Analysis of vertical distribution patterns of dust storms in association with atmospheric circulation patterns and topography in western Iran

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Extanded Abstract

Introduction

The west and southwest areas of Iran are characterized by high-levels of dust events mainly due to their location in the vicinity of vast deserts. Western Iran is located in the vicinity of some important dust sources: the Tigris and Euphrates basin in Iraq as well as Syria in the west and the Arabian Peninsula in the south. These sources are among the most active in the dust belt, especially in the recent years.

Overall, sand and dust storms are the most important atmospheric phenomena in arid and semi-arid regions. They have been recognized as the regions with a wide range of environmental and climate impacts including distractive effects upon air quality and human health, agricultural activities, land use and soil formation. They are also recognized as the factor of desertification. Dust particles are important components of the earth's climate system as they affect the balance of solar radiation by scattering and absorption. These feedbacks have a direct link with the intensity and height of the column of dust in the troposphere. The aim of current study is to understand the vertical distribution patterns of Middle Eastern Dust Storms (MEDS) associated with atmospheric circulation patterns and topography in cold period of the year (November-May) in west Iran.

Material and methods

The horizontal and vertical distribution of dust aerosols was simulated with chemistry/aerosol module of Weather Research Forecast system (WRF-CHEM). The WRF–Chem was configured

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with the Goddard global ozone chemistry aerosol radiation and transport (GOCART) dust emission scheme to calculate the influx of dust into the atmosphere. The effect of the Zagros Mountains on vertical and horizontal distribution of dust emission was also examined by WRF model in an area between 16º–44ºN and 33º–65ºE with a 30 km horizontal grid spacing. The FNL re-analysis data set were used to provide the initial and lateral boundary conditions in a control run and in a simulation run by removing the Zagros Mountains.

The atmospheric circulation pattern was investigated to explain the mechanisms of dust emission in the Middle East and its vertical emission over this region. The hourly visibility and dust dataset of 34 synoptic stations in the western part of Iran were obtained from the Iran Meteorological Organization (in 2004-2013 period) to extract dust events in the study area. The NCEP/NCAR 6-hourly reanalysis dataset with 2.5°×2.5° horizontal resolution was used for this period.

Results and discussion

The atmospheric circulation patterns lead to generation of dust events in the Arabian region in two categories of frontal and non-frontal patterns. In the frontal events of MEDS that occur in the cold period of the year, dust is created under the influence of emigrate systems of westerly winds setting in the Middle East region. Formation of a divergence system in mid-level of troposphere (500 hPa) leads to formation of a surface convergence center as well as frontogenesis, air uplift and atmospheric instability condition in the source areas of MEDS. In addition the Polar Jetstream position as one of the enhancing factors of instabilities and air uplift in the region has a key function in vertical distribution of MEDS. Generally, MEDS events occurred due to the frontal pattern are similar to the precipitation systems except the lack of humidity in case of dust generation in arid lands of the Middle East. Frontal patterns are divided into two patterns including Trough and Blocking. These two patterns are the dominant patterns of dust generation in November to May in this region in cold period. In frontal pattern, the vertical distribution of column dust is divided into two categories: in first pattern the maximum height of dust is above 7 km and in second pattern the maximum height is below 4 km. These patterns are related to the position and strength of Polar Jetstream, the strength of mid-levels vorticity, and upward motions of air flow. In the first vertical distribution pattern, there is upward motion to the 9 km of the troposphere as in second pattern the upward motion is 5 km of the troposphere.

In non-frontal pattern neither frontogenesis happens nor there is a polar front Jetstream which causes instabilities in the Middle East dust storm sources. Dust generation is due to the regional circulation system in the lower level of troposphere. In this pattern, the concentration of dust load is less than frontal MEDS and the maximum height of column dust is below 3.5 km.
The results of the analysis about the impact of topography on vertical and horizontal distribution of MEDS reveal that the Zagros Mountains have a limited effect on the vertical and horizontal distribution of MEDS. However, in the absence of the Zagros Mountains and the main factor which control the vertical and horizontal distribution pf dust storm is the strength of atmospheric systems.

Conclusion

Two main patterns of cold period of MEDS are frontal and non-frontal patterns. The vertical

distribution of column dust in mentioned patterns are different. In frontal pattern the height of dust is varied from 4 to 7 km in the troposphere. The position and strength of Polar Jetstream, the strength of mid-levels vorticity, upward motions of air flow and divergence of moisture flux in MEDS sources are the most important factors which determine the strength and height of dust storm in the Middle East in the cold period. In non-frontal pattern the concentration of dust in the troposphere is below 3.5 km. the result of this study reveals that the important strength of atmospheric systems is more than topography barrier in vertical and horizontal transport of MEDS in west Iran.

Keywords: atmospheric circulation patterns, column dust height, frontogenesis, Zagros Mountains.

Zonnation of temporal changes and uniformity of rainfall in Iran

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Extended Abstract

Introduction

Changes in rainfall regime can represent the effects of climate change. Reduction and increase in rainfall affect many environmental phenomena such as runoff, air temperature, humidity, and also many human activities including agriculture and housing. On the other hand, the growing need for understanding climatic characteristics is essential for human life. Increasing climate information has helped understand the climatic characteristics in different regions. Therefore, use of new classification methods seems inevitable. One of the most widely used methods is cluster analysis classification recently used extensively in climate zoning.

