Optical Morphology and its Application in Geomorphology

Sina Solhi
PhD Student in Physical Geography, Faculty of Geographic Science and Planning, University of Isfahan, Isfahan, Iran
Abdollah Seif[*]
Associate Professor of Physical Geography, Faculty of Geographic Science and Planning, University of Isfahan, Isfahan, Iran

Received: 01/06/2017 Accepted: 24/07/2018

Extended abstract

Introduction
Geomorphologists use different models to illustrate topography and geomorphic features. One of these common models is to use hillshading, as an effective tool to detect and represent morphological shape of the terrain. This model applys a light source to make a contrast between bright sections and the parts that fall in the shadows. Many researchers have worked on the hillshade modelling. Some of them work on the azimuthal and zenithal angle of light source illumination on the earth surfaces. Others focussed on the direction and the gradient of the earth and their effect on the quality of the shadows and bright areas representations. In this research new concepts called optical morphology is introduced which is considerred as a set of methods, models and technics for representing geomorphologic and topographic features more accurate and visible. We have employed 14 terrain curvature models and also 6 models for azimuthal and zenithal angle adjustmernt. For running these models, Digital Surface Model (DSM) extracted from ALOS satellite data was used on Iran diverse geomorphological landforms. Then, these models were scripted by python and Graphical User Interface (GUI)using Python Tkinter library. A GIS-Based toolkit named Optical Morphology was prepared to calculate all introduced models in the form of raster file format. Finally, numerical analysis, including statistical, morphological, directional and contrast analysis, were run for all the model outputs. The performances and some general applications of these models are described in the field of geomorphology.

Materials and methods
In this research, Digital Surface Model published by Japan Aerospace Exploration Agency (JAXA), with a spatial resolution, near 23m, has been used for the purpose. The data were obtained from ALOS satellite image. The database is based on the global 3-D topographical DSM, which is currently the most accurate elevation data on the global scale. Several hill-shade modeling is used to enhance terrain feature's representation. For this purpose, Python programming is used to prepare all these models.

The main local terrain descriptors such as slope and aspect have also been used to enhance terrain morphology appearance. The 6 models were run based on changes of azimuthal and

∗E-mail: a.safe@geo.ui.ac.ir Tel: +98 9133289134

zenithal angles of light source position. The models for azimuthal and zenithal analysis are including Aspect Frequency Distribution Analysis (AFDA), Un-weighted Multi-Directional Light Source (UMDLS), Weighed Multi-Directional Light Source (WMDLS), Vertical Light Source Illumination (VLSI), Slope Shading Model (SSM), and Sinusoidal Light Source Fluctuation (SLSF). The 14 models run according to the terrain curvatures are including Profile Curvature Shading Model (PCSM), Tangential Curvature Shading Model (TCSM), Plan Curvature Shading Model (PCSM), Un-sphericity Curvature Shading Model (UCSM), Mean Curvature Shading Model (MCSM), Differential Curvature Shading Model (DCSM), Maximal Curvature Shading Model (MaCSM), Minimal Curvature Shading Model (MiCSM), Horizontal Excess Curvature Shading Model (HECSM), Vertical Excess Curvature Shading Model (VECSM), Total Gaussian Curvature Shading Model (TGCSM), Total Accumulation Curvature Shading Model (TACSM), Flowlines Curvature Shading Model (FCSM), and Total Ring Curvature Shading Model (TRCSM). All these models are programmed using python (V.2.7 and Tkinter for GUI programming).

Results and discussion

In this research, optical morphology of terrain has been performmed using basic geographic information system concepts. The python programming has been used to execute different hillshade models. Some topographical factors such as terrain slope and aspect have been considered with regards to light source directions (Azimuthal and zenithal directions). In general, 20 different shading models have been programmed for calculating optical morphology and prepared as GIS toolkit named Optical Morphology. This tool is able to uses Digital Elevation Model as an input to analyze its raster structure and then store results as an ASCII file format. Finally, we have explained results, applications, advantages and disadvantages of these models.

Conclusion

Light source direction modeling combined with the geomorphological attributes is a powerful tool to more accurately recognize and detect landforms and could help geomorphologist in different field of studies. In this research, optical morphology modeling was done using Python programming language to enhance representation of the geomorphological terrain features. The results of these efforts are abstracted in the GIS-based toolkit which is applicable in the quantitative geomorphology area. These models have different approaches against local topographic properties, local conditions of each place and shading properties. Some geomorphological factors such as slope and aspect, topographic characteristics, terrain curvatures and, pixel distribution are effective and suitable in running and performing and adjusting the models.

Keywords: optical morphology, geomorphology, python programming, analytical hill-shading.

The Influence of Zagros Mountains on Iran's Rainfall Cyclones

Fatemeh Sotoudeh
PhD Student of Synoptic Climatology, Faculty of Geographical Sciences, Kharazmi University, Iran
Bohlol Alijani
Professor of Climatology, Faculty of Geographical Sciences, Kharazmi University, Iran
Mohammad Saligheh*
Associate Professor of Climatology, Faculty of Geographical Sciences, Kharazmi University, Iran
Mehry Akbary
Assistant Professor of Climatology, Faculty of Geographical Sciences, Kharazmi University, Iran

Received: 03/11/2017 Accepted: 24/07/2018

Extended abstract

Introduction

The activity of synoptic cyclones plays an important role in determining the local climate and forming large-scale atmospheric circulation through the vertical and horizontal exchange of heat, humidity and momentum, coupled with interaction with large scale circulation centers. The cyclones are generally transmitter of the bad weather conditions and also represent the initial mechanism of transmitter moisture and heat to the pole. Systematic changes in geographical location or in the intensity / frequency of cyclone activities will make significant disparities among other regional climate impacts. The effects of mountainous obstacles on synoptic systems, especially the cyclone systems, are recognized. The mountain range is one of the factors that in addition to disrupting the uniformity of the earth face, it also disrupts the climatic uniformity. The purpose of this study is to determine the influence of thermodynamics of Zagros Mountain on the changes in cyclones entering the country from the west.

Materials and methods

For this purpose, the daily precipitation data were obtained from 13 stations of the Meteorological Organization in west Iran. Also geopotential data were extracted from the NCEP / NCAR databases with spatial resolution of 2.5 × 2.5 degrees and ERA-Interim data from ECMWF databases with spatial resolution of 0.125 × 0.125 degrees, their framework is 0 to 80 degrees east and 0 to 60 degrees north. Using the Factor Analysis method, April 14th-18th, 2003 was selected as the best pattern. After selecting the sample day, sea level pressure maps and geopotential heights of different levels were prepared and analyzed.

Results and discussion

The results of the analysis of these maps showed that the cyclone reaching the Zagros Mountains are dynamically strengthened from the day it formed until it arrived in Iraq. When they approach the Zagros, the vorticity and its omega are reduced, but crossing Zagros, a

*E-mail: saligheh@khu.ac.ir Tel: +98 9151412284

positive vorticity increase happens. These types of cyclones call Zagros cyclones. The relationship between the amplified cyclone with the divergence region of the middle and middle levels were observed at all stages. The Zagros roughness, like a wall, initially weakens the cyclone reached Iran and makes them bipolar. However, the passage of the cyclones from the mountain make the thermodynamic conditions of the descending air in the lee mountain range. The condition makes them revival. As the air reaches the roughness, a weak core remains in the Zagros range, and another nucleus is formed by passing through the mountains in the central regions of the country, and is reinforced in the next hours. Finally, the cyclone is amplified and leaves its moisture completely on Iran. These cyclones can be called Zagros second cyclones.

Conclusion

Mountain barriers are considered as the factors destroying the homogeneity of the local climate. Sometimes they act in the planet scale like the Rocky Mountains. Iran has a heterogeneous environment in term of geomorphology and climatology. One of the most outstanding effects of roughness on the climate is the change in the structure of systems passing through these barriers. Zagros Mountains is one of the main mountain ranges of Iran, with an almost northwest-southeast direction and with a maximum height of about 4,400 meters at Zardkuh Peak. It has a significant impact on immigrant systems to the country.

