Exploring the Relation of Snow-Covered Days with Elevation, Slope and Aspect in Iran

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Received:30 June 2015 Accepted: 7 September 2015

Extanded Abstract

Introduction

Snow is a kind of precipitation that is formed by the condensation of moist air mass and in the condition that temperature is below freezing point. Although small areas of the world are mountainous regions, these small territories play an important role in the hydrological context of river basins. In some areas snow covers and glaciers supply drinking water. Monitoring and forecasting of snow cover areas are essential for the promotion of climatic predictions and water-related decisions, particularly in mountainous regions where a great proportion of needed water is provided. Some works have been conducted about the influence of elevation, slope and aspect on the distribution of snow-covered days. In this part, some of these works have been reviewed here. Endrizzi et al. (2006) have indicated that there is a relation between snow water balance, elevation and aspect. They found that the dependence of snow water balance on elevation is poor in fall and strong in the spring. Gurung et al. (2011) have indicated that in Bhutan the accumulation of snow is varied based on aspect. North-east and north-west facing slopes are favored areas for snow accumulation in the seasons of winter, summer and fall.

Materials and Methods

In the present paper, MODIS Terra and MODIS Aqua data were used to explore the relation of snow-covered days with elevation, slope and aspect. The selected study period covers the years from 2003 to 2014. As MODIS Aqua data are missing before the year 2003, we had to limit the study period only to the aforementioned years. The data of these products were downloaded in daily time scale. Before the analysis of the data, we applied two different algorithms to minimize cloud contamination that is a big hindrance against snow cover monitoring. One of the applied algorithms is based on three days filtering and the second is made on the combination of the two products. By exploiting these algorithms, we managed to reduce cloud cover

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considerably. In the second step, we started analysis of the data by creating different codes in MATLAB. As the spatial resolution of the data was in 500 meters, we needed a Digital Elevation Model to be consistent with snow data both in spatial resolution and projection system. Therefore, a DEM with these conditions was obtained from NASA. In the applied Digital Elevation Model, the information of aspect and slope for each of the grids was available. In the next step, we developed some codes in MATLAB to explore the relation between elevation, aspect and slope.

Results and Discussion

The considered relation between the number of snow-covered days and elevation indicated that there are three patterns in this way. Up to the elevation of 700 meters the number of snow-covered days does not increase by the increase of elevations. In the elevations between 700-1700, the number of snow-covered days shows a gradual increase, but in the elevations between 1700-3200 the number of snow-covered days experiences a significant increase by the changes in the elevations. Above the elevation of 3200 meters, the behavior of snow-covered days does not show a clear pattern. Thus, it can be concluded that the number of snow-covered days does not show a linear pattern. The analysis of slope indicated that the snow-covered is the most frequent in the slope of 25 degree. Above this slope the snow-covered days become less frequent. The analysis of aspect indicated that the numbers of snow-covered days are observed frequently in the north facing slopes and less frequent in the south and south-west facing slopes. In another part of this paper, the profile of snow-covered days and other parameters like aspect and elevation was investigated over three mountains of Sahand, Karkas and Lalezar. The obtained results confirmed that in the east and north facing slopes the number of snow-covered days is more frequent than their western and southern counterparts.

Conclusion

In this study, MODIS Terra and MODIS Aqua data were exploited in order to investigate the relation between snow-covered days with elevation, slope and aspect. The study period of the present study is ranged from 2003 to 2014. Before using the daily raw data, two fundamental algorithms were performed on the initial data to minimize cloud cover. After reducing cloud cover in the raw data, we started analysis by creating some codes in MATLAB. The obtained results indicate that in Iran the relation between snow-covered days and elevation does not depict a linear relation and in each of the elevation zones the behaviors are completely different. The most important direction of snow-covered days and elevation was seen in the elevations between 1700 to 3200 meters. The analysis of aspect show that north facing slopes has a good potential to be snow covered during the year. The analysis of slope indicated that in slope of 25 degree, the numbers of snow-covered days are the most frequent in comparison with the other slopes. Therefore, the slope of 25 degree is, indeed, the critical slope in this country.

Keywords: aspect, elevation, Iran, Modis Aqua, Modis Terra, slope, snow-covered days.

Evidence of base Level Changes of Mighan Playa in Quaternary and its Effects on Morphology and Alluvial Fan Sequences

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Received:10 December 2013 Accepted: 17 January 2015

Introduction

Interaction between internal and external processes of the earth during time plays an important role in formation and landforms transformation. We can identify course of their process changes with landform survey. In the middle parts of Iran, there are several geomorphologic evidence of arid and rainy climate changes. Playaes and lakes or generally internal holes had an important role in climate balance and ecological changes in the quaternary on its surrounding areas. Therefore, previous studies have always attempted to determine past climate. Morphology and alluvial fan deposits contain traces of past environmental changes. The key issue is that which tectonic factors determined changes in alluvial fan processes and climatic and or geomorphological conditions of alluvial fans.

Materials and Methods

To conduct this research from fieldwork, we have used sediment core data of wells and further satellite imagery and digital elevation data with different scales in different software. In this research, sediment core of wells on surrounding areas of Mighan hole were compared with interpolation of their common areas to determine maximum spread of the lake. The extraction of alluvial fans, according to region morphology, are compared and analyzed with geological structure and location, region drainage basins, base level changes and alluvial fans sequence in northern part of pit (Ashtian's alluvial fan) and the southern part of the pit (alluvial fans of Arak, Tamar Abad, Mehr Abad).

Results and Discussion

Finding from this research are presented as follows:

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Investigation of clay deposits of the region and interpolation of core wells of Velashjerd, Taremozd and Mashhad Mighan represent about 57 meters of water forasmuch as the same formation area for clay layers of 90, 80, 120 meter for Mighan lake in the quaternary.

Evidence of sediment cores and clay sediments is abundant in the west and south. This proves that maximum deep of lake has been in western and southern slopes of craters and about 8000 to 16000 in last year extent of clay sediments. This also indicates wetter climate conditions and reflects the development and progression of the lake at that time. With study of the region geological conditions and tectonic evidence, it should be stated that clearly visible function of Talkhab and Tabrateh faults and also the effects of craters subsidence on the drainage basin and alluvial fans surrounding the hole have caused asymmetry on the northern slopes. This should also be stated that this region has been affected by the impact of Neotectonics.

With existence of same climate conditions for sedimentary basin of Mighan, we determined five base level changes on the northern slopes of the well (hole) for the Ashtian cone. Three base levels are related to river redirection and resulted from neotectonics activities. This is not sensible for the next two levels in detection of impact of climate and neotectonics function.
Including evidence of base level changes available evidence on the Ashtian alluvial fans indicates considerable activity of neotectonics processes during quaternary. These processes are:

1) Creation of mound hills on the formations of quaternary epoch that are represented by tectonic movements.

