

## Assessing the Impact of Climate Change on Drought and Forecasting Neka River Basin Runoff in Future Periods

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### Abstract

Several studies have shown that climate change will have severe impacts on available water resources worldwide. Due to the effect of climate change on droughts and river flow, it is necessary to investigate the drought and water resources status under climate change conditions. In this study, the effects of climate change on run-off and SPI drought index in the Neka River basin in Mazandaran province were investigated. For this purpose, the data of the weather stations of Barikola, Pajim, Sefidchah, Glevard and Tirtash were used. Historical data of the Neka river discharge was obtained from Glevard hydrometeor Station. For this purpose, during the upcoming period (2018-2081), temperature and precipitation were simulated under three RCP2.6, RCP4.5 and RCP8.5 climate scenarios for the Neka river basin. To determine the mean value of climatic parameters of rainfall and temperature, the Isohyetal method was used between meteorological stations. Then drought and run-off values were calculated. The IHACRES model was used to simulate run-off. The results showed that in all three climate scenarios, drought events will increase during the upcoming periods and wet and normal periods will decrease compared to the base period. Based on the findings, during the upcoming periods, the average annual flow of the Neka River under RCP2.6, RCP4.5, and RCP8.5 scenarios decrease between 15 and 43 percent. Thus, the average annual run-off volume of the Neka River at the Glevard dam will be reduced from 95 MCM in 2014 to 54 to 81 MCM. Therefore, in order to reduce the negative effects of the drought period and also reduce the flow of the Neka River, it is necessary to planning more accurate to avoid social, environmental, economic and cultural tensions.

**Keywords:** Drought index, SPI, IPCC5, IHACRES.

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## Flood Damage Detection Algorithm Using Sentinel-2 Images (Case Study: Golestan Flood of March 2019)

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### Abstract

Remote sensing data can be used with reasonable accuracy today for areas without statistics to investigate natural events. One of these sudden and damaging phenomena is flooding. April flood in Golestan province has caused much damage in various areas of housing, agriculture, forestry and so on. In the present study, using satellite data and presenting flood damage detection algorithm, this phenomenon is investigated. The highest difference in the NDVI index derived from Sentinel-2 data was calculated in the study period of March 2019 and late April 2019 in the study area. These results show that some areas have been severely damaged by floods, in which severity and duration of rainfall have had a significant role. These areas, which are estimated at an area of 70908 hectares, include agricultural, forest, residential, etc. Among the advantages of the proposed algorithm are the ease and speed of calculation, the capability to apply in urban areas, the high accuracy with reduced impact of other phenomena. The overall accuracy of the present algorithm is estimated to be 93.5% using ground control points. The accuracy of the results shows that the flood damage algorithm has a good accuracy to distinguish the areas under flood damage from areas safe from danger.

**Keywords:** Flood, NDVI, Time series, Sentinel-2, Golestan Province.

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## Feasibility of Applying a Simulation-optimization Model for Assessment of Decisions based on Water-energy-food NEXUS Considering the Environmental Damages

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### Abstract

The population growth along with the rise in essential needs, has caused creating the concept of water-energy-food NEXUS and the increase in attention to this framework in order to apply it to optimal use of resources. One of the most important issues in the optimal use of resources that has received less attention is environmental damages which has not been addressed as much as the cost and benefit debate. Beside the optimal use of resources, another point is to attention to sustainable supply needs, so that different parts of the system do not be disrupted during operation. The effectiveness of the NEXUS is also important for decisions as in case of minor effects, there is no need to complicate the decision model. In this study, a mathematical model of water-energy-food NEXUS was implemented in a study area for the purpose of minimizing costs and maximizing reliability, and using ant colony optimization algorithm, optimal solutions were obtained. The effect of considering and not considering the NEXUS between resources and its effect on costs was also examined. The results showed that considering the environmental costs without adopting intensified policies does not affect decisions and only increases the costs of the system. NEXUS impact analysis showed that NEXUS considerations are optimal to make decisions under minimization of costs and it does a better performance of maximizing the overall system reliability index, without negatively affecting other parts.