A study on the cyclone on April 14th, 2003 showed that this cyclone was formed on the April 12th on the northwest Europe, moving towards the Mediterranean Sea. Its trough arrives in the country on the April 14th and it reaches the slopes of Zagros on the 16th. As it is approaching Zagros, changes in pressure in the back and the lee of Zagros are increasing. Vorticity and divergences are completely different in two parts. In the Zagros, during a few days when the cyclone pass across the range, there is a negative vorticity. The vertical velocity also demonstrates subsidence in Zagros altitudinal areas. The results vividly prove that the cyclone gets weakened in collision with the mountain, and its movement gets slow, but it does not disappear. It is re-reinforced on the Zagros lee in the central part of the regions, and continued its route to outside the borders of the country.

Keywords: Lee cyclones, cyclonic vorticity, vertical velocity, humidity flux, Zagros.

Climatology Analysis of Blocking System in Northern Hemisphere on Iran

Fatemeh Abedi
PhD Student in Climatology, University of Isfahan, Iran
Daryush Rahimi[*]
Associate Professor of Hydro-climatology, University of Isfahan, Iran
Seyed Abolfazl Masoodian
Professor of Climatology, University of Isfahan, Iran
Mohammad Sadegh Keikhosravi Kiany
PhD of Climatology, University of Isfahan, Iran

Received: 03/12/2017 Accepted: 24/07/2018

Extended abstract

Introduction

Blocking is one of the most protruding flow patterns and has received attention during the last decades due to its effect on seasonal weather characteristics. The first qualitative conditions for the blocked atmospheric flow was introduced by Rex in 1950 telling the atmospheric jet becomes divided into two separated parts with a considerable connected mass transport, the flow to be meridional at the splitting point and downstream, and the state to continue for at least ten days with a zonal width of at least 45 degrees. The new ideas formulated by Rex became the basis for several blocking indices. Most of the indices detect typical atmospheric patterns. For shorter time series, particular criteria have been used, although, the majority of the analyses are in the 500 hPa geopotential height.

In the face of the differences between the index classifications, they draw similar conclusions regarding the patterns of the Northern Hemisphere blocking climatology. However, the blocking frequency is the percentage of time steps an assured longitude. It can be as low as 5% or higher than 20%. The main aims for this wide range of frequencies in automatic recognition are modifications of the Rex criteria and the use of different parameters.

Due to its simplicity, the index of Tibaldi and Molteni (TM-Index) has become a standard in automated blocking detection analyses. An important problem of the TM-Index is that it cannot effectively distinguish between blocking and cut-off low patterns, since both fulfill the TM-Index criteria. The adapted TM-Index MTM has a higher rejection rate for cut-off lows. Limits in the Rex conditions can be measured as implementations of independent filters which show synergetic effects if they are used in run.

Materials and methods

We have used the 500 hPa geopotential height of the NCEP/NCAR reanalysis dataset (1951–2012) with a spectral truncation of (2.5*2.5 on a Gaussian grid).

∗E-mail: d.rahimi@geo.ui.ac.ir Tel: +98 9133823059

We have defined blocking in north hemisphere by Tibaldi and Molteni index. The blocking can be defined at a longitude as GHGS > 0, GHGN < −10 *m* lat, with the geopotential height gradients in a northern and southern region.

$$GHGN = \frac{Z(\varphi_N) - Z(\varphi_0)}{\varphi_N - \varphi_0}$$

$$GHGS = \frac{Z(\varphi_0) - Z(\varphi_S)}{\varphi_0 - \varphi_S}$$

In the present study, the TM-Index is modified by introducing different ranges for the gradients (this will be denoted as the basic setup in the following):

$$\varphi_N = 80^\circ + \Delta, \quad \varphi_0 = 60^\circ + \Delta, \quad \varphi_S = 40^\circ + \Delta, \quad \Delta = -5^\circ, -2.5^\circ, 0^\circ, 2.5^\circ, .5^\circ$$

And for Iran:

$$\varphi_N = 62.5^\circ + \Delta, \quad \varphi_0 = 42.5^\circ + \Delta, \quad \varphi_S = 22.5^\circ + \Delta, \quad \Delta = -2.5^\circ, 0^\circ, 2.5^\circ$$

where Z is the geopotential height and φ indicates latitudes. So, the 500 hPa geopotential height field is analyzed for a pattern with a positive geopotential height gradient in the southern region and a strongly negative gradient in the northern region. The explanation of a range for Δ leads to a larger number of detected blocking events.

According to this definition, it is possible to find blocking structures with a maximum between the center and southern region. For example, If only the southernmost latitude in the mid-latitude region has higher geopotential height than that of the more northern latitudes of the southern region, GHGS > 0 and blocking will be detected. Without this modification, such a combination is not possible and blocking is not identified, because the high geopotential is located too far south and the lower geopotential too far north, associated with a relatively small meridional extent of the block. The increase of the blocking frequency by the variable gradient is ranged in the basic setup amounts to 20% in regions with high blocking frequency and to 50% in regions with low blocking activity compared with the original TM-Index.

Results and discussion

Location of blocking system

Most of the blocking systems in the northern hemisphere are developed in all seasons and extended over the Atlantic and Pacific. The analysis of the frequency of blocking systems in (2012 -1951) show that most of the blocking systems occurred in the Atlas region 11.2%, the 4.8% pacific, Europe 3.9%, the United States 3.7%, and Asia 0 .75%. The highest frequency of blocking systems was observed in the central part of the Atlantic on the W ° 30, then the Pacific in the western and central part on W ° 140, in the west of the United States on W ° 125, west Europe on the W ° 10 and in Asia in the region E ° 85 - E60 (Figure1 and 2).

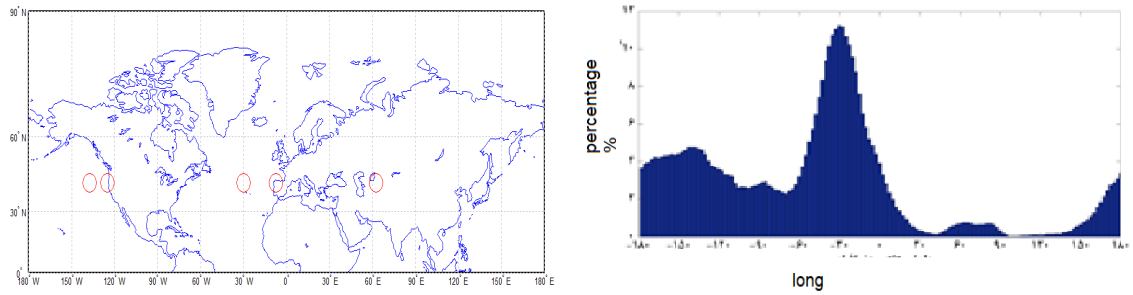

Fig. 1. The location of the blocking systems in the northern hemisphere.

Duration of blocking

Between 1951-2012, the Atlantic was 20.8% in 1954 and 19.5% in 1998, with the highest annual rates in 1968 and 4.6% in 1987, and 5.5% in 1987, with the lowest incidence of 5.5% (Figure 3) and Pacific Ocean in 1985 with 12.9% and 1998 in 10.7% were the highest in 1957 with 3.6% and with 3 .8% in 1968 and 1997 as the lowest incidence (Fig. 4).

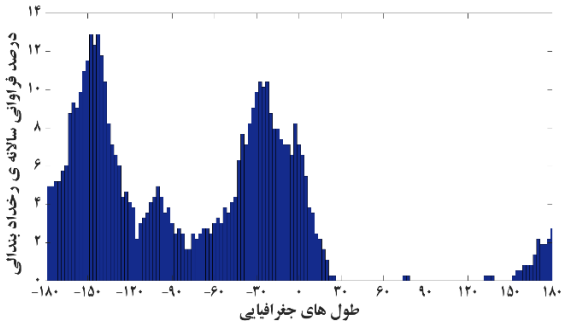

Fig (4) Blocking System Frequency at 1985

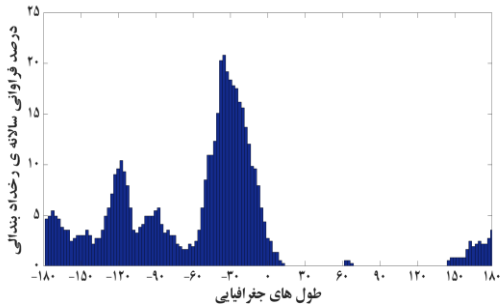

Fig (3) Blocking System Frequency at 1954

Conclusion

Blocking as one of the most protruding flow patterns can greatly affect seasonal weather characteristics. The findings of this research show that most of the blocking systems in the northern hemisphere can occur in all seasons over the Atlantic and Pacific. The analysis of the frequency of blocking systems in (2012 -1951) shows that most of the blocking systems in Iran are very scarce. In 1975, the highest frequency of blocking systems has been observed in the east of the country. The seasonal distribution of the systems showed that the highest frequency of occurrence of blockade systems is in summer, autumn, winter and spring.