Materials and methods

For identifying the Iranian rainy areas, the first hourly data of precipitation of 53 synoptic stations, in a common statistical period, was received from the Meteorological Organization from 1984 to 2013.The hourly data were initially converted to daily to determine the number of days of rain (rainfall of 0.1 mm or more). In order to implement the classification from rainfall continuity period, rainy days were extracted in seven classes of precipitation such as one-day range, two-day range, and three days to seven days range. The precipitation more than seven days put in class with seven days sequence. The cluster analysis was used to identify climatic regions and their features. As a result, Iran was divided into seven regions with the highest intra-group similarity and the most difference among the groups in terms of the number of rainy days. For study of rainfall periodic characteristics, we used two coefficients of variation index and rainfall uniformity index. Using Spatial Analysis in ArcGIS, we prepared annual, decade,

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and seasonal maps for the study areas to find the areas exposed to the risk of intense precipitation and flood events. In other words, vulnerable areas can be identified.

Results and discussion

Based on hierarchical cluster analysis, rainfall day in Iran was separated into seven zones. Coefficient percentage of variation of the annual rainfall in Iran ranges from 73% to 245%. In other words, the spatial variation of rainfall is high in the regions. The third zone, with change coefficient 73, has the lowest coefficient of variation due to the relatively good dispersion of rainfall during the year. After that, the fourth zone has the lowest coefficient of variation. The seventh zone, in western areas of the country and Yasuj station, is in the third rank. The variation coefficient has increasing pattern to the east ward, south ward, and south-east ward of the country. The variability of rainfall on first zone has the highest percentage. The third and fourth zone, with a rainfall uniformity index more than 70%, has periodic form. The uniformity of precipitation has decreased from the north to the central regions, so that the lowest level of the uniformity is related to the first zone with a sporadic and heavy rainfall.

Conclusion

In the present study, using the characteristics of rainy day and applying cluster analysis, it was found that there are seven precipitation zones in the country. Rainfall, Precipitation amount, and rainfall distribution is different in each of the zones. The first zone has the highest spatial variability and the highest percentage of annual variation coefficient. The lowest annual average uniformity index is related to rainfall distribution and precipitation uniformity. Comparison of the rainfall zones in terms of temporal and spatial variability determined that periodic rainfall distribution in the country is mainly concentrated in the third decade of the period of study.

Keywords: Iran, concentration, Sequence of rainfall day, zoning

Comparison of NDSI and LSU Methods in Estimation of Snow Cover by MODIS (Case Study: Saghez Watershed Basin)

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Extended Abstract

Introduction

More than 30 percent of the Earth is covered by seasonal snow and about 10 percent by permanent glaciers. Approximately about 5 percent of global precipitation is snow. About 50 to 95 percent of the value is in polar areas. Spatial-temporal distribution of snow is important. The estimation of snow cover area provides valuable information on snow-melting water in terms of runoff and water supply of the watershed in mountainous regions. Snow is an important geophysical factor for climate through its role in the Earth's albedo and hydrology. It is important role in water storage, agriculture, hydropower generation, and flooding in local scales. Snow creates an insulation to keep plants from the cold weather in winter. Therefore, it is necessary to study the snow cover area, snow depth, and snow water. The snow cover area is affected by environmental factors leading to different melting patterns which are important for a deterministic model.

The importance of snow has been recently understood by scientists and watershed managers in different snow studies. Applying remotely sensed data for such studies is cheaper, faster and easier than traditional approaches. One can also study larger areas using these data which is more beneficial. Snow cover area is the most accurate factor of snow which can be estimated using remotely sensed data. Different sensors have been applied to study snow areas with their own advantages and disadvantages. Earth Observing System (EOS)-Terra was launched with 5

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mounted sensors on December 18, 1999. One of the 5 sensors in EOS is MODIS. The sensor was embedded on Aqua satellite launched on May 3, 2002. Terra is a sun-synchronous satellite, elevated at 705 Km, with polar orbit. Terra passes occur at roughly 11:00 – 12:00 AM and 10:00 – 11:00 PM local standard time each day. MODIS is the biggest sensor in EOS. Its mission is to measure temperature, ocean color, vegetation and deforestation, clouds, aerosols, and snow covers. Different ground resolution, the capability of distinguishing cloud from snow provides complete coverage of the Earth. Therefore, this sensor has very high potentials in snow cover studies. The sensor has a radiometric resolution of 12 bites, spectral resolution of 36 bands from 0.4 till 14.4 µ. It also has a high temporal resolution (Repeating cycle of 1 to 2 days) and moderate spatial resolution (250, 500, and 1000 m).

Materials and Methods

MODIS satellite images are used for estimating snow cover area in this study. In this research, two common techniques including Normalized Difference Snow Index (NDSI) and Linear Spectral Unmixing (LSU) were used. In order to determine the accuracy of NDSI and LSU approaches (MODIS images), the IRS images were selected since their spatial resolution is very high (24 m). The MODIS pixels were interpreted as snow using Snow map algorithm. A number of 11 similar sites on MODIS and IRS were selected to compare the results. The snow area of MODIS images (NDIS and LSU) were compared with the corresponding value on IRS images using t-student test and regression coefficients. A scatter plot of non-snow against snow was used. A regression model was established for the same purpose.

Results and discussions

The scatter plots of the snow areas produced by crossing IRS versus that estimated by NDSI and LSU approaches were separately investigated. The regression model of each scatter plot was then calculated. The results show that both NDSI and LSU methods have high efficiency to compute snow cover areas; however, the LSU method shows a little more efficiency than the NDSI method. Another comparative investigation over the NDSI and LSU methods was performed by t-student test with significant level of 5%. The t-student test indicated that the LSU method has a higher potential in estimating snow cover area in the study area than the NDSI method.

