

Examination of relationship between teleconnection indexes on temperature and precipitation components (Case Study: Karaj Synoptic Stations)

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Abstract

Over the recent decades, human knowledge on earth's climate and his concern about climate change in the future has increased, which has contributed to precise identification of the factors influencing earth's climate. One of the climate phenomena, the change of which causes great anomalies of climate, particularly on temperature and precipitation patterns in many parts of the world, is teleconnection, and it is very important to reveal the relationship between them and climatic parameters for a better understanding of volatility and climate variability in every area. In this study, the relationship between large-scale and well-known patterns such as the Southern Oscillation Index (SOI), North Atlantic oscillation (NAO), Pacific North America (PNA), Multivariate ENSO Index (MEI) and (PDO) with 9 temperature and precipitation variables in the Karaj synoptic station in a monthly basis were analyzed over the 26-year period (2010-1985). First, the normality of the data series based on the Kolmogorov - Smirnov was confirmed. In order to examine the relationship between large-scale patterns with temperature and precipitation variables, the Pearson correlation coefficient was used. The correlations were assessed on a monthly basis without delay and a delay of one month. The results showed that there is a relationship between the NAO index and the temperature and precipitation variables mostly in autumn and winter months and the impact on the autumn months is higher than the winter months. SOI index is more related with the precipitation variables; this index was clearly shown to play a greater role in autumn and winter months, while the MEI index shows a higher correlation with the temperature variables and not particular relation was shown with precipitation variables for this index. Role and impact of this index, in particular on temperature parameters of April and May in spring and December in late autumn, is stronger. The relationship of PDO index with temperature and precipitation variables in May is observed more in the middle of spring. PNA index is effective only on temperature variables, showing higher relationship in December and February. The obtained results are important for greater understanding of the temperature and precipitation variability.

Keywords: ENSO, precipitation, climate indexes, teleconnection, temperature.

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Simulation and prediction of drought using Cellular Automata and Markov methods in Najaf Abad plain

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Abstract

The governing factors of drought are non-linearly correlated. Therefore, researcher needs to apply nonlinear methods such as CA to model and predict the drought. CA and its derivatives are among novel methods of drought simulation that rarely used for predicting the drought. While such methods have simple structures, they provide high visual capabilities for drought monitoring. This paper investigates drought in Najaf Abad plain using Markov, CA Markov and Landsat satellite images. First, satellite image time series of transpiration were classified for 1995, 2008 and 2015, and the land zonation of drought condition was estimated. Then, the drought in 2020 was predicted using CA Markov. The Kappa index is 0.63 and the agreement between actual and predicted map (M (m)) is 0.85. Our findings showed that our proposed model can suitably predict the drought. In addition, the drought distribution map showing the possibility of changes in 2020, suggests that if the situation continues and no changes in the type of cultivation and cropping pattern happen, all areas in danger of drought in 2015, will face drought more intensely and more widely, in 2020.

Keywords: drought, evapotranspiration, Najaf Abad Basin, Markov and cellular automation system.

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Prioritization of potential areas for construction of underground dam using geometric average method in geographical information system

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Abstract

Exploitation of underground water resources is a way to modulate the shortage of seasonal water. In this regard, proper site selection for constructing underground dam to reserve waters is a challenging issue. Thus, using an approach with minimum error is essential. The purpose of this paper was optimum selection of potential sites for constructing underground dam in Hamedan-Bahar catchment basin using a new GIS-based approach to reduce the error. For this purpose, the efficient criteria of a proper site to make underground dam were first recognized. These criteria include density of drainages, separation of the aqueducts, spring and wells, geological appropriate, slope, fault density, proximity to roads and villages and special conditions of land use. Then, different evidence layers were weighted in [0, 1] range using logistic function in geographic information system. Finally, the weighted evidence layers were integrated using geometric average function. Thus, a model representing favorable areas for making underground dam was generated. The results obtained introduced less than 10% of the streams (respecting the whole streams in the study area) as suitable, and demonstrated that the method applied can be used efficiently to delimit the study area and to recognize suitable streams for construction of underground dam.

Keywords: Multi-criteria decision making, integration, Hamedan-Bahar catchment basin, locating, weighting criteria.

