Chapter 5
Analysis Methods for Hydrological Drought

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ABSTRACT

According to the World Meteorological Organization, the total economic impact of drought in Europe in the past 30 years was close to €100 billion. A recent publication by the European Environment Agency states that meteorological and hydrological droughts have become more frequent and severe in most of Europe, "being the highest in southern Europe." Significant changes in worldwide hydrography have occurred recently, as evidenced by the drying up of some lakes and a decrease in river flows. In a handbook published by WMO and Global Water Partnership, a set of indices and indicators were proposed to investigate different drought types. The data needed to calculate these indices refers to different hydrometeorological variables, and their analysis must be carried out. The indices based on remote sensing data could offer a viable alternative to improve the observation. Based on different applications realized by the authors, we propose a review of the methods used to identify hydrological drought. It suggests a methodology appropriate to the Dobrogea region in southeastern Romania.

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INTRODUCTION

World Meteorological Organization reported (World Meteorological Organization -WMO, 2021) that between 1970 and 2019, in Europe, out of all natural disasters, 3% were droughts and 5% were heat-waves. The five hazards that led to the most economic losses were river floods (44%), windstorms (36%), and droughts (10%). The dangers that caused the most significant loss of human life in the top ten natural catastrophes are (World Meteorological Organization -WMO, 2021), in descending order, droughts (650,000 deaths), storms (577,232 deaths), floods (58,700 deaths), and excessive temperatures (55,736). A recent publication offered by the European Environment Agency (European Environment Agency, 2021) states that "the frequency and severity of meteorological and hydrological droughts have increased in most parts of Europe, being the highest in southern Europe." A recent publication by the World Bank experts (World Bank, 2018) referring to drought shows that droughts already affect 48% of Romania's surface, especially the territories located in the southern part of the country (Romanian Plain and Getic Plateau), southeast (Dobrogea), and east (Moldova). Over the last 60 years, drought has caused substantial losses in agriculture, but the most severe drought was the one recorded in 2007, followed by the one in 2011–2012 when there was a total of 8 months of drought. The drying of natural lakes represents one of the main effects of prolonged droughts and anthropogenic influence; possibly the most well-known example is the Aral Sea, classified as a closed sea. The examples could continue with Lake Urmia, an endorheic lake in Iran that was classified as the sixth largest Salt Lake in the world and which, starting from the end of 2007, has lost 10% of its surface area of 5200 km^2. In 2021, the surface area has been reduced by half. In recent years, there have been numerous ecological catastrophes of this type in Romania. In October 2020, Iezer Lake in Călărași County, with an area of approximately 400 hectares, completely dried up. The same event occurred in August 2020 at Lake Nuntaşi-Tuzla (Figure 1(a)) in the Dobrogea region. Lake Amara (Figure 1(b)), located in Buzau County, with an area of over 800 hectares, completely dried up in June 2022.

Figure 1. Photos from (a) Nuntasi Lake and (b) Amara Lake
photo a) National Water Agency; photo b) author

In the context of climate change, the increasing frequency of drought occurrence, to support the efforts of all stakeholders involved in drought management, WMO and GWP (Global Water Partnership) published a handbook (World Meteorological Organization -WMO & Global Water Partnership - GWP,