



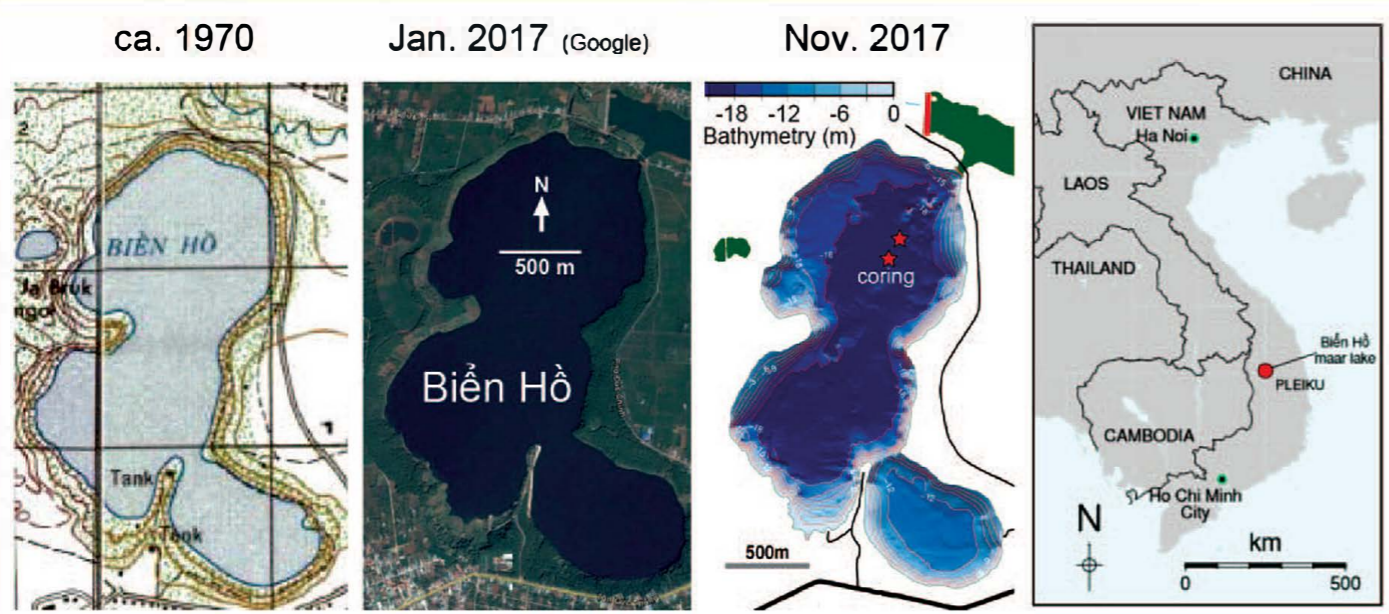
# Maar sediment in central Vietnam Highland near Pleiku: An archive of regional monsoon intensity?