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Spatial distribution of snow water equivalent modeling based on topography and climatic factors

(Case Study: Sohravard watershed, Zanjan Province)

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Abstract

It is inevitable to obtain necessary data including snow depth, snow density and snow water equivalent (SWE) in order to manage water resources in mountains areas. On the other hand, due to financial constraints, unfair weather and impassability of mountainous areas, measurement is limited to the points, and its generalization to larger areas is associated with large errors. A method for predicting the SWE is investigation the relationship between the SWE and effective factors. Therefore, in this research, mountainous Sohravard watershed located in Zanjan Province was selected as the case study. The required data and maps including Digital Elevation Model (DEM), slope, aspect, northern, eastern, profile curvature, plan curvature, topography position index and solar radiation maps were extracted. Then, during the peak of snowfall in the area, snow depth of 150 points and snow density of 18 points were measured using Latin Hypercube and random sampling methods, respectively. The calculation of upwind slope was carried out for the measured snow points. In the next step, the quantitative relation between the SWE and effective factors was determined by fitting a regression relationship. The efficiency of the created models was evaluated by statistical criteria including mean bias error, mean absolute error, root mean square error and correlation coefficient(R). The results showed that SWE in the studied watershed could be estimated by using stepwise regression. As the results show, although climate factor of upwind slope requires high computing, its incorporation in the model can lead to increased model efficiency in the SWE estimation. The SWE had the highest significant correlation equal to 0.607 with the elevation, and the lowest significant correlation equal to 0.204 to the northern part of the study area. Correlation coefficient between the dependent variable SWE and independent variable upwind slope shows that 300 meters distance is the most effective distance of the interaction of wind and terrain in creation of wind sheltering and wind deflation. Coefficient of variation in snow depth and snow density measurements is 54.14% and 7.89%, respectively.

Keywords: Latin hypercube sampling, snow water equivalent, stepwise regression, upwind slope.

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Investigation of relationship between meteorological and hydrological drought in Karkheh watershed

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Abstract

Drought is one of the natural disasters which is strongly influenced by climatic fluctuations and makes a set of complex problems in various parts. The current study aims for investigation of time relationship between meteorological and hydrological drought in Karkheh catchment. For this purpose, 26 rain gauge stations and 8 gauging stations were used. In part of research, for understanding delay trends in comparison with precipitation in reality, Pearson correlation coefficient between precipitation and discharge was calculated with different time delays. Two indices (SPI and SDI index) were selected for examining Meteorological drought and hydrological drought. Index values in short term step (1 to 3 months), medium-term (6 months) and long term (12 months) was calculated by DrinC software. The results showed that there is 99% direct significant correlation between precipitation-discharge and two SPI-SDI indices in four steps of time. However, the correlation coefficient is significant for any four time steps, but the value of correlation coefficient has more delay time in a mood with no delay time compared to other cases. Therefore, we can conclude that drought occurs simultaneously in the catchment Karkheh meteorologically and hydrologically. Also, due to the lack of consistent correlation coefficients and delay time in both cases, two aforementioned indices properly show drought conditions.

Keywords: Drought meteorological, drought hydrological, correlation Pearson, basin Karkheh.

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Estimation of wetland-aquifer exchanges (Case Study: Kaniborazan wetland)

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Abstract

Surface water and groundwater interactions can occur between surface water bodies (such as rivers, lakes, and wetlands) and groundwater resources. Quantifying water exchange between a wetland and an underlying aquifer is an important task for studies in such fields as water budgets and environmental water requirements. In this study, the groundwater component from controlling factors on wetland water level is considered to determine the water requirements of Kaniborazan wetland, located at the southern part of Urmia Lake. The results of the present study indicate that during the assessment period of 1998-2015, Kaniborazan wetland has been always recharged from underlying groundwater resources considering the hydraulic gradient threshold of this wetland. These recharge values have been maximum for 1998, 2002, and 2015 with the annual value of 4.11, 5.09, and 3.78 MCM, respectively. The mean annual value of this wetland depth has been estimated to be less than 16 cm. The impacts of drainage system, channels, and traditional streams have been investigated on this wetland during the assessment period. The obtained results show that these sources have a significant effect on the water supply of the wetland. Based on the available data and information, for example for 2006 and 2015, not taking the impacts of drainage system, channels, and traditional streams on this wetland into account will lead to the wetland water volume reduction of about 15% and 30%, respectively.

