End of introduction

Over the last decades, research on ancient and pluvial lakes has demonstrated their global significance for reconstructing past climate and human settlement histories. In North America, classic cases such as Lake Bonneville and Lake Lahontan in the Great Basin have been extensively studied through geomorphological mapping and geochronology, showing how moisture fluctuations tied to glacial–interglacial cycles created large, interconnected basins (Chen and Maloof, 2017; Reheis et al., 2014).

In Africa, the most prominent example is Mega-Lake Chad, which during the Holocene African Humid Period expanded to an area of about 360,000 km^2 and depths exceeding 150 m. Its reconstructed shorelines and sediment cores not only constrain regional hydroclimate variability but also illustrate strong feedbacks between lake extent and the strength of the West African monsoon (Armitage et al., 2015; Ghienne et al., 2002).

In South America, studies of the Andean Altiplano have resolved the Tauca (ca. 16–12 ka) and Minchin (>30 ka) lake phases using a combination of U–Th dating of tufas, sediment cores, and geomorphic analyses (Fornari et al., 2001; Placzek et al., 2006). These examples highlight how different methodological toolkits ranging from digital elevation models to multiproxy paleolimnology converge to build precise histories of past hydroclimate.

Within this global framework, Iranian basins occupy a critical position at the climatic intersection of the Mediterranean Westerlies and the Indian Summer Monsoon. Regional studies, including sediment cores from Lake Hamoun (Hamzeh et al., 2016), multiproxy reconstructions from the Jazmurian playa (Vaezi et al., 2019), and nationwide paleohydrological modeling (Shoaee et al., 2023), provide important evidence that Iranian closed basins have repeatedly captured regional moisture anomalies comparable to those in the Great Basin, Sahara–Sahel, and Altiplano.

3.4 Methodological transferability and precedent

The integrated approach employed in this study combining digital elevation models (DEMs) and satellite imagery for paleoshoreline mapping with historical textual evidence and geomorphic observations follows established practices in global paleolake research. For instance, high-resolution DEM and LiDAR analyses have been widely applied to reconstruct strandlines and tectonic deformation in the Lake Bonneville system of the western United States (Baran and Cardenas, 2025; Chen and Maloof, 2017). Multiproxy sediment cores coupled with U–Th chronology have resolved lake phases such as Tauca and Minchin on the Andean Altiplano (Fornari et al., 2001; Placzek et al., 2006). Moreover, geo-historical syntheses combining chronicles with geological evidence have successfully reconstructed Caspian Sea level fluctuations during the last millennium (Naderi Beni et al., 2013). These precedents demonstrate both the validity of our chosen methods and their portability to other closed-basin systems across Southwest Asia and beyond.

4.5. Contextualizing PAMELA within global paleolake research

Our reconstruction of the Paleo Mega Lake of Rey (PAMELA) not only provides new insights into the hydrological and cultural history of central Iran but also contributes to broader debates on the role of pluvial basins in shaping human–environment interactions. Similar to the Great Basin lakes of North America (Reheis et al., 2014), Mega-Lake Chad in Africa (Armitage et al., 2015; Li et al., 2023), and the Altiplano lakes of South America (Placzek et al., 2006), PAMELA illustrates how closed-basin hydrosystems can expand dramatically in response to climatic oscillations and then contract, leaving behind enduring geomorphic and cultural legacies. By situating Iranian evidence within this comparative framework, the study highlights both the methodological portability of our approach and the importance of Iran as a climatic crossroads between the Mediterranean Westerlies and the Indian Summer Monsoon.

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