

## ***Dynamic and Genetic Analysis of Aeolian Sedimentation to Determine Origin and Source of Sand Dunes (Case Study: Reza Abad, Sabzevar)***

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### **Extended Abstract**

#### **Introduction**

In desert environments, new sand dune formation or dune reactivation occurs due to a combination of sediment supply, sufficient wind strength and reduced vegetation cover, or prevailing dominance of one of those factors. Studying sediment properties (stratigraphy and sedimentology) of desert dunes can provide important information about the type and materials of sand resources, sedimentation environments and palaeoenvironmental reconstruction in the arid areas. Genetic or dynamic relationships have been used to determine removal areas. The genetic relationship between sediment source and aeolian materials has been identified from observations of the distribution of mineralogy patterns. Dynamic relationships between sediment source and composition and texture of aeolian materials in desert environments are controlled by grain size, grain shape and specific gravity. Field surveys are essential to determine sand sources. Thus, it is very important to understand the erosion patterns of any desert region. During the past 60 years, an accumulation of sand dunes (erg) is created in the Reza Abad of Khartouran with an area of approximately 600 ha. The study area is located between 35° 52' 44" to 35° 54' 24"N and 56° 38' 13" to 56° 38' 55" E. The aim of this research is to detect the origins of sands based on morphology of sand dunes, granulometry and mineralogy of aeolian sediments.

#### **Methodology**

The study has two components; firstly, we have compared the aerial photographs with satellite images of the area, to represent the creation of dunes geomorphic features, and secondly, examined granulometry and mineralogy analysis of sand samples to determine sand sources and origin.

The aerial photographs (1954) and terra satellite images was used for this comparison. The

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comparison showed that the dunes are about 600 hectares during 60 years. Sampling of the sands was performed on transect along the prevailing wind direction. The samples were collected from the middle part of windward. Twenty four sand samples were collected in the survey. Approximately 100 g of the samples were used for grain size analysis. Statistical analysis was calculated by GRADISTAT software according to folk graphic method (1980). The samples were analyzed for mineralogy using Binocular microscope on 100 grains in 10 samples of sand dunes. Mineralogy analysis of sand sources was performed according to the percent of mineral in lithology.

### **Results and discussion**

Since the sand dunes have been configured over the last 60 years, they are young and active. Based on Mainguet classification (1990), they are classified into one main type involve crescent dunes and chains. Crescent dunes are pre-barchan, Barkhoid and transverse dunes. The sand dunes are gradually transformed from the north to the south, from pre barchans form to transverse-formed dunes. Aeolian sands of the study area are fine grained and moderately to well sorted. The grain size distribution of all samples is unimodal. McLaren believes that this feature of the deposit indicates that a source sediment undergoing erosion. The dune sands have an average grain size of  $2.358\phi$  ( $195.8\mu\text{m}$ ). Average sorting value is  $0.53\phi$  ( $1.444\mu\text{m}$ ). The Average skewness and kurtosis values are  $-0.17$  and  $1.11$ , respectively. The grain-size values show incremental changes from the Prebarchanic forms to transverse dunes. The grain-size variations among the dunes can be related to the height of the dune. This is due to the fact that coarse grains do not reach the crest in the dunes with great heights leading to coarse grains and fine grains in the flank and crest, respectively.

The studies have shown that prevailing wind direction is east to west, the strong wind being in north-south direction. It can also be said that sand dunes are formed by strong wind. The result of minerals analysis of the sand dunes showed that calcite is the dominant mineral. The highest percentage of rock fragments is related to quartz sandstone.

### **Conclusion**

The mechanical analysis indicated that the sands have been transported from 20 to 50 km from sand sources. It can be argued that the most sources of sands in Reza Abad are developed in the quaternary materials of the derived bedrock from the North Mountains. The high contains of calcite and quartz in the samples from the Reza Abad dunes strongly indicates that the majority of the sand in the Reza Abad Dunefield is derived from the lithologic units of marl, calcareous marl and agglomerate.

**Keywords:** *Erg, sand dunes, aeolian sediments, pre-Barchanic, granulometry.*

***Analysis of the Effective Factors on Drought Management in Rural Areas, from The Viewpoint of Households  
(Case Study: Eslamaban Gharb)***

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**Extended Abstract**

**Introduction**

In recent years, due to the successive droughts, many villages have suffered from a slight blue crisis. The droughts have certainly caused adverse effects on their social, economic and environmental conditions. The fundamental problem has occurred when the authorities have not discussed the effects of this drought on the lives of villagers and have taken no action in the dysfunctional and cross-sectional measures. Undoubtedly, to adequately deal with the drought and its consequences, the first step is to understand the phenomenon and its effects in different dimensions to be able to draw up effective strategies in this regard. And he worked. Based on a scientific and logical research, it is necessary, first of all, to investigate the effects of this issue on different dimensions of life. Then, the present research seeks to answer the following question: How much is the economic, social, environmental and institutional-physical effects of drought on management in the rural areas? The life of the rural community, among the three existing human societies in Iran, due to drought-induced crises, has had many destructive effects in rural life, and faced them with many challenges. It has had a major impact on the economy and its livelihoods, so that past strategies for managing droughts in rural areas have not been so successful and have not been able to resolve the issues such as water scarcity, and easing rangelands and migration. Kermanshah province is the sixth province of the country due to drought problems. As a result of recent droughts, about 550 villages in the province suffered from a mild crisis. Enormous damages caused to the province due to drought and frost in 2008 exceeded 800 billion USD.

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**Materials and methods**

The statistical population of the study is all the households more than 20 members in seven rural districts. Using the Cochran formula, 374 samples of them (located in 21 villages have been selected for the analysis. To analyze the data, confirmatory factor analysis method was used in SPSS 22 and Smart-PLS software.

