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POLSKA AKADEMIA NAUK

JOURNAL OF WATER AND LAND DEVELOPMENT
e-ISSN 2083-4535

Polish Academy of Sciences (PAN), Committee on Agronomic Sciences
Section of Land Reclamation and Environmental Engineering in Agriculture
Institute of Technology and Life Sciences (ITP)

JOURNAL OF WATER AND LAND DEVELOPMENT
2020, No. 46 (VII–IX): 179–189
https://doi.org/10.24425/jwld.2020.134211

Available (PDF): http://www.itp.edu.pl/wydawnictwo/journal; http://journals.pan.pl/jwld

Received 24.09.2019
Reviewed 02.03.2020
Accepted 10.03.2020

Analyzing spatiotemporal relationship between land use changes and groundwater quantity in Hamedan north plains (Iran)

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For citation: Rafiemehr H., Kozegar Kaleji L. 2020. Analyzing spatiotemporal relationship between land use changes and groundwater quantity in Hamedan north plains (Iran). Journal of Water and Land Development. No. 46 (VII–IX) p. 179–189. DOI: 10.24425/jwld.2020.134211.

Abstract

Perceiving the spatiotemporal relationship of land use changes and groundwater resources is crucial for the effective and sustainable management of the plains. This study aims to investigate the relationship between land use changes and groundwater depth fluctuations in the forbidden plains of northern Hamedan. In the present study, the land use maps for 1989, 1997, 2005, 2013 and 2018 were extracted and categorized from Landsat satellite images and then evaluated for accuracy. In addition, groundwater depth distribution maps were prepared by kriging method for five years from piezometric data. The correlation and relationship between land use changes and groundwater depth fluctuations were determined by REGRESS methods. The findings from kriging method indicated that the intensity of groundwater decline during the last three periods of study (2005, 2013 and 2018) becomes more severe in the study area. Land use change trends indicate a sharp decline in the orchards, pasture lands, barren lands and a relative decline in the irrigated agricultural land, and consequently, increasing in non-irrigation and residential farmland. In addition, the average annual depth of groundwater level during the past 29 years decreased to 1.57 m and 0.87 m in the Kabudrahang and Razan Plains, respectively. The *r* value of REGRESS method during five study periods was the minimum 0.015 and maximum 0.15 in the Kabudrahang Plain and minimum 0.06 and maximum 0.15 in the Razan Plain, respectively. The results of the study indicated that climate changes cannot be considered as the reason for declining the groundwater in the study area. However, along with the relative impacts of land use changes, the role of managerial factors, the prominent example of which is the non-expert location of the Shahid Mofatteh Hydroelectric Power Station, which supplies underground water to cool the generators, should be considered. The present study can be effective in the management, planning, and policy of groundwater resources, land use location, and spatial planning in the areas facing severe water shortages, especially in the northern plains of Hamedan because this study indicates the importance of underground water in arid and semi-arid regions.

Key words: *groundwater, land use, northern plains of Hamedan Province, REGRESS method*

INTRODUCTION

The groundwater is one of the most essential resources water for agriculture, industry and human consumption [DOLL *et al*. 2012]. Although there is no precise statistic related to groundwater consumption, the estimates indicate that the total groundwater extraction in the world in 2010 was 900 km^3 [MARGAT, VAN DER GUN 2013]. The quantity and intensity of extraction in different regions are highly various and the extraction quantity has been reached the maximum in some regions such as Pakistan, China, Iran, Bangladesh and India [FOSTER *et al*. 2013; GWP 2014]. In drylands (like Iran), the groundwater is usually the most important and best option for human consumptions. In addition, the groundwater is the primary factor to protect human ecosystems in drylands and semi-dryland [CALOW *et al*. 1997; EASTMAN 2012]. Therefore, precise evaluation and effective management are critical guarantees and essential prerequisite for extracting the groundwater resources. Further, evaluating the effects of human activities (for instance, land use and cover changes) on groundwater resources plays a vital role in developing and establishing the aimed plans of groundwater extraction [SATO, IWASA (eds.) 2011; SCHWARTZ, ZHANG 2003].

Numerous studies were conducted for identifying the effects of use changes by human activities on groundwater resources in Iran and the world. XU *et al*. [2005] demonstrated that how groundwater resources extraction affects the agricultural land use. SCANLON *et al*. [2005] concluded that replacing the rangelands with agricultural lands resulted in decreasing the groundwater recharge. In addition, LERNER and HARRIS [2009] claimed that the amount of water demand depends on land use entirely. Further, they suggested that human activities impact the access to groundwater resources due to change the water saving rate. In another study, SINGH *et al.* [2011] investigated the effect of land use change on groundwater resources by remote evaluating approach and geographic information system. In order to evaluate land use and cover changes, they used satellite images and studied region use by spatial analysis of groundwater resources. MISHRA *et al.* [2014] reported that the pattern of land use change demonstrates the rate of groundwater recharge. They argued that identifying and examining the land use changes from past to present and spatiotemporal distribution of uses are essential for appropriately managing and planning the groundwater resources. Furthermore, JAVI *et al*. [2014] examined the relationship between land use change and groundwater quantity in Khanmirza Plain by using GWR and OLS models and concluded that R^2s obtained by GWR confirm the spatiotemporal relationship between land use change and groundwater quantity. POURANDARA *et al*. [2018] investigated the effects of land use changes on groundwater recharge in Malaparamba, India by using the model of swim. They suggested that groundwater recharge depends on rain pattern and land use changes mainly and groundwater recharge in jungle lands is more than that of agricultural lands. GOLALIZADEH [2011] evaluated the role of land use changes in groundwater quality. In the study, the role of use changes was examined given the chemical parameters of groundwater resources in aquifer, Alborz province, Iran. The results demonstrated that water quantity related to the uses gets more desirable, if the uses distribute based on ecologic ability. TAGHIPOUR and JAVI [2012], by evaluating the land use changes related to the reduction of groundwater resources in Khanmirza, Chaharmahal and Bakhtiari province, Iran via statistic models based on regression analysis, concluded that there is a significant relationship between land use changes and reduction of groundwater resources. Further, NASROLLAHI *et al*. [2014] evaluated the effects of land use changes on groundwater resources in Gilangharb Plain, Iran by using the satellite images. The study emphasized that groundwater resources are decreasing due to the replacement of rangelands with agricultural lands. Reviewing the previous literatures suggests that plant ecosystem changes impact hydrological cycle significantly due to land use and cover changes [ZHANG *et al*. 2001]. Therefore, land use and cover changes in watershed, which influence hydrological process, become an important scope in developing hydrological science.