**Keywords:** Ant Colony Optimization Algorithm, Reliability, Mathematical Model, Cost.

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## The Role of Land Use Changes on Run-off and Flood Properties in the Doab Catchment

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### Abstract

Deforestation and pastures, invasion of privacy and riverbanks, flooding of the Doab catchment during recent years, especially the downstream flood of 2019, raise the possibility of impacts of land use changes on flood characteristics. The purpose of this study was to evaluate the impact of land use changes on flooding in Doab catchment using HEC-HMS model. For this purpose, first land use map of Doab catchment was prepared for the years 1995 and 2019. SCS method was used to calculate initial rainfall and basin run-off height and Muskingum method was used for flood routing. In order to investigate the effect of land use changes on flood characteristics, precipitation data and discharge for the year 2019 were implemented in the model created with land use conditions of 1995. Evaluation of land use maps showed reduction of forest area and Pastures area to the 56.71 and 28.25 square kilometers equivalent to 7.39 and 3.68 percentage of total basin area, dryland, irrigated and residential areas respectively 58.30, 19.88, and 6.78 square kilometers increased equivalent to 7.60, 2.59, and 0.89 percent. The results of this comparison showed that the average run-off peak increased by an average of 15.46 percent and the volume of run-off by an average of 19.74 percent. This indicates a decrease in the initial amount of rainfall losses and an increase in run-off. Therefore, it can be said that land use changes in the Doab catchment have increased the peak and volume of run-off and ultimately increased flooding in this basin.

**Keywords:** HEC-HMS model, Land use effect, SCS method, curve number (CN).

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## Survey of Area Changes in Water Basins of Shahid Abbaspour Dam Caused by 2019 Floods Using Google Earth Engine

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### Abstract

Shahid Abbaspour Dam area is the largest part of Karun Bozorg which had been exposed to floods twice in 2019. Given the strategic importance of the basin and recent floods, the present study uses Landsat 7, Landsat 8, Google Earth Engine and NDWI algorithms at low cost and low time to isolate the water phenomenon from other phenomena for review purposes. The changes in the area of water areas in this basin have been addressed in the last 20 years. In these studies, the area of all water areas in this catchment area has been calculated and based on it, the changes in the area of water areas resulting from the floods of recent years; It is really efficient to be obtained for managing of water resources, crisis management and to achieve sustainable development of the region. The results of this research show that in the mentioned basin, the highest volume of water was in 2019 and the reservoirs and dams were filled with water, so that with a time difference of one month, 25 square kilometers have been added to the volume of their water. According to this information, the risk of flooding covers residential and agricultural areas, and the lack of serious supervision and attention to this issue can cause irreparable damage in the near future.

**Keywords:** Shahid Abbaspour Dam catchment area, flood, remote sensing, Google Earth Engine, NDWI.

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## Assessment of the Ecosystem Balance of Integrated Water and Food Governance using an Adaptive Actor-Oriented Approach

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### Abstract

The shortcomings of unitary governance have increased the need to refer to integrated governance of food and water to achieve sustainable development. In this research, an approach has been developed that evaluates the governance of food and water comprehensively and through the use of the principles of sustainable governance. The failures in the Minab watershed and the lack of a practical framework for assessing and analyzing comprehensive food and water governance have made this research necessary. The principles of sustainable governance of water and food were developed using research on sustainable governance and sustainable development goals. Accordingly, in the present study, a total of 12 principles and 69 indicators were developed for the ecosystem-balance in food and water governance. The research data were obtained through a face-to-face questionnaire and face-to-face interviews with 40 actors influencing food and water governance. The results showed that 2.89% of the indicators had a favorable status and 97.11% had a poor status. The score for the ecosystem-balance in food and water governance is 2.56 out of 5 and with regard to score 3 as a desirable situation, which points to the failures in the current structure of food and water governance. The current research highlights the challenges of integrated governance of water and food, such as effective stakeholder engagement and for the ecosystem-balance, and contributes to their sustainability. According to the approach presented, the governance structure in arid and dry regions that are highly dependent on agriculture and groundwater can be evaluated in terms of actors and adaptability.

