1.1.1.1.1.1 Assessment of minimum ecological water requirements in Lake Pamvotida – Greece, using an adaptation of the IFIM method

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Introduction

Human interventions and climate change in the Greek territory, so far accompanied by higher temperatures and reduced precipitations, are already exerting pressure on the water level (WL) of the lakes (Papadimos et al., 2022). The severity of the impact of the above pressures on lake ecosystems depends on the magnitude of their WL changes, the duration, the timing of their occurrence during the year and the organisms that occur in the ecosystem (Leira and Cantonati 2008). Therefore, the identification of the ecological water level requirements (EWLR) of the lakes should be considered both necessary and imperative for the conservation and protection of their ecosystems and the services they provide.

A variety of methodological approaches have been used to estimate EWLR in lakes. Among them hydraulic models, combination of historical WL data and the ecological requirements at different life stages of aquatic macrophytes, the protection requirements of specific aquatic flora and fauna species sensitive to hydrological pressures etc.

In this research, we have used an adaptation of the Instream Flow Incremental Method (IFIM, Bovee 1982), which has been mainly applied to streams and rivers, to assess the EWLR of Lake Pamvotida, on the basis of the requirements of its habitat types and species whose conservation depends directly or indirectly on water regime. In addition, justified management measures related to the water balance of the lake have been elaborated and proposed to support the EWLR.

Materials and methods

Lake Pamvotida is located at the western part of Greece, in the region of Epirus. Its basin occupies an area of 489.4 km^2 with pronounced mountainous terrain (maximum altitude 1810 m). The altitude in the plain area varies from 470 to 480 m. The lake is mainly fed with water by four torrents that drain its basin. The lake outflows above the elevation of 469.04 m a.m.s.l. to Lapsista drainage ditch through a 30m long spillway and its gate. The latter is opened for flood protection and for summer water supply to the irrigation networks of the Lapsista area. The lake's surface, mean depth and volume when it outflows are 21.9 km^2, 5.4 m and 118.6 x 10^6 m^3 respectively.

The main pressure on the lake's hydrological balance is exerted by two collective irrigation networks which cover an area of 4,600 ha and claim 9.0 - 11.5x10^6 m^3/year of water from the lake, from May to September.

The ecosystem of the lake overlaps with two Natura 2000 network sites and specifically, with the Special Area of Conservation and Special Protection Area (SAC/SPA) "GR2130005-LIMNI IOANNINON" and with the Special Protection Area (SPA) "GR2130012- EVRYTERI PERIOCHI POLIS IOANNINON".

The methodology followed for the determination of the lake EWLR belongs to the category of Habitat Suitability Simulation and is based on the Instream Flow Incremental Method (IFIM). As a first step, the inter-annual range of the lake WL and the corresponding mean monthly fluctuation were assessed. Target species of lake macrophytes (3), fish (4) and birds (9) were identified and delineated their habitats in the lake. Furthermore, Habitat Suitability Criteria (HSC) were identified for the above species and constructed the corresponding suitability curves. The latter evaluates, using indices from 0 to 1, the suitability of a

habitat for a specific species and criterion. The method (Fig.1), estimates the Usable Habitat Area (UHA), for a species and its life stages under several WLs of the lake. The WL for which UHA becomes maximum, corresponds to the minimum EWLR for the species under consideration. The final EWLR for the lake is obtained by repeating the above procedure (Fig. 1) for all the target species and their life stages and by combining the resulting EWLRs.

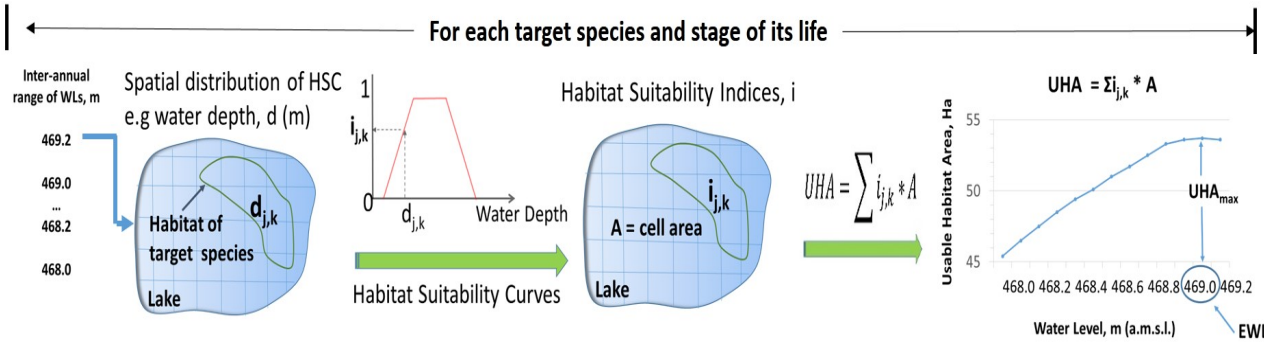

Figure 1. Process for assessing EWLR in Lake Pamvotida.

Results and concluding remarks

Three periods with different needs, in terms of WL fluctuation and its max drop of the lake have been identified, together with the maximum allowable withdrawals from the lake (Table 1).

Table 1. *Proposed WL fluctuation, max drop and max withdrawal from Lake Pamvotida to meet its EWLR*

Period of the Year	WL range, m	Max WL drop, m	Max withdrawal , x10^6 m^3
November – April	469.1 – 469.5		
April – June (bird nesting)	469.0 – 469.1	≤ 0.1	1.2
July – October (macrophyte growth)	468.2 – 469.1		2.4 (Jul), 2.7 (Aug), 0.7 (Sep)

The first period coincides with the rainy season in the area and therefore maintaining the WL at the proposed range is relatively easy. Care should be taken in order the WL to be kept bellow the height of 469.5 m (maximum WL for flood control). In the second period, further to the aquatic bird population, the proposed WL also preserves the reproductive habitat (macrophytes) of the fish species. Pressure on the proposed WL is mainly exerted in June due to increased evaporation rates, reduced water inflow from torrents and increased withdrawals for irrigation. The third period coincides with the maximum withdrawals (July to mid September) for irrigation purposes. In general, it is proposed the withdrawals from the lake should not exceed 8.5 x 10^6 m^3/year.

The method proved to be quite demanding in terms of scientific expertise and resources (e.g. GIS, scripting, hydrological modeling tools). Lack of “ready-to-use” habitat suitability curves for the selected criteria (water depth and rate of change of WL) and target species for the Greek territory rendered the study even more demanding. A strong advantage of the method was proven to be its ability to quantify the effect of any change in lake WL on habitat suitability, making it a strong operational management tool.

References

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