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An Assessment about the Effect of Mineralogical Composition of Alvand Pluton Rock Units on Outcrops Resistance against Weathering and Erosion

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Extended Abstract

Introduction

In general, strength of rocky outcrops is associated with two factors, feature lithology that includes mineralogical composition, texture and rock Structure and environmental factors that is the area stones are located in (Hafezy moghadas, 2011, 229 after Ulusay, 1994). The mineralogical composition determines sensitivity of rocks against physical, chemical and biochemical attacks (Mahmoodi, 2010). Rocks because of containing different minerals show various stability against the degradation factors (Nikoodel, 2011). This is the first time research to use classification system of in geology for naming rocks to determine the degree of resistance of the stones against weathering and erosion.

Methodology

The Alvand Pluton is one of the largest intrusive masses in Sanandaj- Sirjan metamorphic zone (Sepahi, 2008).The exposed area of this mass are approximately 362.92 square kilometers (excluding Quaternary deposits). Alvand Plutonism was started from middle Cretaceous and continued till early Tertiary (Paleocene) (Sepahi & Moeen vaziry, 2000).

Alvand pulotonic rocks have been marked on the geological map (Tuyserkan and

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Hamadan1:100,000 scale) in 100 limited areas with 8 different symbols. That usually has light grey to white color and fine to coarse grains (2-5mm in diameter). About 9 square kilometers of cordierite andalousites and cordierite hornfelses (metamorphic rocks) in the 23 areas with different extent are over the surface of porphyroid granite which mostly matches top heights (especially Heights Gavboreh). This shows diapirism in placement of the mass.

In this research, library and field observation have been used as the methods of data collection, (sampling and observation) and the research method has been descriptive and analytical. For evaluating the effect of mineralogical composition of the Alvand pluton rock on outcrop resistance some steps have been taken. In next step, the classification was proposed by the International Union of Geological Sciences (IUGS), and diagram (QAPF)1 associated with it, was selectedwith range diagram, according to the mineralogical composition. Numerical values are determined for the degree of outcrop resistance of each area against weathering and erosion. In order to determine the degree of Alvand pulotonic outcrops resistance we have specified surface of QAPF diagram. The resistance specified as numerical value is ranged from 1 to 10 classes started from foidolites with least degree of resistance and with ratio of decreasing F and P and increasing A and Q. It is the most sensitive igneous rocks against chemical weathering considering mineralogical composition. Thus, quartz-rich granitic-rocks are in 9 areas and finally quartzolit (silexite) which is the most resistant intrusive igneous rock against weathering.

To test the proposed method, 10 types of Alvand pulotonic rocks which gathered by Zarian et al., 1972 with Modal analysis method was studied and selected by using diagram QAPF for resistance range. In addition, finding equivalent name in classification system of IUGS, the degree of the resistance against weathering and destruction in terms of mineralogical composition is given in.

Results and Discussion

Naming Alvand plutonic rock units on geological maps is based on IUGS classification. Thus, based on provided method, relative strength of the rock outcrop in terms of the effects of mineralogical composition on the resistance against weathering and erosion have been identified and presented in Table 1. Specific degree of resistance for Alvand plutonic rock units are presented on Table 4. Rock units of this mass can be classified in four groups, the least of resistance is related to Olivine gabbro outcrops with 2 degree which cover 14.8% of the mass area.The most resistant rock outcrops are the unit pegmatitic granite, pegmatic- aplite granite, tourmalin granite and granite bearing garnet with a resistance degree of 8. Among other units this later covers just 3.15% of surface area. Degree resistance was determined for different rock units in Alvand pluton and it shows 6 degree resistance differences between them.This difference can be affected by weathering and differential erosion between different units. Average weighted degree rock units outcrop resistance of Alvand in terms of mineralogical

1. Q = Quartz, A= Alkali Feldspar, F= Feld spathoids, P= Plagioclase.

composition is obtained for total mass about 6.59. It shows resistence of the mineralogical composition of the outcrops and the results can be found in relation to high percentage of quartz and alkali feldaspar, and the approximate homogeneity in mineralogical composition of the rock mass. In order to determine the applicability of the results obtained from the proposed method in geomorphological and hydrological analyses, the Digital Elevation Model (DEM) of Alvand pluton was provided.

