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Synoptic Analysis of the Conditions for Occurrence of Mesoscale Convective Systems

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Extended Abstract

Introduction

Convective systems are atmospheric events that are associated with hazardous consequences, such as strong wind drafts, lightning, heavy rainfall, hail, or even tornado. They are manifested in the atmosphere within a broad range of spatial and temporal scales.

A convection cell is composed of two distinct regions: the actual convective part which consists of the coldest intense vertically extended cores and the stratiform region characterized by a more uniform texture with lighter precipitation. The stratiform area is partly produced by dissipation of older convective cells and partly by ascent of a broader sloping mesoscale layer. Typically, these systems can extend over hundred kilometers in one direction, and can last from a few hours up to several days.

Convective Systems (CSs) are very important from two aspects in the southwest of Iran. First, they produce lightning, heavy rainfall, hail and strong winds which can have very hazardous consequences and second, they provide beneficial rainfall for important hydrologic and agricultural needs of this region, because they are maily contributed to the total precipitation accumulation, this is while there are not any CSs database in this region. This study is intended to determine predominant synoptic conditions for CSs occurrence in the study area.

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Methodology

Event days for the study have been selected using a set of storm report and precipitation criteria across the study area (Southwest of Iran: the provinces of Khozestan, Chaharmahal va Bakhtiari and Kohkiloyeh-va-Boyerahmad). If, at least, one station reported 6 hours of total precipitation more than 10 mm, that could be related to convection (storm, lightning, or shower). Pressure patterns of CSs occurrence have been classified using correlation and principal component analysis approaches. Results of correlation approach in further analysis were used because of its better outcome to determine percent of convective systems occurrence in each pressure pattern.

Results and Discussion

Results indicate that occurrence of CSs depends extremely upon outspread of Sudan Low in southwest of Iran. Most of them are initiated in Red Sea convergence zone (southeast of Iraq, Kuwait, Northeast of Saudi Arabia) and some of them are initiated by cyclone or trough formed between west of Iran and Mediterranean Sea. The most frequently flow patterns are induced to CSs initiation at 850 and 500 hPa, respectively. The moist and warm air was transmitted by anticyclone dominated over Arabian Sea or southeast of Saudi Arabia (Saudi Arabia anticyclone) both in surface and at 850 hPa level. In surface, cold air was transmitted either by Siberian high-pressure (which acts independently or integrated with Azores high pressure or North Africa and Azores high-pressure. These flows were spread out of Sudan Low Pressure toward the South-West of Iran because of the pressure gradient strengthening. While at 850 hPa Azores and North Africa high pressure played the most important role in cold air transmitting to the region. The local high pressure located in north of Iran, north and south of Mediterranean Sea or Black Sea was sometimes responsible for this cold air. Under these conditions, Red Sea convergence zone outspread toward the west of Persian Gulf or South-West of Iran. In all flow patterns at 500 hPa, South west of Iran was located in east of a trough which its axis was placed on the east of Mediterranean Sea or between Mediterranean Sea and Iran. It is remarkable that there was no difference between the flow patterns induced by CSs initiation in different months.

Conclusion

In this research pressure patterns on occurrence of Convective Systems (with precipitation more than 10 mm) has been classified using correlation and principal component analysis approaches in the southwest of Iran. Results of correlation approach were used in further analysis, because of its better outcome and percent of CSs in each pressure pattern.

Results indicate that the occurrence of Convective Systems depends extremely upon outspread of Sudan Low in southwest of Iran. Most of them are initiated in Red Sea convergence zone (southeast of Iraq, Kuwait, Northeast of Saudi Arabia) and some of them are initiated by cyclone or the trough formed between west of Iran and Mediterranean Sea.

