



Spatial distribution, hydrological status of Karst Lakes in Türkiye

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Abstract

Türkiye hosts a wide range of karst lakes developed within extensive soluble rock terrains; however, their spatial distribution and current hydrological conditions have not yet been comprehensively quantified at the national scale. This study provides a nationwide assessment of the spatial distribution, morphometric characteristics, and current hydrological status of karst lakes in Türkiye utilising Geographic Information Systems (GIS) and remote sensing (RS) techniques. Based on multi-temporal satellite imagery and topographic maps, 688 karst lakes were identified and classified into doline (69%), glaciokarstic (24%), and polje (7%) lake types. Mean surface areas were 0.021 km² for doline lakes, 0.017 km² for glaciokarstic lakes, and 29 km² for polje lakes, and the lake elevations span a broad altitudinal range from 23 to 3400 m a.s.l., with mean elevations of 1345 m for polje lakes, 1657 m for doline lakes, and 2870 m for glaciokarstic lakes. The 2020–2023 assessment indicates that 41% of the karst lakes have completely dried, with desiccation reaching 54% for polje lakes. Wet lakes generally occur under cooler, wetter climatic conditions than dry lakes, suggesting a strong hydroclimatic control on lake persistence, particularly in doline and glaciokarstic systems. In contrast, polje-lake desiccation is more strongly associated with long-term anthropogenic impacts, including drainage and water abstraction, than with climatic gradients alone. These findings document an accelerated loss of karst lake ecosystems in Türkiye and underline the need for integrated, climate-responsive strategies for groundwater and wetland management.

Keywords Karst geomorphology · Karst lake classification · GIS · Satellite imagery · Türkiye

Introduction

Lakes provide essential ecosystem services, including freshwater supply, biodiversity support, climate regulation, and recreation (Baker & Newman 2013; Bonacci et al. 2009; Ravbar et al. 2021; Sterner et al. 2020; Tockner 2021; Worthington & Lowe-McConnell 1994). However, many lakes are increasingly threatened by pollution, eutrophication, climate change, excessive water abstraction, and other human pressures (Dudgeon et al. 2006; O'Reilly et al. 2015; Schindler 2006; Smith & Schindler 2009) and nearly one-third of the world's lakes are affected by significant human-induced stress (Mammides 2020; Modaresi Rad et al. 2022;

Vavassori et al. 2022). These pressures undermine the ecological integrity and functioning, with consequences for biodiversity and human wellbeing (Carpenter et al. 1998).

Karst lakes are especially sensitive to these pressures because they are strongly connected to groundwater systems and can respond rapidly to both hydroclimatic variability and anthropogenic disturbance (Goldscheider 2019; Radulović, 2018; Vrsalović et al. 2022). They also provide unique habitats that support high biodiversity, including rare and endemic species (Lopez et al. 2009; Morant et al. 2024; Siegel et al. 2023), making them priority targets for integrated management and protection (Goldscheider 2019).

Türkiye is rich in karst landscapes due to the widespread distribution of soluble rocks, which cover approximately 40% of the country's surface area (Nazik et al. 2019) (Fig. 1). Although numerous studies have examined karst lakes in Türkiye (Akpınar & Akbulut 2007; Aşıkkutlu et al. 2014; Biricik & Bozyiğit 1996; Çayır & Küçükönder 2018; Çelik & Gülersoy 2013; Duman & Çiçek 2012; Ekmekçi, 1998; Güldalı, 1976; Kahraman & Öztürk 2025; Kurt 2001; Özdemir & Bahadır, 2009; Öztürk, Poyraz, et al. 2025b, a;

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