Conclusion

In this paper, the effect of mineralogical composition of Alvand plutonic outcrops against the weathering and erosion with the numeric range 1-10 and using QAPF diagrams have been determined. In this method, Surface of QAPF diagram between Q and F has been divided into ten areas with in numerical range of 1-10. The range of values represents the effect of the mineralogical composition on degree of resistance of outcrops of rock units. According to degree resistance designated for Alvand pluton rock units in terms of the effects, this mass can be classified in four groups.In this classification the least resistance is related to Olivine gabbro outcrops with degree resistance of 2 and the most resistant rock outcrops with resistance degree of 8 are the units including pegmatitic granite pegmatitic– aplite granite, tourmaline granite, and granite bearing granite. According to average weighted degree granitic outcrop resistance of Alvand in terms of mineralogical composition, the degree is obtained 6.59for total mass.. Determining resistence of Alvand rock units in quantitative mineralogical composition and the properties of texture and structure characteristics can be used for geomorphological analysis and explanation of predominant form over Alvand mass.

Keywords: ***Alvand Ploton, Mineralogical Composition, Outcrops, QAPF Diagram, Resistance Degree.***

Synoptic Classification Models of Precipitation in the Coastel Areas of the Caspian Sea

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Extended Abstract

Introduction

Atmospheric circulation patterns play the main role in the natural phenomenon occurring on the earth, especially in temperate regions. Some atmospheric circulation patterns cause wet periods and others cause low water and dried periods. Thus, because the annual occurrence of drought and wet events result from the general circulation of the atmosphere, recognizing atmospheric circulation patterns are explained, to some extent, for the possibility of evaluating these phenomena before occurance. Studies show that the floods and droughts phenomenan are influenced by atmospheric circulation patterns. Given the close relationship between the patterns and climatic elements, we can also attribute the extreme climatic events, such as floods and droughts, and dried and wet periods, to changes in atmospheric circulation patterns. In this study, from average daily data balance of 500 and the sea level pressure over the period 1960 to 2008 at two degrees intersection of the reconstructed data setshave been used. The selected range covers all systems affecting the area under study during the year. This range consists of 408 cells from 20 to 60 degrees in north latitude and 10 to 70 degrees in east longitude. Total daily rainfall data from selected synoptic stations over the statistical period 1960-2008 were used to assess the role of the patterns in rainfall. Many climate scientists dealing with variables with different scale or large volumes of data employ reduction variable and data strategy by principal component analysis (PCA), (Gadyial, S. and R. N. Lyengar 1980, Kalkstein. S. *et al*. 1998).

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Methodology

Factor analysis is a statistical technique that establishs a especial relationship among a large number of variables that are seemingly unrelated. It is under a hypothetical model and gathers all the variables in the similar groups. This method retains significant and main components in the same groups and reduce the variables. One of the results of factor analysis is to reduce data dimension. Computational steps of the main component analysis is as follows:

a) The data and variables Selection. b) The second stage of a data matrix p × n formation where n is the number of days and p is the number of variables. In the third stage since the selected meteorological variables of the unit are different (For example, C, hPa, meters per second, and so on), a correlation matrix was used as input for the main component analysis. Data correlation matrix are calculated according to the following formula. The fourth step is used to determine the number of factors by Catel test. Loadings matrix was calculated in the fifth stage. Loadings show the relationship between the factors and the primary variables.

The relationship between atmospheric circulation patterns and rainfall

To evaluate the relationship between atmospheric circulation patterns and rainfall, the following index is applied. This index defines the conditional probability of rainfall occurnece and rainfall intensity in a circulation pattern. The index defines a measure of the relative share of the pattern rainfall in total. Where ni is the number of days with i patterns and Ri is the total rainfall during that days and n is the number of days in the period of the study. If PI<1.

Or even much smaller than the unit, the weather or type pattern i does not greatly affect the area rainfall. Thus, an increase in the frequency of occurrence of such a pattern, reduces rainfall and subsequently, causes drought in a region. If the PI in the statistical method is greater than the unit, then chance of rain (probability of precipitation) also increase and wet periods will be prevailed. For example, precipitation takes place when weather is wet and there is an acsending factor, these conditions are provided by atmospheric circulation patterns.

Results and Discussion

In this study, using PCA and clustering, eighteen circulation patterns according to the sea level pressure and 500 hPa level atmospheric condition have been identified over the study area. The results of this study show that there are significant differences in the arrangement of patterns, the weather type frequency and the way they move towards the study region. The PI index is a appropriate criterion to evaluate the Conditional probability of rainfall and rainfall intensity. If the PI index calculated for a wheather type much smaller than unit, wheather type does not play a role in precipitation of that station or region. Therefore, an increase in the frequency of occurrence of such a pattern in a period reduces rainfall and makes the drought events in that region.

Conclusion

Due to the PI index and the annual frequency distribution of atmospheric circulation patterns, the results can be summarized as follows. Atmospheric circulation patterns of CP1, CP4, CP5,

CP12, and CP15 are part of the patterns leading to heavy and pervasive precipitation. Atmospheric circulation patterns of CP7, CP13, CP16, CP17, and CP18 are part of the patterns leading to moderate precipitation. Atmospheric circulation patterns of CP2, CP8, CP9, CP10, and CP11 are part of the patterns leading to drought, Atmospheric circulation patterns of CP3, CP6, and CP14 are part of the patterns leading to drought. In terms of the annual frequency distribution, atmospheric circulation patterns of CP3, CP5, CP13, and CP15 are active in all seasons of the year, atmospheric circulation patterns of CP2, CP6, and CP10 are active in summer, atmospheric circulation patterns of CP1, CP8, CP9, CP11, CP12, CP14, CP16, CP17, and CP18 in winter, spring and fall and atmospheric circulation patterns of CP7 is active in the spring and fall.

Keywords: ***Atmospheric Circulation Patterns, Clustering, North Caspian Sea, PI Index, Principal Component Analysis.***

Sedimentary Evidence of Climate Changes in Holocene, Zeribar Lake

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Extended Abstract

Introduction

Lakes are very interesting sedimentary environments for study of ancient climate changes in the environments and lake level changes. Lake Zeribar is situated in the province of Kurdistan, in the Zagros Mountains in three kilometers north-west of Marivan. The main purpose of this research is to study grain-size sediments accumulated in Zeribar lakes in order to check the water level fluctuations, climatic and environmental changes during the Holocene. Grain-size of the lake sediments is mainly controlled by the distance of the core site from the shoreline, the kinetic energy of the lake circulation and the source of the sediments (Lerman, 1978). The sediments sorting principle states that the grain size of lake sediments becomes finer and finer from the shore to the center, and sediment belts of different grain-size can be distinguished. Lake Zeribar sediments, providing a record of climatic variations more than 40,000 years long, have been the subject of multidisciplinary investigations reported in several publications (among others: plant macrofossils by Wasylikowa, 1967, 2005; diatoms by Snyder et al., 2001; stable isotopes by Stevens et al., 2001). However, sediments of the lake have not yet been analyzed for grain-size, whereas it could reveal important information about the lake history and sedimentary process-geomorphology.

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Methodology

A 6.88 m long core was extracted from the west part of the lake by a standard chamber corer, the Russian corer, 50 cm in length and 5 cm in diameter.

Sediments were sampled at an interval of 1-10 cm. All samples were split into halves and weighed. One half was wet-sieved using a 63 μm diameter sieve. The >63 μm fraction (sand and granule) was dried and weighed for sand and granule content. The other half was analyzed for mineral type. The <63 μm fraction was analyzed using a laser diffraction particle size analyzer (Micro tec A-22, Analysette 22) which utilizes grain-size range, 0.001-2 mm. Samples were treated with 30% H_2O_2 to remove organic matters. The samples were further dispersed via 10 minutes of exposure in an ultrasonic bath just before size analysis. For the purpose of particle-size specification, the following scale used by Folk and Ward (1957) was adopted; granule: >2mm, sand: 2000-63 μm (-1 to 4ϕ), silt: 63-3.9 μm (4-8ϕ), and clay: 3.9-0.24 μm (8-12ϕ).

Radiocarbon dating of the sediments was performed for three bulk sediments using a standard Accelerator Mass Spectrometer (AMS) method at the Institute of Accelerator Analysis Ltd, Japan. The ^{14}CAMS dates were calibrated to years AD and calendar years BP using OxCalv.4.1 (Bronk Ramsey, 2009) and IntCal09 (Reimer et al, 2009).

Results and Discussion

Based on the patterns of long-term fluctuations in median, mean and mode sample diameters combined with the percentages of the clay: (<2 μm), silt: (2–63 μm) and sand: (>63 μm) size fractions, frequency curves, and lithology, the whole sediment record is divided into 4 subdivisions as A (688-528 cm, 8950-6870 calyr BP), B (528–423cm, 6870-5500 calyr BP), C (423–244 cm, 5500–3170 calyr BP), and D (244–100 cm, 3170–1300 calyr BP) as described below, separately.

During phase A (688-528 cm, 8950-6870 cal BP) the percentage content of silt increases to ~74.8%, while the content of sand decreases to ~6.33%.

During phase B (528–423 cm, 6870–5500 calyr BP), the percentage of sand (average=14%) increases sharply while the percentage of silt (average=67.18%) decreases. The relatively high content of sand likewise implies a low lake level, which reflects effective moisture in the whole drainage.

During phase C (423–244 cm, 5500–3170 calyr BP) the percentage content of silt increases to ~77.4%, while the content of sand decreases to ~5.4% indicating high effective humidity and moisture in Lake Zeribar. The high and stable content of silt and fine components in the sediments indicates that lake-level reaches its highest value in the Holocene at this time.

During phase D (244–100 cm, 3170-1300 calyr BP), the content of sand (average=10.5%) increases while the content of silt (average=69.86%) decreases. Several cycles in grain-size may be related to centennial climate cycles. The high content of the coarse component suggest lake-level lowering.

Conclusion

The grain size data and descriptive statistics (mean, standard deviation, kurtosis, and skewness) showed various degrees of fluctuations in both short and long terms. Changes in climate and lake size appear to be the main factors affecting the variability in the grain-size distribution, properties, and type of minerals. The results of the data analysis suggests the existence of warm and wetter climate, increased spring rains, episode of higher lake water level, existence of fresh-water conditions, prevailing high-energy condition, dominance of erosional processes, seasonal supply of detritus, inflows strength and dominance of chemical weathering about 8950-6870 and 5500-3170 calyr BP. The results indicate the existence of dry climate, reduced rainfall, occurrence of drought, lake-level lowering, prevailing low-energy condition, absence of seasonal supply of detritus, conditions of tidal changes, and dominance of physical weathering about 6870-5500 and 3170-1300 calyr BP. It can be suggested that during the late Holocene 3170-1300 calyr BP variations of water-level occurred irregularly, as the results of precipitation changes, occasional lake overflows, and perhaps human activities.

Keywords: Climate Change, Lake Sediments, Lake Zeribar, Palaeogeomorphology.

Study on Physical Surface Temperature Patterns in Different Weather Conditions

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Extended Abstract

Introduction

Materials and surfaces with different thermo-physical properties provide variety of temperature patterns and temporal changes. Analyzing thermal behavior of the different land covers is one of the significant factors to determine urban microclimates. Urban land covers have usually high temperature. This can potentially increase the intensity of urban heat island effect and building cooling energy consumption and also change energy balance and heat fluxes in these areas. Therefore, regarding to the impact of surface temperature on changes of surrounding air components and formation of Urban Heat Islands (UHI), the main objectives of this study are including identification of the circadian pattern of surface temperature in different weather conditions and providing the best regression model to estimate surface temperature using air temperature.

Methodology

To determine the surface temperature patterns of different land covers such as Asphalt, Soil, Cement and Stone, three data loggers along with four Platinum Resistance Thermometers (PT100 sensors) were installed in Geophysic Weather Station in University of Tehran.

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Therefore, temperature of these land covers was recorded hourly during the November 2012. Furthermore, meteorological data including air temperature (°C), relative humidity (%), precipitation (MM), and cloudiness (Okta) were gathered from Geophysic Weather Station. Then, circadian temperature pattern of different land covers were selected to be analyzed in six days of November with different weather conditions (Sunny, Cloudy, Rainy conditions). Finally, the best regression model for predicting daily mean surface temperature was provided using air temperature. In addition, two statistical methods such as Nash-Sutcliffe efficiency coefficient and correlation coefficient were used for determining the efficiency of the regression model in estimating the different land covers surface temperature.

Results and Discussion

According to the results, it can be concluded that in sunny and cloudy conditions surface temperature of all land covers increase with sunrise at 6 A.M. (local time) and this trend continue until noon so that, maximum surface temperature occur around 12 P.M. Then, surface temperature decreases because of reducing the amount of solar radiation and finally at sunset, the surfaces lose their heat, obtained during the day, as long wave radiation. It is important to note that in cloudy conditions, the amount of energy absorption during the day and it loses during the night is less than sunny conditions because of cloud cover existence in the sky and the effect of the cloud's albedo. Therefore, in these weather conditions surface temperature pattern has sinusoidal mode but temperature range (difference between maximum and minimum temperature) on cloudy conditions is less than sunny conditions due to cloud cover so that studying relationship between surface temperature and cloudiness depicted that there is inverse relationship between them and temperature reduces when cloudiness increase. It was also illustrated that there is no specific hourly trend in surface temperature in rainy conditions and there are many variations in surface temperature. Totally, on sunny and cloudy conditions the highest temperature is related to Asphalt, Cement, soil and Stone, in order. While on rainy conditions Asphalt has the lowest temperature between the studied land covers because of water flow over the surface. Thus, it can also be concluded that permeability of the surfaces is one of the most significant physical properties in the surface temperature behavior. Land covers which are impermeable (such as Asphalt, Cement and Stone) in rainy conditions show lower temperature because of the water impact. In addition, reconstructed surface temperature data display that there is a significant correlation between observed and estimated temperature using daily mean air temperature, so that correlation coefficient between these two parameters varies from 0.98 to 0.97 and is significant at 0.01% level. Moreover, result of Nash-Sutcliffe efficiency coefficient varies from 0.8232 to 0.9205 which shows proper efficiency of the regression model.

