Analysis of land surface temperature gradient of Iran using MODIS Terra and Aqua data

Masood Moradi
Ph.D. Candidate in Climatology, University of Mohaghegh Ardabili, Ardabil, Iran
Broumand Salahi*
Associate Professor, Department of Physical Geography, University of Mohaghegh Ardabili, Ardabil, Iran
Seyyed Abolfazl Masoodian
Ph.D. in Climatology, Department of Physical Geography, University of Isfahan, Isfahan, Iran

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Extanded Abstract

Introduction

The MODIS facility for the Earth Observing System is a key element that supports ambitious goals related to studying the Earth as a system. One of the MODIS products is high quality land surface temperature data produced in Terra and Aqua platforms. Knowledge of the LST provides information on the temporal and spatial variations of the surface equilibrium state and is of fundamental importance in many applications. Therefore, it is required to conduct a wide variety of climatic, hydrological, ecological, and biogeochemical studies. Due to the intrinsic scanning characteristics of the MODIS instrument onboard the polar-orbiting satellites, the differences in local solar time for pixels along a given scan line on the same day or for the same pixel on different days in one revisit period can be detected for 2 hours. As LST changes with local solar time, it is not possible to directly compare the LST of different pixels in the same day or of the same pixels in different days. Awareness about slope of land surface temperature is an important factor for cognition of land surface temperature behavior that can be used for increasing spatial and temporal resolution, comparability with other data, and accuracy achievement. The results will help calculate a time consistent land surface temperature.

Materials and Methods

Land surface temperature data used in this research are produced using Normalized split windows algorithm. These data haver been downloaded from MODIS website (http://reverb.echo.nasa.gov/reverb) in daily time scale for temporal range of 2002/07/08–

* E-mail: bromand416@yahoo.com Tel: +98 9144515922

2015/11/30. Prior to this date, Aqua MODIS data were not available. This dataset contain measurements of land surface temperature, quality assurance, view time, view angel, land surface emissivity available for day time and night time. MODIS Terra 10:30AM and Aqua 1:30PM data have been used in this study. A matrix in dimensions of 4984*1884077 is provided from this dataset for Terra and Aqua day time land surface temperature and day view time. The matrix has provided basic information for this study. The slope of land surface temperature between two observation of Terra (10:30AM) and Aqua (1:30PM) is calculated. View time and land surface temperature measurements should initially be recalled and calculate variation of land surface temperature in relation to observation time distance between Terra/Aqua measurement for each pixel of Iran for every day of time series. The land surface temperature gradient has been calculated in monthly long term mean for spatial and temporal analysis.

Results and Discussion

View time is an important parameter in analysis of land surface temperature gradient. View time distribution of land surface temperature in Iran show that Terra and Aqua view time has a high uniformity in frequency percent of observation times for land surface temperature at 10-12 and 12:30-14:30 for Terra and Aqua, respectively. The coordination of land surface temperature gradient and topography in Iran is high. Low elevation lands between Zagros and central mountain ranges with northwest to southeast direction and central hollows such as Kavir plain, Lut desert and Jazmouryan is visible with higher slope in land surface temperature in all different months of year. North and south shorelines and high elevations are the regions with smaller gradient. The gradient of less than 2 kelvin/hour in land surface temperature occurred in 85% of Iran territory. Difference between Terra and Aqua land surface temperature decreased clockwise from northeast aspects to southwest and increased from northwest to northeast. The gradient of land surface temperature has an inverse relation with slope of land and decreased one kelvin/hour from zero to 22 degree in slope.

Conclusion

Significant spatial and temporal variation that occurred in land surface temperature gradient of Iran is the result of variation in environmental conditions and incoming solar radiation. The gradient of land surface temperature in shorelines and mountainous regions is lower than deserts and low level elevations in all months of year. The gradient of zero to ±1 and +1 to +2 kelvin/hour in land surface temperature has covered great areas of Iran in different months. Zero to -1 kelvin/hour gradient spread can be seen in winter season in high level elevations of Alborz and Zagros mountains. Decrease in land surface temperature gradient with increase land slope can reflect relation between land surface temperature and elevation. The results show that small amounts of land surface temperature gradient are the characteristic of major parts of Iran. In these conditions we can produce a time consistent land surface temperature data for each pixel of every day in available time series for a time between MODIS Terra and Aqua observations.

Keywords: Iran, land surface temperature gradient, MODIS, temporal and spatial variations.

Role of natural factors in spatial distribution of archaeological sites, during the chalcolithic period in Bostanabad, Azerbaijan

Hossein Naseri Some[*]
Ph.D. Candidate in Archeology, Faculty of Literature and Human Sciences, Tarbitat Modares University, Iran
Kamalodin Niknami
Professor, Department of Archeology, Faculty of Literature and Human Sciences, Tarbitat Modares University, Iran

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Extended Abstract

Introduction

When it comes to the ancient settlement patterns and how to set in a region, the role of environment and its infrastructure in a geographical landscape will be highlighted. Distribution of population and human settlements in a geographical area has a great influence on the structure and function of human activities. Not only will these distribution patterns be affected by social and cultural factors, they were highly dependent on natural phenomena; because nature is a context of human geographical activities.

In this paper, we have studied and analyzed the role of environmental factors in spatial distribution and configuration of human settlements during the Chalcolithic period in Bostanabad. For this purpose, we have identified and collected surface data of 55 sites including Chalcolithic works during 3 seasons of archaeological survey and using statistical techniques for data analysis. To accomplish this work, natural factors included surface water, rainfall, climate, altitude, vegetation, land-use, and slope have been evaluated.

The results have illustrated that the geographical features of the region, especially water resources, altitude, and climate were the most important factors in the formation of settlement patterns in the desired area at the Chalcolithic period, and the manner of set of these sites was dependent on these mentioned factors more than any other environmental factor in this district. The vital role of water, especially rivers, developed the sites in form of linear pattern along the rivers.

Materials and Methods

The data for this study have been collected from archaeological survey, and the librarian method was used to identify the sources and texts, use previous studies, and use the results of the excavations; then, the statistical methods were used to analysis of data. These field studies have

* E-mail: Hoseinnaseri16@gmail.com Tel: +98 9143226788

been carried out during the years 2006, 2013, and 2014. We have conducted field surveys in seven rural districts western and eastern Abbas Abad in the first season, eastern western and eastern Owjan, and Sahand Abad in the second season, and central and southern Mehran Roud in the third season. The surveys resulted in identifying and recording a number of prehistiric, historic, and Islamic sites. From them, 55 sites are containing matterials of Chalcolithic period. The analysis of the desired data have been entered in Geographic Information System (GIS) and its outcomes described by the maps.

