Dynamical- synoptical analysis of summer precipitation process in Southeast Iran

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Received: 9 December 2015 Accepted: 16 March 2016

Extanded Abstract

Introduction

In Iran plateau, with movement of the subtropical high pressure to low latitudes in cold period of year, the emigrant systems of westerlies are dominant atmospheric phenomena in this region and control atmospheric phenomena in this period of year. But in the warm period of year the Sub-Tropical high-pressure is dominant atmospheric pattern in higher level of atmosphere in the Iran plateau. It is the main factor that controls the weather and climate over this region in the middle and lower troposphere as a local to regional scale thermal forcing. Focusing on the source and the path of necessary humidity for summer precipitations in this region, Parand (1991), Alijani (1995) and Najarsaliqe (1998) believed that the humidity of Indian Ocean and Arab Sea in low pressure cyclonic circulation of Pakistan move parallel through southern feet of Himalaya Mountain and penetrate southeast Iran in an east- west direction from Pakistan. In case of existing necessary factors, they ascend and make summer precipitations of the region.

Materials and Methods

The period used in this study was 78 days in 22 years (2010-1982) from May until end of September. The atmospheric circulation was extracted using daily mean of the 850 hPa geopotential height. Then, the agglomerative hierarchical cluster analysis with the ward

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algorithm and Euclidean distance are used to identify atmospheric circulation types over Iran in mentioned period of years. Then, we calculated the within-group correlation to identify representative days. The day with the highest within-group correlation was representative day of atmospheric circulation types. Finally, 4 atmospheric circulation types were identified for this summertime precipitation. Humidity flux divergence of the region was calculated by the relationship called horizontal flux divergence, in which in x,y directions (longitude and latitude), (q) stands for small changes of specific humidity, (u) for U component wind, (v) for V component wind.

$$HFD_{ij} = -\left[u_{ij}\frac{q_{i+1j}-q_{i\ 1j}}{x_{i+1j}-x_{i\ 1j}} + v_{ij}\frac{q_{ij+1}-q_{ij\ 1}}{y_{ij+1}-y_{ij\ 1}} + q_{ij}\frac{u_{i+1j}-u_{i\ 1j}}{x_{i+1j}-x_{i\ 1j}} + q_{ij}\frac{v_{ij+1}-v_{ij\ 1}}{y_{ij+1}-y_{ij\ 1}}\right] \quad (1)$$

HFD is horizontal flux divergence, but ∂_x and ∂_y stand for the distance in longitude and latitude, respectively. Besides, positive values mark humidity flux convergence, while negative values show humidity flux divergence. In fact, calculated values are dedicated to each level considering the values for special level, as a result, to find the real values of humidity flux for vertical sum. This value should be calculated for the distance of the height level of atmosphere. Following relationship is used in which (vq) stands for HFD, (p) for the level of atmosphere at geo-potential height, and Qvi for vertical sum of humidity flux.

$$Q_{vi} = 1/g.\int_{p^1}^{p^2} vq.dp \quad (2)$$

Since the used data are 6-hour, these calculations are done for a 6-hour period. To do the aforesaid calculations for a longer period (2 day) and the distance between several atmospheric levels following equation should be used. In this equation, (t1) and (t2) stand for the beginning and end times of calculating, respectively.

$$Q_{vi} = \int_{t1}^{t2}.\left(1/g.\int_{p1}^{p2} vq.dp\right).dt \quad (3)$$

Results and Discussion

Focusing on these precipitations, 4 patterns were recognized. The humidity flux was studied through 3 levels of atmosphere (lower levels, higher levels and vertical profile of atmosphere). There is a core of humidity flux convergence in southeast Iran in lower levels of atmosphere (1000-750 hPa). Besides, cores of humidity flux divergence on north of Arab Sea, west of Arab Sea and Persian Gulf are responsible for injection of humidity to surrounding regions. A core of humidity flux divergence is also formed in southeast Iran in middle and upper levels of atmosphere. Therefore, the injection of these precipitations happened in lower levels of atmosphere. Vertical profile of atmosphere revealed that, among the patterns, there is humidity flux convergence from the surface to 750 hPa level and humidity flux divergence in upper levels.

Conclusion

Study on summer precipitations of southeast Iran revealed that a tongue from Gang low pressure in l000 and 850 hPa levels penetrate Iran Plateau and Arabian Peninsula, while there is no tangible trace of this low pressure on the region in 700 hPa level. The calculation of humidity

flux function is in accordance with the findings of Karimi et al. (2007). Besides, north part of Arab Sea is obviously considered as the most important source of humidity in the region, as a core of humidity flux convergence is made in all patterns from the earth surface to 750 hPa level. Three cores of humidity flux divergence on north part of Arab Sea, west part of Arab Sea and Persian Gulf transfer humidity to surrounding regions. The divergent core of north of Arab Sea and west of this sea are considered to be the most important source to provide humidity for the region, while the core of Persian Gulf is minor. This phenomenon is mainly the result of central and southern Zagros Mountain chains which limit transformation of humidity from Persian Gulf to Iran Plateau. Moreover, there is no core of humidity flux divergence on Oman Sea to transfer humidity to surrounding regions. On the other hand, counter clockwise circulation of air through southern feet of Himalaya Mountain Chain in lower levels of atmosphere can only be seen in pattern 4 (Fig. 4) and slightly in pattern 3 (Fig. 3). Such synoptic order has no role in providing the needed precipitation humidity of southeast Iran, for it is too far from southeast Iran to provide enough humidity. Moreover, a strong core of humidity flux convergence is made in north part and center of Pakistan in which the aforesaid circulation in southern feet of Himalaya penetrates into the area. The atmosphere of the study area can be divided into lower part (1000-750hPa level) and upper part (700- 300 hPa level) through humidity flux convergence and humidity flux divergence, respectively.