Keywords: ***Convective Systems, Correlation, Pressure Patterns, Principal Component Analysis, Southwest of Iran.***

Evaluation of GeoEye-1 Multispectral Imagery Data and Texture Analysis for Urban Scene Classification, Region 3 of Tehran City

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Extended Abstract

Introduction

The increasing use of satellite remote sensing data for civilian use has proved to be the most cost-effective means of mapping and monitoring for environmental changes. Satellite remote sensing has played a pivotal role in finding forest cover, vegetation type and land use changes in urban areas. One of the most complete of these methods is classification. The conventional per-pixel image classification techniques have proven ineffective due to disregarding spatial information of the images in digitally classifying urban land-use and land-cover features in high-resolution images. From all classification approaches, texture is believed to be more advantageous for high-resolution images. This is because texture not only utilizes the spectral information but also takes into account the spatial configuration of pixels. The aim of this study is evaluation on the ability of GeoEye-1 data and image texture features and boosted tree classifiers & regression method (BRT) to delineate the urban land cover and urban land use.

Methodology

GeoEye-1 images have been employed in the land-use classification. We applied geometric rectification using a road network map. The number of training pixels should at least be equal to ten times the number of variables used in the classification model for a parametric classification

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approach. However, several studies have shown that non parametric machine learning algorithms require larger number of training data to attain optimal results. To create an exhaustive database with an optimal size for the training and accuracy assessment, 873 sampling points were taken in field surveys using Global Position System (GPS) in the region 3, Tehran City. The ground reference dataset was divided randomly into 7.10 and 3.10 for training and testing, respectively. Then, image texture features including mean and variance of first order, entropy, dissimilarity and homogeneity of second order was processed in ENVI. The Boosted Tree Classifier and Regression (BRT) were used in land use classification. The error matrix of the classification results was formed. The BRT is a combination of statistical and machine learning techniques and an extension of CART, a promising technique used in ecological modeling. Over the past few years, this technique has emerged as one of the most powerful methods for predictive data mining. The BRT combine the strengths of two algorithms: regression trees, models that relate a response to their predictors by recursive binary splits, and boosting, an adaptive method for combining many simple models to give improved predictive performance. It is one of the several techniques that aim to improve the performance of single models by fitting many models and combining them for prediction. The good performance of BRT is depending on regularizing the boosted trees options and stopping tree growing parameters. For boosted tree options, the shrinkage rate as specific weight for single tree and number of boosted trees are two important parameters. Choosing the best shrinkage rate is important to prevent over fitting the predictions. Empirical studies have shown that shrinkage rate of 0.1 or less usually lead to better models. In addition, for small data sets (n=500), the shrinkage rate can be set as 0.005 and for the larger ones (n=5000) it can be set to 0.05. Therefore, regarding the data, the shrinkage rate of 0.05 was used in the present study. The number of boosted trees is effective to produce unbiased results. Thus, to find the optimal tree, initial 300 additive terms trees were set as the number of simple classification trees to be computed in successive boosting steps. For applying the bootstrap training learning, we used 90 percent of training samples. The stopping parameters control the complexity of the individual trees that will be built at each consecutive boosting step. These parameters are including minimum five in child node, which control the smallest permissible number in a child node, for a split to be applied, and maximum fifteen nodes in each tree, which will split.

Results and Discussion

Our results indicated that the overall accuracy and Kappa coefficient for the best compositions of features and main bands were 92% and 90%, respectively. Texture analysis in classification, in fact, the spectral and spatial pattern of pixels were applied simultaneously to obtain better results. As mentioned previously, the texture analysis is capable to increase the accuracy of classification in the especially heterogeneous urban areas.

This can be concluded that the strengths of the GeoEye imagery data and the potentials of the image texture features and BRT method can help the urban planners monitor and interpret complex urban characteristics.

Conclusion

Classification algorithm and BRT regression using CART method and decision tree can make classification with high volume of data. According to the results of this research, this method can be employed for classification satellite images. High accuracy in classification can be resulted from high resolution satellite data in this study relative to others. The methods used in this study for classification have good ability in modeling, no need for normalization, and collinear relation among independent variables. However, the results indicate that application of GeoEye1 sensor and texture analysis is capable to distinguish land uses in urban areas.

Keywords: Boosted Tree Classifiers and Regression, Classification, GeoEye-1 image, Texture Analyze.

