Modeling Flow Velocity and the Area of Erosion and Sedimentation at the Entrance of Arvand River to the Persian Gulf Using GIS

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Extended abstract

Introduction

The rivers usually affected by erosion and sedimentation are subject to various changes in transverse and longitudinal movements and variations in river bed elevation, particle size and geometrical properties. Erosion and sedimentation studies provide the opportunity to identify the behavior of river morphology and the effects of different measures to reorganize its behavioral performance on quantitative and qualitative data. Arvand is a vital river in southwestern Iran serving as the Iran-Iraq border. The purpose of this research is to determine the area of erosion and sedimentation in relation with flow velocity and pollution dispersion in the banks of Arvand River using Coherence model and GIS.

Materials and methods

In this study, three-dimensional hydrodynamic model of coherence is used to simulate the flow velocity in Navier-Stokes equations in three dimensions. Boundary conditions including changes in temperature, salinity and flow rate, temperature and salinity changes are considered and for open border river and tidal components including O1, S2, M2 and K1 are used in open sea in the model. We have used bathymetric maps of the Armed Forces and also hydrographic

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maps in the scale of 1: 25,000 in GIS through digital interpolation. In this study, we employed a computational grid of 80 x 83 meters with an accuracy of 96.52 * 97.48 km. Aerial photos are one of the most effective tools in the interval erosion and unsustainable use. The aim of this study is to determine the scope of erosion and sedimentation in Arvand River using GIS. The GIS is a computer-based technology that uses geographic information systems as a framework for managing and combining data, solving problems and understand situations in the past, present and future applications. The application can identify the areas of erosion and sedimentation in Arvand River and classification of pollution scattering.

Results and discussion

To show the flow rate in different parts of the river, three cross-sections have been gathered in different times and different places upstream, mid-stream and river mouth for measuring the average speed. According to the average values of the speed upstream, it is observed that the water flow rate of are greater on bank of Iranian coast. In the middle and downstream sections of the river, the average flow rate values can be observed as Table 1.

Table 1. erosion and sedimentation in different parts of the Arvand river coast

	Long range (km)	Long range (%)
Sediment on the beach	45.54	62.57
Beach erosion	19.47	26.75
Established beach	7.77	10.67
Total	100	

Conclusion

Most of the beaches in the study area are related to sedimentation, about 62 percent of the length. Due to different horizontal sectioning of speed on the river and the output flow velocity of the coherence we conclude that in the places where the water flow rate is higher, we can observe more erosion, less flow speed, and more sedimentation. The places covered more with the sediments, there is the highest pollution. The average water flow rate on the Iranian coast is higher than the coast of Iraq. As a result, it is observed that the rate of erosion on the coast of Iran is greater than that in the coast of Iraq and that on the coast of Iraq we can see more sedimentation and less erosion. In the mouth of the river, the average speed is lower than that in the middle of the river and on the other side of the river beach. Therefore, there are more sedimentation and erosion on the two shores of Iran and Iraq.

Keywords: Arvand River, sedimentation, Coherence, Modeling, GIS.

Cryopediments and Cryoplanations as the Heritages of Periglacial Periods (Case Study: Eastern Slopes of Shirkuh)

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Extended abstract

Introduction

Cryopediment and cryoplanation are created in arid and semi-arid regions. According to the studies performed around the world, they are usually formed in the preglacial climatic conditions. The cryopediments are very gently concave erosional bench-like landforms that are usually cut into the base of valley sides or marginal slopes of highlands and mountains. The cryopediments developed by cryogenic processes in cold climates of the periglacial climate-morphogenetic zone are mostly created with the presence of permafrost. Cryopediments are developing due to the activity of a range of cryogenic processes whereby frost action, nivation and other processes cause to retreat back scarps. Cryoplanation terraces are bedrock steps or terraces on ridge crests and hilltops. The tread or "flat" area is 10 to several hundred meters wide and long and the slopes from 1 to 5 degrees parallel to the ridge crests. Cryoplanation terraces exist in many parts of the world in present or past periglacial environments. They occur chiefly in non-glaciated regions and near the general altitude of snowline. Cryoplanation terraces are formed by scarp retreat as the result of nivation. Surficial debris is removed across the terrace by mass-wasting. Terrace morphology depends mainly upon climate, bedrock type, and terrace orientation. The aim of this research is to investigate periglacier landforms especially cryopediments and cryoplanation in Tange-Chenar Catchment, located in the south part of Mehriz city, Yazd province. The study region is located in the west slopes of Shirkuh mountain, more than 4000 meters high, from 31° 18´ to 31° 26´ of northern latitudes and from 54° 18´ to 54°29´ of eastern longitudes.

Material and methods

This research has been performed on basis of field studies and direct observation of the basin landforms. Therefore, we visited the area in two time periods involving 13/11/2015 and 30/9/2014. However, we studied topographical and geological maps and DEM for the study area at first. Therefore, the resulted information of the maps is controlled with GPS system in the field. For knowing morphology of landforms and the role of lithology in their formation, we drew geological and geomorphological maps. In addition, to studythe effects of climate on the formation and development of the landforms, we evaluated climate data, especially temperature

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parameters in the past and present time. Thus, we drew isotherm map for cold season using temperatures data of 8 stations for 14 years. To explore the the forming components of the landforms created in the Pleistocene, we reconstructed temperature data for that time using snowline and equilibrium of ice-water line and drew isotherm map for that time.

Results and discussion

The study area in terms of ground morphology and facies is divided into four categories including mountain, hill, slope terraces and pediments. The results showed that the pediments in the region are different from those in warm arid and semiarid region in the world. Although, both of them have similar morphology with the same slope about less than 12 degrees, they have some significant differences. For example, the cryopediments in the study area have been created and developed as a result of the side valleys. Besides, deposits that cover the surface of cryopediments are not alluvial, while, pediments are covered by alluvial sediment and formed by surface water and floods. Also, one or two and sometimes three terraces can be observed on some slope with relatively flat surfaces. The slope values of their surfaces are often less than 5 degrees. Thick sediments and sometimes suitable soil have covered their surfaces. Thus, gardens and farms had been created on some of them. The width of the terraces varies from 10 to 100 meters. Some of them are still in developing state. Most of the surfaces are located above 2000 meters. Thus, there are alluvial deposits on any of these landforms.

The investigation of climatic parameters shows that these landforms must be currently developed. We also drew an isotherms map for cold season of the year. The map indicates altitudes above 2000 meters where have periglacier condition especially in the cold season. Reconstructed temperature of Pleistocene period also showed that periglacial morphoclimatic system has been dominated on most of the study area. The system has provided favorable context for physical weathering of granites and conglomerate which had formed most of the outcrop stones. The periglacial processes such as creep frost, nivation, congelifluction, rill erosion, dell formation and etc. can form landforms and retreat the slopes.