**Keywords:** Ecosystem balance principals, actors, evaluation index, rules, governance framework.

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## Quality Assessment of Gorganrood River Using NSFQI Index in Gonbad kavus Urban Area

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### Abstract

Creating a regular control program will allow appropriate strategies to reduce the pollution of riverside catchment and, finally, improve the water quality of these resources. The goal of this study was to investigate the effect urban wastewater on the quality of Gorgan River in the Gonbadkavous basin. Sampling was carried out in the 3 months of autumn of 1396 on a monthly basis with a frequency of two weeks from 4 stations at the distance from the sedelstane to the outlet of the Gorgan River from Gonbadkavus. The quality of NSFQI index was used to evaluate the quality of the Gorganrood River. Based on the measured factors, the NSFQI index was calculated for the stations under study. The results showed that the numerical value of this index had the highest value at Gonbadkavous entrance station ( $p < 0.05$ ) and the value of this index decreases from city entrance station to the city exit station. The results were 48.17, 42.72, 43.06 and 40.94, respectively. Interpretation of numerical values based on NSFQI index for the stations under study shows that the water quality of Gorganrood River in the urban area of Gonbadkavus is poor and the color of this index is also orange. The factors involved in reducing the water quality of the river are based on these two indicators of human factors, such as drainage of untreated urban sewage into the river due to the lack of a sewage collection system, disposal and accumulation of waste and animal waste in the river bed.

**Keywords:** Urban Wastewater, Water Resources Quality, Gorganrood Rive, East Golestan Province.

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## Comparison of Distribution of Precipitation in *Quercus castanifolia*, *Ulmus glabra* and *Parotica percica* Forest Types

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### Abstract

In forest ecosystems, vegetation characteristics along with climatic parameters have a great influence on the distribution of precipitation components and water cycle. The present study was therefore conducted to measure the amounts of interception loss, throughfall and stemflow in *Quercus castanifolia*, *Ulmus glabra* and *Parotica Percica* at the campus of Faculty of Natural Resources of Tarbiat Modarres University, Noor, as representative of Hyrcanian forests of the country. Precipitation measurements were carried out by 23 collector containers over the course of a year from 06/10/2018 to 06/10/2019 with 34 storm events. The results showed that the rates of steamflow in *Quercus*, *Parotica* and *Ulmus* species were 0.97, 0.56 and 0.34%, respectively. There was a strong, positive and linear relationship between steamflow and precipitation in the *Parotica* type ( $R^2 = 0.70$ ). The interception losses were also 19, 17 and 8% in the *Quercus*, *Ulmus* and *Parotica* species, respectively. Regressions were also satisfactorily established between total precipitation and mean interception loss with coefficient of determination of 0.61, 0.62 and 0.46 for *Quercus*, *Ulmus* and *Parotica* stands, respectively. The results of ANOVA verified no significant difference between interception loss ( $P = 0.790$ ) and throughfall values ( $P = 0.894$ ) among the three study species. However, there was significant difference ( $p=0.015$ ) between the moisture contents of litters in *Quercus* sp. compared to other two types of *Ulmus* sp. and *Parotica* sp. There was also a significant difference between the values of *Quercus* sp and *Ulmus* sp ( $P = 0.009$ ).

**Keywords:** Ecohydrology, Forest Hydrology, Forest Management, Interception Loss, Water Cycle.

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## **Flood Zoning and Hydraulic Behavior Simulation Using HEC RAS in (GIS) (Case Study: Maroon River - Southwestern Iran)**

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### **Abstract**

The present project was designed with the aim of zoning the flood and determining the limits of the boundary and the boundaries of the Maroon River using the software (GIS) and HEC - RAS. The (HEC-HMS) model was used to simulate the flood hydrograph and determine the flood characteristics including peak discharge and run-off volume in Maroon watershed. Using (GIS) software, land surface maps, topography, curve numbers and elevation digital models were developed. In the next step, the profile of the river network and the geometric characteristics of the river were extracted using the (HEC-GeoRAS) toolbox. Finally, modeling and flood discharge estimation were done using (HEC-HMS) hydrologic model. And the results of the (HEC-HMS) model were combined with the geometric specification extracted from the (HEC-GeoRAS) model to the (HEC-RAS) model for the hydraulic modeling of the Maroon River. The final step is to transfer these results from the (HEC-RAS) hydraulic model to the Arc (GIS) software. At this stage, using available data, flood zoning was conducted for flood with a return period of 5, 10, 25 and 50 years. In this project, five flood events, which were well documented at the Tang-e-Takab Rain Station, were selected to calibrate and evaluate the model. The results of this study indicate that the flood area for 5, 10, 25 and 50 years return periods was 1265, 1651, 333 and 4450 ha, and the number of vulnerable villages arrangements equal to 2.3, 4 and 9 villages are in jeopardy.

