

Modeling the Influence of Biophysical Properties and Surface Topography on the Spatial Distribution of Soil Moisture in the Summer: A Case Study of Balikhli-Chay Watershed

Solmaz Fatholouloumi^{1,2}, Ali Reza Vaezi^{3*}, Seyed Kazem Alavipanah⁴, Ardavan Ghorbani⁵

1. PhD Student, Department of Soil Science, Faculty of Agriculture, University of Zanjan, Iran

2. Expert, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardebili, Ardabil, Iran

3. Professor, Department of Soil Science, Faculty of Agriculture, University of Zanjan, Iran

4. Professor, Department of Remote Sensing & GIS, Faculty of Geography, University of Tehran, Iran

5. Professor, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardebili, Ardabil, Iran

(Received: March 6, 2020- Accepted: May 12, 2020)

Abstract

The use of satellite data for rapid estimation of soil moisture (SM) and determination of environmental factors affecting it has been developed in recent years. The aim of this study was to investigate the effect of biophysical and topographic characteristics on spatial distribution of SM in the summer. For this purpose, SM was measured at 148 points in Balikhli-Chay watershed in Ardabil province and triangular method based on ASTER digital elevation model, land cover map and climatic data was applied for SM modeling. Surface biophysical properties including wetness, greenness, brightness, and land surface temperature and topographic variables (solar local incidence angle, elevation, slope, and aspect) were calculated. Model error in different months was determined using error statistics. According to the results, the average SM content in the region in July, August and September were 4.67, 6.22 and 4.66%, respectively. The lowest coefficient of determination (R^2) and root mean square error (RMSE) of estimated and measured SM were related to September (0.78 and 1.44, respectively). The strongest linear relationship between SM and biophysical variables (topography) was related to July (with R^2 and RMSE equal to 0.53 and 0.29, respectively). SM decreased with increasing land surface temperature and brightness, however increasing greenness, wetness, elevation and solar local incidence angle increased SM content. This study showed that the triangular model can be used to investigate the spatial distribution of SM using biophysical and surface topographic properties. Using the results of the present study can be very useful in improving the accuracy of SM modeling for various applications such as irrigation management, run-off prediction and precision agriculture.

Keywords: Biophysical characteristics, Landsat 8, Land surface temperature, Solar local Incidence angle, Topographic properties.

* Corresponding Author, Email: vaezi.alireza@znu.ac.ir

Spatio-temporal of Walnut Water Footprint Components and Virtual Water Trading in Iran

Zahra Bazrafshan¹, Hadi Ramezani Etedali^{2*}, Omolbanin Bazrafahan³

1. M.Sc. Student, Department of Water Sciences and Engineering, Imam Khomeini International University, Qazvin, Iran
2. Associate Professor, Department of Water Sciences and Engineering, Imam Khomeini International University, Qazvin, Iran
3. Associate Professor, Department of Natural Resources Engineering, Faculty of Agriculture and Natural Resources, University of Hormozgan, Bandar Abbas, Iran

(Received: March 29, 2020- Accepted: June 2, 2020)

Abstract

Many regions of Iran are increasingly faced with water crisis. Since agriculture is the main sector of water resources consumption with 85% of global surface and groundwater, it is necessary to reduce water consumption in this sector. Environmental protection, water resources and agricultural production are the main important goals of echo hydrology. Water footprint (WF) and virtual water trading (VW) concepts are recently used for fresh water resources management and echo hydrology engineering. WF and VW are used for sustainable management of water resources, especially in arid and semi-arid regions. These concepts have been used more in crop productions and less in fruit crops. The purpose of this study was to investigate the water footprint and water footprint in walnut production for duration of 2006-2016 in provincial and national scale of Iran. This study calculates water footprint components in walnut production for duration of 2006-2016 in provincial and nation scale of Iran. Result showed the average of water footprint is 6.42 m³/kg which the share of blue, green and grey water footprint are 90%, 3% and 7%, respectively. The highest and the lowest water footprint are in Yazd (14.11 m³/kg) and Mazandaran (1.94 m³/kg) provinces. Also, the total volume of water footprint is 1493 MCM per year that exported about 94% (1403 MMC per year) in the form of virtual water trade.

Keywords: Water footprint, Walnut, Provincial scale, National Scale, Virtual water Trade.

* Corresponding Author, Email: Ramezani@eng.ikiu.ac.ir

Impacts of the Golestan and Voshmgir Dams on Indicators of Hydrologic Alterations in the Gorganroud River Using Range of Variability Approach

Fatemeh Daiechini¹, Mehdi Vafakhah^{2*}, Vahid Moosavi³

1. M.Sc. Student of Watershed Management Engineering. Faculty of Natural Resources and Marine Sciences. Tarbiat Modares University, Noor, Mazandaran Province, Iran
2. Professor, Department of Watershed Management Engineering. Faculty of Natural Resources and Marine Sciences. Tarbiat Modares University, Noor, Mazandaran Province, Iran
3. Assistant Professor, Department of Watershed Management Engineering. Faculty of Natural Resources and Marine Sciences. Tarbiat Modares University, Noor, Mazandaran Province, Iran

(Received: April 1, 2020- Accepted: June 8, 2020)