Keywords: blocking systems, TM-Index, geopotential height, Iran.

Estimation of Daily Net Radiation in the Urmia Lake Basin under Clear-Sky Conditions Based on MODIS Data

Chiman Hatami Jarabad
Graduate Student, Master in Watershed Management, Urmia University, Urmia, Iran
Mahdi Erfanian*
Associate Professor of Natural Resources, Department of Range and Watershed Management, Urmia University, Urmia, Iran
Sahar Babaei Hessar
PhD in Watershed Management, University of Kashan, Kashan, Iran

Received: 16/04/2017 Accepted: 28/08/2018

Extended abstract

Introduction

Daily average net radiation (DANR) is necessary for hydrological modeling, water resources management and planning, in particular for prediction of daily evapotranspiration (ET). Recently, some remote sensing based methods have been developed at watershed and regional scales to help researchers estimate DANR and ER under both clear and cloudy conditions. DANR is a critical variable linking estimates of instantaneous latent heat flux (satellite overpass time) from energy balance based models. Radiation modeling based on ground or station data is actually point scale estimation. On the other hands, application of geostatistical methods to produce radiation maps at watershed scale is often associated with remarkable errors due to the limited number of stations. In this study, net daily radiation maps were created based on newly developed geometric radiation model based on land and atmospheric MODIS data in the Urmia Lake Basin (ULB) under clear-sky condition for four selected dates in 2006 and 2007.

Materials and Methods

In this study, the ULB located in northwestern Iran was selected as the study area that extending in latitude from around 35.67° to 38.47° N and in longitude from around 44.22° to 47.89° E. The basin has an area of approximately 52700 square kilometers. This study attempts to estimate the DANR maps for four selected days under clear sky. Long et al. (2010) developed a geometric model considering slope and aspect effects to improve parameterization schemes to estimate daily average net shortwave radiation (Rns) and daily average net longwave radiation (Rnl). In present study, the same methodology employed a characteristics model (slope, azimuth and elevation) based on daily MODIS data products and the global ASTER DEM. The DANR is total of the daily net short wavelength radiation and daily net long wavelength radiation. Long wave radiation was estimated using MODIS products including surface albedo, Land Surface Temperature (LST), atmospheric temperature, pressure and emissivity. A four-observation based method using Terra-MODIS and Aqua-MODIS LST data was applied to estimate daily

* E-mail: m.erfanian@urmia.ac.ir Tel: +98 9123328494

average LST in order to improve the accuracy of estimations of Rnl. In the study, we applied the 24-hour incoming direct solar radiation (S_{in24}) measurements of Tabriz and Urmia synoptic stations for validation. The RMSE and MAE measures were used for model evaluation. In addition, due to the lack of ground-based Rnl observations, we utilized the FAO (Penman) method to generate corresponding ground data for model validation.

Results and discussion

In order to compare the amount of incoming S_{in24} on flat and slope surface, the whole study area was assumed as a flat and the S_{in24} maps were produced. The differences between S_{in24} on flat ($S_{in24,s}$) and sloping surfaces ($S_{in24,f}$) were calculated for all pixels. The histogram plot or frequency of $S_{in24,s}$ - $S_{in24,f}$ quantity at different intervals of slope showed that by increasing in slope degree, the frequency of pixels at all slope classes becomes greater. This reflects the importance of the slope for estimating S_{in24}. In addition, the values of S_{in24} at flat are higher than sloping surfaces especially for where slopes < 30 degree. Aspect is another influencing factor on the amount of receiving and absorbed radiation. The RMSE and MAE for observed and estimated S_{in24} values were 30.29 and 19w.m^{-2}, respectively. The models in average overestimate S_{in24} about 10.5%. The results showed that the eastern and western aspects receive more daily net radiation during day and sunshine hours or day length has its impact on radiation. For Rnl estimates, the RMSE was 36w.m^{-2}

Conclusion

In present study, the Sin24 was parameterized by taking into account the effect of terrain factors, such as slope, azimuth and elevation on direct solar radiation. The sunrise and sunset angles for a given sloping surface (pixel) are different in geometric radiation model. Results indicate that the model has the capability to characterize the variability in Sin24. The incoming solar radiation for flat surface is higher than sloping surface. We founded that southeast and southwest aspects receive greater net radiation. The DANR values decrease with an increase in elevation. The geometric model used in this research needs to be evaluated in different watersheds in Iran without data availability problem especially daily Rns, Rnl and LST measurements, a high number of meteorological stations with proper spatial distribution. This research was done under limited data in the ULB.

Keywords: MODIS, net radiation, geometric model, Urmia.

Analysis of Temporal Change of Actual Evapotranspiration and Its Relationship with Temperature and Precipitation in East Azarbayejan Province Using MODIS

Fatemeh Jafari Shendi
PhD Candidate in Climatology, Physical Geography Department, University of Tabriz, Iran
Saeed Jahanbakhsh Asl[*]
Professor of Climatology, Physical Geography Department, University of Tabriz, Iran
Majid Rezaee Banafsheh
Associate Professor of Climatology, Physical Geography Department, University of Tabriz, Iran
Seyed Abolfazl Masoodian
Professor of Climatology, Physical Geography Department, University of Esfahan, Iran

Received: 18/12/2017 Accepted: 28/08/2018

Extended abstract

Introduction

The increasing expansion of industries and the use of fossil fuels have led to an increase in greenhouse gas emissions and, consequently, global warming and the occurrence of climate change phenomena. Climate change is a change in the climate behavior of an area relative to the behavior that is expected during a long-term period of observed or recorded information in that area. The ET element is considered as one of the most important components of water balance in nature; it is strongly influenced by important climate components such as temperature and under the influence of climate change, it can exhibit various reactions. Therefore, in calculating the water balance of each basin, ET calculation is important. Because ET along with the surface flow and water penetration in the soil are considered as components of the water balance. Due to the temporal variations of climate variables and consequently ET, the use of remote sensing methods can consider these changes as more favorable. Using Landsat satellite imagery and energy balance model, using the NOAA, AVHRR and SEBS algorithms, Baba Jafari et al (2015) estimated monthly ETA values for agricultural use in the Akhole region in Tabriz. Comparison of the results of the algorithm with observation values indicates the accuracy of the model with a coefficient of 0.8 and the mean square root error of 9.64 millimeter per month (Baba Jafari et al., 2015: 1).

Materials and methods

In this study, for the analysis of the ETa of the East Azarbaijan province, we applied MOD16A2 remote sensing data in a time interval of 8 days in the period 2014-2000. Data on maximum, minimum and precipitation temperatures of 11 stations of the province were also used for the purpose. Since the relationship between temperature and ETa is linear, the correlation between the average of the maximum and minimum temperatures of 8 days in the stations of the province was calculated with the mean values of 8 daily ETa for representative cells. As the

∗E-mail: s_jahan@tabrizu.ac.ir Tel: +98 9141120860

purpose of the current research is to estimate ETa for explaining the water balance of the province, the correlation between precipitations of the stations in the province with the ETa of the representative cells was also evaluated. Given the fact that the data of the MODIS are 8 daily scales, with programming in MATLAB software, the data of the maximum, minimum and precipitation temperatures of the stations was converted into eight days interval. Investigations showed that MODIS provides only ETa data of the representative cells of Ahar, Jolfa, Sarab, Sahand, Marand and Meyaneh stations, and for other stations due to the placement of the cell in the class of ground cover construction, ETa data has not been recorded.

Results and discussion

The findings of this study indicate that the average maximum and minimum mean and total mean of ETa data on 124546 pixels in the province for the period from 2000 to 2014 were 2.3, 0.5 and 0.8 millimeter per day. The time series ETa of the cells within the boundaries of the province also showed the highest changes in 2003 and 2010, at 9.1 millimeter a day, and the lowest in 2001, at 0.1 millimeter per day. In this regard, the time series of the ETa of the stations in the study years showed that the highest and lowest values of ETa changes were in the Sarab and Sahand stations, and the value was 3.3 (millimeters per day) in 2012 and 0.01(millimeters per day) in 2001. Due to the fact that the temperature relationship with ETa is linear, the correlation between the average maximum and minimum temperatures of 8 days in the stations of the province with average ETa values of 8 days for representative cells of the station was calculated. Investigations showed that there was a negative relationship between the mentioned parameters. Basically, there must be a positive and direct relationship between temperature and ETa. The only factor that can disrupt this relationship is the lack of adequate water in the area. Regression analysis on min and max temperature data matrix with ETa of 8 days in the stations at 95% confidence level showed that with 1 degree increase in temperature in the province, the ETa decreases by 0.02 mm per day. The ETa variation slope in relation to precipitation stations showed that at 95% of confidence level, with an increase of 1 millimeter of precipitation, the ETa would increase by 0.9 millimeter per day.

