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Application of Quality Method for Qualitative Flood Analysis in Flood Irrigation Case Study North Uremia Lake Flood

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1-Introduction

The common method of supplying water for agricultural purposes is flood irrigation used in semi-dry areas from past times. Flood utilization has long been one of the common water supply methods among farmers in dry areas of the world due to inaccessibility to sustainable surface or underground water resources. In North America, Indians have used simple flood irrigation methods for centuries (Hudson, 1975). The studied area is located at 110km from the center of the province, north of Uremia Lake and the drainage basin surrounding Tasoj city at 45°18' to 45°33' eastern longitude 38°20' to 38°24' northern latitude. The area includes ten sub-basins overlooking the city of Tasuj and the villages of Angashtjan and Amstajan, and its area is 9616.79 ha. The average height of the area is 1700m with an average rain of 271mm in 20 years and an average annual temperature of 13.4°C. The region is climatically affected by polar air from the north, polar sea from the northwest, tropical climate from the south. The region's climate is cold semi-arid, and the rainfall regime is in the Mediterranean. The main feature of this regime is intense rainfall, spring rainfalls, and intense snowing in winters, along with several months of drought in summer and late spring. The land use of this region includes farming gardens 938ha, irrigated aquaculture 2050ha, and dry farming 420ha. The cultivation pattern of farms and gardens mostly includes apple, walnut, Elaeagnus Angustifolia, almond, cherries and alfalfa, wheat, barley, and chickpeas that are the farming lands with aridity problems. Angoshtjan and Amstejan ponds and watersheds have two U.R.F upper Miocene geologic formations and the equivalent formations of Qom with marl, limestone, and sandstone deposits that produce high sedimentary floods (Habibzadeh, 2018). One of the main objectives of flood distribution projects is the improvement of the status of natural resources in flooding plains on the alluvial fans of the outflow of the problematic

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watershed, the storage of precipitation, supply of underground sources, supply of required water for crop and farming, quantitative and qualitative changes of vegetation, changes in plant composition and increase of plants for feeding and increase of soil fertility. Lashanizand et al. (2010) studied the changes in surface water quality of Kashkan basin due to periods of water scarcity and watery and for this purpose, 12 parameters of water quality and discharge statistics of eight hydrometric stations in 30 years and concluded qualitative changes from The ascending and descending trends follow the periods of watery and aridity. The purpose of this study, while presenting a qualitative analytical method of floods, is to use floods in agricultural water supply in the agricultural plains north of Lake Urmia.

2-Methodology

The research project investigating the effects of incoming flood quality on flood spreading performance was carried out by the author to create model areas for flood exploitation for agriculture, promotion, and development of flood distribution systems in arid and semi-arid regions. Samplers were installed along the flood paths of the Angoshtjan and Amstejan sub-basins at the entrance of the plain and in three locations of impoundment system, above and below these systems with gages. After the installation of samplers, the flood sampling was done to this end, sampling was performed three times in 2011, two times in 2012 and one time in 2014; the number of samples to be taken was determined based on the flood discharge and the height of samplers and sent to the laboratory for analysis. The results related to the differentiation of the sampling location have been classified using Model and Wilcox diagram (Habibzadeh, 2017).

3-Results and Discussion

The main limitation in agriculture, especially in arid and semi-arid regions, is the supply of water needs. In such areas, water is the basis for planning for agricultural development. Every year, much water flows out of reach in the form of runoff or floods and causes much damage to agricultural lands, residential lands, and roads (Mesbah and Negahdar, 2015). According to the purpose of the research, it was necessary to prepare information about the amount of rainfall and floods in the region. For this purpose, the amount of flood extraction was calculated and collected based on 20-year statistics of rainfall and floods in the region. The average monthly rainfall and flood storage are shown in Table 1. Flood samples were sent to the laboratory for qualitative analysis during six floods over three years. Laboratory analyzes including salinity, acidity, anions, and flood cations were performed. The lowest salinity, or EC, is related to the flood of the Amstajan river with 345 µm /cm, and the highest is related to the flood of the Angoshtjan river with 799µm / cm.

Table (1): Average monthly flood rate in Tasuj study catchments (2000-2020)

Month	Precipitation mm	Flood storage m3	Flood %
April	39.6	53054.0	39.1
May	51.7	51005.2	37.6
June	13.8	2875.0	2.1
July	6.4	865.7	0.6
August	4.1	1432.7	1.1
September	9.3	28.6	0.0
October	11.7	2134.2	1.6
November	35.5	5432.1	4.0
December	25.4	0.0	0.0
January	14.2	0.0	0.0
February	28.2	0.0	0.0
March	29.6	18698.7	13.8
	269.5	135526.2	100.0

4-Conclusions

In this project, to access the 2.5 million m3 outflow flood of Amstejan and Angoshtjan villages, the qualitative analyses of flood samples have been done based on Wilcox, Piper, and Stiff hydro-chemical diagrams. The mean electric conductivity in Amstejan sub-basin floods is 350mho/cm, and for Angoshtjan, the sub-basin is 600 mho/cm. The floods have relatively alkali acidity or neutral. The highest values, 8.06 and 8.04, are related to the inflow flood of the reservoir of flood collection. The quality of floods in terms of irrigation water classification of Wilcox method, where salinity and sodium rate are the most important criteria, is mostly in the C2S1 area. In terms of classification of irrigation water, C2, water with medium salinity that can be used for plants with medium tolerance to salinity, S1 is low sodium water which is good for irrigation of all types of soils and is not risky; therefore, they are good waters for agricultural purposes.

Keywords: Agricultural water, Flood, Qualitative analyses, Tasuj, Uremia Lake.