Results and Discussion

Bostān-Abād relative chronology data were based on the study of collected pottery samples from the area and compared with the samples from the cultural layer in scientific exploration. However, in some cases due to their similarity with potteries from different sites, separating periods becomes quite difficult, and need scientific excavation or laboratory studies, as many factors contribute to the distortion of data in field studies; however, it has been attempted to use reliable data as far as possible. In this regard at the regional scale, data have been compared with neighboring regions outside the current area (Mesopotamia, Anatolia and the Caucasus) and, in the region scale, with sites of Lake Urmia basin and, in the settlement scale, with Kül tepe Hadi-Shahr and Köhne Pasgah tepesi sites.

According to the scattered works in the area (including pottery and surface objects), 11 sites have Dalma pottery culture dates (characteristic of the Early and Middle Chalcolithic of Azerbaijan) and 52 sites have CFW (Chaff-Faced Ware) pottery culture (Characteristic of the Late Chalcolithic of Azerbaijan), which 8 sites last from the Early-Middle to Late Chalcolithic. Regarding the type, extent, situation of settlement, etc., we can claim that in Bostān-Abād we face both permanent and temporary seasonal settlements in the Chalcolithic period.

Conclusion

According to the tables and statistics, water played an important role in the formation of settlements, so that 62% of the settlements have been built at a distance of less than 500 meters to the main water sources (rivers permanent and seasonal). This character is evident in both the Early-middle and Late Chalcolithic period in the region, which 33 sites across 52 sites were attributed to the Late Chalcolithic period, and 8 sites from the 11sites in Early-middle Chalcolithic period (62% of the total collection) are in this distance. The vital role of water, especially rivers, caused sites have been made in form of linear pattern along the rivers.

Elevation is the other main factor in establishment of the Chalcolithic settlements in the area. Charts and maps show Chalcolithic sites in Bostān-Abād extended to highlands; as about 75% of the sites have been established at an altitude of 1750 to 2100 m above the sea level. Altitude has a direct relation with temperature reduction and increase in rainfall. When the weather become warm, these factors lead to accumulation of snow, then, creating feeding nests of streams and melting saved snow which is responsible for having water resources, pastures and vegetation in the summer nomads.

Keywords: Bostanabad, chalcolithic, linear pattern, natural factors, spatial distribution.

Time in geomorphic systems

Mohammad Hossein Ramesht
Professor, Faculty of Geographical Sciences and Planning, Isfahan University, Iran
Mojgan Entezary
Assistant Professor, Faculty of Geographical Sciences and Planning, Isfahan University, Iran
Sosan Delsoz*
Ph.D. in Geomorphology, Isfahan University, Iran

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Extended Abstract

Introduction

The complexity of the phenomenon of time and its meaning has always been considered an obstacle to understanding the nature of time. Time is an important phenomenon in detailed discussions about its nature, particularly in philosophy and physics filed. Sun, Earth and rotations should be considered a major factor in the definition of the concept of astronomical time. The effect of twenty-four-hour in organisms is consisted of the large part of their biological activities. Even questions about the latitude of more than 70 degrees as well. This question is deeply connecting us to other concepts of time events.

The geomorphologists believed that the time shows the range changes and evolution of landscape. The evolution of natural phenomena over time can be oriented in the form of different models to examine and evaluate the concept can be interpreted mother theory of harvest of the main geomorphology. It is explicitly said that there is three major intellectual (historical method, dynamic method and the perspective of a systematic) approaches accidentally caused by different interpretations of the concept of time by geomorphologist.

Methodology

The experience allowed the time and its implications in perspective (Graph 1977) requires an experimental model to determine when concepts such as delay time, reaction time, relaxation time and response time, and their relation to the shock time with different magnitude assessed to check it to achieve this goal for a drainage basin Laboratory.

Model provision (watershed) in a rectangular shape with dimensions of 162 cm long and 215 wide is carried. After modeling to measure the intensity of the rains, an artificial rain system was built that can control the intensity and time precipitation ratio was propelled to evaluate them.

* E-mail: susandelsooz@yahoo.com Tel: +98 9132260232

For avoidance of any error, the irrational numbers were used for the shock time. Irrational numbers were selected from 3 to 101 and the consequent in three separate stages for shock rainfall intensity one liter per minute, 3.8 min and 6 liters per minute. The data used in this study, quantitative data with zero mathematical scalar time in three separate phases in the model was implemented. A total of 260 measurements were obtained and their calculation was done in three months. The breakdown of the figures, the relationship between the persistence of shocks time when other

The elements were extracted based on matrix tables (4) and (5) and (6), and seven models of relationship surveys.

Results and Discussion

According to the matrix of the relationship between the persistence of the shock in the magnitude of one, 3.8 liter and six Liter were analyzed and after testing seven models 30 various manners were obtained. This should be noted that 7 out of 30 were not significant and 23 were attained meaningful relationship.

Conclusions

Geomorphic systems and change in their attitudes and behavior with a variable time is not explaining several concepts used to express them. The task assigned to the variable time with different concepts shock time, latency, response time, response time and rest time and matter is expressed in relation to this issue. This states that these variables can be together because these relationships may indicate a various states in one hand and on the other hand it estimated prediction behavior.

The phase one, two and three field pilot test shock magnitude in 1 liter, 3.8 and 6 min indicate that the continuation of the shock relations is by other concepts the second time on the complex relations and the truth of the relationship provided up to certain extent. Each system can be described with the general rule for any kind of shock to be evaluated in a press statement.

The relations obtained in the first phase include three linear and quadratic five relationships as the following key results.

Systems don’t reaction to every Shook Time

With increase in Shook Time, Reaction Time decreases.

The relationship between Shook Time and Reaction Time is dual.

If Shook Time and Reaction Time are equal, the Memory Time will be zero.

The relation between Delay Time and magnitude of Shook Time is in inverse directions.

Keywords: attachments area, geomorphology, place, space- identity, time.

