Spatial Modeling for Distribution of Thunderstorm Rainfalls in Mountainous Areas of the Northwest Iran

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Extended Abstract

Introduction

Thunderstorm rainfall is one of the most important climatic phenomena in the northwest Iran. It has specific variability in spatial distribution. These rains play an important role in climatic conditions of the study area of this research. The purpose of this study is investigation of spatial distribution of thunderstorm rainfalls in mountainous areas of the Northwest Iran to make a modeling of these events in the study area. Because of that precipitation data of TRMM images from 2009 to 2012 have been selected and processed in the applications of ArcGis, ENVI and EDRISI.

Precipitation is one of the crucial elements of climate that its temporal and spatial variation can produce a variety of geographical areas. In this study, thunderstorm is one of the most important climatic phenomena of this study area. Sometimes these rains provide waters to crops and especially in summer leave catastrophic effects on the natural environmental and agricultural economy. Thunderstorm is related to the warm months of the year. In some cases, thunderstorm rainfall can cause flooding and destructive disaster in all over the area. Therefore, this type of precipitation can be considered as a representative of regional climate, especially in spring and summer.

The purpose of this research is to identify the geographic factors including elevation with precipitation of the study area and find an appropriate regression model.

Conrad (1996) in a study had shown high correlation between height and distance from the source of heat, humidity, cold and warm precipitation in Blorych Mountainous areas of America.

Johansson (2003) in a study about the effect of topography on precipitation distribution on

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Sweden slopes concluded that precipitation increases with increasing elevation in windward slopes.

The study area is located in the range of 40 to 36 degrees north latitude and 49-40 degrees east longitude. Sahand Mountains and Arasbaran, Sabalan Bozghoush, Misho, and Zagros Mountains in West of Lake Urmia are the most important mountains and highlands in study area. Urmia Plain, Moghan, plains of Tabriz, Ardabil, Sarab, and Ahar are the most important regions of the Northwest Iran (Motalab Faed, 1386). Generally, the climate of this area is affected by two major factors, such as the topographic features and synoptic properties.

Materials and Methods

For modeling of thunderstorm rainfall TRMM images of precipitation days from 2010 to 2012 has been downloaded from the site http://lake.nascom.nasa.gov/tovas/.

Interpolation is mainly a mathematical method that is based on the distance between points of observation. The method of Inverse Distance Weighting (IDW) approach which is an advanced proximity of neighboring stations has been used to estimate the weight of factors. In This way nearest station has more weight than the other stations.

Digital Elevation Model (DEM) is a simply statistical representation of the continuous ground by the large number of selected points with coordinates x, y and z of a range of optional coordinates. In the other words, DEM is a digital or numerical display of the true ground.

Results and Discussion

Study about the variations of rainfall with height is important, especially in areas without weather station, to determine the regional gradient rainfalls relation and to estimate the amount of rainfall points. This is usually carried out as parametric methods in whether studies (Jahanbakhsh, 2011).

Regression model: The image height as the independent variable and the precipitation variation as dependent variable have been selected by TRMM images rainfall. The Average rainfall of TRMM images from 2010 to 2012 is used as the dependent variable.

Conclusion

The correlation confident is above 63/0 (R= 0.63) and, thus, shows a positive correlation. As the relation is significant in alpha 0.05, it has a good correlation and shows high positive correlation. This means that the precipitation increased with increasing altitude residual sum of squares is smaller than the regression sum of squares. This indicates that the model has high explanatory ability. The Model is significant in 0.99 of confidence interval. T-test of the model is more than 2.33; as a result, T-test model is significant at 0.99.

The results of this study have also indicated that there is a high correlation between TRMM rain and DEM and thunderstorm rainfall in spring and summer.

Keywords: modeling, mountainous areas of the northwest Iran, spatial distribution, thunderstorm rainfall.

Relation of Vegetation Cover with Land Surface Temperature and Surface Albedo in Warm Period of Year Using MODIS Imagery in North Iran

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Extended Abstract

Introduction

The most important indicator of climate in a region is vegetation communities. Climate may be different over large areas due to changes in vegetation communities. Vegetation influences weather and climate in its surrounding areas mostly by way of evapotranspiration and albedo so they play a role in the earth's energy balance. These effects on the earth's energy balance are taken through air temperature, relative humidity, rainfall, solar radiation and cloud cover on their own micro-weather (Neilson, 1986; Small and Kurc, 2003; Weiss et al., 2004). Disasters such as drought, flood, forest fire and so on can occur whenever the global energy balance goes out of the normal range.

