Climatology of Jet Streams in the Middle East

Bakhtiyar Mohammadi*
Assistant Professor of Climatology, Faculty of Natural Resources, University of Kurdistan, Sanandaj, Iran
Bohloul Alijani
Professor of Climatology and Director of Center of Excellence for Spatial Analysis of Environmental Hazard, Kharazmi University, Tehran, Iran
Aram Omr Saleh
MA in Climatology, University of Kurdistan, Sanandaj, Iran

Received: 01/05/2018 Accepted: 08/10/2018

Extended abstract

Introduction

One of the main elements of the general circulation in mid latitudes are the fast and narrow flow maxmia called jet streams whose speed is usually more than 30 meters per second. They are one of the dominant features of upper level weather maps but changing through time, space and layers of atmosphere. The jetstreams cause vertical motion underneath through which produce stability and instability over the earth surface. It should be mentioned that they are much known for their instability production. Jet cores are one of the main components of the general circulation and their location and displacement are controlled by the elements of the circulation such as the Arctic Oscillation. According to the researches, the location of the jet streams is very important in climate events. Therefore, this research tried to identify and present the location and speed of jet streams in Middle East. There was no comprehensive study in this scale so far.

Materials and methods

In order to study the jet streams, the six hourly (00, 06, 12 and 18 GMT) speed of U and V components of the winds at the 700, 600, 500, 400, and 300 hPa levels were obtained for the window of 0 to 120 E and 0 to 80 N during 1965-2014 period. In total, 20 time series were produced from the combination of these hour and level scales for each pixel with the size of 2.5 by 2.5 degrees. In each time series the wind maxima of 30 m/s and higher were extracted. At the final stage, the mean monthly speed and monthly frequency of jet streams of all pixels were mapped for the study area.

Results and discussion

The frequency and speed of jet cores were mapped and are described here in monthly, seasonal and annual scales. According to annual frequency of jet core locations, the highest speed maxima in 300 hPa level are located over the North Africa in 40 percent of times, depicting the

* Email: b.mohammadi@uok.ac.ir Tel: +98 9188775160

main track of the jet cores. Given the fact that jet cores enter the study region only in the cold period of year, this temporal frequency of 40 percent is not a low value. The location of speed maxima is the same in 500 hPa level but in about 20 percent of the time. This low value is reasonable for this level. As we know, the synoptic systems of this level control most of the time the weather and climate of the surface and these surface systems are not very frequent during a normal year. In this level, the bifurcation of westerlies is obvious. The southern branch is very influential in the Middle East. This bifurcation indicates the presence of a blocking high in the region, which most of the times prevent the entering of jet cores and hence an unstable conditions over the region. There are no speed maxima in the region in 700 hpa level. Since in the annual scale only in the 500 and 300 hPa levels showed the jet cores, in the seasonal scale we look only for these levels. The frequency of jet cores in winter is more than the other seasons and show two separate belts. The jet core affecting the climate of Iran is passing over the Persian Gulf which extends from North Africa towards China. Jet cores pass through this belt all of the winter season. However, their frequency decreases toward the north over Iran and from there extends toward the other maxima over the latitude 50 N to 60 N. The jet frequencies have decreased in spring reaching to about 52 percent over the area (Figure 3B). This rate of decrease indicates the sudden and rapid change from winter to the spring conditions over Iran. Its northward shift is also obvious over Iran. In this season, the jet maxima travel in a ridge like track over Iran. It indicates an unstable weather over the west part of Iran while dominating the stable conditions over the east part of the country.

Conclusion

Jet streams are very important instability factors in the atmosphere. Their spatial location and speeds control the tracks of pressure systems and surface climate. For this reason, this study tried to understand their speed and spatial variations in the Middle East. Their speed and frequencies were studied at the pressure levels from 700 hPa to 300 hPa in the monthly, seasonal and annual scales. The result showed that in all levels and scales, two speed maxima tracks were established over the latitude belts of 20N – 30N and 50N – 60N which is confirmed by findings of Li et al (2004); Zhang et al (2006); Li and Wettstein(2012) and Pena-Ortiz et al (2013). The most important findings of the research is the coincidence of speed maxima with frequency maxima of jet cores in these latitude belts. During the warm period, both the frequency and speed of the jet cores decreased over the Middle East. The jet cores were absent at the levels lower than 500 hPa, and in 300 hPa all winds experienced speeds higher than jet threshold which is in accordance with Geer et al (1996). In brief, we can conclude that through the fall season the jet cores move southward to dominate over the Middle East and Iran during winter. Through the spring season, they began backward movement to the northern latitudes so that in May no jet core could be found in the area. This research demonstrated the importance of the wind patterns of 500 hPa on the climate and weather conditions of the Middle East as well as Iran.

Keywords: jet cores, Middle East, polar front, subtropical jets, instability.

Landform Matching and Evaluation of Tectonic and Seismic Tensions in the Northern Section of Qom-Zefreh Fault Zone

Ebrahim Moghimi*
Professor of Geomorphology, Faculty of Geography, University of Tehran, Tehran, Iran
Mansour Jafarbeglou
Associate Professor of Geomorphology, Faculty of Geography, University of Tehran, Tehran, Iran
Mojtaba Yamani
Professor of Geomorphology, Faculty of Geography, University of Tehran, Tehran, Iran
Seyyed Mohammad Zamanzadeh
Associate Professor of Geology, Faculty of Geography, University of Tehran, Tehran, Iran
Hamid Kamrani Dalir
PhD Student in Geomorphology, Faculty of Geography, University of Tehran, Tehran, Iran

