International Journal of Constructive Research in Civil Engineering (IJCRCE)
Volume 4, Issue 4, 2018, PP 9-13
ISSN 2454-8693 (Online)
DOI: http://dx.doi.org/10.20431/2454-8693.0404002
www.arcjournals.org

Climate Impact on Hydrological Drought

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Abstract: *To study hydrological drought or regional analysis method, using the daily data of twelve atmospheric pollutant stations of ATRAK, the minimum flow rate was calculated with seven days' duration at each station.in order to generalize the analysis of the point on the studied area, appropriate regional model for 7-day minimum flow with the return period of ten years extracted by the regression model and the minimum flow was estimated at the regional level for twenty stations. Considering the measured data at the stations in the area, the daily hydrometric data of the stations was simulated for 50 years using the DIMGEN generator. The minimum seven-day flow was estimated with a return period of 10 years for simulated data for all stations. Then, the zoning maps of the study area were mapped to the minimum flow and the minimum flow rates were compared with two existing assumptions. The results showed that the minimum flow rates in the data generation mode have been decreased and drought have spread throughout the region. By studying the zoning maps, it was found that in case of possible warming and reduced rainfall, drought dangers have increased and the drought-prone areas are seriously affected, which should be considered in the management of water resources.*

Keywords: *Climate Change, Minimum Flow, ATRAK Atmosphere, Hydrological Drought*

1. INTRODUCTION

Due to different variables that affect drought, there is no definite definition for it. Drought is defined as rainfall less than the usual limit of an area in a given time period. In hydrological drought, the rapid reduction of surface currents and the drop in the level of underground reservoirs, lakes and rivers. For example, based on the annual volume of the fourteen rivers in Israel, it was concluded for a thirty years' period that there was no hydrological drought in the country. In regional analysis severity, the duration and period of drought returns are analyzed using rainfall data analysis method in the ATRAK river basin and for generalization of point-to point analysis to regional, drawings of the severity of drought are outlined. Climate change due to short-term climate variability, changing long-term climate trends, changes in natural processes or through human activities. annual precipitation has declined by about 20 to 40 percent in recent decades, and dryness has been increasing. According to hydrologic researchers, the importance of climate change is to exacerbate the hydrological cycle, especially in arid areas. Generally, the researchers predict that in 2100, the temperature of the planet would increase by about 1-1.3 c, which could lead to an increase in winter rainfall in high latitude areas, an increase in the number of high temperature days and an increase or decrease in drought and or flood. The increase in the temperature of the earth has caused extensive changes in ground climates, causing changes in the temporal and spatial variations of rainfall. Therefore, the average of the air temperature at the ground and the changes are indicative of climate change, and the climate change trend can be detected by examining the changes in the mean air temperature. In recent years, many studies have been done on the potential impact of climate change on river flows, and long-term climate change and hydrological characteristics have been studied.

In one method, historic statistics of river flows are analyzed, and in another way, the effect of various climate change scenarios on river flow through hydrological models is investigated. The effect of climate change on the minimum flow has been investigated and adaptations of river flow cycle patterns with rainfall patterns has been proven and a way to improve the estimation of the minimum flow indexes for climate cycles has been proposed. Evidence of climate change has been presented in the UK and shows that the trend is shifting to dry summers and wet autumn. In the study of possible changes in the frequency of hydrological data in Europe, it was found that the discovery of some variations of data with complex statistical short periods is complicated. The apparent increase in summer heat and drought, clearly does not show the result at the lowest minimum flow. In the study of the effects of climate change on hydrological regimes in Europe, four scenarios were used and observed in southern Europe, and in the north, expected annual runoff is expected. It was also concluded that the severity of droughts in the western regions of Europe increased and decreased in the eastern regions. In biophysical studies of natural resource management, it is noted that in the next 30 years the temperature in the continental regions increases by about 0.4-1.42 c, regional rainfall patterns have changed and the storms are continuous and severe. So, in the future, methods for erosion control, water storage and drainage and irrigation systems should be studied. Climate change due to changes in spatial and temporal patterns of heat, rainfall, radiant energy and wind can cause desertification and usually desertification is associated with climate change. Most of the Iran regions are located in arid and semi-arid regions and are subject to persistent droughts and therefore highly vulnerable to climate change. Therefore, studying the effect of climate change on hydrological regimes is necessary and its results can be useful for managers and planners of water resources. The purpose of this study was to investigate the effect of climate change on the minimum flow as a hydrological drought index with the assumption of climate change occurrence.