Groundwater is one of the most crucial parts of hydrological regional cycle, which is affected by land use and cover changes [ALLEY *et al*. 1999; CALOW *et al*. 1997; WANG *et al*. 2005]. Perceiving the relationship between land use and cover changes and hydrological processes, especially groundwater resources, is regarded as one of the main issues in field of investigating the land use changes and water resources [MISHRA *et al*. 2014]. Each decision and action related to land use affect water resources. Although the close relationship between two items has been considered from the past, it is not widely regarded in management actions via comprehensive politics. The focus on actions of land use management could generate the highly significant benefits for quantity and quality of groundwater by spending relatively moderate costs. Therefore, investigating the relationship between land use changes and groundwater quantity is highly vital for managing the groundwater resource. In addition, land use changes such as deforestation, urbanization, development of agricultural lands, conversion of rangelands into arid lands and even economic afforestation could have long-term or permanent effects and sometimes irreversible effects on groundwater resources. Land use highly impacts the quantity and quality of recharge rate of groundwater, since the main part of groundwater is generated by intrusive precipitation. Thus, given the immense volume of groundwater, these resources are responding to land use changes with delay [GWP 2014]. In addition, studying the trends of change in quality and quantity of groundwater before increasing the critical situation is an important step toward sustainable resource management, and the importance of this step in dry areas such as Iran is quite more. Although Iran has one of the most advanced water management systems in the Middle East, like other countries of the region, it has a critical situation in water resources [MADANI 2014]. Further, lack of attention to land use changes causes to lose the balance of Iran land gradually. In Hamedan, like other regions of Iran, groundwater is the most essential water resource for agriculture, industry and human consumption [KORD, MOGHADAM 2014]. Perceiving the relationship between land use changes and groundwater quantity is an important step toward understanding the issue and comprehensive management. In the present study, the north plains of Hamedan province are studied due to the existence of critical situation in their groundwater resources and the main reason for this crisis is excessive extraction of groundwater and severe changes in land use. No study, to the best of our knowledge, has been conducted on investigating the spatiotemporal relationship between land use changes and groundwater quantitative in Razan and Kabudrahang Plains. Therefore, the present study aims to examine the spatiotemporal relationship between land use changes and groundwater during 29 years. The results of the study could be used for principled planning of land in order to sustainable utilization of groundwater resources, especially in Hamedan.

MATERIALS AND METHODS

STUDY AREA

The studied region included Kabudrahang and Razan (in Ghahavand) Plains in the North of Hamedan (Fig. 1). In terms of division of drainage basins, the region is a part of drainage basin of Lake Namak. The drainage basin of Lake Namak is a part of drainage basin of Central Plateau of Iran and limited by drainage basins of Sefidrood and Caspian Sea in the North, Karkheh and Maghreb in the West, Zayandehrood in the South, and Rig Zarrin and Namak desert in the East. It is located at the altitudes between Central Alborz and Zagros. This basin is located between the coordinates of 48.8 to 52.3 E and 33 to 36.22 N latitudes.. The region is located the beneath of South drainage basin, drainage of the Qom and the Gharachay rivers, and Arak and Kashan deserts [WMPO 2014]. The important demographic centers of the cities such as Razan, Kabudrahang, Famenin and Shahid Mofatteh Powerhouse are situated at this region.

This region has an important economic and agricultural position. In addition, 89.0%, 2.9%, and 7.6% of the total groundwater consumption of the province are related to agricultural, industrial and drinking sectors, respectively [HRWC 2019]. The general characteristics of Kaboudrahang and Razan Plains are presented in Table 1.

Figures 2 and 3 display the trends of underground water level and annual precipitation during 1989–2019. The mean groundwater level for the whole Kabudrahang Plains reduced from 1670 m in 1989 to 1633 m in 2019. However, the mean trend of annual precipitation changes during this period indicates a relative increase in the rate of precipitations. The groundwater hydrograph data in the Figures 2 and 3 are obtained from the first layer of underground water in both plains.

The mean groundwater level for the whole Razan Plain reduced from 1700 to 1678 m during 1989–2019, respectively. However, like Kabudrahang plain, the trend of mean annual precipitation changes in this plain indicates a relative increase in the amount of precipitations. Thus, reducing the precipitations cannot be considered as the reason for decreasing the groundwater level in both plains.

Due to the water crisis in the Razan and Kabudarang Plains, Iranian Ministry of Energy reported that these two plains are considered as the forbidden plains to control and prevent from escalating the water crisis during 1982–1983. The plains considered as forbidden are not allowed for well digging due to the reduction of the groundwater level and the diggings should be done according to some rules. Despite reporting these plains as forbidden, Shahid Mofatteh Hydroelectricity Power Plant, requiring abundant water resources to cool the generators, was opened between the Kabudrahang and Razan Plains. Many potholes are created in both plains over the past 20 years.