The Prediction Skill of TT, L and K Instability Indices Derived from MODIS Images: the Case Study of Urmia Station

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Extended Abstract

Introduction

Prediction of thunderstorm is one of the most difficult issues in weather forecasting. Deep convective clouds develop at small spatial and temporal dimensions about 1-10 km and 1-12 h. Various Thermodynamic parameters have been discovered over the past 40 years, according to data obtained by radiosounds. The capability of these indices in forecasting instability varies over time and location. The performance of instability indices obtained from radiosound to predict thunderstorm have been examined. by Schultz (1989), Lee and Passner (1993), Huntrieser *et al*. (1996). Haklander and Van Delden (2003) have also studies the accuracy of 32 instability indices in the Netherlands. They provided estimations for the optimal thresholds and relative forecast skills of all these thunderstorm predictors employing skill score parameters such as True Skill Statistic (TSS) and Heidke Skill Score (HSS). When comparing forecast skills in a dichotomous forecasting scheme, the lowest 100 hPa Lifted Index scores the best, although other versions of the Lifted Index have relatively good performance (Haklander and Van Delden, 2003, 273). Kunz (2007) studied the preconvective environment on days with ordinary, widespread, and severe thunderstorms in Southwest Germany. Various thermodynamic and kinetic parameters calculated from radiosoundings at 12UTC were verified against subsequent thunderstorm observations derived from SYNOP station data, radar data, and damage reports of a building insurance company. For the ordinary decision whether a

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thunderstorm day was expected or not, the best results were obtained by the original Lifted Index, the Showalter Index, and the Modified K- Index (Kunz, 2007, 327). Rasooli *et al*. (2007) studied the changes in the temporal and spatial distribution of thunderstorms in the Northwest of Iran and concluded that the likelihood of thunderstorms precipitation is higher in spring and summer. Therefore, we have selected the spring and summer seasons for this study. Due to the low number and sparse spatial distribution of radiosound network and the high cost of lunching, a prediction based only on radiosound network will suffer from data deficiency. Considering the fact that the Terra and Aqua satellites can cover a very broad area by passing over a region, using MODIS sensor data can improve lack of upper level station observations. MODIS Profiles have been used and verified in some studies. Chryoulakis *et al*. (2003) used 3 instability indices extracted from MODIS and radiosound for assessing atmospheric instability and have shown that the three satellite derived instability indices are well correlated with those derived from radiosound. Halimi *et al*. (2011) studied the verification of MODIS temperature and dew point temperature profiles versus radiosonde's temperature profiles at Mehrabad station. In that study, the MODIS temperature profiles showed acceptable conformity with the radiosound's temperature profiles. The whole Bias of 1.95 and RMSE 2.41°K for above 780 mbar level were obtained. Jafari (2012) compared 3 instability indices TT, L and K obtained from MODIS device with radiosound at Tabriz station. It was observed that the TT, L and K indices show good correlation coefficients of 0.50, 0.58 and 0.63 in spring and 0.77, 0.75 and 0.72 in summer, respectively.

The aim of this study is to evaluate the performance of instability indices derived from vertical profiles of MODIS in predicting instability at Urmia Station.

Methodology

The instability indices of TT, L and K obtained from satellite have been compared with the 3-hour-daily synoptic reports in Urmia station. The World Meteorological Organization has defined some codes to determine the current and past weather conditions, marked by double digits (00-99). In this study, the codes 13, 14, 15, 17, 18, 19, 25, 26, 27, 29 and 80-99 related to thunderstorm activities are used. If any of these numbers is recorded at the station, the day is considered a thunderstorm day. Detecting the number of thunderstorm days in spring and summer 2008 from synoptic station reports, we selected the month May and July as the representatives of spring and summer. The Terra and Aqua satellite images were extracted from LAADS website during these two months. The MODIS atmospheric profile product (MOD-07) consists of several parameters: total ozone burden, atmospheric stability, temperature and moisture profiles, and atmospheric water vapor. All of these parameters are produced day and night for level 2 at 5*5 km pixel resolution when at least 9 FOVs are cloud free. With writing a program in IDL environment the desired pixel values have been extracted from the images. By comparing the instability indices derived from MODIS images and 3-hourly synoptic reporting, the validity of these results in forecasting the probability of occurrence of thunderstorms and weather instability was assessed.

