Long-term drought risk assessment in north africa case study (Algeria and Egypt)

Zeyneb Tifouri*[1,2], Ahmed Nagy Yassen[1,3] , Toumi Fouzia[2] , Benyehia Mohammad[2]

[1] Department of Bioresources and Rural Systems Engineering, Hankyong National University, Anseong, Republic of Korea

[2] laboratory of ecodevelopment of spaces department of environment, Snv university of djillali liabes sidi bel abbés Algeria

[3] Water Resources and Desert Lands Division, Desert Research Center (DRC), Cairo, Egypt

Zeyneb Tifouri*: lune03@hotmail.fr
Ahmed Nagy Yassen: ahmadnagy1991@gmail.com
Fouzia TOUMI BENALI: toumi_fouzia@yahoo.fr
Mohammed BENYAHIA: benyahia133@yahoo.fr

Abstract

In the context of climate change, the world has witnessed much focus on global drought scenarios in recent years. The Near East and North Africa (NENA) region is mostly dry by nature because of its geographic location and climatic conditions. Drought has had large impacts on economies, society and the environment, and could become even more disruptive given the context of climate change characterized by increasing temperature and more variable and extreme precipitation. Changes in the frequency, duration, and severity of droughts will have enormous impacts on the hydrological cycle, water management and agricultural production. Therefore, one major concern arising from climate change is its potential effects on water resources. The present study represents spatial distribution and temporal trends of drought in North Africa. Standardized Precipitation Index (SPI) and Standardized Precipitation Evapotranspiration Index (SPEI) were used for calculation. Based on the results of temporal analysis, spatial mapping is performed using inverse distance weighted (IDW) method, using 35 years historical climate data from 1983 to 2017 for 56 meteorological stations (22 stations covered Algeria and 34 stations covered Egypt), the results showed that SPI showed lower impact than SPEI. Egypt affected by Long-term drought risk more than Algeria. Algeria extremely drought showed in 1983 based on SPI. However, Egypt showed it in 2010 and 2016 based on SPEI. Algeria showed highest impact in 1983 and 2002 based on SPI and SPEI, respectively. 2009-2010 represented the highest impact based on SPI and 1999, 2003-2004 and from 2008 to 2017 the highest impact except 2012 based on SPEI in Egypt. The maps prepared using the spatiotemporal analysis will be useful to policymakers and local administrators to take effective measures for drought relief and to plan water resources in the drought-hit regions.

1. Introduction

Algeria has limited natural resources, erratic and unevenly distributed. With the exception of fossil water in the Sahara, natural water resources are mainly located in the north of the country. for that, groundwater resources are the most important. Egypt does not have a dedicated organization for drought nor a drought management plan [1].

Today, one of the most significant issues facing the world is climate change because it is predicted to alter climate patterns and increase the frequency of extreme weather events [2][3][4].

The changes in the spatial distribution and temporal trends of drought on regional and local scales aids detecting for understanding the impacts of climate change and its subsequent effect on hydrology and agriculture.

The objectives of this research were: (1) analyze and quantify changes in the spatial distribution and temporal trends of drought, (2) detect sharp changes in each of the different analysis periods and showing the spatial distribution of these changes, (3) quantify the different regional responses. Daily data from 34 weather stations were used to analyze the spatial and temporal variations in Egypt over a period of 35 years (1983-2017).

Materials and Methods

1.1. Study area

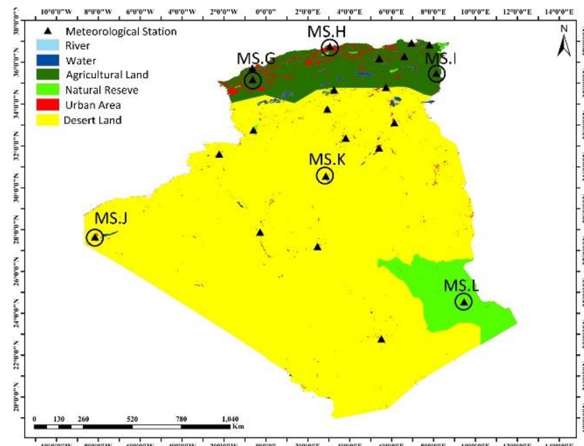

Fig. 1. Spatial distribution of the weather stations and land use map in Algeria. The six stations identified with a letter are used as examples.