**Keyword:** Flood ; Maroon Basin: (HEC-RAS): Arc (GIS).

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## Modeling Ecosystem Production Services (Water Production) in Taleghan Middel Watershed

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### Abstract

Modeling water resource systems is an essential part of the water resource planning and evaluation process. An assessment of how changes in water production and performance are important in the past and in the future. The InVEST model features ecosystem services in the form of maps with low input data levels, but high volume output data, and simplifies complex issues, thereby increasing the ability to solve problems. In the present study, the modeling of ecosystem production services (water production) in the middle of Taleghan watershed was investigated using InVEST Water Inventory. At first, the maps of the limiting root layer, the average annual rainfall, available water availability, land use and the boundary of the basin and sub-basins were entered as inputs of the model and maps of the amount of water produced in each sub-area (Cubic meter/year), the approximate value of actual evapotranspiration with the fraction of rainfall per pixel, the actual evapotranspiration map in terms of (mm) per pixel is estimated, the estimated water production map per pixel (in millimeters per year) was obtained. Based on the calculations done by the model in total in the Taleghan Middel watershed, annual production of 200.9 million cubic meters of water is generated. It has the highest amount of water production under the Hasanjun area with 59.3 million cubic meters of water produced below the Donbalid, Zidast 1 and Zidasht 2 regions.

**Keywords:** Modeling, Water Production, Ecosystem Services, Taleghan Mian Basin.

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## Development of an Agent-Based Model to simulate the behavior of Agricultural Users in Water and Land Management

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### Abstract

Since there are various social factors and differences between different sectors of the system, ignoring water users' attributes and their social behavior as well as considering only the homogeneous and up-down management scheme, would not be a successful approach in sustainable water management. Agent-Based Modeling is a relatively new approach that provides helpful tools to simulate social behaviors in sustainable water management. In this study, the agriculture sector's water use is simulated using a conceptual framework and an Agent-Based Model to study the behavior of the decision-making agents. Therefore, to prepare the conceptual model and to simulate and analyze the social behavior of water users (in three decision levels of the Government, local organizations, and farmers) to decide on the cropping pattern, the irrigation method, and consequently the water withdrawal volume, the MAIA framework has been applied. In this regard, the Agent-Based Model for a pilot study area (the Hablehroud River basin, Iran) was coded, verified, calibrated, and validated. This model had a good performance in simulating the basin's conditions, including cropping patterns and areas, and therefore the stream flow and groundwater use. Furthermore, to assess the impacts of the government's water conservation policies on the hydrologic conditions, different scenarios of taking and increasing water costs were defined and modeled (one to ten thousand IRR per cm of water use led to a decrease in the total water withdrawals in the range of 8-32 million cubic meters per year).

**Keywords:** Agent-Based Model, MAIA framework, Decision-making, the Hablehroud River basin.

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## Simulation and Evaluation of River Habitat Suitability using SEFA Ecohydraulic Model (Case Study: Kordan River)

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### Abstract

The main objective of this study is to investigate habitat suitability in a representative reach of the Kordan River for aquatic species (*Oxyaemacheilus bergianus*) using the SEFA ecohydraulic model. According to a study conducted so far, this software has not been used in Iran. First, using the topographic map of the Kordan River and ArcGIS software, the geometry of the river model and cross sections was created. Hydraulic calculations and simulations in this model including simulation of water levels were conducted using two methods of rating curve and Water Surface Profile (WSP). The calibration of the WSP model is adjusted by the Manning's coefficient to establish a suitable fit between the observed and calculated water levels. In addition to hydraulic simulations in the SEFA model, the relationship between hydraulic flow and habitat requirements was established using the Area-Weighted Suitability (AWS) and Q-AWS curves of target species were extracted at the studied intervals and transverse sections. the best flow assessed  $2.63 - 2.05$  m<sup>3</sup>/s (for target species were identified. According to the flow and AWS monthly time series, in January the AWS in 75% of the days is above 2.03 m<sup>2</sup>/m which is the highest AWS compared to other months. The lowest percentage of AWS is 13% (in September). The results showed that AWS is higher in the middle and downstream reaches of the river.

**Keywords:** Kordan River, *Oxyaemacheilus bergianus* species, SEFA ecohydraulic model, Area Weighted Suitability, Environmental flow, River Habitat.

