Tree Ring Based Precipitation Reconstruction of Northeast Iran Using Juniper Tree Chronology of Lain Region

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1. Introduction

Long-term climatic data are a prerequisite for hydro-meteorological studies and understanding of past climate. Iran is mostly located in semi-arid to arid climate zones, so information on the natural long-term variability of the hydroclimate is of great relevance for land use planning, agriculture, and water supply of a growing population. However, the maximum length of recorded climate data in Iran is less than 60 years, measured at less than 50 synoptic meteorological stations. Therefore, knowledge of the climate history in the distant past requires reconstruction of climate variables from proxy data. Tree-ring data are an important and precisely dated proxy to reconstruct variations in hydroclimate, especially in climates where tree growth is mainly limited by moisture availability. Juniper trees due to high survivability and high sensitivity to weather conditions are suitable tree species for the reconstruction of past climate. The present study is the first effort to reconstruct local precipitation in the northeast region of Iran from tree-ring data of *Juniperus polycarpus*.

2. Study Area

The tree-ring sampling site is located in the Hezarmasjed heights (Lain region) of Khorasan Shomali Province, northeast of Iran (37 N; 59° 21′ E) at an altitude of 2100 MSL. The climate of the region is cold and semi-arid. Climatic data are prepared from meteorological stations and global data networks (NCEP-NCAR) with resolution of 2.5*2.5 deg. with the common period of 1949-2000. In order to understand regional variation rainfall, the average precipitation of six points from NCEP-NCAR network was considered as regional precipitation data. The chronology of tree ring width is developed from 16 increments of Juniper trees. To remove the biological age trend in ring width of data, a double de-trending procedure was applied to all series by using the ARSTAN program.

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3. Material and Methods

In this study, the influence of temperature, precipitation and PDSI on tree ring width of *Juniperus* trees based on station and global network data was investigated and annual precipitation of northeast of Iran was reconstructed using the Juniper chronology in the period 1845-2000. A simple linear regression was employed to reconstruct precipitation. The reconstructed results were compared with recorded data of four long-term stations and also their correspondence with historical famine reports and the reconstruction results from neighboring countries (east and west) was investigated.

4. Results and Discussion

The results showed that tree ring widths of *Juniper* trees have positive correlation with temperature of pre growth December and negative correlation with temperature of May, significantly. Also precipitation in all months of growth season has positive effect on tree growth and annual rainfall has the highest correlation with tree ring widths. So average rainfall of northeast Iran from six points of global network data was calculated and using *Juniperus* chronology was reconstructed in 1845-2000. Correlation coefficients of calibration and evaluation periods were significant ($p<0.01$). The positive amounts of CE and RE statistics and fewer amount of RMSE than standard deviation of actual data, allowed using the reconstruction model. Reconstruction results showed in the past 150 years, 1917 and 1891 were the driest and wettest years, respectively. Also three severe droughts occurred in the early 1870s, 1915-1919 and early twentieth century. The reconstructed results had meaningful correlation with three old stations (100 years old), i.e. Mashhad, Esfahan and Tehran, respectively. Also historical famine reports had good agreement with the reconstructed severe droughts of this region especially the report of L.F. Esseltyn in 21 December 1917 about the famine condition in Mashhad. Also comparison of the reconstruction results with neighboring countries research is more similar to the findings from the east (west and northwest of China) than the west (Middle East and Turkey).

5. Conclusion

Radial growth of *Juniperus polycarpus* trees in northeastern Iran is strongly dependent on rainfall variability during the growing season, as it is indicated by high positive correlations between tree-ring chronology and precipitation from February of pre growth month to September of growth period. Correlation map of tree-ring width and annual precipitation represent that this chronology has the potential to reconstruct precipitation of North half of Iran, Azerbaijan, Turkmenistan, Uzbekistan, Tajikistan, Kyrgyzstan, south half of Kazakhstan and Northwest of China. Based on the reconstructed results, severe droughts had duration of 4-6 years. Also the reconstruction results of past droughts showed that severe droughts before 2000 were not recorded after establishing meteorological stations and this region is prone to experience more severe droughts in the future. Highly significant correlation of these results with long-term stations showed that our findings can represent historical droughts in northeast and central parts of Iran. The reconstructed precipitation can provide possibilities to link

local droughts in northeastern Iran to other areas of the country and also reconstruction results in east and west of Iran.

Key Words: Tree ring, Global data, *Juniperus polycarpus,* Northeast precipitation, Lain.

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