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Evaluation of Changes in Groundwater Storage by Combining GRACE Satellite Data and GLDAS Hydrological Model of Arid and Semi-arid Areas Case Study: Ravansar Aquifer in Kermanshah Province

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1-Introduction

The climate across most of the Middle East is hot and arid. Water scarcity has long been a serious problem in the region; therefore it has been a particularly challenging issue since the onset of a drought period that began in 2007. In many cases, groundwater resources are nonrenewable, and monitoring their utilization rates is important for planning purposes. Therefore, determining groundwater changes in Iran, which is located in an arid to semi-arid region, is of particular importance. In this regard, Kermanshah province with 950,000 hectares of agricultural land and gardens is one of the agricultural hubs of the country and the groundwater level drawdown in its aquifers, especially in the eastern part of the province is more severe.

2-Methodology

In this study, the current situation of the region has been investigated by examining the groundwater level of observation wells in the Ravansar aquifer and also the spatial zoning of these changes using the Kriging method in GIS software.

In order to evaluate the Gravity Recovery and Climate Experiment satellite (GRACE) data with JPL, GFS, CSR, CRI algorithms, coding in Google Earth Engine cloud computing environment has been used.

In addition, monthly and annual changes of Liquid water equivalent (LWE) were calculated. Meanwhile, the amount of soil moisture (SM) was estimated from the Global Land Data Assimilation System (GLDAS) hydrological model. It should be mentioned that the amount of groundwater storage changes -compared to its observational values- was obtained by subtracting the amount of soil moisture from the estimated values of GRACE satellites.

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3-Results and Discussion

This study showed that GRACE satellite data can provide valuable results for evaluating changes in groundwater storage in different regions. In the present study, the study of different GRACE satellite algorithms showed that the JPL algorithm with a correlation coefficient of 0.73 and error criteria of RMSE =3.17 and MAE = 2.11 has acceptable accuracy. Moreover, the trend of decreasing water resources of Ravansar aquifer has been acquired up to -1.8 cm. it should be mentioned that all the calculations were made on the scale of one square degree and units were expressed in centimeters.

4-Conclusion

The results showed that GRACE satellite shows groundwater storage changes accompanied by GLDAS model.

Keywords: GLDAS, GRACE satellite, Kiriging, Liquid Water Equivalent, Ravansar Aquifer and Iran.

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Investigation of Land Use Changes in Zarrineh Rud Catchment and Its Effect on soil Erosion Using WLC Model

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1-Introduction

Vegetation percentage is one of the most important and undeniable factors in the quantitative study and analysis of terrestrial plants (Zhang et al., 2003).As the amount of vegetation increases, the rate of soil erosion decreases (Alol et al., 1976).Vegetation parameter reduces soil erosion by protecting the soil against impact and rainfall, increasing the permeability of water to the soil, reducing the flow rate of surface runoff and improving the physical, biological, chemical and biological properties of the soil (believe , 1956).In addition, it can be said that the genus and type of plant during the winter, especially in agricultural lands, strongly affects the amount of soil erosion and water quality (Dabni et al., 2001).The phenomenon of soil erosion limits the structure and dispersion of land use changes (Lee, 2011). This activity will lead to challenges and tensions between humans and the earth's resources. Soil erosion is post-feed that depends on factors such as land use, vegetation, climate, topography and chemical, and physical properties of the soil (Zhao et al., 2017).

Purpose and method: The purpose of this study is to investigate land use changes in Zarrineh Rud catchment located in Shahin Dej city using object-oriented classification process for 2000 and 2018 and also to produce soil erosion map for these two years using WLC method. First, the images used by the US Geological Survey (USGS) were prepared after the images of radiometric and atmospheric corrections in ENVI software were applied to the images, then to extract the land use map of the study area by object-oriented method using the nearest algorithm. Neighbor was used in Ecognition developer software environment.

Finally, two indicators of kappa coefficient and overall accuracy were used to evaluate the produced maps. But to prepare the soil map, EDRISI SELVA software was used and with the help of WLC algorithm, which is one of the multi-criteria decision making methods. First, we prepare the desired layers including distance from communication

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roads, land use, geology, slope, distance from waterway and rainfall, then we standardize these layers and weigh each layer based on the situation of the region. Finally, Arc Gis 10.6 software was used to calculate the area and obtain the output of the maps.

2-Methodology

First, we standardize each of the layers in question. In the present study, the fuzzy logic method of standardization of maps was used.

In the fuzzy model, the maximum value of 1 is assigned to the highest membership and the minimum value of 0 is assigned to the lowest member in the set (Sui, 1999).After standardization, the standard weight maps of each factor were determined. Thus, directly, the weight is relative Awarded to each of the benchmark maps. Critical weighting method was used. In this technique, information is examined and analyzed based on the values of interference and contradiction between all criteria. Which is expressed in the context of a membership function. Each of the vectors formed for the factors that can be used have statistical parameters such as standard deviation. After estimating and calculating the standard deviation of the factors and factors in question, it is created in the form of different matrices in the form of M*M. Which includes the correlation coefficient between the formed vectors by specifying the specified factors,).By determining the above parameters, the contrast between criterion j and other criteria was calculated from Equation 4.

