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Monitoring Wet and Dry Process Using Precipitation Changes

Jalal Behzadi[a*]

[a]Department of Agriculture and Natural Resources, Lahijan Branch, Islamic Azad University, P.O. 1616, Lahijan, Iran.

*Corresponding Author: drbehzadijalal@yahoo.com

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Abstract

Minimum and maximum precipitation and their oscillations in a specific period of time is a common phenomenon all around the world, which depend on the type of climate. With the climatic variety present in Guilan province, precipitation oscillations are so complicated compared to the average. Precipitation data were collected from weather stations of the Guilan Regional Water Authority and the Meteorological Organization, and they were then reconstructed using the Minitab software. Using the statistical analysis, the minimum and maximum precipitation of twelve stations were estimated, and next to the thirty-year recurrence interval was calculated using the HYFA software. Due to the number of data and stations, the five weather stations of Manjil, Lahijan, Rasht, Rudkhan Castle and Anzali were picked out using the clustering method, and the map of precipitation and their area was created using the GIS. Anzali and Rudkhan Castle stations possess the highest precipitation in their statistical period, while Manjil possesses the lowest amount of precipitation in the whole province, and suffers from more water shortage and aridity compared to other stations. Lahijan and Rasht stations can be classified as stations with medium precipitation, i.e. both conditions equally affect the area. The authorities should be more careful and sensitive when making plans for this region. Unbalanced oscillations and highly severe recurrence intervals must be considered in environmental, agricultural and tourism planning, to reduce the potential losses resulting from strong and weak precipitation, and to prevent the failure of various projects due to lack of correct information and plans.

Keywords: *climate; the return period; Guillen; precipitation.*

1. Introduction

Precipitation is a very important climatic factor which plays a major role in agriculture, economy, industry and even culture. On the other hand, its surplus causes floods and damages resulting from them. Factors such as wind speed, high temperature, and relative humidity play a role in Precipitation increase and occurrence of floods. Usually, a minimum and maximum precipitation relative to average precipitation occur in every climate which determining it is a basic step in environmental concepts of development in architecture and agriculture and also sustainable development. It is a climatologist's job to predict the recurrence interval of the maximum and minimum precipitation and determine the possibility of occurrence of such events. In the present study, not only the minimum and maximum precipitation were studied and ranked, but a map was also developed and the recurrence interval of minimum and maximum precipitation of the selected stations were

obtained. Pre-awareness is considered one of the most important principles of drought and flood management; in this regard, Noah and Joseph can be considered as pioneers of flood and drought risk management. For the first time in the history of mankind, American scientists managed to predict huge floods in California and Florida six months earlier using climatic predictions in the summer of 1997. This prediction and preventing measures led to the decrease in damages up to millions of dollars. In Iran, the climatic forecast was successfully done for the first time in the planning of the Karkheh Dam during the drought of 1999-2000. Also in November 2007, the warning about drought in 2007-2008 was presented to the authorities based on climatic predictions. The Climatic forecast has had important impacts on agriculture, fishing, drought and flood management and environmental preservation. One of the most important steps in evaluating drought in every region is determining indices in order to analyze the severity and continuity of drought.

Hong Wu et.al (2001) used a factor called CZI (China Z-Index) proposed by the Chinese National Aerological Center (1995). This index is so similar to the SPI (Standardized Precipitation Index) but has much simpler calculations.

DrV.U. Smakhtin et.al (2007) utilized a new software which analyzes the five factors of DI (Deciles Index), SPI, EDI (the Effective Drought Index), mean and standard deviation, with the map of each, and is mostly used in South Asia.

In another study in the south of Portugal, Moreira (2008) used a logarithm model to predict the minimum and maximum precipitation and obtained desirable results.

S. Khan et.al (2008) proposed ways to prevent drought in Australia after studying water resources. Morid et.al (2006) compared and analyzed 7 drought factors in Tehran Province in a period of 32 years. They used SPI, Z-score, and CZI as drought indices. The results revealed that the method used to make plans in arid and semi-arid regions is of high importance in preserving and managing water resources.

