Hydroclimatology of East Black Sea Mountain Region

Faize Sarış[1*], David M. Hannah[1], Warren J. Eastwood[1] and Hafzullah Aksoy[2]

[1]School of Geography, Earth & Environmental Sciences The University of Birmingham. Edgbaston, Birmingham. B15 2TT.UK (*fxs720@bham.ac.uk)
[2] Department of Civil Engineering Istanbul Technical University Maslak, Istanbul. 34469 Turkey

BACKGROUND:

The East Black Sea region of Turkey exhibits a highly variable hydroclimate character related to its physical complexity. This research aims to understand the hydroclimatology processes that cause this spatiotemporal variability across the East Black Sea region. Such knowledge cab contribute to sustainable management of freshwaters in a changing climate.

This poster summarises the research project (Figure 1) and some preliminary results.

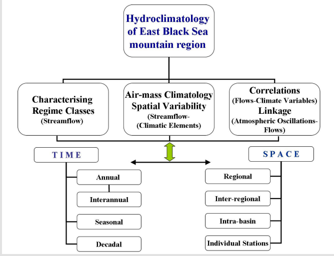

***Figure 1**. The conceptual model of research project.*

SPECIFIC OBJECTIVES:

1) to classify the annual flow regimes based on seasonality and magnitude;
2) to assess the climate characteristics across the study area;
3) to investigate long-term change and trends of hydroclimatological variables;
4) to explain the correlations between streamflow and climatic components;
5) to elucidate the connections between streamflow and atmospheric oscillations; and
6) to illustrate the regionalisation patterns across the study area.

STUDY AREA:

The study area located in northeastern Turkey, specifically the East Black Sea mountains (Figure 2-3). This region is characterized by low annual mean temperature (12ºC; Türkeş *et al.*, 1996). The precipitation regime of the region is controlled mainly by the large-scale pressure systems (Tatlı *et al.* (2004) with maximum precipitation from May to October (Şen & Habib, 2000). The rivers, which rise on the northern part of the mountain range, are relatively short in length and drain into the Black Sea with a parallel drain network. The Çoruh River, which is located in the southern part of the mountain range, is a long river and has a complex drainage system with many tributaries. Maximum flows occur in spring (Atalay and Mortan, 2003).

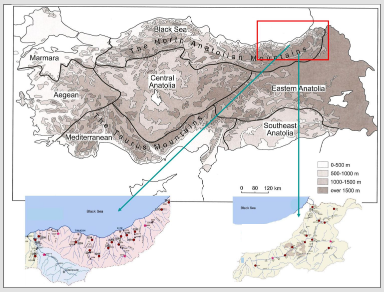

***Figure 2**. General geographic position of the study area and the locations of stations.*

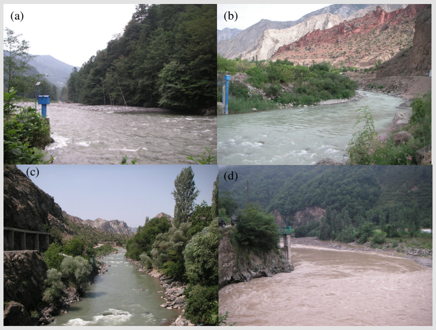

***Figure 3**. Photographs from some rivers and gauging stations (st): (a) Fırtına River Topluca St.; (b) Oltu River – Ishan St.; (c) Çoruh River – Peterek St.; (d) Harşit River – Eymur St.. (Summer term fieldwork which held on between 27 June-05 August 2008).*

DATA:

Required secondary data were obtained from the State Meteorological Service (DMI), Electrical Power Resources Survey and Development Administration (EIEI) and the State Hydraulic Works (DSI) of Turkey.

The selected stations were determined considering the location on basin, observation period and to provide even spatial coverage across the study region. The selected stations have + 25 years of continuous data.

Research	Data	Method
Regimes	streamflow, precipitation, air temperature	Cluster Analysis- Ward's Method Principal Component Analysis
Spatial distribution patterns	precipitation, snowdepth, air temperature, evaporation, radiation duration and intensity, wind speed and direction, cloud cover, relative humidity, flows	Principal Component Analysis Harmonic Analysis
Long-term changes and trends	streamflow, precipitation, snowdepth, air temperature	Kruskal-Wallis Homogeneity Test Mann-Kendall Rank Correlation Spearman Serial Correlation
Time-frequency distribution and fluctuations		Wavelet Analysis
Correlation patterns between river and climate elements	streamflow-precipitation streamflow- temperature streamflow-snowdepth streamflow- evaporation	Canonical Correlation Analysis Linear Regression
Atmospheric linkages (NAO-AO-ENSO)	precipitation, streamflow, air temperature sea surface temperature sea level pressure index	Canonical Correlation Analysis Wavelet Analysis

***Table 1**.Methodological approaches of study and proposed methods.*

METHODS:

The methodological approaches which are addressed to achieve the research objectives can be grouped into three classes:

1- *Regime characteristics*: annual flow regimes classification;

2- *Air-mass climatology and spatial variability of hydroclimatological components*: spatial pattern of climate variables to identify climate characteristics of study area; trend detection of variables to indicate climate change impact;

3- *Hydroclimatological correlations and linkages*: spatial correlation and relationships between river and climate variables.