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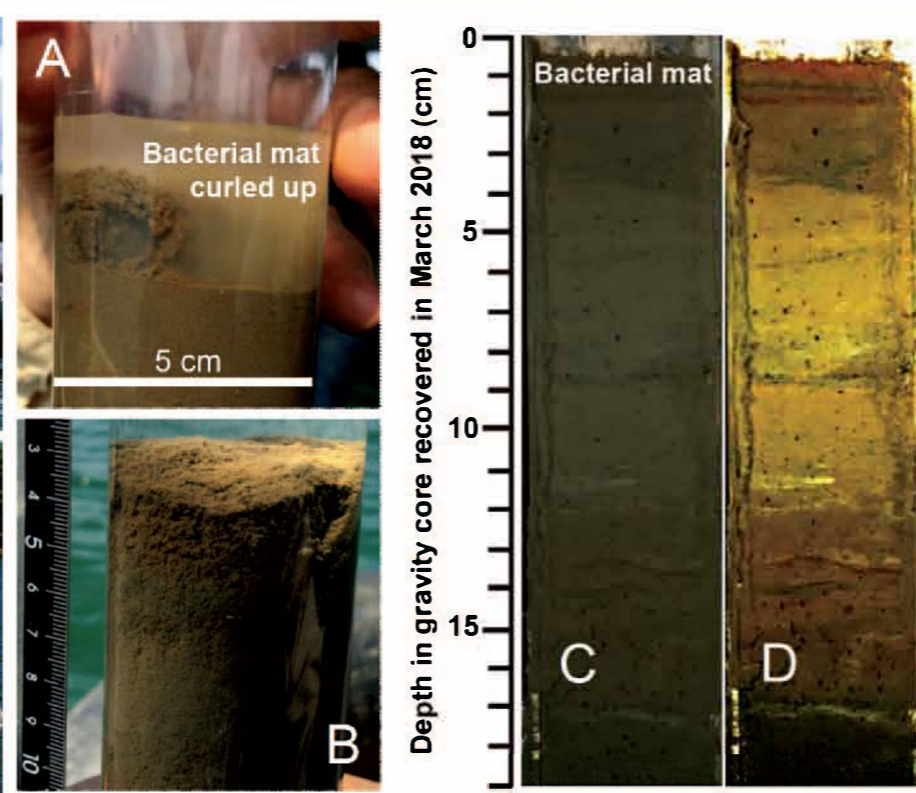
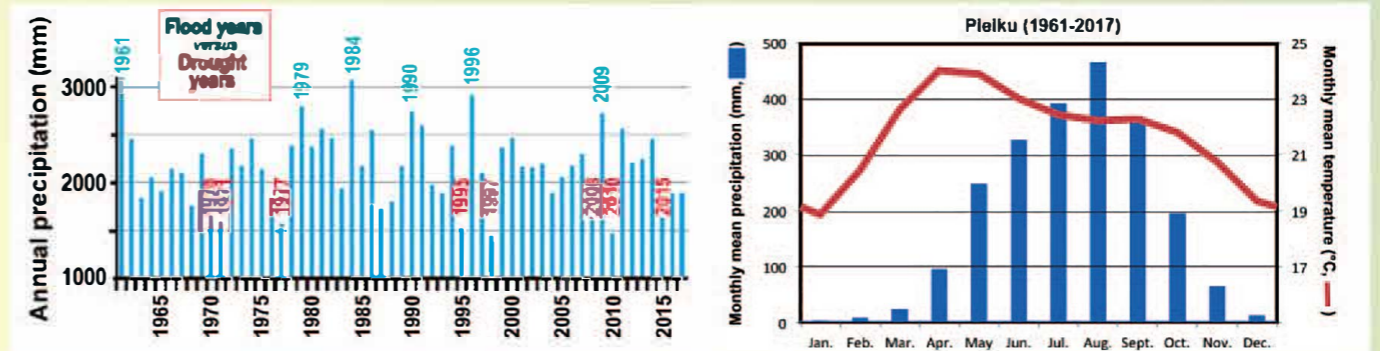


## Introduction

Global warming increases atmospheric humidity and will likely affect the East-Asian monsoon system across Vietnam. It is essential to understand the long-term regional climatic variability to properly evaluate present and potential future trends along global climate change. Sediments from maar lakes can provide long-term paleoenvironmental records. Biển Hồ maar in central Vietnam offers an archive of erosion from a small catchment that had been limited to the interior of the volcanic crater until in 1983 a dam (red bar on bathymetric map) established a reservoir to the northeast from which turbid and nutrient-rich flood water can seasonally spill into the maar.