Keywords: Aquifer, drainage system, groundwater resources, water exchanges, wetland.

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Assessment of the economic and hydrological effects of the climate change on Kharrood Watershed

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Abstract

In the present study, first the behavioral patterns of precipitation climatic variable over the period 1985-2014 in Kharrood watershed was investigated. Then, in order to analyze the effects of climate change resulting from reduced rainfall under different scenarios (i.e. mild, moderate and severe) on hydrological (available water resources and economic value of irrigation water) and economic (agricultural products and farmers' gross profit) variables, a biophysical-economic modeling system was used. The aforementioned modeling system includes the products yield function based on rainfall (biophysical part of model) and positive mathematical programming approach (economic part of model) solved in consecutive three stages and in the GAMS 24.1 software. The required data were collected referring to the rain gauge stations and the relevant agencies in Qazvin province. Behavioral pattern of precipitation showed that this climate variable reduced in Kharrood watershed after year 2001. The results of proposed model showed that climate change resulting from reduced rainfall under mild to severe scenarios decreases the available water resources from 11/3 to 23/0 %, increases the economic value of irrigation water from 7/08 to 15/22 %, decreases the total acreage of water crops from 5/14 to 16/39 % and decreases the farmers' gross profit from 6/58 to 13/41 % compared to the base year. The highest decrease of the available water resources in Kharrood watershed was obtained under severe scenarios and at a rate of 15/29 million cubic meters. Finally, use of deficit irrigation techniques, determination of the rate of water charge for farmers on the basis of equality consideration, fallow-lands and provision of facilities to farmers in order to equip their lands with new irrigation systems were proposed in order to deal with the effects of climate change and protect water resources in this watershed.

Keywords: Behavioral pattern of precipitation, climate change, hydrological variables, sustainability of water resources, biophysical-economic model.

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Evaluation and comparison of frequency ratio, statistic index and entropy methods for groundwater potential mapping using GIS (Case Study: Jahrom Township)

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Abstract

Groundwater is considered one of the most valuable fresh water resources. The rapid increase in human population has increased the demand for groundwater supplies for drinking, agricultural, and industrial purposes. It is necessary to provide groundwater spring potential maps for implementing a successful groundwater determination, protection, and management program. The main objective of this study was to produce groundwater spring potential maps in the Jahrom region, using frequency ratio, statistic index and entropy methods. Twelve hydrological-geological-physiographical (HGP) factors influencing locations of springs were considered in this research and processed in ArcGIS environment. These factors include slope degree, slope aspect, altitude, topographic wetness index (TWI), slope length (LS), distance to roads, distance to rivers, distance to faults, lithology, land use and fault density. The predicted results from the three models were validated using the receiver operating characteristics curve (ROC). From 103 springs identified, 70 ($\approx 70\%$) locations were used for the spring potential mapping, while the remaining 33 ($\approx 30\%$) springs were used for the model validation. The area under the curve (AUC) for the statistic index model was calculated to be $\%91$ and for frequency ratio and entropy the AUC to be $\%92$ and $\%92.7$, respectively.

Keywords: Spring potential mapping, frequency ratio method, statistic index method, entropy method.

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Hydrogeological drought management index (HDMI) as a tool for groundwater resource management under drought conditions (Case Study: Dayyer-Abdan district, Boushehr province)

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Abstract

Drought has major negative effects on water resources and its related environments. Sometimes the drought damages are irreparable. Groundwater drought is one of the most important droughts caused by insufficient groundwater recharge. This study aims to evaluate the effect of drought on groundwater resources of Dayyer-Abdan district, south of Boushehr province. Data and information such as rainfall, groundwater level, well discharge rates and groundwater quality data were used for this purpose. The Standardized Precipitation Index (SPI) and Groundwater Resource Index (GRI) were used to assess the drought situation. A new index called Hydrogeological Drought Management Index (HDMI) is introduced in this research. The HDMI index is a combination of Groundwater Resource Index (GRI), the Modified Standardized Electrical Conductivity Index (MSECI) and Standardized Well Discharge Index (SWDI). Based on the obtained results, average of GRI index is less than -1, indicating a moderate groundwater drought. Groundwater drought also has destroyed the groundwater quality. From the groundwater quality view point (MSECI index), the most critical zone of the aquifer is located in the southern part of the study area. From the aquifer potential view point (SWDI index), the most suitable groundwater zone is in the northern parts of the study area. The southern parts of the Dayyer-Abdan district (adjacent to the Persian Gulf) have the lowest amounts of HDMI index (less than -4). So exploitation of groundwater is not recommended in these areas.