Relationship (4) $cj=8j\sum_{k-1}^{m}(1-rjk)$

3-Results and Discussion

The results of the classification showed that during the 18 years of land use, the average rangeland land use has decreased the most. This area reduction is equal to 30.93%. But the user who has had the most increase among all users in the interval of 18 years It is used for rainfed and irrigated cultivation because it leads to the destruction of pasture and barren lands by increasing the population. According to the results obtained from soil erosion zoning maps using WLC algorithm for 2000 and 2019, the study area can be expressed. High-risk and high-risk areas are in dryland, irrigated medium rangeland and residential areas. One of the most important factors of soil erosion in Zarrineh river basin can be the reduction of rangelands (rich, medium and low density)Because with the loss of natural vegetation will lead to a decrease in soil resistance on the one hand and on the other hand will increase the rate of soil erosion and consequently sedimentation 4-Conclusions

With the loss of vegetation in the Zarrineh River Basin, it has led to an increase in soil

erosion in 2018 compared to 2000.In addition, this type of land use change in the region and the conversion of pastures into rainfed and irrigated lands leads to an insignificant reduction in the amount of groundwater aquifers. This type of events in the future will cause harmful and destructive effects on the ecosystem of the study area. Therefore, as the results of this study and the research of other researchers show in addition to reducing the region's vulnerability to natural disasters and hazards, land use optimization leads to an increase in environmental sustainability. In this regard, the study of land use changes will be one of the first studies to study the stability of the regions.

Keywords: WLC method, Object-oriented classification, Landsat, land use, Zarrineh river catchment.

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Research Paper

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Evaluation of Meta-heuristics Hybrid Models for the River Flow Simulation Case Study: The River Kashkan, Lorestan, Iran

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1-Introduction

Predicting the river flow is one of the most important issues relating to effective management of water resources, especially during the flood and drought. Although there are several hydrological methods to predict flow of rivers, intelligent models are more efficient. In this study, daily data obtained from the Kashkan basin in Lorestan, Iran was used to evaluate the accuracy of the models. Furthermore, in order to simulate its daily flow, three models were applied, including vector-wavelet regression, support vector-regression-gray wolf and support vector-regression-bat. Then the results were compared for accuracy. Each of the models has been often used to predict daily discharge of different rivers in previous studies. However, the present research aimed to examine them simultaneously in the same basin to predict the daily flow of the River kashkan.

2-Method

In this study, the River Kashkan in Lorestan, Iran was selected as the studied region and data relating to its daily flow recorded in the Poldakhtar Hydrometric Station was used to calibrate and validate the models. To this end, first 80% of data concerning the daily flow of the river (2018-2020) was used to calibrate the models and the rest were applied for validation. Support vector machines are an efficient learning system based on the theory of constrained optimization using the inductive principle of structural error minimization in order to achieve a general optimal solution. Wavelet transform is an alternative to short-time Fourier transform, and aims to overcome problems related to frequency resolution in short- time Fourier transforms. In a wavelet transform, namely a short-time Fourier transform, the signal is split into windows, and so the wavelet transform is performed on each of these windows one by one. The Gray Wolf Optimizer (GWO) refers to a meta-heuristics optimizer inspired by the hierarchical structure and social behavior of gray wolves during hunting. This population-based optimizer has a simple process which can be easily generalized to a large scale. The Bat Algorithm (BA) is a metacognitive

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algorithm inspired by the collective behavior of bats in the environment and was introduced by Yang in 2010. It is based on the sound echoed back by bats. To put it simply, bats find the exact position of the prey by sending sound waves and receiving echoes. When sound waves return beck to the transmitter (bat), it draws an acoustic image of the obstacles up ahead, and thanks to this ability bats can see well even in complete darkness.

3-Results and discussion

The results suggest that all three models in a structure consisting of 1 to 4 time delays showed better performance than other models. Moreover, R = 0.960, RMSE = 0.045, MAE = 0.024, NS = 0.968, and PBIAS =0.001 obtained from validation of the wavelet-support vector machine.

4-Conclusion

Taken together, these results suggest that increasing the number of effective parameters in different models for simulation improves performance on evaluating the daily flow of the river. In addition, the support vector-wavelet regression delivered better performance among others.

Keywords: River flow, Simulation, Hybrid model, Kashkan-Lorestan.

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Assessment of Groundwater Vulnerability to Pollution Using DRASTIC Model and Fuzzy Logic Case Study: Tabriz Plain

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1-Introduction

Groundwater aquifers are considered one of the most important freshwater sources globally. Urbanization, industrialization, improper use of fertilizers and pesticides in agriculture, illegal sewage disposal, and population growth are the most important problematic factors for groundwater. Protecting groundwater quality, especially in growing urban areas, is an important issue because, on the one hand, it is the main source of water for drinking and industrial activities, and on the other hand, the cost of reducing groundwater pollutants is high. It takes much time. Therefore, using the most appropriate hydrogeological systems and models is necessary to protect groundwater quality. Groundwater aquifer vulnerability assessment can be used as a preventive action to protect the aquifer against contamination. Tabriz plain is one of the large plains in the northwest of the country, which has been feeding large aquifers for a long time with its large aquifers, and its vast fields have fed many gardens of this aquifer throughout history. From groundwater and pollution of aquifers, it is necessary to study the vulnerable areas of this plain. Since the extent of this vulnerability depends on climatic conditions, soil characteristics, topography, hydrogeological conditions, and countless other factors, these factors have been resorted to in the study of aquifer vulnerability. And water table (D), net nutrition (R), aquifer environment (A), soil type (S), topography (T), the effect of the unsaturated zone (I), and hydraulic conductivity of the aquifer (C), all of which in the studies Is taken into consideration

2-Methodology

In this research, the Darstik method has been used to investigate the vulnerability of the aquifers of Tabriz plain. In this method, a ranking of seven parameters has been used to prepare the vulnerability map. To use the Drastik method, various information sources,

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including Meteorological statistics, information on drilling logs of piezometric wells, pumping tests results, region DEM, geological and soil maps prepared by the regional water companies, and the Geological Survey have been used. The layers are first referenced to prepare the maps, and all the information is converted to an acceptable format for ARC GIS software. In this study, the water table depth is considered, and the water table information is taken from the data of piezometric wells in the Tabriz plain aquifer from the regional water organization. The average aquifer water level from 95 wells for four months since 1997 (May, July, November, March) has been obtained. The generalized unknown and the map obtained from this method are classified according to the Aller ranking of the table. The DRASTIC index is based on seven input data and consists of three parts: weight, range, and rank. Each of these components is given a weight of 1 to 5 based on their importance in vulnerability, which is the most important. The weight parameter is given as five and the minimum weight as 1. Also, each of the seven parameters of this method is divided into important and effective intervals in the contamination potential. Finally, rank is used to evaluate the relative value of these intervals. Ratings range from 1 to 10. The result of using this method is to obtain a numerical index ($D_¡$) which is obtained from the sum of the product of weight (w) and rank (R) of all seven parameters. After ranking all the parameters used according to the table In Arc Map software, the final vulnerability can be obtained using equation (1) below the map.