Results and Discussion

In this study up to 83 images are studied for month May, in which 14 images are related to the days that phenomenon of shower and storm was reported. For month July we examined 98 images in which 12 images were related to the stormy days. Examining the table of contingency the highest HSS rating is for LI with the score of 0.30. After LI, TT with 0.24 and K with 0.21 were in the next rating. The results of this study for the heist HSS are consistent with results of Haklander and Van delden (2003) and Kunz, (2007). In this way, the potential of thunderstorm based on instability indices are more depended on hidden instability like L and then on potential instability and at the end conditional instability. It can be inferred that using MODIS instability indices can be a good replacement of radisound observations.

Conclusion

In conclusion we have studied the potential of MODIS atmospheric profiles in predicting instability of the north west of Iran. By comparing the contingency tables for both spring and summer we have concluded that the better results and higher HSS scores goes for L (indicates hidden instability) instability index and then TT and K (indicating potential instability and conditional instability) indices.

Keywords: ***Contingency Table, MODIS, TT, L and K Instability Indices, Skill Score Parameters.***

Geomorphological Classification of Taleghan River Pattern in Taleghan Town by Rozgen Method

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Extended Abstract

Introduction

The classification of natural streams is not a new approach in geomorphology. Over the past 100 years, there have been about 20 published methods about stream classification systems. The first recognized classification was by Davis in 1899. Davis classified streams in terms of age (youthful, mature, and old age). The classification systems devised between the years 1899 and 1970 were largely qualitative descriptions of stream features and landforms and difficult to apply for all rivers in the world.

Primary efforts in Rosgen classification began in 1973 and the preliminary version was introduced in 1985 to the scientific community. Rosgen classification includes four levels. Level I is a geomorphic characterization that categorizes streams as “A”, “B”, “C”, “D”, “DA”, “E”, “F”, or “G”. Level II is called the morphological description and requires field measurements. Level II assigns a number (1 through 6) to each stream type describing the dominant bed material. Level III is an evaluation of the stream condition and its stability. This requires an assessment and prediction of channel erosion, riparian condition, channel modification, and other characteristics. Level IV is verification of predictions made in Level III and consists of sediment transport, stream flow, and stability measurements. Taleghan River is in the vicinity of Tehran, Capital of Iran. For some economic considerations and that the position of this river upstream of dam reservoir, to increase life of the dam, it seems important to classify this river for planning issues.

Watershed of Taleghan River is one of the major basins in Sefidrood River Basin in the

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southern slopes of Alborz Mountains, located in North West of Tehran. This basin is located from 36◦ 5' 31" N to 36◦ 23' 37" Nto N and from 50◦ 21' 00" to 51◦ 1' 16.

Methodology

In this study, Rosgen classification at level I and II have been conducted. For this, some data including topographic map 1:400 scale of Taleghan has been prepared by the Tehran Regional Water Organization, image of Google earth to determine the overall plan for the river channel patterns and the field studies to determine the bank and increase the accuracy of data grain size. Initially to determine the level I, using satellite imagery the area was divided into three parts based on similarity of shape, then channel patterns (single thread, multiple thread channels) and channel shape (narrow- deep/ wide- shallow) was determined based on these images and fieldwork. Channel slope in each section was also determined. For level II classification, some parameters are required to be studied, that were obtained from cross section for each reach. These are including entrenchment ratio, width/depth, sinuosity and channel slope. Finally, size of the material was used. These data were obtained from Regional Water Organization.

Results and Discussion

The results indicate that the classification of section A is arterial, wide and shallow channel, the slope is less than 4%. The other two have direct channel model with the narrow and deep beds, the slope is less than 4%. In the A section is of type D and the other two parts have the pattern B. The results of the classification of level II the calculation parameters in section A are the D3 and in two other sections the B3c.