Conclusions

The use of remote sensing techniques, satellite images, GIS, and statistical methods for studying and monitoring ground features such as snow is very beneficial due to their lower expenses and ease of use. Among them, high temporal and spatial resolution images are preferred. Due to the importance of snow in the study area, the snow cover area was computed using MODIS and IRS satellite images to determine the best approach. The results showed that to use the methods we apply subpixels to calculate snow cover area. The study reveals that remote sensing techniques can provide reliable information on snow and can overcome the problems stemming from traditional approaches

Keywords: LSU, MODIS images, NDSI, Saghez Basin (Kurdistan), snow cover.

Evaluation of active tectonics in Jarahi - Zohreh Sub-basins based on the morpho-tectonic analysis and its impacts on the oil fields of the basin

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Extended Abstract

Introduction

With 6.8 percent oil reservoirs, Zagros is one of the most prolific oil sedimentary basins. The greater part of its hydrocarbon reservoirs are concentrated in anticlinal traps. They are also the subsets of the structural traps. In addition to rich and vast hydrocarbon reservoirs, Zagros have been also considered in terms of its Neotectonic activities. The studies of neotectonic activities are important in control of landforms in tectonic regions, apart from its social and economic interests. The studies of active tectonics require a multi-disciplinary approach to integrate data from structural geology, geomorphology, stratigraphy, geochronology, seismology, and geodesy .The unrelenting competition between tectonic processes tends to build topography and surface processes to represent the core of tectonic geomorphology. The most effective morphometric indices have been related to erosional and depositional processes associated with fluvial systems. The rivers are highly sensitive to subtle landscape fluctuations induced by tectonic activity and can assist in differentiating active segments of geologic structures. Because drainage basins represent dynamic systems that may retain records of formation and progression since most tectono-geomorphic processes occur within its confines. Therefore, morphometric analyses of river networks, drainage basins and relief using geomorphic indices, as well as geostatistical analyses of topographical data have become useful tools for investigating landform evolution. In recent studies on morphotectonics, a mixture of geomorphologic and morphometric analyses of landforms and topographic analyses are utilized to obtain active tectonics. They have been tested in different tectonically active areas to provide insight about

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particular areas where are subject to active tectonic deformation. Therefore, since many geomorphologic effects are highly susceptible to tectonic movements and their changes are happening at the same time, we should be looking for the forms and shapes that have retained these changes over the years. With regard to the geomorphologic indices, the current study attempts to consider Neotectonic activities and its impact on the positioning of the oil fields in the Jarahi and Zohreh sub-basins.

Materials and methods

In order to achieve the goals of this research, documentary information,1:50000-1:25000 topographic maps and 1:100000-1:250000 geological map, Digital Elevation Model (DEM) related to SRTM topographic data and landsat 8 satellite images have been the important research tools. For the analysis of Neotectonic activities in the case study area, we have used such geomorphologic indices as Stream Length-Gradient index, River Sinuosity, Relief Amplitude, Hypsometric Integral, Basin Shape Factor and Drainage Basin Asymmetry Factor Index. ArcGIS software was used to digitize the topographic maps and draw river networks for calculating these indices.

Results and discussion

Results of the calculation of geomorphologic indices:

The SL values in the study area are ranged from 0 to 573. The S values in the study area are ranged from `1.1 to 2.46. in the study area, the RA values are ranged from 31 to 3254, the HI values from 0.04 to 0.56, the B_S values from 0.19 to 2.49 and the |AF–50| values from -28.83 to 32.59. The classification used in this paper for each geomorphic index is calculated from El Hamdouni's method. According to Relative Tectonic Activity (lat) index, three classes of high active ($1.6 \leq LAT < 2$), 12.2%, moderate active ($2 \leq LAT < 2.5$) 34.5%, and low active ($lat \geq 2.5$) 53.2% values were identified.

Finally, with stratum overlaying of oilfield and the obtained final layer from geomorphologic indices of the studied basin, it was found that in the Class I areas, there was no oil fields with high level of tectonic activity, but 38.3 percent of oil fields are located in Class II areas with average tectonic activity and 61.6 percent of the oil fields are located in Class III areas with their low tectonic activity.

Conclusion

The obtained quantitative values from the results of the geomorphic indices in the 38 sub-basins helped to divide the studied basin into three tectonic areas with low, medium, and high tectonic activity. It was also shown that the Neotectonic activity level in different parts of the basin is not the same and the forces act with greater intensity in the eastern half. This activity was in more oil fields of Jarahi – Zohreh basin, i.e., 61.6 percent in the region with the lowest Neotectonic activity. In the areas with the highest Class of Neotectonic, there was virtually no oil field. The results indicated that Neotectonic has important role in the running or migration of oil traps and the extent of tectonic is necessary to create small fractures to oil running and finally oil production. In fact, it can be attributed to Neotectonic destructive and inhibiting roles in constructive and transferring hydrocarbons.

Keywords: Geomorphologic indices, Neotectonic, Jarahi-Zohreh, Oil fields, Zagros.

Quantitative assessment of salt geomorphosites in Semnan Province using Brilha and Pralong methods with emphasis on west province geosites

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Extended Abstract

Introduction

Nowadays, along with other social and cultural attractions, the geomorphological and climate attractions have the special importance for economic studies and policy making. Geotourism is a new approach to explain the earth planet and its natural capital. In addition to educational and scientific roles, it can cause development of regional tourism and offer strategies for sustainable development in the geotourism sites. Geotourism is one of the new areas in tourism that follow tourism principles and in relation with the studies of geology, geomorphology, natural landscapes, landforms, stones and minerals with emphasis on the processes that create these shapes. This branch of tourism introduce the geology and geomorphology phenomena to tourists by observing the international rules and standards along with keeping the local identity and also arrangement and organization of this treasure observation and preventing from destroying by human mainly for developing region. Therefore, it emphasizes on a set of geographical, geology, bio–environmental, cultural and ancient heritage characterizations. It is necessary for geotourism development in each region to identify the various geotourist attractions such as desert, coastal, volcanic, and mountainous regions and its development need programming and cost spending that finally result in geotourism development of the region. This activity, not only have economical, ecological and cultural – social benefits but also provide the employment of extensive range of students in mine, bio–environment, geography, geology areas and etc. Geomorphotourism is an approach that emphasizes on the use of geomorphological and geological features and their ability with a focus on saving these features and forms and sustainable use of them. This approach also places an emphasis on maintaining the geographical