Conclusion

Cryoplanations and Cryopediments are Quaternary landforms developed in the cold periods of the Pleistocene. The processes responsible for carving cryopediments were frost creep, frost heaving, nivation, congelifluction (solifluction over the permafrost table), rill erosion, piping, dell formation (dells acted as main lines of material removal) and backwearing of the back slope. Although, the morphology of cryopediment is similar to those of the pediments in arid and semiarid region, aridity in both environments can influences weathering and slope processes, which results in similar landforms. But they are created in different condition and different processes. Pediments are created by surface water processes especially sheet washes; while, cryopediments and cryoplanations are formed with permafrost processes and, therefore, their sediments are not alluvial. However, cryoplanations are the landforms created in periglacier morphogenetic system with the context of stones of special outcrop. These stones in the region have been granites and conglomerates.

***Keywords: Tange-chenar Basin, Preglacier, Cryopediment, Cryoplanation, Cryogenetic*.**

Calculation of Fractal Dimension of the Geological Formations and Their Relationship to the Formation Sensibility

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Extended abstract

Introduction

Fractal analysis is one of the quantitative modeling of river networks. By determining the fractal dimension of linear structures such as faults, canals, and meandering river paths, it is possible to estimate many features. Fractal of figure is a component with static geometric patterns that illustrates the general pattern of a phenomenon. The initial studies to create quantitative, mathematical, and geometric proper models for river networks were mainly developed by Horton in 1932 and 1945. The study of relationship and comparison between quantitative parameters with fractal geometry goes back to the last two decades.

Study area

The study area is consisted of 12 watersheds including Holeylan, Doyraj, Tangesazbon, Kolm, Nazar Abad, Jezman, Vargach, Chomgez, Chaviz, Siagav, Jafar Abad, and Ema, Ilam Province. Table 1 showed that the formation of study area.

In Table (1), we can see that by increasing the numerical value of resistance degree, the formation sensitivity to erosion is reduced.

In FayzNiya classification (1995) which is based on Rosovski's classification, the rocks with greater resistance have higher value (max 20) and the rocks with lesser resistance have lower value (min 1). Therefore, resistance to the erosion of the existing formations in the study areas can be ranged from 1 to 9.

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Table 1. the details of formations in the study area

Sensitivity to erosion	Lithology	Symbol	Formation name
1	Alluvial deposits of the platform	Qal	Quaternary
5	Alluvial fan	Qt	Quaternary
6	Sandstone, marl, sandy limestone, conglomerate	Aj	Aghajari
3	Marl, limestone marl	Gs	Gachsaran
9	Karstic limestone, dolomite	Sb	Asmari
7	Mliky gray shale and marl with limestone	Pd	Pabdeh
9	Conglomerate and sandstone and siltstone red	Kn	Kashkan
9	The average white to cream-colored limestone marl layers	Tz	Ahak Tele Zang
7	Siltstone and sandstone olive to dark brown color	Am	Amiran
8	Rifi fossils of cream-colored limestone with interlayers of Chile	Ehm	Ahak Imam
9	Thin layer of limestone	Sr	Sarvak
7	Medium to thin and milky gray limestone layer	Il	Ilam

Materials and methods

Extraction of drainage network via ArcGIS

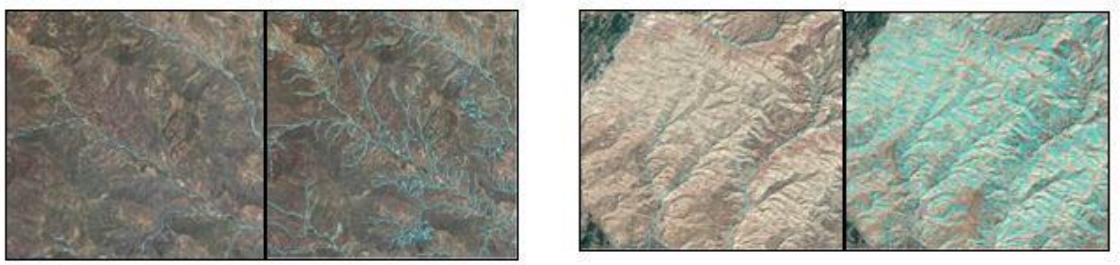
These networks were provided based on 50 DEM coordinates that in many cases, there isn't enough accuracy. Therefore, after transferring data to Google Earth, it was fully matched with the natural drainage and with 5-meter accuracy; hydrographic network map was drawn and completed to reflect the full details of the network.

It is possible to scale the maps via "Fractalys", the fields with the same space of 25 kilometers on similar formations in different areas. For each study formation, three 25 sq. km. fields were selected by the accuracy of 5 meters. These maps had the same drawing accuracy and spacing, in the same scales via GIS on an A4 page in ".bmp" and then were brought to Fractalys and finally, their fractal dimensions were calculated and extracted by the geometric method of counting boxes.

Results and discussion

The results show that a canal with an accuracy of 50 meter on DEM with corresponding 5x5 sq. km pixels has much less accuracy than the drainage networks drawn via Google Earth with less than a 5-meter accuracy. In formations resistant to density changes of the hydrographic network, some have more changes in their fractal dimension as a result.

Google Earth images below are the examples of 25-kilometer zones which their hydrographic networks were revised.



Quaternaryn Gachsaran

Fig. 6. modified hydrographic network of 25 km in Google Earth

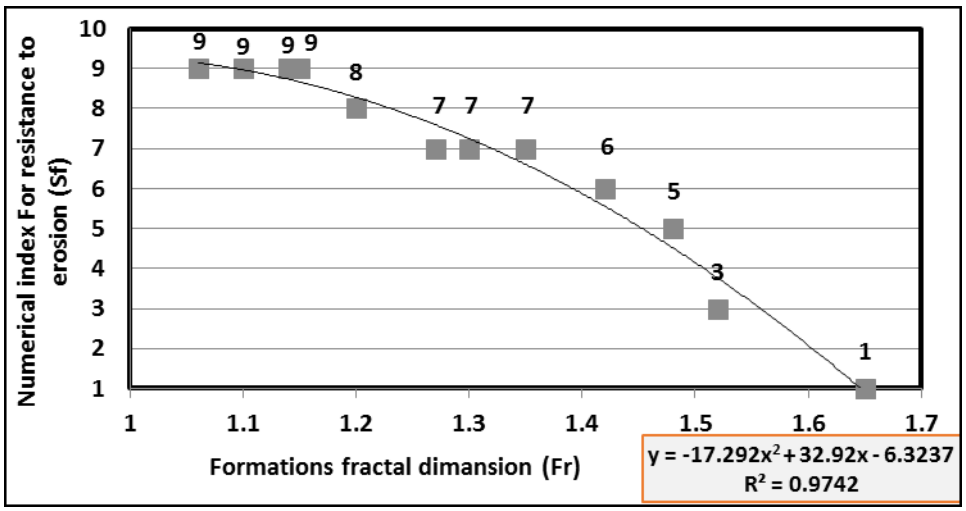


Fig (6) Regression numeric index to erosion resistance (Sf) and formations of fractal dimansion (Fr) after modification of 25 km units

In Fig (6), the amount of R^2 is 0.9742 that shows high correlation and significant relationship of fractal dimension to numerical index for resistance to erosion. By increasing the resistance of the formaion, numerical value of fractal dimension will be decreased.

Table 3 showed statistical analysis between SF and FR.