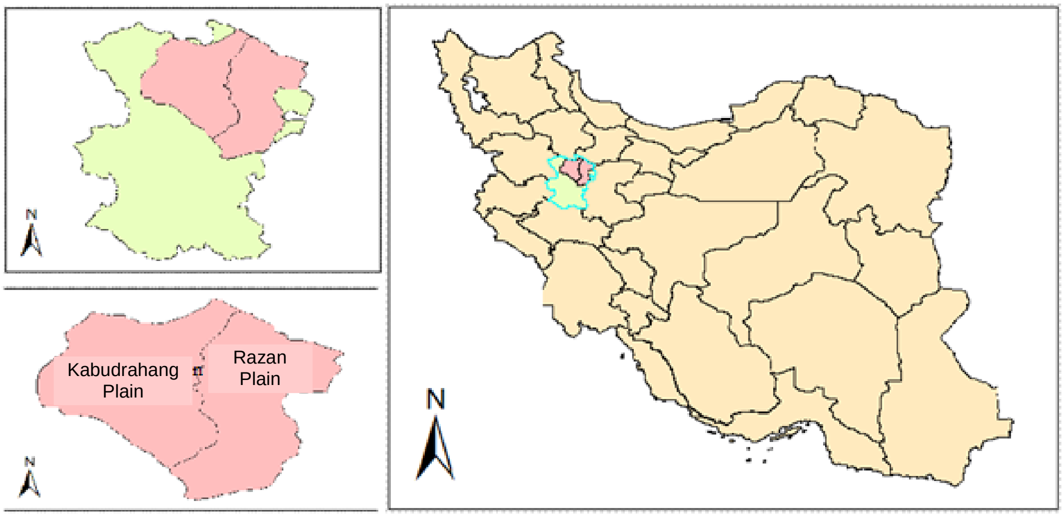

Fig. 1. The location of the studied region; source: own elaboration

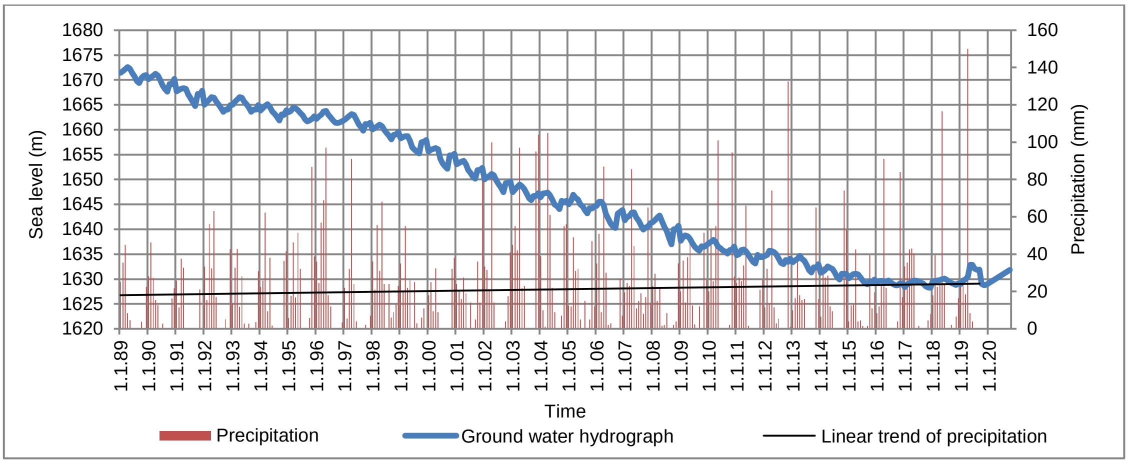

Fig. 2. Groundwater hydrograph and precipitation of the Kabudarahang Aquatic Plain during 1989–2019; source: HRWC [2019]

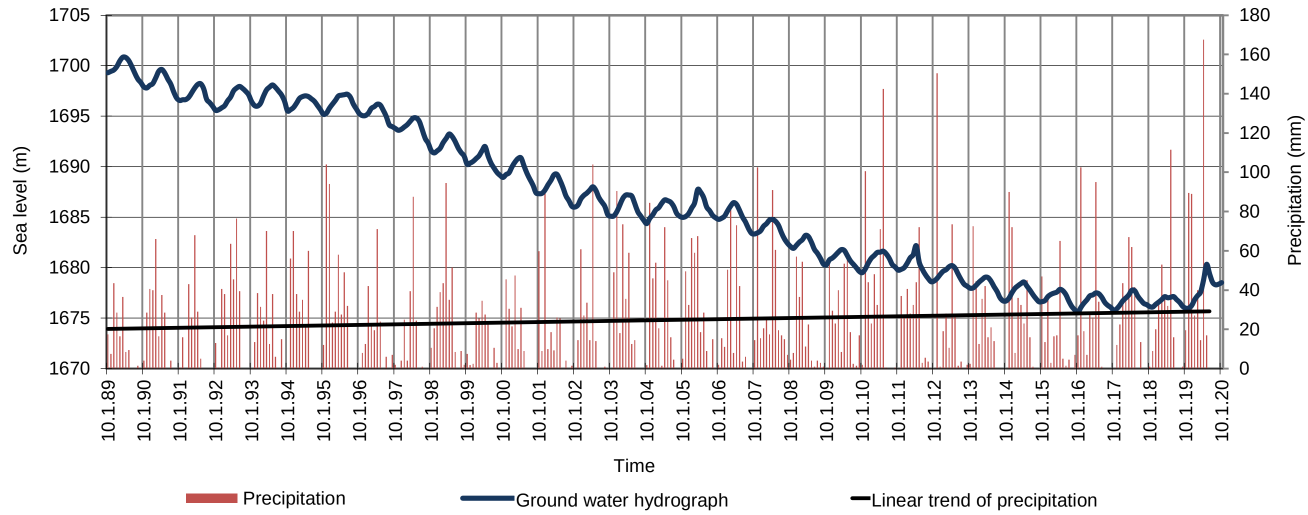

Fig. 3. Groundwater hydrograph and monthly precipitation in the Razan-Ghahavand Plain during 1989–2019; source: HRWC [2019]

Table 1. The specifications of the studied plains

Plain	Extent (km^2)	Population	Mean of annual drop groundwater in long-term (m)
Kabudrahang	3 470	143 171	–1.57
Razan	3 168	167 922	–0.87

Source: HRWC [2019]

METHODS

Figure 4 displays the general trend of the present study. The land use maps of the duration were prepared. To this aim, the satellite images were used. The criteria for selecting the satellite images included the resolution level being identical, lack of cover cloud more than 5% of image and season or time of imaging being the same [SCHWARTZ, ZHANG 2003; SHRESTHA 2006] The images used in the present study belong to Landsat (Tab. 2). In addition, presidential terms were considered for selecting the satellite images. Since the objective is to focus on the environmental effects of political decisions, the images were taken at the end of 8-year presidential term. Using such an approach could help to assess the management efficiency in the region.

