Rainfall event analysis in the north of Tunisia using the self-organizing map

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9th International Workshop on Climate Informatics
October 02-04, 2019
Hosted by École Normale Supérieure, Paris, France

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0. Introduction

The rainfall pattern in the Mediterranean is characterized by an important spatial and temporal variability.

➔ This variability is mainly due to its position (between 30°N and 45° N) which is directly influenced by subtropical high pressures and low mid-latitude pressures.

In Tunisia, the studies of rainfall patterns are often based on sample analysis with a fixed time step (annual, seasonal or monthly).

Since precipitation is an intermittent phenomenon that appears in the form of events. It is proposed in this study to analyze the rainfall variability using event concept using a daily rainfall time series.

➔ **The main objective of this study is to analyze the rainfall event of a single one season (December -January- February) in the north of Tunisia using the Self Organizing Map SOM over 50 years.**

2. Rainfall event definition

The time series in rain gauge stations is broken down into a separate rain event by a dry period called **Minimum Inter event Time MIT**.

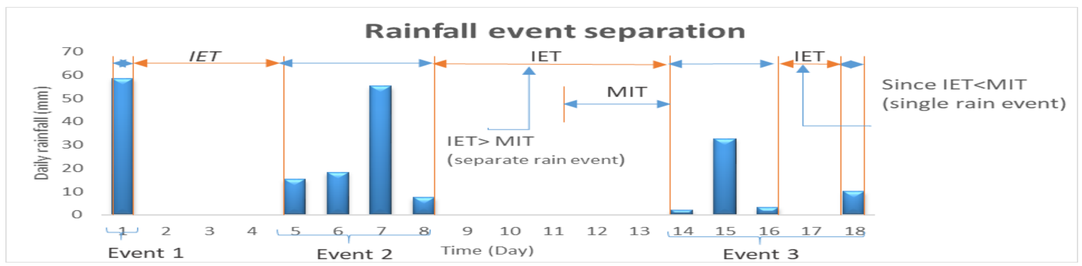

Fig.2: *Rainfall event separation*

Autocorrelation analysis method : The MIT is defined as the lag time where the autocorrelation coefficient of daily rainfall converge to zero.

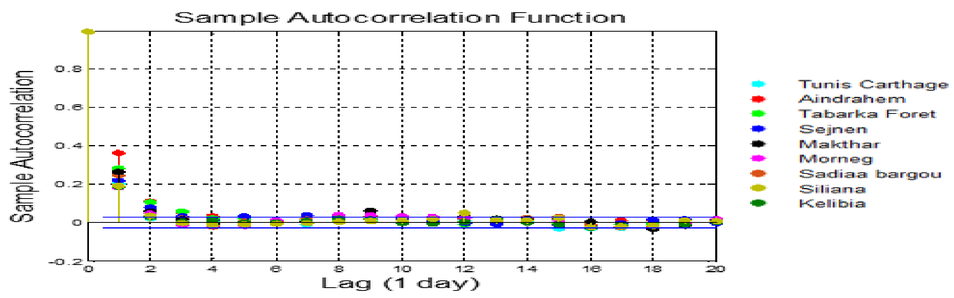

Fig.3*: Autocorrelation Analysis for 9 representative stations*

➔ **The daily rainfall time series are decorrelated after two days (MIT = 2 days)**