Table 3. The formations resistance data (from 20) (Sf) and fractal number (Fr) of formations after correcting the 25-kilometer units

		Sf	**Fr**
Sf	Pearson Correlation	1	-965.0
	Sig. (2-tailed)		000.0
	N	12	12
Fr	Pearson Correlation	-965.0	1
	Sig. (2-tailed)	000.0	
	N	12	12

Table (3) shows the values of data correlation (-965). The values are always ranged between +1 and -1. The more close its absolute gets to 1, the correlation coefficient will be higher, and the more close it gets to zero, the data correlation will get lower. As a result, there is a

meaningful connection between formation resistant and fractal dimension. The minus sign indicates a negative data correlation.

Table 4. Regression of the formation resistance values (Sf) and fractal number (Fr) of the areas after the 25-kilometer unit correction

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.965[a]	0.931	0.924	0.05116

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In the table above, "R" is the correlation coeeficient and its value are always between zero and +1 and "Square" is the coefficient of determination. The more closer "R" value gets to 1, the higher the correlation is between two variables. Therefore, the number of 0.965 illustrates high correlation of the formatuion resistance and its fractal number.

Conclusion

The results show that there is a significant and negative correlation between the fractal dimension and hydrographic network. The highest amount of fractal dimension in study areas is for the Quaternary formation of granule (equals to 1.65) and the lowest numeral amount of fractal dimension belongs to "Sarvak" formation (equals to 1.06).

In formations with greater sensitivity relative to resistant formations after the correction of the hydrographic network via Google Earth, more changes are observed in the hydrographic network congestion, thereupon their fractal dimension change is also observerd more.

Keywords: ***fractal dimension, hydrographic network, geological formations, Ilam.***

Contribution of Inversion Management to Controlling the Threshold of Urban Air Quality Index (Case Study: Isfahan City)

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Extended abstract

Introduction

Air inversion is a climatic phenomenon causing increases in the aggregation of pollutants in highly populated and industrial cities. Hence, changes exceeding the air quality threshold would have extensive problems for the citizens. Attention of managers to this problem is mainly referred to as polluting factors. However, in case this phenomenon exists during all the seasons and as the polluting factors have no great changes during the year, some factors can lead to exceed the air quality index from the threshold value. Hence, there can be an approach for reducing the continuity of this situation, if continuity of the inversion leads to such a condition.

The main problem in this study is whether there is the possibility of managing Esfahan air pollution in such a way for to prevent atmospheric pollution density to reach the critical threshold. Therefore, we try to find a model to control the air pollution crisis threshold by relying on the climatic management.

Materials and methods

The research method of this study is mainly relying on an analytical method and dependent on the principles of interpreting the data of climatic and atmospheric pollutants. The subject of air pollution critical thresholds is considered for analysis of the research purposes. Thus, these data are related to a 30-year statistics (1985-2015) from Meteorological Organization and balloon data including pressure, temperature, speed, wind direction, and rains, and the air pollution data from 14 pollution measurement stations belonging to Esfahan Environmental Organization. The

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analyses in various levels enabled us to find out the inversion conditions in different levels. Hence, only the levels of 1670, 1680, and 1860 m were selected due to formation of pressure and temperature among one hundred weather maps. Then, the cellular excitation index (C.E.=f/k) was calculated, where **k=** $\frac{D}{\Delta t,p}$ and "f" is the Newton mass and the temperature and cellular pressure differences. The two indices showed the conditions and possibility of excitation of temperature and pressure closed cells for reducing the continuity of inversion time.

Results and discussion

Given the documentation data and extracted results, we have determined the inversion in the city of Esfahan in terms of the intensity, continuity, and altitude of the inversion in various levels. Thus, the temperature and pressure inversion conditions were investigated for different levels with regards to the balloon data. The inversion analysis for different levels became possible according to temperature and pressure closed cells. The analyses included 100 maps from different altitudes. According to the analysis results, two levels of 1670 m and 1680 m were for the temperature and the level of 1860 m was for the pressure in the closed cells. In fact, the above altitudes were the levels with temperature and pressure cells with the specific differences providing the possibility of excitation. The excitation conditions were finally calculated by the cellular excitation index. Threshold control models for November, December, and January in multiple basis are as follows:

- General model for November includes:

$A.P.C^{*}_{isf.Nov} = (C.M^{**})\ V\ (U.M^{***})$

$A.P.C_{isf.Nov} = (C.E^{****})\ V$ (C.CO or C.SO2)

$A.P.C_{isf.Nov} = (C.E)\ V$ (C.NO2 or C.O3)

*Air Pollution Control

** Climatic Management

*** Urban Management

**** Cell Excitability

- General model for December includes:

$A.P.C_{isf.Dec} = (C.M)\ V\ (U.M)$

$A.P.C_{isf.Dec} = (C.E)\ V$ (C.CO or C.SO2)

$A.P.C_{isf.Dec} = (C.E)\ V$ (C.NO2 or C.O3)

- General model for January includes:

$A.P.C_{isf.Jan} = (C.M)\ V\ (U.M)$

$A.P.C_{isf.Jan} = (C.E)\ V$ (C.CO or C.SO2)

$A.P.C_{isf.Jan} = (C.E)\ V$ (C.NO2 or C.O3)

Conclusion

Statistical analysis of the obtained information from the balloons and atmospheric profile indicate that the inversion phenomenon in Esfahan occurs in different days of the year. In other words, inversion phenomenon may not be considered as the main factor in emergence of pollution crisis, but its continuity in the condition is a factor for increasing the density of atmospheric pollutants to exceed the critical threshold (AQI 150). Hence, it can be stated that continuity of inversion condition can force the concentration of pollutants to exceed the permissible range.

It can be concluded from the statement that occurrence of atmospheric pollution condition can be prevented by two different methods: (1) reducing inversion continuity, (2) management of urban pollutants. Thus, the following statements can be considered as the achievements of this study:

- In the most intensive dominating days of air inversion, pressure and temperature cellular nuclei provide the possibility to manage the continuity duration of air inversion by exciting the cells,
- Regarding the intensity of inversion phenomenon exceeding quality index from the permissible range can be avoided in November and December by controlling the inter-city traffic control, and in January by controlling the industrial pollutants.

Keywords: Isfahan, air inversion, Air Quality Index (AQI), threshold.

Late-Quaternary Landscape Evolution in Response to Active Tectonic Changes in Base-Level, Tabas Region, Central Iran

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Extended abstract

Introduction

The Tabas zone in the central Iran hosts a series of active landforms, which developed during the late Quaternary. Evolution of these landforms has been controlled by many active faulting and folding systems that have developed since Quaternary. Iran forms a relatively compact zone of active continental deformation resulted from the northward collision of Arabian plate with Eurasia plate during late Cenozoic times, which continues to the present-day at a rate of 25 mm/yrs based on GPS data. The evidence of active tectonic in different parts of Iran has been studied by many researchers. The arid climate, low rates of erosion, and minimal vegetation cover across the majority of the country result in excellent preservation and exposure of surface deformation produced by active faults. Geomorphic indices are useful tools in the evaluation of active tectonics because they can provide rapid insight concerning specific areas within a region which is undergoing adjustment to relatively rapid and even slow rates of active tectonics. Alluvial fans are one of the most important landforms that indicate active tectonics and active faults. When a river reaches from high gradient mountains to low gradient plain, aggradations is occurred and alluvial fans are created. At least, five factors influence fan processes including catchment bedrock lithology, catchment shape, neighboring environments, climate, and tectonics. Active tectonics has a very important role in deformations of the alluvial fans. Without continued tectonics, fans and other quaternary landforms might become minor or short-lived features. In this study, we try to investigate the impacts of the active faults in quaternary landforms and morphometry of alluvial fans and morphology in the Tabas playa.