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## Investigation of Ecological Effects of Waste Disposal Site of Nahavand City On Semi-karst Springs with Emphasis of Hydro Geochemistry

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### Abstract

The production of waste has caused environmental crises that have put the life of the planet in serious trouble; Waste disposal sites are important in this time. The purpose of this study is to investigate the ecological effects of waste disposal site of Nahavand city on semi karstic springs with an emphasis on hydro geochemistry by method of experimental-survey. In the first step, visit was made of the case study and sampling of the site was carried out, then document and collected water sample of chemical and microbial samples were provided to experts. Results of this study indicate that there is no relationship between concentrations of elements; only concentration of Hg Pb more increased due to proximity to landfill (200 m). Due to the fact that the rock bottom is a volcanic rock of the oven and limestone, and such stones have a significant non-resilient erosion and significant permeability, they have an inappropriate capacity for waste disposal, according to the meteorological data for the dominant wind of the study area, is the northwest and the west wind dominates, and as part of the city of Nahavand and the villages surrounding the suggested landfill area along the west. The area under study will not be safe from the effects of an unpleasant smell of landfill. The current burial ground is located almost on the natural drainage route, which makes the site ineligible for hydro geological purposes for landfill (The proposed site has not been justified in terms of environmental standards). Therefore, the suggested area has low capacity for waste disposal in terms of environmental permeability. The results of chemical and microbiological tests indicated spring pollution. So, it recommended that studies are carried out for the selection of suitable areas.

**Keyword:** Water pollution, Waste disposal site, Hydro geochemistry, Semi- karst springs, Nahavand city.

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## Investigating the Effects of Incoming Floods from Afghanistan on the Quantitative and Qualitative Changes of Groundwater Resources in the Sistan Plain

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### Abstract

The aim of this study was investigating the effects of incoming floods from Afghanistan on the quantitative and qualitative changes of groundwater resources in Sistan plain. For this purpose, first by determining the direction of flood flow in Sistan plain, 16 wells drilled near the flood flow were selected. Estimates of reservoir volume changes as well as comparison of rainfall in the region in the same period were made. In the following, using groundwater balance equations and single hydrograph equations before and after flood entry, quantitative changes in groundwater resources in Sistan region over a period of 4 years (1394-1398) were investigated. The qualitative changes in aquifer with sampling of observation wells during the balance and investigation of time changes in water quality parameters such as electrical conductivity (EC) and acidity (pH) was analyzed. The data shows that the floods increased the water level in the wells by an average of 0.39 meters the process of change has a high correlation ( $R^2 = 0.85$ ) with the volume of floods in the region. Also, the hydrographic survey of the plain unit indicates significant changes in groundwater level before and after the flood in the area. As, during the 4-year period, the average water level is 2.16 meters higher than before Floods have increased. With the flooding amount of 20.66202 million cubic meters during the balance period, the reservoir volume has been naturally increased. Due to the low rainfall in the region, the nutrition of groundwater aquifers is affected by low rainfall. In examining the qualitative changes of groundwater, the results show a large decrease in the electrical conductivity index (EC) in observational wells. This change was significance difference at the level of 0.01 between the mean electrical conductivity before and after the flood. Also, groundwater acidity levels decreased with the arrival of floods, but were not statistically significant. According to the results obtained, Floods from Afghanistan with natural feeding of aquifers have improved the quantity and quality of groundwater in Sistan plain. Due to the water shortage crisis in the region, it can be considered an effective step in the development of water resources in Sistan region.

**Keywords:** flood, Ground water, Natural recharge, Siatan plain.

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## **Economic Evaluation of the Effects of Reducing Environmental Water Requirement of Anzali Wetland on the Livelihood and Income of the Local Communities**

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### **Abstract**

Wetlands, because of their direct and indirect services to the human community, are of vital importance and attract growing consideration for rehabilitation and maintenance. To preserve the wetlands' environmental values and henceforth guaranteeing the welfare of the stakeholders, it is essential to provide them with their required water necessary for presenting proper ecological services to the related aqua creatures and stakeholders. In the present research, the international Anzali wetland was selected as the case study and a conceptual model, developed based on IWRM principals, was employed to evaluate the economic loss due to its ecological condition deterioration. Defining the favorable and minium acceptable ecological conditions in Anzali wetland, the economic values of its services in an IWRM framework were calculated. To quantify the ecological condition of Anzali wetland, the economic values of direct and indirect use-values and the non-use values of the wetland was calculated as much as 10,222,220 million Rials. Then, through using the lost benefit method, the reduced values of the present condition of the wetland's ecological services compared with the suitable and minimum conditions were determined. In this paper, by introducing some indices for the main careers of the stakeholders, the impacts of unbalanced hydrological conditions on the wetland's tangible ecological services and through which on the system's integrated water resources management were revealed.