Abstract

Dam construction as one of the methods in water resources management, is among the most important man-made structures along rivers that can make major hydrological changes in the river regime and ultimately in the entire drainage basin and surface flow adjustment. Therefore, the quantitative evaluation of hydrological changes caused by human activities such as dam construction is very important. Therefore, the purpose of this study is the statistical analysis of the indicators of hydrologic alterations affected by the Golestan and Voshmgir dams in the periods before and after the construction of these dams using the IHA software version 1.7. To do this, Gonbad and Ghazaghli hydrometric stations in downstream of Golestan Dam were considered to analyze the effect of Golestan dam and Agh Ghala hydrometric station to analyze the effect of Voshmgir dam. Also, in order to investigate the climate change situation in the study area, the trend of climatic Variables *i.e.* precipitation, temperature and evapotranspiration were evaluated using Mann-Kendall test and Sen's slope. Then, the changes of 33 hydrological indicators in five main groups (magnitude-duration-timing-frequency- rate of change) before and after the construction of Golestan and Voshmgir dams were calculated using Range of Variability Approach (RVA) approach. According to the results of trend analysis, precipitation and temperature had an increasing trend while evapotranspiration had a decreasing trend. Based on the indicators of group one (Magnitude), it can be concluded that average monthly discharge in the period after the construction of Golestan Dam has decreased compared to the period before the construction of the dam in Gonbad and Ghazaghli hydrometric stations. While the average monthly discharge has increased after the construction of the Voshmgir Dam except from March to June. For the indicators of group two (minimum and maximum discharges), it can be stated that all flow indicators except 3-, 7-, and 30-day minimum flow indicators and 1-, 3-, 7-day maximum flow indicators in Gonbad hydrometric station and 1- and 3-day minimum flow indicators and 3-day maximum flow indicators in Ghazaghli hydrometric station have decreased after the Golestan dam construction. While all flow indicators except 1-, 3-, 7-day maximum flow indicators in Agh Ghala hydrometric station have increased after the Voshmgir dam construction. Finally, it can be concluded that flow regime changes can pose significant threats to plant and animal species (aquatic and wildlife) and lead to adverse environmental effects. It should be noted that the variation in the hydrologic indicators is mainly influenced by dam construction and the change of climate variables has also been influential in this regard, and the separation of affecting factors need to be considered in further studies.

Keywords: Climate Variables, Flow Regime, Indicators of Hydrologic Alterations, Trend, Environmental Water Requirement.

* Corresponding Author, Email: vafakhah@modares.ac.ir

Investigating the Effect of Basic Flood Characteristics on Flood Routing Accuracy in Karun River Using Hydrological Routing Methods

Hadi Norouzi¹, Vahid Karimi², Jalal Bazargan^{3*}

1. Ph.D. Student of Water Engineering and Hydraulic Structures, Department of Civil Engineering, Faculty of Engineering, University of Zanjan, Zanjan, Iran
2. MSc. Student of Water Engineering and Hydraulic Structures, Department of Civil Engineering, Faculty of Engineering, University of Zanjan, Zanjan, Iran
3. Associate Professor, Department of Civil Engineering, Faculty of Engineering, University of Zanjan, Zanjan, Iran

(Received: April 1, 2020- Accepted: May 23, 2020)

Abstract

Unsteady flow analysis is performed using hydraulic and hydrological routing methods. Hydrological routing methods, while accurate, are much simpler and less expensive than hydraulic routing methods, and for flood routing calculations, only data related to hydrographs (flow changes over time) recorded at upstream and downstream hydrometric stations of the study area are needed. In the present study, the effect of the basic flood on the accuracy of flood routing in the Karun River was investigated using hydrological routing methods including linear Muskingum method, Working Values, Convex, and modified Att-Kin method. In other words, using the Particle Swarm Optimization (PSO) Algorithm and the 4 observational floods data recorded at the Mollasani (upstream) and Ahwaz (downstream) hydrometric stations of the Karun River, for each flood, separately, the linear Muskingum method parameters (X , K , Δt) Optimized and used to calculate the outflow hydrograph of all floods. The results show that due to the effect of rivers flooding extent on the mentioned parameters, if the range of inflow of basic flood changes is closer to the inflow of calculated flood, the accuracy of hydrological routing methods in outflow hydrograph estimation increases.

Keywords: Basic Flood, Flood Routing, Hydrological Routing, Karun River, Particle Swarm Optimization (PSO) Algorithm.

* Corresponding Author, Email: Jbazargan@znu.ac.ir

Modeling the discharge of Karun River Using a New Method Based on the Joint LSTM and GRU Neural Networks

Pouya Ahmadi¹, Hossein Arefi^{2*}, Nazila Kardan³

1. M.Sc. Student, School of Surveying and Geospatial Engineering, College of Engineering, University of Tehran North Kargar Ave., Jalal Al. Ahmad Crossing
2. Associate Professor, School of Surveying and Geospatial Engineering, College of Engineering, University of Tehran North Kargar Ave., Jalal Al. Ahmad Crossing
3. Assistant Professor, Department of Civil Engineering, Azarbaijan Shahid Madani University, Tabriz, Iran

(Received: March 2, 2020- Accepted: May 23, 2020)