Remote sensing data provide valuable information for vegetation studies because it can give an idea about the vegetation conditions. Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST) and land surface albedo are key biophysical variables for studying land surface processes and surface-atmosphere interactions. These variabels can be calculated by transforming raw satellite data. The aim of this paper is to study relationship between NDVI, LST and land surface albedo due to the impact of vegetation on surface temperature and albedo and identify dryness status in the northern Iran.

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Methods

The study area of this research is located in the northern part of Iran where covered by dense vegetation such as Hyrcanian forests in the north and sparse vegetation in the southern part of the Alborz Mountain range. This area is an alteration bio-climate region lying between the humid climate in the north and arid and semi-arid climate in the south.

The methodology used in this study consisted of remotely sensed data processing. The remotely sensed data processes involved data acquisition of Moderate Resolution Imaging Spectroradiometer (MODIS), data pre-processing (i.e. atmospheric correction, geometric correction, and data masking), and data processing (i.e. derivation of vegetation, biophysical indices such as NDVI, LST and land surface albedo variables). In this study, MODIS data was selected because the MODIS sensor has several benefits compared with other data. For example, MODIS has a wide swath of 2330 km that covering the entire study area. The MODIS dataset has a variety of products that each contained different levels of data processing. In this study, Level 1B dated July, 2010 (MOD021KM and MYD021KM calibrated and geolocated) was used to derive NDVI and surface albedo, and retrieving LST. This level 1B collection contains calibrated and geolocated radiances at-aperture for all 36 MODIS spectral bands at 1km resolution. In this study, Simplified Model for Atmospheric Correction (SMAC) was applied for atmospheric correction of MODIS data.

Absorbtion in visible light (solar radiation) occurs in live green vegetation because of photosynthesis. Scattering (reflectance) of solar energy in the near infrared occurs at the same time. This difference in absorption and reflectance encourage us to use NDVI. NDVI is an vegitation index which measures this difference to show vegetation density and condition. NDVI value ranges between -1 and +1. The values close to zero means no green vegetation and close to +1 (0.8 - 0.9) represents the highest density of green vegetation. LST is an important parameter in determining the earth radiation budget and heat and moisture flow between the surface and the atmosphere and temperature strongly influence vegetation processes. Thermal bands of MODIS data (band 31 and 32) converted to radiance then converted to brightness temperature using plank law for calculating surface temperature. Albedo is also an important bio-physical indicator for reflecting land surface energy distribution and balance. In the process of broadband albedo retrieval, an empirical regression was used for MODIS data (Liang et al., 2002). Finally, regression and geostatistical approach (e.g. CoKriging) was used in this study to estimate LST and surface albedo using NDVI of MODIS data.

Results and Discussion

In this study three criteria such as mean absolute error, root mean square error and mean absolute percentage error have been used to measure the differences between the values estimated for LST and Albedo using regression and CoKriging geostatistical method. The results obtained in this research indicate that the geostatistical method of cokriging has good potential to estimate LST and surface albedo using normalized difference vegetation index. The results of the study show that changes in vegetation cover alter the LST and surface albedo, leading to a local temperature change. Plants and forests have a very low albedo and absorb a large amount of energy. The relationship between normalized difference vegetation index and LST and surface albedo equations were then used to found the surface dryness condition in the

study area. The results of 3D feature space of Albedo-NDVI-LST spectral show that it has a suitable index for extracting drought information. The study has also revealed that coastal and forested northern slopes of the Alborz Mountain are identified with high normalized difference vegetation value (0.85), minimum surface temperature (23°C) and albedo (7%). The southern part of Alborz Mountain and the central Iran experiences low normalized difference vegetation value (-0.09), high surface temperature of 45 ° C and high surface albedo (38%).

Conclusion

In this study, the relationship between NDVI and LST and surface albedo was analyzed to estimate LST and surface albedo derived by regression and CoKriging methods. It has been recognized that there is a strong correlation between albedo, LST and NDVI. By comparison of the regression relationship among LST, Albedo and NDVI, the results exhibit that LST and Albedo have negative correlations with NDVI. In this paper, a 3D feature space of Albedo-NDVI-LST spectral is analyzed for monitoring surface dryness condition. The result represents that surface albedo nad LST is affected by the change of vegetation. This 3D feature space is reliable index to show surface dryness status for soil and plant cover. It is recommended that 3D feature space of Albedo-NDVI-LST spectral can monitor the surface dryness condition and also it is easy to operate for quick surface dryness assessment. Studies are underway to incorporate other variables in surface dryness condition.