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identity and referring to the relationship between geotourism and historic - cultural signs and reminders and also interactions between geomorphology and tourism. That eventually would be related to human activities and the history of the human life. Thus, geomorphotourism is resulted from a combination of tourism goods, services, and foundations that are promoted in the specific region and related cultural elements. Geomorphosite assessment is an issue that most of the geographers are interested in. The various studies have been carried out in internal and world level about estimating the geomarphosites in two past decades and today they are doing with increasing trend. In this research, the capability of landforms resulted from salt diapirism have been estimated in development of tourism in Semnan. Semnan have been known as a salt tourism pole but unfortunately, there isn't any research about tourism result from the salt diapirism in this city and even Iran.

Materials and methods

Semnan province is located between 51° 51′ 51″ E and 57° 03′ 00″ E from prime meridian and 34° 13′ 00″ N and 37° 20′ 00″ from Equator. In this study, descriptive - analytical indicators and brilha method have been used to analyze the data. Salt Geomorphosites of Semnan Province have been identified with using the satellite image processing and combined with topographical and geological maps. Geomorphological properties of the sites had been studied based on Brilha method with the help of library and field studies. The instrument used in this study consists of Digital Elevation Model (DEM), ETM Satellite Images, IRS Images, and Topography Maps in scale of 1:50000 produced by Iran Geographical Organization of the Armed Forces and Geological Maps in the Scale of 1:150000. In the first step, 35 cases of the most important attractions of geo-tourism features in the Semnan province has been selected. Then, the value and criteria have been determined according to brilha method and then each geomorphosite was evaluated. Brilha method is a Quantitive technique for primary evaluation of geomorphosites from the view point of planning and sustainable management of natural heritage sites and turning them into tourist destinations. This method includes 4 criteria including Scientific, Educational, touristic and degradation risk and 37 indicators.

Results and discussion

Landform configuration is one of the tectonic effects of salty diapiar in large and small scales. Geomorphological landform is a geomorphological event that has scientific, cultural – historical, geology and social- economical values according to human identification. In this research, salty capabilities of Semnan province are evaluated for geotourism development. From the salty landforms, finally 35 geomorphosite in the semnan province were selected for evaluation. In order to select these features, some criteria such as representativeness, rarity, integrity and Scientific Knowledge had been considered. The results show that in the Scientific and Educational Criteria, Geomorphosites of Salty dome in southern Semnan has the highest value (3.8, 3.73) and then is placed on the first order. In the touristic criteria, Geomorphosites of Kohdasht Kohan Salty dome get the highest value (3.63) and then is placed on the first order.

Conclusion

In this research, we tried to estimate the capability of salty domes geomorphosites in Semnan

Province from geological and geomorphological point of view according to brilha model. The results have indicated that salty geomorphosites have high scientific, protective and aesthetic values but from the view point of tourism services and foundation they are faced with several problems and there aren't enough facilities in this field. High protection level in this area is not related to administrative and scientific protection but it is related to lack of awareness of these geomorphosites. This means that the authorities and planners performed weak in the field of introducing the desert geomorphosites of the Semnan province.

Keywords：assessment, Brilha method, Geomorphotourism, Geosite, Semnan Province.

Relationship between rock hardness and debris generation by modified Selby method (Case study: Agha - Jari Sandstone)

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Extended Abstract

Introduction

Debris and rocky hillsides are one of the important and typical landforms in arid and semi-arid regions. In this study, the relation between the hardness of Aghajari sandstone with producing the debris has been surveyed by Selby Method. The sandstone rocks display obviously landscape features. Debris is one of these landscapes. Rock fall and rock topple can create these landscapes. Debris is characteristic of arid and semi-arid region. Geology and climate are the main mechanisms for generation of the debris. Weathering, gravity, earthquake, joints and fluctuation of temperature are other agents. Selby (1980) method was used in order to determine the effective factors on production of the debris. To determine resistance of rocks, Schmidt Rebound Hardness (SRH) is so practical. So far in geomorphology and geology, more than half a century, the SRH was used in researches. In addition to the Selby method, porosity was used to determine rock hardness in this paper. The aim of this study is to study the effects of rock hardness characteristics on generation of debris, based on modified Selby method, on Agha - Jari sandstone in southwest Iran (Masjed - Soleyman).

Material and methods

In this study, in sampling and estimation of SRH, the samples were taken along eight layers which are named from A to H. The samples A1 to A4 were taken from the oldest layer and samples H1 to H4 from the youngest. Because the thicknesses of layers vary from place to place, the sampling interval changes from 50 to 150 meters. Geomorphic map was prepared by freehand software and using 1:25,000 topographic maps of Iranian Survey Organization. Geological data, such as lithology and contacts of the Aghajari sandstone layers, were drawn by using 1:100,000 geological maps of Geological Survey of Iran. Also some factors of Selby

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method such as properties of joints including width, spacing, lateral or vertical continuity, and orientation with respect to the slopes as well as weathering of the rocks was estimated on the field. Thin section samples were prepared from fresh rock samples. After preparing thin sections, porosity was determined via point counting by 400 points in each sample.