Keywords: dynamic, Gang Low, Souteast Iran, summer precipitation, synoptic.

A new method for mapping the monthly cooling degree days, Iran

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Received: 21 November 2015 Accepted: 16 March 2016

Extended Abstract

Introduction

One of the main problems in the use of atmospheric general circulation models (GCM) for regional assessments is their low spatial resolution that is required to be downscaling by using statistical or dynamical patterns. Therefore, in this study, it is necessary to consider the effects of different ways on the investigated system. The best mean to consider and investigate the effects of greenhouse gases on the atmosphere at regional scale is the use of hybrid models of AOGCM, as one of the indices of climate degree days that its changes play an important role in environmental issues such as energy consumption for heating and cooling in future. Given the fact that Iran has diversity in elevation and climatic conditions and the most important factor in the cooling needs is along with changes in altitude and atmospheric moisture, the climate change is caused by the effects of global warming.

Materials and Methods

In this study, EH5OM database was used to detect the effects of global warming on cooling degree days. This is like the data of general circulation of the atmosphere and ocean models. This has been formed by data of atmospheric and ocean models. The data are implemented from 1960 to 2100, which are the general circulation of the atmosphere data. An international panel of climate change has been implemented by A1B scenario. EH5OM hybrid model is one of the most successful CMIP3 models in simulating climate, in comparison with the models of the twentieth century. EH5OM is one of the hybrid models of atmosphere-ocean ECHAM5 is related to atmospheric models and MPI-OM is related to ocean model. ECHAM has spectral dynamic core; the data of this scenario have been implemented from 1950 to 2100; the data of this scenario, from 2015 to 2050, were used in this study. Given that this research has regional (Iran) dimension, the data in the fourth climatic regional models (RegCM4) are downscaled that

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are best suited for little scaling and regional processes (Roshan et al., 2012; Randall, 2007). Downscaling model of output data are with dimensions of 0.27×0.27 longitude and latitude. This covers about the dimensions of 30×30 km in area of Iran.

After the simulation, the average of daily temperature for a period of 36 years (2015-2050) was derived by the model in a matrix with 2140×13140 arrays. In the matrix the rows represent the days of a year and the columns are the numbers of cells.

Results and Discussion

Table 1 shows EH5OM model scenarios under the conditions of greenhouse gases (carbon dioxide and sulfur atmosphere) as published by the Max Planck Institute. These scenarios were simulated for the period from 2000 to 2100. In fact, in this study we sought to identify change parameters of cooling degree days, according to the scenario of this model. As it is shown in Figure 1, in most of the scenarios greenhouse gas emission has taken an upward turn from the twentieth century and most of them are included in group A scenarios.

These results were performed with the results of analysis; the process of cooling degree days in the previous period, by Masoodian et al. (1393), showed that most of the upward range of cooling needs can be seen in the summer. But it is in agreement with the results of Roshan et al. (2012) who expressed warming regions of Iran in the first half of the year, in the upcoming period, especially in South Bar. This suggests that hot areas of the country will become warmer in spring. With the onset of summer, the number of the regions possessed the trend will be reduced.

Conclusion

In this research, after calculating the threshold of comfort in each station of the country and its compatibility with the surrounding cells, cooling degree days and its changes were calculated. The results of this research show warmer months of March, April and especially May and June in the coming decades in the country compared with other months of the year. In fact, according to the estimate of this scenario and the use of fossil fuels, the biggest challenge in the months of spring is warmer weather and increased demand for energy consumption. This can be a sign of early consumption of energy for cooling in the country in the coming decades.

Keywords: Arak, linear and non-linear regression, Statistical Downscaling Model (SDSM), trend detection..

Daily river flood modeling using genetic programming and artificial neural network (Case study: Amameh representative watershed)

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Received: 7 April 2016 Accepted: 28 June 2016

Extended Abstract

Introduction

Rainfall-runoff relationship is one the most complicated issues in hydrological cycle and its accurate estimation is one the most important concerns in water resources engineering and management. In addition, Rainfall-runoff modeling process is complex and non-linear due to the large uncertainties in the field of water resources. None of the statistical and conceptual methods are able to provide a better and capable model for that. But today using nonlinear networks as intelligent system for forecasting such complicated events can be efficient and effective in many problems of ecology.

Materials and Methods

Gene expression programming, a branch of evolutionary algorithms, is able to optimize the model structure and its components. Therefore, for modeling river flow we also used artificial neural network and as well as Genetic programming as an explicit method of evolutionary algorithms in Amame watershed in the Northern Slope of the Alborz Range in Mazandaran province, Iran. This is for a period of fifty five years from 1970-1971 to 2011-2012 periods (42 years). For this purpose, the meteorological and hydrometric data were used in the form of 62 proposed models. Every ANN is interconnected network of many processing units called neuron. Neurons are the smallest unit in artificial neural network. These neurons are very similar to biological neuron and the cell of human brain. Whereas the speed of these neurons is