DRASTIC index = Dr*Dw + Rr*Rw + Ar*Aw + Sr*Sw + Tr*Tw + Ir*Iw + Cr*Cw

Finally, to investigate the groundwater quality of Tabriz plain, ten parameters K, Na, Mg, ca, so4, CL, Hco3, TDS, Ec, TH from wells located in the plain collected by the Regional Water Organization used. There are various methods for analyzing the accuracy of the results. In this study, the one-parameter sensitivity analysis method has been used. The result shows the statistical results obtained from the one-parameter sensitivity analysis on the depth and effect parameter of the water table. An unsaturated area is the most effective indicator in assessing the potential of vulnerability. Then net feeding, aquifer environment, and topography also had the greatest impact on the model.

3-Results and Discussion

The result shows the statistical results obtained from the one-parameter sensitivity analysis on the depth and effect parameter of the water table. The unsaturated area is the most effective indicator in assessing the potential of vulnerability, and then net feeding, aquifer environment, and topography also had the greatest impact on the model. In this study, the fuzzy method was used to investigate the vulnerability of the Tabriz plain aquifer more accurately. Considering that each of the seven parameters used has different

scales, before overlapping the layers, a raster map of each was prepared, and then in fuzzy functions, these maps were also scaled and given to each pixel. Values were given between zero and one. The result shows that the lowest vulnerability potential belongs to the southeastern areas of the plain (Sahand Mountains); the northwestern, southwestern areas, and parts of the center of the plain (located in Tabriz) have the highest vulnerability potential. According to the drawing map, about half of the plain (47%) has a high capacity for groundwater vulnerability. In this research, quality maps have been drawn using the GQI index. The information of these maps shows that the concentration of parameters is higher in the northwestern and southwestern parts than in other parts of the aquifer. The components Tds, Th, Ec, have the highest weight and have been identified as the most important factor in reducing the quality of drinking water.

4-Conclusions

Groundwater near large cities is very vulnerable. The large population of these cities, while in dire need of these aquifers, their pollution limits the possibility of using high-quality water. Tabriz plain, including the plain In this study, to evaluate the pollution potential of the Tabriz plain aquifer, the DRASTIC and fuzzy methods were used in the GIS software environment, taking into account parameters such as depth to the water table net feeding. Aquifer environment, soil environment, topography, unsaturation zone, and hydraulic conductivity were evaluated. The results of evaluations and analyzes showed that 5.78, 14.91, 32.02, 27.63, 19.43, and 0.20% of the aquifer, according to the vulnerability classification table, have the potential of vulnerability without risk of contamination, very low, low to medium, medium to high, respectively.

Furthermore, 59% of Tabriz plain was in low and low to medium classes, the most potential related to the northwestern to southwestern regions. The most important reasons are the low water level in these areas, and it is also high in hydraulic conductivity and unsaturated environment. In addition to the Darst method, the fuzzy method was also used. The results of the method showed that the lowest amount of pollution potential is related to the southeastern regions of the plain (Sahand Mountains), and the highest values are allocated to the northwest and southwest as well as parts of the center of the plain (Tabriz) According to the modeling, 47% of the total area of the plain is highly vulnerable, which is very consistent with the result of the DRASTIC method. But because the DRASTIC method ignores the boundaries, for this reason, in the fuzzy model, zoning is done more accurately

Keywords: DRASTIC model, Fuzzy logic, GQI water quality index, WHO global standard, Sensitivity analysis, Tabriz plain

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Examining the Relationship between Hydrogeomorphic Variables and Sediment in Gavi and Kanjancham Basins of Ilam Province

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1-Introduction

Knowledge of the hydrogeomorphic characteristics of the watershed basin concerning the production of sediment and its levels at the hydrometric station to manage the basin can pave the way for a sustainable development. It is estimated that around 0.5 to 1 percent of the world's dam storage capacity is declining on an annual basis owing to sediment deposition (Khanchoul et al., 2010: 246). Geomorphic characteristics of the watershed basins refer to a set of physical factors whose values are relatively constant for each basin as they show the apparent form of the watershed basin (Abdideh et al., 2011: 33). In view of the importance of Kanjancham and Gavi basins, their sub-basins and the dams in Ilam province on which three cities of Ilam, Arkavaz Malekshahi and Mehran as well as hundreds of villages are dependent, this study aimed to review the variables affecting sediment production and sediment load in Kanjancham and Gavi basins. By considering regional data, it seems that some geomorphic parameters greatly contribute to sediment production and load at the sub-basins. Thus, this study aimed to estimate the sediment production taking into account the geomorphic characteristics of the sub-basins of Kanjancham, Rostam Abad, Tang-e-Bajak, Asan and Sarjouy with high potential of sediment production. The use of principal components analysis methods along with cluster analysis and stepwise multivariate regression provides accurate statistical, scientific and computational accuracy. However, this mixed method yields slightly better quantitative accuracy compared to the sediment estimation models as this method can, in combination with the variables and factors affecting the sediment estimation, be an innovative one while also being applicable in research on other basins. The present

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research also highlights sub-basins with high potential of sediment production as future policies and planning are required for further necessary measures.