Abstract

Modeling the river discharge is of great importance in water resources and risk management. This is especially important in mountainous areas since most of the low-income people in such areas are heavily dependent on agriculture and commercial activities such as electricity. In this regard, in recent years, machine learning models have received more attention due to their high accuracy in predicting through black box learning. Therefore, in this study, a combined approach has been proposed to predict the average monthly discharge of the Karun River. This method uses a combination of LSTM and GRU neural networks. The LSTM network is a deep learning neural network that has the ability to add the concept of time to modeling; therefore, this method has been considered in this study due to the nature of time series of the data. However, the utilized network in this method is considerably slow due to its large number of gates. Accordingly, to compensate the speed issue, the GRU layer method, as another example of deep learning networks, is used. To predict the average monthly flow of the Karun River in Dubai, the statistical data of Molasani station from April 1st, 1995 to March 20th, 2016, with five combination of river discharge inputs on monthly basis, has been used. The proposed approach is compared with other available methods such as support vector machine, adaptive fuzzy-neural inference system, and multiple linear regression model. The results show the high accuracy of the proposed approach compared to other methods.

Keywords: Monthly discharge, Forecast, SVM, GRU-LSTM, Karoun River.

* Corresponding Author, Email: hossein.arefi@ut.ac.ir

Development of ANN, FIS and ANFIS Models to Evaluate the Adequacy Index in Agricultural Water Distribution Systems (Case study: Rudasht Irrigation Network)

Habibeh Sharifi¹, Abbas Roozbahani^{2*}, Mehdi Hashemy Shahedany²

1. MSc Student of Water Resources Engineering, Department of Irrigation and Drainage Engineering, Aburaihan Campus, University of Tehran, Tehran, Iran

2. Associate Professor, Department of Irrigation and Drainage Engineering, Aburaihan Campus, University of Tehran, Tehran, Iran

(Received: April 1, 2020- Accepted: May 29, 2020)

Abstract

In order to properly manage water in the agricultural sector, it is necessary to improve the management of agricultural water distribution systems as well as their evaluation. In this research, to achieve this goal, the models of Fuzzy Inference System (FIS), Artificial Neural Network (ANN) and Adaptive Fuzzy Neural Inference System (ANFIS), to develop a smart model for analyzing the adequacy of water delivery in an irrigation canal, given uncertainty. In order to develop and evaluate the performance of the developed models, the main canal of Rudasht Irrigation Network in Isfahan province, which is facing the problem of severe fluctuations in the inflow, was selected as the case study. The HEC-RAS hydrodynamic simulator model was used to generate the information needed to train and validate these models. The results showed that according to the MAPE index, the selected structures in ANN and ANFIS models in estimating the adequacy index of agricultural water delivery compared to FIS model have improved by 57.07% and 56.68%, respectively. Evaluation of the results showed that the developed models compared to conventional evaluation methods (hydrodynamic models and evaluation indicators) not only did not take time but also provided more accurate results, considering the uncertainty and also, ANN and ANFIS models performed better than FIS, so they can be used for other agricultural water distribution systems.

Keywords: Agricultural Water Distribution, Delivery Adequacy, FIS, ANN, ANFIS.

* Corresponding Author, Email: roozbahany@ut.ac.ir

Zoning and Monitoring of Spring 2019 Flood Hazard in Khuzestan Using Landsat-8 Data

Karim Solaimani¹, Shadman Darvishi^{2*}

1. Professor, Department of Watershed Management, Sari Agriculture, Science and Natural Resources University, Sari, Iran

2. M.Sc. Student of Remote Sensing & GIS, Higher Education Institute of Haraz, Amol, Iran

(Received: March 22, 2020- Accepted: May 23, 2020)

Abstract

Flood monitoring and zoning play an important role in reducing the damage caused by this natural crisis. The purpose of this paper is to investigate the risk of flooding of April 2019 in Khuzestan using Landsat-8 data. First, image processing was performed in ENVI 5.3 software and then MNDWI and NDWI indices were used to monitor the floods. Then, the flood hazard map was prepared in ArcGIS10.4 software. The results show that the southern and southwestern parts of the province are in a very severe situation and the central and southeastern parts are in a very hazardous condition, which is one of the most prone flood areas in the province. Also, monitoring of flood maps in Khuzestan province shows that there is a complete similarity between the recent flood and flood zoning map. Examination of the maps showing that the recent floods occurred mostly in the western, southern and southwestern parts. Spatial survey of floodplain areas shows that the cities of Hoveyzeh, Azadegan Plain, Ahvaz, Khorramshahr, Bandar Mahshahr, Abadan and especially Shadegan have been flooded more than other cities. Meanwhile, Shadegan city has been affected by floods based on MNDWI and NDWI indices of 191349 and 174813 hectares, respectively, which shows the highest rate compared to other cities in the province. In general, according to the results, the use of remote sensing data and MNDWI and NDWI indices for flood monitoring, as well as the use of geographic information system for flood risk zoning in related studies are recommended.

Keywords: Flood zoning, MNDWI, NDWI, Landsat 8 and Khuzestan.