**Results and discussion**

The economic dimension of drought management indicates the significance of economic dimension to drought management, with the path coefficient of 0.251 between these two. The drought management is explained directly by the social dimension, with the value of 23.999 and the path coefficient of 0.351, the environmental dimension, with the value of 23.449 and the path coefficient 0.168, and the institutional-institutional subfield, with the value of 32.421 and the path coefficient of 0.381. Therefore, in order to prevent the effects of drought in rural areas of the study area, it is necessary to identify appropriate and effective factors for planning. According to the research findings, the most important factors affecting drought management in rural areas are social dimension. This can be used to reduce drought consequences, increase investment incentives for drought management among locals, use of drought tolerant cultivars, change in cultivars, the process of transformation from agriculture and traditional livestock into new ways, the appropriateness of current consumption methods in villages. The economic factors in rural areas are including low-interest facilities and grants to drought-affected groups, cash subsidies, supporting investment and entrepreneurship in drought-affected areas, the availability of suitable and permanent jobs for dealing with droughts, diversification of production resources and access to the goods and services for agricultural products and handicrafts for proper use of water and soil.

**Conclusion**

In management of drought in rural areas of Islamabad, planning should prioritize the factors affecting drought management, especially social factors. Accordingly, first, government measures should be taken to create the technical, institutional and service infrastructure in the region. Then, based on the capabilities of the region, with regard to the prestigious rural population, the basic measures are consistent with public participation as well as the prevention of migration.

**Keywords:** *drought management, rural areas, Islamabad West, modeling of structural equations.*

## ***Analysis of Wind and Groundwater Contribution to Location and Establishment of Internal Graben (Case Study: Sadegh Abad-Bafgh Rig)***

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### **Extended Abstract**

#### **Introduction**

Wind erosion is one of the most important aspects of land erosion in arid and semi-arid regions. Wind erosion is known as the dominant erosion in these areas and 36 percent of the land surface is arid and semi-arid. Most of these surfaces are almost dry and devoid of vegetation. More than 66% of Iran is covered with arid and semi-arid lands. Due to lack of moisture and reduced vegetation, there is wind erosion, so that there are about 13 million hectares of land covered with sand dunes. The accumulation of sand is controlled by various factors including the amount of sand, sedimentation rate, wind direction, wind speed and obstacles in the sand movement direction. Topography is not only known as an effective factor in the formation and density of sand dunes but also indirectly affects the morphology of sand dunes as well as their impacts on the climate of the area. In Iran, as a country with arid climate, due to the dispersion of different sand dunes, various studies were conducted about the Ergs. Among these studies, researches by Yamani (2002) in the area of Kashan Band-Rig and the role of local low-pressure cell in the establishment of this sandy collection is considerable for understanding the sand development. The researches of Maghsoudi, Yamani, Khoshk-Akhlagh and Shahriar (2013) examined the dispersal of four ergs of Khartooran, Chah Jam, Sargardan and Rige-jen in Dashte- Kavir Desert.

#### **Materials and Methods**

In the southeast of Yazd Province, there is Daranjir graben extended from Kharanagh to Bafgh. Sadegh Abad Rig inside Dranjir is located in the 15 km northwest of Bafgh City. Studying tectonic properties and position of faults by geological maps and studying the underground water with field observations and depth of groundwater illustrated the role of underground water in the establishment of the sand dunes. The region's DEM is also used to determine the topographic position and study the role of topography in formation Daranjir Basin. On the other hand, due to the importance of wind in the transfer and density of the sandy masses, a study on wind regime of the region based on Bafgh synoptic stations data was carried out using Wrplot

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and Sand Rose Graph software. Since recognizing the morphology of the sand dunes can be a sign of the deposition or displacement of the landforms, it can be seen from the study of the direction of flooding in different periods of time that the dominant morphology of the sand dunes is detected in a field. These studies are about the causes of the wide use of sand mounds in order to determine the role of convergence conditions of local winds in Sadegh Abad Bafgh Rig, using the dynamic data of barley in 2016 in IDV 5.0 software. Convergence of the prevailing surface winds on the construction of the hollow and its effects on the study case were investigated using the synoptic data.

### **Results and discussion**

With regard to the role of wind regime and tectonics in the establishment of sand dunes, it can be said that the results and research findings are about wind and tectonic activities. The results of the study about atmospheric pressure systems, the wind rose and sand rose show that due to the low-pressure system, the prevailing winds and the transport of sand from different paths are carried out throughout the year. The study of the tectonic conditions of the Darjeer also indicates that these tectonic conditions have an influence on the groundwater and fault activity and have contributed to the creation of local bays and highlands in the desert in Darjeer. On the other hand, the ascension of groundwater adjacent to the earth's surface and increase in the degree of soil moisture has been effective in stabilizing sand dune and development of Sadeq Abad Bagh Rig.

### **Conclusion**

In this study, the role of dominant wind regime and tectonics on the establishment of Sadegh Abad Bafgh have been examined to understand the effects of tectonic conditions on topographic situation of the flat-hollow Daranjir and its adjacent peaks of mountains. The wind currents of the region created different temperature conditions. This region has played a significant role in creating the atmospheric pressure patterns of this region and development of various local winds and the flow of sand inside the Daranjir Desert. Another tectonic effect in the region is the activity of faults and their role in the transfer of groundwater near to the Earth's surface, concentration of sand in the Sadegh Abad area. Therefore, it can be said that the tectonic has played a direct and indirect role in concentration of sand in the configuration of the Sadegh Abad Rig. In this way, the activity of faults in creation of a difference in the topography in the path of the sand movement in the adjacent Bafgh fault has directly played a role in the concentration and deposition of the sand grains. The tectonics has an effect on the development of groundwater transfer to the adjacent areas. It has increased soil moisture in the adjacent Bafq fault; also the local winds move the sand to the Daranjir and affected the development of sand dune in this part of Daranjir Desert.