2-Methodology

Two Gavi and Kanjancham basins in Ilam province, covering 8 specific sub-basins equipped with hydrometric stations were selected. Research data included observational data of sediment discharge of the hydrometric stations from 1986 to 2020 as dependent variables which were analyzed using the sediment rating curve. In the next stage, the homogeneity of watershed basins was evaluated using cluster analysis. The cluster analysis standardizes the data by Z-Score method, group them by cumulative class method and calculates the Euclidean distance using the Ward's method. Then, the sub-basins of Chaviz, Sarjouy, Emamlekshahi and Asan were analyzed in the first group while Kanjancham, Rostamabad, Tang-e-Bajak and Gonbad in the second group. Stepwise multivariate regression method was used to analyze the relationship between 20 independent geomorphic variables of the basin (area, circumference, slope, rainfall, minimum height, average height, maximum height, length, form factor, form index, compactness coefficient, elongation ratio, roundness ratio, lemniscate ratio, mean elevation-relief and elevation-relief ratio, drainage texture, bifurcation index, relative elevation-relief and roughness of the basin) and the sediment of each sub-basin.

3-Results and Discussion

By considering the correlation matrix of the variables, it was noted that such variables as slope, roundness ratio, rainfall, drainage texture, area, circumference, basin form, and basin roughness had higher correlation with sediment production in the basin than other variables.

Table (1): Correlation between geomorphic variables affecting suspended sediment in the studied sub-basins

Independent variables		Pearson correlation	Sig.
X1	Area	0.723	0.003
X2	Circumference	0.742	0.003
X3	slope	0.815	0.001
X4	Rainfall	0.779	0.001
X10	Basin form index	0.714	0.003
X13	Roundness ratio	0.820	0.001
X17	Drainage texture	0.785	0.001
X20	Basin roughness	0.664	0.004

A specific value is used to determine the number of factors. The minimum eigenvalue for selecting the final factors is one, and factors with a specific value greater than one are considered final factors. The results show that the three factors of roundness coefficient, slope coefficient and drainage texture coefficient of the basin have a specific value of more than one.

Table (2): Cumulative variance percentage and eigenvalues of different factors

Initial special values	
Percentage of variance	Components
Roundness ratio	44.62
slope	25.22
Drainage texture	16.74

4-Conclusions

The results of examining the relationship between geomorphic characteristics and sub-basins sediment revealed that the level of sediment produced was positively correlated with slope, roundness ratio, drainage texture, rainfall, roughness and area of the basin and was significant at 0.001. Principal component analysis and cluster analysis were used to determine the effects of the variables on the sub-basins' sediment levels. The results indicated that the three factors of roundness ratio, slope coefficient and drainage texture coefficient of the basin explained 44.62, 25.22 and 16.74% of the variance of all research variables, respectively. In sum, the three final extracted factors could explain 87% of the variance of all research variables.

Keywords: Cluster analysis, Multivariate regression, Sediment rating curve, Hydro geomorphic, Gavi and Kanjancham basins, Ilam province.

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Investigation of Hydrogeochemical Characteristics of Hajilarchai Basin and Origin of Trace Elements

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1-Introduction

Water resources are vital to living things because of their essential. Therefore, the issue of water pollution is of special importance. The type and concentration of major elements, sub-elements, and trace elements in water depend on aspects e.g. geographical conditions, the availability of rock and soil elements, the origin of rocks and soil in contact with water, and dissolution reactions between rock and water. Contaminants of surface and groundwater resources of natural or geogenic origin may be caused by volcanic activity, natural rock erosion, or anthropogenic activities for instance agriculture, animal feed, mining, and the entry of municipal and industrial wastewater. Beyond the amount of elements of the standards is known as pollution. Some metals (copper, iron, zinc) are essential in small amounts for living organisms, and their deficiency interferes with the body's normal functioning, but is toxic in large quantities, leading to organ damage and poisoning. Trace elements can enter plant and animal tissues through water contact with soil and eventually into the food chain .

Mining, mineral processing, and metallurgical extraction are the three main activities of the gold mining industries that can produce waste. Metallurgical extraction breaks the crystallographic bonds in the ore mineral to recover the desired element or compound. Large amounts of waste may be generated during this activity. Especially in gold mines that release more than 99% of the extracted ore as waste in the environment.

Cyanide used in gold mines is another significant environmental concern. Cyanide is a group of nitriles composed of carbon and nitrogen and is found naturally in some fruits e.g. most bitter seeds, apple seeds, peach kernels, plums, bitter almonds, bamboo shoots, and cassava roots. Cyanide products are used in various industries such as gold and silver

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mines and metallurgical plants. Cyanide ions can enter the environment through wastewater and pollute soil, air, and water sources, which are of great importance due to their high toxicity. Current studies have studied aspects of cyanide behavior in environmental considerations in gold-related mineral processing operations. In the discharge of cyanide solution into the environment, the cyanide concentration is naturally reduced by various mechanisms such as complexation, volatilization, sulfidation, adsorption, precipitation, and biological conversion.

The emission rates of these metals and cyanide compounds have increased in the twentieth century due to the development of mining activities. As the emission of these metals increases, their impact on the lives of plants and animals has enhanced. Therefore, in recent studies, the origin of elements and compounds affected by the mining and industrial activities in water has been investigated to determine the extent of emissions from anthropogenic and geogenic sources and their fate. The present paper examines the hydrochemical properties of the area and then uses multivariate statistical techniques to identify possible sources of elements.