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more than biological neurons, their ability and capacity are less than them. Neuron in every layer is connected through weights to next layer of neurons. The associated parameters with each of these connections are called weights. These weights represent the information being used by the net to solve a problem. During the training network, these weights, constant amount of that assemble with them, and biases are changed consecutively until the target function reached the favorite amount. We used activation functions (sometimes called a transfer function or threshold function) for transfer of output from every layer to next layer. These activation functions may be logistic sigmoid, linear, threshold, Gaussian or hyperbolic tangent functions, depending on the type of network and employed training algorithm. On the other hand, the method which used for achieving weights and biases are learning rule for favorite and terminal amount. In fact, this rule is a complex mathematical algorithm. Every network needs two groups of data for creation: training series and testing series. About 80 percent out of the data is belonging to training and the rest is used for testing. Duration of learning time, learning of network is evaluated continually by target function. In all cases, a multi-layer perceptron (MLP) ANN was employed for rainfall–runoff modeling, with the weights determined by error back-propagation. Sigmoid activation functions were used at all nodes in the hidden and output layers. For ANN method, we used Muti Layer Perceptron with Back Propagation algorithm and from one to three hidden layers and from one to thirty neurons. In spite of statistical methods such as ANN, decision tree etc., GP is self-parameterizing that build models without any user tuning. A GP method is a member of the Evolutionary Algorithm family, which are based upon concept of natural section and genetic. In fact, the basic search strategy behind GP is a genetic algorithm (GA) that was created by Holland (1975), although GP was developed and introduced much later by Koza (1992). This method has many similarities with genetic algorithm such as GP works with a number of solution sets as a population rather than a single solution at any time. Therefore, the possibility of getting trapped in a local optimum is avoided. As you know it is one the most important problems in ANN. But GP is different from traditional genetic algorithm in that it typically operates on parse tree instead of bit string. A parse tree is built up from a terminal set (the input variables in the problem and randomly generated constants, i.e. empirical model coefficients) and a function set, basic operators used to form the GP model.

Results and Discussion

The results showed that a MLP method with two hidden layer has the best function. Furthermore, increase in the number of neurons in the hidden layer can somewhat reduce errors, but then increase in the number of neurons not only increases efficiency but also cause increased errors in the models. The results indicated Amameh is used as hidden layer neurons between 1 and 16, while the hidden layer neurons are used between 1 and 12. In addition, out of many models, genetic programming has fewer errors and when mathematical function and power used it has also less errors.

Conclusion

Given the evaluation criteria used in this study including MSE, RMSE and MAE, the proposed structure of input (model number 54) meteorological variables such as temperature, rain and rain delays up to two days, relative humidity and evapotranspiration and delays during the two

days was obtained as the best the model. Therefore, the errors of this model for MSE, RMSE and MSE were 0.001, 0.031 0.009 and 0.001, 0.032, 0.009 in modeling and testing phase, respectively.

Keywords: Amame representative watershed, genetic programmning, multi layer perceptron, rainfall-runoff.

Palynological reconstruction of 1700 years vegetation dynamics in suburban Urmia, northwestern Iran: the role of climate and humans

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Received: 8 February 2016 Accepted: 25 May 2016

Extended Abstract

Introduction

Palynology is the most important biostratigraphic tool for Quaternary palaeoecology (Ortu et al., 2008), but until now data to reconstruct past environmental conditions in northwestern Iran are only available fragmentarily. This paper provides new palynological insights on the Late-Holocene vegetation history of Urmia as a function of climate and anthropogenic impact.

Materials and Methods

The study site, the Ganligol (Fig. 1; GNL; 37°35'34.7" N; 45°06'43.6" E) wetland near Urmia city, consists of a central shallow lake with marginal peat deposits. Half the lake surface is covered with *Potamogetoncrispus* while the marginal vegetation is predominantly of *Sparganiumerectum*, *Typha* spp. and *Phragmitesaustralis*.

A 5-m core was retrieved from the northern section of the site in 2013 using a Russian type chamber corer. This paper presents the palynological results of the upper 2.6 m. Palynological samples (0.5 cc) at 10cm intervals prepared following Fægri and Iversen (1989). Counting was carried out with an Olympus CX31 microscope with 400x magnification. Pollen-morphological types are displayed in the text by small capitals in order to distinguish them from plant taxa (Joosten & de Klerk, 2002). Pollen and spores were identified following Moore et al. (1991) and

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Beug (2004). The computer program Tilia 1.7.16 (Grimm, 2011) was used for calculating and presenting the palynological data.

The pollen percentage ratio C/A (Chenopodiaceae/Artemisia) was used as a rough index for reconstructing the dry and wet phases in the area (cf. El-Moslimany, 1990).

For age determination, two samples were sent to the AMS radiocarbon lab of National Taiwan University (Table 2). Radiocarbon ages were calibrated into calendar years BP (calBP) with the Bacon 2.2 package (Blaauw & Christen, 2011) using IntCal13 (Reimer et al., 2013).

Results and Discussion

Based on the Bacon age-depth model, the record approximately covers the last 1700 calibrated year BP. In average, 185 pollen grains originating presumably from upland vegetation (AP+NAP) were counted per sample depth. The entire record is overwhelmingly composed of Chenopodiaceae(C-A) and to a lesser extent Artemisia. The arboreal pollen mainly comprised of Quercus shows very low or virtually no values in all the records. Among the wetland pollen types, Poaceae and Cyperaceae prevail in most spectra. The GNL pollen record (Fig. 2) was visually divided into three pollen assemblage zones and one sub-zone as follows:

GNL-A (260-175cm; 1700-1121calBP) is characterized by high values of Artemisia in the midst of the zone and of C-A, particularly in the lower and towards the upper parts. Wild grass group and Cyperaceae are abundantly present. C/A ratio is ranged from 0.5 to 1.

In zone GNL-B (175-95cm; 1121-579calBP), AP disappears in the lower samples and then produces a small peak in the middle. Artemisia abruptly declines both in the onset and close to the upper boundary of the zone. Single grains of Juglans and Plantagolanceolata were encountered. Rumexacetosa produces a prominent peak in the middle of the zone, where Senecio and Lactuceae are also abundant. C/A ratio varies between 3 and 6.

GNL-C (the upper 95cm; since 579 calBP), may be divided into two subzones, GNL-C1 and GNL-C2. In the first subzone (95-35cm; 579-168calBP), C-A remains the most ubiquitous pollen type. Artemisia is the second most abundant type. Quercus and Centaureasolstitialis create continuous low-value curves. Cyperaceae produces prominent peaks in the lower half, where Typhalatifolia shows trivial increase, but gradually decreases towards the upper subzone boundary. Close to the border of the next subzone, Senecio reaches its highest values throughout the entire record. C/A values are ranged from 2 to 3.5.

