Changing Patterns of Extreme Hydrological Events in Morocco

S. BOUGHDADI, M. SAIDI and Y. TRAMBLAY

[1]Georesources, Geoenvironment and Civil Engineering Laboratory, Faculty of Sciences and Technics, BP. 549, Marrakech, Maroc.

[2]HydroSciences Montpellier, University of Montpellier, CNRS, IRD, France.

*boughdadi.sara@gmail.com

Introduction

Morocco is highly vulnerable to extreme hydrological events, such as floods and extended drought periods. Here, we analyzed long-term time series of daily flows from 17 basins of Morocco (fig1). The objective is to evaluate the evolution of floods and low-flows in a regional perspective. For that purpose, statistical models for extreme values allowing non-stationarity are used combination with trend-detection tests.

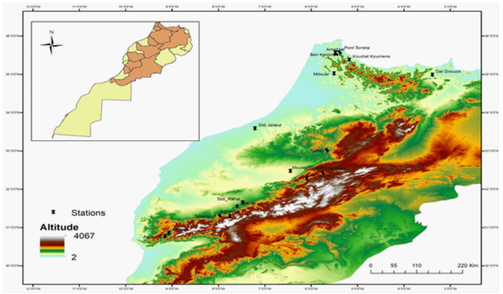

Fig1. Map of selected stations in the study area

Monthly interannual variation of flows:

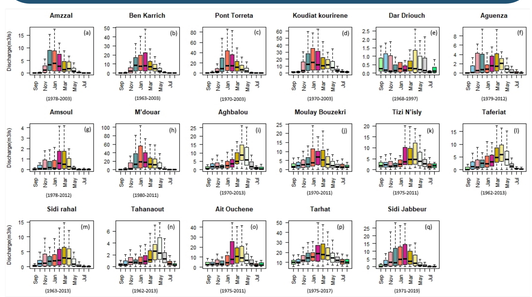

Fig2. Monthly interannual variation of streamflows across all studied stations

The monthly cyclical variations of the flows (fig2) show 2 types of hydrological regime:

-An oceanic hydrological regime characterized by maximum flow values during the winter months (Jan/Feb) at the stations (a,b,c,d,g,h,j,o,q), as well as low values during the summer months.

-A mountainous hydrological regime at the stations (I,k,l,m,n) where the maximum flow values are recorded in March/April explained by the solid precipitations in the high altitudes.

Variation in annual maximum flows

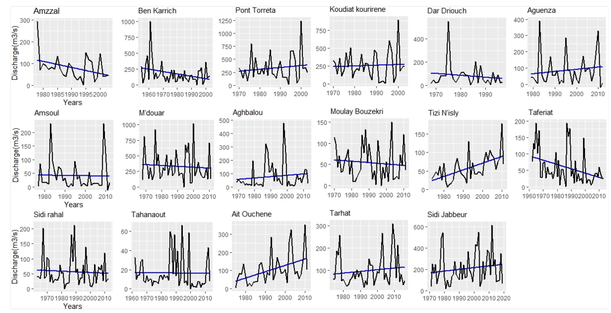

Fig3 : variation and trend of annual maximum streamflows across all studied stations

The Mann-Kendall test :

Tab1 : Results of trend analysis (MK test) for stations with significant trend (level of 5%)

Station	Z	n	p-value	S	varS	tau	Model Interpretation	Sen's slope
Amzzal	-1.542	26	0.0123	-71.00	2058.33	-0.218	H0 rejected	-2.2
Tizi N'isly	3.684	38	0.0002	294	6326	0.419	H0 rejected	1.605
Taferiat	-2.92	52	0.0035	-371	16058.33	-0.28	H0 rejected	-0.943
Ait Ouchene	3.1	37	0.0019	238	5846	0.357	H0 rejected	2.509

Based on the results of the Mann-Kendall test, eleven hydrometric stations indicated a non-significant time trend (level of 5%). Whereas, decreasing trends in maximum annual was detected in Amzzzal and Taferiat stations, while increasing trends in Tizi N'isly and Ait Ouchene stations. To estimate the magnitude of the detected trends, we use Sen's slope.

Variation in seasonal annual maximum flows :

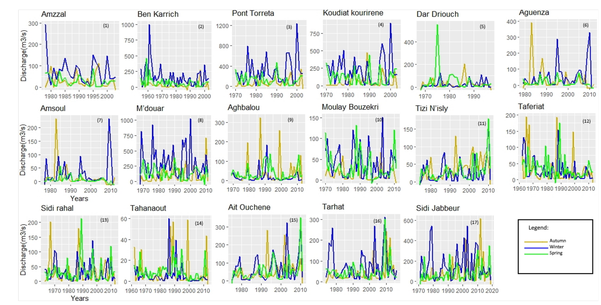

Fig4: variation of seasonal annual maximum streamflows across all studied stations

Increased trend in winter and spring in Pont Torreta, Aguenza, Amsoul, Ait Ouchne and Tarhat, while a decreasing trend was observed in the others stations.

Low flow analysis

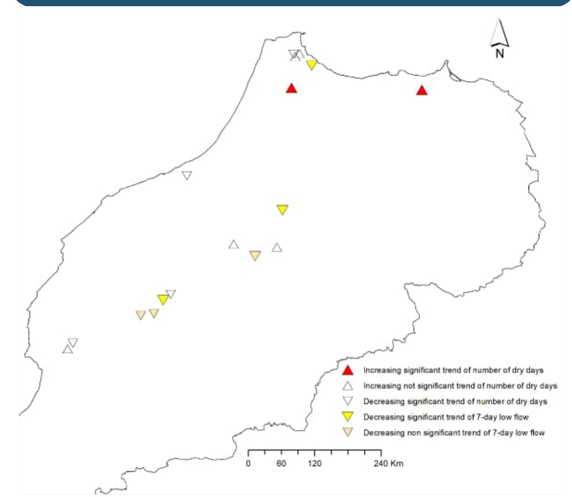

fig5: Analysis and trend of low flow across all studied stations (MK test)

More widespread negative trends for low flows and increased zero-flow days in intermittent rivers, yet a few are significant.

Conclusion

The following conclusions may be drawn from this study :

-Within the 17 stations of Morocco, 2 types of hydrological regime are detected, oceanic hydrological regime with a peak in winter and mountainous hydrological regime where the maximum flow values are recorded in spring explained by the snow melting in the high altitudes.

- Changes in low-flows and river intermittency are more widespread across the basins with contrasted climatic conditions. This decrease in flows may lead to future droughts in these basins.