2-Methodology

2-1-Hydrogeological, geological characteristics of the Study

The study area is located in East Azerbaijan province, in the north of Tabriz and the western part of Varzeqan city and with an approximate distance of 26 km from Varzeqan. The study area consists of 5 sub-basins of Goy Chai, Boyerk Chai, Miverood, Eri Chai, and Hajilarchai, which finally join the Aras River and flow into the Caspian Sea. Due to the location of the Zarrin Dagh Astarcan Gold Factory in the mountainous lands of the basin, with relatively sharp topographic conditions, there is a possibility that the factory will affect the catchment area. According to the Emberger method, the region is known as a semi-arid and cold climate with an average annual temperature of 10.06 ° C. The study area is located in the division of tectonic-sedimentary units of Iran in the Alborz-Azerbaijan zone. The zone of Azerbaijan is covered with Mesozoic to Quaternary sediments, Tertiary-Quaternary volcanic zone, Neogene-Quaternary Intermountain basins. The oldest rock units found in this basin are related to limestone, sand, and Paleozoic shales of the Devonian and Carboniferous periods of Qarahdag Mountain.

In this study, graphic methods such as Piper and Steve diagrams and multivariate statistical methods were used to investigate the hydrochemical properties of water resources to find the source of existing abnormalities. Piper and Stiff diagrams are used to determine the chemical characteristics and source rock of the elements, respectively. Factor analysis and cluster analysis are the most common multivariate statistical techniques used to detect source trace elements and their relationship patterns.

3-Results and Discussion

The location of the samples in the piper diagram shows that the types of water studied are calcium and bicarbonate with temporary hardness except for sample 10. The predominant type of sample 10 is mixing. Stiff diagrams were used to determine the origin of water samples. Based on the stiff diagram drawn for sampling and matching pattern samples, samples 1, 2, 3, 4, 5, 6, 7, and 8 have limestone origin, sample 9 has an igneous origin, and samples 10 and 11 have the origin of limestone. The reason for the high chloride in samples 10 and 11 obtained from factory piezometers is probably the use of calcium hypochlorite in soil treatment activities .

The factor analysis method has been used to determine the factors affecting the water quality of the Hajilarchai basin. Four main factors for the hydrochemical process were identified in the study area. The first factor that is more effective on water quality includes potassium, calcium, parameters of sodium, magnesium, bicarbonate, chlorine, sulfate, barium, EC, cobalt, lead, zinc, nickel with a positive factor loading and pH, with a negative factor loading. This factor reflects the general trend of water and the effect of evaporitic and saline formations. The high factor loads of the trace elements cobalt, nickel, lead, zinc, and bromide shows that these metals are of geogenic origin. The second factor includes nitrate, ammonium, and fluoride with a high operating load. The presence of the nitrate parameter shows the anthropogenic origin of this factor. The third factor includes cyanide and copper. The fourth factor includes manganese with a positive factor loading and arsenic with a negative factor loading. These two factors seem to be of geogenic origin.

Hierarchical clustering (HC) was used to classify the data. HC analysis was conducted once for the parameters and once for the samples. The samples were split into three categories, the first and third clusters representing the origin of geogenic and the second one representing anthropogenic activities. The parameters were divided into two clusters and five sub-clusters. The parameters in each sub-cluster indicate their common origin and high correlation.

4-Conclusions

The results of this study showed that the watercourse of the study area has high amounts of calcium and bicarbonate. It was also found that lithology plays a major role in hydrochemistry and water quality. The outcomes of multivariate statistical analysis indicate the impact of geological formations and anthropogenic activities on watercourses in the region. The origin of trace element concentrations in water sources was identified using factor and hierarchical cluster analysis methods. The effect of anthropogenic activities is also visible in the basin.

Keywords: hydro chemistry, multivariate statistical analysis, trace elements, Hajilar Chai Basin, Northwest of Iran

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Simulation of Marvdasht Groundwater Level and Investigation of Forecast Scenarios Using MODFLOW Mathematical Code

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1-Introduction

This study is one of the first studies on spatial modeling of water quality parameters with geological formations in the basin. Groundwater is the most important water source in many parts of the world, used in drinking water, agriculture, industry, and related ecosystems.

2-Methodology

Marvdasht-Kharameh aquifer is located in the Bakhtegan Lake catchment area, one of Iran's important water sources. Hydrologically, in this basin, the Kor River is a main and permanent river that originates from the northwestern heights of the basin, its length to Bakhtegan Lake is 351.5 km, and the area of Ker aquifer is 1470.540 km2.

In the present study, data and information from the study area, such as exploitation and observation data, including data related to 81 exploration wells and 7500 exploitation wells, were collected from Fars Water Resources Management Organization (Fars Water Organization Statistics, 2019). This equation is given as (Equation 1) in unstable, inhomogeneous, and three-dimensional conditions.

$$T_{XX}\frac{\partial^2 h}{\partial x^2} + T_{YY}\frac{\partial^2 h}{\partial y^2} + T_{zz}\frac{\partial^2 h}{\partial z^2} = S\frac{\partial h}{\partial t} \pm R\,(x, y, z) \quad (1)$$

In this equation, h : height of the hydraulic load; ((x, y, z: flow directions; t: time; [T]: Tzz, Tyy, Txx; aquifer transfer coefficients in the directions (x, y, z); S is the storage coefficient; R (x, y, z): Power supply (positive sign (or discharge) is a negative sign.

After entering all the required data of the model and implementing the groundwater flow model for the period 2008-2019, the hydraulic conductivity, feed values , and coefficient of conductivity of riverbeds and drains were selected as calibration parameters by changing them within the allowable range of final values. For calibration operations in

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unstable conditions, 70% and 30% calibration of piezometric data was used during ten-year periods. Subsequently, the validation of the calibrated model in long-term 126-month data was evaluated based on the height of the hydraulic load values. Moreover, it is calculated according to the groundwater level and the water level in the river. 10 and 30% over the next ten years, the model was fitted.