Keywords: Albedo, geostatistical method, land surface temperature, regression, vegetation covers.

Analysis of Anomalies and Perceptible Water Cycles in Iran Atmosphere

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Extended Abstract

Introduction

Perceptible water is the main part of water cycle in the atmosphere and an important variable for climate studies and also an important element of atmospheric humidity, in particular atmospheric raining. Perceptible water, therefore, has been considered as an appropriate index on short and long term changes in climate. Recognizing the changes within a decade of perceptible water is essential for knowing the region and local climate change. Identification of changes, within a decade, (decade to decade) of perceptible water can lead to the identification of climate oscillations as a decisive factor in raining. Thus, it plays a significant role in macro planning based on precipitation.

Perceptible water has oscillation in different time scales. For example, at the end of afternoon it increases under the influence of sun radiation. Such daily variations following heavy precipitation are very evident. Some anomalies of perceptible water follow the pattern of random behavior and some specific patterns. For example, positive anomalies of mid latitude arise from ocean currents and the effects of beyond phenomenon. Besides the anomalies existing in perceptible water, the cycles are also recognizable in this climate element. Perceptible water is considered as a guide in numerical weather prediction and climate modeling, thus recognizing the necessity is the basis of climatology. Many scientists have studied the cycles of climatic elements, first in relation to the large-and small-scale circulation. One of the most important methods for presenting behavior and oscillating pattern of climate elements is harmonic analysis.

Data and Methods

Considering a column of liquid water with cross-sectional area, and certain height can determine

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the perceptible water. One way to determine the mass of water vapor (in grams) is its amount in a vertical column of one square centimeter in cross-sectional area extending from Earth surface to the upper levels of the atmosphere. Mathematically, if $x(p)$ is the specific humidity at the pressure level, p, then the perceptible water vapor, PW, contained in a layer bounded by pressures p_1 and p_2 is given by:

$$PW = \frac{1}{g}\int_{p_1}^{p_2} x dp$$

where, g refers to gravity acceleration.

For the purposes of our study, the pressure and specific humidity of NCEP/NCAR which exist for each 6 hours has been used. This data characterized by 2.5 longitudes in 2.5 latitude degree resolution. In order to estimate perceptible water anomalies, first the center of perceptible water was calculated during triple period.

For extracting the cycle, the harmonic analysis technique was developed. In harmonic analysis of variance distribution, it uses the whole time series wave length. Each harmonic indicates periodic behavior in a time series. Thus, each sequential wavelength is shown with a harmonic in general, for extraction of cycles by spectrum analyzer the following steps must be taken.

$$a_i = \frac{2}{n}\sum_{t=1}^{n} x_t \cos\left(\frac{2\pi q}{n}t\right) \quad q = 1, 2, \ldots, \frac{n}{2}$$

$$b_i = \frac{2}{n}\sum_{t=1}^{n} x_t \sin\left(\frac{2\pi q}{n}t\right) \quad q = 1, 2, \ldots . n$$

where, Xi is the average perceptible water, q is the number of harmonic for even number series (q = n / 2) and for odd time series (q = n-1.2). Finally, after extraction of variance, the whole waves were evaluated in terms of statistical significance.

Discussion

The area per decade over the entire period was faced with positive anomalies, determined with dark colors, and areas with negative anomalies, determined with light-colors. Positive anomalies indicate increasing of perceptible water and negative anomalies decreasing perceptible water over the entire period. With increasing of perceptible water in northern and southern coasts, center of gravity or the center of perceptible water are inclined toward center of the country. In the third period, this center inclined toward south. This indicates the greater weight of perceptible water of south coastal areas relative to the northern coast. The compression of average center showed that perceptible water in all three periods roughly follows a fairly regular pattern.

B) Perceptible water cycle

By applying harmonic data analysis technique to Iran atmospheric perceptible water, significant sinus cycles were estimated for Iran area. The results are presented in Figure 1. In the North East part of the country, cycle 2,5, and 24 years old, in South East cycle 2 to 8 years old, in the North West, cycle of 2 to 3, 6, 11 and 24 years, and finally in the South West 2, 3, 16, and 24 years old cycles were dominant. Inter-annual variability (5-2 years old) is shown in a wide range

of zones. This indicates that the perceptible water in most parts of the country have been short cycle.