* Corresponding Author, Email: sh_Darvish@haraz.ac.ir

Forecasting Hydrological Regime Based on Rainfall Regime Using Two-dimensional Markov Chain in Anzali Watershed

Fahimeh Razi¹, Alireza Shokoohi^{2*}, Alireza Eslami³

1. Graduated Ph.D. Student, Water Engineering Department, Faculty of Agriculture and Natural Resources, Imam Khomeini International University, Qazvin, Iran
2. Professor of Water Engineering Department, Faculty of Agriculture and Natural Resources, Imam Khomeini International University, Qazvin, Iran
3. Assistant professor, Agricultural Research, Education and Extension Organization, Soil Conservation and Watershed Management Research Institute, Tehran, Iran

(Received: March 2, 2020- Accepted: June 15, 2020)

Abstract

Despite the need to predict the flow regime in rivers, especially in hydrological drought conditions, little progress has been made in this area; so meteorological situation of basins in general, and meteorological drought in particular, have been used for these purposes. In this study, the prediction of hydrological conditions in rivers based on the basin condition in terms of rainfall is done using Markov chain concepts for the case study of Anzali Wetland catchment with 9 meteorological stations and 20 hydrometric stations over the years. The data from 1985 to 2015 have been used. Two-dimensional Markov probability matrix was used to predict the hydrological status of the rivers by observing the meteorological condition of the basin. The two-dimensional transition probability matrix is different from what has been customary so far, using two different phases of moisture flow in hydrometeorological processes in a matrix so that its columns represent the meteorological state and its rows represent the hydrological conditions. Evaluation of Anzali catchment conditions showed that meteorological and hydrological conditions are the same in each month by the probability of higher than 50%. Based on the results of the 2D matrix of the probability of transfer, the probability of being in normal, wet and dry hydrologic conditions, if these conditions occur in a step ahead in the meteorological phase, is 80, 50 and 40%, respectively. Based on the achieved results, with the expected value of the pertinent discharges in the forecasted hydrological condition concerning the former step climatological state, the probable discharge in the river is predicted.

Keywords: Two-Dimensional Markov Chain, meteorological phase, hydrological phase, Discharge forecast.

* Corresponding Author, Email: shokoohi@eng.ikiu.ac.ir

Using Satellite Images the Sentinel-2 for Improving the Classification of Agricultural Products via Artificial Intelligence Methods to Manage the Reservoir Dams Operation

Pouya Ahmadi¹, Hossein Arefi², Nazila Kardan^{3*}

1. M.Sc. Student, School of Surveying and Geospatial Engineering, College of Engineering, University of Tehran North Kargar Ave., Jalal Al. Ahmad Crossing
2. Associate Professor, School of Surveying and Geospatial Engineering, College of Engineering, University of Tehran North Kargar Ave., Jalal Al. Ahmad Crossing
3. Assistant Professor, Department of Civil Engineering, Azarbaijan Shahid Madani University, Tabriz, Iran

(Received: April 10, 2020- Accepted: June 16, 2020)

Abstract

Water is one of the most important factors in the growth and development of human societies, where water resource limitations have always been one of the main barriers to agricultural development as a major basis for achieving food self-sufficiency. One of the main applications of satellite imagery is its utilization in the field of water resources management and agricultural activities, in which managers can benefit from it for studying cultivation levels, crop classification, crop estimation, and agricultural crisis forecasting. Generally, overall consumption estimation, water/irrigation management, and utilization of dams' storage capacity are among the most important research topics. This study benefits from the Sentinel-2 satellite for classifying the agricultural crops based on the multi-temporal methods. Besides, four classification methods are adopted for classifying, namely, minimum distance, maximum likelihood, fuzzy, and neural network. Due to the spectral changes of goods during the growing period, using the multi-temporal methods based on the crop calendar can play a decisive role in the classifying process, such that the classification accuracy increases to 86 percent via the maximum likelihood and neural network methods. Moreover, the normalized Kappa increased to 90.5 percent, when the neural network method parameters are optimized. The results obtained from the simulation indicate that genetic algorithm is the best method for obtaining the optimal results. After selecting the optimized neural network parameters, the classification has been taken into account and observed that Alfalfa has the largest crop surface, while it requires a considerable amount of water and its demand is in a lower value. Wheat, Barely, and Potato considered to be the most sufficient crops, after an analysis based on water demand of the crops and the needs for each product. These crops should be cultivated in the closest location to the divergent water path of Shahrchaei Dam, resulting in lower water waste in the agricultural fields. As result, all Alfalfa cultivated grounds should be replaced with the mentioned products.

Keywords: Classification, Artificial Neural Network, Remote sensing, Optimization, Genetic algorithm.

* Corresponding Author, Email: n.kardan@azaruniv.ac.ir

Use of Gridded Weather Datasets in Simulation of Wheat Yield and Water Requirement (Case Study: Iran's Qazvin Plain)

Rezvan Bahroloum¹, Hadi Ramezani Etedali^{2*}, Asghar Azizian³, Behnam Ababaie⁴

1. M.Sc. Student, Department of Water Sciences and Engineering, Imam Khomeini International University, Qazvin, Iran
2. Associate Professor, Department of Water Sciences and Engineering, Imam Khomeini International University, Qazvin, Iran
3. Assistant Professor, Department of Water Sciences and Engineering, Imam Khomeini International University, Qazvin, Iran
4. Centre for Crop Science, The Queensland Alliance for Agriculture and Food Innovation (QAAFI), University of Queensland, Australia

