th Course Professional Master. Geometric and Natural Resources Evaluation. Istituto Agronomico per L‟Oltremare. 10th November 2003–23rd June 2004, Vol. 21, IAO, Florence, Italy, pp. 41–72.
Nwer, B.A.B. (2006). The application of land evaluation technique in the North-East of Libya. Faculty of Environment, Cranfield University, Silsoe.
O'Neill, R.V. (1989). Perspectives in hierarchy and scale. In: Rougharden, J., May, R.M., Levin, S.A. (Eds.), Perspectives in Ecological Theory. Princeton University Press, Princeton, NJ, USA.
Pan, G., & Pan, J. (2012). Research in crop land suitability analysis based on GIS. *Computer and Computing Technologies in Agriculture, 365,* 314–325.
Sonneveld, M.P.W., Hack-ten Broeke, M.J.D., Van Diepen, C.A., & Boogaard, H.L. (2010). Thirty years of systematic land evaluation in the Netherlands. *Geoderma, 156,* 84–92.
Sys, C., Van Ranst, E., & Debaveye J. (1991). Land evaluation, part l, principles in land evaluation and crop production calculations. International Training Centre for Post-graduate Soil Scientists, University Ghent, Brussels, Belgium. 265 pp.

How to cite this article:
Masoudi, M., Ebrahimi, A., & Jokar, P. (2018). Comparison of different irrigation methods based on the parametric evaluation approach in Chikan and Mourzian Subbasin, Iran. *International Journal of Agricultural Management and Development, 8(3), 355-364.*
URL: