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# Spatial Modeling of Annual Precipitation in Iran

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## Introduction

Due to deep, complex and everlasting interaction between precipitation and climatic elements-factors, there are changes and varieties in both time and space dimensions of precipitation. So that climate experts and related scientists take their attentions to this phenomenon. An approach to do this kind of investigations is to describe spatial variations based on spatial statistics.

The major spatial non-stationary of Iran precipitation is due to variation in situation, elevation and topography characters (slope and its direction) in this country. Circumstances of every one of these characters could determine the precipitation spatial patterns. Accordingly understanding spatial distribution of precipitation and its mechanism are important aspect in climatological researches.

One of the common statistical models in which it is possible to determine the relation between variables as well as reconstruct, estimating and forecasting data is multivariate regression model. These sorts of models are useful for time series analyses as well as spatial modeling. One of the regression models that could be used in spatial analyses is called Geographically Weighted Regression (GWR). In current study it will be attempted to introduce this approach and using General Regression (GR) to justify spatial variation of precipitation in Iran based on 1436 stations in Iran.

## Research Methodology

In this research Esfezary data base have been used. This daily data based contain 15998 days and 7187 pixels (15*15 KM) of precipitation over Iran. Accordingly the data matrix is created in 15998* 7187 and S-mode dimension. This matrix data base is estimated by using 1436 stations and Kriging method.

To achieve independent variables, digital elevation map by 15*15 KM resolution has been created. So that, spatial (including longitude and latitude) and topographic (including slope magnitude and aspect) characters have been derived. Accordingly a data base has been created that contain spatial characters, topographic features and precipitation amounts.

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The proper regression model on precipitation has been chosen based on spatial and topographical characters. Multivariate General Regression (MGR) for these m independent variables is defined as follow:

$$R_i = b_0 + \sum_{k=1}^{m} b_k x_k + \varepsilon_k$$

Where Ri is precipitation in a given pixel that depends on" m "climatic factors.

Geographical Weighted Regression (GWR) allows local rather than global parameters to be estimated and the above model is rewritten as:

$$R_i = b_0(\phi_i, \lambda_i) + \sum_{i=1}^{k} b_k(\phi_i, \lambda_i) x_{ik} + \varepsilon_i$$

In geographically weighted regression, the parameter estimates are made using an approach in which the contribution of a sample to the analysis is weighted based on its spatial proximity to the specific location under consideration. Thus the weighting of an observation is no longer constant in the calibration but varies with different locations. Data from observations close to the location under consideration are weighted more than data from observations far away.

In this paper spatial distribution of precipitation had been modeled using General Regression and Geographical Weighted Regression. Finally the most effective variables on precipitation have been clustered using Euclidean distance method and Ward clustering method.

**Discussion and Results**

Annual mean of Iran precipitation is about 256 mm. Spatial coefficient of variation of Iran precipitation is about 79%. Generally distribution of precipitation isohyets over Iran follows topographic features. The General Regression Model for precipitation is as follow:

R=236s+007a+004r+000006-0000λ7+11081
4798 767 144 16748 -44863

$$r^2 = 0.48$$

This model can justify about 48% of spatial distribution of precipitation.

Using GWR model tends to different coefficients of spatial variables. Accordingly three regions have been denoted: The first region in which precipitation is affected by elevation. This region is about 43% out of the all area of the country that located in northwest, inner parts and southeast of Iran. Precipitation of second region is affected by hillside of mountains in west of country that covers 18% of Iran. The precipitation of third region that is about 39% of the country is determined by slope more than other factors. This region located in small parts of northwest, west and southeast of Iran.

**Conclusion**

In order to justifying spatial changes of precipitation over Iran, 1436 stations and GWR technique have been applied. Based on GWR model, elevation in northwest and inner parts of Iran, direction of slop in Zagros mountain chain and the slop in northeast and Caspian coast are the spatial factors that more controlling precipitation

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**Keywords:** Cluster analyses, Spatial autocorrelation, Geographically weighted regression (GWR), Spatial Modeling.