Method and materials

An integrated multidisciplinary approach was adopted to better constrain the morphotectonic evolution of Tabas region and to reconstruct its Late-Quaternary landscape evolution. The procedure is based on the obtained qualitative and quantitative data. The quantitative data includes satellite image interpretation and digital elevation models, alluvial fan and folds morphometry, channel displacement and rate of sediment uplift. The analysis of longitudinal

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and cross profile and gradient variable are used to interpret the active fault effects on folding and alluvial fans. Topography maps (1:25000), Sentinel 2 and Quickbird satellite image with 10 and less than 3 m spatial resolution, geology maps (1:100000) and digital elevation models (10m pixel resolution) were employed in this study. For such interpretation, we have employed ArcGIS, ENVI and Freehand software.

Results and discussion

Tabas area is characterized by active faults and folds. The strike-slip faults are the dominant structures in the study area. However, the reverse faults are the most important for the landscape, because they form canyons and affect the drainage pattern. The study of satellite imagery and geological maps of the area, especially in the west part of the Shotori Mountains, reveals large and numerous alluvial fans, sometimes created to the desert along the lower sections, developed and expanded by the sedimentation of seasonal and permanent rivers. These alluvial fans are joined together in most parts of southern Tabas. According to the criteria for the differentiation of alluvial fans from each other, three types of old, active and midway are identified at the confluence of the Tabas playa and Shotori Mountains.

There are several new folds in quaternary sediments between Shotori Mountains and Tabas Playa. One of them is Tabas (or Sardar) fold in north part of Tabs city. This fold can be seen among the old alluvial fans hardly excavated by Tabas and Sardar Rivers. Sardar River makes a deep gorgeous canyon through this fold. Other folds are Fahlanj and Fosh that take place in south part of Tabas city and the latter located in north east of Tabas.

The faults are important tectonic elements in the creation of various early landforms such as horst, graben, thrust, etc. in the study area that are along the Nayband fault system with a N-S direction. In the east part of the village of Estahpak, an active strike-slip fault series displaces sandstone and conglomerate sediments of Miocene up to 130 meters. Estahpak fault and its lateral branches in some cases are displaced by the Quaternary sedimentary layers, more than330 meters. In Fosha fold, there is a strike slip displacement of Quaternary sediments, about 350 meters. Stream and rivers are so sensitive to tectonic so that they quickly response to tectonic activities. Estahpak strike-slip fault result in displacement of streams up to 390 meters.

According to seismic data from the US Geological Survey, from 1973 to 2016, about 60 earthquakes ranged from 4.5 to 7.4 in magnitudes has been occurred in the region. Meanwhile, the average depth of earthquakes is at an approximate depth of 31 km, as the earthquake centers between depths of 58 - 2 km. The earthquake centers are mainly concentrated in the beginning of the mountain front and immediately after the occurrence of roughness. In 1979, the Tabas earthquake created a fracture with a length of 80 Km along the Tabas fault and killed more than 25000 people.

Conclusion

The tectonic landforms of the Tabas region are consisted of the faults, folds, segmented alluvial fans and diverted gullies. In addition, elevated anticlines indicate young tectonic movements and their planform outlines are affected by faults. From the morphology and the outcrops, we conclude that the Tabas region contains many active strike-slip faults, arranged presumably en-echelon. Secondary features are reverse faults and folds. The age of the associated basins shows that this tectonic system has been active since late Quaternary. Recent faulting activity is inferred from earthquake activity and the morphology changes with young fault scarps. The

findings show that Tabas, Shotori, Baharestan, Feyzabad and Darya faults were active in quaternary epoch. The position and forms of alluvial fans and river channel and folds are affected by the activities of these faults. These faults have had either lateral or vertical displacements. Findings also show that the alluvial fan formed their longitudinal and lateral profiles are affected by Tabas, Darya and Shotori faults. Investigations show that there is no statistical correlation between the variables affecting the alluvial fans. Generally, tectonic activities disrupt natural evolution of alluvial fans. Each fault has a different effect on alluvial fan evolution. Shotori and Tabas fault caused the displacement of the main channel and the formation of river terraces. Therefore, it has also increased slope of this part. Other faults have caused uplift of fan deposits and changed the intersection point and reconstruction of new alluvial fans in the lower part of this point.

Keywords: Tabas, active tectonics, Central Iran, Quaternary landforms.

The Role of Correction Factors in Sediment Source Fingerprinting of the Lake Urmia Sand Dunes

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Extended abstract

Introduction

Over the last decades, sediment fingerprinting technique relative to the experimental models for erosion and deposition processes is now used for its higher reliability and lower uncertainties. Its reliable information give the best indication of sediment yield produced by spatial sources of a catchment and let authorities know how take conservative operations and proper actions across the catchment to stop the soil erosion. Therefore, identification of the dominant processes and sources generating the sediment within its catchment are vital. The western shore of the Lake Urmia, NW Iran, the world's second largest hyper-saline lake has now retreated more than 7 Km from the shoreAs a result, sand dunes and sand ridges are appearing across its western margin. We made an exploration of the geomorphological/lithological units as the sediment feeders out of its western catchment using geochemical data. As the main aim of the present research, we need to correct the contributing factors including particle size, organic matter and tracer discriminatory weighting in recognition of potential changes in fingerprint properties during sediment delivery.

Material and methods

A mixing model algorithm was used to estimate the relative contributions from the potential sediment sources by minimizing the sum of squares of the weighted relative errors.

$$OF = \sum_{i=1}^{n} 0\left(\frac{S_{Sink} - \left(\sum_{j=1}^{m} S_{Source} \cdot P_s . Z_s . O_s\right)}{S_{Sink}}\right)^2 W_i$$

$$0 \le P_S \le 1 \qquad \sum_{j=1}^{m} P_S = 1$$

S_{Sink}: concentration of fingerprint property (i) in the sediment was collected from the outlet;
P_S: percentage contribution from source category (s);
S_{Source}: mean concentration of fingerprint property (i) in source category (s);
Z_S: particle size correction factor for source category (s);
O_S: organic matter content correction factor for source category (s);
W_i: tracer discriminatory weighting;

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n: number of fingerprint properties comprising the composite fingerprint;

m: number of sediment source categories;

The above algorithm has incorporated three correction factors to reflect the impact of element concentration in given sediment load size. The effects of the correction factors into the fluvial and alluvial sediment loads have been approved, what has not been well understood for Aeolian sediments and desert environments. Therefore, the role of the correction factors is to estimate the proportion of each potentially sediment source. Paired t-student statistical method was applied to find out whether there are differences between being correction factors and not being the correction factors.