Keywords: Groundwater, drought, hydrogeological drought management index (HDMI), Dayyer-Abdan district.

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Evaluation of the role of Sarcahan-Floodwater spreading in the artificial groundwater recharge

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Abstract

Despite the arid and semi-arid climate of Iran, a considerable volume of water becomes out of reach by annual flash flood events. Therefore, in order to solve the problem, Floodwater Spreading Systems have been implemented approximately over the past three decades. The aim of this study was to evaluate quantitative changes of the groundwater affected by the Sarcahan floodwater spreading which was implemented in Hormozgarn Province using *Control Volume* technique. Sarcahan floodwater spreading project has been implemented in an area of 2000 hectares. The well-hydrographs, rainfall histograms, and the fluctuation of groundwater at observation wells synchronizing with the frequency of flooding were used to evaluate the effect of the project on the groundwater. Examined observation wells showed a relative increase in the level of groundwater after the primarily flood controlling; in other words, the hydrograph of observation well located in the area of flooding has considerably increased by about 1.34 meters. Groundwater levels changes recorded at the observation wells are quite similar to the feeding/withdrawing ratio whereas in 2008 groundwater level increased by about 4.43 meters. Furthermore, in the Gahkom-Saadatabad the amount of rain more than 60 mm or continuous rainfall in large quantities can artificially recharge the aquifer. The results indicated that the Sarcahan project has not satisfactory effect on the groundwater according to predictions.

Keywords: Groundwater level, artificial recharge, control volume, fluctuation, Sarcahan.

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Definition of Sarab Aquifer Hydrochemical Facies Distribution by means of Fuzzy C-Mean Clustering and Hierarchical Cluster Analysis Methods

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Abstract

In this research, clustering of a hydrochemical data set from Sarab plain aquifer has been carried out using Fuzzy C-Means (FCM) and Hierarchical Cluster Analysis (HCA) techniques and its application in delineation of hydrochemical facies has been studied. The statistical clusters analyze the spatial coherence indicating that the clusters have a hydrogeological correspondence with aquifer hydrochemical facies. Groundwater samples were grouped into four classes using the fuzzy c-mean. The data set includes 49 water samples and 12 hydrochemical variables selected from the study area. The results obtained from both approaches presented cluster centers that can be used in order to identify the physical and chemical processes causing variations in the hydrochemistry variation of study area. The FCM method is potentially useful in establishing hydrochemical facies distribution. The results showed that the clustering scheme for partitioning water chemistry samples into homogeneous groups produced by FCM method is an important tool for determination of aquifer hydrochemical facies and the FCM method is more capable to investigate threshold data than HCA method which is characterized by sharp and abrupt variation.

Keywords: Groundwater, hydrochemical facies, Sarab Plain Clustering, fuzzy logic.

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Verification methods of Analytical Hierarchy Process (AHP) and Multivariate Regression (MR) in landslide zoning (Case Study: Valiasr Watershed in Ardabil Province)

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Abstracts

Providing effective solutions to prevent and reduce the damage caused by landslides is inevitable. Predicting and zoning landslides are among these solutions. Accordingly, the present study was conducted to compare and assess the accuracy of Analytical Hierarchy Process (AHP) and Multivariate Regression (MR) methods in landslide hazard zoning in Valiasr Watershed with an area of 198 km² located in western Ardebil Province. Six factors including aspect, slope, elevation, lithology, land use and distance from the river were known as the most effective factors in landslide occurrence in the study area. Landslide zones were then obtained in five classes using two AHP and MR methods. Finally, landslide zoning maps were compared and evaluated by Density ratio index (Dr) and Quality sum index (Qs) to assess the accuracy of two studied methods. The results showed that distance from river, slope, land use, lithology and height were weighting in 0.426, 0.173, 0.145, 0.134, 0.089, and 0.033 in the AHP methods and 0.531, 0.109, 0.344, 0.273, 0.123 and 0.061 in the MR method, respectively. The amount of two Dr and Qs indices were calculated to be 5.51 and 0.44 respectively in the AHP method and 6.45 and 0.72 respectively in MR method which indicated that MR method having 28% disagreement with reality was more accurate than AHP method having 56% disagreement with reality for landslide hazard in the study area.