**Keywords:** *Erg establishment, Sadegh Abad Bafq Erg, sand dune, unidirectional index.*

## ***Integrated Assessment of Vulnerability, Resiliency and Spatial Risk against Flooding in Sari City***

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### **Extended Abstract**

#### **Introduction**

Climate change and urbanization have put societies at the forefront of urban planning management challenges for a sustainable future. Recent studies show that climate change is likely to increase the hydrological cycle and increase the probability of severe weather events such as droughts and flood. Urbanization has increased the flood in recent decades with increasing levels of impenetrable and changing the flow paths. A flood itself is a natural phenomenon that is usually associated with positive consequences. However, when the flood occurs in the urban environment, it has devastating consequences for residents, in terms of property destruction as well as a threat to human health. The sensitivity of the elements depends on the readiness of the flood and the ability to deal with the event. The vulnerability of urban elements depends on the characteristics of building structures, services, equipment and fittings, the mobility of equipment and materials available. Vulnerability and Flood Resilience Assessment Methods, based on GIS Modeling and Multi-criteria Decision Making (MCDM), have increasingly been used to evaluate the hazard risks in settlements.

Due to precipitation changes and increase in impenetrable surfaces in northern Iran, the probability of occurrence of flood has increased in these areas. Therefore, this research has been conducted with the purpose to assess the integrated vulnerability, resilience and risk taking of Sari City against potential occurrence of flood.

#### **Materials and methods**

The data used in this research are including the statistical blocks of the city of Sari and the census data for 2017 from the Iranian Statistics Center, as demographic information, economic data and properties of residential units at the level of urban blocks. Digital Elevation Model (DEM) has also been derived from the American Geological Survey and used in the analysis. Exploring in the research literature and existing data helped us determine indicators for analysis.

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After determining the criteria and sub criteria, we have used the AHP questionnaire according to expert opinion, the criteria and sub criteria are compared and ranked in a pair.

### **Results and discussion**

The weight of vulnerability and resilience indicators in different dimensions was obtained using expert opinion and AHP method mentioned in the methodology. According to the results, the spatial vulnerability of the later environmental flood has a higher weight and has a higher value in resilience to the flood of socioeconomic dimension. The central parts of the city have a higher resilience than the periphery of the city and the southern part of the city has a very low resilience. In many traditional approaches to flood risk assessment, vulnerability is considered equivalent to risk level. This is despite the fact that risk-taking today is measured by vulnerability and resilience.

### **Conclusion**

The research had assessed the vulnerability, resilience, and spatial resolution of the Sari city in flooding conditions with an integrated approach. Urban blocks of Sari have been selected as the basis for measurements in order to make the necessary calculations to achieve the goal. Therefore, in this research, the flood has not been simulated and only vulnerability and resilience of urban structures have been evaluated in the urban blocks. The final output was the production of maps for vulnerability, resilience and spatial risk-taking for the urban blocks of Sari. According to the results, more than 600 hectares of the urban areas of Sari have high and very high vulnerability. Meanwhile, more than 800 hectares of the area has a high and very high resilience. According to these results, high and very high levels of risk taking in Sari are about 600 hectares. Compared with other studies, there has not yet been an article on the assessment of vulnerability and spatial resilience in flood conditions in the city of Sari. In 's research using f including: distance from the river, runoff coefficient, CN coefficient, population density, residential density, slope, land use, age of the building and open space of Sari in terms of risk Flood zoned. The results Mahmoud Zadeh and Bakui based on fuzzy analysis showed that the highest flood risk of Sari were located in the center and south parts of the city. Their flood zoning map showed that 24% of Sari was in a very high risk area and 37% of that was very low in flood risk. However, the basic principles of flood risk taking require a vulnerability assessment, resilience and then risk-taking. The occurrence of natural disasters today is a repetitive phenomenon that in some cases is accompanied by severe material-spiritual damage. Therefore, academic experts and planners are trying to assess different approaches and patterns by developing appropriate plans in line with damage reduction of natural disasters.

**Keywords:** *vulnerability, resilience, floodwater, Sari, risk taking.*

## ***Validating MODIS Cloud Mask Based on a Regional Cloud Mask of AVHRR***

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### **Extended abstract**

#### **Introduction**

Cloud plays an important role in the study of radiation balance and greenhouse gases due to existing water vapor as the greenhouse gases of the atmosphere. Clouds can reflect sun radiated in the top of the atmosphere based on their thickness and density. Iran country has different regions in regards to cloudiness. For example, the north of Iran has a cloudy sky in most days of the year, while cloudy conditions are low in the central regions of Iran. One of the most important datasets for cloud detection is satellite data. The two main sensors that can be used in meteorology are Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard Terra and Aqua Platforms and Advanced Very High Resolution Radiometer (AVHRR) aboard National Oceanic and Atmospheric Administration (NOAA) that were used in this paper. Various cloud detection algorithms are applied to different satellite observations over various land surfaces. AVHRR level-1 data is used to introduce a regional cloud detection scheme for two regions in Iran which have different geographical characteristics. Most cloud mask algorithms were developed globally using different spectral tests and have not examined and validated at regional scale. For example, MODIS cloud mask (MCM) algorithm can be applied in five group tests in visible, near infrared, and thermal spectral regions. The goal of the study is to validate the MCM based on AVHRR data and radiative transfer model simulation of clear sky brightness temperature (BT).