2) The effect of Talkhab fault line on quaternary sediments and quaternary landforms.

3) Existence of thick alluvial deposits that starts from 50 meter to 100 meter at the bottom of the cone. Base level changes in southern slopes has not been caused alluvial fans sequence, existence of large mound hills, fraction of alluvial fans and being abandoned cones level.

Conclusion

The results of the study show that the sequence of fine-grained sediments of silt, clay, sand and gravel in the core of exploratory wells indicate environmental changes, particularly climate changes in the quaternary. Likewise the causes of climate change on morphology change of alluvial fans surrounding Mighan hole (Ashtian, Arak and etc) has played a major role. Neotectonics was more effective on deformation and development of Ashtian alluvial fan than the other alluvial fans. In that, it is measurable in the northern part of five old cones to new cones with 700 meters height difference while this sequence cannot be found in the alluvial fans of southern part. Base level changes of Mighan hole and hole gradual subsidence with rising marginal part indicate existence of asymmetry and morphotectonic activities for this hole. These affected the morphology of around alluvial fans. In other words, neotectonic evidence has been more effective on climate change in base level changes of Mighan hole at this region and caused asymmetry in North domain. According to the geomorphological evidence, it can be concluded that this Playa has been placed in dynamic tectonic area. Climate change, especially neo-tectonic, has caused base level changes in Mighan Playa.

Keywords: alluvial fan sequences, base level change, climate change, Mighan Playa, Neotectonic.

Evaluation and Comparison of Reanalysis Precipitation Data in Iran

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Received: 2 January 2015 Accepted: 6 February 2015

Extended Abstract

Introduction

There are significant differences in the spatial distribution of the Iran annual precipitation. This is resulted from spatial behavior of precipitation in the one hand and variation in the sources of precipitation on the other. The lack of adequate distribution of meteorological stations and the unavailability of long-term statistics of precipitation makes the analysis of precipitation more complicated. Precipitation data are constant inputs of research and the models related to water resources (e.g., climate, agriculture, hydrology, and environment). Most of research institutions are used to record the data and present it to different users. Different ways of interpolation of the data will cause different results. Therefore, it is a critical step to select the appropriate data based on research design. This study evaluates APHRODIATE, GPCC and Delaware University precipitation data (UDel) based on precipitation stations using RMSE, R^2 and Taylor diagram techniques.

Materials and Methods

DATA[1]

Daily gridded precipitation of APHRODITE (Asian Precipitation- Highly-Resolved Observational Data Integration Towards Evaluation) is the only long-term (1951 onward) continental-scale daily product that contains a dense network of daily precipitation-gauge data for Asia including the Himalayas, South and Southeast Asia and mountainous areas in the

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1. The description of the data have been driven from the following website: https://climatedataguide.ucar.edu

Middle East. The number of valid stations was between 5000 and 12,000; this represents 2.3 to 4.5 times the data available through the Global Telecommunication System network, which were used for most daily grid precipitation products. The products are available on a regional basis.

Key Strengths: High density and quality station network.

Key Limitations: Station network changes with time and season.

The Global Precipitation Climatology Centre (GPCC) has been established in 1989 on request of the World Meteorological Organization (WMO). It is operated by Deutscher Wetterdienst (DWD, National Meteorological Service of Germany) as a German contribution to the World Climate Research Programme (WCRP). The GPCC provides gridded gauge-analysis products derived from quality controlled station data. Two products are for climate: (a) the Full Data Reanalysis Product (1901-2010) is recommended for global and regional water balance studies, calibration/validation of remote sensing based precipitation estimations and verification of numerical models, and (b) the VASClimO 50-Year Data Set which is for climate variability and trend studies.

Key Strengths: Large number of stations used; gauge network extends beyond GHCN

Key Limitations: Variable number of stations per grid over time can be a major inhomogeneity source. Monitoring products are frequently updated but climate products are not.

The Global (land) precipitation, University of Delaware (UDel) is a series of gridded temperature and precipitation data sets. The data used are including station records served as bases for the Terrestrial Air Temperature, 1900-2010 Gridded Monthly Time Series (Version 3.01) and Terrestrial Precipitation, 1900-2010 Gridded Monthly Time Series (Version 3.02). These are used to help create new gridded climatologies of monthly and annual average air temperature (T) and total precipitation (P). These two sets of station time series were drawn primarily from recent versions of the Global Historical Climatology Network (GHCN version 2) and the Global Surface Summary of Day (GSOD) archive. Selected averages from Legates and Willmott’s (1990a and b) long-term station averages of monthly and annual T and P were also used to help produce this new gridded archive.

Key Strengths: relatively detailed global land surface temperature climatology; higher spatial resolution than comparable data sets

Key Limitations: Infrequent updates.

Materials and Methods

In order to evaluate the data, the closest point from the mentioned precipitation data to meteorological stations (max 40 km) were identified for the period 1961-2007. Then, we used RMSE, the coefficient of determination (R^2) and Taylor diagram to evaluate precipitation data. These methods are formulated as below:

$$RMSD^2 = \sigma_{est}^2 + \sigma_{obs}^2 - 2\sigma_{est}\sigma_{obs}R$$

$$R = \frac{\frac{1}{N}\sum_{n=1}^{N}\left(P_{est\,n}^{(i)} - P_{est}^{(i)}\right)\left(P_{obs\,n}^{(i)} - P_{obs}^{(i)}\right)}{\sigma_f\,\sigma_r}$$

$$\sigma_{est}^2 = \frac{1}{N}\sum_{n=1}^{N}\left(P_{est\,n}^{(i)} - \overline{P_{est}^{(i)}}\right)^2$$

$$\sigma_{obs}^2 = \frac{1}{N}\sum_{n=1}^{N}\left(P_{obs_n}^{(i)} - \overline{P_{obs}^{(i)}}\right)^2$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}\left(P_{obs}^{(i)} - P_{est}^{(i)}\right)^2}{n}}$$

$$R^2 = \frac{n\left(\sum_{i=1}^{n} P_{est}^{(i)} P_{obs}^{(i)}\right) - \left(\sum_{i=1}^{n} P_{est}^{(i)} \sum_{i=1}^{n} P_{obs}^{(i)}\right)}{\sqrt{\left[n\sum_{i=1}^{n} {P_{est}^{(i)}}^2 - \left(\sum_{i=1}^{n} P_{est}^{(i)}\right)^2\right]\left[n\sum_{i=1}^{n} {P_{obs}^{(i)}}^2 - \left(\sum_{i=1}^{n} P_{obs}^{(i)}\right)^2\right]}}$$

where $P_{obs}^{(i)}$ and $P_{est}^{(i)}$ are the precipitation values provided by instrumental data and precipitation data, respectively, σ_{obs}^2 and σ_{est}^2 are also the variance values of instrumental data and precipitation data, respectively; n indicates the number of stations.

