Geography and Environmental Planning Journal
23rd Year, vol. 47, No.3, Autumn 2012
ISSN (Online): 2252-0848
ISSN (Print): 2008-5354
http://uijs.ui.ac.ir/gep

Analysis of Annual Precipitation Changes in Northwest of Iran

H. Asakereh. R. Razmi

Received: May 21, 2011 / Accepted: November 13, 2011, 35-40 P

Extended Abstract

1-Introduction

Climate change could be studied by detection of amount and tempo-spatial pattern of climatic elements. Precipitation is one of important climatic elements that could be studied. Precipitation is one of the most variant climatic elements that could have negative consequences on environment, society, economic and even culture of human society. Accordingly the changes and looking for change and variability of precipitation take the attention of climate experts. This is because of the importance of this sort of studies on climate forecasting and water resources management as well as environmental, economical and agricultural planning.

Author(s)

H. Asakereh (✉)
Associate Professor of Climatology, University of Zanjan, Zanjan, Iran
e-mail: asakereh@znu.ac.ir
R. Razmi
MA. of Climatology, University of Zanjan, Zanjan, Iran

Precipitation as one of fundamental elements in climate has increased by 0.1% in middle and high latitude especially during 20th century. Meanwhile in subtropical lands (Northern latitude of 10-30 degree) decreasing in precipitation by 0.3% has been reported, also there are increasing by 0.2%-0.3% in tropical regions (Mosmann et al. 2004). In addition there are negative trends of precipitation in Mediterranean basin since 1950s. Because of this spatial differ in precipitation changes and in order to precise exploring the changes, a dozen of studies have been accomplished.

2- Methodology

In this paper long term and oscillatory behavior of precipitation in the Northwest of Iran has been evaluated. The area under investigation is about 12654.4 square kilometers and contains four province including west and east Azarbayjan, Ardabil and Zanjan. It

occupied about 7.7% of all country. The average elevation of northwest of Iran is about 1830 meters above sea level. The highest area is about 4500 meters above sea level.

In order to do this research, daily precipitation data of 260 stations during 1966-2005 have been analyzed. The length of recorded data have been used in this study wasn't equal, so it had created a map for every single day using the stations that was available. This stage has been accomplished by Kriging interpolation method. Accordingly 15052 daily precipitation maps by 100*100 pixel resolution were created. To create the 40 annual maps, these maps were used. So the investigated area was covered by 5374 pixels. Finally the matrix of data by dimensions of 5374*41 has been established. The analyses of two approaches were accomplished on this matrix. They are as follow:

1- The trends of annual precipitation have been analyzed using linear non – parametric regression model.

2-annual cycles of precipitation have been estimated using spectral analyses. The cycle that has largest difference with null continuum, is chosen as the significant cycle.

Finally, all result of above two stages is presented in related maps.

3– Discussion

Annual precipitation of northwest of Iran is about 360.9 mm. precipitation mean is spatially different from 200 mm (northeast of area in Dashte-Moghan) to 800 mm (in southwest of area. Accordingly spatial coefficient of variations is about 24.1%. The area with low precipitation is most extending than the area with high precipitation. For example about 58.8% of northwest of Iran has achieved the precipitation lower than its spatial average.

The annual precipitation of northwest of Iran (except of small parts in southwest and north) during the studied period has experienced decreasing trend. The amount of decrease in about 84.5% of area is about 3 mm per year. This kind of trends has been occurred especially in eastern and southern halves. Across west to east and toward the mountains the amounts of trend is decreased. About 16.8% of area is covered by Non – significant trends that contain Dashte-Moghan and western mountains.

The region under increasing trends is about 8% of the area in which the trends is about 5-9 mm per year.

In the 58%-71% of the area, precipitation has experienced the values more than long term average during the first three decades. Meanwhile during the forth decade the area with precipitation lower than long term average has increased by 72%.

By using spectral analyses technique on precipitation data, significant oscillations in 2-3, 3-5, 5-11 and 11 years have been discovered. Major area experienced 5-11 years oscillations. As it has reported by many experts these oscillations periods are due to macro-scales circulations between atmosphere and hydrosphere e.g. quasi binomial oscillation is related to ENSO phenomenon.

4– Conclusion

Based on what discovered in this paper it has been cleared that long-term mean of precipitation in 84.5% of northwest of Iran has been decreased. The increased trends values of precipitation are happened in southwest. The decreasing in precipitation is due to last decade in which the area with low precipitation has increased by 72%.Spectral analyses showed significant oscillations in 2-3, 3-5, 5-11 and 11 years. Major area experienced 5-11 years oscillations. As it has reported by many experts, these oscillations periods are due to macro-scales circulations between atmosphere and hydrosphere e.g. quasi binomial oscillation is related to ENSO phenomenon.

Keywords: Precipitation, Spectral Analysis, Trends, Northwest of Iran, Harmonic, Frequency

References

Arrigo.R.D, R.vilallba, G.wiles. (2001)" Tree-Ring Estimates of Pacific Decadal Climate Variability" Climate Dynamics.18:219-224.

