Flood risk analysis using random forest machine learning method (Case study: Mashhad City)

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Abstract

Flood is one of the most common natural disasters that causes significant financial and human losses. Although rainfall is low in many parts of Iran, in some areas, the highest amount of annual rainfall occurs in just one day or a short period, leading to floods. Due to geological structure and ecosystem destruction, the surface water during floods can be highly polluted and often carries a lot of sediment, which increases flood damage. To reduce potential flood damage, planners and decision-makers must be aware of the time and location of floods. This requires the use of new methods for predicting floods and preventing their damage. In this study, the Random Forest (RF) machine learning method was used to predict the location of floods in Mashhad city, and its performance was evaluated. The impact of each factor including average basin elevation and slope, slope direction, topographic moisture index, drought index, distance from waterways, geology, land use, waterway density, waterways, and maximum average annual rainfall was also examined in this prediction. The evaluation results of the RF model output showed an AUC value of 95%. Overall, the results showed that the RF model has high accuracy in identifying flood-prone areas in the Mashhad city basin.

Keywords: Flood risk assessment, Random Forest, machine learning, Mashhad city, flood zoning.

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Modeling the Impact Of Manangement Scenario On the Kashan Aquifer Using Mathematical Model of Modflow and Seawat

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Abstract

Groundwater is the main component of sustainable development in Iran. Due to population growth, over-exploitation, reduced precipitation, and inappropriate cultivation practices, water storage has significantly declined. Therefore, it is imperative to model groundwater and predict the future state of the aquifer for effective management. In this study, we have modeled the qualitative and quantitative changes of the Kashan aquifer. Based on the hydrological and hydrogeological conditions of the Kashan plain aquifer, we developed a groundwater quantity and quality model (2009-2015) under stable and unstable conditions using the MODFLOW and SEAWAT models in the GMS software. The models were validated through statistical evaluation, demonstrating their accuracy in modeling. Once the models were validated, we assessed the status and quality of the aquifer for the next period (2016-2023) by considering various practical scenarios. Applying the current trend scenarios revealed a projected decrease in aquifer volume to 1.556 Mm3 and an average increase in salt density of quality wells to 160.33 ppm in the next period. Conversely, when simulating the scenario of shutting off wells for a month, the aquifer volume was projected to increase to 0.0147 Mm3, and the salt density of quality wells would decrease to an average of 42.27 ppm during that one-month period. These results highlight the model's capability to accurately recognize and predict observed and calculated outcomes. The expansion of saline water in the northeastern part of the aquifer has resulted in a decline in both quantity and quality in that region. Finally, implementing multiple management and scientific scenarios concurrently is crucial to prevent further deterioration of the quantitative and qualitative status of water resources in this region.

Keywords: Simulation, Saltwater Intrusion, GMS, Kashan Plain, Groundwater.

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Assessment of flood risk using GIS and RS in the south of Kerman province (case study: Hamoon- Jazmoorian catchment)

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Abstract

This research set out to assess the flood risk in the Hamoon-Jazmoorian catchment applying 13 affecting factors as informative layers including elevation, slope, slope direction, topographic curvature, drainage density, distance from the waterway, geology, vegetation, land use, rainfall, topographic moisture index, flow strength index and soil type. To this end, the Analytical Hierarchy Process (AHP) method was applied in the form of a matrix of paired comparisons for prioritizeing and determineing the weight. Then each layer was made fuzzy between 0 and 1 by fuzzy logic model and the weights obtained by AHP method were multiplied in them. Next, based on the method of linear-weighted combination with the integration of 13 layers of information, a flood zoning map was obtained. Finally, the AWEI index was applied to each satellite image before and after the flood separately to validate the results as a ground reality, in which the areas affected by the flood situating around Hamoon-Jazmoorian and areas close to the main waterways were determined using the technique of changes determination. The results of the validation of the map of the flooded areas revealed that the gamma validation method in 1992 and 2016 has the highest consistent with the results of satellite images with 97.96 % and 98.18 % of similarity, respectively.

Keywords: flood risk map, Landsat satellite images, AWEI, AHP, fuzzy logic model.

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The Place of Water in Iranian Gardening

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Abstract

The subject of this research is to investigate the role of water in the formation of architectural elements, especially spaces where water is important in their formation and structure. The purpose of this research is to define the types of elements and spaces related to water, especially the pond in gardens, and on the other hand, to investigate their different forms. The research method is descriptive and analytical, the data are first classified and compared and then analyzed. The theoretical basis of the research is based on the fact that, on the one hand, environmental and climatic phenomena and on the other hand, the function of the garden space itself have an effect on the formation of various garden structures. The results of the research show that water plays a major role in the formation of gardens, especially in hot and dry areas and there is a lack of water in these areas. The pond is one of the richest and most important structures used in garden architecture and has given a symbolic aspect to the garden space, but it has undergone some changes in different historical periods. Due to the presence of various elements in the Iranian garden, water plays the most important role in the identity of this architecture.

