

Climate and desertification: indicators for an assessment methodology

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ABSTRACT

This work aims to define a methodology that, on the basis of commonly available surface climate records, assesses indicators of the increase or decrease of the extension of territories vulnerable to desertification and land degradation. The definition and quantification of environmental policy relevant indicators aims to improve the understanding and the decision making processes in drylands. The results of this study show that since 1931 changes of climate involved 90% of the territory of the Sicilian region, with stronger intensity in the internal areas of Enna, Caltanissetta and Palermo provinces. The present extension of territories vulnerable to desertification increased by 46% in respect to 1931-1960. In Sicily, the increase of vulnerability to desertification is higher in the internal zones. Changes of the aridity index, in terms of extension of areas and of the index itself, are indicators that should be considered for national reporting to UNCCD.

Keywords: climate, desertification indicators, GIS modeling

INTRODUCTION

The identification of indicators of desertification is an issue of debate within the policy and scientific community since the early stages of the United Nation Convention to Combat Desertification (UNCCD). The Aridity Index (AI), adopted by the UNCCD to identify the areas where degradation processes may cause desertification, is one of the indicators that can be properly and reliably measured to identify the vulnerable areas. The definition of desertification implies the concept of time evolution of natural and anthropogenic pressures that may drive degradation process in dry lands. Little attention has been devoted, until now, to the elaboration of indicators addressing the time dependent dimension of the desertification. As consequence of the insufficient availability of data and the short time length of observations more attention has been devoted to identify status indicators. The extension of drylands for the reference period 1961-1990 in Italy has been assessed at national and regional scale and this study aims to study over the pilot territory of the Sicilian region a methodology for the assessment of the time evolution of the aridity index.

DATA AND METHODS

The hydro climatic service of Sicily¹ collects and publishes since 1921 the "Annali Idrologici" that have been recently made available on the internet. The historical database of daily temperatures and precipitation is made of 150 thermometric station and 332 pluviometric

¹ Agenzia Regionale per i Rifiuti e per le Acque, <http://www.osservatorioacque.it/>

stations randomly distributed over the regional territory. The present study utilized a subset of 47 stations where temperature and precipitation records are recorded at the same time. The UNEP Aridity Index (AI) (Middleton, N. and Thomas D., 1997) is computed, for each monitoring station, on a monthly basis as the ratio of annual precipitation to potential evapotranspiration:

$$AI = P / ETP \quad (1)$$

The monthly values were then averaged to provide mean values of the AI for the time periods 1931-1960, 1941-1970, 1951-1980, 1961-1990, 1971-2000.

The determination of the potential evapotranspiration used the empirical relationship between measured ETP and monthly mean temperature and the average number of daylight per month (Thornthwaite 1948. The AI, done using the kriging module of the ArcMAP (ESRI-ArcGIS 9.x), are used to quantify the extension of three classes (arid, semiarid and dry sub humid) and their changes in the 1931-2000 time period.

RESULTS AND DISCUSSION

From 1931-1960 to 1971-2000, semiarid zones increased by 4.478 km² (17%), from 5,2% to 22,8% of the total Sicilian territory. In the same period dry sub-humid zones increased by 2.144 km² (+8%), from 38,5 to 46,9) and the humid zones , consequently decreased by 6.616 km² (-26%) from 56% to 30%,. The changes of climate in the time period considered, increased the extension of dry lands in Sicily by 38%. In the period 1971-2000, 69% (17.769 km²) of the Sicilian territory is below the AI threshold of 0,65 and can therefore be considered vulnerable to desertification.