**Keywords:** Ecological services, Wetland economic value, Stakeholders income, IWRM, Anzali wetland.

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## Preparing the Risk Map of Flood Occurrence in the Ghomnab Chai Basin Using ANP Model and GIS Technique

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### Abstract

The mountainous areas of northwest of the country are susceptible to flood risk due to their topography and relatively good rainfall throughout the year, especially in spring. The aim of this study was to prepare a map of the risk of flooding in the Gomanab Chai catchment, which is located in the East Azerbaijan province. 10 effective factors in the occurrence of this phenomenon, such as Precipitation, Lithology, Land use, Slope, Vegetation density, Stream Power Index, Topographic wetness index, Drainage density, Sediment Transport Index, Gravelius coefficient were used to prepare the zoning map. Network Analysis Method (ANP) and Super Decisions software were used to weighting the criteria in this study. The final results obtained from the present study showed that the weight of the 10 criteria were 0.271, 0.201, 0.150, 0.118, 0.081, 0.056, 0.043, 0.032, 0.025 and 0.018 respectively. Precipitation, lithology, land use and slope had the highest weights, respectively. Finally, by combining these layers according to their weight in GIS, the zoning map was obtained. The results showed that 210 km<sup>2</sup> (50%) of the area is at risk of flooding. Therefore, the necessity of managing surface water in the area seems necessary in order to prevent flooding as well as proper exploitation of the waters of the area.

**Keywords:** Flood, ANP model, Super Decisions, Ghomnab Chai Basin.

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## Performance Assessment of The PERSIANN and PERSIANN-CDR Satellite Precipitation Algorithms and Survey of the Irregularities Effect on It (Case Study: Helleh River Basin)

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### Abstract

In the present study, the effect of elevation on the performance of PERSIANN and PERSIANN-CDR satellite precipitation algorithms in Helleh basin has been investigated. Satellite precipitation data with spatial resolution of  $0.25^{\circ}$  in longitude and latitude, compared with 114 rain gauge stations data during a fourteen-year period (2003- 2016). Also, with the use of errors zoning in the basin area, the effect of elevation on the performance of the satellite precipitation algorithms was investigated. The results showed that the PERSIANN algorithm is underestimate on different temporal and spatial scales and it had a little accuracy. In contrast, the PERSIANN-CDR algorithm was more accurate. However, the performance of the adjusted algorithm is unacceptable at daily scale. The determination coefficient of the adjusted algorithm was 0.7588 and 0.9446, monthly and annual at the cell scale respectively. Intensity-Duration-Frequency of curves. The three types of data sources show that both algorithms unsestimate rainfall values at different times during different Frequency and at different times than observational values. The spatial distribution of errors of satellite precipitation algorithms relative to basin elevation showed that in both algorithms, the RMSE value increases from low to high elevation. It is recommended to be more cautious in the use of satellite precipitation algorithms for estimating precipitation in high altitudes, and in addition to applying cloud properties to satellite imagery, a correction for altitude classes should also be considered.

**Keywords:** Evaluation, Satellite Precipitation Algorithms, PERSIANN, PERSIANN-CDR, Helleh River Basin.

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## Forecast Comparative of Rainfall and Temperature in Kerman County Using LARS-WG6 Models