Results and discussion

As the paired t-student method results show, there is not significant differences between the source contribution before using the correction factors and after using them. However, it is a statistical result and objective function results have another story. According to Table 2, before using the correction factors, Qmf and Qt geomorphological/lithological units with 47.76% and 52.24%, respectively, have the highest proportion in generating the sediment load of the catchment. After implementation of the correction factor, Qf and Klshi geomorphological/lithological units with 67.5% and 32.5%, respectively, have also the highest contribution. Thus, different source proportion was seen with no significant statistic results.

Conclusion

The present research successfully interpreted the impact of correction factors on sediment source contribution of the sand dunes of Lake Urmia. These correction factors are now widely used into the mixing model or objective function to improve the comparability of source and sediment samples. It is inferred that the organic matter correction factor can be used while mineral-magnetism properties of samples are put as the tracers. The particle size correction factor due to its strong influence on many tracers used for fingerprinting is applied, as the relation of grain size to each tracer's concentration is tested. With generating a scatter plot of particle size or organic matter content against tracer concentration for each source group, necessity of correction factor is evaluated. Generally, it is interpreted that applying the correction factors is vital when some other parameters including sediment environments, tracer properties, chronology of sediments, particle size of sediment loads and etc. are preliminary evaluated.

Keywords: sediment source fingerprinting; correction factors; sand dunes; the Lake Urmia.

Analysis of Geodiversity (Case study: Eshtehard County, Iran)

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Extended abstract

Introduction

In recent decades there has been an increasing interest in the earth natural events and this developed three concepts of geodiversity, geotourism and geoconservation. The concept of "Geodiversity" can be defined as the natural diversity of geological (rocks, minerals, fossils), geomorphological (land form, physical processes) and soil features. It covers the assemblages, relationships, properties, interpretations and systems.

There is as much geodiversity in the world as biodiversity. Geodiversity and biodiversity are the concepts evolved from the World Biodiversity Convention, in 1992, in Rio de Janeiro, Brazil (Rio-92). Serrano and Ruiz-Flaño (2007) and Serrano et al. (2009), through detailed geomorphological survey, applied the spatial distribution of geodiversity in Spain, based on the study with a wide range of mapped elements of geomorphology, geology, hydrology, soil, and active processes.

Zwoliński and Stachowiak (2012) carried out research on geodiversity in a protected area that also served as touristic attraction. The evaluation carried out based on some elements such as waterfalls, rock types, cavities, landforms, slopes, presence of lakes, altitude, watercourses on cliffs, soil, and geo-ecological structures. Instead of a variety of elements, the applied method was based on map algebra, as the elements were given different scores. It can be concluded that the mountains with steep cliffs are more geodiverse areas. Manosso & Nóbrega (2015) calculated and analyzed the distribution and the diversity of abiotic elements in landscape units. The sample units were compared according to geological, geomorphological, hydrographical, and pedological elements, as well as land use and habitation.

Haririan (1990) was the first to present a definition of geodiversity in Iran. In his view, the formation of geological diversity depends on the diversity of internal and external processes. Sepehr (2013) also expressed the natural hazards and geodiversity by paleo-geomorphological evidence. As the geodiversity has been affected by complexity of process and time, he has presented a geo-system analysis. Ba-tajrobe et al. (2016) offered the geodiversity map of

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Mashhad City based on the analysis of landforms sensitivity to erosion and weathering. The purpose of this work is to perform a quantitative evaluation of geodiversity in 3 units in Eshtehard County, the southern part of Alborz province, Iran.

Materials and methods

In this study, we have used some data including 1:50,000 scale topographic maps, 1: 100,000 scale geological maps, Googleearth satellite images, Digital Elevation Models (DEM), library resources and field observations. To check the type and distribution of geodiversity elements in the study area, the following five steps were performed using Geographic Information System (GIS):

- The border of the study area was determined using maps and satellite images.
- Geomorphological units were determined based on the three landscape units including plain, hills and mountains.
- Ground elements in the region, using satellite imagery, topographic maps, geological maps, soil maps, hydrographical maps and field observations were also identified.
- Required maps using GIS mapping and photographs of the field works are prepared and evaluated.
- Geodiversity index was calculated for each unit and comparative analysis was performed.

In order to evaluate geodiversity condition in study area, we have used geodiversity index (Serrano and Ruiz-Flaño, 2009) as follows.

$$GD = \frac{Eg.R}{Ln\,S}$$

where GD is Geodiversity index, Eg is Number of abiotic elements, R is Roughness of the relief, and Ln S is Log of the sampling area. Index (R) was calculated using the topographic relative position method in GIS and was placed in Formula 1. The final step is presentation of the concept of protection and maintenance conditions in the study area.

Results and discussion

The diversity of abiotic elements in Eshtehard is not only in terms of geological diversity but also in terms of soil, hydrological conditions and landform. Eshtehard playa is an evidence of environmental changes during the cold periods of Quaternary. According to previous studies, it has been an old lake bed during quaternary. Salt River, in this context, is ongoing and will eventually connect that to Hoz-e-Sultan Lake.

Rainbow-colored hills in north part of the Eshtehard are one of the most remarkable landscapes in the region. Within the colored hills, there are some features including a seasonal lake, salt cave and two different springs as geodiversity features in the hills. The marl hills and stone houses in the northwest part of Eshtehard are other perspectives of the unit G1.

The area in south part of the Eshtehard is surrounded with Halqe-dar and Tavreh mountains. The maximum height of the mountain is 2,000 meters above the sea level. The important differences in unit G3 rather than G2 and G1 are presence of several springs and variable volcanic stones.

The highest (R) is related to unit G1, 0.4745 GD. Most of the abiotic elements are in G3 unit (60 elements) and the least are located in G1 (30 elements). After calculating the parameters, we

realize that the greatest geodiversity index belong to G3 (4.716) in the South Eshtehard area; because of high level of diversity in hydrologic and lithological elements.

Finally, because of importance of abiotic phenomena in study area and high level of geodiversity, geoconservation activities are necessary for valuable land resources; for management of the geotourism capacity.

***Keywords: Eshtehard, geoconservation, geodiversity, geotourism, landform*.**

Accuracy of Various Interpolation Methods in Estimating Rainfall Values to Select the Most Optimal Algorithm (Case Study: Kurdistan Province)

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Extended abstract

Introduction

Continuous spatial data of environmental variables are often required for environmental sciences and management. However, information for environmental variables is usually collected by point sampling. Thus, the methods generating such spatially continuous data from the point samples become essential tools for many environmental analyses. Spatial interpolation is the procedure of estimating the value of un-sampled points using existing observations. The methods for spatial interpolation can be classified into two main categories as deterministic and geostatistical. Deterministic interpolation techniques including Inverse Distance Weighting (IDW), Radial Basis Function (RBF), and so on calculate the values of un-sampled areas based on the known values of the sampled points and create surfaces from measured points. However, Geostatistical interpolation techniques, e.g. Kriging use statistical properties of the measured points to quantify the spatial autocorrelation among the measured points and account for the spatial configuration of the sample points around the estimation location.