Results and Discussion

Fiigure 1, shows the Taylor diagram, plotted by spatially averaged precipitation values, The diagram summarizes the relationship between testing and reference series standard deviations, correlation coefficient, and the RMSD (root mean square difference) as computed by series centered pattern, by means of a trigonometric similitude.

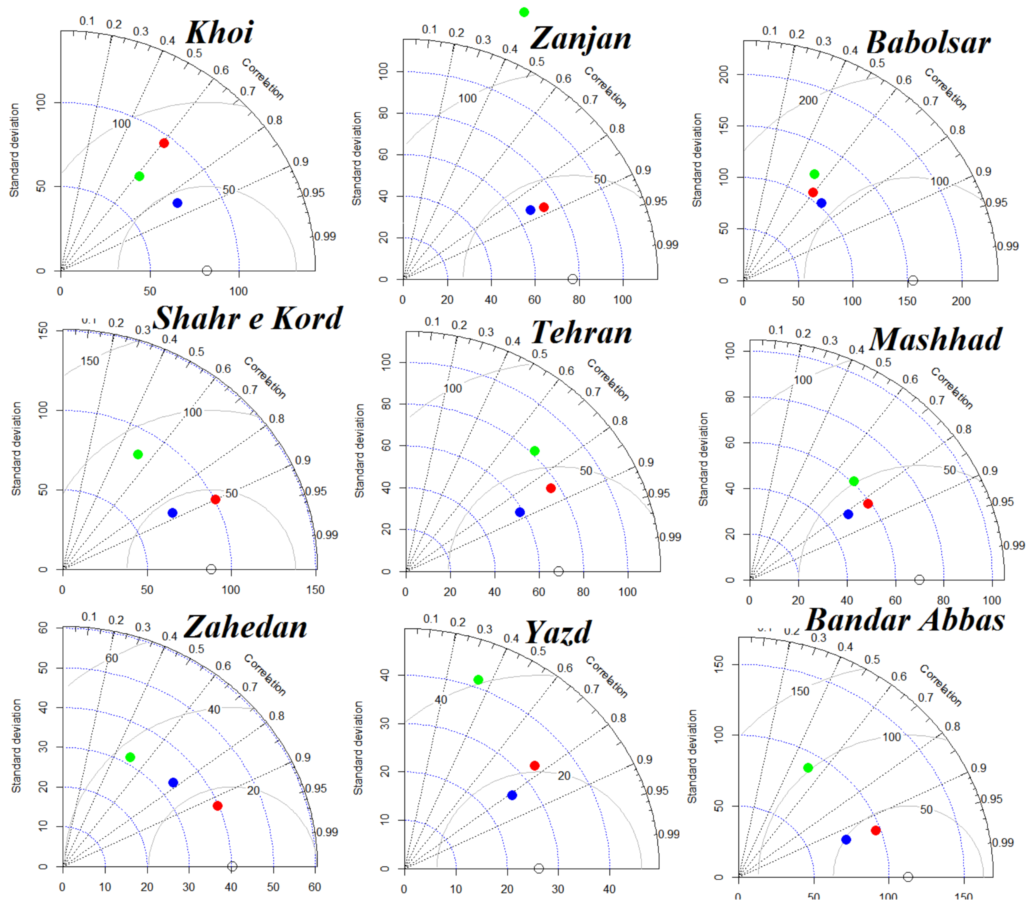

Fig. 1. Taylor diagram obtained from spatial averaged values plotted on the basis of standard deviation values, correlation coefficients between products and reference dataset, and root mean square differences of series-centered pattern, indicated as RMSD in the plot.

Aphrodite data are more accurate at, Khoi, Babolsar, Tehran and Yazd stations. GPCC data have better performance than other data at Zahedan and Bandar Abbas stations. For Shahr-e-Kord, Mashhad, and Zanjan stations, Aphrodite and GPCC data have similar RMSD. However, according to the stronger correlations between GPCC and instrumental data, the GPCC data are more appropriate than Aphrodite data.

Conclusion

Based on the long-term average annual precipitation, Aphrodite and GPCC data are more accurate than UDel data. Taylor diagram is based on the geometrical relationship between correlation coefficient, series standard deviation and centered mean square error. It is more useful than other uni-variable methods as RMSE and R^2. Aphrodite data are better to use for the Northwest, the southern Alborz and internal areas. The GPCC data will lead to better results in the West, South, Southeast and North East Iran. As UDel data consider spatial association of data with dependent variable, it estimates precipitation time series better than other data. This type of data is useful to analyze characteristics of precipitation in the areas with short-term time series.

Keywords: APHRODIATE, GPCC, RMSE, Taylor diagram, UDel.

Rainfall Erosivity Mapping in Kerman Province based on Geostatistical Methods

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Received: 24 June 2015 Accepted: 31 October 2015

Extended Abstract
Introduction
Rainfall erosivity, the propulsion or power of causing erosion in separation and transport of soil particles, is in relation to water erosion. Rainfall erosion is causing loss of soil, damage to agriculture and infrastructures which is followed by water pollution. Changes in rainfall patterns exacerbate risk of erosion globally. Rainfall erosivity plays an effective role in soil erosion and represents potential erosion in the study areas. Following the rainfall erosion, all types of water erosion can be occurred. Consequently, it not only makes soil to be eroded but also lead to filling of dam reservoirs, channels, water pollution and ecological changes. Regarding these mentioned problems, it is necessary to investigate various aspects of water erosion. Under the same condition, rate of soil loss is directly proportional to the rainfall erosivity. This can be expressed as erosivity factors which are based on rainfall characteristics. Various researchers have attempted to provide factors that are based on rainfall characteristics using simultaneous measurement of soil splash (or soil loss) and rainfall characteristics to determine relationships between them. Various factors have been proposed throughout the world. These factors are different because of geographical location, scale, local conditions and type of instruments. The concept of rainfall erosivity was proposed by wischmeier and smith (1958) in order to consider the effects of climate on soil erosion. Rainfall erosivity can be determined either using direct

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measurements or appropriate factors. Direct measurement method is a suitable method to determine rainfall erosivity which is done by measuring the amount of splashed soil. Event-based measurement of erosivity of rainfall for broad area is difficult and time-consuming. Therefore, researchers have attempted to provide factors that are based on rainfall characteristics using simultaneous measurement of soil loss and rainfall characteristics and relationships between them. For different areas, rainfall erosivity can be determined using these characteristics without direct measurement. In general, rainfall erosivity factors can be divided into two groups: 1) factors based on energy and intensity of rainfall; 2) factors based on readily available data. One of the most famous factors is EI_{30} which is based on kinetic energy and intensity of rainfall. One limitation in using this factor and also other factors which are based on rainfall erosivity is that they need long-term data (>20years) recorded with short intervals. Such data are recorded in the stations equipped with rain gauge. Therefore, due to lack of these long-term data, researchers have proposed factors that use available rainfall data (i.e., daily and monthly data). This recent factors are computed based on regional sediment analysis or its relationship with EI_{30}.The purpose of this study is to prepare rainfall erosivity map for Kerman province with semi-arid climate and to determine the most suitable interpolation method. Although such a map has been produced by Nicknami (2014) for Iran, it's not available for Kerman specifically.