Results and discussion

For understanding the effects of each Selby factor with debris, we compared all factors to measure the amount of debris on the layers. The samples B, C, D and F have the most debris in all layers and A layer don't have any debris. The results showed that there is direct relationship by increasing between SRH and amount of debris with a high correlation (89%). The factors showed the correlations; Width of the joints: non correlation, the spacing of joints: low correlation (21%), weathering: high correlation (87%), lateral or vertical continuity of the joints: high correlation (83%), Orientation of joints with respect to the slopes: almost high correlation (63%) and porosity: mid correlation (56%).

Conclusion

The results of this paper showed high relationship between debris and SRH, weathering and lateral or vertical continuity of the joints and also low relationship between the spacing of joints and non-relationship between widths of the joints. Porosity and Orientation of joints with respect to the slopes have mid relationship with debris. The A layer (the oldest layer) is the weakest layer. The layers B, C, D, E, G, and F are resistances and H layer (the youngest) is mid hardness.

Keywords: Agha - Jari sandstone, Debris, Selby method, SRH, Rock hardness.

Modeling and spatial analysis of future needs for cooling in Iran

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Extended Abstract

Introduction

Climate changes and global warming as important issues in environmental sciences have attracted the attention of many researchers. In the study of the climate and atmospheric changes, it is essential to understand the temporal conditions of climate parameters, particularly degree day. The temperature as one of the most critical climate parameter is effective in the global warming. Thus, a variety of indices and methods have been presented for the analysis of this parameter by many researchers. Degree day is one of the important indices. The studies about the climate change and energy requirements are necessary in Iran, in that, the increasing needs of the society due to the energy crisis of the world, fossil fuel resources, and increased temperature lead to a new state of energy in the near future of this country. In the present research, we have attempted to detect cooling degree days of the country using spatial statistics.

Materials and methods

To examine the impacts of global warming on Cooling Degree Days (CDD), we have used the average of the daily temperature data derived from EH5OM database. The EH5OM is an Atmospheric Ocean Global Circulation Model (AOGCM) of the fifth general circulation models of atmosphere with spectral dynamic core. The model was presented by Max Plank physics institute. In this research, we have used the data in a period from 2015-2050 under scenario A1B. The reason we have selected this scenario is the ability to have equal use of fossil and non-fossil resources of the future. For a spatio-temporal exploration of the degree day, the balance of cooling need of Iran has been considered at 23.9° C threshold. The threshold was applied by the institute of US standard of science. We have employed three methods in ArcGIS10.3 for these analyses. We have also used Global Moran I to evaluate the spatial autocorrelation the cooling needs in the future decades, Anselin Local Morans I to draw the

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clusters and non-clusters, and Getis Ord Gi statistic to analyze the spatial patterns of the cooling needs.

Results and discussion

The cooling degree day needs has a positive autocorrelation in the future (α=0.01). This has confirmed dependency of the cooling need for Iran. With the beginning of summer, the Global Moran I is reached 0.9. The changing patterns of the index in different months of the year have given distribution for all the country. In winter times the cooling need is reduced over the country. The parameter is at the peak in April, May, and June. The results have showed the spatial and temporal patterns of the needs for cooling in different regions of Iran. In the winter times, the need for cooling the buildings shows a proportional reduction in all the country. The cold climatic conditions in January and February reduced the need for cooling the house environment. The cooling needs in different areas of Lut, Zabol, and Turkmen regions have indicated the effects of elevation on the temperature. The southern coasts of Chabahar and Hormozgan also observed the temperature higher than average. In Marth and September the country can be categorized into three groups; the coastal plains, mountain areas, and internal arid plains. These regions have different patterns in different months. The southern coasts of Iran and coastal plains of north Iran will have the highest needs for cooling in the future decades. The mountainous areas have the lowest cooling needs in the country. In the mountain areas of Iran the need gradient is reduced towards the central low lands.

Conclusion

The results of spatial autocorrelation using local Moran model for Iran have indicated that the cooling need for the future decades follow a spatial pattern. The LISA has also indicated that the most needs for cooling is in the period from April to September. Thus, the southern areas of Iran and the mountainous areas have the highest and the lowest needs for cooling. The three regions of coastal plains, mountainous areas, and central arid plain will have different spatial patterns of cooling needs in different decades in the period of this study. The results of the study on the difference of cooling needs in two categories of flat and relief terrain areas are consistent with the results of Masoudian et al. (2011). In the future, the patterns may have changes in different latitudes. The highest need for cooling will be occurred in Chabahar and Hormozgan coasts.

Keywords: ArcGIS, degree day, global circulation model, Iran.

Comparison of statistical downscaling in climate change models to simulate climate elements in Northwest Iran

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Extended abstract

Introduction

Linking global climate models with local scale as a micro climatic process is of great importance. Recently, many attempts have been made by researchers to develop dynamics and statistical downscaling methods for expressing climate change at a local and regional scale. Two general techniques are used for downscaling of the output of General Circulation Models (GCM). The primary solution is application of statistical methods in which the output of a statistical model (MOS) and a planned approach to weather short-term numerical prediction is presented. The second is regional climate model (RCM), that same is limited GCM model in a subnet of the network global model and by dynamic method using climatic conditions temporal changes according to GCM model. Both methods play an important role in determination of the potential effects of climate change caused by increased greenhouse gas emissions. Much work is done to use this method for downscaling of the global model output in different areas in which the performance of the model is assessed and uncertainty analysis has been done on these methods or were compared by other statistical methods.