In order to extract the uses (Fig. 4, part 1) the satellite images were pre-processed, processed, post-processed and

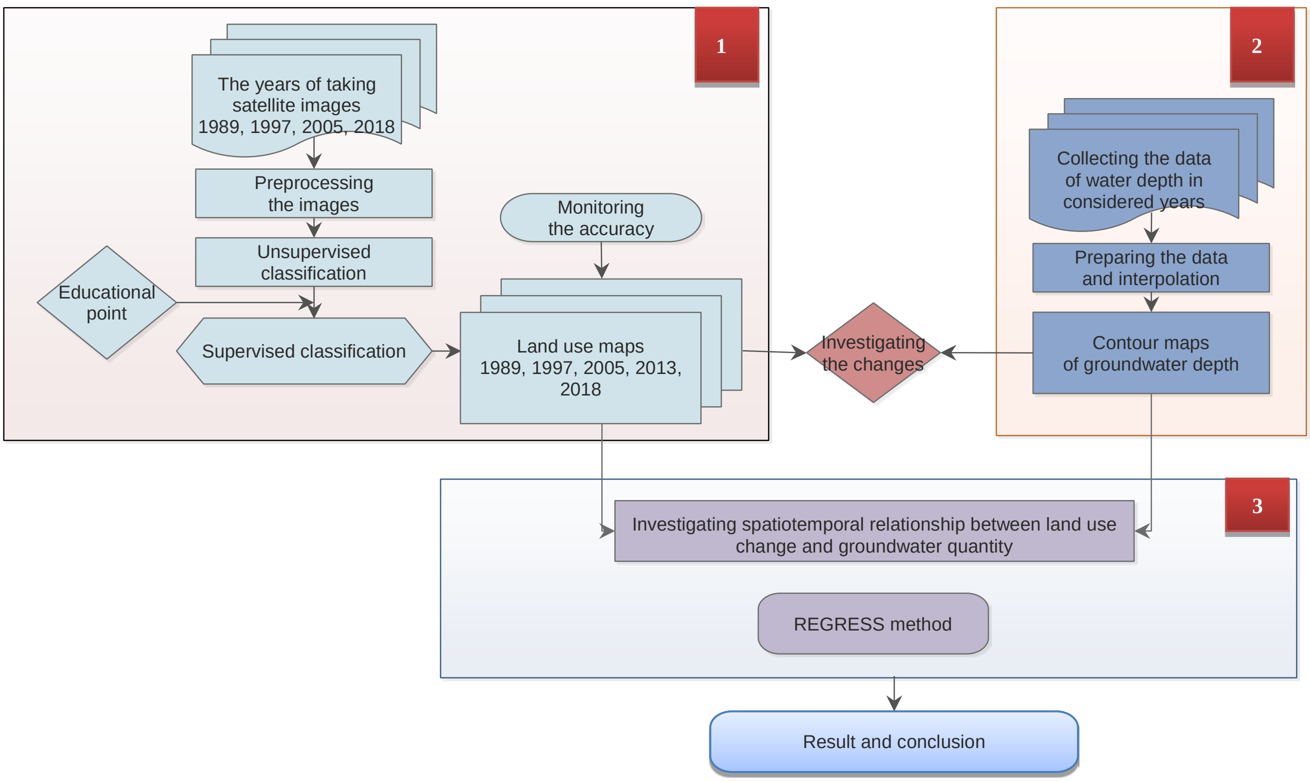

Fig. 4. A flowchart of the study process; source: own elaboration

Table 2. Landsat data sources

Satellite name / Band composite for Landsat	Supervised by	Date of taking the images
Landsat 4 and 5 / Bands: 1, 2, 3, 4, 5, 7	TM	14.05.1989
Landsat 4 and 5 / Bands: 1, 2, 3, 4, 5, 7	TM	26.07.1997
Landsat 7 / Bands: 1, 2, 3, 4, 5, 7	ETM+	24.07.2005
Landsat 8 / Bands: 1, 2, 3, 4, 5, 6, 7	ETM+	27.07.2013
Landsat 8 / Bands: 1, 2, 3, 4, 5, 6, 7	OLI	22.07.2018

Source: own study.

classified. For preprocessing, the images were modified geometrically (unifying the reference of images by ground control points such as roads intersection, etc.) and atmospherically (for eliminating or minimizing the atmosphere effects such as existence of cloud and fog) by Haze reduction module in ERDAS Imagine 2014. Then, the various bands were merged based on reviewing the sources in order to prepare the information.

The histogram equalization of ERDAS Image was used to adjust the image contrast. At the next step, the images were classified in a supervised manner in ERDAS in order to achieve general knowledge on land use classifications of the region. The outputs of this step were used as a useful tool for identifying the educational samples. To this aim, field sampling was performed by GPS, given the results of unsupervised classification, as well as using Google Earth and previous knowledge of the region. The samples were entered to ERDAS. The images were separately classified in a supervised manner in ERDAS based on educational samples of previous step by using Maximum Likelihood method. At this step, primary maps of land use were achieved. The maps were modified and extracted for five periods. After classifying the images, the accuracy was assessed. The land use layers were compared in Idrisi Selva software by using Cross Tabulation method and finally, the land use changes were extracted.

In the second part (Fig. 4), the trend of quantitative change of groundwater was examined. The information related to the groundwater depth was received from Hamedan Regional Water Company and studied. The zoning maps of groundwater level concerning the same periods (1989, 1997, 2005, 2013, and 2018) were prepared in ARC GIS 10.5 by using the kriging interpolation method. These maps indicate the change of groundwater depth.