Conclusion

In this study, was investigated the correlation between the average maximum and minimum temperature of ground stations with the mean values of 8 daily ETa of the representative cells of the stations. The results of the investigations showed that there is a negative relationship between the mentioned parameters. The existence of a negative relationship between the above mentioned parameters reflects the fact that when the warm season approaches, the water resources are decreasing as a result of decreasing water, and also ETa values decrease with increasing temperature. Because there is not enough water to evaporate in the area, the correlation between mean precipitation and ETa also showed a positive relationship. In other words, the higher the rainfall, the higher is the water available to the plant and the soil. Given that the average annual rainfall in the province is 267.27 mm and the annual loss of ETa is 32.4 mm. This amount of evaporation is significant compared with 267.27 millimeters of annual rainfall. The climate condition of the province leads to desert and dry land.

Keywords: actual evapotranspiration, MODIS Terra, climate change, precipitation, temperature.

Investigating the Spatial Distribution Pattern of Nebaka (Case Study: Sufikam Plain, Golestan Province, Iran)

Mohammad Alinejad
MSc Student in Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran
Mohsen Hosseinalizadeh[*]
Assistant Professor of Watershed and Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran
Majid Ownegh
Full Professor of Watershed and Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran
Ali Mohammadian Behbahani
Assistant Professor of Watershed and Arid Zone Management, Gorgan University of Agricultural Sciences and Natural Resources, Iran

Received: 18/05/2018 Accepted: 28/08/2018

Extended abstract

Introduction

Nebkhas are single dunes formed by accumulation of aeolian sediments on shrubs and single trees. They play an essential role in the stability of arid and hyper-arid ecosystems, mostly by preserving the vegetation. Moreover, they are very important in stabilization of moving sand in deserts and semi-arid areas, as well as in protecting human settlements and facilities from sand infestation. The spatial pattern analysis of natural or manmade effects provides useful information about the effects of competition between environmental conditions. The spatial point pattern analysis of every phenomenon and their impacts on environment is being considered as a basic criterion for decision making, especially in risk management. For instance, spatial pattern of plants is a context in ecological theory. A data-set consisting of a series of mapped point locations is a main example of a spatial point pattern. The methods for quantifying these characteristics of point pattern are known as summary statistics. From a statistical point of view, the methods are also appropriate for phenomena that represent various types of geomorphologic features. Thus, to better understand the factors controlling the pattern of Nebakas, univariate and bivariate summary statistics have been used. Moreover, a more promising approach in such analyses is to complement point position with quantitative size attributes and use mark point patterns (i.e., Nebakas with a quantitative characteristic such as physical and chemical properties of the soil). In fact, the spatial distribution of Nebakas in the semi-arid regions can be described and modeled by point pattern processes where the points are given by locations of the Nebakas. Given the importance of spatial statistics in obtaining useful

∗E-mail: mhalizadeh@gau.ac.ir Tel: +98 9390994948

information for better management in all fields, there are not remarkable investigations about the spatial analysis of the Nebka dunes.

Materials and methods

In the present study, we have selected an area of 197 hectare and produced a maps related to 147 Nebkas in the Sufikam plain, northwest of Golestan province, Iran. In order to study the distribution pattern of the Nebkas and also the factors influencing their spatial distribution, we have recorded morphometric characteristics of the Nebkas including length, width and height. The physical and chemical properties of the soil have also been assessed and the spatial pattern of Nebkas analyzed using R and Programita software based on Ripley's K and G univariate functions and Mark Correlation Function (MCF).

Results and discussion

Results showed that by using Ripley K function, the spatial distribution of Nebkas in Sufikam plain is clustered and most of them are located in the north part of the area of interest. Density of Nebkas and also their mean spatial distance (distance between Nebkas) was 0.75 per hectare and 33m in turn. Regarding the results of g(r) in Sufikam plain, the significant aggregation of Nebkas was observed at all scales (0–50 m). As the function failed to be in the bounds of respective 95% simulation envelope, the aggregation of Nebkas in all of the scales was a significant departure from random labeling at the significance level of 0.05 (Fig. 8). Furthermore, regarding the results of mark correlation function (MCF), Nebkas and parameters of the length of the Nebka, sediment deposition, pH and organic matter of the Nebka soil, were highly correlated. Moreover, the parameters of width, volume and height of the Nebkas, EC, SAR, ESP, sorting and mean diameter of sediments did not affect their distribution pattern.

Conclusion

The results of the spatial analysis of the Nebkas helped us identify the factors affecting the distribution of these facies. In this study, it was also found that soil acidity has a significant effect on the distribution pattern of the Nebkas. In addition, greater organic matter content has a greater effect on the growth of the plant species, which can also affect the distribution pattern. Soil textures such as clay, silt and sand did not affect the neighboring Nebkas in the study area. The sediment deposition and the distribution of the Nebkas indicates a positive correlation; which means that the larger its value (or the symmetry of the sediments towards fine particles), the denser the distribution of the points. The results have indicated that the of Nebka landform play a positive role in reducing the effect of wind erosion. The investigation of their spatial dispersion and factors affecting their dispersion, development and natural processes, can be a guide for natural resource managers for controlling and reducing the wind erosion.

Keywords: Nebaka, spatial statistic, Mark Correlation Function, Sufikam Plain, Golestan Province.

Validation and Analysis of Heavy Rainfall Data Derived from Weather Radar Compared with Data from Rain Gauge in the Kermanshah Province, Iran

Farshad Safarpour
PhD Student of Climatology, Esfahan University, Iran
Javad Khoshhal Dastjerdi⁎
Associate Professor of Climatology, Isfahan University, Iran
Abolfazl Masoodian
Professor of Climatology, Isfahan University, Iran

Received: 07/09/2017 Accepted: 08/09/2018

Extended abstract

Introduction

Kermanshah Province is one of the western mountainous provinces located in the middle Zagros Mountains. The rainfall in this province is similar to other mountainous regions in orographic and rugby.

Forecasting rainfall in terms of severity, amount and continuity in the usual way is often not precisely possible and requires very expert forecaster and familiarity with local conditions. This leads to severe, destructive and sometimes catastrophic floods in the province.

Today, weather radars can be a valuable tool for experts to forecast rainfall, provided that they are calibrated in accordance with local conditions and calibrated over time with climate change.

If the calibration of weather radar is accurately conducted, the radar can estimate the amount of rain over the vast areas with good accuracy. Relationship between rain and reflectivity radar exponential show $Z=aR^b$, where a and b are coefficients of radar. The amount of R depends on the factors such as the type of rain, rain season, latitude and topography. Variation is ranged of a in few tens to few hundred, and the range of variation b is 1 to 3. Drop size and distribution of rainfall, the coefficient of this.

Materials and methods

The purpose of this study is to calibrate the Kermanshah weather radar with the conditions of the province, so that the specialists be able to predict data using this radar before any hazard. By the way they can provide warnings to the people and authorities and reduce the damage to the dwellings, historic buildings, administrative centers, urban and rural facilities, farms, humans and animals.

In this study, we have used rain data from November 17 to 18, 2015, and November 30 to December 2, 2016. These rain data have been obtained from the stations including Kermanshah, Eslamabad, Sarpol, Ghasre Shirin, Harsin, Javanroud, Tazabad, Songhor, Ravansar, Ghilan

⁎E-mail: j.khoshhal@geo.ui.ac.ir Tel: +98 9133270366

Gharb and Soumar. The stations are located in distance of 30 to 100 kilometers from Kermanshah's radar.

Results and discussion

For rainfall of November 17 to 18 2015 for all stations, we have different angles of radar beam and the reflectance. The radar beam elevation angle is optimized for each station; a separate line equation was obtained. Using the coefficients of the equation and radar, rain intensity level was determined by Surface Rainfall Intensity (SRI) and the total rainfall was an hour and finally total rain was estimated for each station. Radar estimated rainfall for the first part was more than that measured by rain gauges.