Conclusion

David Rosgen for each river type has expressed specific managerial interpretations. The obtained results suggests: river upstream (4.5 km above the river) have high degree of sensitivity to disturbance, poor recovery potential, too much sediment supply, high erosion potential, and moderate ability in control of vegetation. The two lower sections (2.8 km bottom the river) have low degree of sensitivity to disturbance, excellent recovery potential, low sediment supply, low erosion potential side, and also moderate ability in control of vegetation. Application of these interpretations can be applicable in assessment of potential impacts and risk analysis and management issues.

Keywords: River Classification, River Morphology, Rozgen Method, Taleghan River.

Analysis of Synoptic Syberian High Pressure Position and Entry Paths into Iran in Cold Season

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Extended Abstract

Introduction

Syberian high-pressure is one of the most important systems in climatology. Unique features of this system include expansion zone, the intensity of central pressure, and its temperature and moisture characteristics. Its entry into Iran causes a sharp drop in temperature with occasional frosts and sometimes some extensive damages. Thus, more detailed study and learning more about the activities, entry routes and influence area of this system is necessary for Iran. The first sign of forming this high-pressure mass is a closed curve around Lake Baikal. Due to its proximity to Iran, the system affects the climate of Iran during the year.

Methodology

Fluctuations and movements in a particular system have been surveyed in the present study in an 11-years period. To investigate the influence of the Syberian high-pressure, maps of 45-115 degrees eastern longitude and 20-70 degrees northern latitude are used. Besides, the data for the cold months have been used. To determine the exact position of the Syberian high-pressure, data were analyzed in ArcGI. In analyzing the maps, the average position of the central core, the expansion model and the main axis of the high-pressure were reviewed. The central nucleus of this high-pressure was identified by using the first closed curve in each of the cold months. The Pressure-driven expansion and entry route into Iran also were recorded.

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Results and Discussion

The results indicate that the central core of the Syberian high pressure cell has been started in early autumn over Tibet and by approaching to winter it is gradually dissipated in an area between Lake Baikal and Balkhash. The high pressure mass arrives over Iran at early autumn and expands, then, towards eastern slopes of Alborz. But by approaching cold season and transfer of the central cores to higher latitudes, pressure of this mass arrives on Iran from the northeast and expands to Oman Sea. In autumn, nucleuses are created in Tibet Plateau and by decreasing in temperature they move to higher latitudes and are also more extended. By approaching cold season in northern hemisphere, the nucleuses move to higher latitudes and are gathered in Syberia land. In this season, it seems that temperature of Syberia land has not provided necessary conditions for creating this air mass, while position of the nucleuses in winter has moved to south of Syberian Sahara.

In this season, negative energy on Syberia is near to maximum and temperature is at minimum. Penetration of cold arctic streams from higher latitudes has also increased this coldness and on the other hand, snow on this area has increased reflection and has decreased the temperature in underneath layers.

Conclusion

Main pattern of Syberian high pressure is east-west. This line is more extended when the nucleus is on Baikal and Balkhash lakes. But when it is on Tibet Plateau, its extension line isn't expanded significantly in the east and west. It can be concluded that this high pressure mass directly influences entrance of cold air mass into Iran. In addition, it has direct influence on quality and vastness of rainfall in northern coasts of Iran. Present study indicates that in most of the cases, pressure of central nucleus is near to 1035 hp.

Keywords: ***Axis of Spreading, Central Core, Entry Pathes, Iran, Siberian High-Pressure, Synoptic Patterns.***

The Relationship between the Morphology of Sand Dunes and Morphometric Parameters in East of Babolsar, North of Iran

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Extended Abstract

Introduction

Coastal sand dunes are important morphological forms in Caspian coastal regions. These dunes are formed and developed under the influence of sediment influx, climate, impact of wind, waves, currents. These are parallel to the coastal characterisitics with enough space for expansion. The whole collection of these parameters are available in many coastal areas of the Caspian Sea , but most of the dunes in many parts have been destroyed due to human activities and only a few of these dunes have been remained in complete and intact form. The study area of this research is located in 10 Km east of Babolsar city (Mazandaran Province), south of Caspian Sea, that is coordinated in 36° 39' to 36° 46' N latitude and 52° 37' to 52° 58' E longitude.