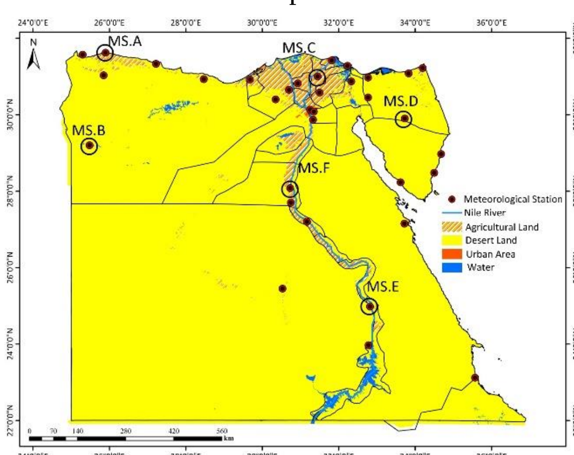

Fig. 2. Spatial distribution of the weather stations and land use map in Egypt. The six stations identified with a letter are used as examples.

2.2. Meteorological data

Meteorological data from 34 weather stations were obtained Goddard's Global Modeling and Assimilation Office (GMAO). The updated meteorological data are derived from the GMAO Modern Era Retrospective-Analysis for Research and Applications (MERRA-2) assimilation model products and GMAO Forward Processing – Instrument Teams (FP-IT) GEOS 5.12.4 near-real time products., NASA Prediction of Worldwide Energy Resources (Power) website. The historical data periods covered 35 years, from 1983-2017. Daily meteorological variables (daily average temperature in degrees Celsius and precipitation in mm) were used to calculate the drought indices.

2.3. Calculating the SPI and SPEI indices

In this study, for the quantitative analysis of drought, two drought indices were selected among the many drought indices currently produced: the SPI [5] and the SPEI [6]. These indices are perceived to be more broadly useful and easy to implement, and are typically calculated from time series measurements of precipitation and temperature [7][8].

Table 1 Classification of drought indices of SPI and SPEI.

SPI and SPEI value	Class
Greater than 2.00	Extremely wet
1.50 to 1.99	Severely wet
1.00 to 1.49	Moderately wet
0.50 to 0.99	Slightly wet
-0.49 to 0.49	Near normal
-0.99 to -0.50	Mild dry
-1.49 to -1.00	Moderately dry
-1.99 to -1.50	Severely dry
Less than -2.00	Extremely dry

2.4. Spatial interpolation

To visualize and interpolate the spatial variability of the drought indices of the weather stations, we used inverse distance weighting (IDW) by grid cell (500 m × 500 m cell size) using three neighbor points, and a distance powered to five. The selection was made after a trial and error interaction method which attempted to replicate a manually drawn isolate. Our results were spatially generated and produced annual and seasonly maps.

In this study, The threshold level of drought can be categorized based on different arbitrary threshold values. The threshold level was obtained by a drought Standardized such as mild drought for each drought indicator to discern between a drought and a non-drought, such as a value −1 for the SPI or SPEI.

2. Results and Discussion

2.1. Temporal trends of drought risk

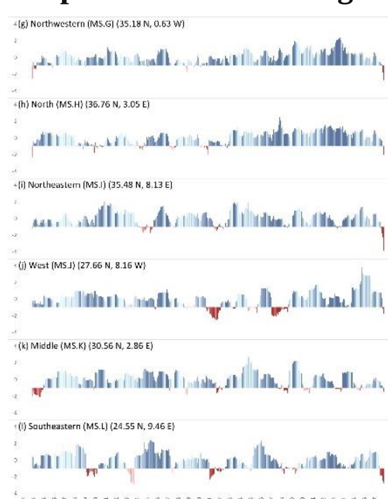

Fig. 3. Time series of the SPI-12 for Algeria using historical data (1983-2017) for six meteorological stations.

