

Analysis of uncertainties in temperature and precipitation variations influenced by climate change (Case study: Southern Khorasan Province)

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Abstract

Adaptation to climate change is almost unavoidable subject in all fields, especially water resources. Most regions have been faced with the growing trend of temperature, intensity and frequency of dust storms, droughts and floods. In most of the regions these changes have been attributed to the increase in greenhouse gases and climate change phenomenon. Objective of this study is to survey climate change impacts on major meteorological components. This assessment contains trend analysis in least and most temperature and precipitation values and the uncertainty analysis related to GCMs output. For survey of climate change effects in this research, fifteen GCMs models and A1, A2, B1 emission scenarios are used. Using downscaling method of LARS-WG, large scale projections of GCMs output have been subgrided from high resolutions to local coordinate. For this aim, observation data (1990-2010) of synoptic stations in province are collected and assumed as base period. After downscaling, we have determined performance of GCMs model by comparing simulation and observation data in 2011-2013 and 5 top models selected for each synoptic stations. Trend analysis was fulfilled by Man-Kendal nonparametric test as well as uncertainty assessment was carried out by bootstrapping function. Annual simulations of rainfall and temperature were used as entrance to Bootstrap. Confidence interval for each station was determined by coding in MATLAB in 0.09 levels. Results about performance of GCMs showed that almost all models don't have high ability for simulation of behavior of precipitation pattern. However, performance of these models for simulation of variations in the least and most temperature was very good. Results of trend analysis for stations and province showed a decrease in rainfall and increase in average temperature. Comparing the temperature variations in the future relative to the historical periods has indicated that minimum and maximum temperature will have 0.6 decrease and 2 increase, respectively. The uncertainty analysis also showed that there are significant sources of uncertainty in simulation of meteorological components. Also annual precipitation variations in future are more severe than historical period. Similar results have also been achieved about minimum and maximum temperature.

Keywords: bootstrapping, LARS-WG, Man-Kendal, pricipitation.

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Runoff prediction using intelligent models

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Abstract

Prediction of river runoff because of its high importance in planning, reservoir operation, and management of surface water has always attracted the attention of officials, planners and water engineers. On the other hand, because of temporal and spatial changes in water supply, non-linear relationships and uncertainty, and many other climatic factors, it is very difficult to predict rainfall-runoff relationship. But today's the use of intelligent systems can be useful for predicting such complex phenomena. In this study, we have used meteorological and hydrometric data for the period from 1970-1971 to 2011-2012 to estimate the runoff in the watershed Amameh using MLP, RBF, and ANFIS. The results showed that out of the models, the ANFIS has the best function and can better predict runoff. Thus, according to the errors, the structure model number 54 was the best model in Amameh Watershed. This model has eight inputs including rainfall and runoff with two days delay and temperature, evaporation and relative humidity and cluster separation with error values of 0.001, 0.025 and 0.008 in training stage and 0.001, 0.026 and 0.008 in test stage.

Keywords: Amameh Representative Watershed, intelligent models, rainfall-runoff relationship

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Estimation of the optimal amount of specific yield and groundwater recharge in unconfined aquifer of Golgir Plain, Khuzestan Province

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Abstract

The water table fluctuations (WTF) method is based on the rises of a water table mainly influenced by recharging groundwater. To apply this method, an appropriate estimate of the specific yield is required in the zone of the groundwater level fluctuation. In this paper, the specific yields are estimated by some methods including Drilling Well Logs (DWL), Envelope Straight Line (ESL) and Vertical Electrical Sounding (VES). To evaluate and choose the best method, specific yields value by hydrologic and hydrogeological data of the Golgir Plain have been gathered during eight years from 2006 to 2013. The correlation coefficients between recharge and rainfall as well as recharge and baseflow in ESL method was obtained $r^2=0.79$ and $r^2=0.90$, respectively. The appropriate correlation coefficient in ESL method shows the optimized value of the specific yield equal 0.12 for Golgir Plain. The correlation coefficients obtained from the relation between recharge groundwater value, base flow, and rainfall using DWL, ESL and VES methods indicated that ESL method with $r^2=90$ is the best method to estimate the specific yield. Hence, attention to importance of recharge value in planning and management of groundwater and high influence of specific yield value in WTF method, groundwater recharge estimation using optimal value of specific yield can be very helpful to the water science researchers.