Because the error was considerable in all stations, it is assumed that the size and distribution of rainfall in the first part of rainfall vary with the next step. To solve this problem, rain at all stations was divided into two parts. For the first part of the conflict between radar rainfall and gauge rainfall, we have used common linear equations and coefficients of a and b obtained again for all stations. The results showed that the amount of rainfall was estimated in this way better than before.

Using this relationship, rain is estimated 31 percent to 96 percent and the average total rainfall by radar is estimated about 8.9 to 32.4 millimeters. The value is increased greater than that before calibration. Acquiring the optimum beam angle of the radar for any location is time-consuming and difficult. Therefore, when the time is not enough, it is better for each rainfall radar to obtain a relationship.

Conclusion

The results have indicated that the coefficients of radar for any location and at any time are different from those of gauge. To increase the accuracy of radar rainfall, it is better to obtain each separate equation. However, to obtain a separate equation for each location is the best. Finally, it is suggested that the radar equation coefficients for each region of Iran, which is covered by the weather radar, are calculated, so that they can accurately predict the precipitation and give warnings to the different centers.

Keywords: weather radar, rainfall estimation, calibration, Kermanshah.

Zonation and Estimation of the Trend of the Thermal Unit of Growing Season due to Temperature Changes, Iran

Mehran Fatemi[*]
Assistant Professor of Climatology, Meybod University, Yazd, Iran
Hamideh Dehghan
MSc in Climatology, Yazd University, Yazd, Iran

Received: 19/04/2018 Accepted: 08/09/2018

Extended abstract

Introduction

One of the challenges in the 21st century is the issue of climate fluctuations. The increased average global temperature and its pursuing changes are part of the climatic changes that have been addressed in all ecological theories. In addition to this global increase in the air temperature, many of the phenomenological, meteorological and satellite-based studies have reported a surge in the length of the growing season caused by the augmented temperature in northern areas during the twentieth century. Any crop for its germination and growth requires a minimal temperature below which the growth process is impeded or stopped. This temperature is specific for each plant variety. One of the critical effects of this phenomenon (global warming) is a change in the degree-days of plants. A plant growth is a variable of the temperature. The growing degree day index and its availability for a crop plays a vital role in the process of the growth and enhanced productivity of inputs, including cultivation date and greater yield. Thus, the growing degree-days vary relative to the temperature fluctuations. Investigating the effects of temperature in different time periods on the growth and development of organisms, especially plants, is of paramount importance.

The objective of this paper is to investigate whether there are specific trends in the number of heat units during the growing season using temperature indices to determine indicators, capacities and limitations of the agricultural climate in planting varieties with different adaptation styles.

Materials and methods

In this paper, daily temperature data (minimum, maximum and average) reported by 31 Iranian synoptic meteorological stations over a 25-year common statistical period were used to estimate the trend of heat units during the growing season for 1985-1986 and 2009-2010 periods.

To calculate heat units, the length of growth season was initially extracted for temperature thresholds of 5 °C and 10 °C using Julian coding (January 21st with code 1 and January 20th with code 365) and then heat units of the length of growth season were calculated by subtracting average day temperature from base temperature. Maps of heat units have been prepared in GIS.

∗E-mail: yazdfatemi@meybod.ac.ir Tel: +98 9132748227

The statistical defects have also been reconstructed using autocorrelation method, and the randomization of the data has been tested by the Mann-Kendall test. The series that had specific changes or trends at the confidence level of α=0.05 were identified. Then, using Mann-Kendall test, it was determined how and when these trends were started and variations in heat units were estimated.

Results and discussion

To calculate the base heat units at 5 °C, the start and end dates of 5 °C and the length of growing season have been first extracted and then based on the length of growing season, the number of heat units during each season has been calculated for the stations. The average length of the growing season at a temperature of 5 °C is varied in different stations ranging from 147 days at Shahrekord station to 365 days at Bandar Abbas and Bushehr stations. The heat units during the growing season also varied from 2218 to 4174 degree-days at stations under study, with the lowest number belonging to Shahr-e-Kord Station and the highest to Gorgan Station. The length of growing season at 10 °C was variable from 67 days at Shahrekord Station to 348 days at Bandar Abbas Station. The number of heat units during the growing season for this base was 861 degree-days for Shahrekord station and 5664 degree-days of the Bandar Abbas station. The results of the Mann-Kendall test indicated that the average heat units in most stations under study over the past 25 years followed a specific trend throughout the growing season. That is, for a temperature threshold of 5 °C, changes in most stations had an increasing trend, with the exception Sanandaj and Shahrekord stations, which pursued a negative or decreasing trend. For a temperature threshold of 10 °C, most stations displayed a positive and incremental trend, except for Abadan and Ahwaz stations that had a negative and declining trend. The results of Mann-Kendall's graphic test on heat unit data with a temperature threshold of 5° C revealed that changes in all stations followed an incremental trend, except for Abadan and Bandar Abbas stations that had a dramatic and decreasing trend. Among the series of heat units at 10 °C, unlike Abadan, Ahwaz and Bam stations, which have a dramatic and declining trend, the rest of the stations followed an incremental trend.

Conclusion

The analysis of the change trends of heat units during the growing season for temperature thresholds of 5 °C and 10 °C indicated that most of these changes were dramatic except few of them following a progressive and steady trend. For a 5 °C temperature threshold, the changes in all stations had an incremental trend with the exception of Bandar Abbas station, which demonstrated a sudden and declining change. Considering the temperature threshold of 10 °C for the analysis of heat unit series, it was observed that Abadan and Ahwaz stations had a sudden and decreasing trend whereas other stations such as Gorgan, Arak, Zahedan, Ramsar, Mashhad, Qom, Sanandaj, Anzali and Tehran followed a steady and incremental trend. Among the series of heat units for 10 °C, unlike the Bam station, which displayed a sudden declining trend, the stations of Urmia, Bushehr, Birjand, Khoy and Sabzevar followed a sudden incremental event. The results of the research exhibited more significant changes in the series of heat units at a threshold of 10 °C in comparison with heat units at a threshold of 5 °C. At the base temperature of 5 °C, the number of heat units for the length of growing season is increased from south to north and from west to east, and at the base temperature of 10 °C, it revealed an increasing trend from south to north and from west to east of the country. According to the

results, it can be suggested that in the areas where the length of the growing season declines, given that farmers struggle with low yields and crops that are not grown adequately, farmers would be better off cultivating crops with the low growth period or early plants to provide the heat energy needed by the plant during the growing season.

Keywords: growth season length, growing degree day trend during the growing season, Mann-Kendall Test, Iran.

Application of Morphometric Indices in Optimization of Landslide Susceptibility Zonation Using Probabilistic Methods

Hamid Baboli Moakher
PhD Student of Geomorphology, University of Isfahan, Iran
Alireza Taghian*
Assistant Professor of Geography, Esfahan University, Iran
Kourosh Shirani
Assistant Professor of Soil Conservation and Watershed Management, Isfahan Agricultural and Natural Resources, Research and Education Center, AREEO, Isfahan, Iran

Received: 09/06/2018 Accepted: 23/09/2018

Extended abstract

Introduction

As a geomorphic hazard, landslide causes great deals of financial damage and casualties every year, and directly and/or indirectly contributes to large economic losses in different areas. Given that numerous factors contribute to the occurrence of a landslide, in order to prepare more accurate zonation maps, it is necessary to use more information layers and evaluate various factors possibly leading to the occurrence of the event before adopting the existing models to zonation the susceptibility map. This phenomenon is a natural hazard which is affected by the land surface shape (morphology). When it comes to susceptibility analysis of landslides in a particular area, not only common factors in zonation, but also morphometric features of ground surface are important and should be evaluated. Geomorphometric indices can be used for analysis of many geomorphologic events and natural hazards. These indices express quantitatively characteristics of hillsides which are susceptible to landslide.