Material and Methods

This study was carried out in Kerman province. The province has an area of181714 square kilometers and is located in the southeastern Iran. Kerman covers more than 11 percent of the area of Iran. It is the largest province in terms of land area which is located in the southeast part of the Central Plateau. In order to estimate EI_{30} index for the areas without rain gauge, the regression analysis were used between this index and some readily available indices of the 17 stations equipped with rainfall stations. Based on average maximum monthly rainfall index, the most fitted regression has R^2=0.882. Twenty years data (rainfall intensity & daily rainfall) for all stations (include: Synoptic, Climatology, Evaporation and Rain gauge stations) were used for this study. Outliers were removed by visual surveying of all collected data. Normality of the data distributions was tested using Kolmogorov-Smirnov in SPSS version 22. Finally, 135 meteorological stations and 17 rain gauge stations were chosen.

Conclusion

The results showed the maximum and minimum index equal to 74.213 and 91.24 (MJ-mm acres per hour) for Soltani and Dolatabad Esfandagheh stations, respectively. Simple kriging method was selected as the most appropriate interpolation method using cross-validation techniques. The zoning map of rainfall erosivity factor was prepared in ArcGIS software. The results also showed the highest rainfall erosivity values for Baft, Bardsir and Sirjan cities (located in southwest of province), and the lowest values for Bam, Jiroft, Kahnouj and Ravar cities (located in east, south and north of province), respectively.

Keywords: cross-validation, ei_{30}, Kerman Province, index, recording rain gauges.

Assessment of the Low Level Jets Effects on MCSS Formation in the Southwest Iran

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Received: 14 July 2015 Accepted: 18 September 2015

Extended Abstract

Introduction

The most notable convective systems are Mesoscale Convective Systems (MCSs). These systems are developed when clouds occurring in response to convective instability organize upscale into a single cloud system with a very large cirriform cloud structure and rainfall covering large contiguous areas (Houz, 2004). Detection and monitoring of MCSs is very important in southwest Iran because they produce hazardous weather, such as lightning, heavy rainfall, hail and strong winds. Several factors influence the development of MCSs such as the flow generated by a weak midlevel trough and the occurrence of low level jets (LLJs). LLJs transport moisture at the jet level, increase the low-level convergence and are responsible for sustaining convection especially at night.

Materials and Methods

The aim of this study was to assess the influence of low level jets on MCSs formation across the southwest Iran in the period from 2001 to 2005. The months of January, Mars, April and December was selected because of more MCSs occurrence. Event days were selected using synoptic station data (a set of storm reports such as thunderstorm, lightning, and shower and precipitation) across the study area. IR brightness temperature data from Meteosat 5 were utilized to detect MCSs. It has a resolution of 4 km with temporal resolution of 30 min. Detection of MCSs was performed on the basis of brightness temperature and areal extent

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thresholds. In this approach ‘convective cells’ are connected zones of the pixels below the temperature threshold that exceed the areal extent threshold (Woodley et al., 1980). The best threshold for detection of the area characterized by deep moist convection was determined 228 K. Based on Morel and Senesi (2002), 1000 km^2 of area threshold was selected. Those systems have been considered as a MCS which reached at least an area of 10000 km^2 during its mature stage and lastedat least 3 h.

To determine the influence of low level jet on MCSs development, the occurrence percent, maximum extension and duration of MCSs was analyzed in both LLJ and NOLLJ condition. The detection of low level jet events is based on Bonner (Bonner, 1968). According to this classical definition, a low level jet event is detected when the wind speed is equal to or higher than 12 *m/s*. In addition, the wind speed should decrease by at least 6 *m/s* to the next higher minimum. Furthermore, the moisture fluxes at 850 hPa are analyzed to identify low level jets in moist air advection. Moisture flux (MF850) is calculated by multiplying the specific humidity and wind speed (Remedio, 2013). The regions with intense moisture transport are identified during the mean monthly conditions as well as during the composite of low level jet events.

Results and Discussion

The result of this study showed that most of the MCSs is triggered and developed during low level jet event in all months. Thus, 85% of MCSs in January, 96% of MCSs in Mars, 84% of MCSs in April and 88% of MCSs in December has formed during Low Level Jet event. The MCSs triggering without low level jets was rare. Analysis of the 850-mb isotachs showed that there was the Low Level Jet many hours before the organized convective systems is established in most of cases. The center of Low Level Jets was mainly in the vicinity of Persian Gulf. Its speed was equal to 14 - 18 *m/s* approximately and its axis was in north to south direction. The high wind speeds generally advect the warm and moist air from the Arab and red sea towards the southwest Iran. These conditions caused the release of latent heat and increase in the low-level convergence. This was favorable for development of convection and MCSs formation.

Westerly wind with low speed is prevailed during the mean monthly conditions at 850 hPa. But, it was southwesterly during the composite of low level jet events which transmitted heat and moisture to the study area.

Conclusion

The result of this research revealed that the biggest and the most lasting formed MCSs in the days with low level jet event was bigger and more lasting than those with no low level jet event. But, the mean extension and duration of MCSs in two different conditions showed no significant difference.

***Keywords*: low level jet, mesoscale convective systems, moisture flux, southwest Iran, wind speed.**

Active Faulting and Its Effects on Quaternary Landform Deformation in North-East Lake Urmia, Iran

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Received: 6 July 2015 Accepted: 1 January 2016

Extended Abstract

Introduction

Iran forms a relatively compact zone of active continental deformation resulted from the northward collision of Arabia with Eurasia during late Cenozoic times, which is continuing to the present-day at a rate of 25 mm/yrs (from GPS data). Evidences of active tectonic in different parts of Iran, has been studied and identified. 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 for 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, river terraces, runoff anomaly and horizontal and vertical displacement of faults are the most important landforms that indicate active tectonics and active faults. Active tectonics play a very important role in deformations of the alluvial fans. Without continued tectonics, fans may become minor or short-lived features. Morphological evidence of different types of faults such as thrust faults and strike-slip faults can be determined in surface of quaternary landforms. For example, Late Quaternary activity on strike-slip faults can be determined from the lateral displacement of young landforms such as river terraces and alluvial fans, or from scarps introduced by slight dip-slip components of motion. In this study, the evidence and impacts of the active faults have been investigated in quaternary landforms such as river terraces, stream displacements and spatially alluvial fans morphometry and morphology located at the south part of the MishoDagh Mountain in northwest Iran.