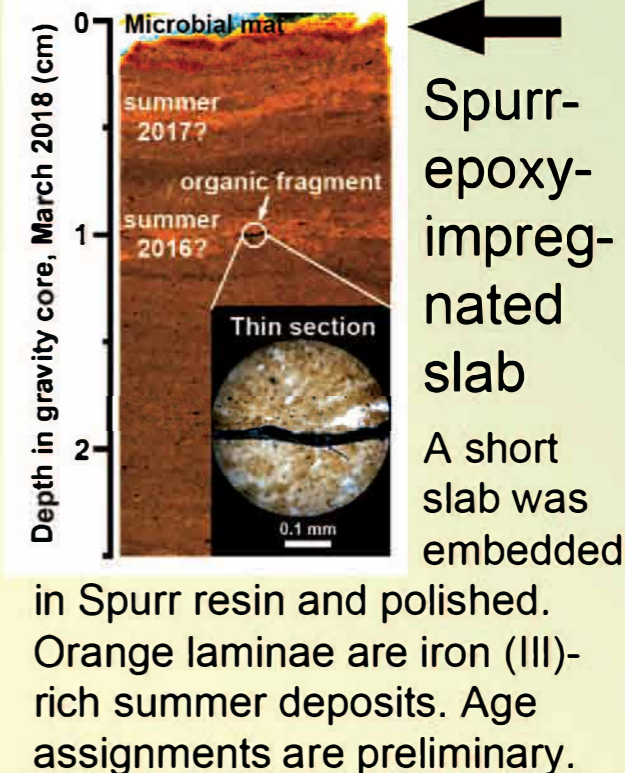
## Local climate time-series

Instrumental records from Pleiku from 1961 to 2017 indicate seasonal monsoonal rainfall peaking in August, and strong interannual variability in rainfall. Historical data indicate flood and drought years back to 1961. Relatively low air temperatures in winter increase lake water stratification.

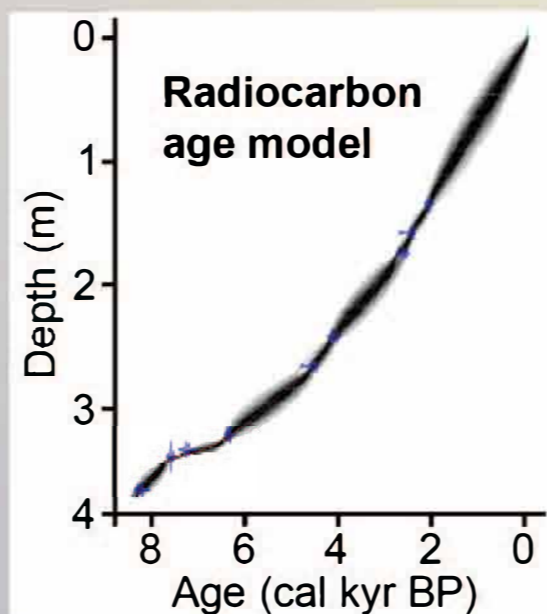
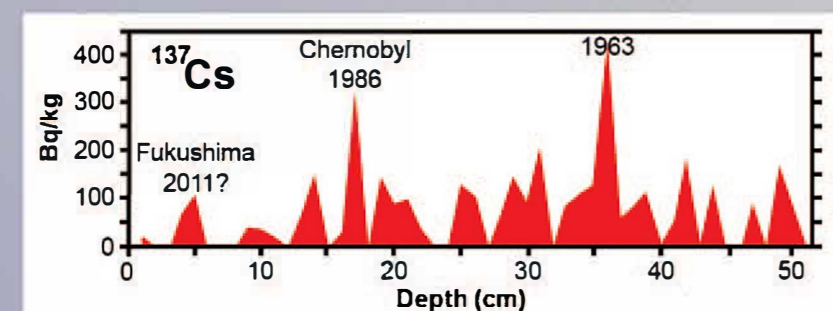


## Coring

Gravity and piston coring in 2016 to 2018 provided evidence for (i) the presence of a bacterial mat in March 2016 (A) and March 2018 (B), (ii) deposition of a reddish clay-rich flood layer in summer 2016, (iii) preservation of laminated sediment across the topmost ca. 40 cm, and (iv) deeper anoxic, dark sediment. (C) Original color of topmost March 2018 sediment and (D) after image enhancement.