3-Results and Discussion

The simulation of groundwater level reduction in the Marvdasht-Kharameh basin showed that this model with high spatial variability power well determines the effect of different parameters on groundwater level in different parts of the aquifer.

The results of calculating the water balance in the Marvdasht aquifer, which was done for 126 months, indicate that the amount of 1100 million cubic meters of water has been reduced from the constant storage of the aquifer.

4-Conclusions

This study is one of the first studies on the simulation of the Marvdasht-Kharameh aquifer with the MODFLOW model in the basin. The model calibration results in both permanent and non-permanent states show that the middle parts of the plain, such as Ramjard and Band Amir Plains, have the highest hydraulic conductivity and special discharge values. The decrease of groundwater level in the central areas of the plain, especially in Shool, Band-e Amir, and Ramjard, is more than other parts of it due to the high concentration of exploitation wells and indicates that the crisis is progressing in this part of the basin. Therefore, the discharge of exploitation wells is one of the most fundamental elements affecting water level changes in the Marvdasht aquifer. Also, by examining the scenario of 10 and 30% reduction of groundwater abstraction from the region, it was determined that these scenarios would be the only housing to reduce the groundwater level in the region. The area should also be examined. The results showed that the highest drop is 24.83 meters in the first scenario, and the lowest drop is 2.184 meters. In the second scenario, the drop has decreased by 4.523, and the water level has reached 20.30 meters.

Keywords: Aquifer balance, management scenarios, groundwater level, Modflow model, Marvdasht basin – Kharameh.

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Estimation of Flood Hydrographs in Ungauged Qareh-Sou Watershed with Gamma Synthetic Unit Hydrograph Model

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1-Introduction

As one of the most common natural disasters, floods have affected communities worldwide. Hydrological and hydraulic investigation to estimate the maximum volume and flow rate of floodwater is one of the most important problems in the water structures design (Adib et al., 2010). Due to the lack of sufficient information to measure rainfall and runoff and the shortage of measuring stations in developing countries, synthetic unit hydrograph models to estimate the characteristics of river floods in basins without statistics are of interest to researchers. Based on the rapid development of computing technologies in the past few decades and the increasing need for flood forecasting in this field, various models have been proposed in flood estimation. Meanwhile, the Gamma model is more accurate than other models and has been less used and evaluated. This is especially noticeable in small basins. Due to the high cost of setting up measuring stations and their maintenance, these basins face the problem of lack of information and flood data. Many investigations have been performed in flood estimation using unit hydrograph models and synthetic unit hydrographs (Adib et al., 2011). A unit hydrograph model was developed to calculate the flood hydrograph resulting from the Effective Rainfall Hyetograph (ERH) of the watershed, widely used in applied hydrology (Eidipour et al., 2016). Based on the studies and the need for the country to use simple and appropriate hydrological models for flood prediction, it is necessary to independently select and apply the method of losses and base flow extraction and study its simultaneous effect on the shape of the flood hydrograph; the peak flows, the flood volume, the time to reach the peak flows, the flood flow, of flood and the time of the beginning of the flood and its end (Vartalska et al., 2002). A comparative study of these methods can lead to a preliminary result that has not yet been considered in the country. Therefore, considering the importance of the issue in this field, this study aims to introduce the Gamma synthetic unit and evaluate this model accuracy in estimating flood hydrographs in a basin without statistics in the west of the country.

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2-Materials and methods

2-1 Estimation of base flow and excess rainfall

2-1-1- Straight line method

The straight line is the simplest method for extracting base flow (Chow, 1988). Here, in a river hydrograph, a straight line is drawn from the flood starting point to the point where the flood ends. The part of the hydrograph above this line is called the direct runoff hydrograph. Fig. 2 shows a schematic of the used method.

2-1-2-Ø Method

The index of Ø was used to determine the excess rainfall height in this study. In this method, the direct runoff height is defined as RD. The following Equation was used to estimate Ø (Chow, 1988). By selecting a time interval of ΔT, estimating the number of M intervals of rainfall that joins the direct runoff, and subtracting the term of ØΔT from the measured rainfall at each interval time, the direct runoff was obtained.

In this equation:

RD = ∑(RM -ØΔT) RM: Largest precipitation pulse (mm), RD: Direct runoff (mm) , Ø: Fi index (mm/h), M: number of pulses in excess precipitation

2-2-Gamma Method

Calculating the Gamma synthetic unit hydrograph is easier and more accurate than other available methods. This model represents the empirical relationships to estimate the overall form required for the IUH by providing an accurate approximation.

2-2-1-Gamma distribution

The shapes of hydrographs often match closely with a two-parameter Gamma function, given by the following Equation $F(x)=\frac{x^{\alpha}e^{\frac{x}{\beta}}}{\beta^{\alpha+1}\Gamma(\alpha+1)}$

Where $0<x<\infty$ .The parameter α is a dimensionless shape factor (which must be greater than -1), and β is a positive scale factor having the same units as x controlling the base length in the products of α and β which in turn gives the value x, corresponding with the apex or maximum value of f(x). For α>1, the distribution has a single apex and several plots similar in shape of hydrograph (Croley, 1980). By determining α and β, the hydrograph peak value can be obtained from Equation.