Materials and Methods

The method is based on the obtained qualitative and quantitative data. The quantitative data includes satellite image interpretation and digital elevation models, alluvial fan morphometry,

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channel displacement and rate of sediments uplift. Longitudinal and cross profile and gradient analysis used to interpret the active fault effects on alluvial fans. Topography maps (1:25000), ETM, SPOT and Quickbird satellite images with 30, 15 and less than 3 m spatial resolution, geology maps (1:100000) and digital elevation models (10m pixel resolution) were applied in this study. For such interpretation, ArcGIS, ENVI and Freehand software were utilized. All of the maps were produced using freehand and ArcGIS software. The field works for investigation of the evidence of fault activities were performed. Field studies were performed for the identification and measurement of parameters such as the uplift of sediments, displacements of river, alluvial fans, and channel avulsion and river terraces. Finally, the data obtained during field studies are compared and analyzed through quantitative and descriptive methods. It was also attempted to estimate spatial development and effectiveness of active tectonics on quaternary landforms and alluvial fans.

Results and Discussion

The study area of this research is located in south part of MishoDagh Mountains, northwest Iran (north of Lake Urmia). Tabriz fault is located in east part of the study area. There are three main faults in this area. South Misho Fault (SMF) is located in mountain front and affects the apex of alluvial fans and river terraces. The faults of Shabestar, Daryan-Heris-Shanlan, and Sharafkhane are located far from the mountain front. South Misho Fault has caused displacement of the main channel in fan apex, and alluvial terrace sequence. This fault has elevated river terraces about 150m from river bed. while evidence of the activities of the two other faults are more, and has caused uplifting of terain, derelict of fan surface, change of intersection point, uplift of fan sediment and lateral change of fan surface channels. The slope of most alluvial fans is 3-5 percent. The Sis fan is the largest fan in the study area. This fan is combined from several quaternary surfaces elevated in response to fault activity. Sis fan are affected by the faults more than the others and reformated to present landform since quaternary. The faults of Shabestar, Sharafkhane and Heris-Daryan-Shanjan are strike-slip faults that have changed rivers and runoff laterally.

Conclusion

The findings show that the faults of Shabester, Sharafkhane, Heris-Daryan-Shanjan and South Misho were active in quaternary. The position and forms of alluvial fans are affected by the activities of these faults. The faults have had either lateral or vertical displacements. The findings have also indicated that the alluvial fan forms and their longitudinal and lateral profiles are affected by Shabester, Sharafkhane, Heris-Daryan-Shanjan faults. Investigations show that there is no statistical correlation among the variables that affect the alluvial fans. Generally, tectonic activities disrupt natural evolution of alluvial fans. Each fault has a different effect on alluvial fan evolution. South Misho fault has caused the displacement of the main channel and the formation of river terraces. Therefore, has increased slope of this part. Other faults have caused uplift of fan deposits, change in the intersection point and reconstruction of new alluvial fans in the lower part of this point. Remote sensing studies can provide a valuable first step in the identification and analysis of active faulting in actively deforming regions.

Keywords: active faulting, active tectonic, alluvial fan, mishodagh, remote sensing

Assessment of the Precipitation and Temperature Changes over South East Iran Using Downscaling Of General Circulation Models Outputs

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Received: 16 June 2015 Accepted: 1 January 2016

Extended Abstract

Introduction

Numerous studies have demonstrated the relationship between the amount of CO_2 in the atmosphere and climate change. In this respect, developed countries have an undeniable role and cause serious damage to earth environment throughout the world. IPCC' forth evaluation report implies that adding greenhouse gases to the atmosphere during recent decades prevents the heat rays to emit which, in turn, cause atmospheric temperature to increase. During the past centuries, the temperature has increased by 3 to 6 Degrees Centigrade, with a rapid speed in the recent decades. It is believed that if greenhouse gases continue to increase at the present rate, an average increase in temperature, from 1^c to3.5^c, is expected by the year 2100. Therefore, it is necessary to study and evaluate climate changes in the future decades so as to plan a proper environmental program corresponding to future climate conditions, consequently reduce its unfavorable effects. With the uncertainty in Atmospheric Circulation Models being taken into account, the present study investigates the temperature and precipitation changes in Southeastern Iran during the following periods: 2011-30, 2044-65, and 2080-99.

Material and Methods

We have used two datum groups, namely, observed data and model data. These are including maximum and minimum temperature, precipitation and solar radiation. The period, 1983-2007, was chosen as the observed period; data from weather synoptic stations were gathered. The required data for General Circulation Models including IPCM4, NCCCM3, HADCH3, and INCM3 with three scenarios of A1B, A2, B1 were gathered from the two Reference Networks,

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Canada Climate Change Reference and data bank of LARS-WG5.1. The most upgraded version of LARS-WG5.1 was used to evaluate climate change in Eastern South of Iran. This version observes the forth report on IPCC. Therefore, it uses the outputs of 15 General Circulation Models with A1B, A2, and B1 Scenarios. Four climate models with three shared Scenarios were used in this study.

Time series of the observed data from synoptic stations in Eastern South of Iran were compared with those of IPCM4, NCCCM3, HADCH3, and INCM3 in similar periods with A1B, A2, and B1 scenarioes. To do so, first, average time series of each station were computed using temperature and precipitation data from synoptic stations; then, monthly thermal data and those of GCM fall values during the study period were received from CCCSN (Canada). Finally, the mentioned data were compared with the average temperature and precipitation during the study period. To investigate the uncertainty resulted from employing various GCM models, weighting method of averages of the observed temperature and precipitation was used.

Results and Discussions

General circulation models don't have equal results in estimating long-term temperature and precipitation. This indicates the existing uncertainty in their outputs. Analysis by T-test and Chi square statics results for all stations, revealed no significant difference between the modeled and observed values at $P < 0.05$.