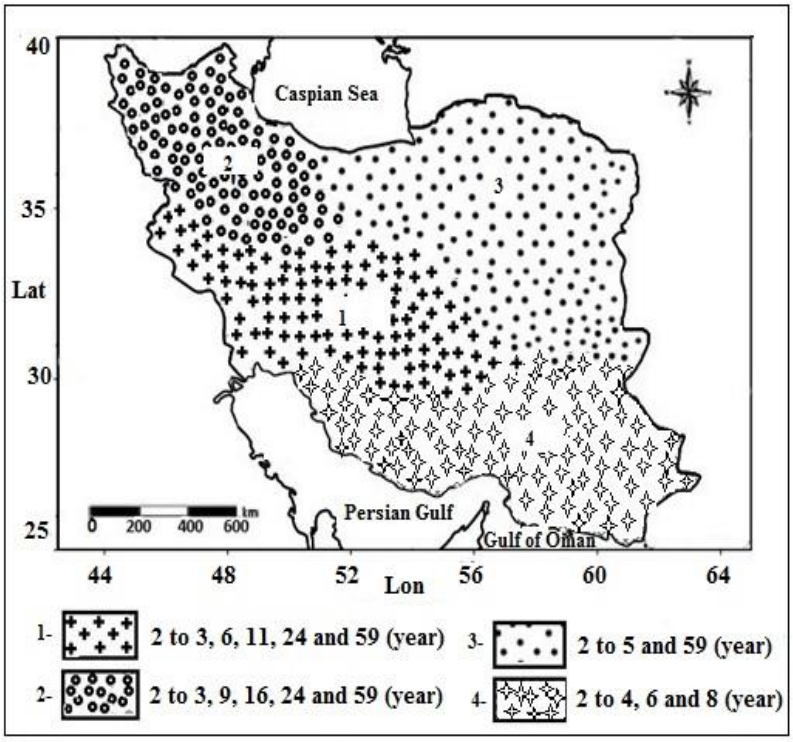

Fig. 1. Spatial distribution of annual precipitation and the water cycle in the atmosphere

Keywords: anomalies, harmonic analysis, Iran, perceptible water.

Optimal Development of Rain Gauge Network Using Kriging and Entropy in Geographic Information System (GIS) (Case Study: Karkhe Basin)

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Extended Abstract

Introduction

Rainfall, as the main representative factor of every region's natural and hydro-climatic specifications, has a high degree of importance in water resources planning and management. Rainfall events have noticeable spatial and temporal variations. Rain gauges of various types are used for the measurement of spatial variations of precipitation. Due to the limitation of the possibility for expanding these rain-gauge stations to all locations, the precise estimation of a regional rainfall is not possible. Therefore, sufficient consideration is required to be taken into for choosing the location and number of stations for achieving sufficient precision in regional rainfall estimation. Because of numerous factors involved in determining the optimal location of these stations, development of an optimal structure seems necessary for placement of the stations or expansion of an existing rain-gauge network. In this research, information transformation entropy and estimation variance of regional rainfall are used for determining optimal locations for expansion of an existing rain-gauge network structure. In the proposed structure, the points with maximum estimation variance and minimum information transformation entropy over a region are considered as candidates for new stations. An optimization model for combining the results of these two methods is developed. Finally, suggested locations for establishing new stations are determined. In the proposed structure, GIS

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environment is used for better illustration of the results of spatial analysis. Given its high importance in terms of national water resources, the KARKHE basin is considered as a case study in this research. The results of the investigation and analysis performed in this research show that using 17 suggested new stations in the KARKHE basin, the precision of results of rainfall spatial analysis can be enhanced significantly.

Methods

This proposed methodology in this study involves the following steps: 1. Data collection and analysis, 2. application of kriging to existing rainfall data to calculate the rainfall spatial analysis variance, 3. calculating the transformation entropy in the basin surface, 4. selection of candidates points for rain gauge development with the minimum transformation entropy and the maximum rainfall estimation error, 5. presentation of rain gauge network final map.

In this paper, the best combination of sampling stations in a monitoring network is selected using the entropy theory by taking into account the maximum uncertainty (minimum redundant information in the system) and the maximum rainfall estimation Kriging error. Hence, in this study, a new model composed of variance estimation and entropy is proposed to relocate the rainfall network and to obtain the optimal design with the minimum number of rain gauges.