4. SOM and HAC results and clusters identification

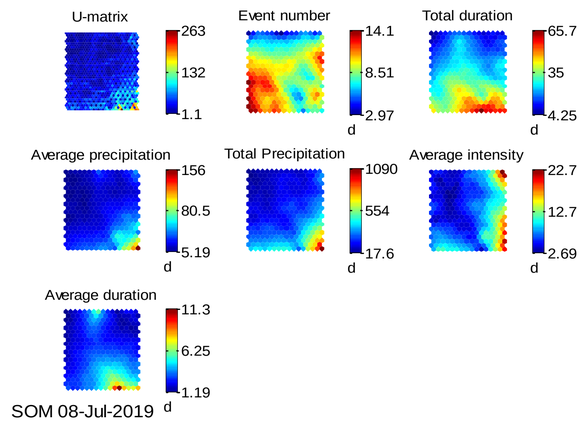

Fig.5*: Variables projection in topological Map*

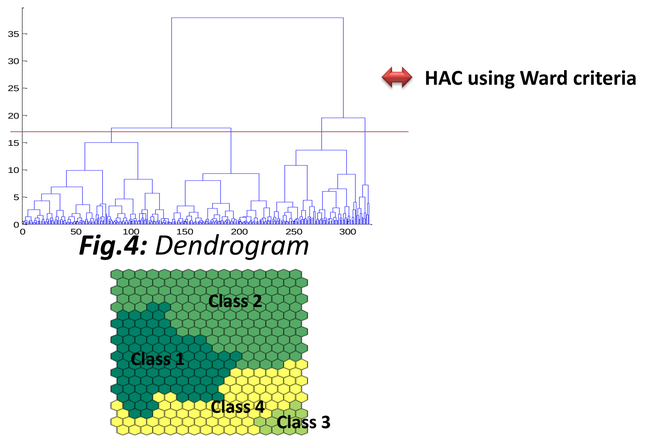

Fig.4: *Dendrogram*

Fig.6*: Clusters delimitation in topological map*

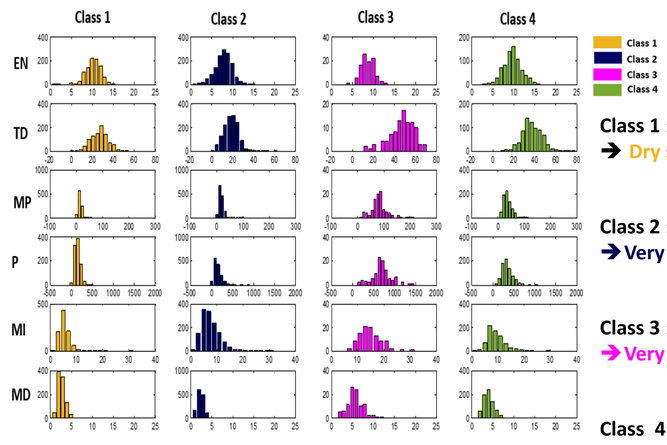

Fig.7: *Histogram of six seasonal rain event variables corresponding to the obtained clusters*

Class 1 : low amount of precipitation, strong event number and total duration.
➔ **Dry seasons with intermittent low rainfall**

Class 2 : weak values of all variables.
➔ **Very dry seasons with infrequent rain event**

Class 3 : Strong and long events, important amount of rainfall, strong intensity.
➔ **Very wet seasons with extreme events**

Class 4 : good amount of precipitation, strong intensity , important event number.
➔ **Wet seasons with intermittency of precipitation in the season**

1. Data

Data: daily rainfall database from 1959 to 2008 distributed over 70 rain gauge stations in Northern of Tunisia.
Source: General Direction of Water Resources of Tunisia