In general, the results show that LARS-WG Model is capable of modeling the climate in previous periods of the studied stations. The average precipitation and temperature of the stations were compared using LARS-WG Model. The results revealed an increasing trend in the temperature of all the studied regional stations in future. The 90 year thermal increases in the following stations are 0.44-3.53 in Bam, 0.52-3.30 in Bandar Abbas, 0 .39-2.64 in Chabahar, 0.85-3.41 in Iranshahr, 0.38-2.27 in Jusk, 0.76-3.82 in Kerman, 0.55-3.47 in Zabol, and 0.54-3.57 in Zahedan. The above values are in Degree Centigrade.

The most distinctive feature of modeling, in regard to precipitation, is lack of harmony in its increase or decrease trends in future. In other words, it cannot be concluded that precipitation, like temperature, has an increasing trend; rather it has fluctuations. As the modeled values revealed, precipitation increases in all the stations during spring. Although it is relatively more in such dry stations as Bam, Kerman, Zahedan, Zabol, and Iranshahr, this, in turn, causes spring floods.

Conclusion

This study investigated the effects of climate change on the two weather parameters, temperature and precipitation. This was carried by the data gathered by Atmospheric General Circulation from the synoptic stations located in Eastern South of Iran. The obtained results showed that LAR-WG Model is capable of modeling precipitation and temperature values. According to the results, it was indicated that NCCCM3, HADCH3, IPSLM4, and INCM3 models have a good performance in simulation of precipitation. Regarding temperature, HADCH3 Model proved a good capability in most months. The obtained weights having been applied on model values, an increasing temperature trend was indicated in all the stations. Furthermore, it was also indicated that thermal increasing amount in coastal stations is higher than that of dry ones. The highest increase in temperature belongs to Kerman, Zahedan, Bam, Zabol, and Iranshahr, in order. Accordingly, all coastal stations would experience a thermal increase less than 3^c, while the value for dry stations would exceed 3^c. It seems that temperature follows a steady increasing trend, whereas precipitation in various stations is fluctuating during different seasons.

Keywords: climate change, downscaling, general circulation model, southeast Iran.

Environmental Conditions of Iran Pluvial Lakes using Sedimentary Evidence (Case study: Lut Desert Kalut)

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Received: 15 May 2015 Accepted: 10 September 2015

Extended abstract

Introduction

Iran Kaluts (Yardang) which are considered as special models in terms of magnitude and extension have been shaped in the west part of the central Lut desert. Although these Kaluts now are influenced by the selective windy erosion, they can be shaped through the process of wind and water erosion. The suitable environment for formation of these Kaluts are the arid region together with little raining and the intensive and continuous wind. The Lut desert Kaluts are shaped in the grounds with finer structure and wind and water erosion. This erosion can be produced when the water is accumulated in the small pit and holes in the humid season after temporary precipitation in the desert. Then, a doughy substance is made and wakened. After drying and as a result of the predominant wind on the district, these pit and holes gradually become enlarged and the long silts produce the Kaluts. In this research, we want to study the sedimentary characteristics of the Kaluts and Iran pluvial lakes by sampling of one of the high Kaluts in Lut desert through sedimentary and granulometery experiences on these samples.

Materials and Methods

Firstly, through an extensive survey in the district and visual examination of Kaluts, a high Kalut of the district was selected for modeling. After recording the exact position of Kalut by GPS, the related Kalut was sampled. The taken samples crushed in geomorphology laboratory

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and sieved by shaker. Those samples that were under 63 micron were separated in 10 grams and were used in granulometery test in Pipette way and scaled graduated cylinder. This sampling was done in two days (8 samples for the first day and 2 samples for the second). After sampling in the specific time and in the specific depth of cylinder, the samples were dried and the remained sedimentary samples were weighted in the beakers. Thirdly, the GradiStat software was used to analyze the number gained from the pipette test and figures were drawn.

Results and Discussion

After testing 15 layers taken from the Kalut, granulometery elements of particles such as the context and the size of particles near to the average, qualitative and quantitative measures of Sorting, Skewness and Kurtosis of the particles were identified by the GradiStat statistical software and by statistical relationship between Folk and Ward (1975). The gathering center of bimodal and Unimodal aggregation show very poorly sorted sediments. This position could be observed in most of underneath layers. This could be produced by shaping sedimentary in the specific context that could create different particles with different sizes. According to the obtained results from statistical and experimental analysis, the context of all layers in Folk triangles was determined as muddy and their particles as the rate of silt and clay. It was expected that the Skewness of all layers was positive and the results show that most of the layers have positive title to fine and very fine particles.

Conclusion

Iran kaluts are unique example of the magnitude and extent of desert areas. Although these Kaluts are affected by wind erosion, but water and wind erosion processes are involved in their formation simultaneously. In this study, after sampling from a Kalut with 33 meters high and 15 layers, these sediment samples were transferred to the laboratory and examined by granulometery tests. The results of this study revealed that the Kalut sedimentary samples in the rate of silt and clay have horizontal and lamination classification. This refers to this fact that the tiny sediments hanging in the water were deposited in a calm environment. Furthermore, on the muddy silts some chaps were observed. The silts were produced when the lakes were dried and the water was vaporized severely and then the sediments could be observed in the form of salty and chalky layers of Kaluts along with silt and clay particles carried by the wind. This fact can be certified with respect to this fact that in the past the shallow lake was severely vaporized and dried in the low energy environment. As a result of this, the chalky and salty layers were made. Based on the experiments, most of the related layers have the muddy context with very bad sorting and fine skewness. This reveals that the following activities in the district were low and the environment was low energy during sedimentation of the kaluts.

Keywords: Gradistat, granulometery, Kalut, Lut Desert.

Prioritization of Flooding Potential in Beheshtabad Subbasins

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Received: 29 July 2015 Accepted: 1 January 2016

Extended Abstract

Introduction

Flood is a natural hazard that its occurrences can be observed more frequently in recent years. For better flood mitigation and control, it is needed to identify flood production factors and determine the high potential flood areas. Hydrological model is a simplified representation of natural system and the rainfall-runoff model is one of the most frequently used events for flood simulation. HEC-HMS is one computer model that becomes very popular for its ability in simulation of short time events. The aim of this research is to investigate spatial prioritization of flooding in Beheshtabad sub-catchments using HEC-HMS software.

Material and Method

Behashtabad Basin located in Chaharmahal-va-Bakhtiary Province, Iran, is 3866 km^2 and its mean elevation is 2317 meters above sea level. It is divided into 6 sub basins according to 6 hydrometric stations. Land use categories of the study basin were extracted using ETM+ Images for 2009. Using 170 ground control points, land use map of Beheshtabad basin was prepared with total accuracy of 99.34 and Kappa Index equal to 0.81. Rangelands cover most of the study area. Soil Hydrological groups and land use data have also been used for mapping sub basins curve number with antecedent moisture of past five days. The mean curve number of the study basin is 72.69. Daily precipitation data of 6 rain gauges in study area have been used for analysis of maximum 24 hr precipitation in different return periods. Rainfall hyetographs of flood events have been derived from recording rain gauges data. CN method has been used for

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estimation of initial loss, SCS method for runoff hydrograph simulation, and Muskingum method for flood routing simulation. HEC-HMS model was calibrated using 2 Flood hydrographs and corresponding hyetographs for each sub-basin and validated for 1 flood event.