Keywords: Golgir Plain, groundwater recharge, specific yield, WTF method.

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Moldeling of dissolved solids using Hybrid Soft Computing Methods (Case study: Nazluchay Basin)

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Abstract

Rivers plays important roles in providing drinking and agricultural water supply. In this study, single and hybrid-wavelet methods of artificial neural networks, adaptive neuro fuzzy inference system and Gene expression programming were validated for total dissolved solids modelling of Nazluchay Basin. Therefore, water quality data with 19 years length (1993-2011), four hydrometric stations at Nazluchay Basin, were used. After validating of data and selected stations were analyzed by using Daubechies-4 wavelet transform. For modelling, 80% of data were used for training and 20% of data for testing of the model. The evaluation of models performance is applied based on different statistical tests, correlation coefficient, and mean root of error squares and mean absolute error. The results indicate acceptable performance of all single and hybrid-wavelet methods of artificial neural networks, adaptive neuro fuzzy inference system and Gene expression programming for modeling the total dissolved solids in the Nazluchay basin. A ranking of the top performance of the models is WGEP, GEP, WANFIS, ANFIS-SC, WANN, ANFIS-GP and ANN, in order. In addition, Gene expression programming-wavelet hybrid model with the minimum RMSE of 21.078 has best performance compared with other single and hybrid models.

Keywords: Gene Expression; wavelet transform; dissolved solids; Nazluchay.

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Multi-criteria evaluation of spatial variations of water poverty index in some watersheds of Ardabil Province

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Abstract

Water resources are common objective and challenges of sustainable development, and its scarcity is one of the biggest multidimensional issues of current century. This could be the source of many positive and negative aspects of developments. The need for a comprehensive and multi-dimensional survey to assess the condition and to predict the future status of surface water resources has become increasingly important. To this end, Water Poverty Index (WPI) is proposed to assess the availability of water resources. In this study, the WPI consider the resources, cost, environmental and socio-economic capacity criteria. The index has been calculated for the subwatersheds of Ardabil Province. Then, the different weighting approaches (equal weight to all criteria and one-at-a-time emphasizing on different criteria), were used to examine the WPI values. As a result, the sub-watersheds of the study area were ranked in terms of water poverty degree. The results showed that the values of water poverty index were ranged from 22 to 65, according to the different weighting in the study area. With the equal weighted Water Poverty Index, the Shamsabad watershed had a higher water poverty index (29), while the Polesoltan watershed had the best condition with respect to water poverty condition compared with other watersheds in the Ardabil Province. The average WPI value in study area was 43, which classified as extreme water poverty condition according to the Center of Ecology and Hydrology of Wallingford classification. Water Poverty Index is a combination of influencing factors on water stress and scarcity, which provide a basis to prioritize and specify management options for different watersheds. It should be noted that determination and analysis of water scarcity in different areas is dependent on the condition of water resources, data availability and the employed sub-criteria in the calculation of water poverty index.

Keywords: water shortage, spatial variations, Water Poverty Index (WPI), prioritization, multi-criteria weighting

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Analysis of the role of organizational stakeholders in executive management network of water resources in Garmsar Plain

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Abstract

Organizational stakeholders network Analysis, as a structural method resulting from the interrelationships of various stakeholders can be considered in integrated and participatory water resources management approaches. The aim of this research was to use the network analysis model for understanding the role and position of organizations related to the executive level of water resources management In Garmsar Plain. The analysis of the capabilities of this network is conducted to create and establish an integrated and participatory water resources system. Accordingly, 29 organizations were identified as the network boundaries. Based on the role and position in the network management of water resources, these organizations were divided into three developmental, protective and intermediate groups. The coherence and sustainability of this network were studied based on network level indicators including size, density, centralization, the reciprocity rate of links, and the subgroup level indices of the network consisting of core-periphery and the E-I. According to the results of indicators at the network level, the link density of information exchange and cooperation is poor and does not benefit from a proper distribution among the subgroups. The reciprocity of the network links is equal to 50.48% and the shortest distance between the two actors in this network is 1.815. Accordingly, nearly half the relationships are one-sided and the speed of information flow in the network is moderate to low. Based on the subgroup level indicators of the network, the density rate of the central actors is equal to 82.2%, while the density between the periphery actors is 5.6%. The results also emphasize the need to reduce centralization within the network and to strengthen the relations between intermediate and peripheral actors to achieve the integrated and participatory management of water resources.

