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Late Quaternary climate and vegetation changes at Braamhoek wetland, South Africa

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This study contributes a continuous paleo-environmental record from Braamhoek wetland, eastern Free State, South Africa, covering the last 16 ka (16 000 cal yrs BP). The multi-proxy study includes analysis of microfossils (pollen, diatoms, phytoliths, charcoal fragments), stable isotopes (carbon and nitrogen) and lithological properties (carbon content, grain size).

Braamhoek wetland is situated at an altitude of c. 1700 meters, a few kilometres north-west of the eastern escarpment, where the large difference in altitude results in orographic uplift of easterly air masses and annual rainfall is c. 1400 mm. The wetland is fed by ground-water springs, promoting continuous local wetness and organic preservation, which explains the accumulative conditions throughout Holocene and late Pleistocene.

Analysis of fossil pollen suggests variations in vegetation patterns throughout the 16 ka period. The most important proxies for past vegetation are pollen of fynbos, forest trees, Poaceae and Asteraceae. Principal component analysis (PCA) was performed on 26 of the regional pollen taxa, yielding high positive loadings on forest trees and fynbos, which may reflect relatively moist conditions, particularly in combination with high representation of Poaceae pollen.

The carbon isotope composition is a potential proxy for the relative abundance of C3 versus C4 grasses. The late Pleistocene carbon isotope values are probably an artefact of low carbon dioxide levels favouring C4 plants during late glacial conditions, while during the Holocene-Pleistocene transition and onwards, the isotopes probably reflect the local and regional C3/C4 grass ratio. The phytolith index gives additional information about environmental factors coupled to the grass distribution, while occurrences of planktonic diatoms indicate shifts in the moisture status within the wetland.

We interpret depleted carbon isotope values, high PCA-score, high Poaceae/Asteraceae ratio, low phytolith index, as well as presence of planktonic diatoms, as a response to increased wetness, locally and/or regionally. The Braamhoek multi-proxy record suggests three major phases of increased wetness; c. 13.7-12.8 ka, 10.5-9.5 ka, 8.2-7.5 ka and 1.5-0.5 ka. Further, the decline in fynbos pollen representation after c. 9.5 ka and afromontane forest elements being prominent between c. 11 and 8 ka, infer a shift from cooler late glacial conditions, to warmer Holocene conditions at some stage between 11 and 8 ka.

The inferred climate and environmental changes suggest a response to millennial scale astronomical forcing and latitudinal shifts in the major weather systems affecting the subcontinent.