Received: 20/08/2018 Accepted: 22/12/2018

Extended abstract

Introduction

The faults of the northern section of Qom-Zafreh faulting system with right-lateral right-angled movements, along with reversed components configure the northern parts of the central Iran zone. In this research, seismic potential and tectonic stresses of this fault system are investigated based on geomorphometric and morphotectonic methods. Field data and morphotectonic evidence in the area have been used to analyze the data. To this end, were measured some geomorphic indices and their adaptation to the location of the main faults. These indicators, as the most widely used in the tectonics and neotectonic evaluation studies, are considered as the first category. The second category is the indices related to the catchment basin dynamics. On the one hand, the characteristics of the mentioned indices are sensitivity to the movements of sliding and steady-state faults and, on the other hand, the reason for the predominance of deformed phenomena in relation to the erosion in the region. To calculate geomorphic indices in 18 sub-basins in the study area, the TecDEM extension program was also used. The initial results indicate the high tectonic activity near the main faults of the northern part of the Qom-Zafare zone such as Bidadeh fault, Qom fault, Kashan fault, and other faults. These findings are consistent with landforms and tectonic activities existing in the region.

Materials and methods

In this research, the seismic potential and tectonic activity of the northern section of the Qom-Zafare fault system have been evaluated using geomorphometric and morphotectonic methods in the sub-basins of the study area. In order to investigate the tectonic activity, the study area

* Email: emoghimi@ut.ac.ir Tel: +98 9124392790

was divided into 18 sub-basins. Then, to measure and evaluate the tectonic activities of the study area, we measured geomorphic indices and their adaptation to the location of the main faults.

In order to calculate the geomorphic indices of the study area, they were classified into two general categories: 1) Dynamic indicators of the surface including longitudinal gradient (SL), sine wave of the mountain front (Smf) and ratio of valley width to valley height (Vf). 2) Dynamic catchment indicators of the catchment area including drainage basin asymmetry (AF), hypsometric integral (Hi) and drainage basin shape (Bs). To improve the quality of measuring the tectonic and neotectonic indices, the computational capability of the TecDEM software, as an add-on, has been employed in the Matlab software environment. After extraction, the results of the geomorphic indices were separated into ArcGIS environment by separating study basins of each study area and to obtain the tectonic activity index (Iat). Based on the obtained values from the active land development index (IAT), the five study areas were very active, active, moderate, and low activity and very low activity.

Results and discussion

The study area includes the northern section of Qom-Zefreh fault zone, which includes a large part of the Qom province. This zone extends from the east and south-east to the Central Iran and from the north to the Alborz zone and from the west and southwest to Sanandaj Zone of Garrison.

In general, there are active tectonic processes and seismic faults in the northwest-southeastern region. Measurements and investigation of the evidence of the activity of faults in quaternary sediments indicate the change in the process of these faults and cause the alteration of these faults to be generally right-angled, although the left-handed movements in some of the secondary or non-essential faults are due to their orientation in relation to the main stress.

Conclusion

In order to conclude and evaluate the seismic potential and tectonic activity in this part of the Qom-Zefref fault zone, these indicators are divided into two general categories: dynamic indicators of catchment basins, then by the relative activity index Iat. They were classified into three categories. Finally, by integrating the Iat index layer and other information layers, including the deformation of the main faults and the intensity of seismic centers in the ArcMap10.3 software environment, based on seismicity and tectonic activity, we determined five classes of very low, low, moderate, high and very high. By the way, we extracted the seismic potential zonation map and tectonic activities of the study area. In this research, for the first time, geomorphic indices are used for zonation of seismicity and tectonic activities in terms of the relative tectonic activity index of Iat, in contrast to other studies only used geological parameters (lithology).

Keywords: Qom-Zffer fault zone, tectonic stress, geomorphic index, geomorphometry, seismicity, TecDEM Extension Program.

The Effect of Urban Expansion on Climate Conditions of Mehrabad Synoptic Station

Firuz Ranjbar
PhD in Climatology, Researcher at Malek Ashtar University of Technology, Iran
Masoumeh Moghbel⁎
Assistant Professor of Climatology, Faculty of Geography, University of Tehran, Iran
Received: 17/09/2018 Accepted: 14/01/2019

Extended abstract

Introduction
The UN Population Demographics in 2014 has indicated that there is a reversal of the demographic trend of urban and rural areas, with the world's largest population (54%) living in urban areas. This trend is increasing, while by the year 1990, a small population lived in the cities. This undocumented development leads to major changes in the environment including a reduction in natural surfaces and the replacement of them by artificial and human land covers. Urban areas are often identified with impenetrable and constructional surfaces that often have a negative impact on ecosystems. Urbanization changed the natural landscape into built areas of completely different physical characteristics. The transformation in surface land covers has an important effect on energy balance and local climate. As a result, urban climate is formed from the climatic factors of the city that are changing with the impact of urban factors over time.

Materials and methods
In order to study the effects of urban expansion on climatic condition of Tehran, we extracted daily precipitation, minimum and maximum temperature data from Mehrabad synoptic station during a period of 50 statistical periods (1966-2016). Different methods and tests have been used to analyze trends and changes in climatic conditions. The trend in the cluster data series was studied using the Mann-Kendall test. The Mann-Kendall test is a base-rating nonparametric test for trend analysis which was first used by Mann for public applications in 1945 and revised by Kendall in 1948 and presented in a different way. Then, RClimDex software was used to extract the process of extreme weather indicators. This software has been developed by Zheng and Yang (2004 & 2005) at the Canadian Weather Service's Climate Research Branch. In the present study, 23 indicators of ETCCDI indicators were used using RClimDex. The indicators are divided into five groups based on percentiles, periodic indicators, absolute indices, threshold indicators and other indices such as temperature change overnight.