Materials and methods

In this research, a total of 18 factors contributing to the occurrence of landslides in Fahlian watershed were identified and evaluated. These factors are including slope, aspect, slope length, altitude, distance to fault, distance to river, precipitation, lithology, landuse, general curvature, Plan curvature, profile curvature, Normalized Difference Vegetation Index (NVDI), topographic position index (TPI), Length and Slope Factor (LSF), Terrain Ruggedness Index (TRI), Stream Power Index (SPI), and topographic wetness index (TWI). In order to prepare the layers of the effective factors, we have used geological maps at scale 1:100,000, topographic maps at scale 1:50,000, Digital Elevation Model (DEM: ASTER), satellite images, and aerial photographs. The data have been analyzed by ArcGIS, Global Mapper, Surfer, and ENVI 4.5 software packages. Given the focus of this research on the application of morphometric indices to optimize zonation map of susceptibility to landslide, the indices were extracted. Land surface characteristics, i.e., morphometric, hydrologic, and climatic properties, etc., and land features

*E-mail: a.taghian@geo.ui.ac.ir Tel: +98 9133287573

including watersheds, stream networks, landforms, etc. were extracted using digital models of ground surface (DEM) and parameterization software. Subsequently, using Dempster-Shafer probabilistic models and the morphometric indices, we have prepared zonation map of landslide susceptibility for Fahlian River watershed. Finally, using receiver operating characteristics (ROC), both models were validated.

Results and discussion

Based on the weights related to the role of each unit of factor layers and their order of priority and importance in the occurrence of landslide, factor maps have been combined to produce landslide distribution maps. The weights of each level have been calculated based on the relationships related to the Dempster-Shafer model in GIS environment. For example, in this study the slope > 40% in weight and imposes the largest contributions into the occurrence of landslide across the watershed. At lower slopes, other forces such as the friction between soil particles and other hillside material are usually dominant over driving forces such as gravity. In contrast, on highly sloping hillsides, due to the dominance of shear stress over resisting force, one may end up with increased probability of the occurrence of a landslide. Moreover, based on the obtained results, with a belief weight of 0.77, TRI > 14 was the second most effective factor on the occurrence of landslides across the studied watershed. Other contributions are as following: Stream Power Index < 1.2, precipitation < 750 mm/year, TPI < -4.2, profile curvature of 0.3 – 4.2, TWI of -1.5 to 2.5, surface curvature of -5 to -2.99, distance to fault from 0 to 500. The Pabdeh – Gurpi have belief function values of 0.68, 0.63, 0.60, 0.57, 0.49, 0.49, 0.47, 0.46, 0.38, and 0.37, in order..

According to the evidence of weight model, the class of TRI >14 (final weight: 2939.32) was found to be the most effective factor on the occurrence of landslide across the region. Following a similar trend of reasoning, the class of slopes higher than 40% (final weight: 2611.21) was the second most important factor, which are in agreement with the results of Javadi *et al.* (2014) and Teymoori-Yanseri *et al.* (2017). Moreover, in their research, Pourghasemi *et al.* (2011) referred to the slope as the second most important factor contributing to the occurrence of landslide. In this model, NVDI > 0.6 (final weight: 400.60) is identified as the third most important factor. Following the land use, Stream Power Index > 1.2, TPI < -4.2, TRI of 7 – 14, profile curvature of 0.1 – 0.3, NVDI of 04 – 0.6, precipitation > 750 mm. The Pabdeh-Gurpi Formation imposed the largest impacts. The impacts are sorted in the order of effectiveness, from final weights of 2037.60, 1925.99, 1803.48, 1793.34, 1722.40, 1494.60, and 1340.28.

Conclusion

Final results of the present research have indicated that, in both of the models, slopes higher than 40% and TRI > 14 exhibited the highest weights and played the most significant roles in the occurrence of landslide across the region. Moreover, based on the obtained results, 82.59% of the landslides across the watershed in an area of 547.82 hectare had occurred in pastures. Based on the results of Dempster-Shafer model, very low, low, intermediate, high, and very high susceptibility classes covered 23.85% (961.34 km^2), 31.82% (1282.49 km^2), 21.72% (875.63 km^2), 16.41% (661.45 km^2), and 6.20% (249.97 km^2) of the entire region, respectively.

Moreover, the results obtained from the evidence of weight model shows that zones of very low, low, intermediate, high, and very high susceptibility have areas of 25.29% (1019.59 km^2), 30.98% (1248.82 km^2), 21.28% (857.64 km^2), 15.68% (631.93 km^2), and 6.77% (272.90 km^2)

on the entire susceptibility zonation map, respectively. Results of evaluating the models using ROC documented that the Dempster-Shafer model provides higher prediction accuracy (0.79) than the evidence of weight model (0.76). Given quantitative results of validation, the combination of Dempster-Shafer model with morphometric indices is herein introduced as an appropriate model for landslide susceptibility zonation.

Keywords: landslide, Dempster-Shafer model, evidence of weight model, morphometry, Fahlian Watershed.

Comparison of Land Use and Climate Change Impacts on Runoff in a Small Mountainous Catchment (Case Study: Garin Dam Catchment)

Hamid Nouri[*]
Assistant Professor of Watershed Management, Malayer University, Malayer, Iran
Alireza Ildoromi
Associate Professor of Watershed Management, Malayer University, Malayer, Iran
Mahin Naderi
MS In Watershed Management, Malayer University, Malayer, Iran
Soheila Aghabeigi Amin
Assistant Professor of Watershed Management, University of Razi, Kermanshah, Iran
Hosein Zeinivand
Assistant Professor of Watershed Management, University of Lorestan, Khoramabad, Iran

Received: 15/01/2016 Accepted: 25/09/2018

Extended abstract

Introduction

Land use and climate change and its impacts on water resources and hydrological regime have always been the most important problems in recent decades in Iran. These environmental risks will have direct and indirect impacts on health, economy and society by accelerating the hydrological cycle, drought and flood. Some researchers have examined the impacts of climate and land use change on extreme rainfall, runoff and flood events. Water resources have been investigated in different basins using hydrological models and GIS in arid and semi-arid regions via different scenarios and strategies. They have identified a serious increasing trend of extreme rainfall and drought intensity and duration due to land use change and climate change. Western Iran has experienced an agriculture growth and land use change that can alter evaporation patterns and affect the more frequent occurrence of drought and flood extremes largely due to climate change in this mountainous region. Definitely, there is an increasingly notable challenge in management of water resources, prediction of future changes in land use and climate variabilities, and human activities. In a watershed, climate change and human activities both contribute to the hydrological cycle, and this result has been supported by many researches. In this study, climate change scenarios and land use change models are coupled with a hydrological model to study impacts of these changes on runoff in a mountain catchment in western Iran.

Materials and methods

Under the assumption that runoff is affected only by land use and climate changes, the effects of climate changes on runoff were studied using SWAT model. This hydrological model calibrated for the period of 2002 to 2007 and was then validated for the period of 2008 to 2010, and after

∗E-mail: hamidwatershed@yahoo.com Tel: +98 9188521059

that it is operated in base (2014) and future (2042) period. The required data are including a Digital Elevation Model (DEM), soil properties, vegetation, land use, climate observations, and discharge observations in Garin dam gauging station. Land use in the Garin Basin was extracted from the Natural Resources Department of Hamadan in 1986. These maps have been produced from Landsat 8 images in 2000 and 2014. Additionally, Land use map has been predicted for 2042 using Markov and CA Markov models based on transition probabilities. Curve number can reflect the capacity of runoff yield for the land cover with a continuous spatial distribution. Based on land use maps of two periods and soil type data of Garin catchment, CN distribution maps in the same periods were obtained with spatial interpolation. To predict the future climate, the HADCM3 model was used and its outputs were scaled up with SDSM model. SDSM Model used for down scaling of rainfall and temperature data obtained in Hadcm3 output for prediction of Garin future climate.

Results and discussion

The SWAT model is performed well in both the calibration and validation periods, accurately simulating the outlet flows according to the model performance criteria after the sensitive parameters were optimized. The simulation coefficients for calibration and validation are presented in Table 1 and 2. The results show that the forest area will be increased and rangeland will be decreased until 2042 (table3). The Result of Markov chain and CA Markov Chain analysis indicate that land use change will make less the runoff rate under A2 and B2 scenarios in 2042. The results reveal that climate change impacts on reduction of runoff is more than land use change during 2042 to 2050 compared with 2000 to 2010.