Subzone GNL-C2 (the uppermost 35cm; since 168calBP) is distinguished from the lower subzone by higher values of C-A. Artemisia progressively decreases towards the topmost sample. Remarkable is the peak value of Plantagolanceolata in the mid-part, where Ribes rubrum and Plantagocoronops slightly rise. Both Poaceae and Cyperaceae prevail in the lower spectra. Lemna makes a conspicuous peak near to the uppermost spectrum. Another important constituent of this subzone is Lactuceae. C/A ratio fluctuates between 3 and 7.

The overall high values of Chenopodiaceae and Artemisia indicate that their corresponding taxa must have been important components of the vegetation in suburban Urmia over the last 1700 years. However, changes in regional and local vegetation have been frequently recorded and can be interpreted as the changes in climate, local hydrology, and human impact. The rather low values of the C/A ratio during the period 1700-1121 BP may indicate a relatively wet period. A similar wet condition has been postulated for southwestern Lake Urmia (Talebi et al., 2016),

Lake Nar in central Turkey (Woodbridge & Roberts, 2011) and central northern Iran (Ramezani et al., 2016). Alternatively, Djamali et al. (2009a) addressed a comparable increase of Artemisia in Almalou site (NW Iran) to the intensified agro-sylvo-pastoral practices during the Sasanian Empire. The replacement of Poaceae by Cyperaceaeat around 1430 BP not only indicates a prominent change in wetland vegetation composition but also a hydrological change in the wetland system. A change in the lithology of the core, i.e. the input of clastic material into the sediment (Table 1), may indicate more human activity in the catchment of the wetland.

The substantial rise of Chenopodiaceae (C/A=3-6) and the disappearance of AP pollen in the first half of the next period (1121-886BP) presumably refer to climate deterioration. El-Moslimany (1990) claims that a C/A ratio above 4.5 may indicate increased aridity in western Iran. Talebi et al. (2016) similarly proposed a cold and dry environment for southwestern Lake Urmia for the period 1100-850 BP correlative with the Medieval Climatic Anomaly. Anthropogenic activity in the area is evidenced by findings of Juglans pollen and a prominent peak of Rumexacetosaat 830BP.

The more frequent occurrences of Centaureasolstitialis, Juglans and Plantagolanceolata pollen during the period 590-180BP probably indicate intensified human impacts in the area. The re-expansion of reeds in the wetland fringes, possibly following a fall in water level, can be inferred from the substantial values of Cyperaceae, and, to a lesser extent, of Typhalatifolia and Sparganiumerrectum pollens.

The substantial decline of Artemisia since 180BP while Chenopodiaceae still maintains its predominance may refer to progressively increased aridity (C/A ratio: up to 7) in the most recent time. This, together with rather high values of Lactuceae pollen, is signals of development of steppe-desert vegetation in the area. However, recent intensification of human impacts, as evidenced in this record by the prominent peak of Plantagolanceolataat ca. 110BP which is further supported by other studies in northwestern Iran (e.g., Talebi et al., 2016), undoubtedly has been a major driving force in shaping landscapes in the area.

Conclusion

Our pollen records provide information on the Late-Holocene vegetation dynamics of suburban areas of Urmia city under the influence of climate change and human impact. *Artemisia* and chenopods must have the major constituents of regional vegetation in the entire period covered by the records, while sedges, grasses and other reeds have shown to be the most abundant wetland plant taxa.

Keywords: anthropogenic activity, holocene, palaeoclimate, pollen ratio, vegetation history.

Analysis of spatial variation of land surface temperature over Zayanderoud River Basin based on MODIS sensor

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Received: 9 January 2016 Accepted: 28 June 2016

Extended Abstract

Introduction

Soil temperature and its changes both in space and time is one of the most important factors that not only affect matter and energy transfer in soil but also influence the direction and amount of all physical processes in soil. Soil temperature depends on several factors including topography, sun radiation, air temperature, amount of soil moisture, the thermal properties such as heat capacity, coefficient of thermal conduction and specific heat. By the advent of satellite measurements in the last decades, there have been some studies focusing on the use and validation of remote sensing measurement of land surface temperature data mainly MODIS products. MODIS land surface data have been validated over different land types like lake (Want et al., 2002; Hook et al., 2004; Wan, 2008) and rice (Want et al., 2004; Galve et al., 2007).

Materials and Methods

In this research, the land surface temperature data of MODIS Terra in the spatial resolution of 1×1 km was exploited from NASA web site. These kinds of data are available in sinusoidal projection system. To investigate the role of elevation on land surface temperature, the digital elevation model (Dem) of the region was also obtained from NASA web site. Terra data are available from the year 2000 to 2015. These data are available in hdf format. As the first step only the pixels that felled into the Zayanderoud River Basin were selected from the data. This extraction was done using the inpolygon function in Matlab. By applying this function in Matlab there were exactly 48347 pixels that were the corner stone of our judgment about land surface temperature. In the second step, the daily matrix of temperature was constructed for

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each calendar day and based on the daily time series of the seasonal data were based on the daily data. Then, we calculated the rate of trend over each of the pixels for each season by applying regression equation on each of the 48347 pixels.

Results and Discussion

Analysis of trend in land surface temperature for each of the seasons indicated that there has been trend whether positive or negative in each of the seasons. The examination of trend for the season of spring showed that most of the territories of the Basin have experienced a negative trend but in central parts of the Basin a very marked positive trend dominates this region. The investigations for the summer season indicated that in many parts of the Basin negative trend has occurred but in the central parts of the Basin a distinguished positive trend can be seen. The analysis for the fall season showed that in this time many parts of the Basin like the other seasons have had a downward trend in the land surface temperature. But similar to the other seasons, central parts of the Basin have experienced a positive trend. The analysis for the winter season showed that in this period the areas that have had negative trend are less than the areas that have had positive trend in extent. The surprising note about this season is that there is a positive and direct relation between the rate of trend and elevation. Greater is the elevations, the greater the rate of trend. This means that in this season the highlands of the western parts of the Basin that are basically regarded as the valuable source for keeping snow covers and snow glaciers can't have snow covers like before, due to the dominating positive trend occurring in these regions.