The influence of lower tropospheric circulation of Arabian high pressure on Iran precipitation

Mostafa Karimi[*]
Assistant Professor, Faculty of Geography, University of Tehran, Iran
Faramarz Khoshakhlagh
Assistant Professor, Faculty of Geography, University of Tehran, Iran
Saeed Bazgir
Assistant Professor, Faculty of Geography, University of Tehran, Iran
Mahnaz Jafari
M.A. Student of Synoptic Climatology, Faculty of Geography, University of Tehran, Iran

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Extended Abstract

Introduction

Atmospheric circulation patterns result in different weather conditions. Rainfall changes are controlled by seasonal and irregular variations of atmospheric circulation pattern. A variety of climate changes such as drought and flood can result in changes in the spatio-temporal precipitation, one of the important parameters of heterogeneity in moisture transmission and injection in the rainy systems of Iran. One component of the atmospheric circulation of moisture transmission is the high pressure centers and the most important point is their location on the water surface.

Saudi Arabian high pressure is one of the main elements of the general circulation on the lower level of the atmosphere which affects climatic characteristics of the region. Therefore, the main aim of recent study was to investigate Saudi Arabian High Pressure circulation patterns and its impacts on the moisture and precipitation by using cluster analysis.

Materials and Methods

In order to assess the role of Saudi Arabian high pressure patterns on the rainfall and moisture of Iran, we have derived hourly data *viz.*, 00, 06, 12 and 18 global standard geopotential data in height of 850 hPa for 11 years during the period 2000 to 2010 for the area in 30° to 80° longitude and 5° to 30° latitude with a spatial resolution of 1° * 1°. The data are from the re-analysis of the ERA interim center of Europe medium-term forecasts (ECMWF).

By scripting in MATLAB software, we employed cluster analysis for correlation method and performed Clustering based on the threshold correlation coefficient of 0.5. We initially obtained

∗ E-mail: mostafakarimi.a@ut.ac.ir Tel: +98 21 61113522

the 160 groups from which the greater number of days whose the higher correlation were more than 0.5 have been placed in one group.
In the later steps to reduce the groups between correlations to less than coefficient threshold, we have reduced number of groups in each step using reiteration of operation by calculation and integration of the average of any of days of the each cluster groups to finally obtain the 5 large patterns.

In order to evaluate the resulting patterns all the days in each pattern were pulled out. Traced maps, the mean geopotential height, zonal and meridional component of wind were obtained through the scripting GrADS software. In addition, rain and moisture advection based on the total days of each pattern on a large scale were mapped and frequency of the monthly patterns were calculated as well.

Results and Discussion

In this study, 5 large patterns were detected such that 2 of them were rare patterns and 5 dominant patterns. The 4 patterns have been more abundant in the cold season and 1 pattern in the warm season. The second pattern of the cold season is the highest and most pervasive precipitation of Iran, and fourth pattern are in second order. The summer pattern has lowest rainfall pattern during the 11 years of the study.

The transfer and placement of center core of high pressure over the seas in the south of the country, especially over the Arabian Sea, are involved in southwest flows. It is clear that the moisture injection could be observed in the second and fourth pattern of high precipitation and high pressure core with the stretching on the sea. Moreover, the existence of a trough at 500 mb level over the country has additional impact on the recent condition.

The first and second patterns have less rainfall with the high pressure displacement to the western and northern parts. In the warm season of the year, the expansion of the Ganges low pressure at the lower level and integration and expansion of the subtropical high pressure and Saudi Arabian high pressure at the higher levels over the country result in sharply decrease in the amount of moisture and precipitation in the country. This causes consequently a reduction in the activity of this high pressure. While there are other atmospheric systems in the higher latitudes such as the blocking system and its link with Saudi Arabia high pressure behavior, this can lead to specific situations that caused different precipitation conditions in various parts.

Conclusion

The results showed that the spatio-temporal behavior of Saudi Arabian high pressure such as east-west, north-south displacement and even center core stretching has very significant role in the infusion of moisture and consequently the precipitation over Iran. The spatial distribution of precipitation in the country depends on the location, shape and area of circulation of high pressure. Generally, the high pressure has more impact at cold season with remarkable role in moisture and precipitation of Iran. However, in the warm seasons, the role of the high pressure is greatly reduced due to its integration with subtropical high pressure and transfer to the North over the country and increase in air stability of the region.

Keywords: cluster analysis, geopotential height, humidity transfer, Saudi Arabian High Pressure.

Simulation of flood hazard using GIS-based cellular automata (Case study: Chirchir Catchment)

Somaiyeh Khaleghi
Assistant Professor, Department of Physical Geography, Earth Science Faculty, Shahid Beheshti University, Iran
Leila Malekani*
Assistant Professor, Department of Civil Engineering, Faculty of Technical and Engineering of Marand, University of Tabriz, Iran

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Extended Abstract

Introduction

Flood is an inevitable natural phenomenon occurring from time to time in all rivers and natural drainage systems, which not only damages the lives, natural resources and environment, but it also causes the loss of economy and health. Thus, estimation and prediction of flood hazard is very important spatially in the watersheds without measurement stations. There are many models in the water and environmental studies for investigation about the runoff and flood in the watersheds without measurement stations. One of the newest is cellular automata model that has been combined well with the GIS for simulation of runoff and flood hazard. Cellular automata as a tool for modeling and simulation of processes taking place in the real world are now increasingly used, as evidenced by their use not only as a tool for creating simulations, but also by their use in the areas of crisis management. Using GIS knowledge, it is possible to create cellular automata appropriately and authentically reflect the water flow on the Earth's surface. Cellular automata tool (CA) is a mathematical model that can be used for computation and simulation of the systems. In this method, the basin is defined with a network of the rectangular cells, and the interactions between the cells together with the geographic rules that govern the area result in the runoff modeling. This model relies on the GIS and satellite images. Cellular automata model uses various data such as Digital Elevation Model (DEM), landuse, hydrologic soil groups, rainfall, slope and etc. for runoff estimation. In the present study, the runoff of the Chirchir catchment in East Azarbaijan province, Iran, has been modeled by means of the GIS-based cellular Automata.