#### **Materials and methods**

We have executed the analysis in two regions of Guilan, located in southern coasts of Caspian Sea with maritime climate as well as in Khohgiluyeh Va Boyerahmad in west Iran with

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mountainous climate. We have employed five spectral threshold tests for the regions. Radiative Transfer for Television and Infrared Observation Satellite (TIROS) Operational (RTTOV) simulation of clear sky BT was also applied for clear sky BT thresholding. Snow have detected by NearIR(1.6) /VIS(0.6) test ranging values below and equal to 0.2 with a BT test at 12  $\mu\text{m}$  ranging -8.16 to 11.84 degrees Celsius. The reflectance test was also performed. Fourth test was a NearIR (0.9)/VIS (0.6) ranging from 0.6 to 1.3 over cloudy area and finally a clear sky BT test was applied to the areas.

### **Results and discussion**

These all tests were applied to five dates with the highest positive anomalies (Dec 2003, Oct 2006, Jan 2008 and Nov2011) and the highest negative anomaly (Dec 2010) during 2001-2015. The results showed that although an extended area have values below and equal to 0.2, BT test for cloudy region have values below -8.16 degrees Celsius. According to the results of the fourth test, the test indicated the values between 0.6 and 1.3 over Guilan and 0.7 and 1.3 over Khohgiluyeh Va Boyerahmad for detecting the clouds. The fifth test revealed interesting results due to different properties over low and high skin temperature area so that an area with values of skin temperature higher than 5 degrees Celsius experienced clear sky BT colder than cloudy sky temperature and vice versa. This test showed that the values of T12 $\mu\text{m}$  below -2.5 C can detect clouds in both cases (skin temperature below 5 C and greater than 5 C) over Khohgiluyeh Va Boyerahmad. The values of 5 and -13.68 C can be used for the thresholding over the area with skin temperature greater and below 5 C on Guilan province, respectively. The results demonstrated that these tests can well detect clouds over more than 90 percent of the areas. With applying these tests over 90 and 91 points of Guilan and Khohgiluyeh Va Boyerahmad, the results showed good agreement between new cloud mask and MCM and weather stations total cloud cover data.

### **Conclusion**

This study has addressed the cloud mask properties by MCM using AVHRR imagery data and weather stations statistic data. Results of the radiative transfer model revealed interesting effects on cloud detection. is the results of this research, as the first attempt to introduce a regional cloud mask over Iran, suggested the use of SEVIRI data with higher temporal resolution over two regions. The radiative transfer simulation results can compare the radiative transfer model in this research. It is recommended to use more geographic areas and more different dates for such researches.

**Keywords:** *cloud detection, AVHRR, RTTOV, Guilan, Khohgiluyeh Va Boyerahmad.*

## ***Path Analysis in Identification of Dominant Effective Meteorological Parameters on $ET_0$ in East Azarbaijan***

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### **Extended Abstract**

#### **Introduction**

Reference potential evapotranspiration ( $ET_0$ ) is one of the main elements of hydrologic cycle which can be estimated from weather data. This element can be used in calculating crop water requirements, scheduling irrigation systems, preparing input data to hydrological water-balance models, regional water resources assessment, and planning and management of water in a region and/or basin. The use of  $ET_0$  permits a physically realistic characterization of the effect of the microclimate in a field on the evaporative transfer of water from the soil-plant system to the atmosphere. It provides a measure of the integrated effects of radiation, wind speed, temperature and humidity on evapotranspiration. The long-term mean  $ET_0$  value in a certain timescale (month, season or year) can be changed during the recent decades in a given station. By decreasing  $ET_0$ , crop water demand decreases. Conversely, by increasing  $ET_0$  the crop water requirements can also increase accordingly. Therefore, it can be suggested that change in the rates of  $ET_0$  due to climate change would have great importance for agriculturalists and water decision makers. On the other hand, accurate estimation of  $ET_0$  is crucial in improving the irrigation efficiency in a region. Many climatic parameters impacted the  $ET_0$  value in a single site. On the other hand, these parameters are correlated to each other.

#### **Materials and methods**

The climatic data from the synoptic stations with at least 20 years of continuous records in East Azarbaijan province were gathered from the Islamic Republic of Iran Meteorological Organization (IRIMO). The obtained data are including maximum air temperature ( $T_{max}$ ), minimum air temperature ( $T_{min}$ ), wind speed in 10 m height ( $U$ ), maximum relative humidity ( $RH_{max}$ ), minimum relative humidity ( $RH_{min}$ ), and duration of sunshine hours ( $n$ ). The well-known FAO-PM56 method was used to calculate the  $ET_0$ . There are many methods for  $ET_0$  estimation. The Penman–Monteith (PM) method is recommended as the standard by the United Nations Food and Agriculture Organization (UNFAO) and has gained worldwide acceptance and received much research interests. The PM equation has been widely used in  $ET_0$  estimation.

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However, this method needs more meteorological data which is not available in many regions. This led scientists to use other methods which do not need more parameters. Among the empirical methods which estimate  $ET_0$  using less climatic parameters are Hargreaves, Thornthwait, Belaney-Criddle and Priestley–Taylor. Unfortunately, outputs of these models are not accurate in all the sites. Therefore, for using these simple empirical models the calibration process should be done as well. Therefore, the following issues need urgent study: (1) selection of as few dominant meteorological variables as possible in meteorological parameters affecting  $ET_0$ , and (2) universal application of an established model in more regions.

The alternative method namely Multiple Linear Regression (MLR) can be used to estimate the  $ET_0$ . In order to evaluate the performance of the MLR method, some measures were calculated by comparing the results of MLR with FAO56-PM method. These measures are the Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Nash–Sutcliffe Efficiency (NSE), and the coefficient of determination ( $R^2$ ). Then, the correlation coefficients ( $r_{yxi}$ ) calculated for the  $ET_0$  time series ( $y$ ) and each of the meteorological parameters ( $x_i$ ). Then, the partial correlation coefficients ( $r_{ij}$ ) are calculated for the explanatory variables ( $x_i$  and  $x_j$ ) as well. Both of the direct and indirect effects of each climatic parameter on  $ET_0$  were evaluated by path analysis. These effects are denoted by  $P$  and  $R_{dc}$ , respectively. By solving the Eq. 6, the elements of  $P$  (direct effect of  $x_i$  on  $y$  or  $ET_0$ ) are obtained. By multiplying the obtained  $P$  vector (direct effects) on  $r_{x_i x_j}$ , we calculated the indirect effect of  $x_i$  through the  $x_j$  on  $ET_0$ . This process is repeated for all the selected sites.