Results and Discussion

Rainfall loss in Beheshtabad sub-basins is ranged from 0.13 to 0.19, curve number ranged from 69.73 in Kooh-Sookhteh sub-basin to 73.71 in Kharaji sub-basin, and lag time also ranged from 0.99 hr in end Beheshtabad to 5.72 hr in Kharaji sub-basin. Using optimized rainfall loss index derived from calibration stage, HEC-HMS is validated for one flood event for each sub-basin. Model validation shows very little difference (below 1%) between estimated and recorded data in all sub-basins. Among sub-basins, Darkesh-Varkesh has the most and end Beheshtababd has the lowest peak discharge in all return periods. Prioritization of sub-basins according to their areas indicates that bigger sub-basins don’t have essentially highest amount of the rate of Q_{sub}/Q_{total}. In this comparison, Darkesh-Varkesh sub-basin with an $Area_{sub}/Area_{total}$ rate of 0.13 has the highest rate of Q_{sub}/Q_{total}. Flood routing in streams indicated that the rate of participation of sub-catchments in output flood is not proportional to sub-catchment peak discharge. Therefore, in order to eliminate the effects of area in participating sub-catchments, the rate of influence on each unit of sub-catchment area in output flood was calculated as well. The results of prioritization by peak discharge, based on participation of each sub-catchment in output location of watershed, indicates that Darkesh-Varkesh and Beheshtabad sub-catchments with 29.16 and 2.5 percent have, respectively, the maximum and minimum of participation in output flood peak discharge of the watershed. Results of prioritization based on reduction of discharge per unit area show that Beheshabad sub-catchment with the lowest area in comparison with other sub-catchments has the highest participation and Tange-Dehno has the lowest role and contribution.

Conclusion

In the present study, rainfall-runoff modeling is carried out using HEC-HMS hydrologic model. Results of simulation in 18 events and comparison of simulated and observed hydrographs indicated that the model can be applied for simulation of rainfall-runoff in this study area. Other researches like Kumar and Bhattacharjya (2011) and Hegdus et al. (2013) found same results as our findings. Ranking sub-basins according to peak discharge without flood routing show that Darkesh-Varkesh has the most and end Beheshtabad has the lowest peak discharge. According to contribution in total discharge, the results are also the similar. Soleimani et al (2008) and Zehtabian et al. (2010) also found the same results. Finally, according to decrease in total Q per unit area, ranking show that end Beheshtabad sub-basin, despite of the smallest area, has the highest contribution in total Q per unit area. Nasri et al. (2011) also concluded that the areas located near the outlet of study basin have the most contribution in flood production. This research shows that the Darkesh-Varkesh sub-basin needs the most attention in selection of management practices especially to optimize flood control and flood mitigation solutions.

Keywords: Beheshtabad Basin, Chaharmahal- va- Bakhtiary Province, curve number, HEC-HMS, Muskingham method, SCS Method.

Observational and Synoptic Behavior of Shamal Wind in the North West Coast of Persian Gulf: Bushehr, Iran

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Received: 22 April 2015 Accepted: 20 October 2015

Extended Abstract

Introduction

Shamal winds recognized as a climate regime with a common occurrence in the Persian Gulf makes periodically adverse weather conditions in this region. Among the phenomena occurring under the influence of Shamal wind, we can mention dust storms, low-level winds and turbulent marine conditions (Rao, 2003). Shamal winds are categorized into two types, winter Shamal and summer Shamal. Sea-land breezes are also classified as a frequent mesoscale and heat driven flow associated with coastal areas. Temperature gradient between sea and land is the main reason for the formation of a sea breeze circulation blowing from sea to land in low level coastal atmospheric boundary layer. The suitable condition for sea-land breezes is when the synoptic winds are weak (low synoptic forcing) and temperature level is high in the coastal city of Bushehr (Bidokhti and Moradi, 2004).

The purpose of this research is to investigate seasonal Shamal wind event and its associated synoptic conditions by observations analysis and numerical experiments on Persian Gulf. The impacts of these conditions on wind pattern are studied in the northwestern Persian Gulf coastal area and in optional case in the coastal area of Bushehr. It is intruded interaction between meteorological mesoscale (sea-land breeze) and large-scale (synoptic pattern Shamal wind) forcing effects in this area.

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Materials and Methods

Study Area

North part of middle east is dominated by the seasonal Shamal wind regime, that begin from the central deserts of Iraq and the mountains of northern Iraq, Turkey and Syria to Persian Gulf. In this study, the coastal city of Bushehr in the northwest Persian Gulf and southwest Iran have been selected as a case to investigate about interaction of Shamal wind pattern on local breeze on the coastal areas (Figure 1). Based on the location of Bushehr and sea-land breeze definition, it can be said that sea breeze will occur in the sector of 180-270 degree.

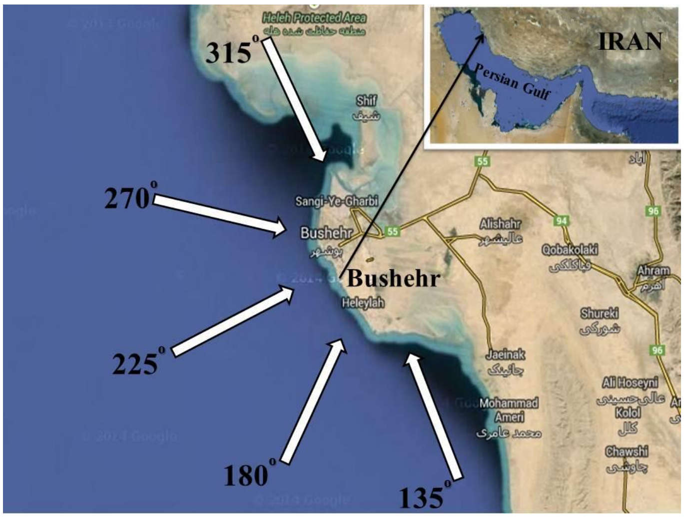

Fig. 1. Coastal case study area

Basic data

In order to analyze the time series of coastal wind, we used hourly wind speed and direction data from meteorological tower and meteorological station of Bushehr power plant and also wind data from Bushehr airport weather station. The meteorological station of Bushehr power plant is located at 28°59' N and 50°00' E and Bushehr Airport Station is located at 28°58' N and 50°49' E. Both the weather stations are located in a relatively small distance from each other.