2. Materials and Methods

2-1 The geography of Guilan province and measurement stations

Guilan province is located in the north of Iran in 37.2774°N 49.5890°E. It lies along the Caspian Sea, just west of the province of Mazandaran, east of the province of Ardabil, north of the provinces of Zanjan and Qazvin. The total area of the province equals 13790.5 m^2 (5,422 sq mi). 29% of the land is agricultural, 41% forestial and 16% is the plain area. The plain areas include the 2 parts of Talesh and Shafarood to the east of Kelachay. Talesh, Tarom-Khalkhal, and Deylaman are the three mountain fit of rage surrounding the province. (figure 1).

Fig. 1. the location of stations in Guilan province

Among 35 climatology stations and 5 synoptic ones, 12 were chosen for studying and simulating. Table (1) presents the geographical location of these stations.

Among all the stations of the province, Rudbar and Manjil have a different climate compared to the other parts and have a dramatic difference with other parts regarding the obtained patterns such as mean precipitation. Thus, the evaluation of the climate of Guilan, Manjil is studied separately. the monitoring of the precipitation in Guilan using the Thiessen method, the amount of annual precipitation in the province is 1070 mm with an 1137 mm without Manjil.

Table 1.the location of Guilan stations and their amount of precipitation

Name of Station	Longitude	Latitude	Altitude	Average Precipitation(mm)
Anzali	49.26	37.28	-26.8	1745.4
Rasht	49.36	37.19	-8.6	1369.45
Astaneh	49.55	37.15	-5	1241.8
Lahijan	50	37.12	34.2	1049.1
Shalman	50.6	37.3	150	1163
Somoosh	50.17	37	80	1330
Saravan	49.38	37.1	185	1246
Qale-Rudkhan	49.16	37.06	170	1683.9
Kasma	49.18	37.19	-2	1070
Shanderman	49.09	37.27	42	974
Hashtpar	48.54	37.48	99	3100
Astara	48.50	38.21	-21.2	1396.9

2-2 Climatic Classification

Based on the existing classification methods, the stations located in the plain areas are the same type as the climate of highly wet rain forests, and Manjil is of semi-arid and step type. This region is located in a mild semi-arid area. The rest of the stations are located in humid and mild areas. The presence of the Alborz mountain range and the Caspian Sea, the type of movement of western systems, and the entrance of Mediterranean currents, have all led to the presence of a wet and mild climate, especially in the plain areas. In some classifications and from what can be inferred from the latitude, Guilan Province possesses a semi-arid climate, but in some other classifications and from what can be inferred from climatic elements, it can be considered as having a humid climate. This is why Guilan Province possesses one of the most unique climatic conditions in the world.

2-3 Clustering stations based on climatic elements (the Cluster method)

In order to facilitate the study and obtain valid results in Guilan Province, which possesses various climatic elements, the clustering method on the MINITAB software was used. The whole climatic elements, including maximum, minimum and average temperature, precipitation, and relative evaporation and humidity of stations were studied. Five stations naming Anzali, Qale-Rudkhan, Lahijan, Rasht, and Manjil were picked out after the clustering.

Using the data obtained from these stations, we can have a quicker interpretation of the climate of Guilan. This classification also plays a major role in environmental planning (figure 2).