Conclusion

In this study, the daily time series of MODIS Terra was applied to explore the spatial trend of land surface temperature over Zayanderoud River Basin. The smallest resolution of 1×1 km of these data was used to get a better picture of the trend. As the first step, only the pixels that fell into the natural border of the Basin were extracted by using Matlab functions. In the next step, the daily values of land surface temperature were aggregated to monthly and seasonal time scales. The analysis of the trend for each of the seasons indicated that in all of the seasons positive and negative trends have occurred but in general negative trend has had a greater domination. In the spring season only central parts of the basin has represented a positive trend but in the other parts decreasing trend prevailed. In the summer and fall like spring only the central parts of the Basin have had a positive trend. But in the winter the highland of western parts of the Basin has had a very marked positive trend that can be hazardous for this region due to this fact that these mountainous regions of the Basin is regarded as the source of snow cover of the Basin.

Keywords：land surface temperature, MODIS Terra, spatial variations, Zayandroud River Basin.

Performance assessment of Kernel-Based methods in estimation of suspended sediment loads (Case study: Maragheh SofiChay River)

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Received: 2 May 2016 Accepted: 28 June 2016

Extended Abstract

Introduction

Because of the importance of sediment transport in the efficient use of water resources and dam designing, estimation of the sediment load in rivers has been an essential interest to the engineers from long time ago. This leads to the design of various methods such as different empirical equations for solving the sediment transport. The error in most traditional experimental methods is common due to complexities in how this process works out and the vast amount of factors that cause this phenomenon. Therefore, achieving a suitable method that can accurately estimate the amount of sediment is very essential. In this study, the suspended sediment loads of SofiChay river have been estimated by modern data mining methods including Gaussian process and support vector machines that use the kernel functions that have a high ability to solve nonlinear problems. The results that obtained were compared with experimental methods such as sediment rating curve and seasonal method.

Materials and Methods

The study area

Sofi Chay catchment is up to 311 Km^3 in area and has been located in the south part of East Azerbaijan province and the northern city of Maragheh. Sofi Chay river is located within the geographical coordinates 37^0 '15 "2 to 37^0 '45 3" north latitude and 45^0 '56 " 31 to 46^0 '25 "5 east longitude.

Gaussian process regression

Gaussian processes are a fruitful way of defining prior distributions for flexible regression and

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classification models in which the regression or class probability functions are not limited to simple parametric forms. One attraction of Gaussian processes is the variety of covariance functions one can choose from. These lead to functions with different degrees of smoothness or different sorts of additive structures. When such a function defines the average response in a regression model with Gaussian errors, we can use matrix calculations to deduce that it is possible for data sets with more than a thousand samples. Gaussian processes in statistical modeling are very important because they are normal characteristics. Gaussian processes and related methods have been used in various contexts for many years. Despite this past usage, and despite the fundamental simplicity of the idea, Gaussian process models appear to have been little appreciated by most Bayesians. I speculate that this could be partly due to confusion between the properties one expects of the true function being modeled and those of the best predictor for this unknown function.

Support Vector Regression (SVR)

SVRs are a subset of SVMs that are particular learning systems that use a linear high dimensional hypothesis space called feature space. These systems are trained using a learning algorithm based on optimization theory. This method was introduced by Vapnik in 1995. SVMs have been employed for regression estimation, so called support vector regression (SVR), in which the real value functions are estimated. In this case, the aim of learning process is to find a function f(x) as an approximation of the value y(x) with minimum risk, and only based on the available independent and identically distributed data. Often in complex nonlinear problems, the original input space (predictor variable) is non-linearly related to the predicted variable (lateral spread displacement).

Results and Discussions

In this study, after required data related to the Sofi ChayRiver were collected, these data were examined by the standard normal homogeneity tests such as the Buishand range, Pettitt and Von Neumann ratio; and after refining the data, the drawing of sediment rating curve was developed. Then, the amount of sediment discharge of the river Sofi Chay was estimated using Gaussian process regression, support vector regression, sediment rating curve and seasonal methods. To achieve optimum results by the used data mining techniques, various scenarios including different types of kernel functions and different intervals of hyper parameters of kernel functions were defined. When Gaussian process regression, along with radial basis function kernel (Gaussian noise (ε) equal to 0.01 and gamma (Y) equal to 0.5), were used to estimate sediment discharge rate of the river Sofi Chay, it was observed that this method by presenting statistical indicators (correlation coefficient (R) equal to 0.977, Nash-Sutcliffe coefficient (NS) equal to 0.794, mean absolute error (MAE) equal to 77.4278 **(**tons/day) and root mean square error (RMSE) equal to 698.7455 (ton**s**/day)), have the highest accuracy and lowest error among the methods investigated in this study. Also the both investigated data mining methods have far greater efficiency and accuracy in this area.

Conclusion

In this study, the amount of suspended sediment load was estimated using traditional methods

such as sediment rating curve and seasonal method in comparison with modern data mining methods based on kernel functions such as Gaussian process regression and support vector regression. The results indicated that seasonal method has better performance in this case rather than sediment rating curve. The comprehensive results show that both modern data mining methods examined in this study outperform rather than traditional methods. Among the Gaussian process regression and support vector regression results, we observed the higher ability of Gaussian process regression method with using radial basis function as a kernel function. Generally, use of Gaussian process regression method suggested in similar cases.

