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Trends in the daily precipitation categories of Calabria (southern Italy)

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Abstract

This study presents an analysis of daily rainfall categories over a region of southern Italy using a set of daily homogenous precipitation series for the period 1916–2006. Six daily rainfall categories have been considered: Light, 0–4 mm/day; Light-Moderate, 4–16 mm/day; Moderate-Heavy, 16–32 mm/day; Heavy, 32–64 mm/day; Heavy-Torrential, 64–128 mm/day; Torrential, 128-up mm/day. Results showed that Light-Moderate, Moderate-Heavy and Heavy rainfall are the main contributors to the total annual rainfall. Moreover, a trend analysis through the Mann-Kendall test showed a decreasing trend of the higher categories and an increasing trend of the weaker categories.

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Keywords: Daily Rainfall; Rainfall Categories; Trend; Mann-Kendall; Calabria

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1. Introduction

Due to the considerable environmental impacts of climate change, research in the past century has focused on precipitation trend analysis. In particular, change in extreme events can impact on natural environments, and human activities, as well as human health and safety. Extreme events represent a key aspect of climatic analyses and it is now widely accepted that changes in total precipitation can be associated with changes in the frequency of precipitation events, the amount of precipitation per event, or a combination of both [1]. In order to improve the understanding of the precipitation behavior of a region, daily precipitation series must be analyzed [2]. Numerous studies on precipitation variability have been undertaken all over the world using various statistical procedures and have evidenced a positive trend in daily precipitation intensity and a tendency toward higher frequencies of heavy and extreme rainfall in USA [3,4], in Australia [5], in New Zealand [6,7], in South Africa [8], and in the UK [9]. [10] conducted a coherent study of the full-scale of daily rainfall categories over the Mediterranean in order to assess the paradoxical behavior characterized by an increase in extreme rainfall in spite of a decrease in the totals. Unfortunately, there are few studies based on daily rainfall series in Italy, probably due to the lack of high-quality long daily rainfall series. In northern Italy, the results of an analysis on six daily rainfall series [2] showed a significant decreasing trend in the annual number of wet days and an increasing tendency in the mean and maximum precipitation heights related to one day, with a generalized increasing tendency for the number of dry days following and followed by wet days. Similar results have been obtained by a stochastic approach analysis of some rain gauges in Calabria, southern Italy [11,12]. An increase in heavy precipitation has been detected simultaneously with a decreasing trend in total precipitation in a wider area of northern Italy [13].

In this study, the daily rainfall series recorded in the Calabria region (southern Italy) have been analysed by classifying the events into different rainfall categories, following the classification proposed by [10]. In particular, for each category, the presence of any significant trend has been detected using the non-parametric Mann–Kendall test. The aim of this study is to analyze if the decrease in the rainfall totals, evidenced in previous studies [14-18], is also confirmed for the extreme rainfall.

2. Study area and data

Calabria is in the farthest south of the Italian peninsula, with an area of 15080 km^2 and a perimeter of about 818 km (Fig. 1). Because of its geographic position and its mountainous nature, Calabria presents high climatic contrasts. In fact, Calabria has a typical summer subtropical climate, also known as Mediterranean climate. Particularly, the Ionian side of Calabria is influenced by warm currents coming from Africa, which cause high temperatures with short and heavy precipitation. By contrast, the Tyrrhenian side is influenced by western air currents and presents milder temperatures and many orographic precipitation. In the inland zones, colder winters with snow and fresher summers with some precipitation are observed [19].

In this paper a daily homogeneous and complete database, with 129 rainfall series for the 1916–2006 period (Fig. 1), has been used [20].

3. Methodology

As suggested by [10] six daily rainfall categories have been considered: Light (A) 0–4 mm/day, Light-Moderate (B) 4–16 mm/day; Moderate-Heavy (C1) 16–32 mm/day; Heavy (C2) 32–64 mm/day; Heavy-Torrential (D1) 64–128 mm/day; and Torrential (D2) 128-up mm/day. However, due to the characteristics of rainfall intensity in Calabria, in some applications of this study, another class (D1+D2: 64-up mm/day) has been used.

First, for each rain gauge and for each year, the percentage of the annual amount of each daily rainfall category, and the annual number of daily rainfall events falling within each class, have been computed. Then, each of these annual series was analyzed for trends, and statistical significance assessed through the well-known Mann-Kendall non-parametric test [21,22].