Methodology

In this study, first of all the northern coast of the Caspian Sea was explored using satellite images and four stations with the highest density of not destroyed coastal sand dunes were identified and labeled with letters A to D eastward to investigate changes between groups and also inside each group at each station. Then sand dunes of each area were detected and coded using satellite images, based on geomorphologic features. Finally, field images were taken and morphometric parameters of 17 sand dunes along the shoreline including crest, lee, stoss and

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height were measured to determine the correlation among the properties of the components and also to analyze form of the graphs and statistical parameters.

Results and Discussion

Parabolic dunes are considered as the most important types of coastal sand dunes in the east of Babolsar area. This Parabolic dune are divided morphologically into seven types: lunate, hairpian, hemicyclic, digitate, nested, long-walled transgressive ridge with secondary transverse and rake-like en-echelon dunes. Geomorphological situation of these sand dunes are mainly influenced by the prevailing winds in the area. It usually shows tip region that will contribute to prevailing wind direction. Pattern of wind speed and direction of rose diagram based on the data from climatology station of Babolsar can also reveal the major annual eastward winds in this region with 0.5 to more than 11 m/sec speed. Moreover, sometimes these parabolic-shaped sand dunes are different within a small geographic area in terms of geomorphology and direction. This indicates local annual changes in the wind conditions and directions in certain periods of time. Simple lunate dunes by 59.5 percent frequency are the most abundant types of the seven parabolic dunes group in the study area.Parabolic hemicyclic shape, hairpian, digitate, nested, long-walled transgressive ridge with secondary transverse and rake-like en-echelon dunes are the most abundant types of dunes in this group. Simple lunate form with 45 percent and hemicyclic form with 25 percent of frequency, totally more than 70 percent, are also the two most common types of sand dunes on coastal barrier system of Miankaleh. Therefore, parabolic sand dunes in east of Babolsar and Miankaleh show similar patterns of the seven parabolic dunes and are different from each other only in terms of scale and magnitude of morphometric parameters. They are related to the effect of key factors on distribution of these dunes. Also, for determination of type of relationship among the morphometric parameters measured in the parabolic dunes of this area, statistical calculations including a variety of linear and nonlinear simple regressions were carried out. Ultimately, the best model were applied in two steps firstly for all of dunes regardless their form and in second step based on the forms for the lunate and hemicyclic dunes. Statistical relationships of the measured components of these dunes regardless of their form indicate that the linear and cubic regressions of crest and stoss lengths are 0.771 and 0.778, respectively. This could properly be correlated with parameter of height. The following results were obtained from sand dunes form-based data: Type of dunes (hemicyclic) show proper correlation coefficient in variables of height and the best with lee-side squares regression. In type B dunes (lunate), powered crest length and squared stoss-side regressions reveal the best correlation coefficient with height of dunes. Therefore, the second best regression is the squared lee-side coefficient of hemicyclic dunes with the value of 1 correlation coefficient for the height component.

Conclusion

Due to the aboundance of simple lunate form with 59.5 percent frequency compared to the other seven forms of paraboplic dunes in this area, it can be concluded that the prevailing winds are unidirectional, blowing from west of Babolsar in eastward direction which is corresponding to

the data obtained from climatology station of Babolsar. Statistic correlation between the measured parameters of these dunes indicate that the height, crest and stoss length parameters show the best correlation coefficient. In orther words, the dune height changes with the crest and stoss lengths whereas the lee length parameter has no effect on height. Because of the difficulties of field works in examination and measurement of height of sand dunes using their morphometric parameters such as length of peaks and sides, the application of satellite images is an easier method. It could be applied with field data for the purpose of morphometric parameters analysis on the areas with similar conditions.