Materials and methods

In this study, three approaches to statistical downscaling methods are provided. The first approach uses random generation of climate models based on time series and fourier series delivers. LARS-WG statistical model is one of the ways to build this approach. In this model, the empirical distribution of daily series of dry and wet precipitation and solar radiation is desirable. The minimum and maximum daily temperatures are the daily stochastic process with mean and standard deviations. Seasonal cycles by means of finite fourier series have the order 3

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and model residuals (model errors) is approximated by a normal distribution.
The second approach is regression model or transfer function that is used to examine the relationship between atmospheric parameters and synoptic factors (predictor variables) to have a vision of the future (Instant predictor variable) for a transfer function. One of the applications that combine these two approaches is based on statistical downscaling model (SDSM). The meteorological station data are required as input and output in seven steps of GCM model are downscaled on the basis of daily data in the area.

The third downscaling model is Artificial Neural Network (ANN). This model is a non-linear regression type in which a relationship is developed between a few selected large-scale atmospheric predictors and basin scale meteorological predictors. In developing that relationship a time lagged recurrent network is used in which the inputs are supplied through tap delay line and the network is trained using a variation of backpropagation algorithm. A slightly different approach is application of the predictors for the case of neural network downscaling.

To compare the data generated by the models and observation values, we employed two non-parametric tests of MANN-Whitney. For the observed values and the model values, we have also used Spearman correlation. The basic correlation analysis is based on linear correlation coefficient of the two variables. One of the important indicators that can be used for performance evaluation model, index model mean square error (LARS-WG) is defined as follows:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(O_i - E_i)^2}{N}}$$

The North West area of Iran, including the provinces of East Azerbaijan and West Azerbaijan, Ardabil, Zanjan and a part of Kurdistan in the geographical coordinates ˚49 '30 ˚44 '07 and the ˚36 '00 to ˚39 '50 North. To study the effects of climate change in the region, we used statistical models for a minimum period of 1961-1990. In addition to the complete statistical period, synoptic meteorological stations of old climate data confirmed the country's Meteorological Agency to help some regional stations for multi-year statistical vacuum.

Results and discussion

The results indicated that according to the MANN-Whitney test the performance of three models for minimum temperature in the study area are close together. Spearman correlation test results for minimum temperature show that the number of correlation, in all stations for LARS-WG model is less than the other two. This demonstrates low performance of LARS-WG model in this respect. The average number of months with significant correlation for ANN model with seven months of the year represented that the best performance was among the three models. SDSM model with a four-month correlation table is in the middle. In terms of LARS-WG index for the minimum temperature, LARS-WG and ANN models have average values close together. This shows the error of sum of squares closer to the two models. LARS-WG values are less than the SDSM model and this shows the SDSM model is less accurate than the other two models.

According to our evaluation, according to MANN-Whitney test of the model generated

values it can be stated that the difference between the observed and tested model values, for minimum and maximum temperatures in three models have not different performance. But the results were somewhat different in different stations. Correlation data for SDSM and ANN models for maximum high temperature and minimum temperature for solidarity in SDSM model is less than ANN model. However, because the same structure prediction methods and large-scale use of such an outcome was not unexpected.

MANN-Whitney test for precipitation results show that significant differences between the observed and modeled data for ANN is much more than the other two. This reflects the low performance of this model. SDSM and LARS-WG models have similar good performance in this regard. The Spearman correlation test indicated that all three models have a low correlation. This represents that the three models are low in this respect in the study area. According to the LARS-WG, the SDSM model is better than the other two models in average performance.

Keywords: ANN, climate change model, downscaling, LARS-WG, SDSM.

Monitoring of Monthly and Seasonal Methane Amplitude in Iran using GOSAT Data

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Extended Abstract

Introduction

Global warming and climate change have been identified as the most important challenges of the current century. Methane as one of the most important greenhouse gasses accounted for about 18% of the total increase in radiative forcing due to long-lived greenhouse gases in the atmosphere. The average CH_4 concentration (XCH4) was 1808 ppb in 2010. This represents an increase of 158% from approximately 700 ppb in the pre-industrial era. Satellite observations with continuous monitoring can be used to provide the extensive information on the temporal and spatial variations of atmospheric CH_4 concentration. The Greenhouse Gases Observing Satellite (GOSAT) as the first satellite dedicated to the observation of greenhouse gases has provided extensive research opportunities for applications using space-based greenhouse gas measurement .The main objectives of this study are investigation of methane concentration trend changes and amplitude in XCH_4 from 2009 to 2015 in Iran using GOSAT data and assessment of the relationship between XCH_4 and Meteorological parameters obtained from weather stations and MODIS products for the year 2013 on the study area.

Materials and Methods

Study area

The study area of this research is IRAN located in Middle East Asia between 25°-40° N and 44°-64° E, covering approximately 1645000 km^2 .The location of the study area is shown in Figure1.

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Data

The GOSAT was launched in January 2009 as a joint effort of the Ministry of Environment (MOE), National Institute for Environmental Studies (NIES) and Japan Aerospace Exploration Agency (JAXA). It is equipped with two sensors: The Thermal and Near-infrared Sensor for Carbon Observation Fourier Transform Spectrometer (TANSO-FTS) and the Cloud and Aerosol Imager (TANSO-CAI). MODIS (Moderate Resolution Imaging Spectroradiometer) as a key instrument aboard the Terra and Aqua is one of the most reliable data sources at the global scale. Terra MODIS and Aqua MODIS are viewing the entire Earth's surface every 1 to 2 days, acquiring data in 36 spectral bands, or groups of wavelengths (see MODIS Technical Specifications). The meteorological parameters (temperature, humidity and precipitation) used in this study were obtained from the Islamic Republic of Iran Meteorological Organization (http://www.irimo.ir/) .In this research, we used GOSAT TANSO-FTS level 2 data, MOD13Q1 and MOD11C3 products of MODIS satellite, meteorological parameters (Temperature, Precipitation and Humidity) for 2013.