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**Refrences**


1. Alijani. B (1995). The Role of Alborz Mountain Chain on Elevation Distribution of Precipitation. Geographic Research Quarterly. Vol 38.
2. Alijani. B (2002). The Role of Statistics on Developing of Geography Science. The 6th of International Conference of Iran Statistic. Trbiat Modares University. Tehran. Iran.
3. Alijani B (2008). Effect of Zagros Mountain on the Spatial Distribution of Precipitation, Journal of Mountain Sciences, 5.
4. Asakereh. H (2000). Spatial Modeling of Climate Elements. A Case Study: Annual Precipitation of Isfahan Province. Geographic Research Quarterly. Vol 74.
5. Asakereh. H (2010). Study of Dry Days Probability in Golestan Province by Using Markov Chain Model. Geography and Development. Vol 17.
6. Brunsdon C, McClatchey. J and Unwin. D.J (2001). Spatial Variation in the Average Rainfall – Altitude Relationship in Great Britain: An Approach Using Geographically Weighted Regression. Int. J. Climatol. 21.
7. Fotheringham. A. S, Brunsdon. C , Charlton. M (2002). Geographically Weighted Regression, John Wiley & Son, UK.
8. Foody G. M (2003). Geographical Weighting as a Further Refinement to Regression Modeling an Example Focused on the NDVI-Rainfall Relationship, Remote Sensing of Environment, 88.
9. Gao. X, Asami. Y and Chung Chang-Jo F (2006). An Empirical Evaluation of Spatial Regression Models. Computers & Geosciences 32 (2006) 1040–1051
10. Ghayoor H, Masodian S. A (1996). Study of Spatial Correlation of Precipitation and Elevation in Iran. Geographic Research Quarterly. Vol 41.
11. Glazirin G.E (1997). Precipitation Distribution with Altitude, Theoretical and Applied Climatology, 58.
12. Griffith Daniel A (2009). Spatial Autocorrelation, International Encyclopedia of Human Geography.
13. Hansen. J and Lebedeff, S (1987). Global Trend of Measured Surface Air Temperature. Journal of Geophysical Research. 92.
14. Harris. P, Fotheringham A. S, Crespo R, Charlton M.(2010). The Use of Geographically Weighted Regression for Spatial Prediction: An Evaluation Weighted of Models Using Simulated Data Sets, Mathematical Geosciences, 42.
15. Hasseler,U. (1997). Simple Regression with Time Trend. Journal of Time Series Analysis Vol.21 No1.
16. Huang Y, Leung Y (2002) Analyzing Regional Industrialization in Jiangsu Province Using Geographically Weighted Regression. J Geogr Syst 4.
17. Jedari. E. J. (1994). Geomorphology of Iran, Payam Noor Publication.
18. Jones, P. D., Raper, S. C. B. , Bradley. R. S , Diaz. H. F. , Kelly, P.M, and Wigley. T.M.L. (1986) Northern Hemisphere Surface Temperature Variation: 1851-1984. J.clim. Appl . Meteorol. 25.


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19. Khalili. A. (1995). Three Dimensional Changes of Long Term of Atmospheric Annual Temperature over Iran. Nivar. Vol. 32, 13-34.
20. Legendre P.(1993). Spatial Autocorrelation: Trouble or New Paradigm, Eclogy, 74:1659-1673.
21. Masodian. S. A. (1996). Analyses of Structure of Monthly Temperature of Iran. Research Journal of Isfahan University. Vol 1,2. 87-96.
22. Masoodian S.A(2008). On Precipitation Mapping in Iran , Journal of Humanities the University of Isfahan , 30:68-80.
23. Mojarad F, Moradi Farhaji M. (1996). Modeling the Relationships of Precipitation and Elevation in Zagros area. Modares Quarterly. Vol 2. 163-182.
24. Moradi. H. (1997). The Role of Caspian Sea on Precipitation of North Coast of the Country. Marian science of Iran. Vol 2, 3. 84-85.
25. Ranhao S., Baiping Z. and Jing T.(2008). A Multivariate Regression Model for Predicting Precipitation in the Daqing Mountains, Mountain Research and Development. 28:318-325.
26. Razai T and Azizi GH. (2008). Study of Spatial Distribution of Seasonal and Annual Precipitation in West of Iran. Geographic Research. Vol. 65. 18-39.
27. Sari saraf. B, Rajaei B., Mesri. A. and Almdari, P. (2009). Study the Relationship of Precipitation and Topography in East and West of Talesh Hillside. Geography and Environmental Planning. Vol 35. 63-84.
28. Singh. P and Kumar. N. (1997). Effect of Orography on Precipitation in the Western Himalayan Region", Journal of Hydrology,199:183-206.
29. Wheeler. D. and Tiefelsdorf M.(2005). Multicollinearity and Correlation among Local Regression Coefficients in Geographically Weighted Regression, Journal of Geographical Systems, 7:161-187.
30. Zhang. T., Gove. J.H and Heath. L. S (2005). Spatial Residual Analysis of Six Modeling Techniques, Ecological Modeling, 186:154-177.
31. Zhang. T. and Lin. G (2007). A Decomposition of Moran's I for Clustering Detection. Computational Statistics and Data Analysis, 51: 6123-6137.


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