(Received: April 10, 2020- Accepted: June 21, 2020)

Abstract

Temperature and rainfall affect the quantity and quality of agricultural products. Therefore, it is important to estimate its spatial-temporal changes. In many region of the country, due to the low density of meteorological stations or the small statistical period of new stations, limited time and space information is available. Therefore, this study aims to use the data of CRU, AgMERRA, AgCFSR and GPCC gridded weather datasets in estimation of yield and water requirement of wheat and compare them with the estimated values with the information of Qazvin Synoptic Station. For this purpose, monthly weather time series of Qazvin synoptic station were extracted from 1980 to 2010 along with the data from the selected gridded datasets extracted from the closest grid cell to the synoptic station (K1), the average of four closest grid cells to the synoptic station (K4), and the average of eight closest grid cells to the synoptic station (K8). The quality of the gridded datasets was assessed with four statistical indices (R^2 , RMSE, NRMSE, ME) in a direct and indirect way (the latter using the outputs of the AquaCrop model). In estimating wheat water requirement, GPCC database with four points (K4) and one point (K1) showed the best performance. Wheat yield simulated with AgMERRA data with one (K1) and four (K4) closest grid cells had the highest correlation with the simulated values with data from the synoptic station. Results showed that all selected gridded datasets can be used to simulate grain yield with satisfactory performance, but only data from GPCC-CUR dataset would result in reliable estimation of wheat water requirement.

Keywords: AquaCrop, Qazvin plain, CRU, AgMERRA, AgCFSR, GPCC.

* Corresponding Author, Email: Ramezani@eng.ikiu.ac.ir

Time series of discharge changes in Karkheh watershed using parametric and nonparametric methods

Fahimeh Mokhtari¹, Afshin Honarbakhsh^{2*}, Saeed Soltani³, Khodayar Abdolahi⁴, Mehdi Pajohesh⁴

1. Ph.D. Watershed, Faculty of Natural Resources, Shahrekord University, Shahrekord, Iran

2. Associate Professor, Department of Environmental Engineering, Faculty of Natural Resources, Shahrekord University, Shahrekord, Iran

3. Professor of Range and Watershed Management, Natural Resources Faculty, Isfahan University of Technology, Isfahan, Iran

4. Assistant Professor, Department of Natural Engineering, Faculty of Natural Resources, Shahrekord University, Shahrekord, Iran

(Received: April 10, 2020- Accepted: June 26, 2020)

Abstract

The study of river flow trends in water management and irrigation and water management is an important issue. In addition, monthly, seasonal and annual discharge trends of Karkheh watershed were evaluated using non-parametric Mann-Kendall tests, Sen's slope estimator and regression analysis. Inverse distance weighting method was also used to study the spatial variation of discharge trends in Karkheh watershed. Accordingly, discharge data from eleven wells of the above-mentioned basin for the period 1990 to 2018 were used. The results of this study showed that Dubai has had annual rainfall at all of these stations, except for Mir-Sayed Ali. The values of this major are Hamidieh, Pai Pol, Pol Zal, Poldokhtar, Afrin, Cham Fig, Noorabad, Doab Merak, Kakarza and Pulchehr, respectively, 48, 33, 16, 5, 15, 4, 0.4, 1.4. It decreased by 2.6 and 13 cubic meters, while it increased by 0.4 cubic meters at the Sarab Ali station. Based on the findings of the study, applying nonparametric Mann-Kendall method and age in trend analysis of monthly, seasonal and annual discharge series have shown that the performance of these two tests are similar at times and when the frequency of duplicate data is high, the age method can be answered. More realistic than Mann-Kendall's approach, this approach can be applied to future water, water planning and management.

Keywords: Discharge Trend, Man-Kendall Method, Age Method, Regression Analysis Method, Parametric test, Karkheh Watershed.

* Corresponding Author, Email: afshin.honarbakhsh@gmail.com

Evaluation of TRMM satellite accuracy and efficiency in estimating monthly rainfall in Gorganroud watershed

Hossein Emami¹, Ali Salajeghe^{2*}, Alireza Moghaddamnia³, Shahram Khalighi Sigaroudi³

1. MSc Watershed Science and Engineering, Faculty of Natural Resource, University of Tehran, Iran

2. Professor, Faculty of Natural Resource, University of Tehran, Iran

3. Associate Professor, Faculty of Natural Resource, University of Tehran, Iran

(Received: June 12, 2019- Accepted: June 11, 2020)

Abstract

Satellite remote sensing methods especially the TRMM satellite are used to estimate the precipitation of watersheds with a dispersed rainfall station. It is necessary to compare the rainfall data of the TRMM satellite with the observation precipitation data. We first used four statistical methods: Standard Normal Homogeneity Test, Buishand, Pettit, and Von Neuman, the accuracy and quality of precipitation data of rainfall stations in the Gorganroud watershed was investigated in order to predict the accuracy and performance of the TRMM satellite rainfall data. After extracting the results of homogeneous tests, by comparing with the data of adjacent stations, a suspicious station was removed from the study due to the lack of conformity with the data of adjacent stations. Then, in order to evaluate the TRMM satellite performance in estimating monthly precipitation, it was compared with the observational precipitation data using Bias, RMSE, R^2 and NSE. The results showed that the R^2 value for all rain gauge stations in the Gorganroud watershed is between 0.31 and 0.75. RMSE was obtained between 15.85 and 56.82. The rain gauge stations located in the Gorganroud watershed have a NSE value of -0.82 to 0.66. The Bias index is between -55.74 and 69.01. Also, the R^2 , RMSE, NSE and Bias values for the whole Gorganroud basin were obtained 0.79, 20.94, 0.57 and -28.13 respectively. The results of the TRMM efficiency evaluation in the monthly rainfall estimation showed that it has a good performance in estimating the precipitation and is very valuable for areas without a station.