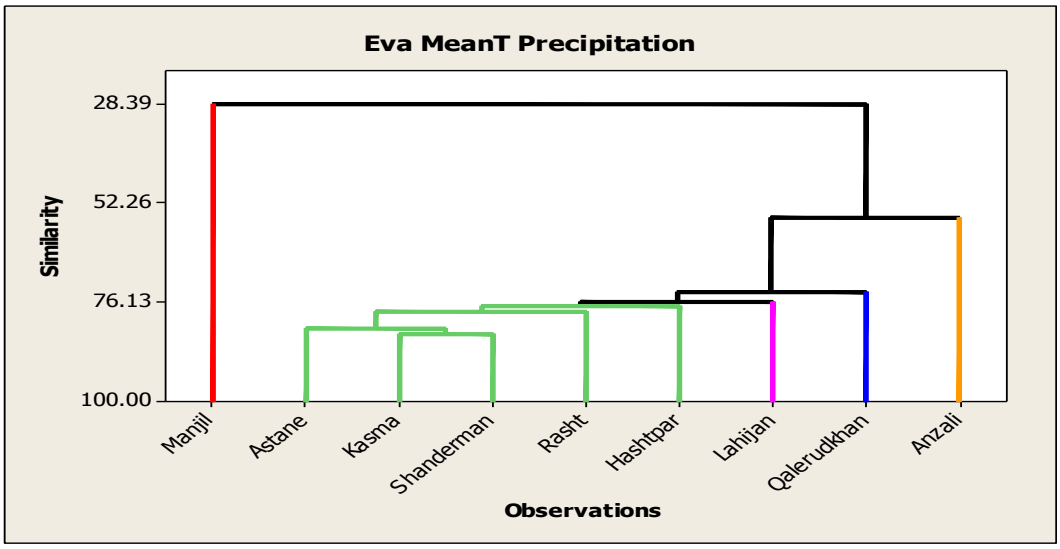

Fig. 2. the diagram of clustering with the help of all climatic elements

3. Results

Probability Analyses and Calculations and the time period analysis

In Hydrology and Climatology, the attempt is to find and draw proper probability functions for the data in order to be able to calculate the value of the desired variable per various probabilities based on them. Analyzing data is not possible without probability calculations. One frequently used the term in probability and statistics is the occurrence rate or frequency, which means the number of times a specific parameter occurs in a specific time. Keeping in mind that the occurrence of climatic parameters such as rainfall happens randomly, it is not possible to generalize the same probability formula or law to the whole cases. Therefore, several formulas are proposed from which we can point out the California formula, the Weibull formula, and the Hazen formula. In Hydrology, the term "recurrence interval" is used instead of "probability".

Table 2. The precipitation time period analysis in Guilan Province

Station	Wet Year	Amount of Precipitation	Recurrence Interval	Minimum Precipitation	Maximum Precipitation	Dry Year	Amount of Precipitation	Recurrence Interval	Minimum Precipitation	Maximum Precipitation
Anzali	1977	2336	20	1908	2749	1991	1237	500	993	1612
	1982	2662	100	1877	3487	1995	1367	25	1195	1546
Rasht	1982	1937	100	1703	2179	1983	988	50	787	1154
	1993	1895	50	1656	2092	1995	1000	25	854	1153
Lahijan	1992	2111	25	1573	2558	1983	1203	500	848	1396
	1993	2236	50	1540	2915	1995	1041	500	848	1396
Qale-Rudkhan	1992	2383	50	1681	3221	1979	1283	500	1067	1624
	1993	2534	50	1681	3221	1995	1223	500	1067	1624
Manjil	1982	391	10	284	449	1991	87	50	0	195
	1993	402	20	306	515	1999	112	25	29	199

In order to facilitate the process and obtain a better understanding of the condition of minimum and maximum precipitation, the stations were clustered into five categories. Then the stations were ranked based on their minimum and maximum precipitation. In the next step, the 30-years precipitation data were analyzed using the HYFA software, and the minimum and maximum precipitation were calculated along with the recurrence interval. The highest precipitation of Anzali which was 2662 mm has occurred in 1982, which has the possibility of increasing to 3487 mm with a recurrence interval of 100 years. The highest precipitation of Rasht which was 1895 mm has occurred in 1993, which has the possibility of increasing to 2092 mm with a recurrence interval of 50 years. The highest precipitation of Lahijan which was 2236 mm has occurred in 1993, which has the

possibility of increasing to 2915 mm with a recurrence interval of 50 years. The highest precipitation of Qale-Rudkhan which was 2534 mm has occurred in 1993, which has the possibility of increasing to 3221 mm with a recurrence interval of 50 years. The highest precipitation of Manjil which was 402 mm has occurred in 1993, which has the possibility of increasing to 515 mm with a recurrence interval of 20 years.