In the next step, the NCEP FNL data are used to generate the initial and boundary conditions for regional simulations by WRF model. These data has 1° × 1° resolution and are available for every 6 hours. The data are produced by Global Data Assimilation System (GDAS) that continuously receive monitoring global data for analysis from Global Telemetry System (GTS) and other resources. Selected physical schemes for Model setup are represented in table 1:

Table 1. Selected physical schemes for WRF model setup

scheme	Selected physical scheme
Microphysics of cloud	WSM 6 (Hong et al., 2004)
Radiation of short wavelength	Dudhia (Dudhia, 1989)
Radiation of long wavelength	RRTM (Mlawer et al., 1997)

Physics of soil	NOAH [Chen and Dudhia, 2001; Ek et al., 2003] time interval of summer Shamal PX (Pleim and Xiu, 2003) time interval of winter Shamal
Physics of surface layer	MM5 SLS (Zhang and Anthes, 1982) time interval of summer Shamal
	PX (Pleim and Xiu, 2003) time interval of winter Shamal
Boundary layer	YSU [Hong et al., 2006; Hong, 2010] time interval of summer Shamal
	ACM2 (Pleim, 2007), time interval of winter Shamal
Convection of Cumulus	Kain-Fristch (Kain and Fristch, 1993; Kain, 2003)

Results and Discussion

The results of the observational time series analysis from the meteorological tower of Bushehr power plant are shown in table 2 for winter (January) and summer (May). These results show the mean detail information of typical wind regimes such as summer and winter Shamal and sea-breeze regimes during January and May, 2010. This table represented formation quality, duration, mean speed, mean direction of sea-breeze wind in the beginning and ending of sea-breeze regimes during these months. It also represented frequency of daily occurrences of typical wind regimes with their mean speed in Bushehr coastal area.

Table 2. Specifications of typical wind regimes in Bushehr coastal area during January and May 2010

Shamal wind regime Type	Mean wind speed of Shamal wind regime	Number of the days with Shamal wind activity	during the days without sea-breeze occurrence	Mean wind speed of sea-breeze regime	Pure sea-breeze occurrence (225 °)	Daily duration of sea-breeze activity (hours)	Mean wind direction in the ending time of sea-breeze period	Mean wind direction in the beginning of sea-breeze period	**Month**
Winter	14 m/s	5 days	12.5 m/s	9 m/s	no	6	290	269	**January**
Summer	14 m/s	14 days	14 m/s	9 m/s	yes	9	230	210	**May**

Figure 1 represents synoptic condition at 10 pm, 24 June 2010, local time. As it can be seen, the northern Saudi Arabia is influenced by a high pressure system with central pressure around 1012 hPa in this region. As well, on the Persian Gulf a low pressure trough is dominant with 1000 hPa central pressure. In addition, a heat low pressure system is seen over east Iran (region of Afghanistan, Pakistan and etc.). This area is experienced the pressure less than 996 hPa. Turkey, Iraq and west Zagross mountain rang are affected with interaction of these dynamical systems that lead to the creation of Shamal wind in northwest of Persian Gulf.

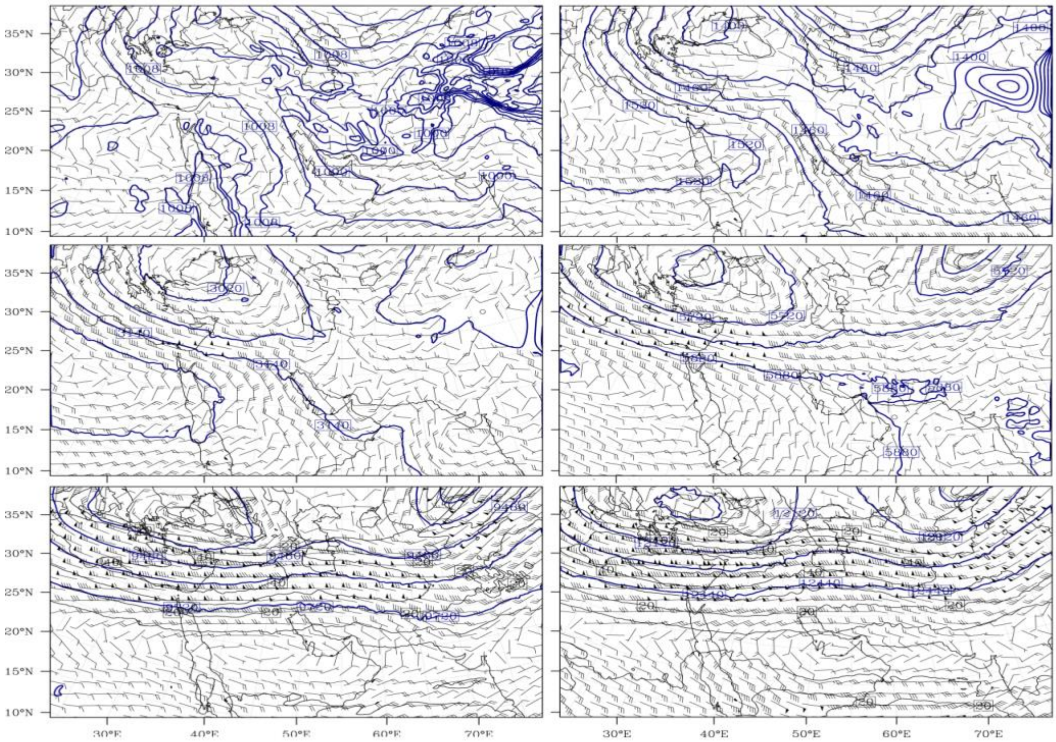

Fig. 1. Simulated synoptic maps for 24 June 2010 at 10 pm local time (top left: sea level pressure, top right: 850 hPa, middle left: 700 hPa, middle right: 500 hPa, down left: 300 hPa and downright: 200 hPa)

Conclusion

In general, Shamal wind affects Turkey, Iraq, Iran, Arabian Peninsula and adjacent areas. The maximum activity during 2010 was observed in the winter in late January and in the summer in June by maximum number of Shamal. This result is obtained by analysis of the data from the meteorological tower 100 meters high in Bushehr weather station. The summer Shamal caused disruption of coastal wind pattern in 14 days of May, 14 days in June, and about 10 days in July, and usually less than three to five days in other months. Winter Shamal occurs at intervals of 3 to 9 days from December to March. During the period that the sea-breeze is removed by synoptic Shamal winds, the average daily wind speed is more than period of sea-breeze activity.

Keywords: Bushehr, rose diagram, Shamal Wind, sea breeze, WRF.