Development of lakes in recent de-glaciated areas in the central Pyrenees: the Arrablo Lake (Ordesa- Monte Perdido National Park)

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During the Quaternary glacial and interglacial periods, mountain glaciers have advanced and retreated following climate fluctuations. Nowadays, humans have the ability to influence the climate system, a phenomenon that has led to an increase in the average temperature in the last few decades. Glaciers are one of the key indicators of global climate change and during the last decades, increasing temperatures due to global warming have greatly affected mountain areas all over the world and in particular glacial dynamics and cryospheric processes.

In the Pyrenees, where the largest glaciers of southern Europe are found, the glaciers retreat has been documented since the second half of the 20th century. Many of these glaciers eventually disappear, forming small high-altitude lakes throughout the Pyrenees.

This paper aims to identify and characterise the appearance of new high mountain lakes in the few areas with still active glaciers. In order to understand the changes in the limnological processes in these new lakes and its relationship with climate, we have chosen as a case study the lake known as Arrablo (2964 masl) in the Ordesa – Monte Perdido National Park that was formed in the late 1980s. The evolution of the lake has been described using remote observation systems, for which aerial images are available since 1956 and remote sensing techniques with images available since the end of the 1980s. In addition to this, a field campaign carried out in October 2021 included a bathymetric survey, the installation of two thermistors on the surface and at a depth of 3.5 metres, water sampling and the recovery of a transect of gravity cores. The chemical composition of the water preliminary analysis shows that the lake waters have very low conductivity and alkaline pH.

Interpretation by aerial imagery suggests that the generation of Arrablo lake occurred at some point between 1980 and 1990. One of the cores (ARB21-1B-1G, 22 cm long) has been selected for multiproxy analyses including magnetic susceptibility, sedimentary features and geochemical composition using an XRF scanner. Dating, isotopic and diatom analyses are in progress. The sedimentary sequence is composed of massive silty sediments at the base and laminated facies at the top with higher content of organic matter. This major change is likely indicative of the transition from a permanent ice - covered lake to a few months ice-free period and likely corresponds to the late 1980s when the new lake was reported. These preliminary results suggest that the lake basin was created long before it was detected by aerial photos and hikers, and there was a prior lake phase under permanent ice. Laminated facies likely reflect annual changes brought by increased runoff and sediment delivery and primary productivity during the ice-free period.

Combining monitoring of biological, geochemical and water properties of the new lakes, with paleolimnological studies and regional and local instrumental records of climate variables will help to understand the effects of current global change in these vulnerable alpine ecosystems and to improve our reconstructions of past environmental – climate synergies.