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Palaeoclimatic and environmental multiproxy reconstruction of lake Fúquene, Colombia

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Tropical lake systems are of great importance for the ecosystem services they provide and due to the key role they play in climate regulation and the carbon cycle. It is expected that increased anthropogenic pressure together with the raise of environmental temperatures will result in release of organic carbon mainly in the form of CH4. Lake Fúquene is one of the largest natural shallow lakes in the Colombian eastern mountain range with approximate surface area of 30 square kilometres1. It has been extensively studied for paleoclimatic pollen studies but little is known about biomarker representation and its use as a reliable proxy for studying changes in the aquatic vegetation, methane emissions, anoxic phases and climate variations. We carried out a paleoclimatic and paleoecological reconstruction covering the last c. 800 in Lake Fúquene using both n-alkanes2 and glycerol dyalkil glycerol tetraethers (GDGTs)3. The aim was to understand changes in the communities both within and around the lake and how those relate to both increasing anthropic pressure and climate change. To have a holistic interpretation of the long-term ecological and climatological variation in this tropical lagoon, we compared biomarker results with both historical1 and paleoclimatic reconstructions as well as palynological achieves. Results showed a steady increase in sedimentation rates from 0.2 mm per year at the bottom of the record to 0.7 mm in recent years. The BIT index values were high indicating that a large proportion of increases in lake sedimentation may be derived from the surrounding catchment. Changes in the catchment are mainly associated with land use changes for agriculture and coal mining. At bottom of the core, lake sediments presented a 25% of organic matter content that sharply decreased at c. 1100 AD. Around 1800 AD, organic matter content gradually increased to reach a current value of 42%. The recent sharp increase in organic matter is associated with a marked change in the aquatic vegetation, in particular Azolla filiculoides and Eichornia crasssippes, which strongly expanded their abundances during the last two centuries in response to nutrient-enrichment. Our analysis derived from the n-alkane and GDGT indices, supports the increases in floating vegetation since the last 100 c. years and indicates a concomitant rise in bacterial abundance and methanogenic activity in the lake sediments. Biomarker climate signal presented little variation during the time of study, suggesting that the observed shifts in bacterial and methanogenic activity mainly derives form anthropogenic activity.

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