Results and Discussion

The rainfall data of the 49 stations in the study region for the period of October to April are utilized in this research. With the correlation coefficient higher than 0.6 in rainfall and height, Cokriging method was employed to analyze the spatial rainfall. Kolmogorov Smirnov test (K-S) with a confidence level of 95% of normal monthly precipitation data is verified. In case of non-normal data conversion in Cox- Box or log normal distribution, the data are close to normal distribution. The estimated variance is calculated for each month. After calculating variance estimates for each month, the layers can be weighted according to the average rainfall. The final layer of the overlapping layers is obtained and considered as a measure of the objective function. The transformation entropy layer such as variance estimation layer is also obtained. A new model composed of variance estimation and entropy is proposed to relocate the rainfall network to obtain the optimal design with the minimum number of rain gauges. As a case study, the application of the proposed method to an existing rain network over the Karkhe catchment region under a minimum transformation entropy of 30% and maximum Kriging error of 60% resulted in 17 new rain stations to be added to the original network.

Conclusions

In this study, a methodology is proposed to suggest new locations for rain gauges development using kriging and entropy methods. On the basis of the rainfall data from the current rain gauge stations, the rainfall of the candidate rain gauge stations are generated by estimation Kriging error. The information entropy is based on the concept of probability to measure uncertainties. A network optimization model based on minimizing the estimated variance and by rain gauge data suggest that with the implementation of this new model, 17 stations should be added to the network location. Most of the stations in the eastern and north-eastern border of the basin, in the highlands and in places where the space station is too high, they were located. The results show

that using the theory of Entropy with geostatistical methods, a higher accuracy in rain gauge network development, can be provided. By taking the two methods into account, it will be possible to determine the best sites for establishment of the stations, so that the two factors cover each other. Spatial design using the model proposed in this research, the best combination for rainguage stations can be selected using the minimum transformation entropy and the maximum rainfall estimation Kriging error.

Keywords: entropy, estimation variance, Geography Information System (GIS), KARKHE basin, rain-gauge network optimization.

The Role of Climatic Factors in Determining the Start Date of Planting and Growing Period of Colza with Application of CropSyst Model (Case Study: Coastal Provinces of Caspian Sea in Iran)

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Extended Abstract

Introduction

The use of climatic and natural variables in regulation of agricultural activities has a particular importance. One of the important characteristics of climate is the onset and retreat dates of rainy seasons which have a deterministic role in the agricultural activities such as seeding time, cultivation period, irrigation and other agricultural programs and strategies. Iran located in the arid and semiarid region has a variety of climates and consequently experiences high irregularities in spatial and temporal distribution of precipitation and other climatic elements. Southern coasts of Caspian Sea in Iran as a region with the highest precipitation in the country, has good potentials for agricultural activities. Among the most important crops for the development of cultivation in this plain is colza (canola). Since colza can be cultivated under rainfed conditions in high precipitation areas. Therefore, the analysis of precipitation characteristics in the region in one hand, and onset and retreat dates of major rainy season in that plain on the other hand, can play an important role in the development of cultivation area.

Materials and Methods

Average onset and retreat dates of major rainy season were calculated at selected stations of the region using an index called "cumulative percentage of mean daily rainfall during the year in 5-day periods (pentads)" by instant application and the relevant graphs were plotted. Average

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onset and retreat dates of major rainy seasons are observed when 10% and 90% cumulative mean annual rainfall during pentads are obtained, respectively. The length of the major rainy season is taken as the time interval between the rainfall onset and retreat. The cumulative rainfall based on pentads is used to decrease the daily rainfall fluctuations during the year, so that the detection of onset and retreat dates of main rainy season is much more convenient. Based on the dates obtained from the application and using the daily data of climatic elements including rainfall, minimum temperature, maximum temperature, minimum relative humidity, maximum relative humidity, solar radiation and wind speed in a 26-year period (1984-2009) were estimated by CropSyst model. With the aid of soil properties at the stations, the cultivation period and potential yield values of colza has also been determined by the program. Finally, based on the highest yield obtained from the dates entered to the model, the most suitable planting date and duration of cultivation were determined.