Keywords: garden, Iranian garden, water, garden elements.

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Evaluation of effective criteria on flood risk based on network analysis process and GIS in Vazroud basin of Mazandaran province

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Abstract

Flood risk zoning as a fundamental problem is always the concern of many researchers. Due to its need for detailed spatial analysis, therefore, several criteria should be evaluated. This research has been conducted with the aim of preparing a flood risk zoning map in the Vazroud watershed located in Mazandaran province. For this purpose, 6 variables were evaluated slope, land use, hydrological group, curve number, stability, and rainfall. Network analysis process (ANP) and GIS were used to weigh the criteria and prepare information layers, respectively. The results obtained from the research showed that the criteria of curve number and slope with a weighted value of 1.42 and 1.00 are the first and second priorities of flood risk. Finally, the final flood zoning map was obtained by merging each of the layers and based on the weight in the GIS environment. The results showed that 78.7 km2 (57.36 %) of the area is at risk of flooding (high and very high). Despite the medium permeability of the soil, this is due to the involvement of factors such as high curve number, higher runoff depth, and poor vegetation cover, which due to the high altitude and possible prosperity of the region in the future, planners should take necessary procedures (construction control and construction in these areas and the use of land use plans and planting vegetation), prevent or reduce the risk of flooding in these areas.

Keywords: Hydrologic Group, Curve Number, Runoff, Analytical Network Process (ANP).

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Analysis of the spatial distribution of snow water equivalent in the watersheds of West Azerbaijan

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Abstract

A significant part of the precipitation in the upstream areas of the watersheds of West Azerbaijan province is in the form of snow, especially in the cold months of the year. Analyzing the data of these sources is very important for the optimal management of reservoir dams in the region, especially in spring, which is the season of snow melting in the respective basins. In common traditional methods for estimating water equivalent of snow storage, the height gradient relationship (linear regression relationship between water equivalent of snow and the height of snow measuring points from the surface of the oceans) is used, which sometimes due to lack of proper fit, some points are removed from the calculations. In this study, for the data of 65 snow measuring stations in snowy months of the water year 2020-2021, instead of the relation of altitude gradient, the four-variable regression of water equivalent to altitude, longitude and latitude (in the UTM coordinate system) was used. It improved the regression characteristics (an increase of more than 3 times the A.R.S., i.e. the square of the adjusted correlation coefficient, or the coefficient of determination, and a decrease of more than 10,000 times the significance level, i.e. the alpha of the correlation coefficient). Also, in order to further investigate, the simulation of relationships with artificial neural networks (selected network: three-layer perceptron with 3, 8 and 1 neurons in the input, middle and output layers) was used; So that the correlation coefficient of the estimated data with the available observations for the selected artificial neural network model was 0.97.

Keywords: snow water equivalent, multivariate regression, artificial neural network.

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Estimation of daily evaporation from the dam reservoir using the energy budget method and comparison with common equations (case study: Ekbatan dam)

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Abstract

Evaporation is known as one of the main factors in reducing surface water resources such as lakes and dam reservoirs. Due to the multitude of components affecting evaporation, its correct estimation has always been of interest to researchers in the field of hydrology. In this research, the daily evaporation from the surface of the Ekbatan dam reservoir has been estimated using the Bowen ratio energy budget method as the basic method and compared with the results of 20 different equations. Investigations indicate that the Brutsaert-Stricker equation with MSE, MAE, and RMSE values equal to 0.36, 0.41, and 0.60 mm/day, respectively, and the NSE and R^2 equal to 0.97 and 0.98, respectively, had the best performance in estimating daily evaporation rate from the surface of Ekbatan dam reservoir. On the other hand, Harbeck and Ryan-Harleman equations, in the group of mass transfer equations, have performed the weakest. Also, the relationship presented in this research to calculate evaporation from Ekbatan dam reservoir using weather parameters and without the need to calculate thermal storage of water with MSE, MAE, and RMSE values equal to 0.81, 0.67 and 0.90 mm/day, respectively, and the NSE and R^2 equal to 0.93 and 0.94, respectively, for the test data have a good performance in estimating the evaporation rate.

Keywords: Lake, Multivariable regression, Equation ranking, Combination methods, Open-water surface.