Conclusion

The main objective of this study is analyzing surface temperature of different land covers during the day/night and different weather conditions and also providing a regression model for estimating the surface temperature in these land covers. Generally, this can be concluded that different land covers surface temperature is completely a function of their thermal properties in

calm and sunny weather conditions. Some surfaces such as Asphalt and cement which have less thermal conductivity and high absorbency show the highest surface temperature during the day. While, on rainy conditions both air and surface temperature have many variation because of cloudiness and precipitation. In such conditions some physical properties like permeability of the surfaces play significant role in thermal behavior of land covers. Finally, according to the correlation and Nash-Sutcliffe coefficients it is concluded that regression coefficients between daily mean air temperature and surface temperature have proper efficiency for calculating daily mean surface temperature.

Keywords: Land Cover, Regression Model, Surface Temperature Pattern, Weather Condition.

Hydroclimatology Analysis of Water Level Fluctuations in Urmia Lake

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Extended Abstract

Introduction

Lake Urmia, at the northwestern tip of Iran, is one of the largest permanent hyper saline lakes in the world and the largest lake in the Middle East. The lake is located between Eastern Azerbaijan and Western Azerbaijan, west of the southern portion of the similarly shaped Caspian Sea. It extends as much as 140km from north to south and is as wide as 85km from east to west during high water level periods. Because of being located in a dry and semi-dry region, this region doesn't have suitable water resources comparing with global average water resources. Drought, climatic fluctuations, and shortage and disorder of rainfall cause many problems with regard to food and water for people who live in this region. Urmia lake is also one the most important and the largest aquatic ecosystems of Iran. The systemic and chain changes in the lake will lead to great effects on the climate and economic, social and hydrology conditions. Oscillations of the lake water levels and volume in recent years have attracted many opinions and created apprehensions.

Methodology

Groundwater data, meteorological precipitation and temperature data were obtained from Urmia station of Meteorology Organization for the period from 1981 to 2010. Then time series were formed for temperature and precipitation in the form of annual, seasonal, and monthly files. The time series of temperature, precipitation, rivers discharges, and water table levels and oscillations of the lake water level were collected and adjusted for the periods 1981-2010. To inform homogeneity and randomness of data and possibility of any trends in the time series, the nonparametric test was used. In this study, precipitation, river discharges and water tables and

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temperatures were assessed as the independent variable and the water level as the dependent variable. After reviewing the different parametric and nonparametric tests on the data in this study, we eventually used a multivariable regression parametric test (Y=a+b1x1+b2x2) for temperature and precipitation and these tests ultimately showed the ability to cover the analysis of data and review of this study.

To determine the direction of the trend, type and time of changes based on a Man-Kendall graphical and statistical test, the following formulas were used:

1) $$Ui = \frac{(\sum ti - Ei)}{\sqrt{\mathrm{Vi}}}$$

2) $$U'i = \frac{-(\sum t'i - E'i)}{\sqrt{\mathrm{V'i}}}$$

Results and Discussion

In this study, the relationship between climatic factors and their effects on the hydrological conditions such as the river discharge, water level of Urmia Lake and wells water table were studied. For presence or absence of relationship between them, the Pearson correlation coefficient was used. The highest correlation between the water table and lake water level was 0.71 which is significant at the level of 0.05. Among the four effective independent variables, the lowest correlation was observed between climate change and the water level of the lake. The coefficient for the river discharge and the water table was, respectively, 0.72 and -0.71. The Pearson correlation test shows that linear gradient during the period is significant with time increasing. The results indicate that the relationship between the precipitation and water level is negative and temperature and the water table is positive. The regression gradient line at the scatter plot shows that the precipitation increase raises the water level. The highest annual decreasing rainfall is -2.56. Increasing temperatures and declining rainfall, snowfall reduction, increasing evapotranspiration and reducing the water as input decreased the water level of the lake. As a result, the lake water level trend was decreasing 0.18 mm in each year. The model and the regression analysis were calculated due to the delayed effects of climate and hydrological factors interference in each other. The coefficient determination indicates that other factors remain constant; approximately 0.30 of the dispersion of the observed changes in the lake water level is justified by temperature and precipitation variations. If we assume that hydrology parameters are constant, we can say that lake water level increases 0.005 meters per one mm rainfall and the lake water increases 1.672 meter per one cm river discharge.

