# Estimating the Fluctuations of Rainfall Extreme Indices in Mashhad for the Next Two Periods of 2011-2030 and 2046-2065 Using LARS-WG Model's Downscaling

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**Extended abstract**

## 1. Introduction

Today, it is accepted that the occurrence of any change in the climatic system is important in water and soil resources management. Climate fluctuations have had irreparable effects on water and soil resources of Khorasan Razavi area, especially in Mashhad. Hence, the attitude towards the future is considered as one of the essential requirements for metropolitan and regional management.

In order to provide an outlook from future changes of extreme events, especially precipitation, the output of models of atmosphere general circulation (HadCM3, CNCM3, NCCCSM) are used based on A1B, and A2 scenarios under the LARS-WG model for the two upcoming periods of 2011-2030 and 2046-2065. The studied rainfall indices in this research include PRCPTOT, R10mm, R20mm, R95p, R99p, RX1day, RX5day, and SDII.

## 2. Theoretical Framework

The prediction of changes in the extreme events caused by global warming and climate change is very important in assessing the potential impacts of climate change on different sectors, such as water, agriculture, and management of urban water collection systems. Since the city of Mashhad has a density of large urban population and is known as a semi-industrial region in which the effects of climate parameters on different parts of the urban and industrial community are important, economic development and sustainable living conditions in the future years depend on the ability to manage the risks associated with extreme events.

## 3. Methodology

In this study, the magnitude of extreme values change in the predicted rainfall of Mashhad station was investigated for the two periods of 2011-2030 and 2046-2065 using simulated data through three general circulation models (HadCM3, CNCM3,

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NCCCSM) under the two scenarios of A2 and A1B, and was downscaled in the station scale by LARS-WG Model (Baseline Statistical Period 2014-2016). It was obtained from the reduction of the uncertainty of the average of calculated indices for the three models. Finally, the percentage rate and the amount of index change were calculated.

In this research, data quality control was performed using a software package called RClimDex. Also, the homogeneity of the data used was done by using RHtests_dlyPrcp software package under R programming language.

## 4. Results and Discussion

To investigate the ability of HadCM3, NCCCSM, and CNCM3 models in the simulation of weather data, especially rainfall, correlation coefficient was used between the monthly rainfall data observed and simulation data of the three models during the base period of 1966-2014.

The results showed that there was a relationship between the two series of data with 99% confidence. Despite the low amount of correlation coefficient between the observed and simulated data, the significance test of this coefficient showed that there is a relationship between the two series of data with 99 certainty. The mean values, variance and standard deviation of climate variables can be compared using T and F tests in surveying the ability of LARS-WG model in simulation of climatic data. The climatic parameters of precipitation were firstly calculated using 53 years of monitored data in Mashhad station (2014-2016) using the semi-experimental distribution in the LARS-WG model.

Then, the model was performed to generate 80 years of data based on the obtained parameters based on the data series observed at the station. This operation was performed several times by changing the random number to obtain acceptable statistical results. The results of t-test for this station showed that there was no significant difference in the significance level of 0.05 between the mean of simulated rainfall and its actual value, and, correlation coefficients, bias, and mean of absolute error were also calculated for this station in the monthly series of observed and simulated data. Consequently, a comparison was made between the mean values, the standard deviation, and the maximum of monthly rainfall of the two observational and simulated series.

## 5. Conclusions and Suggestions

This study aims to present an outlook of the events and investigate the effect of changes in greenhouse gas rates based on A1B and A2 scenarios on the mentioned indices in terms of percent and the amount of their change relative to the basic period. The results showed an average of five-day precipitation and rainfall intensity during the 2011-2030 period will probably increase under the A2 scenario. Also, a more share of the total annual precipitation will belong to the occurrence of torrential and floody rains, i.e., precipitations over the percentile of 95 and 99 basic period. According to the results, the increase of these indices means an increase in the frequency of flood occurrence and its severity, especially during the upcoming period of 2011-2030.

However, the probability of decreasing precipitation intensity and indices of maximum five-day rainfall are predicted during the period from 2046 to 2065. Due to the importance of the subject, it is recommended that the authorities pave the way for further studies such as the use of other methods of downscaling under new scenarios in this field, since such results are necessary in long-term planning in the urban services sector.