Keywords: Density ratio index, geographic information systems (GIS), mass movements, quality sum index.

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Simulation of two-dimensional velocity distributions in rivers based on Chiu's theory (Case Study: Gorganrood River)

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Abstract

Solution of stream-wise flow velocity in two dimensions (in width and depth directions) in rivers is essential for many hydraulic features such as stage-discharge rating curve development, suspended sediment transport estimation and boundary shear stress calculation. In this paper, using Chiu's entropy theory, a simple method has been proposed for simulation of vertical and transverse profiles of flow velocity in the straight rivers. For calibration and validation of the proposed method, a new idea based on the optimum estimation of entropy parameter in rivers was used. The results of this study at Aghghalla hydrometric station located on Gorganrood River showed that velocity flow field obtained by the Chiu's theory has suitable accuracy compared to the field data. Further, statistical analysis of the results revealed that the mean absolute errors of this method for solution of flow velocities in calibration and validation stages are 5.2% and 3.5%, respectively. These errors are 5.9% and 6.04% respectively for the total river flow discharge prediction. According to little input data, the proposed method has more advantage than other existing methods.

Keywords: Chiu's theory, probability, stage-discharge relationship, vertical and transverse velocity distribution.

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Calibrating Priestley-Taylor coefficient to estimate free water surface evaporation (Case Study: Mahabad Dam Reservoir)

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Abstract

Evapotranspiration is one of the important components of basin water balance which cannot be measured directly at the basin scale. Therefore, it is inevitably estimated through indirect methods. In this regard, the Advection Aridity model, one of the widely used models of complementary relationship, has attracted lots of attentions. Due to the existence of Priestley-Taylor equation in the Advection Aridity model, it is required to calibrate Priestley-Taylor coefficient to increase the accuracy of the model. The current research aims at calibrating Priestley-Taylor coefficient in estimation of potential evaporation through Penman method to apply it in the Advection Aridity model in the studied area of Mahabad dam reservoir, Iran. The required data were collected for a period of 26 years (1986-2012) from Mahabad 1st order meteorological station which is located a short distance from Mahabad reservoir. The results showed that Priestley-Taylor coefficient undergoes monthly changes during a year and decreases during the warm months of the year. Therefore, it is better to use its monthly values in calculations. *In the area under study*, its minimum and maximum averages were 1.01 and 1.68, respectively. Moreover, the long term average of this coefficient during a period of 26 years has been calculated *to be* 1.25.

Keywords: Priestley-Taylor coefficient, Penman equation, advection aridity model, Bouchet hypothesis, Mahabad dam reservoir.

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Habitat utility modeling of organic (wild) pistachios (*Pistacia Vera*) using Maximum Entropy Method (MaxEnt) in Sarakhs Forest Area (Gonbadli in Khorasan Province)

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Abstract

Organic (wild) *Pistacia vera* is a species of broadleaf forest. One of the most important natural forest habitats in the world is located at northwest and southwest of the city of Sarakhs, Khorasan Razavi Province, Iran. In addition, the unique ecological features of this habitat and the economic value of organic pistachio greatly impact the lives of people residing in this region and the country. Unfortunately, continuous overharvesting and drought-stricken development endanger natural life, regrowth and cultivation of this unique species. Understanding spatial distribution of this species plays a significant role in assessing regional protection and development; on the other hand, it can be helpful to recognize effective ecological factors on its habitat. Therefore, modeling this distribution is very important. In this paper, habitat modeling of this species is studied using maximum entropy method according to edaphic, climatic and physiographic data in the city of Sarakhs (in district of Gonbadli). The results of Jackknife test for surveying significance of variables shows that changes in soil properties such as gravel percentage, exchangeable sodium adsorption ratio, sodium content soil, gypsum, climatic factors (temperature and precipitation) and height above sea level are the most important factors affecting the distribution of habitats. The accuracy of model is assessed by kappa coefficient to be 0.72 and AUC 0.92. Moreover, the obtained results reveal that maximum entropy method is an appropriate method for habitat modeling.