Keywords: network analysis, organizational stakeholders (executives), Garmsar Plain, integrated management of water resources, cooperation

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Evaluation of the performance of bat algorithm in optimization of nonlinear Muskingum model parameters for flood trend analysis

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Abstract

In this study, bat algorithm is used as an algorithm based on velocity and location of bats to optimize the parameters of Muskingum's nonlinear model for flood routing. The case study of Wilson flood and also a historical flood from Lighvan area were selected to trace flood routes and calculate the parameters of Muskingum's model. The aim of this analysis is to examine the efficiency of this algorithm. The sum of squares of deviations and the sum of the absolute values of deviations between routed and observational flows were considered as the objective functions. According to the results obtained from the Wilson flood routing using the bat algorithm, the values of these objective functions are equal to 35.14 and 22.76 m³ per second, respectively. The results of routing of Lighvan flood using bat algorithm also indicated that the sum of squared deviations, the sum of absolute values of deviations, and the difference between observed and routed peak flows are equal to 7.24, 6.23 and 0 m³/s, respectively. In the present study, the performance of the bat algorithm was compared with evolutionary algorithms such as genetic, particle swarm, and harmony algorithms. The results have indicated the superiority of the bat method in relation to the accurate calculation of the parameters of the Muskingum's model and accurate prediction of the flood. Therefore, it could be mentioned that bat algorithm method can be used to solve the problems related to hydrology and water resources management, so that, in many of these problems we encounter nonlinear objective functions and complex constraints that the algorithm is of proper answers in the shortest possible time.

Keywords: flood routing, Bat algorithm, Muskingum model, optimization

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Modelling of flow discharge in Great Karun sub-basins in terms of future climate

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Abstract

Climate change affects runoff flow of the basin by changing in the parameters of hydrological cycle. Understanding the possible changes in the amount of precipitation and runoff of the basin can help make a better planning and management of water resources. Precipitation changes due to climate change can be simulated using atmospheric general circulation models under different scenarios. Assessment of runoff involves application of precipitation- runoff models. The aim of this research is to make flow modelling in some parts of the Great Karun Basin as a result of possible changes in future climate. For this purpose, temperature and precipitation changes of the Great Karun Basin are simulated for years 2011-2030 and 2046-2065 using two general circulation models and downscaling process under B1 and A2 scenarios. Then, the output flow of Andimeshk, Ahwaz and Yasouj sub-basins was predicted by IHACRES rainfall- runoff model and using precipitation and temperature data predicted under B1 and A2 scenarios. Comparison revealed that the amount of precipitation, maximum temperature and minimum temperature will be increased in the future periods under both scenarios. The results of flow simulation also show that the runoff of future periods under both scenarios will decrease in spring and summer and increase in autumn and winter in study area.

Keywords: climate change, simulation, general atmospheric circulation model, statistical downscaling.

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Assessment of hydrochemical characteristics and water quality of springs and wells in Zarivar Lake zone

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Abstract

This study attempts to investigate the physicochemical and hydrogeochemical properties, hydrochemical features, thermodynamic equilibrium, and controlling mechanisms of 7 springs and 15 wells in Zarivar Lake, Kurdistan province. This study has used 15 water quality data variables from 1998 to 2013 and also compared the quality of water in springs and wells and their seasonal variations. Piper, Schoeller, Durov, Ludwig-Langelier, Wilcox and Gibbs diagrams, have been applied to calculate different ionic ratios and saturation indices, using Wilcoxon and Mann-Whitney tests. Abundant ions are bicarbonate, calcium and magnesium, and the dissolution of carbonate rocks in the ground water recharge area. The ratio of Ca/Mg are between 2 and 9 in all springs and wells due to dissolution of silicate minerals. Total hardness is greater than 300 mg/l based on CaHCO_3 or very hard water. Two main hydrochemical facies are Ca-Mg- HCO_3 and Ca-Mg- HCO_3 - SO_4 that are the result of changing water chemistry processes along the flow path and lithology of underlying geological formation. Ion ratios of Mg/Ca to Cl and Gibbs diagram showed the dominant mechanisms of interaction between rock and water, cation exchange and dissolution of carbonate and silicate minerals for determination of the chemical quality of water in springs and wells.