Keywords: ***Coastal Sand Dunes, East of Babolsar, Morphology Classification, Morphometery.***

Event of Climate Change, Its Impact on Durum Wheat Planting and During the Growing Season Case Study: Station of Sararood, Kermanshah

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Extended Abstract

Introduction

Climate change, generally, affect all economic sectors. But agriculture is the most sensitive and vulnerable sector, because agricultural products are highly associated with climatic resources. According to scientific evidences, climate change in the future, especially the combined effects of rising temperature and CO_2 concentrations in the atmosphere and increase in the likelihood of some natural events, may have significant impacts on agricultural products. This paper is aimed to explore the trend of climatic parameters in the past and future, and their outcomes on the sowing date and length of the growing season for rainfed wheat in the Kermanshah region.

Methodology

The synoptic station of Sararood, Kermanshah, has geographical position at 47 degrees and 20 minutes western with elevation of 1351.6 meters above sea level. Simulation of climate parameters i.e., maximum and minimum temperatures and rainfall in coming decades was carried out using the results from the output of CCSM4 model under the scenario RCP4.5.

The outputs of the above mentioned model is low. Thus, to produce the climatic data of temperature in the study area, these outputs were statistically small-scaled in the period 2013-2039 and consequently the simulated data were used for next stages.

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In order to study the impact of climate change on the displacement of sowing date and change in the length of growth period in the future, to estimate sowing date of rainfed wheat, initial rainfall dates were extracted from the synoptic station of Sararood. Then, according to the definition that the sowing date can be considered when the total rainfall by early October reaches to five mm, if 15 days after that should not be dry, sowing date for both past and future climates was determined. In regard to the correlation between growth stage in wheat and the temperature factor, the length of growth period of wheat using the index GDD (growth degree day) was calculated. But the remarkable point here is that due to the lack of data on the growth period before 1988, this year was considered as the length of growth period for base period.

Results and Discussion

Changes in temperature and rainfall in the past

Results of Kendall and sen's Estimator slope indicated that changes in rainfall have been decreased in most of the months of the year. This trend was significant (P<0.01) in March and annually; and temperature variables has significantly increased in most of the months of the year. Thus, it can be concluded that the temperature of the region has been influenced by the factors in the past that has increased the temperature.

The results of climate change on the study area in the period of 2013-2039, in which climate behavior of base period is compared with the future period, indicated that average maximum temperature was lesser than average minimum and maximum temperatures, with the except for the years 2013 and 2022, and minimum temperature with the except for the years 2015 and 2018. The rainfall during the years under study in the future was more than that of the average long-term in the base period.

Appropriate time for sowing date of wheat in the present and future conditions

To study the changes of initiation times of sowing in the future periods, we compared the long-term average of initiation date of wheat sowing based on distance from the source (first of October) of base climate with the initiation of sowing date of wheat based on future years. The results indicated, on average, that sowing date of wheat in the past climate was started from the second decade of December, while sowing date in future climate will be started from third decade of October. Furthermore, temperature in future climate will be more than past climate, thus the only reason for this, could be the start of earlier rainfall, in future years. Based on these, on average, rainfall in the past climate was started from the second decade of October and will be started in future climate from the second decade of December.

Changes of growth period length

To investigate the changes in length of growth period of wheat for the future periods, the mean of growth period length in base climate was compared with the growth period length in future years. The results indicated that mean of growth period length in past climate was 209 days, while in future climate was 184 days. Thus, it can be concluded that mean of growth period length of wheat in future climate will be 25 days shorter. The reason of decrease in growth

period length can be due to increasing of temperature in future climate, where the mean temperature in the future climate will be 15.8 ^{o}C and in past climate 14.5^{o} C.

Conclusion

The results indicated that in Kermanshah region, rainfall of past periods has a decreasing trend, while temperature has an increasing trend in most months of year, especially in cold months. In the future period, the temperature in all months of year will be increased from 1.7 to 2.5 C º until the end of 2039. Appropriate sowing dates for wheat will also be the second decade of December for the past period, whereas for the future period it will be the third decade of October and later. Displacement of rainfall in the future period toward early cool-season has caused that sowing dates of wheat to start earlier in future climate compared with that of the past. Comparison of growth period length in the future and past periods indicated that in spite of initiation of sowing date of wheat in the past period later than future period, the length of growth period of wheat in the future climate will be shorter than 25 days relative to past climate. This can be resulted from increasing temperature in future periods relative to past.