Statistical analysis

GOSAT data, MODIS products and meteorological parameter value were analyzed in SPSS statistical program. The correlation coefficient was calculated to investigate the relationships between CH4 concentration and used variable (temperature, precipitation, humidity, NDVI and LST). Analysis of Variance was applied for investigation of difference between XCH_4 concentrations in different years.

Results and Discussion

In this research, the CH4 concentration values were calculated using TANSO-FTS sensor from 2009 to 2015 in whole the study area. The results show a steady increase in the mean atmospheric XCH4 from 1788.36 ppb in the year 2009 to 1823.45 ppb in the year 2015. This illustrates an increase of about 35.09 ppb for a 6-year period. To assess the monthly changes of CH4 concentration, we calculated the monthly average concentrations of this gas from 2009 to 2015. The results reveal that CH4 concentration was changed significantly between different months, with the highest concentration of XCH4 in October-September and its lowest concentration in March –April. According to the results, the coefficient of correlation between CH4 concentration and MODIS products showed that the correlation of this gas with NDVI and LST was negative and positive, respectively. As correlations coefficient for NDVI is -0.526, -0.138, -0.186 and -0.322 for spring, summer, autumn and winter, respectively. The correlation coefficient between XCH4 and LST is 0.6, 0.223, 0.458 and 0.634 for spring, summer, autumn and winter, respectively. Moreover, the coefficient of correlation between CH4 concentration and metrological parameters indicate that correlation of this gas with humidity and precipitation are negative (r humidity= -0.479, r precipitation= -0.505) and the correlation between this gas and temperature is positive (r=0.484). This means that CH4 concentration will increases with increases in temperature and LST, and decrease in precipitation, humidity and NDVI.

Conclusion

The satellite monitoring of CH_4 concentrations showed increase in about 35.09 ppb over time from 2009 to 2015 in the study area. We observed that the XCH4 was changed significantly between different months, with the highest concentration of XCH4 in October-September and its lowest concentration in March–April. This amplitude is related to different sources and sink of methane in different seasons. The correlation between this gas and NDVI and precipitation humidity was negative, and correlation between this gas and LST, and temperature was positive. Therefore, it is necessary to conserve the natural ecosystems in whole IRAN especially in arid and semi-arid regions for decreasing CH4 concentrations.

Keywords: Climate change, CH_4, GOSAT, MODIS, Satellite monitoring.

Remote sensing of burned plant residue in fields using Landsat sensor imagery

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Extended Abstract

Introduction

In the recent years, due to the benefits of conservation tillage and also disadvantages of crop residue burning, extension and education of conservation tillage has been highlighted on the agenda of agriculture policymakers. In this regard, subsidies or crimes are, respectively, considered for the farmers who use conservation tillage or crop residue burning on their farms. Lack of information, time consuming and high cost efforts of information gathering from the farm using conventional methods led to the poor performance of law enforcement. Therefore, the present research was carried out to find an accurate and fast method for monitoring the residue management. In this research, the ability of Landsat-8 satellite imagery for monitoring of burned fields was evaluated using spectral indices and linear spectral unmixing analysis.

Materials and methods

The present research was carried out in the Orzooiyeh region of Kerman province. For conducting the experiment, an area with approximate size of 25 square kilometers is considered and 10 farms (with burnt residues of wheat or corn) were selected randomly in this area as 10 replications of experimental plots. The images were downloaded from the landsat-8 website and all features were extracted from the images using ENVI software. On the other hand, the data of real burned areas on the farm were collected using handheld GPS device and the exact date of residue burning was also recorded directly on the field. The maps of experimental farms were prepared using ArcGIS software. The correlation between data of real burned area on the farms

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and ENVI extracted data of the burned areas were studied and real burned areas were expressed as a function of burned area that extracted from satellite images by a linear regression curve. Finally, the accuracy of regression functions and correlation between real data and satellite data were calculated. For this purpose, spectral indices including Normalized Difference of Vegetation Index (NDVI), Burned Area Index (BAI), Normalized Burn Ratio (NBR) and Normalized Burn Ratio Thermal (NBRT) were created for experimental lands and four soil surface conditions as experimental plots were considered including no planted field, residue covered field, green vegetation field and burned residue field.

Results and discussion

In the present study, because of extracting the pure spectral data of soil and residue, directly from Landsat-8 images, spectral unmixing analysis was not sensitive to the spectral changes that caused by conditions such as moisture content of soil and plant residue. The average value of BAI index obtained the values of 88.39, 9.29, 4.20 and 6.87 for burned residue field, no planted field, residue covered field and green vegetation field, respectively. As it can be seen, the average value of BAI index for burned residue field is significantly higher than the values for other soil surface conditions. This difference is because of the very low percentage of spectral reflectance of ash in the red and near-infrared bands. Therefore, BAI index was selected as an indicator to distinguish between burnt residue and other three surface conditions in the farm. The result showed that there is a significant difference between means in four soil surface conditions of the studied indices. Also, the results showed that the BAI index can be used as a good indicator for separation of burned fields. By the BAI index, location and area of trial burned farms were determined with higher accuracy than other indices. The average of burned fields that had been separated from other fields using BAI index had high correlation (R^2=0.95) with ground-truth data. Also, the area of burned fields estimated by linear spectral unmixing analysis had a good correlation (R^2=0.89) with the obtained data from the ground-based method.