Keywords: Organic (wild) *Pistacia vera*, maximum entropy, habitat modeling, Sarakhs (in district Gonbadli)

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Investigation of the determination relationship of effective rainfall in high rainfall and low rainfall zones (Case Study: Rasht and Daran)

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Abstract

Given the vital importance of water in human life, recognizing the effective use of rainfall and crop water requirement and economic planning are very important. Identifying and applying appropriate method for estimating effective rainfall, especially in rainfed is highly important. The current study aims to determine the most suitable experimental method for estimating effective rainfall for sowing Wheat, Barley, Peas and Lentils in high rainfall zones (Rasht in Gilan) as compared to low rainfall zones (Daran in Isfahan). In this study, five different experimental methods are presented in order to determine the effective rainfall including: the Soil Conservation Service (SCS), reliable method, empirical method, United States Department of Agriculture (USDA), and percentage method. The results show that all methods used for determination of effective rainfall in Rasht are useful. However, these methods require to be pre-calibrated in order to determine the effective rainfall in Daran identified as a low rainfall area. Based on the obtained results, as regards prioritization of using the methods under study in these areas, SCS and USDA methods are proposed for Rasht, while the USDA and percentage methods are proposed for Daran. Since the amount and duration of rainfall is not controllable, effective strategies can be applied to increase precipitation efficiency and consequently effective precipitation; these strategies include: reduction of surface runoff, water storage for times of low rainfall, reduced water depth penetration, and planning for the cultivation of plants that are consistent with the precipitation regime.

Keywords: Effective rainfall, runoff, experimental, USDA, SCS.

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Effects of consecutive storms on splash erosion components for two different rainfall intensities under laboratory conditions

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Abstract

Obviously, no erosion occurs unless detachment takes place first, either by raindrop or runoff. The Raindrop-Impact-Induced Erosion (RIIE) occurs when detachment is caused by raindrop energy. For this purpose, a set of laboratorial experiments were scheduled to examine the effects of consecutive storms on RIIE components (i.e. upward splash, downward splash, net splash, total splash and upward splash/downward splash). The experiments were conducted for two different rainfall intensities of 30 and 90 mm h⁻¹ at slope of 5% under rainfall simulation and soil erosion for a soil collected from Kojour rangeland watershed in the Alborz Mountains, northern of Iran. The comparative analysis of the results showed that there was no significant difference between upward with downward splash under rainfall intensity of 30 as well as under rainfall intensity of 90 mm h⁻¹ in consecutive storms ($p \leq 0.05$) using One-Way ANOVA in SPSS Statistics 22 software. In addition, the obtained results indicated that RIIE components viz. total and upward and downward splash were significantly different ($p \leq 0.01$) under rainfall intensities of 30 and 90 mm h⁻¹ in the third, fourth and fifth consecutive storms. However, net splash and upward/downward splash proportion was not significantly different ($p > 0.05$) under rainfall intensities of 30 and 90 mm h⁻¹ in different consecutive storms. The results also indicated a 2.5-fold increase in coefficient of variation of net splash and total splash under rainfall intensity of 30 mm h⁻¹ then the rainfall intensity of 90 mm h⁻¹.

Keywords: Event storm, rainfall simulation, splash cup, net splash.

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Climate change impact on annual precipitation and temperature of Zanjan province with uncertainties investigation

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Abstract

In this paper, climate change impact on annual precipitation and temperature series for Zanjan province was assessed and uncertainties were investigated. Spatial average of annual time series of precipitation and temperature for Zanjan province were calculated and then modelled using ARMA model and 100 annual precipitation and temperature series of length 30 years were generated for spatial average of Zanjan province. Using the models, future scenarios of 6 GCMs under 3 emission scenarios were downscaled and 100 annual precipitation and temperature series of length 30 years were generated for each of the scenarios. 90% bounds of the variable statistics for the current condition were compared with the 90% bounds of the corresponding values for all of the future scenarios and the uncertainties were investigated. Model validation showed that the models are adequate for generation of the annual temperature and precipitation series. In confidence level of 90%, it is expected that average temperature of Zanjan province increase from 0.6 to 3.2 °C and average precipitation change from -25% to +15% in 2035-64 period. So, the uncertainty due to the GCMs structure and the emission scenarios are considerable and should be taken into account.