Table1. The model criteria in Calibration and validation for discharge simulation in Garin catchment

br2	MSE	P-factor	R-factor	R^2	NS
0.36	0.39	0.47	0.03	0.60	0.59
0.51	0.16	0.39	0.04	0.67	0.66

Table2. The comparison of the land uses areas in 2014 compared with 2042

Rockland	Rangeland	Cultivated Forest	Natural Forest	Year
3.24	14.63	0.82	2.35	2014
3.20	14.19	1.05	2.59	2042

Conclusion

The results of NC, br^2, R^2, MSE, P-factor and R-factor coefficients show that validation was better than calibration and both reveal that performance of the model is reasonable. It was obvious that climate change with increased precipitation and decreased evaporation caused an increase in runoff in the study area. The results show that if the trend remain stable during 1986 to 2014, the forest area will be increased by 2.28 percent and rangeland will be decreased by 2.07 percent until 2042 and also, mean precipitation will be reduced but mean temperature will be increased. The results indicate that decrease in rangeland and rock land area and increase in forest area result in a reduction in runoff under A2 and B2 scenarios in the future. The output of the SWAT model show that the monthly runoff has decreased in January, February, March, April, May and December and has increased in July, August and September due to the rainfall decrease and increase compared with the base period. Overall, the results show that the effects

of climate change on runoff reduction is more than the effects of land use change from 2014 to 2042. The results can be used to improve management of Garin watershed and to focus on soil and vegetation cover damage. Besides, the amount of runoff altered by land use change (6.5%) is lower than the climate change effect (10.7%) in this mountainous catchment. Further research is required to acquire the regional future climate scenarios coupled with the hydrological model of a basin under GCMs (general circulation models) with the downscaling technique, so as to further quantify the relations between runoff and climatic variables. In addition, the space-time distribution of floods and droughts resulted from the runoff change should also be examined to provide scientific framework for basin-scale water resource management.

Keywords: climate change, Garin Catchment, runoff, land use, SWAT model.

Suitable Areas for Construction of Ski Fasilities with Sport Tourism Approach (Case Study: Chaharmahal & Bakhtiari Province, Iran)

Sedigheh Kiani Salmi*
Assistant Professor of Geography and Ecotourism, Faculty of Natural Resources and Earth Science, Kashan University, Iran
Seyed Hojat Mousavi
Assistant Professor of Geography and Ecotourism, Faculty of Natural Resources and Earth Science, Kashan University, Iran
Parisa Yeganeh Dastgerdi
MA in Geography and Ecotourism, Faculty of Natural Resources and Earth Science, Kashan University, Iran

Received: 02/10/2017 Accepted: 25/09/2018

Extended abstract

Introduction

Skiing is one of the branches of sport tourism in winter sports sector. This kind of tourism today has become a special trend in the mountainous regions of developed countries and is known as the "white gold", which has a great contribution to the economy of the local communities of these countries. From a global point of view, ski tourism has become an industry, but the industry is now threatened by changes in climate change. The results of general atmospheric circulation models indicate a rise in temperature and a decrease in summer rainfall in Europe. As global warming continues, some of the tourist destinations of skiing will be faced with the risk of decreasing in amount of snow and consequently loss of visitor numbers. Therefore, in such a situation, planning should be aimed at selecting the most suitable places for the construction of ski resorts with the least problem in terms of snowfall and other required parameters and the choice is made in principle and accurately. One of the problems that ski tourism in Iran faces is the installation of ski facilities and ski resorts in unsuitable places. Sit is important to specify proper location for construction of sports places and facilities for optimal and efficient exploitation in the present and future. Ignoring this issue in many cases leads to a lack of proper use of those places as well as spending too many to build them. One of the useful solutions in selecting and determining suitable sites for the construction of winter sports facilities and ski resorts is application of GIS to select the best cases.

Therefore, in this study, the ArcGIS software is used to locate proper areas for construction of ski resorts.

Materials and methods

This is an applied research using a researcher-made questionnaire as research tool. The reliability of the tool was confirmed by calculating the incompatibility rate. The sample

* E-mail: s.kiani@kashanu.ac.ir Tel: +98 9131283870

population of the study is 20 experts from the physical education and cultural heritage organizations of Chaharmahal and Bakhtiari province who respond to the questionnaire and have performed paired comparisons. In this research, the identification of suitable areas for the construction of a ski resort was carried out by weighting the criteria using the network analysis process and Super decision software. The network analysis process considers each issue and problem as a network of criteria, sub-criteria, and options. All elements in a network can, in any case, be linked together. In other words, in a network, feedback and interconnection between clusters are possible. Mapping is done by the ArcGIS software. In this regard, the most important measures affecting the location of the ski resort were studied. The combination of these standards with the experimental knowledge of experts in the field of sports helps to identify the proper locations for skiing.

Results and discussion

Sports tourism in our country is not well-developed and there is no systematic program for sport tourism marketing. Despite the huge costs of the physical education organization, the National Olympic Committee, federations and other relevant institutions for conducting national and international sporting events, the great benefits of tourism development cannot be obtained and there is always a loss of opportunities in this area. Assessing the environmental capability and determining the potential power and allocating appropriate funds to that can provide a logical and sustainable adaptation between the natural power of the environment, the needs of communities and human activities in space. In this way, while protecting biodiversity, we can be benefited from sustainable productivity of the land. Optimal locating attempts to help decision-makers and planners for regulating indicators and factors influencing decision making and finding logical solutions to choose appropriate places to carry out activities. In the site selection, it is necessary to see various parameters in relation to each other. In the present study, in order to identify suitable areas for the construction of a ski resort using the history of the research, interviews have been made with the experts. Three main criteria and eight sub-criteria have been obtained. It should be noted that due to the lack of snowflake network density in the country, the number of snow and frost days and the amount of precipitation have been used. After obtaining criteria and sub-criteria, the indices were weighed using ANP technique and by combining the results with the layers generated in ArcGIS software. The final map of the suitable areas for skiing in Chaharmahal and Bakhtiari province was produced.

Conclusion

After compiling the indices, the final score of each element was calculated using the ANP technique. In the next step, the layer has been combined considering the weights obtained in the layers. After obtaining the indices, the final score of each element was calculated using the ANP technique. In the next step, the required maps were drawn and, by combining the weights obtained in the layers, the suitable areas for the construction of the ski resort were located. According to the findings, about 4.93 percent of the province has the necessary conditions for the construction of a ski resort with an area of 802.77 square kilometers. The main part of the area is located in Koohrang city, the current most famous resort of Chahar Mahal and Bakhtiari province. Chelgaird is also located in this area. The specified level is considered appropriate in terms of technical conditions, which are considered as necessary indicators. If the research

findings are combined with empirical knowledge of experts, the best places in the province for the construction of ski resorts will be located.

Keywords: Zoning, ski resort, susceptible areas, sport tourism, Chaharmahal and Bakhtiari province.

Efficiency of Gravitational Search Algorithm on Land Multi-Objectives Allocation in Optimal Selection of Agricultural Land Use in Birjand Basin

Elham Yusefi Rubiat[*]
Assistant Professor of Environment, University of Birjand, Iran
Fatemeh Jahani Shakib
Assistant Professor of Environment, University of Birjand, Iran
Ali Nakhaei
MA in Computer Engineering, Department of Information and Communication Technology, Payame Noor University, Iran

Received: 12/12/2017 Accepted: 25/09/2018

Extended abstract

Introduction

The background of spatial sustainable land planning is based on the proper position and establishment of the land use activities and their interaction. The suitability should be rooted in three main elements of sustainable development including economic, social, and environmental aspects. To the best of our knowledge, over the past 20 years, significant developments have been invented in the field of artificial intelligence techniques and the tools that can be used to solve many practical geographic problems. The present research aims to introduce a new and effective searching method in order to solve complex, multiple, and non-obvious problems existing in the evolution of land suitability using optimization algorithms.

Materials and methods

The Birjand basin with 3435 km^2 is located in longitude from 88º, 41´ to 59º,44´ E and lattitude from 32º, 44´ to 33º, 8´ N in the northern part of Bagheran mountains.

Employing GSA

This algorithm is designed to simulate the laws of gravity and Newton's motion in a discrete-time environment in search space. The positive features of GSA, including fast convergence, non-stop in local optimizations and computational volume reduction are compared to Evolutionary Algorithms (EA). By the way, there is no need for memory in comparison with other collective intelligence algorithms as a new research field created for researchers. Therefore, in the present study, given the advantages of GSA, its capability was used in optimizing the multi-objective land suitability problems.

The objective functions of optimization model are including:

1- **Maximize the environmental suitability**: Compatibility of land for objective use based on physical, environmental and infrastructure factors requires the mapping of effective factors and their integration.

∗E-mail: e_yusefi_31@ut.ac.ir Tel: +98 9151600625

2- Minimize the Land-use conversion: it results in a decrease in social capital costs and increase in economic benefit of society.