Materials and methods

In this study, to assess the accuracy of the various interpolation methods to estimate the rainfall distribution of Kurdistan Province, we have used data from rain gauge stations, and synoptic and climatology data. After reviewing the statistical situation of the stations, statistical period of 2001-2013 has been selected. Among all stations in the basin, the stations which had 12 years of full or recyclable statistics until 2013 were selected for the study. It must be noted that the selection of the stations was according to their statistics rebuilt by the application of the highest correlation with the adjacent stations. Finally, normality of data quality and data sets were recorded and evaluated using Komogorov-Smirnov and Chi square X2 statistical tests. In addition, we have used the digital elevation model data collected by the SRTM satellite sensors with spatial resolution of 30 m. We have also employed analytic functions of the ArcGIS 10.2.2, Surfer 11, and IBM SPSS Statistics 22. After reviewing data on existing stations (77 Rain gauge

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stations, 22 synoptic and climatology stations of the Meteorology Organization, and 76 Rain gauge stations and evaporation stations of the Department of Energy), we have rebuilt the missing rainfall data and selected the minimum length of the statistical common period for less than 10 years. The normality of data has been evaluated to select 145 stations for the analysis of the interpolation methods and choosing the best method. The methods used in this study were IDW, Spline (with Tension, Thin Plate and Completely Regular functions), Ordinary Kriging (with Circular, Spherical, Exponential, and Gussian functions), and Universal Kriging (with Rational Quadratic and Liner functions).

Results and discussion

In order to conduct this statistical analysis, the data should be normal. Therefore, the average annual rainfall values of the Kurdistan Province were tested for normality. In this research, Komogorov - Smirnov and Chi square X2 tests in SPSS have revealed that the data have the normal distribution. In order to analyze the accuracy of the various interpolation methods, the models were implemented using the ArcGIS application. By applying each of these models on rainfall data, the maps were obtained. In order to evaluate and determine the most optimal model, the validity and the accuracy of the maps were evaluated. As it mentioned in the previous section, the more the Mean Absolute Error (MAE) and the closer Mean Bias Error (MBE) to zero, the accuracy of the model is higher. On the other hand, the less the Root Mean Square Error (RMSE) and the higher the correlation coefficient (R2), the less is the model error is. The results also show the error rate of implementation of the interpolation methods. Based on the findings of the study, the lowest error is related to the Ordinary Kriging Method with the circular function; and after that, it is related to the General Kriging Method with the Quadratic Variogram. In general, the Kriging method provides results with higher accuracy than those of other methods.

Conclusion

In this study, the models of the deterministic and geostatistical methods were compared with each other to find the most suitable spatial interpolation method in Kurdistan Province. To compare the actual results, the same conditions were used to assess the accuracy. Then, the most important methods of the validity were extracted and identified: Mean Absolute Error (MAE), Mean Bias Error (MBE), Root Mean Square Error (RMSE) and correlation coefficient (R2). Ordinary Kriging Method of interpolation with the circular function had the highest accuracy compared with the other methods. One of the most important factors to achieve high accuracy in this method is its ability to depict the non-bias linear estimation. However, other methods, especially the Universal Kriging with Quadratic function, due to the use of local procedures offers an acceptable accuracy.

Keywords: accuracy assessment, Kordestan Province, estimated distribution of precipitation, interpolation.

Factors Affecting Hydrodynamics of Arvandrud Delta Coastline during 1955-2016

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Extended abstract

Introduction
A shoreline is defined as the line of contact between land and a body of water. The most effective processes on the changes of coastal morphology are wind, wave, marine current, tides and human activity. Prodelta of Arvandrud delta, as the largest delta of the Persian Gulf, has very low slope in foreshore. Historical data of the last 60 years show that the shoreline experienced transgression and degradation several times. The aim of this study is to assess shoreline displacement rate and the factors affecting that.

Materials and methods
In order to gain an understanding of the effective factors on shoreline changes, we have analyzed flow rate and sedimentary changes of Ahvaz (Karun) hydrometric stations statistics, area tidal data, wave rose, wind rose and current rose statistics. To determine the spatial and temporal changes in the shoreline, we have also used Cartosat (2011) and Landsat (1973, 1982, 1994, 2002, and 2016) satellite imagery and aerial photographs (2016). To calculate the rate of the shoreline changes, DSAS (Digital Shoreline Analysis System) method was used. In this study, upper limit of tidal zone (Diurnal) was selected as shoreline for all time periods.

Results and discussion
Shoreline position in periodic changes in the years 1955-2016 show that shoreline has had progradation in most areas. Increases in 3.98 km during the last 60 years indicate this

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sedimentation rate in shoreline. Shoreline progradation, has been notable at the mouth of the Arvandrud. Recent progress is related to the period 1955 - 1973. Relatively stable parts are mostly in the east part of the area. These areas have been the old mouths of Karun River, which has been now converted into estuary. The speed of dominant wind is 3.5 m/s and frequency is 62%. Since the direction of dominant winds of the region are northwest, wind factor can't play an effective role on the shoreline morphology changes of this region. The directions of dominant waves also are from the NW. About 72% of the wave's heights are at 0.02- 0.99 meters. Only affective waves in this area are those with southwest and south east (diagonal) directions. These waves, according to the frequency and lower height, have the longest distance from the shore. The directions of marine currents are from NW-SE in this area. This current carries water and sediment of Arvandrud and Bahmanshir rivers from east to west. More than 51% of the marine flows have the velocity about 0 - 0.05 cm/s that can affect shoreline morphology. The results can also show the level of the tide in this area of the Persian Gulf (except Khore Musa) at its maximum. The maximum and minimum heights of sea water are 322 cm and 32 cm progress in land (backshore), respectively. To understand the reasons of the shoreline progress, during dam construction upstream Karun River in Ahvaz, especially from 1975 until now, trend of water and sediment discharges into the mouth of Arvandrud has been gradually reduced. In the years of 1973-1955, Karun River has experienced one of the highest peaks of water and sediment flow to the Arvandrud. This has been coincident with the most shoreline progradation. An increase in the flow rate and deposition in this period correspond to the time with less number of built dams on the Karun River in comparison with the next periods.

Conclusion

Dynamics of water and sediment flow transport of Arvandrud to the shoreline has been introduced as the main factor of propagation in this part of Persian Gulf shoreline. Delta-making process had been the largest in the area between the years 1955 to 1973. This progradation has been associated with one of the highest peaks of water and sediment flow to Arvandrud. Marine currents (local scale) with direction of east to west and Coriolis factor with regional scale have played a major role in shaping shoreline convexity and development of spits to the west. The results of this study have been conformed more or less to the findings of Yamani et al (2013) for the period 1977-2005 and Ranjbar and Iranmanesh (2011) for the period 1955-1992.

Keywords: Arvandrud Delta, Persian Gulf, Digital Shoreline Analysis System (DSAS), coastal hydrodynamics.

