

## Sediments from the Enol lake reveal more than 13,500 years of environmental history

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This is a research campaign in the Enol lake. Credit: Ana Moreno et al./IPE(CSIC)

A team of Spanish researchers have used different geological samples, extracted from the Enol lake in Asturias, to show that the Holocene, a period that started 11,600 years ago, did not have a climate as stable as was believed.

The <u>Holocene period</u>, which includes the last 11,600 years of our history, has always been described as a stable period in terms of <u>climatic</u> <u>conditions</u>, especially when compared to the abrupt changes that occurred in the <u>last ice age</u>, which ended around 10,000 years ago, giving way to the Holocene.



A study carried out by researchers from the Pyrenean Institute of Ecology (IPE) at the Spanish Research Scientific Council (CSIC), in collaboration with other scientists from Zaragoza, La Coruña, Valencia and Cádiz universities, and published in the *Journal of Paleolimnology*, has found climatic differences amongst the "stable" 13,500 years.

The study specifically focused on the Enol lake (Asturias), where various sediment samples were extracted from the bottom. These samples provide data about the regional humidity and temperature changes in the area over more than 135 centuries.

The project, together with a previous study that details the last ice age and another, more recent one that examines the last centuries, implies "the first time glacial evolution and <u>climate</u> change have been registered in the last 40,000 years in the Picos de Europa National Park" claims Ana Moreno, researcher from the IPE-CSIC and lead author of the study.

The Enol lake was formed 40,000 years ago following the retreat of a glacier which dug a trough, allowing the accumulation of sediments and water. 18,000 years ago it was already a lake and organic sediments that are currently being studied were starting to be deposited.

From the lake sediments the physical properties and the amounts of organic carbon, carbonate and other elements, could be analysed, as well as some biological indicators, such as diatom and ostracod fossils.

## **Vegetation cover evolution**

Furthermore, the detailed study of pollen accumulated in this material allows us to make a reconstruction of the variations of vegetation cover, which is crucial information in the context of climate change and the impact of human beings.



The researchers recognised at least 4 different stages in the Holocene: the first one was cold and dry, between 13,500 to 11,600 years ago (cal years BP) which included a brief return to the icy condition known as Younger Dryas. This was followed by a period of higher temperature and humidity, between 11,600 and 8,700 years ago, which coincided with the beginning of the Holocene.

The third period had a drier climate, between 8,700 and 4,650 years ago, and finally a return to the more humid climate from then up to 2,220 years ago. The study also highlights the changes caused in the latest period caused by human activity, specifically from pasture and deforestation.

The study's conclusions therefore report significant environmental changes throughout the last 13,500 years in history. They also show how at the beginning of the Holocene, the vegetation coverage of the area, which until that time had consisted of Pinus (pine), Betula (birch) and Quercus (oak), then became a forest of mainly Quercus.

Researchers also highlight an increase in precipitation for nearly twelve centuries (between 9,750 and 8,600 years ago), which led to an increase in Corylus, or in other words, Hazel. Although the study of these geological traces from the Enol lake only covers up to 2,200 years ago, it is possible to determine the environmental impact that the region's inhabitants of that time had from studying the pollen.

## Former use of mountain pastures

Moreno said that "The use of mountain pastures is possibly the oldest documented human activity in the area. As we have seen, the lengthy sampling of Lago Enol detected that an opening in the landscape began 4,650 years ago, and most notably from 2,700 years ago".



The results also show that from 4,650 years ago, humans contributed a greater presence of herbaceous species (from the Plantago and Rumex Acetosella genera) and a decrease in the area's woodlands.

Those in charge of the study claim that these hydrological and landscape stages from the Enol lake sediments demonstrate the biggest changes in the climate registered during the Holocene in the south of Europe. The Cantabria mountains were like that 2,200 years ago, a date that coincided with the Roman occupation and the start of the Second Punic Wars against the Carthaginians led by Hannibal.

In a more recent study, these researchers found from the pollen register that there have been many alterations in the landscape, which were caused by <u>human activity</u> in the last 200 years. For example, they detected a change in the number of coprophilious fungi (which feed on the faeces of the livestock that graze there) throughout the twentieth century.

According to the researchers, this is due to the fact that "the indigenous bovine livestock were replaced by Alpine Brown cattle, and, before that, high-milk yielding Frisians. This way it changes from being an extensive livestock on the mountain, with the indigenous cattle, to another intensive type, with stables at the bottom of the valley. Another change that the pollen shows is the introduction of eucalyptus plants in 1930.

**More information:** Moreno, A., López-Merino, L., Leira, M., Marco-Barba, J., González-Sampériz, P., Valero-Garcés, B., López-Sáez, J. A., Santos, L., Mata, P., Ito, E.. "Revealing the last 13,500 years of environmental history from the multiproxy record of a mountain lake (Lago Enol, northern Iberian Peninsula)". "Journal of Paleolimnology" 46 (3): 327-349, 2011. DOI 10.1007/s10933-009-9387-7.



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