* E-mail: lmalekani@tabrizu.ac.ir Tel: +98 9141907477

Materials and Methods

In this study, GIS-based cellular automata were used to simulate flood in the Chirchir catchment in the northwest part of Iran. CA models use several primary components including the cells arranged in a regular mosaic pattern (raster, grid), transition rules determining the changes in cell properties, neighborhood of the cell, and boundary conditions. These components affect the status of each individual cell in a network in a given time span. In this research, Chirchir catchment in East Azerbaijan province is modeled using cellular automata. First, SCS formula is used to predict the runoff in each cell. Map of hydrological soil groups of Chirchir catchment is determined by means of soil texture map, then land use and SHG maps are prepared for calculating the runoff curve number (CN) map for the normal conditions. Since the soil has dry moisture condition and the slope is greater than 5%, adjusted CN is calculated for dry antecedent moisture condition and catchment slope using the common relationship. After reading the rainfall and the CN map for dry antecedent moisture condition, the runoff was calculated using the SCS equation. Then Kinematic wave model is used for flow depth in the cells and runoff production within each cell is simulated by determining the cell state (water surface elevation) that included both the cell altitude and the water depth. The distribution of water flow among the cells was determined by applying CA transition rules based on conservation of energy and continuity equations. D8 algorithm is used to simulate flow direction during the calculation of the surface convergence. The procedures for channel network delineation are based on the D8 model for flow over a terrain surface represented by a grid DEM. In this model, a single flow direction in the direction of steepest slope towards one of the eight (cardinal and diagonal) grid cells neighboring is used to represent the flow field. Also for calculating flood hydrograph, travel time is calculated using flow length and flow velocity. So roughness coefficient and flow depth is used for flow velocity and then travel time map is obtained. Finally, Python programming language is used to estimating flow hydrograph due to simplicity, powerful and object-oriented programming language and supported by GIS.

Results and Discussion

Results show that the most areas of the Chirchir catchment have pasture and type D of hydrological soil group. Therefore, it has very low permeability which means that a large amount of rainfall is converted into runoff. Runoff depth is high in east and southeast of the Chirchir catchment due to physical characteristics and rainfall of the catchment but among these parameters, the slope was the most important parameter in the runoff generation. Also, map of the flood hazard shows that downstream river has high potential in flood hazard due to receiving water from upstream. Then, for simulation of flood hydrograph, travel time was calculated using ratio between flow lengths to flow velocity. Flood hydrograph estimated for two events, June 17, 2009 and June 02, 2007. The computational runoff is very adapted to observational runoff. The correlation coefficient for the two events (0.82 and 0.70) indicates the good accuracy of the model. Low error rates also indicated that the cellular automata model has the high efficiency to predict the flood peak and the time of its occurrence in the Chirchir catchment. The results of this study are consistent with the results of researchers such as Aboudagga (2005), Rinaldi et al. (2012) and Cirbus and Podhoranyi (2013). They stated that the use of cellular automata model compared to the conventional methods by GIS, has higher accuracy and capable to estimate

flood hydrograph. Therefore, the use of cellular automata with GIS, not only accelerates the calculation of runoff, but also increases the accuracy of the results.

Conclusion

Comparison of the results with the observation proved that the results are well accurate. Besides the advantages of this method in simplicity and implementation of the realistic rules, this method is good at gaining the runoff data at any point of the basin except the exit point. Good agreement between the model output and the empirical measurements revealed that a CA approach can provide realistic results for a complex natural process like flood.

Keywords：cellular automata, Chirchir catchment, flood hazard, GIS.

A survey on the synoptic patterns based on critical periods of air pollution in severe inversions of Tabriz, Iran

Ali Panahi*
Assistant Professor, Department of Geography, Tabriz Branch, Islamic Azad University, Tabriz, Iran

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Extended Abstract

Introduction

Air pollution as one of the most important technological risks of contemporary era is mainly resulted from the emergence of large cities and fast growing industries. One of the main objectives of climatic and environmental studies is to survey atmospheric pollutions. Tabriz is one of the metropolises where air pollution is a problem. However, what is essential to consider the severity of air pollution in the city of Tabriz is the function of atmospheric processes that act widely. In this case temperature inversion is one of the most important factors. Weather condition of each single day is affected by synoptic conditions. Therefore, sometimes it can result in stability and tranquility in the atmospheric conditions and due to the concentration of pollutants in lower atmospheric layers and the lack of or poor atmospheric motions, the severity of pollution increases. Given the importance of weather stability in the occurrence of atmospheric problems, it seems essential to investigate the synoptic conditions of Tabriz city during critical air pollution periods and providing recommendations and preventive measures. For this reason, the present article aims to investigate the cause of severe and periodic air pollutions in Tabriz.

Materials and Methods

The daily data of Tabriz pollution over a 6 year period (2008-2013) were the data of current study (CO, PM10) that were collected from the Department of Environmental Protection, East Azerbaijan Province. Among these data, four successive pollution periods along with temperature inversion were selected by EXCEL filtering software. Then, the situation of pollutants regarding their healthiness and unhealthiness were studied using PSI index. Also in this article due to the direct effect of temperature inversion on intensity of pollutant concentrations and depth of temperature inversion, Skew-T maps were used to determine the

* E-mail: panahi@iaut.ac.ir Tel: +98 9141205953

pollution periods of Tabriz. According to the purpose of this study which was to identify the synoptic systems affecting air pollution in Tabriz, to identify synoptic patterns that influence the amount of pollutants in polluted days, daily synoptic maps at ground level and 500 hp of pollutant days were received from NCEP/NCAR and to investigate the synoptic patterns affecting sustainable and long-term periods of air pollution in Tabriz.

Results and Discussion

The study area is often influenced by synoptic patterns of mid-latitudes. The most important seasonal thermal systems that affects large sections of the country are Siberian high pressure and low pressure summer heat. During the cold season, Siberian high pressure is strengthened which can affect the frequency of large areas of Iran including Tabriz. In the most days of the year especially in cold season, due to shortness of the length of day and cold radiation at night, temperature inversion including radiation and subsidence can occur in the area. The local characteristics of the area especially lack of high speed winds in cold seasons, i.e., autumn and winter, can reduce the intensity of inversion layer. The concentration of pollutants has provided the situation for air pollution. When a high-pressure system constantly during successive days focuses on a special area, the intensity of temperature inversion reaches its peak. Then, with the arrival of a low pressure systems inversion fades away. In general, the main factor reinforcing inversion in high temperature is due to the continuity of high-pressure systems which can cause long-term pollutions.

Conclusion

In present study, we investigated the atmospheric patterns affecting air pollution in Tabriz during the statistical period of 2008-2013. The main objective of this study was to investigate the relationship between sea level and 500 hPa synoptic patterns with temperature inversion and prolonged periods of pollution. The results showed that the concentration of pollutants in most days was due to the intensity inversion layer in a way that when the intensity of temperature inversion reaches more than 5°C it has the greatest impact on the increase of the concentration of pollutants in all investigated periods. The findings also indicated a strong correlation between the function of strong and weak inversion layers with low pressure and high pressure systems in a way that strong inversion layer is always associated with high pressure systems. Results indicate that the Siberian high pressure has a significant role in the occurrence of pollutions in Tabriz city. The circulation system in more than half of the studied days can cause formation of high concentration of pollution in Tabriz. This synoptic system due to the establishment of cold weather on the Zagros and the combination of high pressure developed in the Zagros Mountains has created strong pressure. However, this system is more powerful when in middle levels of atmosphere in all phases the high altitude was 500 hPa level along with the stack system based on the region have developed and intensified the high pressure on the ground and caused the stability of clear weather and also caused the formation of a strong inversion layer and increase in the concentration of suspended particles in the atmosphere of the city of Tabriz.