The lowest amount of precipitation of Anzali which was 1237 mm occurred in 1997, with a recurrence interval of fifty years, probably reducing down to 993 mm. The lowest amount of precipitation of Rasht which was 988 mm occurred in 1983, with a recurrence interval of fifty years, probably reducing down to 787 mm. The lowest amount of precipitation of Lahijan which was 1041 mm occurred in 1995, with a recurrence interval of fifty years, probably reducing down to 848 mm. The lowest amount of precipitation of Rudkhan Castle which was 1223 mm occurred in 1995, with a recurrence interval of fifty years, probably reducing down to 1067 mm. The lowest amount of precipitation of Manjil which was 112 mm occurred in 1991, with a recurrence interval of 25 years, probably reducing down to 0 mm.

Therefore, the highest precipitation rates are ranked as Anzali, Rudkhan Castle, Lahijan, Rasht, and Manjil, and the lowest precipitation rate is ranked as Manjil, Lahijan, Rasht, Rudkhan Castle, and Anzali. Lahijan possesses the third rank of the maximums and the first rank of minimums in the plain area. In the evaluation of the recurrence interval of the stations, the probability of the highest precipitation is ranked as Anzali, Rudkhan Castle, Lahijan, Rasht, and Manjil, and the lowest precipitation is estimated to occur in Manjil, Rasht, Lahijan, Anzali, and Rudkhan Castle respectively (figure 3,4).