Keywords: ***Gaussian process regression, sediment rating curve, Sofi Chay River, support vector regression, suspended sediment load.***

Study of Sensible Heat Flux and its Relationship with Temperature Changes and Wind during Warm Periods of Year in Iran

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Received: 12 August 2015 Accepted: 26 April 2016

Extended Abstract

Introduction

Changes in the Earth radiation balance not only affects the physical and ecological variables, but also disturbs the ecological balance, especially in arid and semi-arid regions. The energy budget in the earth surface is measured with flux content for the ideal surface. The flux is defined as the amount of matter passing through the unit of area in the unit of time with vertical direction. There are four types of energy fluxes at an ideal surface, namely the net radiation to or from surface, the sensible heat fluxes to or from the atmosphere, latent heat flux to or from the atmosphere, and the heat flux into or out of sub surface (water or soil). The net radiation flux is the result of radiation balance at the surface. The changes of surface sensible heat flux has a great impact on local and remote climate variability and climate hazards such as dust storms, particularly in warm months. Several studies have led to a good understanding of the changes of surface fluxes. For example, Zhou and Huang (2009) investigated the changes of heat flux in arid and semi-arid regions of northwest China and its relationship with summer precipitation in China. The results showed that any change in spring heat flux in northwest China in the east of Asia affects the summer precipitation. There are many researches in Iran, (Zare, 1999; Khalili 1997, 2002; Sadrinasab & Meyvand, 2010). For example, studying the thermal energy balance in Persian Gulf, Rais-Alsadat and Rais-Alsadat (2012) concluded that according to precipitation, evaporation and the volume of the water in and out of the Persian Gulf, the net heat transferring

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in this area is about 25 w/m^2. This extra heat can be justified by surface heat fluxes. Although, there are limited studies about heat flux changes in Iran, the changes of temperature and wind speed have been investigated in different aspects (Masoodaian, 2004; Zahedi et al., 2007; Ghahreman & Gharakhani, 2010). For example, Danesh Kararasteh (2007) studied the process of temporal and spatial changes of temperature and precipitation in Iran by applying remote sensing. He determined the affected climatic regions. The results revealed that the uptrend on monthly temperature mean affects the precipitation trends in north-northwest and south-southeast rain regions. As a matter of fact, the necessity of having a long-term time series to show heat flux changes in the areas with limited coverage of stations indicates the importance of applying reanalyzed data. Using these kinds of data, Roshani et al. (2014) analyzed temporal-spatial changes of the net radiation flux over a long time in Iran. They concluded that not only yearly changes of net radiation flux have sinusoidal behavior, but also monthly changes are influenced by the change in radiation angle, the general circulation and local phenomena.

Materials and Methods

Sensible heat flux of Iran was calculated based on the data of air temperature, land temperature and wind speed obtained from reanalysis of the data during a 34-year period (1980-2014) for a limited area (43^o to 64.5^o eastern longitude, 20^o to 41^o northern latitude). In this study, sensible heat flux was calculated for warm months (spring and summer) by using the bulk formula. Moving average and anomaly were used to consider the changes of monthly and seasonal time series of sensible heat flux, temperature and wind speed variables. Linear and polynomial regressions were calculated to determine the trends in every variable. Correlation and multi-variable regression and Pearson correlation coefficient were used to show the relationships between sensible heat flux, temperature and wind speed variables. Excel and SPSS were used to run all the statistical calculations. Finally, the isohyet maps were plotted using GIS.

Results and Discussion

This study aimed at observing uptrend trend in spring sensible heat flux and down trend in summer heat flux. The gradient in spring, (0.18), and summer, (0.039), showed the high intense of variations in spring. Spring sensible heat flux shows positive anomalies in recent years while sensible heat flux in summer shows variations with regular periods and mostly in negative anomalies. Despite the spring precipitation, wet soil, growing vegetation and increase in latent heat flux, North West Iran shows the minimum sensible heat flux and maximum standard deviation. The changes of air temperature and land temperature are increasing during the study period representing the uptrend in seasonal time series. However, the decrease in wind speed makes little trend changes in long-term wind speed in spring and summer. It was found that spring and summer sensible heat fluxes were greater in the 1990s than other decades. All land temperature, air temperature and wind speed displayed an obvious interdecadal increase in 1990s. In addition to west, North West regions, central and east Iran showed maximum standard deviation in sensible heat flux in 1990s. Multi regression was applied for each season separately. The results were in accordance with the results of correlation in the relationship between the variables (land temperature, air temperature and wind speed) and sensible heat flux. Linear R-squared value is 0.49 showing that land temperature can determine 50 percent of sensible heat flux changes in spring. Besides, polynomial R-squared value is 0.19 in wind speed to determine 20 percent of sensible heat flux variations in summer

Conclusion

This study could prove the relationship between maximum sensible heat flux and maximum land and air temperature in west, North West, center and southern part of Caspian Sea. The change in the surface wind speed played a more important role in the interdecadal variations in sensible heat flux during the summer, whereas the change in the land temperature was more important for the interdecadal variations in sensible heat flux in the spring. Therefore, it seems that land temperature in spring can affect the relative humidity, precipitation and drought in summer leading to the occurrence of climatic hazards such as dust storms.

Keywords: climatic elements, Iran, sensible heat flux, variations trend, warm period.

Estimation of bankfull discharge based on stream channel characteristics in Garmabdasht Catchment, Golestan Province

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Received: 3 April 2015 Accepted: 16 March 2016

Extended abstract

Introduction

The bankfull discharge corresponds to the river level just before it starts to flow out of its main channel and over its floodplain (Navratil et al., 2006). Bankfull discharge is a deterministic discharge often used to estimate the channel-forming discharge. It is adopted that the bankfull discharge (magnitude and frequency) is one of the important concepts in the analysis of river morphology, flood events and ecological systems. River geomorphologists are particularly interested in bankfull discharge because it serves as a consistent morphological index that can be applied in river engineering and stream restoration to design a stable size and shape for a stream so that its channel will maintain its dimensions, pattern, and profile over time without degrading or aggrading (Rosgen, 1994; Knighton, 1996). Bankfull hydraulic geometry relationships vary by region along with changes in hydrology, soils, and land uses (Doll et al., 2002). This study investigates spatial changes in the bankfull hydraulic geometry such as width, depth and cross section area with bankfull discharge and catchment area.