Keywords: groundwater, saturation index, Gibbs, ion ratio, Marivan.

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Influence of vermicompost and urea chemical fertilizer on monthly changes in runoff at plot scale

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Abstract

This study has investigated monthly changes in runoff quality and quantity under the influence of Vermicompost and urea in Northern Iran. For this purpose, 18 runoff measurement plots of 1× 5 m were installed on 14% slopes under natural rainfall during 5 months (from January 2014 to April 2015). In total, 12 rainfall events and their runoff were considered. Treatments in this study included 100% Vermicompost, 100% Urea fertilizer, 100% Vermicompost and 50% Urea chemical fertilizer, 75% Vermicompost and 50% Urea chemical fertilizer, 50% Vermicompost and 50% Urea chemical fertilizer. The results showed that sediment yields, nitrate amount, pH and EC of runoff were not influenced by Vermicompost and Urea fertilizer. However, using Vermicompost reduced volume of runoff in the first month of the experiment (sig=0.002). This shows the positive effect of Vermicompost on runoff quantity but it has a limited impact on runoff management on steep terrain.

Keywords: agricultural land, runoff volume, Northern Iran, runoff quality, vermicompost

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Development of a model for calculation of sustainability index of groundwater resources

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Abstract

Nowadays, one of the most important concerns in many countries is sustainable water supply. For efficient management of groundwater resources it is required to have an appropriate tool for modeling and a measurement tool for evaluating sustainability. This paper analyzes the sustainability condition of the system using an integrated modeling framework that contains in a watershed agricultural based hydrological model (Soil and Water Assessment Tool, SWAT) and a groundwater flow model developed in MODFLOW. The framework has also a TDS mass-transport model in MT3DMS in Esfahan-Borkhar, Iran. Outputs of SWAT model (mainly for groundwater recharge and pumping) are used as MODFLOW inputs to simulate changes in groundwater flow and storage and the impacts on stream–aquifer interaction. The outputs of MODFLOW (groundwater velocity field from MODFLOW) are used as MT3DMS inputs to assess the fate and transport of TDS. Heads and concentrations of each cell of the models of MODFLOW and MT3DMS are used to calculate the developed Sustainability Index, three performance criteria of Reliability, Resilience and Vulnerability. This method is conducted under three scenarios including continuation of the previous trend in groundwater abstraction, 30 percent increase, and a reduction in Groundwater Abstraction. The results have indicated that SI in simulation period is 0.052 and under the first, second and third scenarios the value is 0.040, 0.033 and 0.050, respectively. The results also show that a 30 percent reduction in abstraction of groundwater can improve the quantity and quality of sustainability conditions.

Keywords: sustainability index, SWAT, MODFLOW, MT3DMS, MATLAB

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Optimization of DRASTIC method using ANN to evaluate vulnerability of Varzqan multiple aquifer

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Abstract

Population growth and development of agriculture and mining activities in the Varzeqan plain increased the amount of nitrate concentration to 5 times the standard value of World Health Organization (WHO). Thus, evaluation of vulnerability and protection of groundwater resources are very important in this area. The DRASTIC method uses seven effective environmental parameters on assessment of aquifer vulnerability such as **D**epth to groundwater level, **R**echarge, **A**quifer media, **S**oil media, **T**opography, **I**mpact of vadose zone and hydraulic **C**onductivity. The seven layers were prepared separately for unconfined and confined aquifers by corresponding rate and weighting. The DRASTIC vulnerability Index is obtained by overlaying these seven DRASTIC layers. The DRASTIC index value was evaluated for unconfined and confined aquifers 92-163 and 48-93, respectively. The artificial neural network model was also used to optimize the DRASTIC method. In this model, the DRASTIC parameters were considered as input, and conditioned DRASTIC index were used as output, and the data were divided into two categories of train and test. After model training, the model results were evaluated by the nitrate concentration through coefficient of determination (R^2) and correlation index (CI) criteria. The results showed that artificial neural network model show high capability to improve the results of general DRASTIC and reduce subjectivity of model, especially in multiple aquifers.