Keywords: air pollution, high pressure system, synoptic patterns, Tabriz, temperature inversion.

Assessment of regional precipitation trend in the Lake Urmia basin

Mohsen Ghaderpour
Master Graduate, Faculty of Natural Resources, Urmia University, Urmia, Iran
Hirad Abghari*
Associate Professor, Faculty of Natural Resources, Urmia University, Urmia, Iran
Hossein Tabari
Researcher at Hydraulics Division, Department of Civil Engineering, KU Leuven, Belgium

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Extended Abstract

Introduction

Recent global warming has led to a change in the global hydrological cycle and an increase in extreme events such as flood and drought at the global and continental scales. However, at the regional scale, the magnitude of warming and the resulting changes in water resources are different from one region to another. Unlike air temperature whose increase is evident throughout the world, there is no unique and defined pattern for global precipitation changes. In recent years, climatic changes and precipitation can decrease in water level of the Lake Urmia. Extension of salt flats near the lake has caused many adverse environmental and economic effects. This necessitates the analysis of precipitation changes as the main input of the lake and one of the possible reasons for the water level decrease. Most of the previous studies on precipitation trends have been performed using data from sparse synoptic stations. Therefore, this study analyzed precipitation time series from a dense rain gauge network in the Urmia Lake basin at the annual and seasonal scales.

Materials and Methods

The Mann-Kendall test is one of the most common non-parametric tests for trend analysis of hydrological and meteorological variables. The main advantage of this test is that it doesn't need the data to be normally distributed. The Z statistic of the Mann-Kendall test for different series can be summed in the framework of a multivariate Mann-Kendall test. The multivariate Mann-Kendall test was used in this study for trend detection in the precipitation time series of the study area. The non-parametric Theil-Sen method was also applied for estimation of the trend magnitude. The existence of serial correlation in hydro-meteorological time series is one of the difficulties of performing a meaningful trend analysis. The effect of serial correlation in the precipitation time series on the trend results was limited in this study. After analyzing the

* E-mail: h.abghari@urmia.ac.ir Tel: +98 91480719001

trends using the aforementioned methods, the results were shown on interpolation maps prepared by the Inverse Distance Weighting (IDW) method in the ArcGIS environment.

Results and Discussion

The analysis of the annual precipitation time series using the multivariate Mann-Kendall test showed that most of the stations had an increasing trend. The Z statistic of the multivariate Mann-Kendall test revealed that all of the significant precipitation trends were found to be increasing. The precipitation decrease of 30% was observed in the central, eastern and southern parts of the basin, while in the western, northeastern, southwestern and most eastern parts an increase in precipitation was found. Most of the spring precipitation trends (about 60% of the stations) were found to be decreasing. Based on the results of the statistical tests, almost all of the decreasing trends in spring were statistically insignificant. The only significant (increasing) trend at the 95% confidence level was detected at Tamr station. For summer precipitation, the number of increasing trends was very larger than that of decreasing trends. Nevertheless, only nine stations showed a significant increasing trend in summer precipitation. According to the obtained results, there was a good agreement between the trend results of spring and autumn precipitation. The autumn precipitation time series revealed a decreasing trend at 33 out of the 37 study stations and an increasing trend for the remaining stations. The decreasing trends were found to be significant only at five stations, whereas the increasing trends were not statistically significant. For winter precipitation, an increasing (decreasing) trend was observed at 23 (14) stations. The statistical analysis confirmed the significance of only four increasing trends, while the decreasing trends were not significant.

Conclusion

In this research, the multivariate Mann-Kendall test and the Theil-Sen approach were used to detect spatial and temporal trends in precipitation at 37 stations in the Lake Urmia basin at the annual and seasonal scales. The results showed an increasing trend in annual precipitation at 54% of the stations. Seasonal and monthly trends provided a more detailed picture on temporal changes in precipitation time series at the basin. The majority of the trends in spring precipitation at the surveyed stations were found to be decreasing. The spring precipitation decrease in the southern part of the basin (between 20% and 30% or more) was more noticeable compared with the eastern part. As for the summer season, precipitation increased during the last 3 decades from 10% in the west to 20-30% in the east and south of the region. It is worthy to note that the obtained significant trends in summer precipitation series are not so reliable due to the existence of numerous zero values in these series in the study region. In the case of autumn precipitation, a decreasing trend was observed in the whole basin, ranging from 10% in the south to more than 30% in the eastern part of the lake. Winter precipitation had a moderate slope in most of the basin, with a slight decrease in the east and central parts.

Keywords: Lake Urmia basin, precipitation, regional trend, statistical tests, trend magnitude.

Prioritization of suitable axes for construction of underground dam in the Doostbeiglou watershed

Abazar Esmali Ouri *
Associate Professor, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran
Mohammad Golshan
Ph.D. Candidate, Faculty of Natural Resources, Sari Agriculture and Natural Resources University, Iran
Keyvan Khorrami
M.Sc., Faculty of Natural Resources, Sari Agriculture and Natural Resources University, Iran

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Extended abstract

Introduction

Water resources management in arid and semi-arid areas is very important to provide water for stakeholders. In recent decades, construction of underground dams has been considered for the issue, because of its advantages. These dams have many advantages, e.g., unlike a surface dam, land is not submerged to store water and there is no danger of breaching due to natural or manmade disasters. The surface area can be used in the same way both before and after construction of the underground dam. A subsurface dam is a facility that stores groundwater in the pores of strata and uses groundwater in a sustainable way. Underground dams are used for various purposes such as prevention of combining salt water and fresh water, reserve water for management using and creating an obstacle against influencing water to structures. The water gathered in subsurface dams has good quality for drinking, as it has been filtered by the sand and is stored underground away from contamination. The aim of this research is to identify the areas suitable for underground dam construction, so that in these areas there is no limit to the underground dam and then appropriate priorities in these areas.