In the last part (Fig. 4), the statistic models based on regression analysis were used for perceiving the relationship land use changes and groundwater quantity. To this aim, REGRESS module in Idrisi Selva was used. This model examines the relationship between two layers as linear regression [KORD, MOGHADDAM 2014]. REGRESS method assesses the linear regression between dependent and independent variables. In this method, land use change and groundwater quantity were regarded as independent and dependent variables, respectively.

RESULTS AND DISCUSSIONS

In the present study, trend of land use changes was considered during a 29-year period. After extracting and processing Landsat satellite images related to 1989, 1997, 2005, 2013 and 2018, land uses maps were prepared. Then, sixes uses including irrigated and dry agricultural lands, gardens, man-made areas (such as urban-rural and industrial), arid lands (such as rangeland and uncultivated land) and salt marsh were extracted and classified. After classifying the images, the accuracy was assessed based on relative knowledge of the region, Google Earth and GPS points by using 256 points and stratified random sampling. The main object of accuracy assessment is to supply an index for determining the degree of map accuracy and classifying the image [SINGH et al, 2011]. Kappa coefficient is 0.862, 0.881, 0.876, and 0.893 for use land maps in 1989, 1997, 2005, 2013 and 2018, respectively. High value for kappa coefficient indicates high accuracy of classification. Figure 5 and Table 3 display the area and percentage of each use. The results demonstrated that rangelands, arid lands, and gardens have fewer shares compared with previous period while man-made areas and dry agricultural lands have more shares during 29 recent years.

The remarkable point is that the share of irrigated agricultural lands of groundwater resources as the main consumer has not been changed significantly. The share of this use in Razan and Kabudrahang has reached from 4.56 and 5.2% in 1989 to 4.7 and 4.5% in 2018, respectively. The results of changing the land use method are also shown in Table 4.

The remarkable point is conversion arid lands to dry agricultural lands. These changes are significant in terms of keeping the balance of ground water resources since, arid lands lead to the intrusion of surface water and recharge of groundwater resources due to high permeability. However, agricultural and man-made uses, in addition to prevent water intrusion, have a high tendency for consuming the groundwater resources.

In 1989, the highest depth of groundwater in the North of Razan and Kabudrahang Plains were 73.15 and 77.15, respectively. In addition, the least depth of groundwater in the South of Razan and Kabudrahang Plains were 0.6 and 1.3 respectively. As shown in Table 5, the maximum depth of groundwater increases, indicating that the groundwater reserves decrease during the last decades. The results suggest that the mean of groundwater depth have increased during 1989–2018. The general trend of groundwater depth indicates the constant reduction of water reserves. The difference of mean depth during 1989–2018 in Razan and Kabudrahang are 16.5 and 27.0, respectively.

As shown in Figure 6, a considerable increase occurred in the severity of groundwater decline on the 2005 map. It is worth noting that Shahid Mofatteh Hydroelectric Power Plant was opened in 1996 and is equipped with many wells to cool the generators. Because the environmental impacts of policies and decisions are usually resulted in the long run, a significant difference to the first study period, i.e. 1990 can be observed on the map of 1998, i.e. one year after the plant was built. However, its effects are clearly visible in the maps of 2005 onwards.

As mentioned before, REGRESS method assesses the linear regression between dependent and independent variables. To this aim, land use changes and groundwater depth were considered as independent and dependent

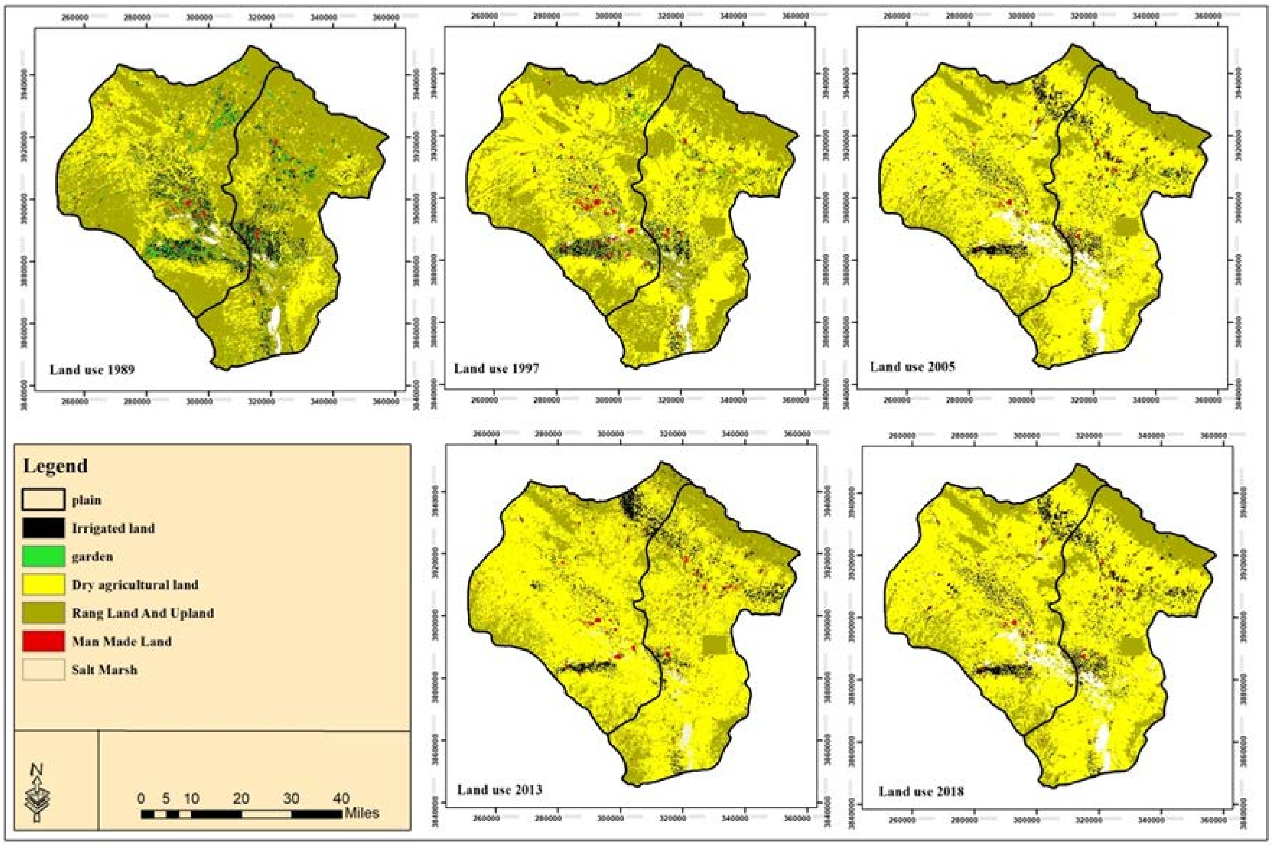

Fig. 5. Classification map of land use for the studied periods; source: own study