Keywords: vulnerability, multiple aquifer, DRASTIC model, Artificial Neural Network

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Using a hybrid Multiple Criteria Decision Making model for the strategic restoration of a seasonal-urban river

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Abstract

The aim of this study is to determine the best strategy for restoration of a seasonal-urban river. Brainstorming sessions were held and SWOT method was used to determine the strategies and effective criteria. Then, the strategies were ranked by using the hybrid model of Analytical Hierarchy Process (AHP) and Modified Technique for Order of Preference by Similarity to Ideal Solution and the best strategy was selected. In this study, two basic goals of river's restoration were considered separately. This is to restore the quality and quantity of water flow and recharging its aquifer and securing to reduce the risk of floods. The results showed that the best strategy for restoring the quality and quantity of aquifer and water flow is balancing the sources and uses of river and groundwater. On other hand, for flood risk management, only management strategy (flood plain management including control of development and construction) was recognized as the best strategy. The results showed that for restoration of a seasonal-urban river, the management strategies have higher priority compared with structural strategies. The proposed framework of this paper can be used in the strategic management of river restoration in other seasonal-urban rivers.

Keywords: strategic management, Multi-Criteria Decision Making, river restoration, flood safety.

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Sensitivity analysis of the Soil Moisture Accounting Algorithm for Continuous Hydrological Modeling in Beheshtabad Basin

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Abstract

Sensitivity analysis is a common tool to study how changes due to uncertainty in the inputs or parameters can affect the outputs of the simulatinon model. This analysis is an effective way to identify important inputs/parameters for model calibration. It is also useful to recognize sensitive parameters to noise. The aim of this study is to perform sensitivity analysis and model calibration for a hydrological model called HEC-HMS with Soil Moisture Accounting (SMA) algorithm. In this research, manual and automatic parameter sensitivity analysis was used to calibrate and validate the model in Beheshtabad Basin. The data (1998 to 2015) was separated into 2 parts, the first 13 years daily data set including discharge, rainfall, temperature and evapotranspiration were used for calibration. The second period of the data from 2012 to 2015 was used to test the model. The evaluation was based on model efficiency coefficient and root mean square error indexes. The Nash-Sutcliffe model efficiency coefficient values of 0.696 and 0.63 were resulted for both calibration and validation, respectively. The root mean square error was found to be 13.2 m³/s and 7 m³/s for corresponding stages. The results of performed sensitivity analysis in both forms of automatic and manual have indicated that the parameters of soil storage, tension storage and recession constant have the highest sensitivity. This is an indicator for the importance of these factors in continuous modeling in a specified catchment.

Keywords: validate, hydrological model, model efficiency coefficient, recession constant

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Hourly and daily prediction of sea wave height in the Chabahar

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Abstract

The waves are important, because of their energy and high impact on maritime activities. Given the effects of wave on marine activities in Chabahar, different factors influencing the wave height were considered in the present study. In this paper, the Wolf Search Algorithm (WSA) was used to predict wave height in two categories, daily and hourly. For this purpose, the daily data of the year 2007-2011 and hourly data of two months of the year, 2006, were employed. The results of the WSA were compared with Genetic Algorithm (GA) and Harmony Search Algorithm (HS). The WSA had a better performance for both hourly and daily data. Thus, R^2 , RMSE, d And MAE have predicted 0.9497, 0.0704, 0.987 and 0.0483 for hourly prediction and 0.8558, 0.1742, 0.9599 and 0.1138 for daily prediction, respectively. The results show the high ability of evolutionary algorithms in wave height prediction in this Region.

Keywords: sea wave height, prediction, Wolf Search Algorithm, Chabahar.