Asakereh, H. (2002). Statistical Study of Annual Precipitation Trends in Tabriz. Geographical Space. Vol 10: 57-67.

Asakereh. H. (2004). Trend Analyses of Annual Precipitation of Isfahan Province. Nivar. Vol.56-57

Asakereh. H. (2009). Spectral Analyses of Temperature Time Series of Tabriz. Geographic Research Quarterly. Vol . 93.

Askary , A. Rahimzadeh,F. (2006), Study of Variability of Iran Precipitation during Recent Decades. Geographic Researchs. Vol 58: 67-80.

Azad, Sarita and T. S. Vigneshb and R. Narasimha,(2009)" Periodicities in Indian Monsoon Rainfall over Spectrally Homogeneous Regions" Int. J. Climatol, DOI: 10.1002/joc.2045.

Campagnucci.R.H, E.A.Agosta, W.M.vargas(2002)"Climatic Change and Quasi-Oscillations Central-West Argentina Summer Precipitation : Main Features and Coherent Behavior with Southern African Region" Climate Dynamics, 18:421-435.

Cannarozzo.M and L.V. Noto, F. Viola(2006)" Spatial Distribution of Rainfall Trends in Sicily (1921–2000) "Physics and Chemistry of the Earth 31 1201–1211.

Chatfield, C (1991). The Analysis of Time Series. An Introduction. Translated by : Niroomand and Bozorgnia. University of Ferdosy. Mashhad. Iran. 289p.

Earle M.D, K.E. Steele, D.W.C. Wang(1999)" Use of Advanced Directional Wave Spectra Analysis Methods" Ocean Engineering 26, 1421–1434.

Domonkos(2003)" Recent Precipitation Trends in Hungary in the Context of Larger Scale Climatic Changes" Natural Hazards 29: 255–271.

Feidas and Ch. Noulopoulou, T. Makrogiannis, and E. Bora-Senta(2007)" Trend Analysis of Precipitation Time Series in Greece and Their Relationship with Circulation Using Surface and Satellite Data: 1955–2001" Theor. Appl. Climatol. 87, 155–177.

Garcia.J.A,A.Serrano and M.Cruz Gallego(2002)"A Spectral Analysis of Iberian Peninsula Monthly

Rainfall" Theor. Appl. Climatol. 71, 77-95.

Ghil.M, M. R. Allen, M. D. Dettinger, K. Ide, D. Kondrashov, M. E. Mann, A. W. Robertson, A. Saunders,Y. Tian, F. Varadi, and P. Yiou(2001)" Advanced Spectral Methods for Climatic Time Series" Reviews of Geophysics, 40, 1 , pages 1-1–1-41.

Goldasteh, A, S. Aghamirkarimi. M. Khodarahmi, M. Torabi, R. Asghari. (1998). Manual for SPSS User. Tehran: Cultural Pub. 533p.

Hartmann, S. Becker, and L. King, (2008) "Quasi-Periodicities in Chinese Precipitation Time Series" Theor. Appl. Climatol. 92, 155–163.

Hegge, Gerhard Masselink, (1996) "Spectral Analysis of Geomorphic Time Series: Auto-Spectrum "Earth Surface Processes and Landforms, vol. 21, 1021-1040.

Hejam, S, Y.Khoshkhoo, R. Shams-oldin-Vandi (2008). Trend Analysis of Changes in Annual and Seasonal Precipitation of Selected Stations in Central Basin of Iran by Using Non-Parametric Methods. Geographic Research. Vol 64: 157-168

Henderson, S. (2000) "Autumn Precipitation Trends in the Northeast United States" Middle States Geographer, 33: 74-81.

Hidalgo.J.C.G and Joan-Albert Lopez-Bustins, b Petr ˇ Step´anek,c Javier Martin-Videb and Martin de Luisa (2009)" Monthly Precipitation Trends on the Mediterranean Fringe of the Iberian Peninsula during the Second-Half of the Twentieth Century (1951–2000)" Int. J. Climatol. 29: 1415–1429.

Hoaglin, David C. Mosteller, Frederick and Tukey, John W. (edit) 2006: Exploring Data Table, Trends, and Shapes. John Wily & Sons. Inc. U.S.A . 527pp

Huth. R, Pokorna.L 2004: Parametric Versus Non-Parametric Estimates of Climatic Trends. Theor.Appl.Climatol. **77:** 107-112

Jahanbakhsh, S., M.Edaladoost (2008). Climate Change Study in Iran (Case Study : North Atlantic Oscillations as an Index of Sun Activity Effects on Precipitation Changes in Azarbayjan), The Third Conference on Management of Water resources of Iran. Civil Engineering Faculty. University of Tabriz. .Tabriz..

Kampata and B.P. Parida, D.B. Moalafhi (2008)" Trend analysis of rainfall in the Headstreams of the Zambezi River Basin in Zambia" Physics and Chemistry of the Earth 33 621–625.

Kane, R. P. and Teixeira. N R. (1991), "Power Spectrum Analysis of the Annual Rainfall Series for Massachusetts (NE. U.S.A)", Climatic Change, 18: 89-94.