Analysis of Iran Temperature Structure Based on ECMWF, ERA Interim Version

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Extended abstract

Introduction

Air temperature is one of the most important climate measurements in the human environment, which directly affects the physical and biological processes of the ecosystem. Understanding this climate measure can be the basis for understanding many climatic processes, especially evapotranspiration (due to the climate of Iran). Reanalysis have been used in recent years in many studies, including the studies about climate trends, climate modeling, and the assessment of renewable resources, and their high accuracy. The purpose of this present study is to evaluate the accuracy of the open-baseline base temperature data of the European Centre for Medium-Range Weather Forecasts (ECMWF) of the ERA-Interim version with a 0.125 × 0.125 arc-spatial resolution in a survey with observational data from the weather stations and the National Bassoon database. In this regard, we have evaluated the temporal changes of the temperature of Iran.

Materials and methods

In this study, we have used data from 32 weather observation points during the statistical period of 1979-2015 to validate the ESFAZRI national Database. ERA-Interim, also produced by ECMWF, uses 4D-variational analysis on a spectral grid with triangular truncation of 255 waves (corresponds to approximately 80 km) and a hybrid vertical coordinate system with 60 levels. The ECMWF global model is used for the forward integration in the 4D-variational analysis and the temporal length of the variational window in 12 h.

As stated for the validation of the temperature data of the ECMWF database of the ERA-Interim version, we verified the cells of this site with the data of the 32 well-selected stations in the period 1979-2015. The nearest cells were selected to be sampled. To verify the two data sets, the R2 and RMSE indices were used. In order to evaluate the changes in Iran's monthly temperature, fractal dimension was calculated.

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Results and discussion

The results of the validation between the European Centre for Medium-Range Weather Forecasts (ECMWF) and the ERA-Interim Emission and Interim National Projections for the period (1979-2015) showed that this base has a high performance, as observed in most of the pioneering cases. In the section, more than 98% of the coefficient of determination between the data of this base is observed with the data observed and recorded in the observer weather stations of the country. In the following summer, the fractal has reached its maximum value, reaching 1.63 in August for its growth over the year. Accordingly, the fractal dimension is increased and this increase reflects short-term variations, which means that the standard error also increases. In the cold period of the next year, fractals showed a decrease in value, reflecting short-term changes.

In the cold season from December to March, the average temperature varies from 7.2 to 7.3. The minimum air temperature varies from -3 to -6 degrees, and the maximum air temperature from 21.4 to 23.0 degrees. The dispersion of the December temperature values is more than that in January and February. The data distribution was observed positively at 0.51 in December, 0.41 in January, and 0.30 in December. In the cold months, the temperature distribution is more positive and, in fact, the values are less than the average values of a higher frequency.

The average temperature in June was 28.2, 30 and 29 degrees Celsius. The range of changes in June, July and August was 22.3, 20.3 and 19.6, and the temperature diffraction in these months was also 27.9, 20.19 and 18.4, respectively. The range of changes and dispersion in the months of July and August is higher than that in September.

Conclusion

This study evaluated the mean air temperature based on the ERA Interim version of the European Centre for Medium-Range Weather Forecasts (ECMWF) data model. The results showed that the model was able to measure the temperature in the long run. The average of air temperature in all months of the year with the spatial component of the latitude has the highest correlation coefficient. The fractal dimension of the air temperature in the cold months is less than the warm months of the year. The highest fractal dimension occurs in the months of July and August coincident with the warmest periods of the year. This indicates short-term changes due to the stability of the systems in the warm period of the year and long-term changes due to the variety of macro-scale systems in the cold period of the year. This statistic for Iran's temperature indicated that the climate and, more specifically, temperature are a complex and non-linear system composed of different measures and interactions.

According to the results, it can be stated that the southern regions of the country on the coast of Oman Sea and the Persian Gulf and the northern Persian Gulf in Khuzestan province require to consider the days of cooling demand in the warm months of the year in order to adjust the air temperature for providing comfort in these areas. On the other hand, the pattern map for each month showed that the Northwest, high Zagros and Northeastern regions required more attention in terms of heating in the cold months of the year.

Keywords: reanalysis database, ECMWF, air temperature, fractal dimension, Iran.

Impacts of Climate Change on Canola Yields and Phenology (Case Study: Chahrmahal Va Bakhtiari, Iran)

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Extended Abstract

Introduction

Climate has a key role in plant growth process and, therefore, it is clear that climate change will directly affect sowing and harvesting of cultivate crops. Many scientists used APSIM to simulate the phenology and yield of canola. To understand the impacts of climate change, it is necessary to project the future climate based on different emission scenarios. These results must be combined with simulation models to predict crop yield and phenological stages. Assessment of the impacts of climate change on phenology and yield of agricultural crops in different regions show different results. The aim of this study is to investigate the impacts of climate change on phenological stages and yield of Canola by APSIM-canola modules.

Materials and methods

Chaharmahl va Bakhtiari in the southwestern Iran is one of the main agricultural production zones in Iran. The soil physical properties were obtained from Agricultural Research center of Farokhshahr. Required meteorological data including precipitation, solar radiation, and daily maximum and minimum temperature were obtained from 6 synoptic weather stations in the study area. The data were used after quality control process. The meteorological data have been converted into compatible text format with APSIM.

Biometric data and phenology

Canola has several varieties. Okapi is one of the winter varieties which were recommended for the study area. Agrometeorological data, including phenology and biometry from 2001 to 2010 were gathered and summarized. The canola phenological stages are including planting, germination, emergence, the first true leaf, rosette, ceasing of the winter growth, budding, stem

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elongation, flowering, pod, ripening and harvesting. Farming management information such as the amount of fertilizer, irrigation and frost and pest were also recorded. A total of 1700 phenological stages were used over the 10 years of crop evaluation.

Future climate data

Climate change data were downloaded from one of The World Climate Research Programme (WCRP) project so called Coordinated Regional Climate Downscaling Experiment (CORDEX). We used CORDEX MENA data in which the simulations were performed on a rotated grid with the pole at 180°W longitude and 90°N latitude. The domain covers roughly the region from about 27°W to 76°E longitude and 7°S to 45°N latitude. The simulations were carried out using two different resolutions: 0.44° (approx. 50 km) and 0.22° (approx. 25 km).

Model description

Agricultural Production Systems Simulator (APSIM) is known as a highly advanced simulator agricultural systems in the world. There are 43 selectable varieties of spring and winter canola on APSIM v 7.7, but none of them are now cultivated in the study area. Germination, emergence, end of juvenile phase, flower initiation, flowering, grain filling and maturating are seven simulations of the phenological stages.

Results and discussion

For simulation of each phonological stage, elapsed time from sowing to the first day of reaching at each stage was counted. Water stress, nutrition, photoperiod, and vernalization have influence on the phenological stages (Zhang et al., 2014).

The highest RMSE was in the simulation of the days after sowing to maturity (DTM) stage with 5 days and bias error was -0.7 days. Greatest bias error occurred in simulation of the days after sowing to emergence (DTE). The correlation coefficient of the DTG and DTE was not statistically significant and this indicator in the other stages (P-Value = 0.01) is significant. The strongest correlation was obtained between observed and simulation of the days after sowing to flower initiation (DTFI) and the days after sowing to flowering (DTFL).