Materials and Methods

Doostbeigloo watershed with an area of 7461 square kilometers is located in the Ardebil province (North Western Iran). In this research, we have considered several criteria for suitable site selection of underground dams in watershed, including: topography, hydrography,

* E-mail: esmaliouri@uma.ac.ir Tel: +98 9144538623

hydrogeology, geology and land use. These factors were used to initial mapping suitable regions for underground dam construction. Firstly, for this purpose we have used Boolean logic and fuzzy logic models. Then, we have also used the analytical hierarchy process to prioritize the suitable axes in appropriate areas for underground dam construction.

Boolean logic

Boolean (logic) algebra is the branch of algebra in which the values of the variables are the truth values true and false, usually denoted 1 and 0, respectively. The value 1 is for suitable areas and 0 for unsuitable areas. The maps of different factors involved in locating underground dam in the GIS environment were combined using Boolean logic. Therefore, the map of suitable areas for underground dam construction was created.

Fuzzy logic

In a Fuzzy logic the layers are weighted in values from zero to one, which gives more data than Boolean method. This method is defined as Fuzzy AHP in many studies. In this research with regarding donned studies we used 0.9 fuzzy gamma operator in order to find suitable areas for underground dam construction.

Analytic Hierarchy Process (AHP) method

The analytic hierarchy process (AHP) is a structured technique for organizing and analyzing complex decisions. It provides a comprehensive and rational framework for structuring a decision problem, for representing and quantifying its elements. In this step after determining the suitable areas for underground dam construction, AHP method was used for prioritization of appropriate axes. The AHP method is based on analysis, binary compression, summarizing, prioritizing and selection among alternatives. After determining the subject, it's divided to many criteria, and many various sub criteria. In this method assessment for selecting criteria is performed with consistency index (C.I). Based on previous studies, the (C.I) must be less than 0.1 value.

Results and Discussion

The extracted results showed that the areas in the southeast and northwest are unrestricted for underground dam construction. Site selection of the underground dam with using Boolean logic and Fuzzy logic showed that suitable areas in 3 streams are more than other stream in ranks. This is in accordance with previous studies. The compatibility rate value for AHP method was obtained 0.03 that this rate in AHP method is acceptable. The results from prioritization of the selected dams in this area showed that water criteria are the most important factor to prioritize the proposed axis. The water quantity and quality criteria with 0.11 and 0.104 weights, respectively, have the highest important than other criteria. The 9 number axes located in Meshgin shahr plain and 30, 33 and 34 number axes in Ardabil plain are more preferred than other axes.

Conclusion

Construction of underground dam and use of surface runoff is an appropriate way to secure and

expand water supplies. The Boolean logic and Fuzzy logic showed suitable areas for construction of underground dams with acceptable accuracy and between these methods the Fuzzy logic model showed higher performance than Boolean logic method. With using of AHP method, we determined the axes that are more prefered for construction of underground dam than other axis. This can be said that using GIS and satellite images to locate underground dams has a significant impact on the success of the project, because the maps produced in this process can be used at a later stage and as an executive guide for underground dam construction. Thus, with utilization of these methods we can show suitable areas and axis for underground dam construction in the Doostbeigloo Watershed.

Keywords: AHP, boolean logic, fuzzy logic, site selection, underground dam.

Predicting future dynamics of landscape structure within protected areas using CA-Markov model (Case study: Dizmar protected area)

Vahid Amini Parsa *
Ph.D. Candidate in Environmental Planning, Faculty of Environment, University of Tehran, Iran
Athare Nejadi
Ph.D. in Environmental Planning, Faculty of Environment, University of Tehran, Iran

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Extended Abstract

Introduction

Land use and land cover change (LUCC) is a complex issue resulted from biophysical, socio-economic, cultural, organizational and technological factors in different spatial and temporal scales. LUCCs have both direct and indirect effects on the environment not only globally but also locally. LUCC is considered as an important threat to biodiversity as causing the fragmentation, natural vegetation destruction and natural areas isolation. The regions which managed by environmental protection organizations all over the world are established based on a common goal to maintain biodiversity. Current insufficient preservative and management actions in the protected areas (especially in Iran) are unable to guarantee the areas protection. Therefore, analyzing previous and current land use and land cover (LULC) status and predicting the future pattern within and surrounding protected areas are likely to provide more efficient information for proper natural resources management. RS data is cost effective means to detect changes on the Earth's surface and provide up to date information. Over the last decades, several methods and models are developed for extracting LULC maps, detecting LUCCs and modelling the future pattern using remotely sensed data. The objective of this study is to analyze spatiotemporal patterns of LUCC from the past to the future within Dizmar protected area in Iran. Firstly, LULC maps of 1989, 2000 and 2013 were extracted and then future LULC was predicted using CA- Markov models from 2013 to 2037.

Study area

Dizmar protected area is a mountainous-forested region located in the north of Eastern Azerbaijan province, Iran. It lies between the 41◦38' to 57◦38' N and 18◦40' to 46◦40' E with total area about 68576 ha. Its connections to Kiamaky nature reserve in the west, Arasbaran

∗ E-mail: aminiparsa@ut.ac.ir Tel: +98 9364960818

protected area in the east, the national park of Zagatay (in the Republic of Azerbaijan and Armenia) in the north, makes an important wildlife corridor in local, national and international levels. It is home to 849 plant species (76 of them is endemic) and about 320 species of wildlife (such as Tetrao mlokosiewiczi placed in the IUCN list of globally threatened species). This protected area was faced with extra pressure on natural sources causes LUCC.

Materials and Methods

This study used Landsat satellite images (1989, 2000 and 2013) to extract LULC maps. After preprocessing step (such as image enhancement using Histogram Equalization) unsupervised classification was done. Then, the supervised classification was performed using the Maximum Likelihood Classifier (MLC) based on signatures file (generated from ground reference data that gathered in the field survey) for each of the images separately. Three LULC categories were extracted from TM, ETM+, and OLI images. Stratified random method in ERDAS Imagine 2013 is used to assess the accuracy of each obtained maps. CA-Markov model was applied to project LULC in the study area for 2037. Validating the LULC prediction model is carried out using KIA (Kappa Agreement Index). LUCCs during studied timespans were calculated using the cross tabulation technique in Idirisi Selva environment.

Results and Discussion

The distribution, coverage and percentage of major LULC types (classified as agricultural land, barren/range land and forestland) for 1989, 2000 and 2013 are shown in Figure 1and Table 1.