Table 3. Area (km^2) and percentage of land use types in the studied region

Use		1989		1997		2005		2013		2018	
		Razan	Kabudra-hang	Razan	Kabudra-hang	Razan	Kabudra-hang	Razan	Kabudra-hang	Razan	Kabudra-hang
Irrigated agriculture	km^2	140.6	181.0	124.0	160.0	139.0	166.0	104.0	124.0	139.0	167
	%	4.56	5.2	4.0	4.6	4.5	4.7	3.4	3.5	4.5	4.7
Dry agriculture	km^2	623.4	882.0	1408.0	1831.0	1554.0	2270.0	1864.0	2338.0	1961.0	2271.0
	%	20.2	25.0	45.0	53.0	50.4	65.0	60.0	67.0	63.0	65.0
Rangelands and arid lands	km^2	2176.0	2213.0	1398.0	1292.0	1233.0	867.0	1033.0	921.0	847.0	865.0
	%	70.6	64.0	45.0	37.0	40.0	25.0	33.0	26.0	27.0	24.8
Gardens	km^2	76.2	122.0	81.0	94.5	22.0	30.0	19.0	29.0	17.0	28.5
	%	2.47	3.5	2.6	2.7	0.7	0.86	0.6	0.8	0.54	0.81
Man-made areas	km^2	11.0	16.4	18.0	24.0	19.3	25.0	27.4	34.0	25.0	35.0
	%	0.36	0.47	0.58	0.7	0.6	0.7	0.8	1.0	0.8	1.0
Salt marsh	km^2	53.6	28.0	49.0	23.0	111.0	112.0	52.0	31.0	111.0	112.0
	%	1.7	0.8	1.6	0.7	3.6	3.2	1.7	0.89	3.5	3.2

Source: own study.

Table 4. Land use changes and conversions (km^2) in the studied region during the studied periods

Use change	Plain	1989–1997	1997–2005	2005–2013	2013–2018
1	2	3	4	5	6
Rangeland and arid land to dry agricultural land	Razan	888.04	699.82	259.09	422.66
	Kabudrahang	1 128.28	710.28	423.44	474.50
Rangeland and arid land to man-made area	Razan	4.11	4.90	5.91	3.94
	Kabudrahang	2.93	3.93	5.16	4.64
Rangeland and arid land to salt marsh	Razan	10.75	49.36	0.75	4.49
	Kabudrahang	9.40	61.94	0.15	7.81
Garden to irrigated agricultural land	Razan	16.97	23.23	3.24	2.23
	Kabudrahang	5.57	30.31	0.32	0.23
Garden to dry agricultural land	Razan	26.36	32.28	0.65	2.15
	Kabudrahang	5.85	45.01	0.12	0.14

continue Tab. 4

1	2	3	4	5	6
Garden to man-made area	Razan	1.05	1.45	0.23	0.75
	Kabudrahang	2.6	1.48	0.574	0.564
Irrigated agricultural land to Dry agricultural land	Razan	58.21	63.06	58.13	47.78
	Kabudrahang	85.85	89.81	83.13	57.42
Irrigated agricultural land to man-made area	Razan	1.53	0.87	1.35	0.43
	Kabudrahang	2.63	0.88	0.72	0.61
Irrigated agricultural land to rangeland and arid land	Razan	15.25	61.01	47.01	59.03
	Kabudrahang	22.93	25.37	47.49	30.36
Dry agricultural land to man-made area	Razan	2.04	5.06	9.67	6.22
	Kabudrahang	0.56	6.64	11.92	1.11
Dry agricultural land to irrigated agricultural land	Razan	10.97	29.36	51.70	50.78
	Kabudrahang	15.21	77.20	54.76	88.05
Dry agricultural land to rangeland and arid land	Razan	177.64	177.06	414.51	260.62
	Kabudrahang	186.73	259.82	461.80	432.32

Source: own study.

Table 5. Trend of the minimum, maximum and mean of groundwater depth (m) changes in the studied region during the studied years

Year	Plain	Minimum	Maximum	Mean
1989	Kabudrahang	1.30	77.15	21.33
	Razan	0.60	73.15	15.59
1997	Kabudrahang	3.90	77.00	27.36
	Razan	2.18	81.05	19.98
2005	Kabudrahang	3.80	78.76	39.63
	Razan	2.98	128.05	27.72
2013	Kabudrahang	4.55	96.90	52.04
	Razan	3.38	96.32	32.25
2018	Kabudrahang	5.50	102.50	48.45
	Razan	1.98	96.32	32.10

Source: HRWC [2019].

variables, respectively. This method provides a regression equation and a correlation coefficient. Figures 7, 8, 9 and 10 indicate the correlation values between land use changes and groundwater quantity by REGRESS method. Correlation values in Kabudrahang during 1989–1997, and in Razan during 2005-2013 are more than other periods. As shown in Figure 9, a low correlation was reported between land use changes and underground water changes during 1989–2018 ($r = 0.01$).

As shown in Figure 9, a low relationship is observed between land use changes and groundwater depth changes based on the REGRESS method for the study timespan during 1989–2018.