Keywords: Climate Change, Climate Model, Growth Period Length, Sowing Date, Wheat.

Monthly Rainfall Prediction using Artificial Neural Networks and M5 Model Tree (Case Study: Station of Ahar)

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Extended Abstract

Introduction

Rainfall is considered as one of the most important factures in water cycle. Prediction of monthly rainfall is important for many purposes such as estimating torrent, drought, run-off, sediment, irrigation programming and also management of drainage basins. Rainfall prediction in each area is mediated by punctual data measured as humidity, temperature, wind speed and etc. As Iran is located in a hot and arid region and also for lack of water sources, and water supply and protection it is important to study rainfall characteristics in this area. The limitations such as unavailability of adequate data about rainfall measure in different temporal and spatial scales and also complicated boundaries among meteorology factures related to rainfall caused inexact and non- trustable examinations. According to recent improvements especially in the field of computer processing and new data mining methods such as artificial neural network, decision trees, genetic algorithms and Support vector machines, so many efforts have been taken to solve complicated and high dimension issues in different kinds of engineering fields.

Methodology

In this study, we have used different kinds of meteorology parameters on month scale in AHAR region. It is located in East Azarbayjan Province, IRAN. Different concepts of combination of these meteorology parameters have been entered to artificial neural network and M5 model tree as our chosen data mining methods. The idea of artificial neural networks is based on structure

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of human brain. These structures include three layers that named as input layer, hidden layer and output layer. To achieve the best structure of this network we must try different combination of parameters and change the type of transfer function and other factures. M5 model tree is a data mining approach that divides the data space into smaller subspaces by divide-and-conquer method. This technique splits the parameter space into areas (subspaces) and builds in each of them by a linear regression model. The M5 model tree approach, (Quinlan, 1992), based on the principle of information theory, makes it possible to split the multidimensional parameter of space and generate the models automatically according to the overall quality criterion. It also allows the number of models. The splitting in this approach follows the idea of a decision tree, but instead of the class labels, it has linear regression functions at the leaves, which can predict continuous numerical attributes. Thus, they are analogous to piece-wise linear functions. Computational requirements for model trees grow rapidly with increase in dimensionality of the data set. Model trees learn efficiently and can tackle tasks with very high dimensionality. The major advantage of the model trees relative to regression trees is that model trees are much smaller than regression trees, the decision strength is clear, and regression functions do not normally involve many variables. Finally, after making these models, we evaluate these models with statistics such as RMSE and R coefficient.

Results and Discussion

In this paper, we have tried various combinations of different meteorology parameters. Then we choose the best model according to these facts. At first, that model has high amount of R coefficient and lesser amount of RMSE and it is also made by less meteorology parameters. We achieve, respectively, the amount of 0.84 and 12.14 for R and RMSE statistics in artificial neural network method and amount of 0.87 and 11.45 for R and RMSE statistics in M5 model tree approaches. We achieve our best results in M5 model tree method, with using the combination of maximum and minimum amount of monthly temperature, maximum and minimum amount of monthly relative humidity and maximum and minimum amount of monthly pressure at station. We also achieve our the best result in artificial neural network method by using the combination of maximum and minimum amount of monthly temperature, maximum and minimum amount of monthly relative humidity, and maximum and minimum amount of monthly pressure at station. The results indicate that, both of artificial neural networks and M5 model tree methods present the comparatively exact result for rainfall prediction in the region. However, due to having simple and understandable equations provided with M5 model tree method, this method could be considerate as an efficient application and as substitute for rainfall measurement.

Conclusion

Both of artificial neural networks and M5 model tree have good performance in predicting monthly rainfall. The results shows that both of these methods have almost equal performance in this case but due to providing simple and explicit equations with M5 model tree method, this method could be considerate as an efficient and practical application and substitutes for rainfall measurement.

Keywords: Ahar, Artificial Neural Networks, M5 Tree Model, Prediction of Monthly Rainfall.