Because of the crop management, soil and water conditions, simulation was conducted in three cases of poor, middle and high management. The RMSE in estimation of yield was 329.8 kg/ha which included 7.2% of canola average yield on the study area. The rate of Bias error was 18.2 kg and correlation between actual and simulated data was 0.96. We considered every year of farm management, nutrient and irrigation in the simulation. The results showed that APSIM has reliability skill in simulation. Based on scenario RCP8.5, the DTE, DTFI, DTFL, DTEGF and DTM stages will be reduced from 1 to 13 days and the maximum reduction can be seen in the flowering and grain filling phases.

The results of data from RCP4.5 showed that DTFL and DTEGF stages will decrease from 2 to 3 days and that the greatest rate of decline was observed in the flowering period. DTEJ, DTFI and DTM stages will rise following that. DTFI and DTM stages will be increased up to 3 days. Similar to RCP8.5, DTEJ will be raised up to 9 days. It is expected that with RCP8.5 scenario the average of yield on the optimal nutrition and management will be increased to 18%; whereas in poor management conditions of the yield will be increased 18 and 13.6 percent.

RCP 4.5 in optimal nutrition and management will be increased 13.4% and in intermediate and poor management it will raise about 14.3 and 13.6 percent. This suggests that without water limit, global warming will have positive impacts on canola yield in this area.

Conclusion

The study revealed that APSIM could simulate the yield of canola with RMSE 320 kg/ha. The results showed that with RCP8.5, phenological stages including DTE, DTFL and DTEGF and DTM will be declined. With RCP4.5, phenological stages including DTFL and DTEGF will also be shortened. The higher rate of decline was observed by RCP 8.5 scenario. DTEJ on RCP 8.5 and RCP 4.5 will be longer in 10 days and 9 days, respectively. It is expected that canola yield will be increased in both studied scenarios in optimum nutrition about 18%, more than 13 percent in average and up to 18 percent on low nutrient. The outlook of Canola-Okapi yield increase in Iran show a good potential for planting of this variety and this product will be developed in 2030 plan.

Keywords: Canola-APSIM, CORDEX, RCP4.5, RCP8.5, phase, yield, phenological stages.

Environmental Consequences of Water Resources Instability in the Zayandeh-Rud Basin

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Extended abstract

Introduction

Water has been a major issue for sustainable development in the twenty-first century. It has been so essential that some experts believe that water issues will become a major crisis in the coming years and will result in regional wars and even a world war to gain dominance over water resources. Instability of water resources resulted from drought or water shortage has affected many countries throughout history, especially in the arid regions. This instability had caused many losses and resulted in many severe consequences in the economic, social and environmental sections. Zayandeh-Rud basin in central Iran is highly encountered with water problems. Zayandehrood River originates from Zardkuh Bakhtiary Mountains. It is the most important river of this region for the development of agriculture, a necessary supply for industry and an important supply for drinking water. It can also feed all of the economic activities. Climate instability in recent decades caused increasing pressure on the river by depleting too much water from that to compensate for the water shortage.This pressure led to instability of agricultural water resources and droughts in recent years. This research has tried to study the environmental consequences of water resources instability in the river basin by using analysis of land use changes on two different time periods to assess the changes in the number of wells and the exploitation of the groundwater reservoirs. We have also distributed questionnaires to analyze the effects of drought downstream the basin.

Materials and methods

In this research, we have applied library research data from book, papers, and basic written resources from National Forest and Land Organization and also Iran Water Resources Management Co. Field survey have also been employed using observation, interview with experts and distribution of the questionnaire. Accordingly, three different methods have been used in this research:

Detection of changes in land use: All of the basic data of this section are prepared by "Land Use National Plan" from the "National Forest and Range Organization". In addition, the experts' views were used in all of the phases of the research. These maps were created between 2002 and 2013 and their authenticity was confirmed officially. The study area in this research is

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Zayandeh-Rud River Basin. The zone of the study area was specified based on the defined goals of research and experts' views. Then, this zone was mapped in "Google Earth" and the study border area of the research was defined from the basic map of National Forest and Land Organization of Iran". The Study area of the research was divided into three sections. The Land use basic map in "National Forest and Land Organization" had twenty-two items that were merged into nine land-uses. Change detection analysis was conducted by ArcGIS software using Union program and are shown by the maps, tables and descriptive information.

Changes in groundwater: The basic data of this section were gathered from "Iran Water Resources Management Co. and Esfahan Regional Water Authority. Changes in the number of wells, Qanats and springs and also the depletion level of the groundwater and also changes in reservoirs of groundwater aquifers in the Zayandeh-Rud basin is processed in two statistical years 2006 and 2011.

Consequences of water resources instability on environmental indicators: The statistical population of this research is the villages of a region downstream Zayandeh-Rud basin. The sample was selected based on Cochran formula and in the form of Stratified Probability sampling. The study area downstream the river, from Isfahan city to Gavkhoni marsh, is divided into two parts, Western and Eastern, according to geographic, socio-cultural and political indicators. Out of 33153 rural households, 380 people completed the questionnaires and by removing the incorrect questionnaires our cases became 323 people during the study. The estimated sample of rural settlements is 25 villages. Using the questionnaires in the study area, we can analyze and compare these indices before and after the drought. In the following, average values of research triple indices are analyzed in SPSS software. Then, the results are analyzed by one sample T-test and compared in significant differences of impact of drought in various rural districts with ANOVA test.

Results and discussion

The comparison of land use maps in 2002 and 2013 of the study basin indicates that dry farming, agriculture, forest, residential settlements and marshland uses have been increased while water surface, canebrake, and deserts as well as rangelands have been decreased during this period. Examination of groundwater indicates that after water sources instability has increased level the exploitation of groundwater aquifers is intensified. It increased in the middle and downstream sections of the basin where the river flow is not permanent. The water shortages by drought are intensified by drilling and exploitation of water from wells. In this context, in 2006-2011 up to 9277 numbers of new wells are drilled. During these five years, average depth of wells is added 4.8 meters and groundwater level has dropped about 5 meters. Analysis of qanat statistics indicate that due to droughts, the qanats water resource is drained almost halved and the number of springs has also declined. To assess the environmental effects of Water Resources instability, we used 13 indices. The highest impact of drought on environmental indicators is in drying qanats, wells and springs, reducing the amount of surface water and increasing the depth of water wells, decline in groundwater levels. The least effect is seen on the indicators as follows: increase in fire in the natural environment of the region and reduction of medicinal plants. The average values of environmental impacts of droughts are 4.24. The results show that there is no significant difference between rural districts in study area

in terms of the impact of drought; this means that the rural districts in study area are relatively similar to the impact of the negative consequences of drought in various aspects.

Conclusion

This process of development is dangerous for human and environmental sustainability in Zayandeh-Rud river basin. The development of the human residence and overuse of the natural resources give rise to the destruction of nature and the natural ecosystem. The disruptions in the ecosystem in such a short time have misbalanced the sustainability of water resources and have negatively affected plant, animal and human ecology. The continued development of residences and the alteration of the land use will heavily damage the sustainability of the environment in Zayande Rood Basin. Increase in exploitation of the aquifers can escalate the cycle of water resources instability, drought and ecological unsustainability.

Keywords: environmental consequences, land use changes, Zayandeh-Rud Basin, groundwater, instability of water resources.