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Evaluation of SEBS Model to estimate actual evapotranspiration using MODIS sensor data in regional scale (Case study: Sistan Plain)

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Abstract

The purpose of this study is apply remote sensing technology and data including MODIS sensor images and also performance of Surface Energy Balance (SEBS) model to estimate actual evapotranspiration in Sistan Plain. Surface flux of energy balance is calculated for each image pixel and actual evapotranspiration were estimated by the remaining amount of the energy balance at the level. The results were compared with the results of two point ground-based data of the hay grown on the sidelines of Zahak synoptic station and water level data of Chahnime reservoir. Based on spatial instant evapotranspiration distribution map, maximum rate of evaporation is resulted from water body including Chahnime reservoir and part of Hamoon wetland. This rate is equal to 1.13 mm/hr. Sistan agricultural plain area are also benefiting from the distribution of evaporation rate between 0.5 to 1 stake in evapotranspiration area. The comparison of SEBS results with two point ground-based data, with Mean absolute percent difference, Root-mean-square difference and the correlation coefficient has revealed good performance of SEBS model for both land and water body.

Keywords: evapotranspiration, remote sensing, SEBS, Penman-Monteith, Sistan Plain.

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Contribution of climate variability and land use changes to water quality changes of Haraz River, Mazandaran Province

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Abstract

Identifying the trend of water quality parameters and their changes as same quantitative analysis of water resources is essential for sustainable management of the basins. Given the importance of surface water resources for different uses in the Haraz River basin, it is necessary to have an accurate understanding of water resources quality and identifying the factors affecting their changes. For this purpose, to analyze surface water quality in the Haraz River, 12 water quality variables accompanied by hydro-climatologic parameters have been analyzed by Mann-Kendall Non-parametric test for the period of 1991-2015. To detect probable effects of land use changes, these changes also have been analyzed by GIS for 1991, 2006 and 2015. The results showed that most of time series of water quality have significant increasing trend. This is representative of severe reduction in water quality of Haraz River. According to the results of Mann-Kendall test (trend analysis of hydro-climatic parameters, detection of abrupt change point and Kendall τ correlation test) and also land use changes trend, it was concluded that both climatic and land use changes can be effective on reduction of the quality of water resources so that temperature increase and precipitation decrease in one hand can lead to a decrease in some parameters such as Ca^{2+} , HCO_3^- and TH, and on the other hand, these changes together with land use changes can be the main reason of increase in most of parameters such as TDS, EC, Na^+ , Cl^- , SAR etc.

Keywords: trend analysis, water quality, climate variability, land use change, Haraz River Basin.

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Role of suspended particulates on the transport of heavy elements in the middle part of Dez River

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Abstract

This study has been conducted to monitor and recognize the condition of transported suspended particulates and absorbed heavy metals in Dez River between Shahid Abbaspour Dam and Shotate River Junction. This study has also examined the effects of inflow from two tributaries in Kouzestan province, Iran. We took 38 samples in three steps in a base flow period and two flood events from four gauging sites including Dokouheh on Balaroud, Zourabad on Kohnak, Dezful on Dez upstream and Harmalah on Dez downstream. After sediment filtration, some samples have been analyzed by Inductively Coupled Plasma to determine 12 heavy metals. The results showed that the river suspended sediments are classified as not polluted by heavy metals for agriculture purpose at least for the examined samples. However, the amount of three heavy metals including Cobalt (20-22 ppm), Chrome (88-96 ppm) and Nickel (76-91 ppm) are more than environmental safe thresholds. In addition, the concentration of those heavy metals in downstream station is more than the tributaries which is probably due to deposition of coarser sediment particles. Therefore, it can be concluded that the suspended sediments between Dokouheh to Haramalah reach and Zourabad to Haramalah reaches are polluted by the three mentioned heavy metals.

Keywords: heavy metals, non-source pollutants, suspended sediment, sediment management.

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Correction of annual maximum discharge based on appropriate probability distribution function in south Iran