Katiraie, P. S.Hajam, P. Iran Nejad. (2007). The Ratio of frequency and Intensity of Daily Precipitation in Trends of Iran Precipitation during 1960-2001. Earth and Space Physics. Vol 33(1): 67-83.

Kaviani, M. R. H.Asakereh (2005), Statistical Investigation of long-Term Trends of Annual Precipitation of Isfahan. Isfahan University Magazine . 18(1): 143-162.

Kaviani, M. R. S. Masoodian. (2008). Climatology of Iran. Isfahan University Press. P 179.

Khalili, A, J. Bazrafshan. (2003). Trend Analysis of Changes in Annual and Seasonal Precipitation of Five Old

Station during Last 116 Years. Biaban . Vol. 9(1).

Lana, M. D. Martı´nez, C. Serra, and A. Burguen,(2005), "Periodicities and Irregularities of Indices Describing the Daily Pluviometer regime of the Fabra Observatory (NE Spain)for the Years 1917–1999" Theor. Appl. Climatol. 82, 183–198.

Lana.x and A. BurguenÄo(2000)" Statistical Distribution and Spectral Analysis of Rainfall Anomalies for Barcelona (NE Spain)" Theor. Appl. Climatol. 66, 211-227.

Liu, Z. Y , Baoshan Cui(2008)" Spatial and Temporal Variability of Annual Precipitation during 1961–2006 in Yellow River Basin, China" Journal of Hydrology 361, 330– 338.

Matyasovszky.I (2009)" Improving the Methodology for Spectral Analysis of Climatic Time Series" Theor Appl Climatol , DOI 10.1007/s00704-0212

Marengo .J. A, (2004) "Interdecadal Variability and Trends of Rainfall across the Amazon Basin" Theor. Appl. Climatol. 78, 79–96 .

Maslen. David. K. and Rockmore. Daniel.N 1997, Separation of Variables and The Computation of Fourier Transforms on Finit Groups, I., American Mathematical Society. Volume 10 number 1 . PP 169-214

Mitchell.,Dzerdzeevskii,B.,Flohn,H.,Hofmeyr,W.L.,Lamb,H.H.,Rao,K.N.,and Wallen,c.c., (1966)" Climatic Change: Technical Note No. 79, Report of Working Group of Commission for Climatology" WMO No . 195 TP 100: Geneva, Switzerland, World Meteorological Organization, 81 P.

Mosmann, A. Castro, R. Fraile, J. Dessens, J.L. Sa´nchez (2004)" Detection of Statistically Significant Trends in the Summer Precipitation of Mainland Spain" Atmospheric Research 70 , 43–53.

Olsen Lena Ringstad,_, Probal Chaudhuri, Fred Godtliebsen(2008)" Multiscale Spectral Analysis for Detecting Short and Long Range Change Points in Time Series" Computational Statistics and Data Analysis 52, 3310–3330.

Razaie, T. P. Danesh . B.Saghafian (2005). Trends Investigation of Annual Precipitation in Central and Eastern Arid and Semi- Arid region of Iran Water and Sewage. Vol 54: 73-81

Rodriguez .roberto, mari´a-carmen llasat, and dennis wheeler (1999)" Analysis of the Barcelona Precipitation Series 1850–1991" int. J. Climatol. 19: 787–801.

Schickedanz, Paul T and Bowen. E. G (1977)" The Computation of Climatological Power Spectra, Journal of Applied Meteorology" Vol 16, 359-367.

Solow, Andrew, and james m.broadus, (1989)" On the Detection of Greenhouse Warming" Climatic Change 15:449-153.

Selwam and R.Joshi ,(1995)"Universal Spectrum for Interannual Variability in Coads Global Air and Sea-Surface Temperature" Int. J. Climatol, 15:613-623.

Spangenberg.A and M. Bredemeier (1999)"Applications of Spectral Analysis to Meteorological and Soil Solution Chemistry Data". Chemosphere.Vol.39, NO,10,pp,1651-1665.

Tomozeiu1. R., A. Busuioc2, V. Marletto1, F. Zinoni1, and C. Cacciamani, (2000) "Detection of Changes in the Summer Precipitation

Time Series of the Region Emilia-Romagna, Italy "Theor. Appl. Climatol. 67, 193±200 .

Torrence and Webster,(1999)" Interdecadal Changes in the ENSO–Monsoon System" J. Climatol, 12: 2679- 2690.

Ventura and P. Rossi Pisa , E. Ardizzoni(2002)" Temperature and Precipitation Trends in Bologna (Italy) from 1952 to 1999 "Atmospheric Research 61 ,203–214.

Yun-Ju. J, and Lee. J.Y. (2010) "Time Series Analysis of Hydrologic Data Obtained from a Man-Made Undersea LPG Cavern" Engineering Geology 113 , 70–80.

Zahedi, M. B. Sarisaraf. J. Jameie. (1386). Analysis of Tempo-Spatial Changes of Temperature in Northwest of Iran. Geography and Development. 10: 183-198