Garmab-Dasht catchment is located in the northeastern Alborz, Golestan province and south east Gorgan. The study area geologically consists of marine and continental sequences, which deposited through the Msozoic to Cenozoic. The altitude of the Garmab-Dasht catchment varies from a maximum of 3400 m to 400 m on the valley floor. Mean annual rainfall in the catchment is around 550 mm. Mean annual discharge of main stream is measured 0.58 m_3/s.

Materials and Methods

In this research, Garmabdasht catchment is divided into eleven reaches. Several criteria have been identified to assist in field identification of the bankfull stage. It contains significant breaks in slope, changes in vegetation, the highest scour line, and the top of the bank. Field measurements of bankfull width (W), bankfull depth (d) channel slope (S), bankfull cross-sectional area and streambed-material sizes (D_i) were conducted at each site. Two or three width measurements per channel reach were conducted and a mean width per reach was calculated.

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The grain sizes of surface sediments were sampled along the channel by pebble count method. After data collection, hydraulic geometry relationships calculated for bankfull discharge, cross-sectional area, width, and mean depth as functions of watershed area for the Garmab Dasht catchment. Flood frequency analysis is used to estimate the recurrence of bankfull discharge by a 30 years Annual Maximum Series (AMS).

Results and Discussion

The relationships between channel-morphology characteristics and bankfull discharges were examined using the power function regression equations. The high coefficients of determination indicate good agreement between the measured data and the best-fit relationships. The exponent value of width and depth were obtained 0.42 and 0.34, respectively. It shows that channel width increases more rapidly with the area than channel depth. Also, values of shear stress and stream power at bankfull condition represent a power function regression with catchment area. The study reaches show a good relationship between cross section area, bankfull discharge and drainage area, through the linear regression with a high R^2 (0.95). Shear stress and stream power show a power regression with catchment area. Also, stream power has a good relationship with bankfull width ($R^2 = 0.74$). The empirical equations expressing the relationships between D_i (in m) and drainage area is calculated as power regression. But, correlation results give no significant p level ($P>0.05$) for D_i and drainage area. Many research show that there are relationships between bankfull hydraulic geometry (width, depth, cross section area) and drainage area (Harman et al., 1999; Vianello & D'Agostino, 2007; Mulvihill & Baldigo, 2012; Modrick & Georgakakos, 2014). The results of this study verify such relations in Garmab-Dasht catchment.

Log-Pearson Type III distributions were used to analyze annual peak discharge data for Garmab Dasht gage station. Many studies have found that bankfull discharge occurs at a recurrence interval of about 1–2 years on the basis of the annual maximum series (AMS) approach (Leopold et al., 1964; Dury, 1976; Castro & Jackson, 2001, Navratil et al., 2006; Schneider, 2011). The recurrence interval for the bankfull discharge in study area obtained 2 years.

Conclusion

The results of the regression analyses indicated that Bankfull width, bankfull depth, bankfull cross-sectional area, and bankfull discharge were related to drainage area using regression analysis. Bankfull hydraulic geometry relationships can be used to estimate the bankfull discharge at an ungaged site. Also, it can be toassist in field identification of bankfull stage and dimension in un-gaged watersheds. Further work is necessary to develop reliable relationships for other regions and rainfall/runoff conditions of Iran.

Keywords: Bankfull discharge, Garmab-Dasht, Golestan province, stream channel morphometery.

Assessment of the tracks of spatio-temporal precipitation, Iran

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Received: 20 January 2016 Accepted: 30 April 2016

Extended Abstract

Introduction

Rainfall is a fundamental meteorological element that directly or indirectly affected human life. In many climatic studies, it is necessary to make reviews and analyses of suitable temporal and spatial resolution data in atmosphere based on detailed monitoring. There is also the need for resources and authoritative database. Today, with the emergence of the phenomenon of climate change and its consequences and the need to study all aspects of climate, these kinds of data especially in recent decades has been more needed. On the other hand, since spatial patterns of rainfall in short-term time scale was often too heterogeneous, it is essential to achieve a suitable method for estimating large regional rainfall in large areas.

Materials and Methods

To assess the temporal and spatial behavior of precipitation in Iran during last two decades, we used the Aphrodite pixel database. The base period of spatial data with spatial resolution of the Middle East and the period from 01/01/1988 to 31/12/2007 AD by pixel size value 25.0×25.0 arc were taken. To assess spatial autocorrelation data during last two decades we applied the spatial autocorrelation of Global Moran Method. In this study, we also used cluster analysis and outlier analysis (Anselin Local Moran's I) and also applied hot spot analysis (Getis-OrdGi*) to study the temporal and spatial changes in precipitation patterns.

Results and Discussion

The global Moran index for all four seasons of two periods of study is more than 0.75. Based on global Moran index, rainfall in the country in two decades of study indicates a cluster pattern of up to 95 and 99 percent confidence level. Due to the high value of Z and low value of Probability the hypothesis of no spatial autocorrelation between data during two periods is not verified. In most parts of the country (43.78%), there was not any type of patterns. Then, the lack of spatial autocorrelation during second period caused increase in the amount of area equal to 5.88 percent. The areas with no spatial autocorrelation in the summer reached maximum value, and it was in the first and second period equal to 90.88% and consequently 92.36%. In other seasons, spring and autumn, there were also the areas with no spatial autocorrelation

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pattern and is allocated relatively half of the country. The amounts of spatial autocorrelation for rainfall data in spring were negative during the first period and it decreased relative to the second period of 1.53 percent. This decrease is mostly found in Northern Khorasan and Central Zagras. There was a low-LL cluster at any of a two periods of study in the summer. The cluster of low (LL) in the autumn of the second period (25.30%) is compared with the first period (28.01 %) changed small value (2.71). However, it changed significantly in terms of location and the center of low precipitation patterns displaced toward east and southeast regions of Iran. The patterns of negative spatial autocorrelation in winter, autumn and spring show changes in spatial and temporal dimension. Then, most of the decline in the two decades of study is associated with the second period in winter season with a numerical reduction (6.62%) compared to the first period (31.30%). It is worth mentioning that most of the reduction is allocated to Zagros region, South East Iran and Northern Khorasan. In general it can be concluded that local factors and general atmospheric circulation systems in the first and second stages affected distribution of precipitation patterns in Iran.