Results and discussion
Based on non-graphical Mann-Kendall Test, both temperature parameters (minimum and maximum temperatures) have an increasing trend during the 1966-2016 period, which is more

⁎Email: Moghbel@ut.ac.ir Tel: +98 9126044836

evident at the minimum temperature; while precipitation in the same period of time has been a slight downward trend. Based on the Mann-Kendall graphical test, when there is a significant trend in data, the lines ui and u'i interrupt each other. The results of the Man-Kendall test show that the increase in minimum temperature is higher than the maximum temperature. Moreover, during 1976-1986, Tehran experienced rapid physical growth and this period is coincided with an increase in temperature, which continued until the end of the period. Based on the analysis of the temperature extremes index, the cold day indices (TX10p) are facing a downward slope. On the other hand, the Hot Days Index (TX90p) faces an upward slope in the period of 1966-2016. In fact, it can be concluded that during the study period, the percentage of hot days in the Mehrabad station has an increasing trend and that of cold days has a decreasing trend. These results are consistent with the studies of Rahimzadeh et al. (2011), Niw et al. (2006) and Brown et al., 2010, on the trend of the temperature range of the night temperature.

Conclusion

In recent years, the spread of cities and their growth has had a great impact on the environmental conditions in different parts of the world. In the meantime, some cities have been experiencing rapid and significant growth. Urban change has today had widespread effects on urban climatic conditions. One of these effects is the change in the temperature of the cities (formation of the UHI) and the increase in night temperatures. The present research was carried out to investigate the effects of the expansion of Tehran on the climatic conditions of the Mehrabad synoptic station. The study of the climate conditions of the Mehrabad station shows that during the study period, the air temperature of the Mehrabad station has undergone a change. Thus, the minimum and maximum temperature is facing an increasing trend, which is, of course, more severe at the minimum temperature. The average minimum temperature of the Mehrabad station during the 1996-75 period was about 10.9 ° C, reaching about 13.7 ° C in the period 2005-2015. On the other hand, the average maximum temperature during the 1975-1996 periods was about 5.5 ° C 22 ° C. In the period 2015-2005, it reached about 23.6 ° C. In addition to temperature averages, temperature indices have also changed significantly at Mehrabad station so that cold and warm extreme events have decreasing and increasing trends, respectively.

Keywords: precipitation, temperature, extreme indices, urban expansion, Tehran.

Investigating the Effects of Environmental and Demographic Parameters on the Spatial Distribution of Surface Temperature of Tehran by Combining Statistical and Mono-Window Models

Saman Nadizadeh Shorabeh
PhD Candidate in Remote Sensing and GIS, Faculty Geography, University of Tehran, Tehran, Iran
Saeid Hamzeh*
Associate Professor of Remote Sensing and GIS, Faculty of Geography, University of Tehran, Tehran, Iran

Received: 30/10/2018 Accepted: 29/01/2019

Extended abstract

Introduction

One of the emerging environmental hazards arising from the expansion of urbanization is the phenomenon of urban heat island. Urban heat island is a phenomenon in which urban areas experience warmer temperatures than the surrounding countryside. This phenomenon has been studied and recorded in the world over 150 years ago and generally, along with natural vegetation changes; It usually can appear in impenetrable surfaces such as pavement streets, cement, asphalt, concrete, etc. The effects of urban heat island on human life include increased energy consumption due to increased demand for building cooling during the warm seasons, increased heat stress and reduced staffing efficiency, increased water consumption and increased urban air pollution. Also, UHI has caused a change in the urban and global climate. Given the increase in population, the importance of energy and the issue of global warming will be increased over the coming decades.

The Tehran city is the capital of Iran and center of economic activity in the country. Each year, a large number of different provinces migrate to the province to work, which will destroy the green space and increase population in the city. This causes a lot of problems including increasing the surface temperature. Therefore, the aim of this paper is to investigate the effect of demographic and environmental parameters on the spatial distribution of Tehran's metropolis surface temperature.

Materials and methods

In this study, the Landsat 5 satellite image of TM sensor has been used for the studied area. In order to complete input parameters for mapping surface temperature using satellite imagery of meteorological data, and for providing field samples, we used Google Earth images and topographic maps of Iran Cartographic Center to provide surface weather maps.

At first, the preprocessing steps were applied to prepare images including atmospheric

*Email: saeid.hamzeh@ut.ac.ir Tel: +98 9183511959

correction. Then, the images were classified using a Maximum Likelihood and were classified into four landuses, built up, fallow, water and green space. After classification, each of the images was categorized using precision classification controls. In the next step, using the Mono Window algorithm, surface temperature was obtained for each image.

Results and discussion

Given the existing landuses, the area was classified by 4 types of built-up, green space, bare land, and water using the supervised classification method. The area built-up, green space, bare land and water are 37061.46, 9512.91, 11470.05 and 44.91 ha, respectively. The most of the landuse is built environment. The surface temperature values here are ranged from 294 to 328 degrees Kelvin. The lowest average temperature is for water use and natural areas such as green spaces, forest and urban parks, while the maximum temperatures are in shallow land and impenetrable lands such as asphalt, street paving and other Man-made coatings, as well as industrial and commercial lands, and the surfaces of residential and transportation facilities.

Based on the total population of Tehran in 2011, the districts of 21, 22, 12 and 9 are considered as the main core of the urban heat island among the low population areas of Tehran. Due to various landuses (industrial, commercial, transportation, etc.), low population density in these areas appears natural. While the urban heat island in these areas is mainly resulted from industrial activities, airports, transportation, commercial land use, and bare land degradation. Map of surface temperature and population distribution in different regions of Tehran show that the regions with high temperatures in districts of 4, 5, 15, 2 and 14, have a high population density. Although these areas are not among the main heat islands in Tehran; however, due to high population density, high traffic volume, and air pollution from these areas is endangered by the emergence and expansion of urban heat islands.