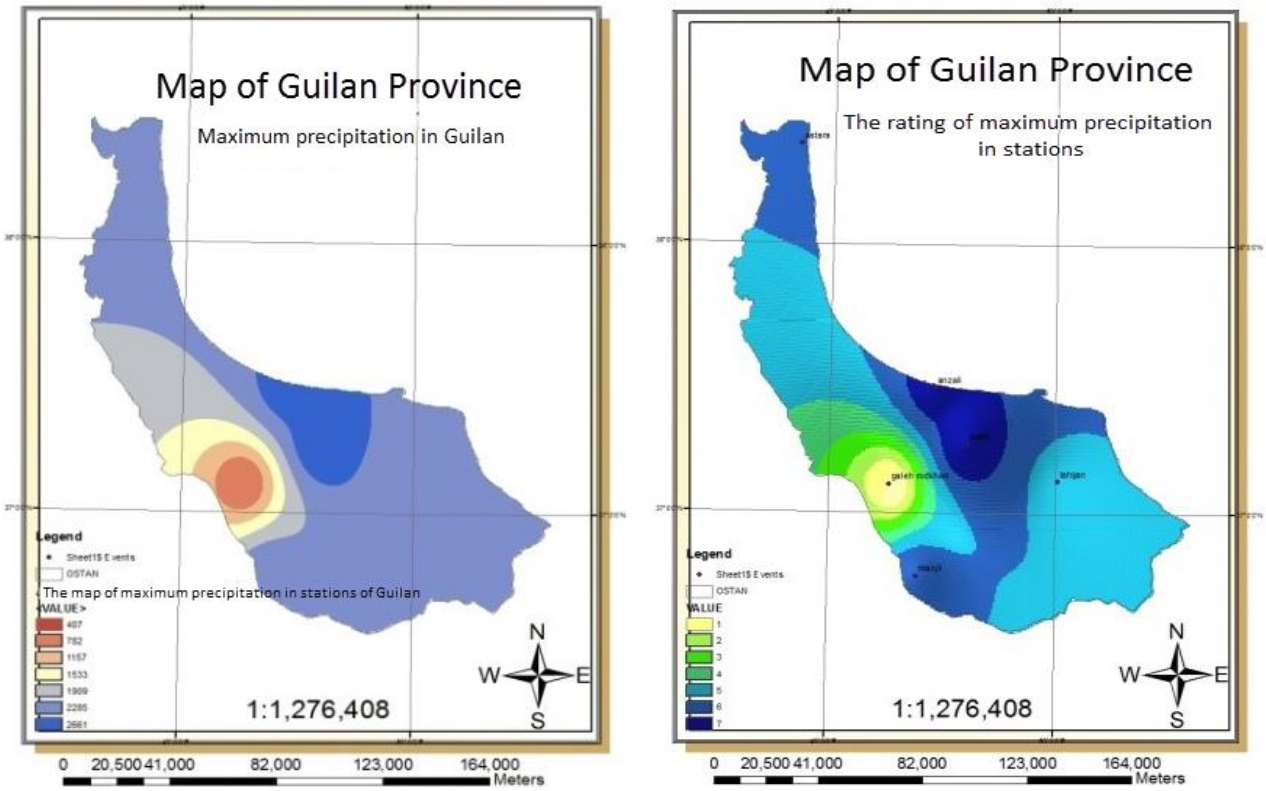

Fig. 3. the maximum precipitation in the stations of Guilan

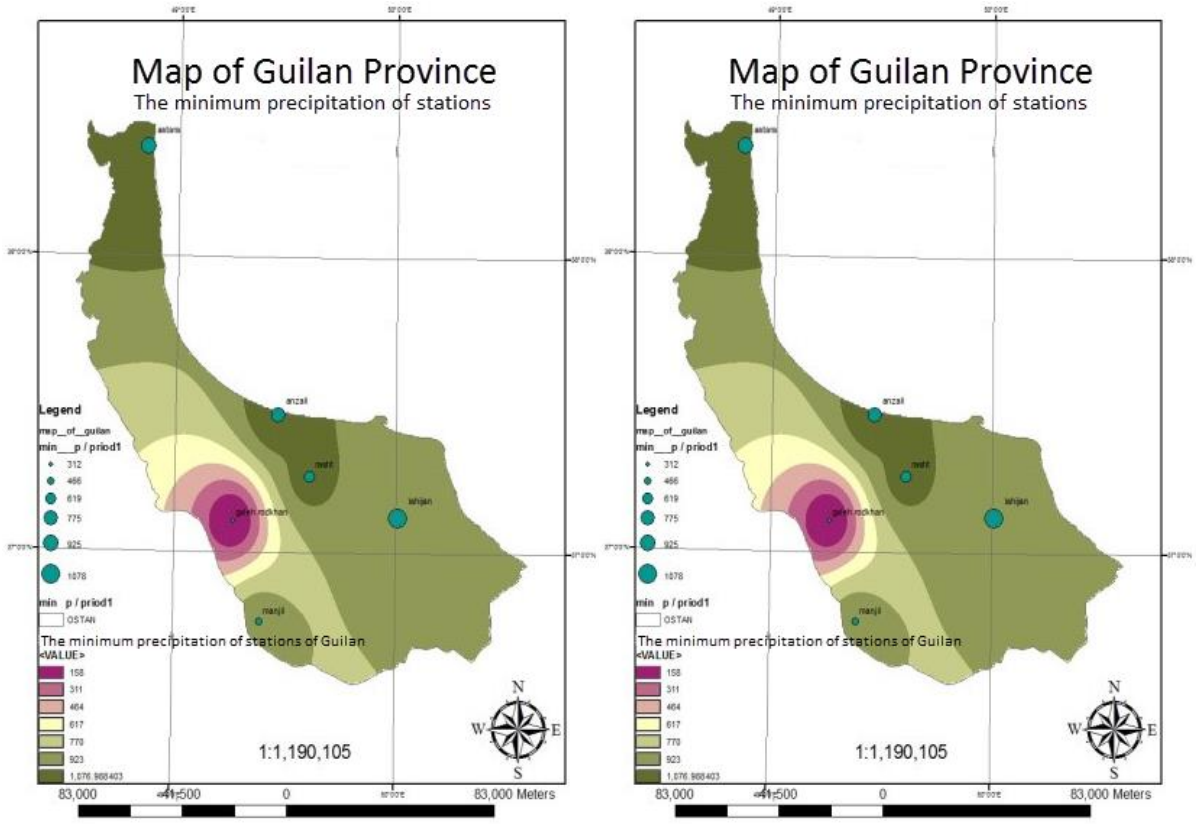

Fig. 4. the minimum precipitation of the stations of Guilan

4. Conclusion

Precipitation is one of the most variable climatic elements whose changes can have negative environmental, social, economic and even cultural effects on human societies. Thus, studying precipitation changes is a center of attention for climatologists. Especially, severe changes and changeability of precipitation is of a great deal of importance and can play a major role in the management of water resources and optimized environmental, economic and agricultural planning. The present study has tried to evaluate the long-term behavior (variations) and oscillations (changeability) of precipitation in the stations of Guilan. The data were reconstructed using the MINITAB software, and the statistical trends of the stations were analyzed. In order to facilitate the process, the clustering method was utilized to narrow down the stations to five. The statistical results indicated that the annual precipitation of most stations has a decreasing behavior. Generally speaking, the dry year trend is increasing and the wet-year trend is decreasing. Using the MINITAB software, the minimum and maximum precipitation of the stations were evaluated and ranked and using the HYFA software, the lowest and highest precipitations and their recurrence intervals were evaluated and ranked in Guilan Province. These data were then utilized to draw maps. By having other related data, such as the soil thickness and type, the physical condition of the region, etc. one can evaluate the structures and canals, and manage the water resources. The ranking of the maximum precipitation indicated that Anzali and Rudkhan Castle are examples of areas with adequate precipitation with frequent heavy rainfalls and a good supply of water surplus. An attempt must be made to preserve and save their surplus water and even guide it towards areas with fewer water supplies in

order to prevent its wastage by going to the sea.