3-Results and Discussion

According to the error criterion in estimating the peak flow, the Gamma synthetic unit hydrograph model has led to underestimating peak flows of the flood hydrograph in some events and overestimating peak flows of the flood hydrograph in other events so that both are relatively equal. According to the numbers provided for this criterion (as shown in Table 2), the error value in this field is quite limited. Evaluation of the criterion of error in estimating flood volume also shows that the behavior of the Gamma synthetic unit hydrograph model in overestimating and underestimating flood volume in the studied events is relatively balanced. However, it should be noted that the values provided for this criterion in modeling the basins without statistics are completely acceptable. According to the mean absolute error criterion, on average, there is a very limited error in estimating the values corresponding to the flood hydrograph observed by the Gamma synthetic unit hydrograph model in the studied events in this study. The mean bias error also shows that in five of the ten studied events, the observed hydrograph flows values are slightly higher than the corresponding computational values and slightly lower in the other five events. It shows the balanced behavior of the Gamma synthetic unit hydrograph model in this study. Kling-Gupta criteria and coefficient of explanation show the flood accuracy. These criteria in different events show the complete and appropriate accuracy of the Gamma synthetic unit hydrograph model for estimating flood hydrograph in the studied events in the Qareh-sou watershed.

4-Conclusions

The Gamma model has a high potential for estimating flood runoff in basins without statistics as a widely used model. With attention to the previous studies, there is only one method in most research to estimate the excess rainfall or the extraction of the base flow, and significant attention has not been paid to this method. The developed models feature for basins without statistics is that it can be used to estimate flood hydrograph using limited data and without considering the simultaneously recorded rainfall-runoff data. In the present study, flood modeling in the Qareh-sou watershed in Kermanshah province was investigated, and ten rainfall-runoff events were used to evaluate this model efficiency. Criteria such as peak flow error, flow volume error, mean absolute error value, mean bias error, explanation coefficient, and Kling-Gupta efficiency were used in this study to evaluate the simulation results.

Keywords: Gamma Model, Simulation, Flood Estimation, Qareh-Sou Watershed

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Evaluating the Efficiency of New Hybrid Artificial Intelligence Models to Estimate Flood Discharge Kashkan Basin

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1-Introduction

Human beings have long grappled with the problem of the flood as one of the natural phenomena. Iran is not the exception to the rule. Every year the country strikes by devastating floods that often cause heavy casualties due to its vast area, spatial and temporal changes in the rainfall pattern in most basins, and having different climates. Today, artificial intelligence systems, including artificial neural networks, are widely used as an effective way to simulate hydrological processes. They have some errors in the estimation of networks parameters (weights and biases) due to their trial-error nature. As a result, researchers have combined artificial intelligence systems with an optimization algorithm to moderate errors and improve their function.

In the present research, modern artificial intelligence models, including an innovative gunner, black widow spider, and hen swarm, were used to estimate flood discharge of the Kashkan catchment basin in Lorestan from 2011 to 2021.

2-Method

The Kashan catchment basin with an area of 66.97 square kilometers is in the southwest of Iran. It is the most flood-stricken river in Lorestan. It is a major tributary of the Karkhe River, covering almost one-third of this region. It is considered a part of the Persian Gulf catchment according to the Iranian hydrological division.

In recent years, artificial neural networks have been widely used in hydrological studies and water resources management. An artificial neural network normally consists of three layers including input, middle, and output. The input layer serves as a transmitter layer and provides data. The output layer includes the values predicted by the network. And the middle or hidden layer is composed of processor nodes in which data are processed.

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Artificial neural network

Today, artificial neural networks are widely used in hydrological studies and water resources management. The structure of the neural network usually consists of the input layer, the middle layer and the output layer. Input layer A transmitter layer and a means of providing data. The output layer contains the values predicted by the network and the middle or hidden layer, which consists of processor nodes, is the data processing site.

Innovative Gunner algorithm

The algorithm of the innovative gunner (AIG) is one of the state-of-the-art Meta-heuristic optimization algorithms proposed by Pijarski and Kasjko (2019). Having a powerful structure, the algorithm is expected to be widely used in various scientific and technological fields in the future. It is able to solve various optimization tasks in different fields such as mechanics and benchmark mathematical operations efficiently and fast. One of the many advantages of this algorithm is that it can find the most accurate solution in a short time and at the lowest cost due to it great convergence speed.

Black Widow Spider Algorithm

This algorithm was first proposed by Sebastian and Peter (2009). It is based on the survival of the superior or natural selection, so that the early spiders, in pairs, tried to reproduce the new generation, and the black widow ate the male during or after mating, then she carried his sperm stored in sperm cavities and finally released them into the egg sacs.

Chicken swarming algorithm

Chicken swarm optimization is a bio-inspired algorithm used for single-objective optimization. It was first proposed by Meng et al. It simulates the hierarchical order and behavior of a flock of hens when searching for food, so each hen represents a potential solution to an optimization problem.

Grasshopper Optimisation Algorithm

It was proposed by Saremi et al. (2017). Like other optimization algorithms, it tries to find the optimal solution among several ones. The proposed algorithm simulates the behavior presented in swarms of locusts for food search.

It is one of the latest meta-heuristic algorithms. It is categorized as a collective intelligence algorithm and emulates the social behavior of locusts as well as how each locust is affected by its surrounding environment. In this study, such statistical indices as the coefficient of determination (R2), mean absolute error (MAE), Nash-Sutcliffe

efficiency coefficient (NSE), and percentage of Bias were used to evaluate the simulation performance.

3-Results and discussion

The results showed that hybrid artificial intelligence models could improve the performance of the single model. Moreover, the combined artificial neural network-innovative gunner model illustrated more accuracy and less error than the artificial neural network-black widow spider, artificial neural network--chicken swarm, artificial neural network- Grasshopper Optimisation Algorithm, and single artificial neural network. The results also showed that the four models could estimate the flood discharge rate accurately.

4-Conclusion

This study supported the efficiency of the artificial neural network-innovative gunner model to estimate flood discharge. In addition, the results showed that this model works best to increase the development and implementation of strategies for surface water resources management. Therefore, it can be considered as an important step toward making decisions to improve the number of surface water resources.

Keywords: Innovative Gunner, Simulation, Artificial Intelligence, Southwest, Kashkan Basin.