Conclusion

The purpose of this research is to investigate the effect of demographic and environmental parameters on the spatial distribution of Tehran's surface temperature. The results of the study indicate that heterogeneous spatial distribution factors of surface temperature in Tehran are different. These factors are deliberately due to different land use and vegetation in the region. In the northern regions of Tehran, an uncompromising urban structure along with green space has caused these areas to have a low surface temperature, while it is high in the major proportion of the central part of the city with high building density and poor green space. Finally, the results of the relationship between surface temperature and population distribution in different regions of Tehran show that the regions with high temperatures in districts of 4, 5, 15, 2 and 14 have a high population density.

Keywords: surface temperature, environmental and demographic parameters, Mono-Window model, Tehran.

Assessment of Climate Change Effects on Degree Days of Cooling and Heating Conditions in Selected Stations in Ilam Province

Mohamad Ahmadi
PhD Candidate in Urban Climatology, Islamic Azad University, Sciences and Research, Tehran, Iran
Ghasem Azizi*
Associate Professor of Climatology, Faculty of Geography, University of Tehran, Tehran, Iran
Parviz Kardavani
Professor of Climatology, Faculty of Geography, University of Tehran, Tehran, Iran
Hamzeh Ahmadi
PhD Candidate in Agricultural Climatology, Hakimsabzevari University, Sabzevar, Iran

Received: 18/09/2018 Accepted: 06/03/2019

Extended abstract

Introduction
The phenomenon of climate change is the most important challenge and threat to human societies in the future. Urban areas and human settlements are most vulnerable parts of the climate change. Any change in climate patterns will change the amount of energy. Due to global warming, we will see an increase in the average temperature of Iran in the coming decades compared to the present. As a result, the country will face a crisis of increasing energy consumption in the coming decades to cold environment, not only in the warm season.

Materials and methods
In this research, two types of data are obtained; historical observational data and simulated data on the output of general circulation models. Historical observational or baseline data course covering the period from 1980 to 2005. In the future data section, the output of simulator models was used for the upcoming period of the CMIP5 model. The results of the global circulation models do not have the capability for the local dimension, so, in order to compensate for this problem, it is necessary to use the methods of quantum microscopy. In order to achieve the climatic simulation data in the upcoming period, MarkSIMGCM database was used for exponential imaging of the AOGCM models. This database, as a web-based tool, uses a randomized third-order Markov model to downscale the minimum and maximum temperature values, and rainfall and sunshine daily fluctuations. In order to simulate the data for the upcoming period, the output of the proposed AOGCM Models (BCC-CSM1.1, HadGEM2-ES and GFDL-CM3) from the CMIP5 model (Comparison of Coupled Models Compared) was used with better spatial resolution. The RMSE, MBE, MAE and R2 indicators used for comparison.

* Email: ghazizi@ut.ac.ir Tel: +98 9122313131

Results and discussion

The results showed that the HadGEM2-ES of the CMIP5 general circulation model series has a higher performance and higher compliance with observation data. Assessments indicated that the amount of heat accumulation will increase under the conditions of climate change in the upcoming period. In the middle and far futures, the amount of cooling requirements will increase to adjust the ambient temperature due to increased air temperature. The magnitude of the incremental changes in the number of days of the cold need and the decrease in the value of the heating days is one of the major consequences of climate change in the energy field. At Dehloran Station, the cooling time period will be deployed between April and December. Under the conditions of the climate change, the current period, the number of days with cooling requirements will go up, and on the other hand, the time interval required for cooling will be wider. Most cooling needs will occur between June and August. Therefore, the amount of cooling requirements due to the increase in air temperature in tropical areas such as Dehloran is much higher than in high and mountainous areas such as the city of Ilam.

Conclusion

The results showed that in the middle and far future, the amount of cooling requirements will be increased to adjust the ambient temperature due to increased air temperature. At Dehloran Station, the cooling time will be switched between April and December. Under the conditions of the climate change of the current period, the number of days with cooling needs will go ahead and, on the other hand, the cooling-up time required will be wider. In both patterns of radiation induction, any change in the air temperature pattern will increase the cooling demand of different regions and urban settlements. Therefore, based on the results of this study, it is necessary for planners to take necessary measures to reduce the harmful effects in order to optimize energy consumption and increase the swing in different regions, especially tropical areas.

Keywords: climate change, CMIP5, heating and cooling degree days, Ilam.

Analysis of Relationship between Climatic Variables and Electricity Consumption and Estimated Demand by General Circulation Models in Western Iran

Afsaneh Salmani
MA in Climatology, Geography Department, Razi University, Kermanshah, Iran
Firouz Mojarrad*
Associate Professor of Climatology, Geography Department, Razi University, Kermanshah, Iran

Received: 21/12/2018 Accepted: 06/03/2019

Extended abstract

Introduction

Electricity energy has no storage capacity on a large scale. Given the importance of this energy in various programs and increasing consumption in the context of global warming, it seems necessary to forecast its future consumption with in the energy sector policy. Therefore, awareness of the variables affecting electricity consumption and the impact of each of them will enable policy makers to make more precise planning and prediction of electricity consumption in the coming years. Therefore, accurate estimation of the consumption with regard to climatic conditions can play an important role in the economic use of electrical energy. The purpose of this research is to investigate the relationship between climatic variables with electricity consumption and prediction of electricity consumption under the influence of climate change in western Iran.