In the ranking of minimum precipitation, the ranking is as follows: Manjil, Rasht, Lahijan, Anzali, Rudkhan Castle. Rasht possesses the first rank of lowest precipitation among plain regions. Manjil has one of the lowest amounts of precipitation in the whole province. This region which has the lowest precipitation and recurrence interval in the province has always suffered from water shortage and recurrence of arid periods. A serious decision must be made to address this problem in the region. Lahijan and Rasht possess almost the same condition regarding the minimum and maximum precipitation and the calculation of the recurrence interval. In making important decisions, such as matters related to agriculture and tourism in these areas, the authorities need to be more sensitive.

5. References

E. C. Merem, Y. Twumasi, D. Foster, Ch. Richardson, S.YeramilliUsing.1998 .GIS and Climate Risks Information to Analyze the Vulnerability of Coastal Counties in Louisiana and Mississippi. Scientific and academic publishing. 2(1): 1-16.

E. Moreira, C. A. Coelho, A .Paulo, L.S Pereira, João T.2008.SPI-based drought category prediction using loglinear models. Journal of Hydrology. 354(1-4): 116-130.

H. wu, J.hayes, A.weiss and Q. HU.2001.the standardized precipitation index,the china Z.index and the statistical Z.score . international journal of climatology int.J.climatol.21:745-758.

Khan, T. Rana,H, Gabriel. 2008. Standard precipitation index to track drought and assess impact of rainfall on water tables in irrigation areas"/journal of Irrigation and Drainage Systems. 22(2).159-177pp.

S. Jahanbakhsh.2016. Climate fluctuations on surface runoff changes in the Urmia tea town basin. Conference on the Environmental Consequences of Lake Urmia.

S. Jahanbakhsh, M. Hosseini and H. Sayadi .2009. Determination of Urinea Station Station and Station Station using Palmer Drought Intensity . International Drought Conference.

S. Morid, V.Smakhtin and M.Moghaddasi. 2006.Comparison of seven meteorological indices for drought monitoring in Iran. International Journal of climatology. 26(7) : 971-985.

V. U .Smakhtin and D. A. Hughes. 2007. Automated estimation and analyses of meteorological drought characteristics from monthly rainfall data"/journal of Environmental Modeling & Software. 22(6). 880-890pp.