Conclusion

According to the results, BAI index had the most accuracy for estimating burned area of farms and BAI index is proposed for separation of the areas of burnt fields. However, there is a slight error in estimation of the burned areas using spectral indicators and linear spectral unmixing analysis due to pixel nature of satellite images .Since there is only one spectral data for each pixel of satellite images, spectral data of the pixels that are more than the threshold value are considered as the burned pixels while it is possible that actual amount of burned area have been overestimated. For spectral data of the pixels that are less than the threshold value, we considered the unburned pixels while that may be estimating the burned area less than the actual amount.

Keywords: burned residue, imagery, Landsat-8, remote sensing.

Investigation of the relationship between thermal sensation and hospital admissions of cardiovascular patients in Kermanshah

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Extended Abstract

Introduction

In recent years, urban developments have created changes in the climate. Such changes affected the sustainability of the natural environment and the rate people's health is affected, especially in cities. If the human body is an environment warmer so that skin surface begins to absorb the heat and in the colder environment gradually loses its heat. In addition, the air moisture has affected evaporation capacity and amount of cooling by evapotranspiration. At 20 to 25 degrees, the air humidity has almost no effect on human and relative humidity about 30 to 85 percent. In more than 25 ° C, the effect of air humidity on the human being is gradually increased, because the hot and humid conditions of evaporation and transpiration of Human body is reduced and led to nervous tension. On the other hand, dry air also creates problems for the respiratory mucosa. Increasing duration of the heat also has a significant impact on the daily mortality. Duration of cold and heat also has effects on resonance of some diseases. Thus, in tropical climates, coronary heart disease during cold periods has shown a significant increase. In the present study, Kermanshah bioclimatic conditions were identified using several indicators. Relationship between bioclimatic conditions determined by each of those indices was evaluated with cardiovascular disease admissions in Kermanshah individually.

Materials and methods

In this study, two types of data are used to assess the bioclimatic conditions and their relationship with Kermanshah cardiovascular admissions. In other words, the set of climate variables from synoptic station of Kermanshah and cardiovascular admissions of Imam Ali Hospital of Kermanshah were selected for analysis as samples. We used Atmospheric variables including average temperature (°C), wind speed (meters per second), relative humidity

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(percent), solar radiation (watt per square meter), height or sun angle (degrees) and dew point temperature (°C), cloudiness (Octa), water vapor pressure (hPa), as well as statistics about the number of daily admissions for cardiovascular patients. Although data on atmospheric variables in Kermanshah station were available in the long term, but due to lack of information about the admissions of cardiovascular disease, we selected the period of the day from September 9 2009 to April 30 2015 to determine the relationship between them. The data related to cardiovascular patients admission in Imam Ali Hospital of Kermanshah were collected. A database of this information was provided during the period. Another database of meteorological variables (average temperature, relative humidity, wind speed, solar radiation, water vapor pressure and the height of the sun) was created on a daily basis for the same period. Based on this database, bioclimatic conditions of Kermanshah on a daily basis were identified. In this study, two software RayMan and BioKlima was used to determine bioclimatic conditions of Kermanshah. PET and PMV bioclimatic indices were calculated based on RayMan software. Finally, the link between acceptance of cardiovascular disease and each bioclimatic conditions in Kermanshah individually through statistical tests (Levene test, Univariate Analysis of Variance, Scheffe and Games-Howell post hoc) were investigated using SPSS software.

Results and discussion

Generally, investigation about the relationship between bioclimate indices and cardiovascular disease in the Kermanshah showed that acute climatic conditions are the most important factor in the increasing acceptance of cardiovascular disease in Kermanshah. In other words, under the cold, hot and sultry conditions, Admission cardiovascular patients in Kermanshah had significant increase compared with the climatic comfort condition. In general, based on the results of this study it can be said that in each index, one or two different bioclimatic conditions were effective on the hospital admissions of cardiovascular patients. For example, based on Tek index slightly sultry have been effective in increasing cardiovascular diseases. In the slightly sultry conditions, every day 20 people on average are referred to the Imam Ali hospital. Moreover, in cold conditions, an average of 19 people admitted with cardiovascular disease. Meanwhile at the thermal comfort condition we found the lowest rate of hospital admissions. In fact, at the confidence level 95 percent, there is significant difference in the number of cardiovascular patients in sultry and cold condition compared with thermal comfort. Therefore, based on Tek index cold and sultry conditions are effective in increasing hospital admissions and ssimultaneously with the occurrence of thermal comfort a significant reduction has been observed in the mean number of patients. In fact, this index relationship between extreme conditions with an increase in cardiovascular admissions is approved. Among other indices, TE index showed direct correlation between hot and warm conditions with increased hospital admissions. The results of PMV and PET indices also indicated that cold and cool bioclimatic conditions (generally tend to cold conditions) more than the warm and comfort conditions are effective on the admission of cardiovascular patients. As a conclusion, we can say that extreme bioclimatic conditions (very cold or hot and sultry) are directly related to the increase in cardiovascular disease in Kermanshah. Under comfort or close to the comfort condition, the hospital admissions have been lower.

Conclusion

The results of this study showed that in each index, one or two bioclimatic conditions have been effective in increasing admissions of cardiovascular patients. For example, based on Tek index, there is significant relationship between extreme conditions (very hot and very cold) with increase in cardiovascular admissions in 95 percent confident level. But in the TE index, a significant correlation was seen between warm and hot conditions with increase in cardiovascular admissions in the confident level 95 percent. Based on the PMV and PET indices cool and cold bioclimatic conditions (in general tend to cold conditions) are affected by warm and comfort conditions on the acceptance of cardiovascular patients. Finally, the results of most indicators suggest that acute climatic conditions (very cold or hot and sultry) are directly related to increase in cardiovascular disease in Kermanshah.

Keywords: bioclimatology, cardiovascular disease, Kermanshah, thermal stress.