2. Materials And Methods

The catchment area of the ATRAK river basin in northeastern Iran is in the range of longitudes 54 to 59 4` and latitude 36 57` to 38 17`. This watershed is part of the watershed of MAZANDARAN Sea in the division of watersheds of the entire country. The area of this catchment is 27480 square kilometers. The part that related to the SOBBAR basin is located in the republic of Turkmenistan. Its area is about 7600 square kilometers. By examining the hydrometric stations in the ATRAK basin, 12 suitable hydrometric stations were selected for statistical period. Using the daily Debi statistics of these stations and the excel software, a daily Debi blueprint was prepared every year. Then the seven-day successive averages were calculated and the lowest value was obtained for each year. Minimum flow with seven days' persistence is the most suitable indicator in the regional minimum flow estimation and expresses the hydrological drought pattern. By processing eight distribution functions on the seven-day minimum flows, Log Pearson`s function. Type 3 was identified as the most appropriate regional distribution function, and the minimum seven-day flow with a return period of 10 years was calculated with the help of regional distribution at each station. Hydrological homogeneous regions were classified using cluster analysis method by using physiographic features of watersheds and stations were classified in a homogenous group. In each of the watersheds selected for frequency analysis, two factors influencing the occurrence of the minimum current and influenced by climate change were determined. The average annual temperature data from the comprehensive water resources report was extracted. In order to determine the average annual precipitation and its generalization to the whole region due to the low correlation between height and rainfall, practically, the zoning technique of the area was neglected using altitudinal relationships. Due to the efficiency of the KRIJING method and its prominent feature depends on the estimation of the variance of the phenomenon at each interpolated point, for determining the average rainfall, the precipitation lines of this method and the WINSURFER software were used and the rainfall data was determined. In order to analyze regional droughts, the minimum flow must be determined regionally. For this reason, the results of the minimum current-frequency analysis that are valid in the measured points should be generalized to non-statistics or short-term statistics. Thus, the regression model method, which is one of the methods of regional analysis of the frequency of minimum flow, is used and the regional minimum flow of seven days with a return period of 10 years is estimated. The average annual temperature and annual average precipitation characteristics were calculated for 8 other stations and total was estimated with the help of regional relations for twenty stations, the minimum flow with a seven-day continuation and a ten-year return period. In order to make climate change, using the CLIMGEN generator, consider the daily rainfall data, available temperature and hydrometric, assuming the climate change event, the temperature increased to 2 c and the annual rainfall decreased by 10 percent the daily data from the stations in the study area was simulated for fifty years. Regional frequency analysis of the minimum flow was performed by using regression models. So that the minimum data flow independent and annual temperature and annual precipitation of the model variables were considered and the minimum flow was estimated with seven days' continuation and the return period of 10 years in each of the twenty stations. In order to prepare a hydrological drought zoning map with a return period of 10 years and compare them in two realistic data and simulated data, WINSURFER software was used for KRIJING method interpolation. Draw lines of drought severity for each station; consider the geographical coordinates of the point and the amount of minimum flow proportional to that point in the software environment.

3. Discussion And Conclusion

The result of regression analysis was investigated in both logarithmic and normal conditions. According to the correlation coefficient and standard errors, the equation was obtained as the regional relation for the minimum flow to determine the accuracy of the relationships. The percentage of relative error rate for several stations was not used in the frequency analysis and the error value was not significant compared to other studies and the accuracy of the relationships was confirmed.

$Q=0.0123R-0.183T-0.25$

In this formula Q is the minimum flow, R is the annual precipitation and T is annual average of temperature. By using this relationship, the minimum flow was estimated with seven days duration and the return period of 10 years at 20 stations, and the maps of the same amount of the minimum flow were plotted. The results of regression model analysis for simulated data in two logarithmic and normal modes were studied and according to the correlation coefficient and standard error of the equation, the regional equation for the minimum flow was obtained. $Q=0.9\log R-1.123\log T$.

In figure 1, the map of the values of the minimum current flow is shown with a return period of ten years, considering the simulated data. Based on these forms, with the possible warming of the earth, the intensity of the drought increases and the minimum current flux decreases. This range is 0.2 to 2.8 cubic meter per second in the normal state to 0 to 1.5 cubic meters per second in the event of possible warming.