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Abstract

In this research, to select the best distribution function for the annual maximum discharge in the southern provinces of Iran (Sistan & Baloochistan, Fars, Kerman, Booshehr & Hormozgan), we have used daily discharge data of 108 hydrometric stations during a 30 years period 1983-2012. These data have been fitted with 65 probability distribution functions. After conducting the goodness of fit tests using the statistical calculations, the best distribution functions for the annual maximum discharge was determined. Eventually, the discharge values have been calculated with different return periods and compared with the results of the common distribution functions like log- Pearson (III), log- normal (III) and Weakby. The best statistical distributions are the Waekby distribution functions with the 2.43% as the first rank, the log- Pearson (III) with the frequency of 6.13% as the second rank and log- normal (III) with the frequency of 5.6% as the third rand. The MBE index in the annual maximum discharge estimation showed that in 2.5 and 10- year return period, the Weakby statistical distribution has a better estimation and in the 25.5 and 100-year return period, the log- Pearson (III) statistical distribution is better. As the RMSE index is compared with the mean absolute percentage error (MAPE) in both Weakby and log Pearson (III) statistical distributions, it is found that Weakby statistical distribution has a better estimation in the different return periods in this index. Thus, using the Weakby distribution in the flood frequency analysis for an accurate prediction of annual maximum discharge can be helpful in different return periods.

Keywords: annual maximum discharge, Waekby distribution, log- Pearson (III), goodness of fit tests.

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Modeling the response of groundwater flow to tidal fluctuations in a coastal leaky aquifer by separation of variables and Fourier transformation

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Abstract

In this paper, groundwater response to tidal effects in a Coastal Leaky Aquifer is simulated via analytical solutions. The solutions are obtained using the method of separation of variables and Fourier transformation. It is shown that those points of the aquifer near to the coastal shore are much more influenced by the tidal fluctuations in the boundary than the rest of the aquifer. The amplitude of tidal change is significant at the points of the aquifer near to the coastal shore and gets smaller with distance from the boundary. In addition, it is indicated that groundwater level increases with rises in transmissivity. This phenomenon is more significant when transmissivity is less than $400m^2/hr$. Also, the groundwater head rises with rises in recharge rate. The effects of variations in transmissivity and recharge rate on hydraulic head is more significant at the points located between 30 and 75 meters and less significant at those near to the coastal shore. The presented analytical solution is compared and verified with those results obtained from MODFLOW.

Keywords: analytical solution, coastal leaky aquifer, groundwater flow, tide, method of separation of variables and Fourier transformation

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Potential Evaluation of underground water resources with hybrid approach to Particle Swarm Optimization Algorithm and Geographic Information Systems (Case study: Mehran, Ilam)

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Abstract

One of important problems in management of groundwater resources is to find potential of the resources for correct planning and decision making for use. The purpose of this research is to evaluate the potential of groundwater resources with the hybrid approach to particle swarm optimization algorithm and geographic information systems in Mehran plain. For the evaluation of groundwater resources potential in this area, we have considered 13 various factors that have great impact on the level of water permeability in groundwater resources formation. These factors are including the slope, height, drainage density, fault density, T map, K map, recharge map, landuse map, lithology map, Sy map, depth of groundwater map, well density map and Cl map. We have prepared and classified these criteria. Then, by PSO algorithm, each map was assigned a weight based on its preference. Using overlay method in GIS, the criteria have been combined with each other and at the end 2 final groundwater potential map obtained, one is created as the optimization equation is equal to the well density map (PSO_chah), and the other is again created as the optimization equation is equal to the Sy map (PSO_Sy). In this context, PSO_chah map determined 2.56% and PSO_Sy map about 2.40% of the area as the zones with very high potential with groundwater resources.

Keywords: potential evaluation, underground water, Particle Swarm Optimization Algorithm, Geographic Information Systems

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Event-oriented runoff estimation in mountainous basin by GSSHA Physically-Distributed Model

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Abstract

The physically-distributed models lead to more reliable results for surface runoff process simulation in the basins with complicated physical condition. In this study, rainfall-runoff modeling in Ziarat mountainous basin was investigated using GSSHA physically-distributed model. Digital elevation model, soil type and land use maps have been prepared and three and two events are considered for calibration and validation, respectively. Fitness precision criteria including Nash-Sutcliffe (NSE), Percentage Error in Volume (PEV), Percentage Error in Time to Peak (PETP) and Percentage Error in Peak (PEP) have been used for result analysis. Median of PEV, PEP and PETP for calibration and validation steps were (25.3 and 61.5), (5.5 and 11.8) and (4.8 and 0), respectively. This has indicated underestimation for volume, suitable precision for peak and excellent precision for time to peak estimations. The evaluation of simulated hydrographs using visual and NSE criteria confirmed model precision for hydrograph simulation. The results have indicated that although soil initial moisture is selected based on initial estimation in validation step but the overall precision of the model is suitable in runoff characteristics estimations.