**Keywords:** Extreme indices, The model of general circulation of atmosphere – ocean, Downscaling, Mashhad.

**References (In Persian)**

1. Asakereh, H. (2010). Tahlil taghirat bareshhaye hady shahr zanjan [Analysis of changes in hady rainfall in Zanjan city]. *Climatology Research*, *1*(1-2), 89-100.
2. Ashraf, B., Mousavibaygi, M., Kamali, G., & Davari, K. (2011). Pishbini niaz choghondar dar dore 2011-2030 ba estefade az dadehaye eghlimi shabihsazy shode tavasote model zir meghyas konande motaleh moredy Khorasan razavi [The prediction of the water need for sugar beet in the period of 2011-2030 using climate data simulated by the LARS-WG sub-scaling model (Case study: Korasan Razavi Province)]. *Journal of Water and Soil*, *25*(5), 1184-1194.
3. Askari, A., & Rahimzadeh, F. (2006). Totae'eh taghyirpaziri baresh dahehaye akhir Iran [A study on the variability of rainfall in recent decades of Iran]. *Journal of Geographical Research*, *58*, 67-80.
4. Babaeian, I., Najafinik, Z., Zabol Abbasi, F., Adab, A., & Malbousi, Sh. (2005). Arzyabi taghir eghlim ostan Khorasan Razavi dar dore 2020- 2039 ba estefade az zir meghyas namaie khorege modle GCM [An Assessment of climate change in Khorasan Razavi province in the period of 2010-2039 using downscaling of the outcome of GCM Model]. *Geography and Development, 7*(16), 135-152.
5. Baraty,gh, & Jahadi Toroghi, mahnaz M. (1999). Taien Ravand taghirat dama va baresh shahre mashhad teie dore Amari 1951-1994 [Determination of changes trend in temperature and precipitation in Mashhad during 1951-94]. *Geography Research Quarterly*, 54-55.
6. Golmohammadi, M., & Massah Bavani, A. (2011). Barasi taghirat shedat va dore bazgasht khoshksaly hoze ghare su dar dorehay aty tahte tasir taghir eghlim [An investigation of changes in severity and period of drought recurrence in Qara-Souz basin in future periods affected by climate change]. *Water and Soil Journal*, *25*(2), 315- 326.
7. Massah, A., & Ashofteh, P. (2008, February 13). *Barrasi ahamiat mozoe taghir eghlim dar jahan va tasir an bar sistemhay mokhtalef* [The study of the importance of climate change in the world and its impact on different systems]. Paper presented at Technical Workshop on the Effects of Climate Change on Water Resources Management, Iranian National Committee on Irrigation and Drainage, Tehran, Iran.
8. Rahimzadeh, F., Askari, A., Fattahi, A., Mohammadian, N., & Taghipour, A. (2009). Ravand namayehay hadi eghlimi dama dar iran tei dore 1951-2003 [The

indexes process of temperature climatic Ferin in Iran for the period of 1951-2003]. *Journal of Geographic Research, 93*, 119-144.

**References (In English)**

1. Bonsal, B. R., Zhang, X., Vincent, L. A., & Hogg, W. D. (2001). Characteristics of daily and extreme temperature over Canada. *Journal of Climate, 14*, 1959-19766
2. DeaGaetano, A. T. (1996). Recent trends in maximum and minimum temperature threshold exceedances in Northern United States. *Journal of Climate, 9*, 1646-1657.
3. Intergovernmental Panel on Climate Change. (2010). *Meeting report: IPCC expert meeting on assessing and combining multi model climate projections.* Boulder, Colorado: National Center for Atmospheric Research.
4. Plummer, N., Salinger, M. J., Nicholls, N., Suppiah, R., Hennessy K.J., … Lough, J. M. (1999). Changes in climate extremes over the Australian region and New Zeland during the twentieth century. *Climate Change, 42*, 183-202.
5. Semenov, M. (2008). Simulation of extreme weather events by stochastic weather generator. *Climate Research, 35*, 203–212.
6. Semenov, M. A., & Barrow, E. M. (1997). Use of a stochastic weather generator in the development of climate change scenarios. *Climatic Change, 35*, 397-414.
7. Semenov, M. A., & Stratonovitch, P. (2010). Use of multi-model ensembles from global climate models for assessment of climate change impacts. *Climate Research, 4*, 1–14 .
8. World Meteorological Organization. (2011). *Weather extremes in a changing climate report: Hindsight on foresight*. Retrieved from https:// www. preventionweb. net/ publications/view/17033
9. Zhai, P. M., Sun, A., Ren, F., Liu, X., Gao, B., & Zhang, Q. (1999). Changes of climate extremes in China. *Climate Change, 42*, 203-218.

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