Keywords: Annual model, ARMA, climate change, stochastic, uncertainty.

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Site selection of aquifers of Ghorveh pasture areas using satellite images

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Abstract

Over the recent years, given lack of surface water, population growth, and agricultural development, more attention has been paid to underground water, its management and extraction. This source is considered as one of the valuable resources of freshwater making it as one of the most valuable vital resources. Groundwater extraction, over the recent years, has given rise to decreased water level of this resource, that is, its level has decreased by an amount of 19.9m in the plain of Qorveh since 1986, 1987 until 2015. Therefore, the plain has become one of the forbidden plains out of 625 country plains. In recent years, integrating data of remote sensing (RS) and geographic information system (GIS) has increased for exploration of this valuable material. So that the combination of these two has become a point in the fields related to the issue of water. In this study, using (RS) and (GIS), data of potential areas of groundwater were identified. Layers created for site selection of aquifer in this study are as follows: geology, topography, slope, lineament, density of lineament, drainage, density of drainage, land use and vegetation of cover. Then, the final map was obtained using respective layers by means of fuzzy method in gis. The resulted map was divided into five groups of very good, good, average, weak and very weak. The results showed that the areas with good and very good potential with an area of 136461 hectare forming about half of the area of plain under study are located more in northern and eastern parts characterized by alluvial lands, vegetation and low slope, while regions with lower potential are located more in southern parts characterized by high slope areas covered with rock solid.

Keywords: GIS, RS, Site Selection, Aquifer, Fuzzy

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Investigating modern methods of water wells rehabilitation for use in Iran

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Abstract

One of the problems associated with long term use of wells is creation of deposits on well screen or gravel packs. The deposits, despite the presence of water in the context of the aquifer, prevent the penetration of water into the well. As a result, it greatly reduces the amount of water production of the well. Rehabilitation of wells is characterized by removing the deposits from the front and back of the well screen. So far, there have been some methods of well rehabilitation, nowadays, however, with the development of technology, more efficient methods have been developed causing less damage to the aquifer and the environment. In this study, new methods of well rehabilitation are investigated for implementation in Iran. A criterion for determining the efficiency of the methods is proposed. The method of air shock in combination to water jet is estimated to be more efficient with less time and cost consumption for implementation in Iran.

Keywords: Well rehabilitation, design, well development, air shock, water jet.

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Investigating suspended sediment yield in Ziarat Drainage Basin, Gorgan in different seasons using sediment fingerprinting technique

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Abstract

Soil erosion is the most serious and irreversible threat to sustainable development. According to the increasing rate of soil erosion and sediment yield, the current study aimed to determine relative contribution of sediment sources in Ziarat catchment in fall, winter and spring seasons using sediment fingerprinting technique. In this regard, 43 samples from sediment sources including rangeland and cultivated land as surface erosion and stream bank and road verges as sub-surface erosion as well as 14 samples of suspended sediment at outlet of catchment were collected and concentration of geochemical tracers, organic carbon and ^{137}Cs were measured. The optimum set of tracers was selected using the Kruskal-Wallis H test and discriminant function analysis. Finally, the relative contribution of sediment sources was determined through mixing model in different seasons. The results showed that the maximum relative contribution was related to surface erosion in winter and spring seasons. Sub-surface erosion in spring season with 60.4% also caused a large amount of sediment yield. The results of this study can be used to select the management strategies in soil erosion and sediment control of Ziarat catchment in different seasons.

Keywords: Sediment fingerprinting, seasonal erosion, ^{137}Cs , Ziarat catchment.