Path analysis was first proposed in 1921 as a mathematical and statistical method by the geneticist Sewell Wright. Nowadays, the method is broadly used in agriculture and energy demands to reveal direct or indirect relationships between some morphological characters. However, information is available on the use of this technique to evaluate the factors affecting  $ET_0$ . Given the fact that all the meteorological variables are strongly correlated and ultimately lead to multi-collinearity, traditional trend and correlation analyses cannot quantify the interactions among the meteorological factors when filtering the suitable parameters.

Path analysis is a type of multivariate statistical analysis for studying relationships among variables. It can reveal the strength of the effects of independent variables on a dependent variable. Path analysis can determine direct and indirect effects of independent variables on the dependent variable; multi-collinear independent variables resulted from their own strong correlations, and optimal regression equations without unnecessary independent variables. The path coefficient is a type of standard partial regression coefficient (without units) that expresses causalities among related variables. It is also a directional correlation coefficient between independent and dependent variables. This analysis was conducted for each of the selected stations in East Azarbaijan province, Iran. To do this, we initially calculated the correlation coefficients between each of the climatic parameters and  $ET_0$  time series. Similarly, correlation coefficients matrix between the climatic parameters affecting  $ET_0$  was obtained for each of the stations.

## **Results and discussion**

The results of this research showed that the values of MAPE obtained for the stations were between 0.433 and 0.874. However, the  $R^2$  values were between 0.972 and 0.9953. Similarly,

the RMSE were between 0.042 (mm/day) and 0.982 (mm/day), and the obtained MAE values were between 0.033 and 0.057. It was also found that the wind speed at the stations namely Tabriz, Jolfa, Sarab, Sahand, Maragheh and Mianeh had significant correlation (at the 0.01% level) with  $ET_0$ . The strongest correlation was related to the station Ahar, which was between  $ET_0$  and the wind speed (at the 0.01% level). The results of path analysis showed that the maximum value of P (direct effects of meteorological parameters on  $ET_0$  belonged to the wind speed). The P values of wind speed in the stations Tabriz, Julfa, Sahand, Sarab, Maragheh, and Mianeh were equal to 0.637, 0.787, 0.877, 0.578, 0.850, and 0.780, respectively. In the station Ahar, the highest value of the P observed belong to the  $T_{max}$  (equal to 0.398).

### **Conclusion**

Accurate estimation of  $ET_0$  is very important from the view of optimal water management in any region. Wind speed was found to be the dominant direct climatic parameter due to having the largest value of the P. In general, it can be concluded that the causal analysis method can be considered as an effective way to investigate the direct and indirect effects of meteorological parameters on  $ET_0$ . Overall, it is more reasonable to apply path analysis method to evaluate dominant meteorological parameters of the  $ET_0$  in direct and indirect ways. The further research can be oriented in analysis on why dominant factors vary with meteorological stations. Development of other soft computing techniques calculated  $ET_0$  using the climatic methods (such as firefly algorithm, artificial neural networks, support vector regression, and genetic expression programming) and comparing their accuracy with that of the MLR are recommended for further studies.

**Keywords:** *meteorological parameters, path analysis, reference evapotranspiration, stepwise regression.*

## ***Rainwater Harvesting from Kermanshah City Roofs and Recognizing the Suitable Places for Water Saving to Irrigate Urban Green Spaces***

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### **Extended Abstract**

#### **Introduction**

Water is considered as an important and determinative factor for the continuity of human, animal and plants living on the earth and biosphere. This vital material resolves the primary requirements of human such as drinking, agriculture, and industry. Nowadays, providing water is regarded as a basic challenge in developing countries, like Iran. Given the climate tensions and excessive consumption in most major cities, the problem of water scarcity can be minimized by harvesting rainwater. Since Rainwater Harvesting of roofs in some regions in Iran is considerably remarkable, it can provide some non-drinking requirements of citizens. Basic concept of rainwater harvesting is simple; it is the water can be collected from the roofs and appropriate surfaces, and conveyed downwards by pipes for saving. This water is saved in an appropriate place which can be used in proper time. If the saved water is considered for non-drinking consumption, no filtering will be needed; desalination is enough. It should be noted that rainwater needs to be filtered for drinking. Therefore, for arid and semi-arid regions such as Kermanshah, Rainwater Harvesting from the building roofs to supply water requirement of urban green places can solve a major problem of dehydration.

#### **Material and method**

The necessary climatic data for this study are precipitation statistic of synoptic station in Kermanshah during a 65-year period, from 1951 to 2016. They were used as annually and monthly average. Due to the climate of Kermanshah, precipitation period lasts from October to June. The urban data used includes the area of building roofs, the area of urban green places and trees, and the volume of water required for irrigation. The area of building roofs (in meter) of Kermanshah city was extracted from aerial photos in Google Earth.