Figure 10 shows a low relationship between land use changes and groundwater depth changes based on the REGRESS method during 1989–2018 ($r = 0.06$).

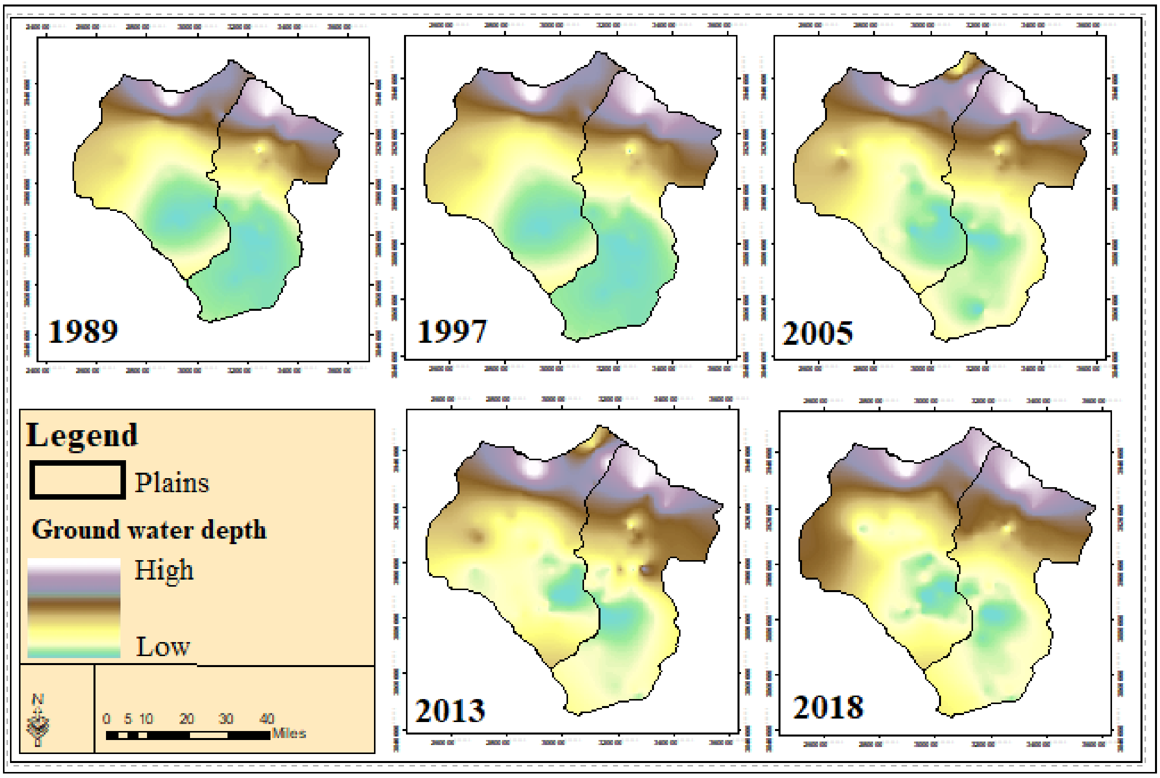

Fig. 6. Groundwater depth maps in the studied timespan; source: own study

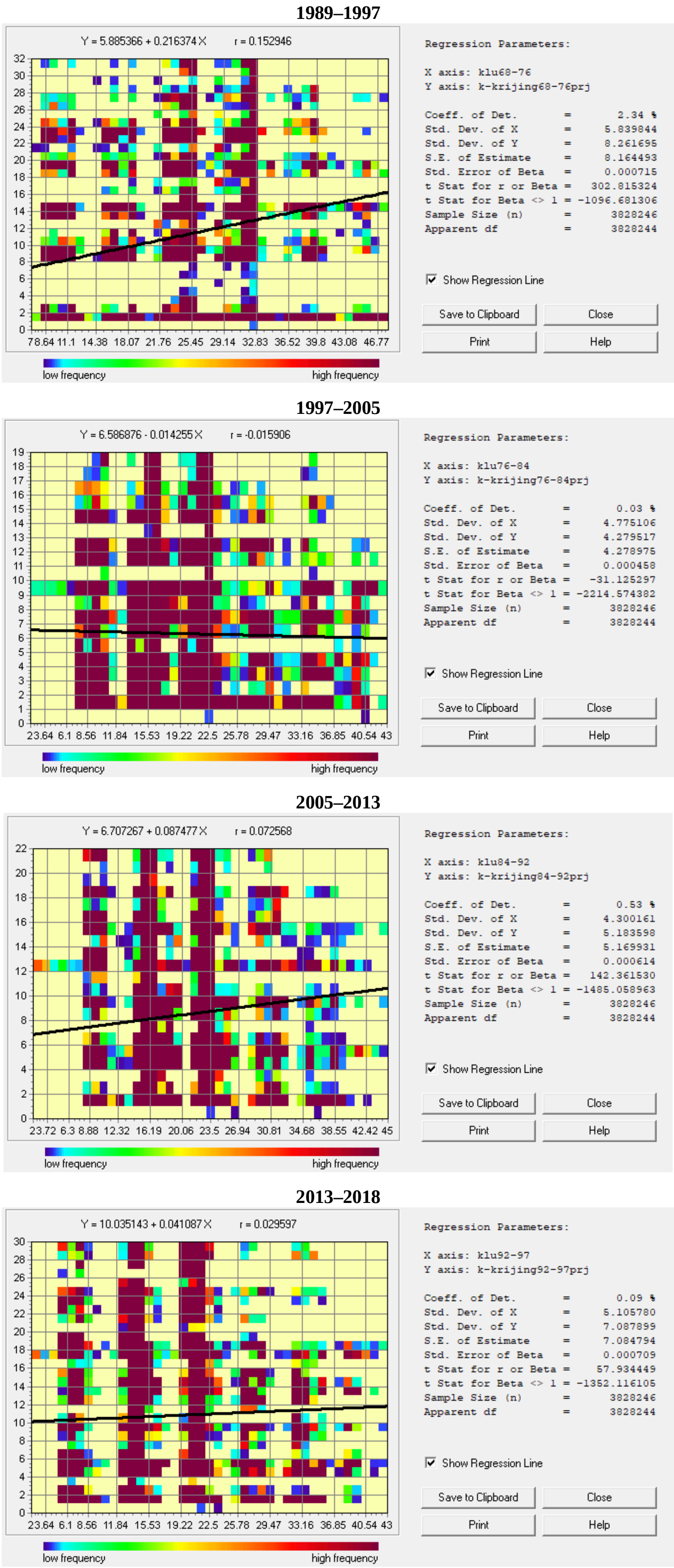

Fig. 7. Relationship between land use change and ground water depth in the studied timespan in Kabudrahang basin; source: own study