Materials and methods

The study area of this research is western Iran including provinces of Kermanshah, Kurdistan, Hamedan, Ilam and Lorestan. This region has a variety of climate conditions due to its location on the path of hot and cold air masses and mid-latitude cyclones. The data used in this study are including 1) meteorological data of 13 stations in the region over a 28-year period (1987 to 2014), including minimum temperature, maximum temperature, relative humidity, wind speed, sunshine hours and rainfall, 2) data on monthly electricity consumption during the corresponding period, 3) data simulated by CCSM4 General Circulation Model. To calculate the heating and cooling requirements, values of Heating Degree Days (HDD) and Cooling Degree Days (CDD) were calculated using the minimum and maximum temperature data. First, the relationship between climatic variables and electricity consumption at stations was modeled using multiple regression equations. In the case of significant models based on the data of the CCSM4 model, the electricity consumption at the stations during the period 2080-2080 was estimated under two scenarios RCP4.5 and RCP8.5. Future climate scenarios were then downscaled using the "change factor" method. To verify the downscaled data, we used the Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Coefficient of Determination (R2).

* Email: f_mojarrad@razi.ac.ir Tel: +98 9183398676

Results and discussion

At all stations, the CDD have a direct and significant relationship with electricity consumption, due to the high consumption of air conditioning/cooling equipment in summer. But the relationship between the HDD and electricity consumption is weaker than the CDD; because in winter, less electricity is used to heat the environment. Especially in warm stations such as Ilam, Dehloran and Sarpole-Zahab, the relationship between the HDD and electricity consumption is not substantially significant. At these stations, during the cold season due to the mildness and shortness of the cold, there is little need for electrical equipment for heating purposes. In contrast, in these three stations, humidity has a significant and inverse relationship with electricity consumption. Other climatic parameters have no significant relationship with the consumption. The mean maximum and minimum temperatures in the region in the future period (2021-2080) will increase on average under the RCP4.5 scenario by 1.95ºC and 2.01ºC, respectively, and under the RCP8.5 scenario by 3.46ºC and 3.81ºC. Therefore, electricity consumption at all stations in the upcoming period (2021-2080) will increase more than the past period. This increase will be much higher in the warm period of the year. The average increase in consumption during the warm period at the stations under the two scenarios will be 80% and 150%, respectively. Particularly warm stations in the west of the region, such as Dehloran, Sarpole-Zahab and Ilam in the warm months (6 months, from May to October) will experience the highest increase in electricity consumption under two scenarios, about 110% and 210%, respectively. The lowest increase in demand for electricity in the upcoming period is related to the relatively cold stations of Hamedan, Sanandaj, Saqez and Bijar. Because of the mountainous nature, the high altitude and the longer cold period, the main need of these stations is heating, a significant part of which is supplied by natural gas. This clearly has little dependence on electricity. During the warm period of these stations, which is shorter and lasts for 4 months (June to September), the increase in consumption is lower than that in warm stations and under the two scenarios, it would be about 60% And 110%, respectively. Other stations like Khorramabad, Kermanshah, Kangavar, Boroujerd and Islamabad will have an intermediate level of consumption. However, it should be noted that regardless of the increase, electricity supply for larger and more populous cities such as Kermanshah and Hamedan will be more important than warm cities. There is not much increase in consumption in cold-period months at any warm and cold station.

Conclusion

Since a significant part of the electricity consumption in the region is due to the use of conditioning/cooling equipment, any change in temperature during the warm period will be effective on increasing or decreasing trends using the equipment, and consequently, increasing power consumption. Given the significant increase in the temperature of the region during the 2021-2080 period under the two scenarios, it is necessary to take appropriate strategies to deal with the drastic increase in electricity consumption in the future, especially during the warm period of the year.

Keywords: multiple linear regressions, West Iran, climatic variables, electricity consumption, general circulation models.

Impacts of Landuse/Landcover Changes on the Ecosystem Service Values in Pars Special Economic Energy Zone Using Remote Sensing

Qadir Ashournejad
PhD Candidate of Remote Sensing and GIS, Faculty of Geography, University of Tehran, Tehran, Iran
Farshad Amiraslani*
Associate Professor of Remote Sensing and GIS, Faculty of Geography, University of Tehran, Tehran, Iran
Majid Kiavarz Moghadam
Assistant Professor of Remote Sensing, Faculty of Geography, University of Tehran, Tehran, Iran
Ara Toomanian
Assistant Professor of GIS, Faculty of Geography, University of Tehran, Tehran, Iran

Received: 24/11/2018 Accepted: 10/03/2019

Extended abstract

Introduction

Ecosystem services are the benefits people get from ecosystems and human always needs ecosystem services and products for survival. These services are divided into four categories of productive, regulatory, cultural and life support services; the first three categories are directly affecting people, and the fourth one is critical for the continuation of other services provided by ecosystems. Each of these four categories comprises a wide range of services. Since ecosystem services are not either fully tradable in commercial markets or quantifiable like economic services, they are often being ignored in policy making and spatial planning. Assessing the impacts of landuse/landcover changes on the ecosystem service values is required for the special economic zones that are experiencing rapid changes in land use/land cover. Pars Special Economic Energy Zone (PSEEZ) located in southern Iran is considered as an example of these areas which has become a national and transnational zone within a short period of time due to the activities related to the extraction, exploitation, refining and exporting of gas resources. Extensive industrial investment has been made in less than 10 years in this zone. This area was established in 1998 to extract oil and gas resources from the South Pars Oil Field with economic activities carried out in the city of Assaluyeh, Bushehr province. The Nayband national marine park is located in the PSEEZ along with a part of Nayband's headland with an area of 19,500 hectares. It was designated as Nayband Protected Area in Iran. This area stretched along the coast of Persian Gulf in an approximate area of 49,815 hectares, were registered as the first Iranian marine national park in 2003. The presence of coral reefs, mangrove forests, rocky beaches, and real estuaries make this area one of the most diverse and beautiful coastal