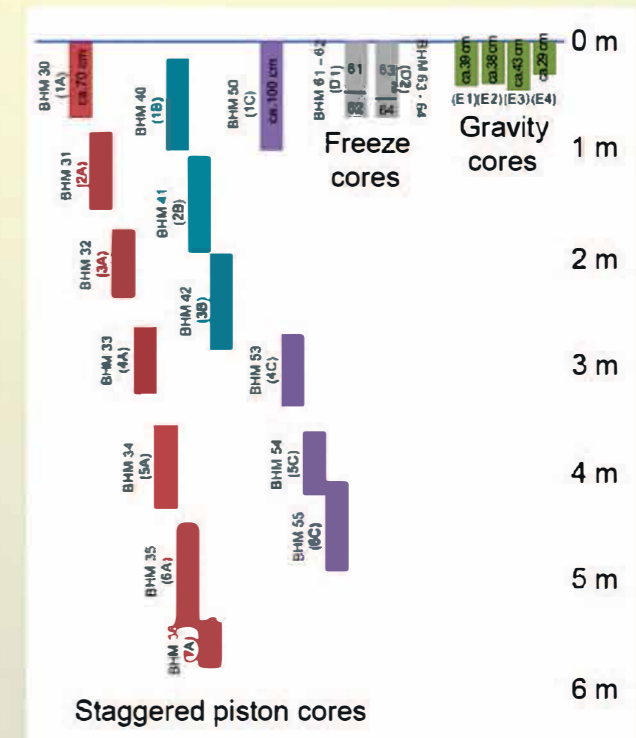


<sup>137</sup>Cs dating Despite limited airborne fallout in Vietnam from nuclear testing and accidents, we tentatively identified 3 events. This dating indicates a significant increase in recent sedimentation due to anthropogenic activities.



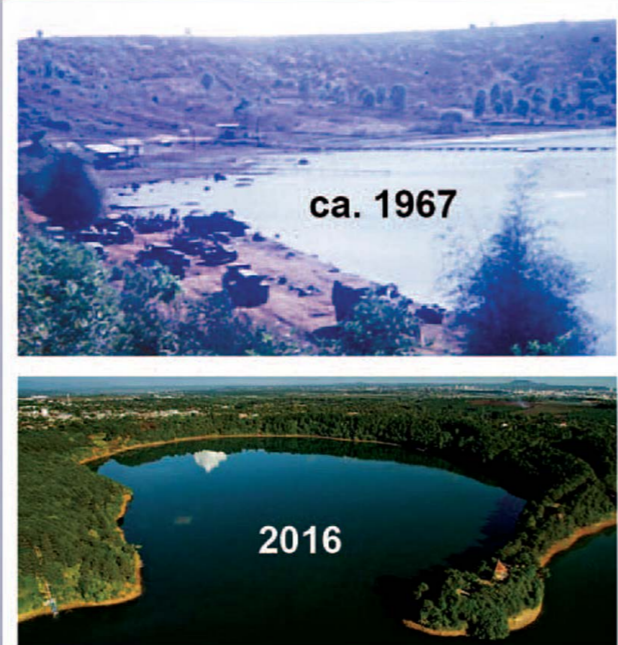
Since 2016, we recovered numerous gravity, piston, and freeze cores that reach as deep as ca. 6 m.

Fossil leaves from distinct depth intervals yielded radiocarbon AMS dates at NOSAMS as far back as ca. 8 ka cal BP at ca. 4 m depth. Deeper leaves are currently being dated.



## Recent environmental changes

Images from the 1960s show exposed terraces at low water level in the southeastern part of the maar. In 1983, a new reservoir to the northeast began spilling into the maar lake, thus raising its water level. Protection and reforestation improved the maar's environment after 1990.



## Conclusions

The sedimentary archive in central Vietnam's Biển Hồ maar extends deep into the Pleistocene. Maar lakes with suboxic bottom waters may offer well-preserved laminated sediments with paleoenvironmental information, including a record of monsoon-related flood layers. The anthropogenically influenced last few decades of lake history can provide proof-of-concept when interpreting earlier flood layers of similar composition. Similarly, the recent reforestation efforts around the maar crater's rim offer a test case for evaluating vegetation dynamics and pollen accumulation in relation to rapid environmental change. In addition to Biển Hồ maar lake, the region offers numerous other maars with potentially valuable paleoenvironmental records.