Conclusion

By designing a hydrology model, it was determined that 42 percent of water level fluctuations is due to changes in the river discharge of the region and groundwater and water table. By examining regression models, we find that changes in hydrological parameters that are related to human factors rather than climatic parameters have the most influential effects on the lake water level fluctuations. The temperature increase affected the lake water level dropping more than the

rainfall decrease. By examining Man-Kendall graphics, we characterized that leaping in temperature started in 1993. Precipitation and discharge decreasedin1993-1994 and this caused the rise of the trend water table and reducing of water level in Urmia Lake, happened with a four-year delay which started from 1998.

Keywords: ***Discharge, Precipitation, Temperature, Urmia Lake, Water Table.***

A New Method for Drought Risk Assessment by Integrating the TRMM Monthly Rainfall Data and the Terra/MODIS NDVI Data in Fars Province, Iran

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Extended Abstract

Introduction

Drought monitoring and assessment is usually done through either ground observation or remote sensing. Due to having some limitations, gathering and analyzing ground observations are a time-consuming and expensive way to approach a precise drought monitoring and assessment. In contrast, remote sensing represents a fast and economic way of monitoring, but an applicable approach needs to be developed. To this end, using satellite sensor data which are continuously available provides cost-effective data for a better understanding of the region. They can be used to detect the drought commencement, duration and magnitude. Tropical Rainfall Measuring Mission monthly data (TRMM-3B43) and Monthly Normalized Difference Vegetation Index (NDVI) data of the MODIS on Terra satellite are freely available for this objective. The main objectives of the present study, which was carried out in the Fars Province, Iran, were: 1. integrating the satellite data for mapping drought severity classes using the Standardized Precipitation Index (SPI) and the NDVI anomaly maps, 2. creating drought risk maps, 3. calculating the percentage of drought affected area by drought risk level, 4. showing the effectiveness of satellite derived drought indices as an indicator for drought assessment, and 5. identifying the most drought vulnerable areas of the surveyed region.

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Methodology

This research was carried out in Fars Province, Iran. It is located between 50˚30' and 55˚36 E longitude and from 27˚03' to 31˚42 N latitude and cover an approximate area of 122661 km^2. This study aimed to map drought risk area in the Fars Province, by integrating the Standard Precipitation Index (SPI) and the Normalized Difference Vegetation Index (NDVI) Anomaly methods. As the first step, the growing season-based SPI (April- September) at 44 stations were calculated for 2000-2008 period using the standard normal distribution. The SPI raster layer (for each year), was created using the ordinary Kriging method. Then, all SPI maps were reclassified into five drought severity classes. As the second step, NDVI anomaly maps were created for the growing season based-NDVI anomaly of MODIS during the same period (9-year period). The NDVI anomaly map in each year was reclassified into five classes in a similar way. At the next part, for both methods, Boolean drought frequency map (presence or absence of drought) derived for each year. The derivation of final drought risk map was done by a simple weighted linear combination of the drought frequency maps. In this research, another drought risk map was created by integrating the NDVI anomaly and the TRMM-based SPI maps to introduce a new remote sensing method.

Results and Discussion

The ground-based SPI method applied for the growing seasons showed that in 2000, 2001, 2005 and 2008, some severe droughts occurred whereas the NDVI anomaly resulted in 2000, 2001 and 2008. The drought severity maps of TRMM based on SPI method indicated some noticeable drought occurrences in the Fars Province in 2000, 2005, and 2008 as well. The comparison of drought risk maps created by the TRMM-based SPI and the ground-based SPI methods showed that the majority of the surveyed regions are highly prone to drought occurrence. The TRMM could predict the monthly rainfall at most of 44 rain-gauge stations. Comparing drought risk maps, the high and moderate risk classes in the first method contain % 59.58 and % 39.84, while in the TRMM based method, they cover %61.1 and %37.12 of the area, respectively. Before drought risk assessment, it is highly recommended to evaluate the TRMM data for future events. The risk maps can be compared with the actual decrease in agricultural products for a better understanding of the events and their verifications.

Conclusion

The method applied in this study showed that almost whole the province is prone to drought occurrences. The northern and southern areas of the province were more susceptible to drought with different severities during the growing seasons in 2000-2008. It is notable to express that there are still some limitations to apply the satellite data for a long period. These might be data availability problem with moderate spatial resolution. The TRMM and the MODIS data have been available since 2000 and 1998, respectively. Furthermore, the TRMM data calibration and validation is required before creating the TRMM-based SPI maps. Despite their shortages, the application of remote sensing data for drought risk assessment can still be done as an acceptable method in ungauged regions.

Keywords: Drought, Fars, MODIS, NDVI Anomaly, TRMM.