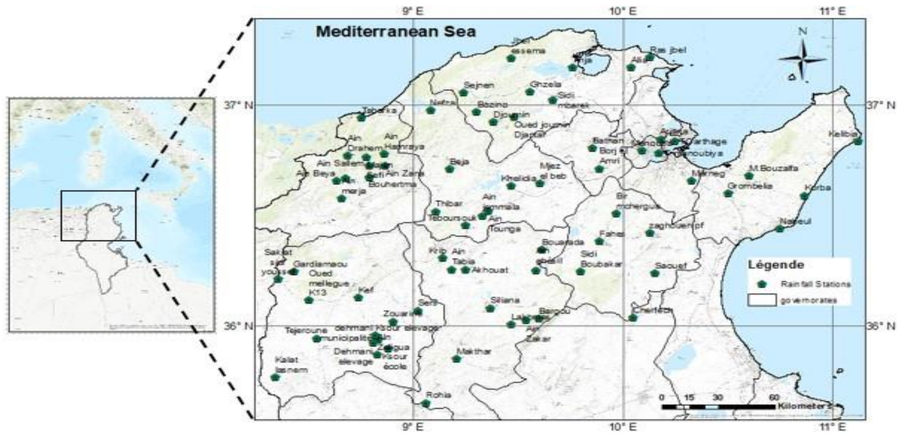

Fig.1*: Rainfall stations distribution*

3. Variables characterizing seasonal rain event DJF and SOM parameters

Tab.1*: Variables are characterizing seasonal rain events (DJF)*

Nom	Symbol	Unit	Formula
Event number	EN	Events	
Total duration	TD	days	$TD = \sum_{i}^{NE} TD_i$
Precipitation	P	mm	
Average precipitation	MP	mm/event	$MP = \frac{P}{EN}$
Average duration	MD	days/event	$MD = \frac{TD}{EN}$
Average intensity	MI	mm/day	$MI = \frac{P}{TD}$

Tab.2*: SOM parameters*

parameters	
Neuron number	320
Map dimension	(20 *16)
Grid	Hexagonal
Neighborhood function	Gauss
Neighborhood radius	$\sigma(t)=\sigma_{initial}\left(\sigma_{final}/\sigma_{initial}\right)^{\frac{t}{T}}$
Rough tuning	
Epoch number T	1000
Initial and Final radius of training	[8 3]
Fine-tuning	
Epoch number T	5000
Initial and Final radius of training	[3 0.5]

The training of Kohonen map is done starting from the matrix of input data constituted of 3500 (50 years * 70 stations) Observations and the six seasonal rain event variables.

5. Conclusions and perspectives

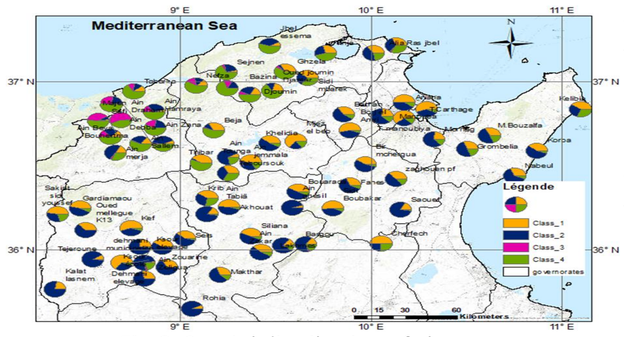

Fig.8*: Spatial distribution of classes*

The wet seasons, classes 3 and 4, are located in the northern part of the region.

➔ **influenced by North West flux coming from the Atlantic during the winter season.**

The dry seasons, classes 1 and, are located in the southern part of the study area.

➔ **warm desert climate**

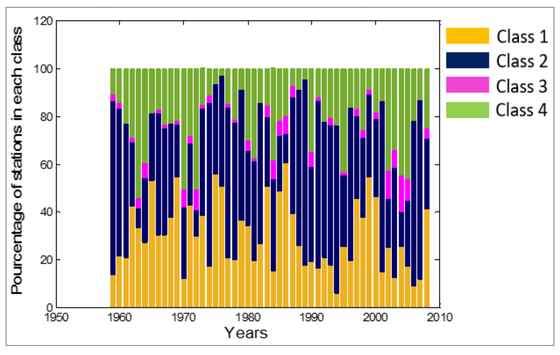

Fig.9*: Temporal distribution of classes*

Exceptional wet seasons: 1963, 1970, 1973, 2002, 2003, 2004 and 2005.

➔ **predominance of class 3 and 4.**

Very dry seasons: 1975, 1976, 1988 and 1989

➔ **predominance of class 1 and 2 for more than 90 % of stations**

The objective of this classification is to study the links between the temporal structure of seasonal precipitations and climate indices that influence the rainfall in the Mediterranean.

6. References

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