Conclusion

The results showed that long-term rainfall patterns are formed over a period of interaction of local factors and elements of atmospheric circulation. The geographical feature of precipitation patterns are based on local factors, especially latitude and topography. However, we should not ignore the role of external factors in the formation of rainfall patterns because the external factors like general atmospheric circulation play a significant role in the precipitation regime and spatial and temporal changes of precipitation. If we pay attention to cluster rainfall map of Iran we can conclude that the cluster of high rainfall and low precipitation are not similar to each other due to the effect of the general atmospheric circulation patterns. In general, we can conclude that the precipitation patterns are affected and controlled by two main factors, which include: (1) local factors controlling the location (geographic feature of precipitation patterns) and (2) external factors controlling time (regime of precipitation patterns). Finally, this study could be a model for other studies of climatic parameters by a general comparison of precipitation patterns of pixel based data of Aphrodite compared with measured values in climatology and synoptic stations. In all the studies in general and in other fields of study for example ecology and environmental sciences in particular which require updated and accurate climatic data in terms of time and space, we can use Aphrodite data.

Keywords: Aphrodite, Iran, precipitation, spatial autocorrelation.

A survey of variability relationship between temporal variations of temperature and Cutaneous Leishmaniasis disease in Isfahan Province

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Received: 26 December 2015 Accepted: 28 June 2016

Extended Abstract

Introduction

Changes of climatic elements such as temperature on a temporal scale follow different patterns under various trend and seasonal models. Associated with these changes, many environment elements are affected. One of the most important effects of climate is on health. Cutaneous Leishmaniasis (CL) is one type of disease caused by protozoan parasites of the genus Leis mania and localized CL in various countries as stated by Alvar et al. (2012). The agent of this disease is transmitted into the skin of mammalian host by a kind of female sand flies. CL is a major neglected tropical disease (Alvar et al., 2012) with a complex ecology, whose transmission, in the New World, requires the co-existence of vectors, reservoirs and humans. The importance of temperature variations and anomalies for temporal variations in the diseases has been well recognized. Temperature variations can enhance diseases through environmental process.

Materials and Methods

Study region (◦N, ◦50_E) is approximately 33 km^2 and situated in the center of Ira. It is ranged from 25^o 3’ to 39^o 47’ N and from 44^o 5’ to 63^o 18’ E. We want to make identification of temperatures effects on CL in order to better forecast the CL variations in Isfahan Province. With regard to temperature changes in Isfahan Province, we chose 13 stations. The temperature was obtained from meteorological organization and included the monthly, seasonal and annual information of 13 stations in Isfahan Province for the period of 1979-2014. All the observed temperature data have been subject to strict quality control obtained from http://www.irimo.ir/eng/wd/720-Products-Services.html. The study focused on monthly and seasonal variations. The CL data were obtained from Heath Center of Isfahan and Kashan Heath Center and included the monthly, seasonal and annual information of 13 cities in Isfahan Province.

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Study of temperature trend on CL changes is based on exploratory and confirmatory analyses with the incorporation of trended and non-trend patterns of predictor variables on response variables. Trend model is a multivariate statistical method that uses factor analysis to evaluate the relationship between temperature and CL (Paul & Anderson, 2013). Application of this technique in climatology leads to this question of how the trend pattern among temperature variables and the CL factors are studied. Trend model analysis can be used to answer this question. We studied the possible trend patterns between temperature and CL. Upward and downward trends of temperature on CL is highly related to the relationship link between temperatures and CL. Nevertheless, temperature could influence CL with only no direct link between temperature and CL.

Results and Discussion

The temperature and CL trends are addressed about the effects of temperature variables or the variables which are not directly observable. These temperature variables are measured by several trend models. Concerning the relationship of temperature trend on CL, three indicators of monthly, seasonal and annual temperature indices and CL data were studied with respect to research model. The test of the model is done along with testing the measurement model, analyzing and forecasting models. Hence, the distribution of temperature and CL data showed a suitable time series patterns. Also, the results show that the series of temperature have an acceptable trend and the mentioned constructs of research have a suitable diagnostic trend. Also, the results show that the series of CL disease have an acceptable seasonality in the stations. The mentioned constructs of the research have a suitable diagnostic seasonal pattern. In order to evaluate the relationship of temperature elements trend and CL disease, linear model to being noncompliance into trend model, the data from analysis model were extracted, and the forecasted temperatures relationship to CL disease were obtained.

Conclusion

A primary purpose of our study was zoning of temperature and CL data trend. Our other aim was to examine the relationship of the temperature and CL disease trend in causal indicators. The results indicated that there are relationship of trend between temperature and CL disease in Isfahan province. The findings of this study also indicated that among the temperature values influential on CL disease, the monthly temperature factor had the highest effect on the rate of CL disease. The results show that temperature and disease are followed to a seasonal pattern, with the highest (lowest) cases in autumn (spring) season with a seasonal time delay to the maximum (minimum) temperature in summer winter.

Keywords: Cutaneous Leishmaniasis, disease, Isfahan Province, temperature, trend.