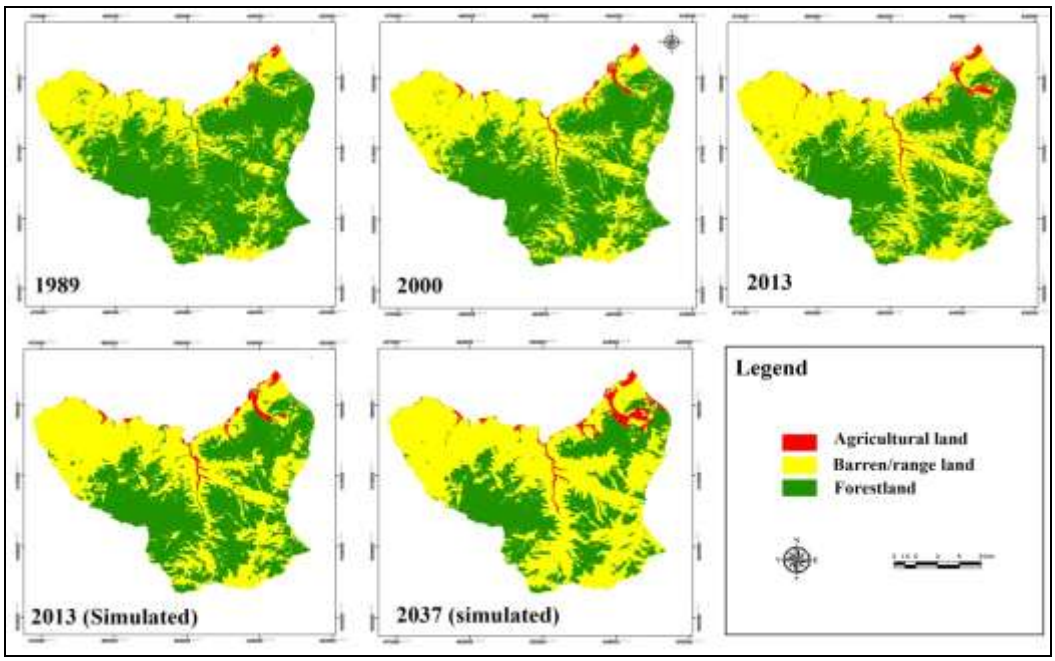

Fig. 1. LULC maps of actual (1989, 2000 and 2013) and simulated (2013 and 2037)

The overall classification accuracy of each map for 1989, 2000 and 2013 are estimated to be 89%, 90% and 91%, respectively. The Kappa values also yield 0.81, 0.84 and 0.88, respectively. The main types of LULC was forestland (with 62.20% and 54.30% of the total area) from 1989 to 2000 but it changed to barren/range land in 2013 (52.53% of the total area).

Results show a reduction in forestland between 1989 and 2013. Subsequently, agricultural land is increased from 0.72% in 1989 to 2.14% in 2013 due to the fact that the traditional livelihood remains farming.

Table 1. Distribution of LULC type in Dizamr protected area (in ha)

LULC type	Year				
	Actual			Simulated	
	1989	2000	2013	2013	2037
Agricultural land	498.9053	933.7649	1471.464	1317.42	2213.654
Barren/range land	25142.94	30400.17	35343.74	34705.46	42541.57
Forestland	42934.52	37242.43	31761.16	32602.59	23821.14

The projected land use map by the CA-Markov model indicates that if the current management continues, barren/range land and agricultural land reach to 62.03% and 3.22% of the total area at the expense of decreasing forestland area to 34.73% by 2030 (Fig. 2). In order to validate the CA-Markov model outputs the VALIDATE module existing in the IDRISI Selva was used. This is done by comparing simulated land use maps of 2013 with the actual ones based on Kappa statistics. Resulting Kappa values (Kno= 0.9295, Kstandard= 0.918, KlocationStrata= 0.9273 and Klocation= 0.9273) were all greater than 0.9 showing a satisfactory level of accuracy.

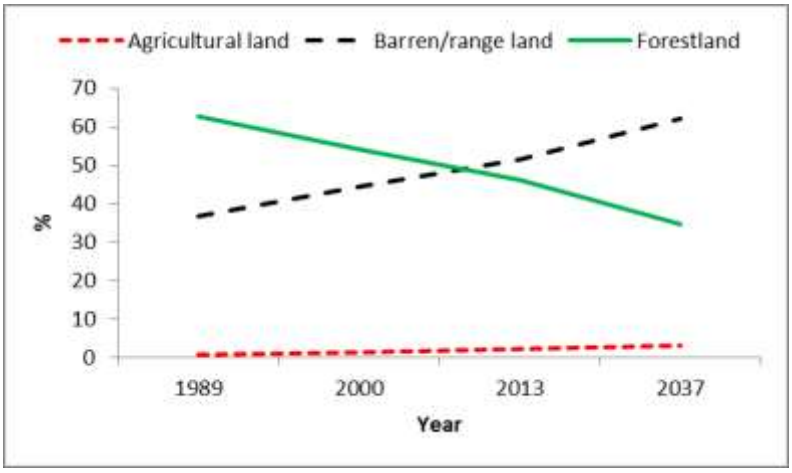

Fig. 2. Area of LULC types (as percentage of the total area) over the studied period

The area of 701.46 ha has been deforested and changed into agricultural land during 1989 to 2013. The amount of deforestation will be 521.19 ha by 2013. On the contrary, only 5.22 ha will be forested by transformation of barren/range land during 2013-2037.

Table 2. LULC conversions types during studied time spans (areas in ha)

LULC conversions	Times pan			
	1989-2000	2000-2013	1989-2013	2013-2037
F to A	285.75	462.87	701.46	521.19
F to BR	6377.4	5802.93	0	7424.19
A to BR	69.21	223.74	91.08	0
BR to F	932.76	800.46	6.59	5.22
BR to A	233.82	299.34	363.69	230.49
Total	7898.94	7589.34	1162.82	8181.09

*A: Agricultural land, BR= Barren/range land, F= Forestland

Conclusion

LUCC within and surrounding the protected areas probably continue to be expanded and intensified. Monitoring and projecting these changes can play key roles in preventing negative consequences of the changes by providing up to date information to planners and managers. This study shows the important role of LUCCs analysis and modeling to provide proper information for the protected area management. We applied dynamic approach to analyze LUCCs by analyzing previous and current LULC maps and predict the future trends. The results indicate the high capability of CA-Markov model to predict future LUCC in the study area. Therefore, it can be useful in the protected area's land use policy and action design. Indeed, between 1989 and 2013, there has been a notable reduction in forestland and it was predicted to continue the reduction over the next 24 years. Agricultural land has been steady in increment during 1989-2013 and this trend continues by 2037. Expansion of agricultural land and barren/range land in the study area has led to rapid changes in landscape dynamics. Thus, it is recommended to create and strengthen non-farm/off-farm income. Adoption of agricultural policy based on the agroecological condition of the Dizmar protected area is important. Analysis of other factors such as land capability, stakeholders and LUCC drivers along with the obtained results can be useful in proper LULC planning and management. The strategies of land resources (especially forest resources) development, attempts to overcome the current deterioration and avoid further extinction of remnant forest within the study area.