Investigating the Effects of Climate Change on the Number of Visitors in Hengam Island

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Extended Abstract

Introduction

Climate have strong impact on tourism and leisure time. Climate as a natural environmental factor plays an important role in tourism development in different regions of the world. Climate change and global warming, due to increasing greenhouse gases have many effects on procedure of tourism areas. Evaluation of predictions on future climate change can reduce these effects on tourism industry. Unfortunately, despite the obvious importance of climate change on tourism, researchers have paid little attention to this topic until the 1980s. Thus, one of the oldest researches in this region is the examination about the impacts of carbon dioxide on earth warming and its effects on tourism (skiing Laavrntyds area) discussed by Boyle and Wall. This research has been done in Canada in 1980. In this study, climate change phenomenon has been examined using two scenarios A and B. The effect of climate change on snow condition, snow cover of the region, and ski industry were examined. The results show that this phenomenon has impact on the ski industry and shorten duration of the ski season. It should be noted that among researches carried out, a few of the issues of climate change was about the effects of climate change on tourism activities.

In another study, climate change has been investigated according to the GCM and regression models. Then, the effects of climate change on the number of visitors have been investigated using economic models such as travel cost (TCM). In some of these studies suitable conditions of tourism in nowadays and in the future (of climate change) has been determined by

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TCI Index and also effects of time of climate comfort on the number of visitors have been studied. The results show that climate change has effects on the number of visitors (Scott *et al*., 2007; Chotiyaputta and Pongkijvorasin, 2013; Amelung *et al*., 2007; Hein, 2009; Yu *et al*., 2010).

Few studies on the effects of climate and climate change on tourism have been conducted in Iran. In these studies, the relationship between climate impacts and tourism as well as the impacts of climate change on the tourism industry has been investigated. The results express the close relationship between climate and tourism activities and the impact of climate change on the industry (Mohammadi *et al*., 2008; Ranjbar *et al*., 2010; Kaviani *et al*., 2007; Ramezani and Abraham, 2007; Ghaderi, 2010, Bonn, 2010; Ziai *et al.*, 2010; Haji Amini and Ghaffarzadeh, 2010; Bakhtiari, 2010). Rainfall and temperature changes and their impacts on tourism were examined by Ataee and Fanaee in 2011 in Shiraz. Results of the study indicate that Shiraz rainfall and temperature are in two states of without a process and with process, respectively. Temperature process is ascending. This matter could have a major impact on the amount of tourists of this city. Karimi in 2008 have also studies about the relationship between climate and tourism using climate tourism indices such as PET, PMV, SET, ET, and stress pressure index for Tabriz City. The purpose of this study is to investigate the effects of climate change on the visit level in Hengam Island.

Methodology

To achieve the purpose of this research, climatic factors are used as independent variables and the number of visitors as dependent variable in stepwise multiple linear regression models. In order to simulate climate change based on general circulation models (GCMs), LARS-WG downscaling tool is applied. This stochastic weather generator downscaled the climate of Bandarabass synoptic station by using HADCM3 model and A1B, A2, B1emission scenarios, for 2040.

LARS-WG is one of the most popular models for random generation of weather data. This model is used for generating daily rainfall, minimum temperature, and radiation or sunshine hours in a station, for base data and future climate. Table 1-1 represents characteristics of three scenarios used in this study.

Table 1. Characteristics of scenarios as used in this study

characteristics	scenario
Rapid economic growth, population growth maximum at mid-century and then declined, the rapid development of modern technologies	A1B
Rapid population growth in the world, heterogeneity in economy and in line with the regional growth throughout the world	A2
The convergence of the global population, changes in the structure of the economy (Pollutions reduction and introduce clean and efficient technology resources,)	B1

Results and Discussion

The results show that there is a reverse relationship between temperature and the number of visitors in Hengam Island. The number of visitors decrease when temperature rise in warm seasons (spring, summer), and visitors increase with decreasing temperature in the cold season (winter, spring). The results also show that the number of visitors was affected by seasonal changes in the future. Generally, it is predicted that visits increase in summer and autumn seasons and decrease in spring and winter seasons. The highest visit frequency is predicted for autumn season in the A1B scenario and the lowest belongs to summer in the A2 scenario. The highest visit reduction is predicted for spring season in the A1B scenario and the lowest reduction belongs to winter in the B1 scenario.