Keywords: Estimating rainfall, TRMM Satellite, Homogeneous Tests, Validation, Watershed Gorganroud.

* Corresponding Author, Email: salajegh@ut.ac.ir

Flood Hazard Assessment Using Geospatial Information System in Tajan Basin

Amir Hossein Mohammad Pour¹, Alireza Vafaeinejad^{2*}

1. Master of Water and Hydraulic Structures Engineering, Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran
2. Associate Professor, Faculty of Civil, Water and Environmental Engineering, Shahid Beheshti University, Tehran, Iran

(Received: March 20, 2020- Accepted: July 26, 2020)

Abstract

In this study, it is attempted to provide a proper assessment of flood status and flood risk for Tajan watershed. In this regard, by preparing flood hazard zoning maps and flood sensitivity analysis for the basin, susceptible areas have been identified and the extent of the hazard has been assessed for the basin. To this end, a fuzzy hierarchical fuzzy analysis (F-AHP) integrated model is used to prioritize, identify the factors influencing flood events (including geological, climate, human factors, etc.) and determine the extent of impact of each. Flood assessment indices (including flow velocity, flow depth, mean precipitation, evaporation, slope aspect, drift pattern, flood plain, road network and land cover) were used. This information was transferred to the GIS environment after fuzzy evaluation in MATLAB and fuzzified/defuzzified index maps of the area were prepared. The goal of this work is to increase accuracy as well as integrate fuzzy models. These maps are used to identify flood sensitive areas (hazard maps) and hazard zoning (in 5 high-risk to low-risk groups). Based on the results of the hazard assessment, it has been identified that the most important concentration of flood sensitive areas in the main river is in relation to other parts and in the delta. Also, according to the drainage pattern of the region, especially in the eastern part of the basin, it has been determined that these areas also have a high sensitivity to flooding.

Keywords: Flood Risk Assessment, Fuzzy Logic, Analytical Hierarchy Process (AHP), Geospatial Information System (GIS), Tajan River Basin.

* Corresponding Author, Email: a_vafaei@sbu.ac.ir

Concentration of Heavy and Toxic Metals in Downstream of Sungun Mine Dumping Site and the Role of Lime-Bed of the River in the Attenuation of the Pollutants

Reza Mahjoubi¹, Mohammad Hassanpour Sedghi^{2*}, Abdolreza Vaezihir³, Nader Mazaheri⁴

1. Master graduate, Department of Earth Science, University of Tabriz

2. Assistant Professor, Department of Earth Science, University of Tabriz

3. Associate Professor, Department of Earth Sciences, University of Tabriz

4. Master of Environmental Sciences, Azerbaijan Copper Complex, National Iranian Copper Industries Company

(Received: April 17, 2020- Accepted: August 17, 2020)

Abstract

Pollution of rivers can be decreased by means of self-purification character of rivers. Activity of the Sungun copper mine at north west of Iran, causes pollution of the downstream. Also, the study of river's water quality and self-purification potential changing procedure are very important. For this purpose, the samples were selected from 9 stations in Sungun mining area in Sungunchai, Pakhirschai, Arghanehchai, Miankafe and Ilgineh rivers, and chemical parameters such as pH, EC, TDS, TSS and heavy metals were studied. HPI (Heavy Metal pollution index) and MI (metal index) are used for investigation of heavy metal pollution. The evidence shows that contamination was decreased at the river route and correlation of this phenomenon with pH value was investigated. The correlation between heavy metal in water and sediment was compared, and it was found that, concentration of heavy metal in water and sediment have a correlation and it influenced from changing of pH value. Interaction between water and limestone in the river-bed caused an increase in self-purification of the river.

Keywords: SUNGUN COPEER MINE, HEAVY METALS, SELF- PURIFICATION, TSS, TDS.

* Corresponding Author Email: hassanpour_mhd@tabrizu.ac.ir

Application of Nexus Approach in Hydropolitics of Transboundary Rivers

Hamidreza Barjeste¹, Seyedeh Zahra Ghoreishi², Hojjat Mianabadi^{3*}

1. M.Sc. Student, Department of Water Engineering and Management, Tarbiat Modares University, Tehran, Iran

2. M.Sc. Student, Department of Irrigation & Reclamation Engineering, University of Tehran, Iran

3. Assistant Professor, Department of Water Engineering and Management, Tarbiat Modares University, Tehran, Iran

(Received: April 10, 2020- Accepted: July 17, 2020)