* Email: amiraslani@ut.ac.ir Tel: +98 9196262153

ecosystems in the world. There are also various aquatic species, marine mammals such as dolphins and whales, endangered reptiles, such as the green and eagle tip turtle and various kinds of aquatic birds in the area. The construction of PSEEZ has led to development of petrochemical refineries, which in turn resulted in an increase in population (from 2000 to 60,000) and the expansion of human settlements. On the other hand, the development has led to the expansion of land, sea, and air transport infrastructure. Due to the rapid changes in this region, it is required to assess the impacts of landuse/landcover changes on the ecosystem service values. In this regard, remote sensing as the most important way of obtaining the spatial data, allows the quantification and mapping of these services. This technology brings practical benefits to biodiversity conservation and promotes the sustainable utilization of natural resources within the arena of ecosystem services.

Methodology

This research emphasizes on landuse/landcover changes as the basis of the evaluation of ecosystem services. In assessing the status of changes in the PSEEZ, a surface area of 300,000 hectares (3000 square kilometres) were reviewed over a period of 32 years. Those images of 1986 and 1998 were considered to show the trend of regional changes before the establishment of the PSEEZ, and the image of 2018 was used to show the current changes. In selecting Landsat images, we considered climate conditions as well as the characteristics of the Persian Gulf tide and its effects on mangrove forests. The weather condition of the region is suitable for farming during the winter season. According to the data captured by remote sensing images, crop fields in the months of January, February and March had better resolution than other months of the year. To classify the images for detecting the changes, Random Forest technique was used for the higher classification accuracy and processing speed compared to the other two methods. In assessing the economic value of the ecosystem services in the PSEEZ, landuse/landcover changes and global estimations of ecosystem services are integrated.

Results and discussion

The results indicate that agricultural lands and palm groves had a significant increase of 308.79 and 852.48 hectares before the establishment of the PSEEZ and the mangroves forests decreased by 67.68 hectares. With the establishment of the PSEEZ, human built-ups and mangrove forests were increased by 2756.61 and 113.4 hectares, while Barren lands, agricultural lands and palm groves decreased by 4651.92, 397.53 and 579.33 hectares.

The drying of wetlands for the construction of roads and airports has greatly reduced the size of the wetland area with an estimated loss 100 million dollars for economic value of the ecosystem services. The results also indicate that the economic value of the ecosystem services of the PSEEZ for the years 1986, 1998 and 2018 is equal to 570.02, 393.92 and 463.52 million dollars, respectively. The service function and its changes indicate that erosion control, recreation, nutrient cycling, waste treatment and food production are of the highest value in the study area. In contrast, pollination, gas regulation, soil formation, water supply and biological control have indicated the lowest value. It was revealed that during these years, water regulation, habitat/refugia, disturbance regulation, erosion control and recreation had the highest changes about 22.772, 12.445, 11.89, 10.791 and 9.192 million dollars in the study area.

Conclusion

Based on the findings of this research, we conclude that the status of the Nayband wetland is in a warning state, and human built-ups in its remaining space should be avoided. More attention must be paid to potential of the recreation ecosystem service of this region for its preservation. Since it is not possible to classify coral reefs in the region (Haleh and Asaloyeh) with these images, the studies are recommended to review their ecosystem service value. It is necessary to investigate the condition of the estuaries (Bidkhun or Asaloyeh, Basatin and Haleh) and mangroves in these estuaries to make policies for their preservation and development.

Keywords: ecosystem services, landuse/landcover, remote sensing, Landsat, PSEEZ.

Analysis of the Amount, Frequency and Intensity of Annual Precipitation in Caspian Region during 1966-2016

Hossein Asakereh[*]
Professor of Climatology, University of Zanjan, Zanjan, Iran
Nasrin Varnaseri Ghandali
PhD Candidate in Climate Changes, University of Zanjan, Zanjan, Iran

Received: 03/11/2018 Accepted: 18/03/2019

Extended abstract

Introduction

Precipitation is one of the most important climatic elements in every given region that plays a decisive role in urban and rural planning, architecture, agriculture, industry, and so on. Accordingly, the present study attempts to evaluate the amount, frequency and intensity of annual precipitation in the Caspian coastal region in which the economic planning is fundamentally based on precipitation. The spatial temporal variations of the parameter in this region affects many climatic and environmental phenomena (such as runoff, flood, air temperature, humidity), as well as many human activities (such as agriculture and housing). On the other hand, the growing need for recognizing its climatic features is one of the essential requirements of human life today. In addition, previous studies in this part of the country have mainly examined one of the characteristics of precipitation, but the present study attempts to analyze three characteristics (amount, frequency and intensity) of the element.

Materials and methods

To this end, the daily data of 385 stations of Meteorological Organization and the Ministry of Energy's have been used for the period of 2016-1966 (51 years). Then, the amount, frequency and intensity of annual precipitation were investigated and finally, the trend was verified by fitting the linear regression model using parametric method.