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Optimization of the number of rain gage stations based on interpolation methods and principal components analysis in Iran

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Abstract

Optimization of the number of synoptic stations in the estimation of rainfall is an important step in terms of reducing the maintenance cost and saving the data collection. The main objective of this study was to determine the optimal number of synoptic stations to estimate the amount of rainfall in Iran. Accordingly, the amount of rainfall of synoptic stations related to a common 14-year period was received from the National Weather Service and the performances of five different interpolation methods were evaluated. Based on the results of radial basis function (RBF), with a margin of error of 0.63, this method was selected as the most appropriate method in fitting the data. Studies show that eliminating the synoptic stations in PCA method increases the estimation error of RMSE from 0.48 to 0.52 related given that all synoptic stations were used; moreover, in the radial basis function, interpolation method decreases from 0.63 to 0.55 which indicates the suitability of this method in the optimization of synoptic stations. The results indicate that through removing 34 and 22 points from the network of synoptic stations in Iran respectively in the PCA method and interpolation method of radial basis, the resulting error will be acceptable.

Keywords: Optimization, interpolation, PCA, validation, synoptic stations.

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Scrutiny of base flow separation using natural monthly discharge

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Abstract

In hydrology studies, the river regimes are considered to be natural while this assumption is not correct since the river water is used for developing agriculture, industry, and other needs, particularly in the middle basins. The requirement for river base flow separation is to have access to natural river regime on a daily basis, which, regarding the limitations of naturalization, natural river regime can be calculated on an annual or monthly basis. Therefore, the estimation of base flow has been faced with some difficulties. On the other side, due to the complex relation of surface water with groundwater, the estimation of base flow is too hard. Therefore, in this study, the removal process method was used for naturalizing monthly discharge of Belbar basin, and Eckhart RDF algorithm was used since it takes aquifer characteristics into account for calculating base flow and it has the ability to optimize its parameters. The constant parameters of return and the maximum base flow index for monthly natural river discharge in hydrometric stations of Belbar dam were optimized. Then, the monthly base flow was calculated and the results showed that the monthly natural river discharge can be used like the daily natural river discharge with the same accuracy.

Keywords: Base flow, recursive digital filter, natural discharge, rock aquifer, belbar dam.

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Numerical comparison of RAI and PNPI meteorological indices to assess and quantify the drought situation in Khuzestan province

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Abstract

Over the past few decades, the frequency and number of drought occurrence has been more than other natural disasters influencing human societies. Drought is a kind of natural disaster formed and extended smoothly and in a crawling way in comparison with other natural hazards like heavy precipitations and floodwaters. There are different and numerous indicators for quantitative expression of drought. Percentage Indicators of normal precipitation (PNPI) and precipitation abnormality (RAI) status and continuation of drought in 8 stations of Abadan, Ahvaz, Bandar-e Mahshahr, Bostan, Masjed Soleyman, Omidieh, Ramhormoz and Safi Abad in Khuzestan province during the statistical period (1990-2014) have been considered in this research. As the obtained results show, based on PNPI indicator, the most severe drought happened during period 1990-2014 in Bandar- e Mahshahr station with the amount of 20.39 in 2010. Also, the most severe wet period happened in Ahvaz station with the amount of 216.33 in 1997, based on PNPI indicator. Also, based on RAI indicator, the most severe drought happened in Bandar- e Mahshahr with the amount of 6.26 in 2010 during the period 1990-2014. Based on RAI indicator, the most severe wet period occurred in Ahvaz station with the amount of 8.6 in 1997.

Keywords: Drought, PNPI indicator, RAI indicator, Khuzestan province, zoning.

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Water resources and their role in attracting tourists (Case Study: Tehran's Qanats)

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Abstract

Since Iranians introduced Qanat to the world, it has been widely spread around the world due to its usefulness providing people with groundwater. According to studies conducted in Iran, it is estimated that about 10,000 km qanats with 300,000 wells lie under Iranian urban areas. In order to utilize these water resources, sustainable development should be taken into account, which is exploitation of these resources with responsibility, reasonable and proper planning. Tourism is associated with many advantages including cultural exchange, flourished native businesses, increased rate of employment, and familiarity of communities with each other. Studying the history and structure of Qanats in Iran and other regions reveals the high technical knowledge of our ancestors. Many reasons contribute to the decline of Qanats in Iran including new methods of irrigation, climate changes and inappropriate management knowledge. However, based on previous successful experiences in reviving Qanats and turning them into tourist attractions in different parts of the world and also Iran, the high potential of this structure to attract a huge number of tourists is revealed; therefore, reviving and improving these structures in historical parts of Tehran is recommended.

Keywords: Qanat, tourism, Tehran, resuscitation of water resources.

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