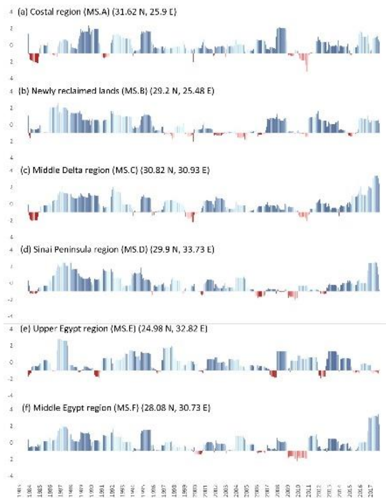

Fig. 4. Time series of the SPI-12 for Egypt using historical data (1983-2017) for six meteorological stations.

3.2. Annual drought distribution

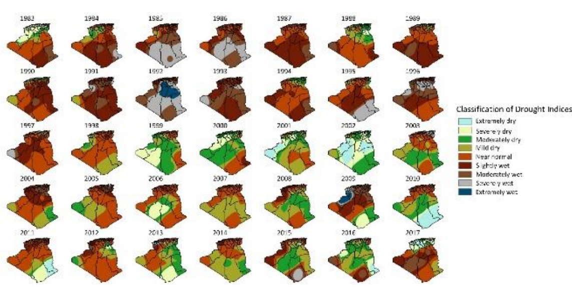

Fig. 5. Annual spatial distribution of SPEI-12 in Algeria using historical data (1983-2017) for 22 meteorological stations.

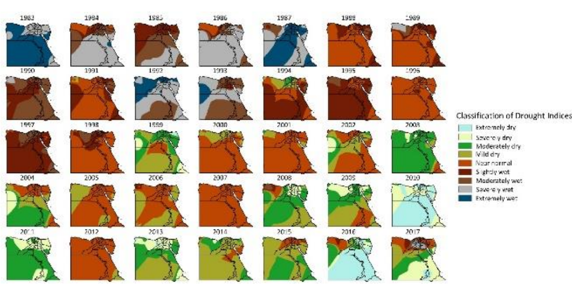

Fig. 6. Annual spatial distribution of SPEI-12 in Egypt using historical data (1983-2017) for 34 meteorological stations.

3.3. Monthly distribution of drought year

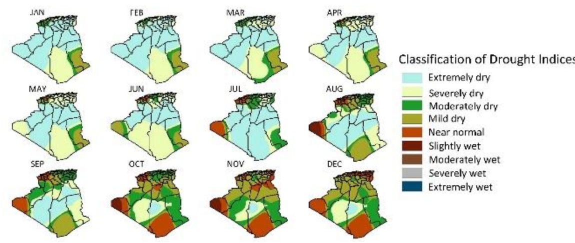

Fig. 7. Monthly spatial distribution for drought year in Algeria (2002) of SPEI-12 for 22 meteorological stations.

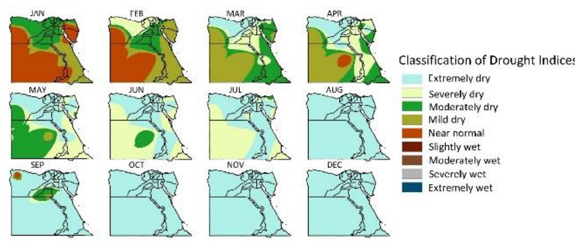

Fig. 8. Monthly spatial distribution for in drought year in Egypt (2010) of SPEI-12 for 34 meteorological stations.

3. Conclusions

This study is significant, as it provides baseline information about long-term trends in spatial and temporal variations related to climate variability and change.

Acknowledgment

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