Results and discussion

The results showed that the annual precipitation in 61.4% and the frequency of precipitation in 47.1% of the study area has an increasing trend. The annual precipitation is also stationary in entire study area. The trend of the variation coefficient in the month- to- month precipitation indicated that the stationary trend is overcome in the majority of the area. Consequently, precipitation throughout the coastline and parts of Alborz mountain chain has not changed during the year. Some parts of the area including the eastern parts, the Alborz mountain (south of the Caspian Sea), parts of the western Alborz, and a very small part of the west have experienced declining trend in the coefficient of variation in the annual rainfall. The results

∗ Email: asakereh@znu.ac.ir Tel: +98 9122416658

indicate that the precipitation in the Caspian region has a strong inverse correlation with the longitude, a inverse correlation with altitude, and a poor direct correlation with latitude. The relationship between precipitation and the number of rainy days is higher than other events with a direct and high correlation. In other words, with increasing rainfall, the number of rainy days also increases. With increase in the longitude of the mountains, the number of rainy days is reduced. The least inverse relationship is between the number of precipitation days and latitude and longitude.

Conclusion

The average annual rainfall in the Caspian region showed that the average annual precipitation in the coastline is higher, especially in the southwestern part of the Caspian Sea. The precipitation decreases as it passes from the coast.The results of this study are consistent with the findings of some researchers. The maximum number of rainy days is on the part of the western and southern Caspian Sea (Bandar Anzali). The maximum average annual precipitation is in the coasts of the Caspian Sea and its minimum in the eastern part and Alborz Highlands. Thus, the precipitation varies considerably in different parts of the Caspian region; these conditions can have an influence on the increase of greenhouse gases at the local level as well as the distance from the huge Caspian Sea. Frequency of crossing or formation of synoptic systems has led to precipitation changes in different parts. Therefore, understanding this issue and its causes can be important in the study of water resources, soil and ecosystems in the region, as well as the urban and environmental management of this valuable area of the country. Therefore, it is suggested that the changes in the synoptic systems and the changes and seasonal shifting of precipitation in this region should be considered.

Keywords: Precipitation, trend, Caspian region.

Comparison of Multiple Linear Regression and Artificial Intelligence Models in Estimating Global Solar Radiation

Ali Aakbar Sabziparvar*
Professor in Meteorology, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran
Pouya Aghelpour
MA in Agricultural Meteorology, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran
Vahid Varshavian
Assistant Professor in Meteorology, Faculty of Agriculture, Bu-Ali Sina University, Hamedan, Iran

Received: 19/08/2018 Accepted: 06/04/2019

Extended abstract

Introduction

Solar radiation is the main source of all energies on the Earth and is an important parameter in hydrology studies, water resource management, water balance equations, and plant growth simulation models. In the areas where ground measurements are not available, the Global Solar Radiation (GSR) can be estimated by empirical and semi-empirical models, satellite techniques, artificial intelligence models and other geostatistical approaches. In artificial intelligence models such as neural networks, various meteorological parameters like air temperature, relative humidity, sunshine hours, etc. are easily integrated to estimate global solar radiation.

In most commonly used radiation models (e.g. Angstrom-based models) for estimating daily GSR, the sunshine hours and cloud cover are two important input parameters. Unfortunately, those parameters are not measured very accurately in weather sites. Moreover, for time scales less than daily (e.g., hourly) using sunshine hour as an input, is not possible for predicting the sub-scale temporal GSR.

The main purpose of this study is to compare Multiple Linear Regression model and three types of artificial intelligence models (MLP, GRNN, and ANFIS) against each other to estimate GSR in cold semi-arid climate of Hamedan, Iran. This is to present the most accurate model by including the soil data and ignoring the sunshine hours.

Materials and methods

According to the Extended De-Martonne climate classification model, Hamedan is located in a semi-arid-very cold area and has a mean altitude of 1851 meters above sea level. In this study, GSR and meteorological variables (daily values of maximum air temperature, mean air temperature, minimum air temperature, air pressure, air relative humidity, soil temperature and rainfall) are recorded at Bu-Ali Sina University weather site, located at latitude 34°48″ and longitude 48° 28″. These data were recorded every 10 minute during 31 Dec. 2016, to 10 Mar. 2018 by using an automated Spanish GEONICA Logger.

* Email: swsabzi@basu.ac.ir Tel: +98 9121859970

Multiple Linear Regressions (MR): This model is a simple and linear model that estimates the target variable by assigning a constant optimized coefficient for each input variable.

Adaptive Neuro-Fuzzy Inference System (ANFIS): A multi-layered network model that uses advanced neural network learning algorithms and fuzzy logic to describe the relationships between inputs and outputs. This model uses the neural network's Learning ability and fuzzy rules to define the relationships between input-output variables.

Generalized Regression Neural Network (GRNN): This is a three-layered neural network, which the number of neurons in the first and last layers like other neural networks, is respectively equal to the input and output vectors. But, unlike other networks, the number of hidden layers of neurons in GRNN model is equal to the number of observational data.

Evaluation criteria: To evaluate the model performances against actual field measurements, we have used the Root Mean Square Error (RMSE) and Coefficient of Determination (R^2).

Results and discussion

The correlations of models input variables (eight independent variables) versus GSR (dependent variable) were evaluated. The results revealed that maximum air temperature; average air temperature, relative humidity and soil temperature are the most influencing inputs for modeling GSR, using minimum numbers of meteorological parameters. Among them, maximum air temperature, minimum air temperature, atmospheric relative humidity and soil temperature, were selected as the best inputs for modeling least parameters. The percentages of train and test data were 75% and 25%, respectively. In this research, the models were run using two different samples. The results of the evaluations showed that random samples had higher accuracy in GSR estimates. In MR model, the 4-variables input, and in three artificial intelligence models (GRNN, ANFIS, MLP), 3-variables input showed the superior performances.

Finally, the models were evaluated by using all the eight inputs. At this stage, MLP with RMSE=3.04 $Mj.m^{-2}.day^{-1}$ and R^2=86.33%, ANFIS with RMSE=3.26 $Mj.m^{-2}.day^{-1}$ and R^2=84.43%, GRNN with RMSE=3.41 $Mj.m^{-2}.day^{-1}$ and R^2=82.86%, and MR with RMSE=4.11 $Mj.m^{-2}.day^{-1}$ and R^2=75.20%, provided the best GSR estimates, respectively.

