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The Water Level Fall of Lake Megali Prespa (N Greece): an Indicator of Regional Water Stress Driven by Climate Change and Amplified by Water Extraction?

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The Mediterranean stands out globally due to its sensitivity to (future) climate change, with future projections predicting an increase in excessive drought events and declining rainfall. Regional freshwater ecosystems are particularly threatened: precipitation decreases, while extreme droughts increase and human impacts intensify (e.g. water extraction, drainage, pollution and dam-building). Many Mediterranean lake-wetland systems have shrunk or disappeared over the past two decades. Protecting the remaining systems is extremely important for supporting global biodiversity and for ensuring sustainable water availability. This protection should be based on a clear understanding of lake-wetland hydrological responses to natural and human-induced changes, which is currently lacking in many parts of the Mediterranean.

The interconnected Prespa-Ohrid Lake system is a global hotspot of biodiversity and endemism. The unprecedented fall in water level (∼8m) of Lake Megali Prespa threatens this system, but causes remain debated. Modelling suggests that the S Balkan will experience rainfall and runoff decreases of ∼30% by 2050. However, projections revealing the potential impact of these changes on future lake level are unavailable as lake regime is not understood. A further drop in lake level may have serious consequences. The Prespa Lakes contribute ∼25% of the total inflow into Lake Ohrid through underground karst channels; falling lake levels decrease this discharge. Lake Ohrid, in turn, feeds the Drim River. This entire catchment may therefore be affected by falling lake levels; its water resources are of great importance for Greece, Albania, FYROM and Montenegro (e.g. tourism, agriculture, hydro-energy, urban & industrial use).

This new work proves that annual water level fluctuations of Lake Megali Prespa are predominantly related to precipitation during the first 7 months (Oct-Apr) of the hydrological year (Oct-Sep). Lake level is very sensitive to regional and Mediterranean wet-dry events during this period. There are robust indications for a link between lake level and the North Atlantic Oscillation, which is known to strongly influence Mediterranean winter precipitation. Hydro-climatic records show a complicated picture, but tentatively support the conclusion that the unprecedented lake level fall is principally related to climate change. The available fluvial discharge record and most existing snowfall records show statistically significant decreases in annual averages. Annual rainfall only shows a statistically significant decrease of the 25th percentile; 7-month rainfall (Oct-Apr) additionally shows a statistically significant but non-robust decrease of the mean.

The modest amount of water extraction (annually: ∼14*103m3, ∼0.004% of total lake volume) exerts a progressive and significant impact on lake level over the longer term, accounting for ∼25% of the observed fall. Lake level lowering ends when lake-surface area shrinkage has led to a decrease in lake-surface evaporation that is equivalent to the amount of water extracted. The adjustment of lake level to stable extraction rates requires two to three decades. This work aims to steer adaptation and mitigation strategies by informing on lake response under different climate change and extraction scenarios. Lake protection is a cost effective solution for supporting global biodiversity and for providing sustainable water resources.