Results and Discussion

The results of this study showed that the onset dates of main rainy season in the stations are ranged from 30 Aug to 1 Nov, and these dates have had less fluctuations in comparison with the retreat dates; since the retreat dates have had differences about 50 days, i.e. from 17 Mar in Bandar Anzali in the west to 6 May in Gorgan in the east of the region. The low differences among onset dates of main rainy season in the stations can prove the regularity of rainfalls resulted from the regularity of rainfall-producing mechanisms in the region. This occurs especially in September as the onset of rainy season in the region and the onset of advection rainfalls originating from Siberian high pressure, particularly around the Rasht and Bandar Anzali. It seems that determining the onset and retreat dates of main rainy season using rainfall amounts leads to more reasonable results than the use of number of the rainy days. The length of the main rainy season in the stations varies from 185 days in Manjil to 234 days in Ghaemshahr. This represents difference of a few weeks in comparison with the graph illustrated by Sedaghat (2007: 36) regarding the cumulative mean monthly rainfall in Iran. The most appropriate planting dates for colza in the selected stations of the region were suggested from 5 Oct in Manjil to 20 Nov in Bandar Anzali. Relevant cultivation durations in the stations vary from 173 to 209 days. Potential yield of the product in the region shows significant direct correlation with the amount of rainfall, and significant inverse correlation with distance from shore.

Conclusion

Recognition of characteristics of main rainy season and its onset and retreat dates have a determining role in the various activities especially agricultural works. In this research, average onset and retreat dates of main rainy season were calculated at selected stations of coastal provinces of Caspian Sea in Iran using an index called “cumulative percentage of mean daily rainfalls during the year in 5-days periods”. The results showed that the onset dates are more regular than the retreat dates due to regularity of rainfall-producing mechanisms in September. Differences in the suggested planting dates in this study and the report of the Ministry of Agriculture can be attributed to different varieties of colza used in the studies, and different calibrations of the models based on the climatic and natural circumstances in the various parts of the country. Hence, our special offer for respected researchers in the future studies is to

calibrate the CropSyst model with regard to the climatic and natural circumstances of the study area.

Keywords: coastal provinces of Caspian Sea, Colza (Canola), CropSyst model, growing period, start date of planting.

Feasibility Study for Suitable Areas of Ecotourism in Talesh County Using GIS

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Extended Abstract

Introduction

To avoid the adverse consequences of tourism, some appropriate decisions must be made about its development. To achieve this purpose, one of the first steps is to identify suitable areas for tourism development and optimum land use planning. This will eventually lead to a model for development of tourism destination. Due to having unique natural attractions such as mountains, dense forests, rivers, up-country - historical villages, waterfalls and natural springs as well as beautiful beaches of the Caspian Sea, Talesh County has a very good potential for ecotourism. However, unfortunately, lack of proper tourism management and the unsustainable tourism development have led to destruction of these unique resources in a growing trend. As the largest county of Gilan province, Talesh is located in the west part of this province.

Materials and Methods

According to the intended evaluation features of the research aimed at identifying the ecological capabilities and the regional zonation in terms of ecotourism development capabilities and nature-based tourism planning, the feasibility of the areas for ecotourism development in the region was performed by the use of Geographical Information System (GIS) and ecological model of ecotourism for Iran. These were accordant with the special conditions of the region. In this survey, the researcher used the ArcGIS 10 application in order to overlay the maps and create the layers. Moreover, the information which had been obtained through climatic data (temperature, precipitation, humidity, number of sunny days), topography, vegetation, soil texture, geology and protected areas were used in this research. The model used in this study

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was the ecological model of ecotourism for land use development. This had been based on the systemic analysis and multiple criteria evaluation and proposed for Iran. This model has classified the region into two groups of intensive and extensive ecotourism and each of which are classified and analyzed in two classes. The first class represents the most suitable condition and the second one represents the suitable condition for the development of ecotourism.

Results and Discussions

To achieve an optimal model for the evaluation of the ecological potential of ecotourism, in the first step of the research, the effective spatial and descriptive data were collected and the georeferenced data have been linked to descriptive tables to create data layers. To achieve this purpose, ArcGIS 10 application has been employed. The data layers were prepared based on data classification in the evaluation model to obtain the classified information. Then, through overlaying the maps, the spatial information was integrated together and based on their ratings the potential regions for ecotourism development were identified. To overlay the maps,the findings suggest that 406 square kilometers of Talesh lands have the potential for development of intensive ecotourism and 1541 square kilometers of the lands have the potential for development of extensive ecotourism. In addition, Markazi district has the most potential areas for the development of intensive and extensive ecotourism.