Abstract

Most of the water problems are complex, with unpredictable and dynamic interactions as well as multiple feedbacks with different sectors, like energy, food, and climate. A holistic approach is required for recognizing the interactions among different parts of water resources with other sources. "Nexus" as a novel and holistic approach can be applied to deal with the complexities of water-food-energy interactions. This approach is also so fruitful in transboundary water relations among riparian countries. Considering the interactions among water, food, energy sectors, and the direct effect of the allocation of water resources across borders can be a great potential for dealing with transboundary basin conflicts. It is necessary to apply nexus approach as an appropriate and comprehensive approach for the right policy-making and good governance in transboundary river basins. This paper, with its fundamental-theoretical and descriptive and analytical method, tries to examine the function of the WFE nexus approach in water governance in general and governance of transboundary water relations in particular. As case studies approach, the Brahmaputra and Aral basins are analyzed. Finally, it will be shown how the use of water, energy and the environment nexus approach has created sustainable interactions between India and Bhutan in the Brahmaputra basin and how non-compliance with the WFE nexus approach for Central Asian countries in the Aral basin has created economic costs and environmental damage.

Keywords: Water-Food-Energy Nexus, Transboundary Water, Integrated Water Resources Management, Hydropolitics, Water Diplomacy.

* Corresponding Author Email: hmianabadi@modares.ac.ir

Developing and Comparing Compensatory Multi-Criteria Decision Making Models for the Reservoir-dam Site Selection Based on Sustainable Development Criteria

Mohammad Ebrahim Banihabib^{1*}, Bahman Vaziri², Reza Hashemi³, Mitra Tanhapour⁴

1. Professor, Department of irrigation and drainage engineering, Aburaihan Faculty, University of Tehran, Iran
2. PhD, Department of irrigation and drainage engineering, Aburaihan Faculty, University of Tehran, Iran
3. Assistant Professor, Department of water engineering, Agriculture Faculty, University of Birjand, Iran
4. PhD candidate, Department of irrigation and drainage engineering, Aburaihan Faculty, University of Tehran, Iran

(Received: April 10, 2020- Accepted: August 17, 2020)

Abstract

Unsustainable dam construction causes an imbalance between water resources and environmental sustainability. Thus, it is crucial to observe the principles and criteria of sustainable development in dam construction. In this study, the priority of the construction site of Kandoleh Dam in Kermanshah province was investigated using different techniques of the MCDM including simple additive weighting, compromise programming and Analytical Hierarchy Process (AHP). For this purpose, after determining the appropriate criteria with the help of studies and experts' opinions, group decision-making was employed to determine the weight of the criteria by measuring the decision-makers' agreement. Then, the four proposed sites for the Kondoleh dam were ranked based on technical, economic, social, environmental criteria and relevant sub-criteria. Finally, the results were compared. In addition to determining the best site, 17 sub-criteria were also ranked for electing this site, and the sensitivity analysis of the models to evaluate the final ranking the alternatives was carried out. Based on experts' opinions, the economic criterion was the most important in selecting a suitable site. In all models, the fourth alternative was proposed as the best alternative, and the third, first and second alternatives respectively were placed in the next ranks. The results of the sensitivity analysis of the models illustrated that final ranking of the alternatives does not change due to the variations of the criterion weights. The present study provides a valid and inexpensive approach for decision-makers to identify the best dam construction site to achieve sustainable development goals.

Keywords: Multi-criteria decision making, Dam site selection, Simple additive weighting, Compromise programming, Analytical hierarchy process.

* Corresponding Author Email: banihabib@ut.ac.ir

Assessing the Status of Iran's Policies in the Field of Marine Environment Based on Three Criteria of Efficiency, Coherence and Comprehensiveness

Farshid Akbarzadeh¹, Mohammad Ali Hajidehabadi^{2*} Mohammad Ebrahim Shams Nateri³, Seyed Mahmood Mirkhilili³

1. PhD Student in Criminal Law and Criminology, Qom Islamic Azad University, Iran

2. Associate Professor, Department of Criminal Law and Criminology, Faculty of Law, University of Qom, Iran

3. Associate Professor, Faculty of law, University of Tehran, Iran

(Received: April 3, 2020- Accepted: August 25, 2020)

Abstract

From long time ago, human beings have used the seas to continue or optimize their lives and have benefited from the gifts of the seas. The marine environment has a unique position due to its eco-hydrological function, providing a large portion of the world's population food and facilitating trade relations. In this research, 3 criteria are investigated for measuring criminal policy. These criteria include efficiency, coherence and comprehensiveness. The results of the criteria show that, due to the dispersion of laws and lack of integrity of the law, despite the use of human resources and spending money against marine environment crimes, there is no expected efficiency. Iran's criminal policy does not have the necessary coherence and alignment in legislative, judicial, executive and participatory dimensions. Iran's criminal policy on crime detection is relatively good, but it does not work well in terms of accountability. Almost from the beginning to the end of the laws, traditional punishments are monopolized, specifically imprisonment and fines. Criminal policy has stopped in traditional criminal responses and has not approved a new plan to use other criminal, non-criminal and legal responses in the field of ecology and hydrology, so Iran's criminal policy in this regard is lacking in comprehensiveness.

Keywords: Environmental law, marine environment, cohesion, efficiency, comprehensiveness.