To calculate the volume of harvesting rainwater, we used three components including precipitation, the area of building roofs and run-off coefficient. Run-off coefficient of building

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roofs is 0.7 by default. Moreover, the required water for irrigation of the green places of Kermanshah city is 12 liters per  $m^2$  during 24 hours. Although there is rainfall during cold season of the year (January, February and March) with decrease in plant growth, irrigation is stopped. The water consumed for irrigation is on average 4 liters per  $m^2$  in fall and spring mainly due to moderate weather and rainfall conditions. In the present study, WLC and AHP methods were applied to determine the appropriate location of rainwater saving. The evaluated variables to determine the place are including green places, unused places, agricultural lands in the city, suburb agriculture lands, slope and the proximity to the buildings which were gathered by questionnaire through experts of municipality officials, parks organization and urban green places of Kermanshah city. Moreover, it should be noted that some land uses are considered as the unsuitable places to save rainwater such as asphalt surface, roof surface, and all kinds of service land uses across the city.

### **Results and discussion**

The built area of Kermanshah city is 108365238  $m^2$ . The maximum precipitation usually occurs in March and April, 70.6 mm, while the minimum is occurs in July and August. The average annual precipitation is 441 mm. Besides, the maximum temperature of Kermanshah city is 38 C in August, while the minimum is -3.6 C in January.

The biggest value is recorded for zone 3 in Kermanshah, 21.28  $Km^2$ , and the greatest area of building roofs is recorded for district 4, 23.8 % with the highest building density. Moreover, the greenest places are related to zone 5, 6.4%. The highest water requirement is also related to zone 5, due to the green places and higher number of trees (8110 ones), 14.7%. The highest ratio of harvesting rainwater is calculated for zone 4 (due to more building density), while the least ratio is calculated for zone 8 (due to less building density). The ratio of the area of urban green places is 4.3% and the ratio of water requirement is 9.8%. The most percent reserve of rainwater requirement is related to zone 4 located in the southeast of the city, 76.5%; zone 3, in the east of the city. It is regarded in the second class. The least percent of reserve rainwater requirement is recognized for zone 8, located in the southwest Kermanshah city. As a matter of fact, it is important to recognize these regions for green places may be of the far regions to gather rainwater which require the transition and saving according to the effective variables. The total volume of water requirement is about 10620000  $m^3$  and the volume of harvesting rainwater is 6200000  $m^3$  which can provide 58.4% of water requirement.

The highest effectiveness of locating is related to the variable of the locations with green places. Unused places and agriculture lands in the city are in the next priority for rainwater saving, due to easier land use conversion. In fact, the areas of lower slope are more appropriate for rainwater saving. Besides, the proximity to the place for gathering rainwater is economically efficient. Totally, 42000  $m^2$  of the total area of Kermanshah city is more suitable for saving rainwater which is mostly located in district 5 in the northeast of the city. Building roofs, passages, medical centers, service centers, refinery and airports are not appropriate enough to save rainwater, they are approximately 42000000  $m^2$ .

### **Conclusion**

Rainwater is changed into run-off and flood-water in most of the cities in Iran which is moved out of the city by water channels. Rainwater Harvesting is of considerable importance due to the

conservation and management of water sources. The present study is carried out to determine the amount of harvesting rainwater from the building roofs of Kermanshah city to supply water requirement of urban green places. The suitable places for rainwater harvesting were determined by WLC models. The findings show that 6200000 m<sup>3</sup> (58.4%) out of total 10620000 m<sup>3</sup> of annually water requirement of Kermanshah green places, is provided by rainwater harvesting of the building roofs. According to different environmental variables, about 42000 m<sup>2</sup> of urban area and suburb of the city are recognized as more appropriate regions for the saving rainwater. Zone 5 of Kermanshah city has better conditions compared with other zones.

***Keywords:*** *rainwater harvesting, building roofs, urban green places, Kermanshah City.*

## ***Prognosis of Frosting Occurrence in Almond Orchards, Najafabad Region***

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### **Extended Abstract**

#### **Introduction**

Nowadays, one of the greatest difficulties in agricultural activities is effects of weather factors on agricultural crops. The purpose of this research is to present prognosis of frosting occurrence in almond orchards in Najafabad region. Freezing can damage agriculture crops on the condition that it was prolonging and intense. The frost phenomenon and consequent damages is a serious problem in all the regions of the world. On time and accurate forecasting of occurrence time can reduce damages. Though about frostbite many studies have been done but the majority of this research just has examined this phenomenon from the perspective of the weather and by specifically the productive synoptic patterns. In the agricultural scale, great views have often useless results. These predictions are scale down on spatial and temporal (Downscaling). The purpose of this research is to combine two phenological and meteorological models (WRF) in order to predict the phenomenon of spring frost in almond gardens of the region.

#### **Materials and methods**

Case of study of this research is Zayandeh Rud Basin. Zayandeh Rud Basin as the study area is located 50 degrees and 20 minute until 52 degrees and 24 minute eastern longitude and 31 degrees and 12 minute until 33 degrees and 42 minute northern latitude.

Since the concept of cold damage in agriculture, regardless of product development stages (phenology) and only the temperature test, has no practical value. Therefore, it was necessary to estimate the model of almond flowering in studied gardens. The results are combined with weather forecasting model (WRF). According to the phenology long-term statistics of almond trees in the Najafabad region, the extracted flowering dates were calculated based on Julian dates. Then, the GDD matrix table is plotted for the analysis.

The relationship between flowering history is evaluated with the parameters mentioned. The strongest relationship is selected for further evaluations. The flowering is dependent variable and the other above mentioned is independent variable. The most relevant regression equation is

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determined with high correlation coefficient. According to the WRF model, such analysis in the study area was performed by Nasr Esfahani et al and predicted model temperature was statistically significant. A quick warning can be made of the occurrence of frostbite in the coming days for the flowering date.