Conclusions

Given that the regions where are related to intensive and extensive ecotourism of the first type can mostly be observed in plains and coastal areas of Talesh County, these regions have the necessary conditions for the development of water-based and coastal tourism activities as well as the rural tourism and agritourism. The regions where have the potential for intensive and extensive ecotourism of the second type can mostly be observed in the highlands of the county. These regions have the required conditions for the development of the mountain sports and activities. Due to the existence of Marian and Agh Evlar up-country-Historical villages, the scientific and specialized tours can also be recommended in this area. In general, it can be concluded that most parts of the county have the required conditions for the development of ecotourism and it indicates that Talesh County has a high potential for ecotourism development. It is in such a way that about 19% of the total area of the county (406 square kilometers) is suitable for the development of the intensive ecotourism and 71% of the total area (1541 square kilometers) is suitable for the development of the extensive ecotourism. Moreover, given that Markazi district has regions for development of both types of intensive and extensive ecotourism, it is essential to make planning for the development of infrastructures and provide programs for tourism development in this region.

Keywords: ecotourism, feasibility, GIS, sustainable tourism development, Talesh county.

Assessment of Landslide Potential in the Axis Areas and Reservoirs of Dams Using Analytical Network Process and Multi-Criteria Analysis, Ghaleh Chai Dam

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Introduction

Natural disasters management requires local information to make human societies ready against dangers and reduce the disaster procedure. Hence, evaluation of landslide occurrence in the areas prone to landslide due to geographical condition and human constructions is highly crucial. Ghale Chai Dam located at Ajabshir Watershed is one case of such areas. Thus, the aim of present investigation is to identify hillside instabilities and movements and their influencing factors to prevent their harmful effects on natural resources and other parts of economical and engineering development and recognize points with high vulnerability. Hence, the aim of the present investigation is to assess Analytical Network Process (ANP) and Heuristic method to determine the landslide prone areas in range axis and reservoir of Ghale Chai Dam of Ajabshir.

Materials and Methods

The efficiency of network analysis process and logistic regression method were studied to investigate landslide potential in dam of the study area. ANP model building requires the definition of elements and their assignment to clusters and a definition of their relationships (i.e., the connections between them indicate the flow of influence between the elements). The Analytical Hierarchy Process (AHP) and ANP is founded on ratio scale measurements and pairwise comparisons of elements to divide priorities of selected alternatives. In addition, relations among criteria and sub-criteria are included in evaluations, allowing dependencies both within a cluster (inner dependence) and between clusters (outer dependence) (Saaty: 2001).

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Pairwise comparison is now carried out both for weighting clusters (criteria) and for estimating the direction and importance of influences between elements, numerically pictured as ratio scale in a so-called super matrix. Network analysis process was used for the first time in Iran in order to evaluate landslide using super decision and ArcGIS application. However, to assess landslide susceptibility using heuristic method there are two common approaches: direct and indirect methods. The first method applies direct assessment to interpret susceptibility in the field on the basis of detailed maps (geomorphological maps, for instance). The latter does not assess directly in the field, but via data integration techniques in any particular software. This study uses indirect heuristic method. Heuristic approach is a semi-qualitative method. Besides uses of knowledge properties (expert opinions, previous research results or literature recommendations), it also uses index-based procedures such as simple ranking and rating or AHP in assigning weights and creating the model. Scoring and weighting process are crucial to build a model in heuristic approach.

Results and Discussion

According to research questions, a three-layer network model composed of target layer, criteria layer and options layer was designed and organized in ANP. The priority of danger classes was determined based on their coefficients after doing paired comparisons among elements and clusters. Zoning map was classified in five classes from very high to very low. The weighting judgment process in pairwise comparison gives a weight for every influential factor. From the calculation, the final criteria tree (with weight in 2 digits) was created. Bigger weights indicates that the pertinent factor gives bigger influence toward the model. Aspect has the biggest contribution (0.2519), followed by distance to road and lithology with value 0.1786 and 0.1747, respectively. On the other side, the lowest contribution is given by slope (0.0387), followed by DEM (0.0590). There are no negative weights in the heuristic method. The inconsistency value is 0, 0 62194: smaller than 0, 1. It means, according to SMCE validation, the selection process is consistent. After running paired comparisons between elements and clusters, the priorities of the danger classes based on their significance were determined and the coefficients of the factors showed that the aspect factor has the maximum effect in occurrence of the landslides. The zonation map was classified into five classes of very high to very low risk.

Conclusion

The results obtained from this investigation indicated that from eight influential factors of landslide occurrence in the area, land use, height classes and domain direction have the highest influence in occurrence of landslide. Moreover, comparisons of distributed landslide proportion degrees with zonation maps of the above mentioned models indicated that heuristic model with 86.25 percent of proportion had better performance than network analysis. Therefore, from the two statistical models obtained from two the methods used in this study, that obtained from heuristic method administration (2nd equation) is selected and introduced as the best. Furthermore, according to the results obtained from landslide danger zonation in study area, using two early mentioned methods, it was concluded that 67.33% of the total area has very high danger of landslide occurrence.