Keywords: Arasbaran region, CA-markov, change detection, deforestation, protected areas.

Analysis of ecosystem and natural geography of the eastern bank plains of Alvand and their role in primitive human communities attraction, based on archaeological studies

Khalilollah Beik Mohammadi *
Ph.D. Candidate in Archaeology, University of Mohaghegh Ardabili, Ardabil, Iran
Nasrin Beik Mohammadi
Ph.D. Candidate in Archaeology, Art University of Isfahan, Iran
Reza Nazari Arshad
Assistant Professor, Department of Archaeology, Azad University of Hamadan, Iran
Mehdi Heidari
Ph.D. Candidate in Archaeology, University of Bu-Ali Sina, Hamadan, Iran

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Extended Abstract

Introduction

Present research is a wide reflection of coordination of archeology and geography based on different geographical components to examine the role of geography in forming human communities with the wide view and to introduce catcher of its role in absorbing and non-absorbing primary societies. The emergence concept of primary societies should be analyzed based on geography. From this perspective, geography of eastern bank plain of Alvand is less considered that includes large area of Hamadan province with different mountain plains and basins surrounded by different bumps and folds such as Hamadan–Bahar, Ghahavand, Kaboudrahang and Razan-Famenin plains to Avaj Mountains. By studying Alvand eastern bank, two factors of the place of this basin in the cold and dry geography, with respect to its height degree from the sea level (1500 to 2000 m), and also lack of mineral resources of raw material outcrops (ChertStone) for industry of primary societies (Paleolithic to Neolithic) are the most important agents of non-absorbing settlement of human primary societies in this basin.

Materials and methods

Present research by descriptive-analytical method is based on two library and field methods. It has explained climate and geography of eastern Central Zagros and Alvand Eastern bank based on written sources left by travelers, historians and geographers and then addressed by geographical studies and classifications explained by contemporary researchers of geography and in the field

* E-mail: Khalil_bm@yahoo.com Tel: +98 9183166173

studies area. This research addressed the the ecosystem and natural geography of Alvand Eastern bank plains and its role in non-attracting habitats of human primary societies based on field findings of the plains archeology. By examining types of geography and consequences of environmental conditions with a view to the vegetation, animal coverage and its role in forming primary deployments, the factors of climate and natural environments in the perspective of geomorphology and ecosystem were effective on non-absorbing primary deployments. What is the role of geography in archeologic studies? What are the effects of natural geography of Alvand Eastern bank plains on absorbing and non-absorbing human primary societies?

Results and Discussion

The most obvious features of Central Zagros highlands is their wrinkle and being tattered, apparent conformity of geological structure and ripples form as a large number of parallel northwest-southeast mountain ranges. Alvand Eastern bank is studied as a part of natural and cultural basin of "East Central Zagros" in archeology literature. Alvand mountain range in its north- west to south-east direction serves as a natural limiting factor. In political classifications the area in two western and eastern basins acts as a buffer zone between Central Plateau and Central Zagros and created the connected plains in its eastern bank (east and northeast). This is also among the condensation plains and granite formation from the geomorphological perspective in which formation of caves and Karstic shelters is not possible. Generally, weather of Alvand Eastern bank is variable despite of high mountains, rivers, abundant springs and ups and downs. Therefore, air of this basin has cold winters (similar to weather of Younger Dryas) with low water and moderate summers.It has not favorable conditions for human primary societies (Paleolithic and Neolithic), because, yet, despite of archeology studies carried out in the set limit of Alvand Eastern bank plains, no reporting is obtained about the deployments of Paleolithic and Neolithic communities. With respect to the life style based on hunting and deployment of the human in the cave and natural shelters, Alvand Eastern bank plains ecosystem and natural geography has not environmental conditions of human primary societies. The findings of archeology have introduced formation of human primary societies in this basin from Bronze Age.

Conclusion

The results of present research are concluded in two main and basic points by geographical examining and analyzing of Alvand Eastern bank by archeological approach. First, from ecosystem perspectives (vegetation and fauna); any region has deep dependence on the natural geography and its weather and based on the conducted examination and study, the most important factor of non-absorption is the climate weakness and impropriate geography of natural environment in Alvand Eastern bank with high height degree of the region that the plains of the basin show higher than 1500 m from the sea level (average height 1700 m from sea level). This bank has the slope and mountains that are factor on the lack of natural environment and plain and unfavorable lands for agriculture (Especially in Neolithic Age). In addition to above points, the regions of Alvand Eastern bank with respect to its cold and dry climate (Similar to Weather of Younger Dryas) have low capabilities for forming Pre-Neolithic and Neolithic deployment. Second, from geomorphology perspective (Geomorphological Formation), most plains of the area, especially Alvand mountain range unlike high Zagros have Granite formations in which it is

impossible to find caves and Karstic shelter. Therefore, with deployment of the human groups, least in the form of seasonal in the region, it should be in the open place that most of places are completely covered due to young sediment of the late Pleistocene and Holocene period. Also, in relation to the lack of the deployments from Neolithic periods in the high plains of Eastern bank of Alvand and with respect to the height, it has high frigidity and more cold duration. It is impossible to deploy human life and use its resources until Chalcolithic periods and progress in the architectural technique to overcome living conditions. This can only took place from Chalcolithic periods to the next. Therefore, this reason is the effective factor for the lack of deployment of Pre-Neolithic and Neolithic periods. From the raw materials of stone industrial period, presence of mineralogical composition and locating Eastern bank of Alvand and large part of Hamadan province in "Iranid" region (and absence of outcrops of Cherty Stone) have caused lack of law materials for producing required tools for industrial stone communities (Paleolithic and Neolithic). This problem has also been important reason in the absence of primitive human communities.

Keywords: archaeological studies, eastern bank plains of Alvand, geography, primitive humans.