### **Results and discussion**

According to the phenological data of Najafabad station, the flowering date for each year based on Julian calendar, was analyzed in the statistical population of 10 years (2006-2017). The average flowering period is eighty days (80). The years 2007, 2011 and 2014 have the highest flowering time. The number of flowering days was twelve days in 2007, ten days in 2011, fifteen days in 2012, eight days in 2014 and six days in 2017. Among the existing parameters, the highest correlation (0.945) was revealed between the flowering date and the number of days above the mean. This is a positive relationship and show that the number of days above the average is related to the flowering in almonds. The value of P-value <0.01 is significant at 1% level. After the flowering date and GDD greater than zero (0.938) with a significant level of 0.01, there is the highest correlation between the flowering date and the number of days below the average of over five (0.921) with a significant level of 0.05. Linear multi-variable regression equations were also investigated. This equation was correlated with 0.96 and there is a very strong connection between the dependent and independent variables. The regression coefficients are estimated separately for the two models using the first column of the table. We can use the regression model as  $Y = 36.605 + 1.761X$  for the first model. Where x is the number of days above the average and y is the date of flowering. The estimated regression model for the second model is  $Y = 33.514 + 1.083X_1 + 0.945X_2$

Where, X1 is the number of days above the average and X2 is the number of days below the average. Then, we have selected the best model and defined the coefficient for both models. It is noted that the modified coefficient of the second model is determined with two independent variables (0.998). This is higher than the first-order correction coefficient (0.88). It can be concluded that the second model is better than the first one.

### **Conclusion**

As we have seen, the linear multivariate regression equation was significant for predicting flowering history at 1% confidence level. Now with the temperature prediction by the WRF model and calculating the number of days above the average and below the average, the flowering date can be obtained and show the warnings of frostbite in the presence of flowering.

Similar to this study, Prabha and Hoogenboom (2008) showed that use of the WRF Intermediate Scale for effective protection management is a good strategy to protect products and reduce frost damage. The results of this study reveal the feasibility and accuracy of the WRF model for radiation and radiant frost warning. Given the daily temperature test outputs of the WRF model in the study area, we can observe very good results in smooth areas. It can be combined with two phenology models and the prediction of temperature by the WRF model, as a quick warning of 48 hours of frostbite occurred in the gardens of the area with sufficient accuracy.

**Keywords:** *phenology models, WRF model, flowering date, temperature forecast.*

***The Effects of Different Weather Conditions on the Mobility of Salt Masses Using Interferometry Method of ASAR Time Series Images  
(Case Study: Larestan Shah-gheyb Salt Dome)***

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### **Extended Abstract**

#### **Introduction**

Exploring the behavior of exposed salt structures and its relationship to the environmental factors can be effective in identification of these structures and their environmental effects. Salt layers beneath the sediments, due to their lower viscosity than the surrounding rocks, can flow upward and form different salt structures such as salt pillows, walls and salt domes. Kinematics study of outcropped salt structures has great potential to provide valuable information for engineering and scientific purposes, such as the storage of natural gas. The behavior of salt masses is usually difficult to investigate their instability and extreme variability on the surface. A study of the world's salt domes shows that the evolution of many salt structures is influenced by tectonic factors and regimes. However, the life span of salt masses on the earth's surface is short, but because salts are exposed, they are affected by the processes of the earth surface and undergo various changes. By examining these changes over this short period we can find key and important evidence of evolutionary trends. As a result, it is important for the overall exploration of crustal salt to study the few available sub-aerial salt bodies. Most of our information on salt kinematics and mobility is related to the studies on the Zagros and Alborz salt domes in southern and northern Iran. The Shahgheyb-e-Larestan salt dome is one of the largest exposed saline structures that have been used in the study of salt motility. We have addressed the possible relationship with climate change in this research. Hence, the accrued deformation on this salt dome was identified and measured by time series interferometry technique of ASAR images related to the years of 2003 to 2008.

#### **Materials and methods**

InSAR is a remote sensing technique using radar imagery to measure the satellite line of sight (LOS) displacements rate in millimeter to centimeter accuracy. Multiple SAR images are used to generate a set of interferograms and to form a time series after a joint inversion. InSAR time series analysis help us reduce the impact of several noise sources (decorrelation, orbital and DEM errors, atmospheric delays, phase unwrapping errors) on displacement rates estimation during the time period spanned by the full dataset with an accuracy for surface displacement velocity at the

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mm/yr scale. The short baseline method is used to minimize the spatio-temporal baseline by a combination of interferograms. We have used 22 ESA ASAR C-band radar images acquired by the Envisat satellite between June 2003 and October 2008 from Track 291 (along descending orbits). A small-baseline approach was used to process interferograms. This method was used to calculate average displacement rates in the period with the New Small Baseline Algorithm Subset chain. Eleven individual interferograms were generated using a modified version of the SARscape and the STRM 30-global DEM. The interferograms were corrected from DEM errors.

### **Results and discussion**

In order to investigate the relationship between salt kinematics and different weather conditions, the individual maps of 10 different periods between 2003 and 2008 were correlated with the temperature and precipitation data corresponding to the mentioned periods. The radar interferometry method was performed on the pair of images from 2003 and 2008 from the study area to produce the interferogram images. Several fringes are formed in the interferogram image. Since the used satellite (Envisat) works in the C band, and each obtained fringe is  $\lambda/2$  equal to 2.8 centimeters, the displacement rate to the satellite's view is obtained by counting the number of fringes. The mechanism of displacement also varies depending on the color cycle (fringes pattern), so that if the color cycle is yellow-blue-red, displacement moving away from the radar. If the color cycle is yellow-red-blue, the displacement has occurred into the radar. The surface displacement rate in the Shah-Gheyb salt dome is 2.3 to 2.8 cm per year, between 2003 and 2008 into the satellite view. Two regions of the salt dome have been uplifted and one region in the northwestern part of the dome has been subsided. Based on the cross-sectional displacement maps, there is an apparent relationship between the hot and cold months of the year and the surface displacement rates of the salts. Corresponding to the two warm months of the year; the rate of uplift is much higher than that of subsidence. The results obtained from the time series analysis and displacement rates indicate that this salt dome is active. It determines the salt motion in the satellite's view of 2.8 cm per year. Based on correlation coefficients, there is a direct relationship between displacement and average temperature. As the temperature increases, the salt uplift rises and the subsidence decreases. But there was no relationship between rainfall and surface changes of the salt.