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### Abstract

Assessment of climate change in arid and semiarid areas where water crisis is taken it is a matter of special importance. Therefore, the purpose of this study was to investigate climate change forecasting in Kerman city using general atmospheric circulation models available in LARS-WG6 software (EC-EARTH, GFDL-CM, HadGEM2-ES, MIROC5 and MPI-ESM-MR) under scenarios RCP4.5 and RCP8.5 for the period (2020–2050) and estimate its maximum precipitation over the various return periods during the base period (1961–2010) and future (2020–2050) using the Gamble distribution. The results showed that all five models have the same response in increasing the minimum and maximum temperatures in the city so that the maximum increase in the minimum temperature in GFDL-CM, HadGEM2-ES, MIROC5 and MPI-ESM-MR models is the results were 3.56, 2.73, 2.33 and 2.30 degrees Celsius, respectively. Also, the maximum temperature in the RCP4.5 scenario in May, September, May, September and July, respectively, in EC-EARTH, GFDL-CM, HadGEM2-ES, MIROC5 and MPI-ESM-MR models, respectively, increased by 2.20, 2.82, 2.46, 1.98 and 2.38 °C, respectively. Precipitation decreased by 19.05% and 4.62% in EC-EARTH and MIROC5 models, respectively. The results show that maximum precipitation will occur with higher rainfall in all models except MPI-ESM-MR. Finally, it can be concluded that with increasing return period, the maximum amount of probable precipitation increased under RCP4.5 and RCP8.5 scenarios and was more severe under RCP8.5 scenario.

**Keywords:** Maximum Possible Precipitation, Climate Change, LARS-WG6, Kerman County.

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## Evaluating Satellite Indicators in Determining the Level of Aquatic Areas Using Satellite Sensors (Case Study: Zaribar Wetland, Kurdistan Province)

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### Abstract

tension are contributing factors for understanding the hydrological cycle and water resources management. Recently, remote sensing technique has become a common approach for monitoring surface water resources. The main objective of this study is the determination of the suitable satellite indices for extracting Zaribar wetland area using Landsat 5.7.8 satellite images. The area of the wetland is calculated by using the supervised classification method (maximum likelihood) between 2005 and 2016, and this method is considered as the basis for determining the best indices. NDVI, NDWI, MNDWI, SWI, AWEI, and WRI were compared with each other as the most common indices in determining water bodies. The values of each index in every image were extracted and the threshold values for each image were determined and finally verified by using the base method. Comparison with reference method (supervised classification) revealed that, MNDWI, AWEI, and SWI indices with correlation values of 0/76, 0/76, and 0/74, and RMSE value of 108/80, 111/30, and 113/80 hectares, and MAE error values of 85/63, 94/28 and 87/30 hectares, respectively are the best indicators for determining water body area. Considering the easiness and rate of calculation, it is more likely that using these indicators would help us to create a time series of wetland area changes for efficient management of this water body.

**Keywords:** Water body, Supervised Classification Method, Landsat Satellite, Satellite Index, Zaribar Wetland.

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## Prediction and Analysis of Flood Zones under Climate Change Conditions based on CanESM2 Model's Scenarios

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### Abstract

North of Iran is one of the flood-prone areas as a result of the humid climate and the large amount of maximum daily rainfall. This study aims to predict flood zone in climate change conditions based on the fifth assessment report of the intergovernmental panel on climate change (IPCC) scenarios in the Talar watershed (Zirab city). To investigate the effect of climate change, six synoptic stations were used. Among the general circulation models (GCM), Canadian Earth System Model (CanESM2) based on Representative Concentration Pathway (RCP) 2.6, RCP4.5, and RCP8.5 scenarios were applied for statistical downscaling of the maximum daily rainfall. To hydrologic and hydraulic simulation of flood were used from Hydrologic Engineering Center-Hydrologic Modeling System (HEC- HMS) and Hydrologic Engineering Center-Hydrologic River System (HEC- RAS) models in the recent decades and the future. The results indicated that maximum daily rainfall will increase in the watershed. The results also showed that the increase in maximum daily rainfall in humid climate (the North) is more than dry climate (the South). In general, maximum daily rainfall will increase the minimum and maximum 8 and 33 mm, respectively in the watershed. The simulation results in terms of flood hydrograph indicate that flood increase in the all periods. The RCP 4.5 scenario will produce at minimum and maximum flood discharge in 2020-2040 (374 m<sup>3</sup>/s) and 2020-2100 (1209 m<sup>3</sup>/s), respectively. Flood zoning map showed that floodplain area is the base period in the river basin, but climate change will increase the flood zone in this region. Besides, the results showed that at least 0.18 percent and at most 8.7 percent of the total Zirab city will effect on flood under climate change conditions.

**Keywords:** Hydrological Variability, Maximum Daily Rainfall, The Fifth Report's Scenarios, Statistical Downscaling.

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