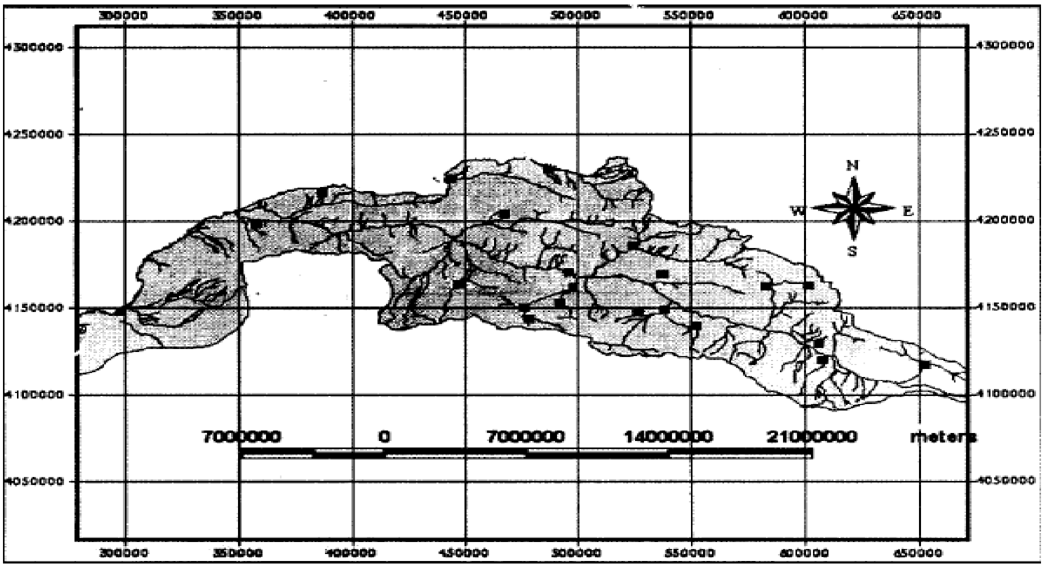

Figure1. *distribution map of selected stations in the study area*

In figure 2, only a drought cores are seen in the center of the region, but with the extraction of lines, it is observed that limestone core is moving toward the south and limiting the extent of the hydrological droughts.

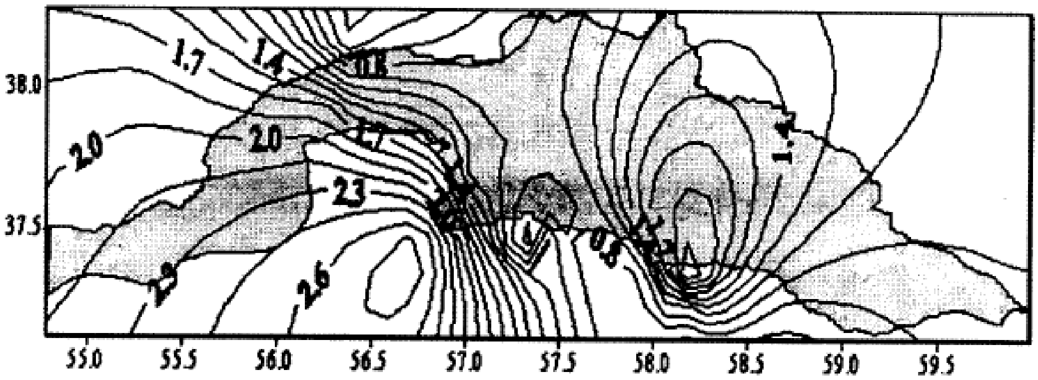

Figure2. *the map of the values of the same amount of minimum flow with a return period of 10 years in normal state*

Figure 3 shows that there are drought cores in the north and south-east with the extrapolation of the lines, it is also determined that the dead cores pass through the area and the possible warming of the earth, the number of drought-causing core has increased in the region. Therefore, the central and eastern parts of the region are affected by hydrological drought, regardless of the probable, land degradation scenario, and these areas are susceptible to drought and should be considered in terms of water resources management and land use. With the possibility of a possible warming of the earth, the extent of the drought has increased and the areas susceptible to desertification have also increased substantially. It should be noted that although in this study one aspect was considered in this scenario and it may increase with warming and rising temperatures, but global warming is effective for various reasons in the life of living organisms.

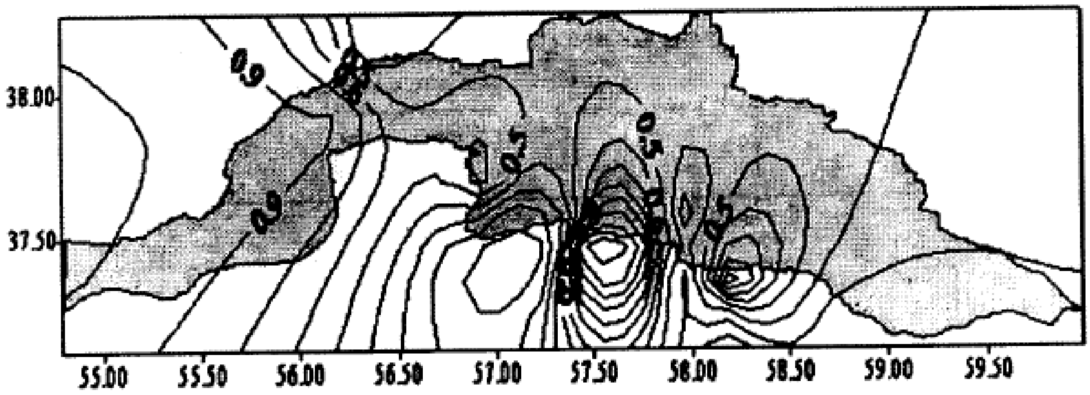

Figure3. *The map of the values of the same amount of minimum flow with a return period of 10 years in the climate change*

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Citation: *Kazem Nosrati. et.al, "Climate Impact on Hydrological Drought", International Journal of Constructive Research in Civil Engineering, 4(4), pp. 9-13. DOI: http://dx. doi.org/10.20431/2454-8693.0404002*