

Hazard identification of the Mediterranean Temporary Mountain Pond ecosystems in Central Greece: A Geo-environmental approach

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Mediterranean Temporary Ponds (MTPs) are shallow water bodies which are characterized from a short wet period and their small size (Zacharias et al., 2007). MTPs of Europe have are under an effective protection status, as a result of their identification as a priority habitat (Annex I code 3170*) in the EU Directive 92/43/EEC (Habitats' Directive). These ponds are very delicate ecosystems regarding their hydrological and geochemical characteristics. Due to their small size, they are open to random destruction or other unpredictable dangers. Although small in size, MTPs are complex ecosystems where topography, soil, water and hydrological conditions and microorganisms are closely connected (Zacharias et al., 2007; Stamatakis et al., 2015). The conservation and restoration of such ecosystems is very difficult because of their unique characteristics. The most common threats for MTPs include destruction of the hosting area through human and animal pressures, hydrological disturbance, fire and generally changes in ecological conditions resulting in an increase of competitive plants, nutrition influx, toxic contaminants and wastes, sedimentary deposit filling, exotic-invasive fauna and flora and negative effects from domesticated or hunted fauna (Dimitriou et al., 2006).

The study was carried out in the MTPs area of the National Forest Park of Mt. Oiti (GR2440004) and Mt. Kallidromo (GR2440006). The National Forest Park of Mt. Oiti covers an area of 7.210 ha, extends at altitudes of 400-2.116 m and encompasses a small network of four temporary ponds (TPs) of natural origin. The protected area of Mt. Kallidromo extends at altitudes of 43–1.393 m. and includes several streams which are tributaries of Spercheios River. Mt Kallidromo covers an area of 6.685ha and also encompasses a small network of three temporary ponds. Overall, the survey has included seven small and independent MTPs of high altitude in the areas of Mt. Oiti (Louka, Livadies, Greveno and Alikaina) and Mt. Kallidromo (Nevropolis, Mourouzou and Souvala) (Figs 1, 2).

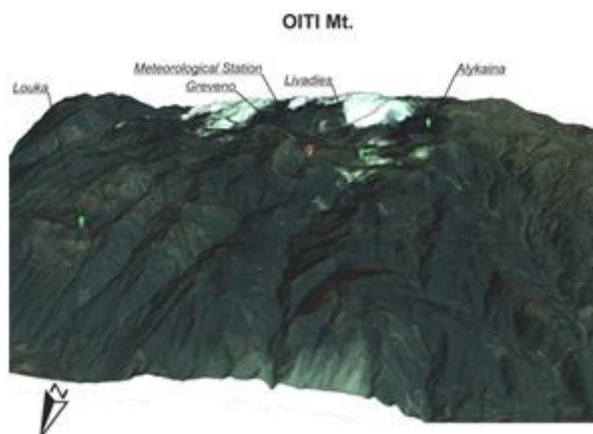


Figure 1. Locations of the studied MTPs of Mt. Oiti, on a Digital Elevation Model (Alexopoulos et al., 2015).



Figure 2. Locations of the studied MTPs of Mt. Kallidromo on a Digital Elevation Model (Alexopoulos et al., 2015).

The current study aims to present a dataset of the geo-environmental parameters in order to assess the potential hazards for these priority habitats. Furthermore, it is also worth mentioning that MTPs are unevenly studied, regarding their geological, hydrological, hydrochemical, geochemical and mineralogical characteristics and this work provides a first report on an integrated evaluation of these parameters regarding the qualitative and quantitative risk identification of the MTPs in Central Greece (Alexopoulos et al., 2015; Delipetrou et al., 2015; Stamatakis et al., 2015; Vasilatos et al., 2015).

A 3-year sampling campaign took place at the temporary ponds (TPs) of the Mt. Oiti and Kallidromo, over two different time periods, autumn and spring, by doing so, we ensured that the data were representative and comparable to the conditions during the wet and the dry period (Stamatakis et al., 2015). Bottom sediments and water samples were collected from each pond. Sampling was carried out at the bottom of the outer part of the habitat, from designated sampling points, with a maximum uppermost of 15cm and side inspection of the plant communities.

The analytical methods used on the sediments consist of granulometric characterization, mineralogical analysis (powder XRD), chemical analysis of major and trace elements (ICP-AES and ICP-MS) and organic matter determination (Stamatakis et al., 2015). Water measurements include pH, Eh, conductivity and TDS values and were performed in situ. The water samples were also analyzed for NO_2^- , NO_3^- , NH_4^+ , PO_4^{3-} , HCO_3^- and SO_4^{2-} (Stamatakis et al., 2015).

Regarding mineralogical analysis, Kallidromo bottom sediment samples revealed high participation of quartz and clay minerals, mostly montmorillonite. High clay mineral participation in Kallidromo, results in mostly fine grained fractions.

Oiti samples consist of quartz. However, albite, iron-rich smectites and clay minerals have also been defined. Furthermore, in terms of granulometry, Oiti samples composed mostly of sand.

The studied MTPs develop hydrochemical fluctuations as a result of annual hydrological changes. The MTPs of Mt. Oiti present very low dissolved salts concentrations. On the other hand, ion concentrations in Mt. Kallidromo MTPs are higher due to its geological background. The geochemical results and the water chemistry coupled with temporal analysis indicated that precipitation (meteoric water) is the main mechanism for the Mt. Oiti MTPs formation. Hydrochemistry suggests that there is no interaction between the ponds and the geological background. On the other hand, Mt. Kallidromo MTPs show a strong affection to the local geological background, exhibiting higher Fe concentrations compared to those of Mt. Oiti. Fe presence is related to high concentrations of As and Co, which indicate a strong correlation to the geological formations of the area. pH variation is controlled by processes such as photosynthesis and oxidation of organic matter. These processes can succeed one another in short time. Bottom sediment samples from Mt. Oiti present high concentrations of SiO₂ in comparison to the Kallidromo samples, but show lower Fe₂O₃, MgO and CaO rates. Trace elements in the samples from the Oiti bottom sediments show lower Ni numbers, but all the other trace elements are in comparable numbers. The MTPs present sporadic sensitivity regarding ammonium and phosphate ions, derived from decomposition of organic matter (mostly cattle feces in Oiti and cattle and horse feces in Kallidromo). Pb enrichment noticed in the second sampling campaign of Nevropoli pond in Mt. Kallidromo, which might come from buckshot during hunting activity in the area. The same enrichment determined to the respective bottom sediment sample.

The morphology of Mt. Oiti and Mt. Kallidromo MTPs is unaffected from anthropogenic factors. Animal manures affect the nutritional status of the examined Mediterranean Temporary Ponds. It is noticed that animal manures increase the area's fertility and could result in the invasion of competitive flora species that might reduce the endemic flora of the ponds.

A monitoring procedure would be important for this type of ecosystems (Vasilatos et al., 2015). This procedure may be implemented based on the geological, hydrochemical and geochemical parameters of the MTPs. Some of the parameters that need monitoring are: i) the pond surface area, ii) the climatic conditions, iii) the anion and cation levels, ammonia and phosphorus concentrations, iv) water pH, Eh and conductivity together with total dissolved salts and oxygen saturation in the pond's water and v) the fluctuation of the organic matter in the bottom sediments.

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