Conclusion

The results show the greatest increasing changes of visits in autumn (according to scenario A1B) and the smallest increase in summer (according to scenario A2). The main results obtained in this study are consistent with similar studies by other researchers. The main results are increase of temperature in the regions (Ataee and Fanaei, 2011; Shah Karami, 2007; Abbasi *et al*., 2010; Massah Bavanat *et al*., 2010; Babaeian and Najafi Nick, 2010; Ashraf *et al.*, 2011; Abbasi *et al.*, 2010; Azizi and Roshan, 2008; Rahimi and Majd, 2011; Babaeian *et al*., 2009; Azad Torabi *et al*., 2010; Babaeian and Kuhi, 2012; Azizi *et al*., 2008) and (Berrittella *et al*., 2006; Hein, 2009; Giannakopoulos, 2009; Burki and Elsasser, 2002; Chotiyaputta, and Pongkijvorasin, 2013; Yu *et al*., 2009). But the result is not consistent with the decrease of temperature in the summer and autumn, which could be due to the specific conditions of each region (latitude, location, topography, etc.).

Keywords: ***Climate Change, Ecotourism, GCM Models, Hengam Island, Linear Regression Model.***

Climate Oscillation Assessment by Meridional Displacement of Sub Tropical High Passing over Fars Province

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Extended Abstract

Introduction

According to General Circulation Model (GCM), zonal thermal belts are: 1. Inter- Tropical Convergence Zones (ITCZ) around equator; 2. Sub Tropical High (STH) belt around 30 degree latitude; 3. Sub Polar Low (SPL) belt around high latitudes. Inter- Tropical Convergence Zones belt has meridional migration on the different seasons and its position affects directly the situation of STH. The STH situation is the most important synoptic climatological pattern in Middle East and Iran due to changing season. The belt of Inter Tropical Convergence Zone (ITCZ) displaces in meridional path, about 5° over oceans and up to 40° in continents, during seasons of a year. The position of Sub Tropical High (STH) belt has been also affected by ITCZ movements. STH displacement may change the area covered by westerly Baroclinic Waves (BW) in temperate regions. The Northern Boundary Sub Tropical High (NBSTH) moves coincidently as the northern border of the STH belt. The position of the NBSTH is an important issue for changing precipitation regime and onset of precipitation events in Fars Province. The goal of this research is to determine the position of NBSTH over Fars in monthly scale during the period 1948 - 2010, undertaking its meridional displacement.

Methodology

Dataset of geopotential height in multi levels (monthly scale) was extracted from NCEP/ DOE Reanalysis published by NOAA using by GrADS (Grid Analysis and Display System) software for 52.5°E meridian over Fars Province. By consecutive observation of 756 numbers of 500 hPa monthly maps in GrADS scope, 5840 gpm contour was indicated as the NBSTH indicator. It is

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because southern area of 5840 gpm contour is almost covered by STH system while the northern area occupied by westerlies during monthly round maps. This result agrees with previous studies. The strip of NBSTH is considered with 20 m width ranging from 5830 gpm to 5850 gpm. Monthly time series of NBSTH position (unit: degree of northern latitude) was then detected using GrADS programming. The non-parametric Mann-Kendall trend test was applied on time series of NBSTH position in monthly and annual scale.

Results and Discussion

Results show that the position of NBSTH is between 10°N and 47.5°N as the most extremes in winter and summer, respectively. For long term means, the minimum latitude of NBSTH was in average observed in January, placed on 18°N zone while maximum is happened in August, crossing 41°N zone during the investigated period. Its meridional displacement then reaches to 23° over Iran in average. Moreover, climatic means of Northern Boundary Sub Tropical High positions during 1981- 2010 period with respect to 1951-1980 period were migrated approximately 2.7° northward. The non-parametric Mann-Kendall trend test was then applied. It showed generally raising trends under 0.01 significance level, with 0.07 slope approximations during 1948-2010. It demonstrated the signal of climatic variability of atmospheric circulation over Fars. This significant trend may also shorten the period of the rainy season in Fars. Rainy season of the most stations in Fars may be defined as the period when the NBSTH position goes to the southern zones of the station and consequently subjected to the atmospheric baroclinic state of westerlies.

Conclusion

The more precise results need primitive data in daily scale that suggested for the next step. Nevertheless, it is generally deduced that the lower latitudes of Fars have thus shorter duration of the precipitation seasons. The belt of STH dominates over a zone when the Northern Boundary Sub Tropical High (NBSTH) position is above latitude the station. Changes in precipitation regimes are also related to the NBSTH position. The onset of precipitation events for the stations located in the Fars starts climatically later than those located in the north because of NBSTH situations. It is also suggested to use time series of NBSTH position as the input of climatic prediction models yielding temperature and precipitation. It is suggested that the time series of NBSTH position is as the input of climate prediction models yielding temperature and precipitation as well as drought study. In drought study, agricultural management as well as massive economical and social programming in Iran seems to be essential due to NBSTH position.

Keywords: ***Climate Oscillation, Fars, Meridional Displacement, Northern Boundary Sub Tropical High (Nbsth).***