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Determining the best discharge-suspended sediment relationship based on different time classifications and correction coefficients (Case study: Bashar River)

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Abstract

Using complex hydraulic equations to estimate river sedimentation requires a lot of data that is not available in many rivers. Therefore, simpler equations such as the Sediment rating curve (SRC) are used to estimate river sediment load. In some cases, rating curves are not accurate enough. To solve this problem, applying correction coefficients and temporal classification of discharge and sediment data based on the different factors. The present study was conducted with the aim of evaluating the effect of different correction methods and data classification to increase the accuracy of SRC in the Bashar river, southwest of Iran. The models were examined by 7 statistical criteria. The results showed that any temporal classification of the data increases the accuracy of sediment estimation and applying monthly and seasonal models, on average, increased the accuracy of estimates by 36 and 61 percent. Although using the middle of the classes model had 70% more points than the annual model. However, using the FAO correction method caused a 22% decrease in the accuracy of the estimates. In general, despite the positive effect of climatic, hydrological and vegetation models on increasing the accuracy of SRC, by 35, 28 and 20%, respectively, none of the models were superior. The results confirmed that the production and transfer of suspended sediment in the river are influenced by various factors such as climatic factors and especially the presence of vegetation. Paying attention to these changes in the use of discharge-sediment equations increases the accuracy of SRCs.

Keywords: Climate Condition, Flood, Rating curve, Vegetation.

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Investigation of groundwater level changes using particle filtering algorithm based on satellite data absorption (case study: Khorasan Jonoubi)

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Abstract

In the past decades, due to excessive extraction of underground water resources, decrease in rainfall and increase in air temperature, the level of underground water has decreased drastically. According to previous researches, Iran has 130 billion cubic meters of underground water resources; but in the last 20 and six years, renewable water resources have decreased to 110 and less than 100 billion cubic meters, respectively. Therefore, the issue of underground water level changes and the prediction it, is of particular importance. Therefore, in this research, a model was developed to predict these changes using the data absorption algorithm. In addition, a deep learning model was also developed as a competing model to compare the results of the proposed model with it. South Khorasan province was selected as a case study for modeling. The comparison between the proposed model and the competing model showed that the proposed model has a very high prediction ability and its accuracy is close to the accuracy of the competitor model. Based on this evaluation, for the proposed model and the competing model, (R^2) was equal to 0.91 and 0.95, and the root mean square error (RMSE) was equal to 0.18 and 0.20, respectively. Also, explicit presentation of equations and parameters of the model along with providing uncertainties and a confidence interval are other advantages of proposed model that can provide a wide future for data absorption algorithms. Meanwhile, machine learning and deep learning models, that are widely used today, do not provide such benefits.

Keywords: Groundwater Level, Particle Filter Algorithm, GRACE Satellite, Deep Learning, Satellite Data.

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A practical method for completing the physical water supply table in the modified System of Environmental-Economic Accounts for Water (SEEA-Water) in Irrigation Districts Scale

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Abstract

The primary purpose is to introduce a systematic approach to determine the surface and groudwater resources contributions in the agricultural water supply as the primary basis for completing the physical water supply table in the customized System of Environmental-Economic Accounts for Water (SEEA-Water) to be employed in a scale of an irrigation district. The developed methodology is based on 1) spatial analysis of surface water distribution within the irrigation district upon the developed hydraulic simulation model for the main and secondary canals, 2) spatial evaluation of extracted water from exploitation tubewells located within the district, & 3) updating the agricultural water demands based on the dominant crops of the latest cultivation pattern and comparing it with the values of traditional water rights. Also, the parameters of the physical water supply table were customized in the SEEWA-Water framework that can be used for managerial purposes at the scale of an irrigation district. The effectiveness of the proposed method was investigated in the Abshar Irrigation District, Isfahan. Simulating the surface water distribution within the entire main and laterals off-takes conducted through developing an integral-delay simulator model. In this regard, surface water distribution regionalization and spatial analysis of water extracted from the aquifer were conducted in GIS and provided in the form of two separate layers. The update of agricultural water demand was carried out based on the latest cultivation pattern in the region using Netwat. The simulation results of surface water distribution indicated the decreasing trend of surface water distribution adequacy from upstream to downstream units in the two main canals and some laterals. The spatial analysis results were presented by determining the share of surface and groundwater resources by separating the entitled villages - based on the management point of view- and based on the main crops of the cultivation pattern, based on the water accounting point of view. Finally, the values of the customized parameters of the SEEWA-Water' physical supply table were calculated and reported. It needs to mention that in addition to the presented systematic method, the customized components of the physical supply table of the SEEWA-Water accounting method were presented in a way that can be employed in other Iranian irrigation districts.

Keywords: Environmental-Economic Water Accounting, Spatial analysis of surface water distribution, Hydraulic Simulation, Information Management, Abshar Irrigation District.

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