### **Conclusion**

In this study, the displacement rate of Shah-Gheyb salt dome was calculated using radar interferometry method in the folded Zagros area. The average uplift rate of salt mass was 2.8 centimeters per year and the average rate of subsidence was 2.2 centimeters per year. This rate of change has been varied in different times according to the temperature of the region. The correlation of different weather conditions with sectional displacement maps revealed that there are a relative correlation between the salt kinematics and climatic conditions. Therefore, in this salt dome, salt kinematics can be controlled by climate conditions. In addition, the time series analysis has indicated that the difference between the uplift and subsidence has steadily increased in 2003 to 2008. Therefore, secondary salt changes after the outbreak of salt domes on earth were often influenced by climatic conditions and physicochemical properties of salt as well as tectonic conditions.

**Keywords:** *salt movement, weather condition, radar interferometry, salt dome, Larestan.*

## ***The impacts of Climate Change on Growth Period and Water Requirement of the Apple Tree (Case Study: Semirom and Urmia, Iran)***

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### **Extended Abstract**

#### **Introduction**

Climate plays a key role in the successful production of horticultural products for the global trade. Horticultural activities are highly dependent on local weather conditions. The study of the phenomenological behavior of the products as part of the impact of environmental conditions is important, because for optimal production as well as more appropriate management, it is essential to know the phenological stages and changes in the product.

#### **Materials and methods**

In this study, the ECMWF database has been used for observation data of Semirom and Urmia stations during 20-year period (1996-2001). To evaluate the accuracy of ECMWF data with the observation data of the Iranian Meteorological Organization during the common time interval with the nearest point of ERA-Interim to the stations studied, we have used the Pearson Correlation Coefficient (R), Coefficient of Determination (R<sup>2</sup>), Mean Squared Error (MSE), Root Mean Square Error (RMSE), and Normalized Root Mean Squared Error (NRMSE). The most important factor in determining the need for water is the accurate ETo estimation in each region, so the potential evapotranspiration (ET<sup>0</sup>) values were calculated using the Penman-Monteith FAO method. To investigate the effects of climate change on water requirement and duration of growth, the daily micro scale dynamic data of the CORDEX project with a precision of 44% \* 44% for the output of the ICHEC-EC-EARTH model under the two lines of 4.5 and 8.5 (RCP) was used for the period (2017-2037). In order to reduce the errors in the model estimates, the post-processing action of the estimated events was fulfilled. The water requirement and growth season length of the apples was also evaluated. Given the highest amount of apple cultivars in the study area is autumn, the type of late fall apple is selected for evaluation. According to correlation of each step of growing apples with thermal operating

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temperature, length of growing season and vegetative stages of apple tree were calculated using GDD.

### **Results and discussion**

The statistical results between ERA-Interim data and observational data at the stations were examined and the accuracy of the database was confirmed for both stations. In the next section, in order to select the best model for the study area, the data of the base year of the growth season of the CORDEX project models was compared with the observational data. The ICHEC-EC-EARTH model has a lower error rate than the other two. The post processing of historical events has been able to greatly increase the model's performance data. The results of the two man-Kendall and Sen's slope at the Semirom station on the ETo observations were reduced during the growing season, but in the Urumia station, the slope is positive and incremental. The evapotranspiration potential was observed in the growing season, under the RCP4 / 5 and RCP8 / 5 trajectories for the stations. This is typical of an incremental trend. At the Uromiyah station, the results of the ETo on the growth stages of the apple tree indicate an increasing trend for observational data in all stages. For the estimated data, the effective rainfall season in Urumieh station is more than Semirom. Therefore, during the growth season of the apple tree, the Semirom station will need more water in the observation period and years of forecasting than the station in Orumiyeh. At both stations, in the observation period and the estimated data, the rainfall level is effective in the germination stage, more than other stages. In the course of 8/8 for both effective precipitation stations will be increased in the observation period. Given the evapotranspiration and precipitation during the growing season of apples, the results of simulations showed that under climate change conditions compared with the base period, the need for irrigation of apple trees at Urmia and Semirom stations should be increased under both scenarios. The results from the comparison of the growth period of the base period and the estimated data at the stations under both scenarios indicate a decrease in the growth period in the future. The trend was not statistically verified. Earlier heat supply due to increased temperature has led to some shortening steps. Decrease in the growth period in the scenario is 5.8 and more than the 4.5scenario.

### **Conclusion**

Based on the evaluation methods, the ECMWF data estimation error with observational data was negligible, and the database for the study stations can be verified. The results showed that evapotranspiration in both stations are increasing during the growing season. The ETo increase in the growth season of the apple tree was predicted from the base period for the trajectories of 4.5 and 8.5 for the Semirom at 4.14.7 and 7.99.7, respectively, and for Orumiye Station, the values are 26.5 and 11.8, respectively. However, this increasing process will raise the apple's need for water. The highest amount of evaporation and water requirement in the observed and estimated data has been occurred in the period of growth. At this stage, the lowest effective rainfall and the highest average temperature have occurred but generally the percentage of upcoming changes of germination stage was more than other stages. Earlier heat supply will reduce the growth period of the apple tree. In fact, the plant will complete its growth and reproduction cycle earlier, resulting in reduced yield, reduced quality and color, increased

temperature and increased water requirement. Earlier heat supply due to increased temperature has led to some shortening steps.

**Keywords:** *apple tree, evapotranspiration, water requirement, growth length, Penman Monteith FAO method.*