Keywords: Analytic Network Process (ANP), Ghale Chai Dam, heuristic method, landslide.

Synoptic Analysis of Flood Eventof November 2011 in Behbahan and Likak Cities

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Extended Abstract

Introduction

The recognition of the behaviors of atmospheric circulation patterns and effective climatic elements is very important in occurrence of floods. Abnormal climate changes such as global warming in the recent years tend to make changes in atmospheric circulation patterns and outbreak climatic inelegances in many areas of the world. Intensive and torrential precipitations in anomalous time and space are very important for a country like Iran with specific climatic characteristics. It is always among the factors that may have some irrecoverable effects on human life and finance in different geographical regions. The event has widely affected human beings and nature. The south-west region of Iran is located in the windward slopes of Zagros Mountains and in the path of westerlies and rain bearing air masses. It is among the regions exposed to destructive floods due to different atmospheric circulation patterns and receives heavy precipitations. The flood event of November 20, 2011, which has occurred in Khuzestan and Kohkilou-e-va-Buyer-Ahmad Provinces, is an obvious example of such flood events. This flood imposed many death tolls and caused a big mass of financial damages in those regions. Precautious measures before happening of accidents and hazards is key factor in crisis management. Therefore, identification of the patterns causing flood and their punctual prediction can facilitate better management of the crises and hazards and also minimize death tolls and financial damages caused by these natural disasters.

Materials and Methods

This flood was created by an extreme storm in western and southwestern regions of Iran. In

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order to analyze the synoptic patterns of this flood event, some data were collected. These data are including sea level pressure, surface wind direction, surface temperature, geopotential height of 500 hPa and data of zonal wind and meridional wind of 200 hPa for drawing jet stream map, specific moisture and wind direction of 850 and 700 hPa and the data representing omega values were also derived from NCEP/NCAR website. Then, synoptic maps were drawn by using GrADS application. These were related to 2 days before flood-maker rainfall until a day after its occuarrence. The causes of this flood were revealed by synoptic analysis of the maps.

Results and Discussion

Analysis of synoptic maps revealed the role of some systems in creating the flood. Lying of low pressure center of Sudan between European High Pressure and Arabian Subtropical High Pressure has resulted in formation of a convergence belt over the Sudan and the Red Sea. European High Pressure caused the advection of cold air of higher latitude and on the other hand, Arabian Subtropical High Pressure caused the advection of warm and humid air of low latitudes into the Sudan Low - Red Sea's convergence belt. Convergence of northern cold air and southern warm air in this belt can be helpful in intensifying the belt. Gradually, with intensification of the system and its NE movement, the convergence belt lied over SW regions of Iran. Pressure map of 500 hPa showed a deep trough in North Africa. This trough intensified temperature gradient in upper levels of the atmosphere following of this event, the trough became deeper and its axis laid over the Red Sea. Location of the study area in exit part of Subtropical Jet Stream (STJ) contributed to intensification of Sudan Low and its transfer to the east. Analysis of specific humidity and wind direction maps of 850 and 700 hPa indicated that the moisture sources for the rainfall systems were the Red Sea, Arabian Sea and Persian Gulf in 850 hPa level and Red Sea and Persian Gulf in 700 hPa level.

Conclusion

Situation of Sudan Low between Arabian Subtropical High and European High tends to create an air convergence belt with SW-NE direction from Sudan to north part of Arabian Peninsula. The cold advection from European High Pressure and the warm advection from Arabian High finally intensified temperature and pressure gradients in the convergence belt. Furthermore, location of the study area in northeast part of exit area of STJ caused to intensify Sudan Low and transform it into a dynamic system. As a result of the advection of cold air to back part of the system, its eastward movement became faster and pulled the entire system over SW area of Iran. Movement of cold air in back part of the system caused an extreme updraft of humid air and generated a severe rainfall. The Arabian Subtropical High provided required moisture for this rainfall from warm waters of Red Sea, Arabian Sea and Persian Gulf into the system. The system eventually resulted in a heavy rainfall in a short time and generated the disastrous flood with abundant damages in study area.

Keywords: flood, Southwest Iran, subtropical high pressure, Sudan low, synoptic climatology.