3- Maximize the ecological suitability: it means the preservation of natural features and environmental structures by maximizing the green lands. This can be evaluated using the Ecosystem Service Values (ESV).

4- Maximize the stability of landscapes: in concepts of landscape, compressed forms close to the circle have more stability than shredded structures. This goal is achieved by maximizing compression function.

5- Maximizing the compression function: In the present study, in order to create an integrated and compact surface a circle form was used around the image gravity centers. Besides, the noise and single cells were removed using the image-processing algorithm.

Optimization model constraints

Setting constraint functions were applied in optimization model by considering the flood-protected areas, the areas with a slope over than 70%, amount of demand for agricultural areas, placing a user per pixel, and the total area of the region.

Measuring the efficiency of GSA

In order to evaluate the efficiency of GSA, its results were compared with those of MOLA. At the end, three following approaches were used to compare and measure the efficiency of the algorithm.

First approach: visual evaluation and studying the coherence of allocated spots

Second approach: the use of statistical parameter such as mean and standard deviation of agricultural use suitability.

Third approach: Calculating and analyzing the landscape measures such as a number of plots (NP), plot density (PD), mean shape index (SHAPE_MN), mean plot area (PARA_MN), proximity index (PROX_MN), and cohesion of spot (COHESION) using FRAGSTATS software.

Results and discussion

All objectives and constraints of optimization model were mapped. Therefore, suitability of agriculture use was applied using ANP Fuzzy technique of weight, fuzzier, and constraints (Fig. 1).

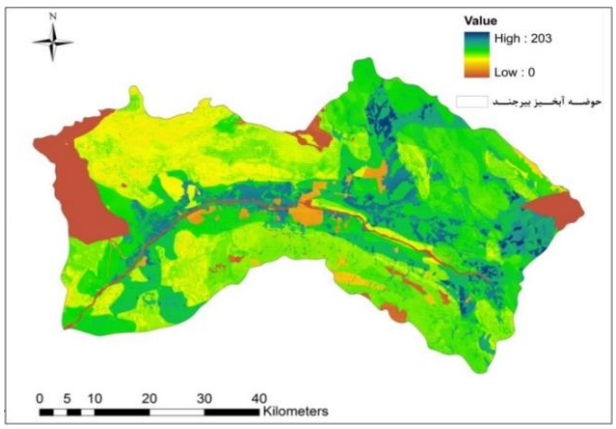

Fig. 1. Agriculture use suitability using ANP fuzzy and WLC

In Birjand basin, the change was mapped from land covers to agricultural use (Fig. 2).

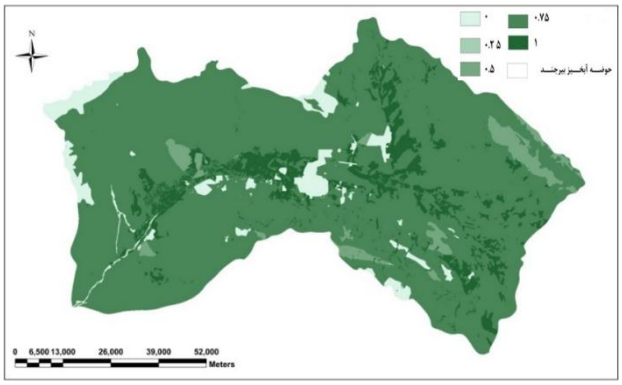

Fig. 2. the ease of change from land covers to agricultural use

The results from maximizing the ecological suitability were modeled using the difference between the present and future ESV (Fig. 3).

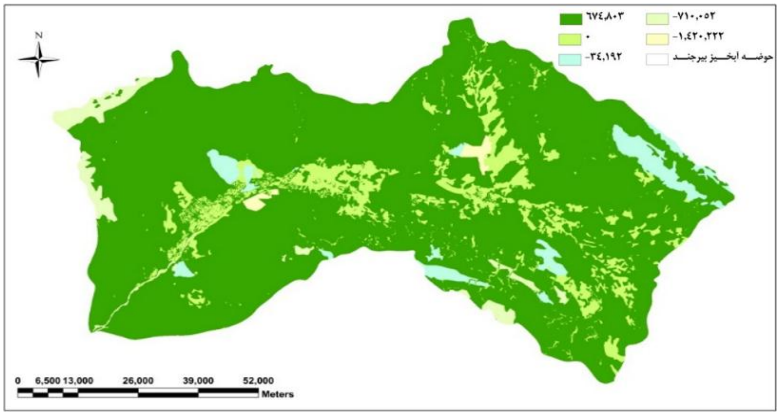

Fig. 3. the difference between the present and future ESV

After fitting all considered objectives and constraints by GSA, the allocation of agricultural use was provided (Fig. 4).

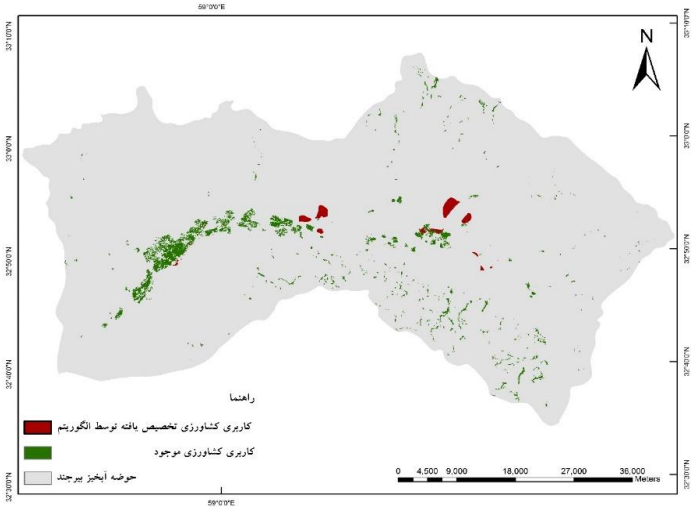

Fig. 4. Allocated agricultural use through GSA

Relative efficiency of GSA

The results of GSA were compared with those of MOLA. The results of allocating agricultural use by MOLA were presented in Fig. 5.

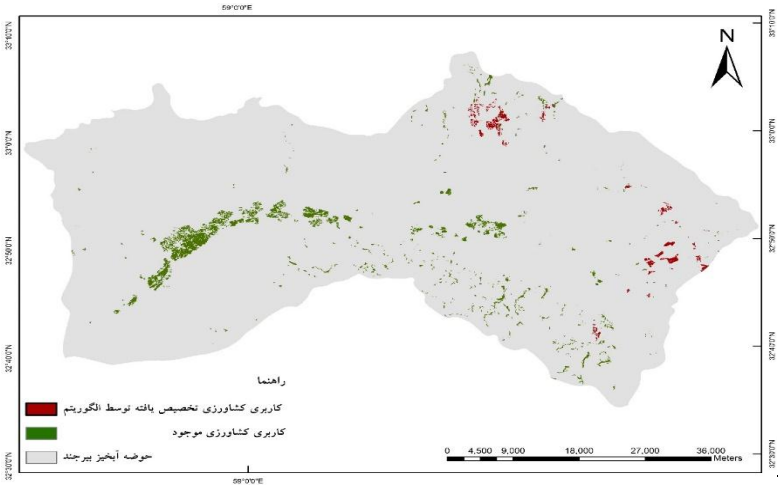

Fig. 5. Allocated agricultural use through MOLA

According to the comparison of statistical parameters, mean agricultural suitability in MOLA had better performance. However, in terms of SD, GSA showed better performance. Besides, analysis of all landscape measures demonstrated the efficiency and relative advantage of GSA compared with MOLA.

Conclusion

In the present research, optimal allocation of agricultural use was carried out using GSA.I In order to measure the efficiency, its results was compared with those of MOLA. The results revealed higher allocated spot for agriculture in MOLA as a disadvantage and higher suitability average as an advantage. On the other hand, since in the GSA, the number of allocated spots was less than MOLA, their suitability was not much higher. The GSA showed the maximum sum of suitability with less spot on the map, which depended on the amount of demand. Therefore, it was a great advantage for GSA. Moreover, analyzing the landscape measures demonstrated the efficiency and priority of GSA compared with MOLA. Finally, it can show that the GSA have higher capacity in solving problems with complex and large space in short time and higher objectives and constraints.

Keyword: optimal selection of agricultural land, Gravitational Search Algorithm (GSA), Meta-heuristic algorithms, Multi-Objective Land Algorithm.