Fig. 8. Relationship between land use change and ground water depth in the studied timespan in Razan basin; source: own study

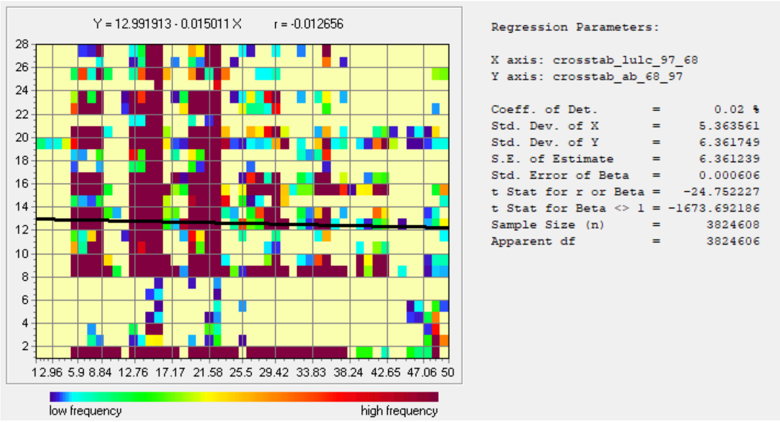

Fig. 9. Relationship between land use changes and groundwater depth changes based on the REGRESS method in Kaboodarahang plain during 1989–2018; source: own study

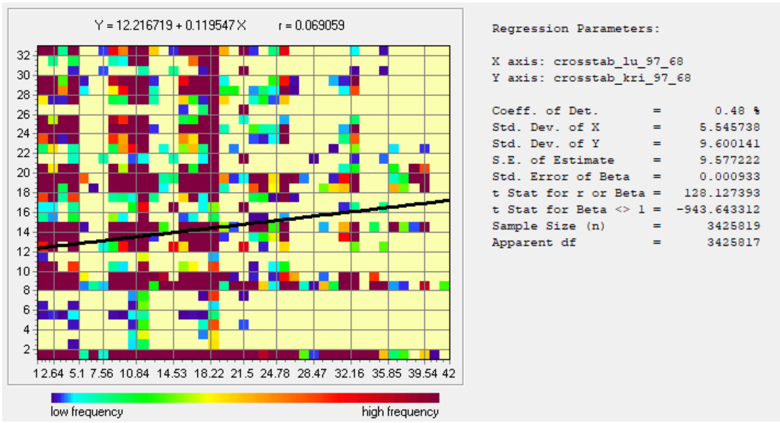

Fig. 10. Relationship between land use changes and groundwater depth changes based on the REGRESS method during 1989–2018 studied in the Razan plain; source: own study

CONCLUSIONS

Evaluating the relationship between land use changes and groundwater level fluctuations in the forbidden plains at the Kabudrahang and Razan Plains can be very useful in managing, planning and making policy for low-water areas. Therefore, land use maps were extracted using 29-year time-series techniques and categorized into six irrigated agricultural, non-irrigation lands, man-made, barren, orchards and salt-marsh uses. Then, distributing, changing, and converting the land use classes in the area were considered, along with groundwater depth distribution mapping in different periods. Finally, the relationship between these two variables was evaluated. The results indicated that climate change and precipitation decrease were not considered in these areas. In addition, there is a relative correlation between land use changes and quantitative groundwater changes in the study plains. These correlations indicate that managerial factors and managers' policies, along with land use changes, can play an important role, the most prominent example of which is constructing the Shahid Mofatteh Hydroelectric Power Plant. Other factors such as the region's agricultural economy and people's dependence on agriculture, especially cultivating high-water crops such as potatoes and watermelons, should be highlighted. The results of the present study are in line with those obtained by MISHRA *et al.* [2014], TAGHIPOUR JAVI [2012], and NASROLLAHI *et al.* [2014]. However, the findings of the present study indicate that developing agricultural lands, man-made areas, and consequently declining the rangelands, is directly related to the decrease in the depth of groundwater. Therefore, remote sensing techniques and GIS, along with spatiotemporal correlation assessment methods, can facilitate and enhance managing and monitoring groundwater programs. This claim is supported by using remote sensing techniques and GIS along with regression analysis-based statistical models in this study and its acceptable results.

The results of this study can be used to select priority sites for land use and groundwater managements because disregarding groundwater considerations in land use change decisions and generally land management can have long-term consequences and costs based on drinking water security and sustainability of aquatic ecosystems, occupational safety of residents, widespread migration and national security in the forbidden plains. In contrast, managerial measures regarding the relationship between land and groundwater uses can provide more benefits to groundwater resources at a relatively proportionate cost in the area and prevent these issues, especially public dissatisfaction and security issues.

By considering the above results, the following suggestions can be made as follows:
- organizing and planning toward modern agriculture with an emphasis on low water consumption,
- organizing the pattern of cultivation and preventing cultivating agroforestry products such as potatoes and watermelons,
- preventing the destruction of rangelands and their conversion to non-irrigation lands,
- updating Shahid Mofatteh Hydroelectric Power Plant by focusing on optimizing water consumption.

ACKNOWLEDGMENTS

The present article is derived from the doctoral thesis entitled "The Cross-functional of Spatial Structure Changes and Water Resources (Case Study: Hamedan, Razan and Kaboodrahang areas)".

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