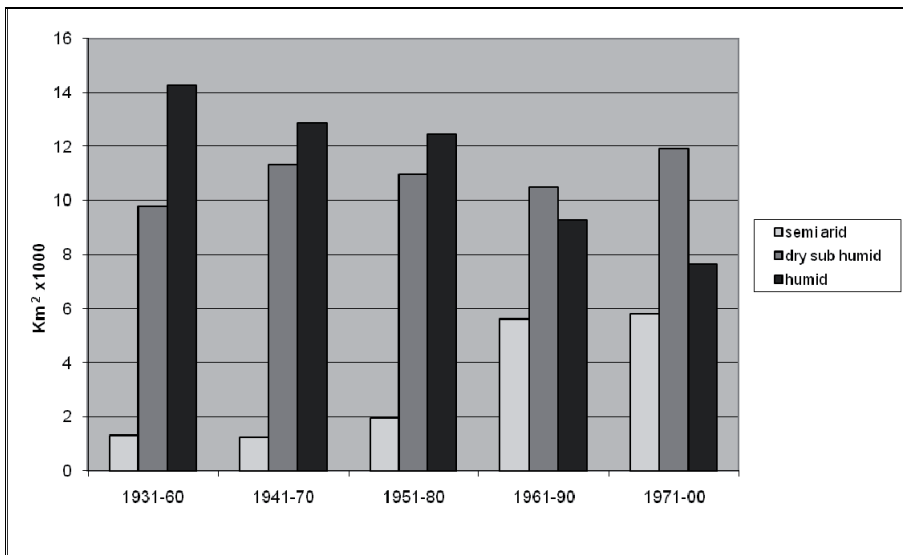


Figure 1. Extension of climatic areas according to the Aridity Index.

The progressive drying affected the whole regional territory reaching values of 30% in the internal territories and ranging between 0-20% in the humid areas (Figure 2). The time evolution of the AI affected both humid and drylands with the only exception of the coastal areas where the changes have been below the 10% threshold.

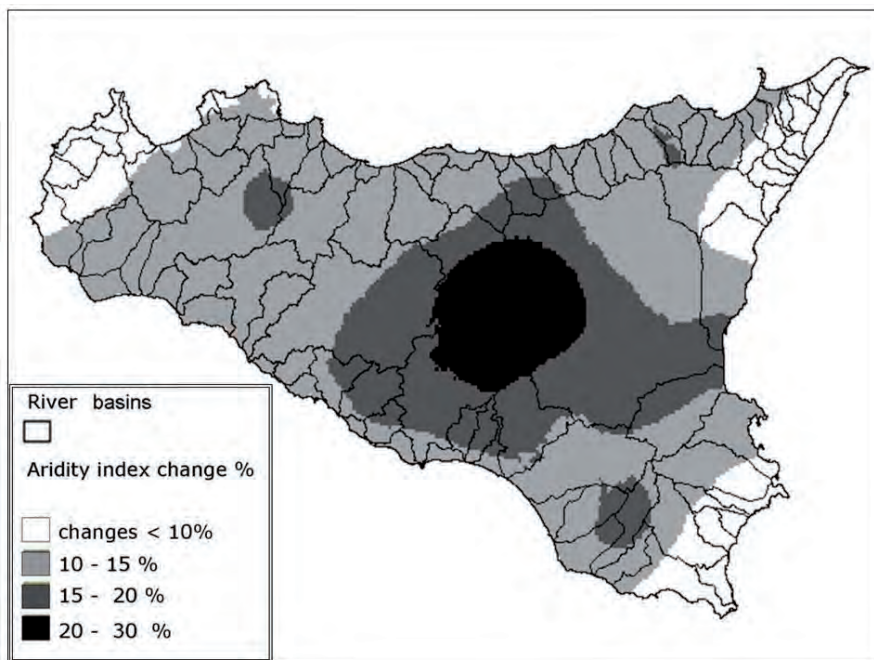


Figure 2, Aridity index % change between 1971-2000 and 1931-1960

The surface of territories in different aridity classes is a first desertification relevant indicator from which a second indicator of the increase/decrease of dry lands areas can be derived. The impacts of the increase of aridity in the time period under investigation (1931-2000) are difficult to assess in quantitative terms because also non environmental changes took place at the same time. The aridity increase certainly modified the quality and quantity of the natural resources on which many productive activities depend. In the drylands, drought is the mechanisms that may have serious short and medium term economic and environmental impacts. Unfortunately the occurrence of drought is intrinsically unpredictable but more aridity surely increases the vulnerability to drought and desertification. The indicators and the methodology proposed address the key question of the present extension of drylands and the extension of the new territories that becoming dry lands have become more vulnerable to desertification.

CONCLUSIONS

After more than 10 years of activity of the UNCCD, desertification remains a marginal issue in national policies of Mediterranean European countries. The vulnerable drylands should become a priority for policies and actions to combat desertification and the identification of proper indicators for the national environmental reporting to UNCCD is a pre requisite for this purpose.

The results for the Sicilian region should be a warning signal for Italian policy makers. More aridity and new vulnerable territories should deserve specific attention to prevent degradation and to develop new conservation and development strategies.

AKNOWLEDGEMENTS

This study has been supported by the Italian National Committee to Combat Desertification of the Ministry of the Environment for the Protection of the Territory and Sea.

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