* Corresponding Author Email: dr_hajidehabadi@yahoo.com

Assessing Climate Change Impacts on Groundwater Fluctuations Using RCP Scenarios

Massoud Goodarzi^{1*}, Fateme Sadat Mortazavizadeh²

1. Assistant professor, Department of Drought and climate change, Soil Conservation and Watershed Management Research Institute (SCWMRI), AREEO, Tehran, Iran
2. Msc. Graduated, Water resources engineering, Water engineering Department, Islamic Azad University, Shiraz Branch, Shiraz, Iran

(Received: April 10, 2020- Accepted: July 17, 2020)

Abstract

Nowadays the negative effects of climate change along with the water crisis are the most important global challenges. This is an advanced method to study the impact of climate change on groundwater level fluctuations. In this study the conceptual Modflow model was used to simulate groundwater levels and to analysis groundwater balance of Hashtgerd plain. Hydraulic conductivity in steady state and specific yield in unsteady state were calibrated. In order to estimate rainfall and temperature in the area, the CMIP5 integrated climate model under RCP2.5 and RCP 8.5 scenarios were used. The data for the period of 2015-2040 by LARS-WG model was downscaled. The output data in IHACRES rainfall-runoff model was entered, then the run-off under climate change was determined. The penetration rate of run-off with parameters affected by climate change entered and modeling was performed. Quantitative model showed a decrease of 73 cm in water table in the current status of the Hashtgerd aquifer. According to the witnesses, the present status would be worsened in future and will change the situation of aquifer from crisis mode to supercritical state. The predicted results show that the RCP8.5 scenarios has more critical situation than RCP2.5 scenarios and would be even worse in the region. It is predicted that the decline in groundwater level in 2040 (even if assuming a constant harvest rate) would be lowered up to of 18 meters from the comparing to the present status.

Keywords: climate change, Hashtgerd plain, downscaling, RCP scenarios, IHACRES model, MODFLOW model, groundwater fluctuation, CMIP5.

* Corresponding Author, Email: m.goodarzi@areeo.ac.ir

Analysis of Groundwater Uncertainty in Climate Change (Case study: Hashtgerd Plain)

Amir Hossein Rasaei¹, Ahmad Sharafati^{1*}, Hamid Kardan Moghaddam²

1. Civil Engineering Department, Science and Research Branch, Islamic Azad University, Tehran, Iran

2. Assistant Professor, Water Research Institute, Ministry of Energy Water Research Institute, Tehran, Iran

(Received: April 10, 2020- Accepted: September 2, 2020)

Abstract

The study of the effect of climate change on groundwater resources using climate change scenarios fifth report under 5 models HadGem2Es, Micro5, MPI-Esm-MR, EC-ERATH and GFDL-CM3 simulated temperature and precipitation was carried out. Results derived from the results of climate scenarios in the groundwater flow model MODFLOW actions and for the near future time period (2020-2040), the intermediate future (2060 -2040) far future (2080-2060) was predicted groundwater level. Simulation of groundwater flow in the aquifer indicates that the annual loss of 73 cm water level underground aquifer from the situation becomes critical to critical conditions for operation. As this trend continues in the years to come, the phenomenon of land subsidence should not be out of the question. The results of the current situation shows that the aquifer at the end of the year compared to October 1389 Blue 04-1403 is the beginning of the simulation period, more than 22 meters will drop and more than half of this drop will end in 8 years. Accordingly, based on the results of 5 climatic models and three propagation scenarios, the aquifer status was predicted and according to the obtained hydrograph, the uncertainty of the results of climate models in the aquifer hydrograph was evaluated. The results showed that the release of RCP 8.5 scenario has the highest difference between the minimum and maximum groundwater level.

Keywords: Climate change, Uncertainty, RCP scenarios, Hashtgerd aquifer, CMIP5 models.

* Corresponding Author, Email: asharafati@gmail.com

Investigating and Analyzing the Drought Trend in the Givi Dam Catchment with a Multiple Index Approach

Atabak Feizi^{1*}, Vahid Maleki²

1. Assistant Professor of Civil Engineering, Faculty of Engineering, University of Mohaghegh Ardabili, Ardabil, Iran
2. M.Sc. Student in Civil Engineering Water Resource Management and Engineering, University of Mohaghegh Ardabili, Ardabil, Iran

(Received: May 11, 2020- Accepted: September 17, 2020)

Abstract

Assessing the drought situation and formation trend has always been one of the most important factors to deal with the devastating effects of this phenomenon. Different indices are used to determine the drought, depending on location in specific periods. The main purpose of this study is to assess the drought situation of Givi Dam Catchment with the multiple index approach. Accordingly, this phenomenon was analyzed using the precipitation data of the two selected stations in the Givi Dam Catchment during a 31-year statistical period, using SPI, RDI, CZI, SZI, PNI, and DI. The results showed that severe drought occurred in 2005, 2008, and 2013 in Khalkhal station and 2013 and 2017 in Firoozabad station. Moreover, using the Effective Drought Index (EDI), the number of dry days was obtained in the fall and winter seasons of the years with severe drought. By examining the indicators monthly, it became clear that despite the relatively high similarity of SPI, CZI, SZI, and RDI in showing the main drought and wet periods, SPI is more effective in detecting the onset of drought periods than the other indices.

Keywords: Standardized Precipitation, Effective Drought, RDI, Givi Dam Catchment.

* Corresponding Author, Email: a_feizi@uma.ac.ir