Conclusion

The results showed that in all input variables, random and non-random samples, artificial intelligence models have better performance than linear regression. By availability of the whole eight meteorological variables (daily values of maximum air temperature, mean air temperature, minimum air temperature, air pressure, air relative humidity, soil temperature and rainfall), MLP model can present the best GSR estimates. If all input parameters are not available, employing Generalized Regression Neural Network (GRNN) model and 3-variable inputs of mean air temperature, relative air humidity, and soil temperature is suggested for estimating the Global Solar Radiation (GSR) in cold semi-arid climate of Hamedan.

It is noteworthy that in estimating GSR, two important parameters of sunshine hours and cloud cover were not used in our research. Testing the models performances in other climate types is suggested as future works.

Keywords: GSR, Soil temperature, Soil moisture, MLP, ANFIS, GRNN.

Investigation of Rainfall Variation of Sudan Low during the Historical Process in Southwestern Iran

Hassan Lashkari*
Associate Professor of Climatology, Shahid Beheshti University, Tehran, Iran
Fahimeh Mohammadi
PhD Candidate in Climatology, Shahid Beheshti University, Tehran, Iran

Received: 30/12/2018 Accepted: 30/04/2019

Extended abstract

Introduction

Rain is one of the most important elements of the atmosphere. In addition to supplying water of the natural ecosystems, the rainfall plays an irrefutable role in the atmosphere and thermodynamics. The purpose of this research is to study the behavior of the southwestern region of Iran as one of the important agricultural and industrial poles in the country. Therefore, understanding changes in rainfall from the past to now, and the readiness for the changes, should be one of the most important goals of the administration.

Material and methods

At first, daily precipitation data of 22 stations were obtained from the Meteorological Organization of Iran. The rainfall data were used from 1957 to 2017 for a period of 8 months (October to May). In order to determine the prevalence of rainfall, the rainfall criterion is considered to be above 5 mm. In the next step, by determining 3 priorities, the frequency of the system was obtained with a continuity pattern per day. The first priority is to see the daily rainfall occurrence over 5 mm in common at all synoptic stations. The second priority is that the rain above 5 mm has occurred at least in 50% of the selected stations. If the two top priorities are not observed, in the third priority, and the precipitation is above 5 mm for at least one third of the stations (7 stations), it is acceptable as a result of atmospheric pressure on that day. The purpose of this research is to investigate the historical trend of Sudan's low pressure system in terms of durability and intensity. Thus, for selecting rainwater systems due to Sudan's low pressure, we have used surface-level maps (slp) and pressure levels of 1000 hP from database of the National Center for Atmospheric Research (NCEP / NCAR), with spatial resolution 2.5 * 2.5 degrees, for all continuity patterns. Using the optical analysis method and using the results of the Lashkari (2013) and Alfandi (1950) based on the determination of the spatial displacement of the Sudan low pressure system during the cold period; we investigated logging of the systems into the southwest region of Iran.

* Email: h-lashkari@sbu.ac.ir Tel: +98 9123273715

Result and discussion

There are a total of 227 days or a one-day billing system. The highest number of overnight days is in January with 53 records. The lowest number of day offs was in October and May, with 2 records. Precipitation frequency with continuity of 2 days with 306 repetitions over the course of eight months from the past to today has been superior to the prevalence of precipitation occurrence with one to several days. In other words, from October to May, the share of precipitation with duration of 2 days during the historical process is rising relative to the share of other precipitation with different lengths. Meanwhile, the maximum amount of monthly rainfall with a 2 day continuation in January is 68 with a minimum share in October and May. The precipitation with the duration of one day and the most frequent repetition occurred in January and the lowest in October. However, with the increase in the duration of the precipitation, the share of January will be lower in these rainfalls. With the exception of May, the prevalence of rainfall distribution is approximately the same for all three months. These conditions can be counted with less frequency for 4 days persistence, with the difference that they have a very small contribution to the 4-day rainfall in April and May. Rainfall with duration of five days in March and February was the most frequent with 4 and 3 occurrences, respectively. Precipitation is not formed for six days only in November and April. The precipitation of seven days is just one case in January. Here is the question that how the flow pattern of the Southwest region in the historic process has been dominated, which is increasing with two days' persistence over other rainfall. To understand the reasons for these changes, other studies are required to investigate changes in air masses and circulation patterns in the southwestern region of Iran.

Conclusion

Compared with other months of the cold season, January has had the most rainfall in most stations (about 17 stations). This month can be important for agriculture and cultivation in the southwestern region of Iran. At all stations, from October to January, the slope of the high rainfall variations shows a rising pattern. Since February, except for the Yasuj station, in all other stations the frequency of precipitation is reduced at the same station. In fact, a general overview of the monthly rainfall variations in Khuzestan province shows that this area is much weaker than in other provinces from February to the end of the cold season. Certainly, this disrupted changes in the availability of atmospheric precipitation in the production, industry, agriculture and even supply of drinking water in the area. Precipitation survey in the pattern of continuity in the day showed that during the historical process from the past to the present day, the frequency and severity of precipitation with duration of 2 days was more than the precipitation occurred with duration of one or more. As the frequency of precipitation systems varied from one to five days or more, there is an increasing trend in Sudanese systems entrance into the South West region. Therefore, it can be concluded that the contribution of Sudanese low pressure precipitation is increasing in the region.

Keywords: Sudan Low,Frequency and intensity of rainfall, Historic path, Southwest Iran.