Table 1 presents the data and proposed methods to meet the specific objectives.

PRELIMINARY RESULTS:

Four different precipitation regimes were identified for East Black Sea region by running Cluster analysis- Ward's method.

Regime A, B and C is specified for the inland part of the region (Figure 4). There are important differences in annual cycle of precipitation regimes. December peak (A) is only observed in Artvin. May peak (B and C) regime is specific for the southern part of the mountains. Regime D implies the characteristics precipitation regime of coastal part of the region with the rainy autumn, and October peak (Figure 4).

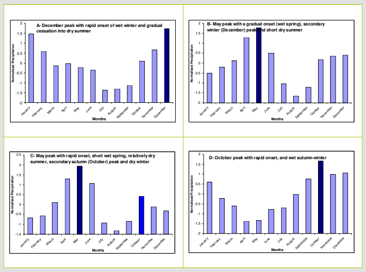

***Figure 4**. Annual precipitation variations of different regimes in East Black Sea region.*

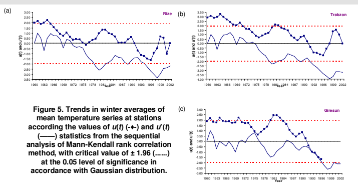

Figure 5. Trends in winter averages of mean temperature series at stations according the values of $u(t)$ (-+-) and $u'(t)$ (——) statistics from the sequential analysis of Mann-Kendall rank correlation method, with critical value of ± 1.96 (......) at the 0.05 level of significance in accordance with Gaussian distribution.

Initial assessments of the long-term changes and trends in mean temperature, total precipitation and mean streamflow series were performed with Mann-Kendall rank correlation test by using the seasonal data of some representative stations on the northeast coast.

Winter temperature indicates a statistically significant, strong decreasing trends (Figure 5).

Seasonal precipitation totals were specified by non-significant decreasing trend in winter, and increasing trend for other seasons (Figure 6).

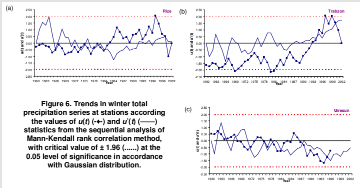

Figure 6. Trends in winter total precipitation series at stations according the values of $u(t)$ (-+-) and $u'(t)$ (——) statistics from the sequential analysis of Mann-Kendall rank correlation method, with critical value of ± 1.96 (......) at the 0.05 level of significance in accordance with Gaussian distribution.

Flows exhibit an increasing pattern in all seasons, except summer. A statistically significant trend was only detected in winter flows of Çamlık River (Figure 7).

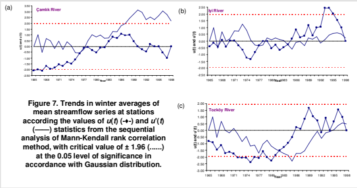

Figure 7. Trends in winter averages of mean streamflow series at stations according the values of $u(t)$ (-+-) and $u'(t)$ (——) statistics from the sequential analysis of Mann-Kendall rank correlation method, with critical value of ± 1.96 (......) at the 0.05 level of significance in accordance with Gaussian distribution.

FUTURE RESEARCH:

1.Assessing the climate characteristics over the study area;
2.Identifying linkages between atmospheric oscillations and streamflows;
3.Classifying flow regimes of the study area;
4.Defining spatial pattern of hydroclimatic variables over study area;
5.Detecting secular changes and trends in time series;

REFERENCES:

Atalay İ., Mortan K. Türkiye Bölgesel Coğrafyası (*Regional Geography of Turkey*). Inkilap Publishing, Ankara(in Turkish).

Şen Z., Habib Z. 2000. Spatial analysis of monthly precipitation in Turkey. *Theoretical and Applied Climatology* **67**: 81-96.

Tatli H, Dalfes N, Menteş S. 2004. A statistical downscaling method for monthly total precipitation over Turkey. *International Journal of Climatology* **24**: 161-188.

Türkeş M. 1996. Spatial and temporal analysis of annual rainfall variations in Turkey. *International Journal of Climatology* **16**: 1057-1076.

ACKNOWLEDGEMENTS:

F. Sarış is supported by the Higher Education Council of Turkey. The fieldwork was sponsored by British Institute Archaeology at Ankara (BIAA).

First MedCLIVAR-ESF Summer School
Climate variability over the Mediterranean area: atmospheric and oceanic components
17-27 September 2008
Hellenic Centre for Marine Research Hydrobiological Station and Aquarium of Rhodes
Island of Rhodes, Greece