Keywords: physically-distributed, rainfall-runoff, GSSHA, Ziarat.

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Meteorological drought monitoring to keep sustainability in RCP scenarios (Case study: Doiraj Watershed)

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Abstract

Climate change will lead to repeated unexpected disasters such as droughts and floods affecting human life and the natural ecosystems. The aim of this study is to preserve the sustainability of the Doiraj watershed in Dehloran City against climate change events in RCP scenarios. The observation and future period in this study is (1987-2015) and (2044-2016). For this purpose, the combined weights of 5 models of Fifth Report (AR5), rcp8.5 scenario, have been used to assess the changes in temperature and precipitation in the coming period. MOTP weighting method has been used to reduce uncertainty of GCM models applying the change factor downscaling method. Meteorological drought monitoring in monthly, seasonal and yearly intervals has been calculated by Markov chain, frequency analysis and drought indexes of SIAP, SPI, Z score and BMDI. The results have indicated that long-term average monthly rainfall and temperature is at a rate of 14 percent and 2.1 degrees Celsius, compared with the baseline. Markov chain probability of uncertainty precipitation showed two months without precipitation in winter, spring and autumn with 56, 63 and 52 percent, respectively. The chance of precipitation after a month of dry seasons is 44, 35 and 47 percent for winter, spring and autumn, respectively. The maximum probability of precipitation is revealed for April. Based on the analysis of the indices in this research, the period 2017-2018 is wetter than the period of 2016-2017 and the periods of 2024-2025 and 2025-2026 are the wettest periods. Rainfall frequency analysis of Doiraj dam catchment has estimated a 727.61 mm rainfall for a return period of 50 years.

Keywords: climate change, AR5, drought indecies, Markov chain, frequency analysis.

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Assessment of artificial recharge for aquifer restoring using sustainability index

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Abstract

Restoring of groundwater level to its optimum using restoration plans is one of the main objectives of water policy makers. One of the strategies is to conduct artificial recharge. This type of recharge is required to be evaluated using sustainability indexes in order to quantify the effects. In this research, a new approach is utilized for evaluation of groundwater system sustainability. This is combined with the indexes, reliability, vulnerability and desirability with regard to the effects of artificial recharge scenario. For this reason, the effects of Shurab Sivjan artificial recharge project on Birjand aquifer is simulated for a nine-year period, projected to 1404 Hijri (2025 Gregorian) with normal climatic condition, using MODFLOW model. Simulation results show that aquifer system sustainability is higher in the downstream parts, where the Khusf observation well is located. This is justified by the groundwater recharge flow direction, low difference between optimum and measured groundwater level, and thin saturated thickness with 55 percent. According to reduction, constant and increment discharge scenarios, evaluation of the indices for the aquifer shows that the artificial recharge project could enhance the system sustainability between 21 to 25 percent. The proposed index in this research can be utilized for the other aquifers as well as in decision-making, because of its ability to define distributed manner and possibility of evaluating the effects of different scenarios.

Keywords: sustainability index, reliability, vulnerability, desirability, artificial recharge

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Economic and environmental analysis of the small hydropower plants development

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Abstract

The environmental problems in one hand and the depletion of fossil fuels for energy production on the other have attracted the attention of human society to the use of alternative and renewable sources of energy. Hence, development of hydropower plants is one of the solutions in many countries. Since the hydropower plants division into small and large scales, economic and environmental factors play an important role in choosing the optimal scale of hydropower plants. In this study, an analytical and comparative method has been used to determine the economic and environmental effects of the construction of small hydropower plants compared with large hydropower plants. The results indicate that small hydropower plants, in addition to the ability to use the minimum potential of water, are economically and environmentally advantageous in comparison with large hydropower plants. Some of the main advantages of small hydropower plants that differentiate them from large hydropower plants are: low investment costs, shorter construction time, reduced greenhouse gas emissions, the proper dispersal units, enabling capacity for technology transfer and private sector investment capability. These advantages made small hydropowers a good alternative relative to large hydropower plants.

Keywords: small hydropower plants, large hydropower plants, environment factors, economic factors, renewable energies

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