Late Holocene records of fire and human presence in New Zealand

E. Argiriadis1, M. Vecchietti1, T. Kirchgeorg1, D. Battestelli1, D.B. McWethy2, C. Whitlock3, N.M. Kehrwald3, C. Barbante1,4

1 Department of Environmental Sciences, Informatics and Statistics, Ca' Foscari University of Venice, Via Torino 153, 30170 Venice, Italy
2 Department of Earth Sciences, Montana State University, 226 Traphagen Hall, Bozeman, MT 59717-3480, USA
3 U.S. Geological Survey, Geosciences and Environmental Change Science Center, W 6th Ave Kipling St, Lakewood, CO 80225, USA
4 Institute for the Dynamics of Environmental Processes (IDPA-CNIR), Via Torino 153, 30170 Venice, Italy

The location, WHY NEW ZEALAND?

New Zealand, and in particular the South Island, is considered ancalculate for new asdue to major shifts in burn impact or early human presence. Anthropogenic events occurred only about 700-800 years ago and caused abrupt landscape modifications, with the loss of 40–50% of the pre-existing forest, which used to cover almost the 90% of New Zealand. A shift in fire regime and in the composition of vegetation is observed in charcoal and pollen records as a result of increased fire activity. Wildfires were more frequent before the advent of human and vegetation was not adapted to fire. Such an abrupt, fast and well-documented transition, together with the isolated nature of New Zealand, makes it a perfect study site for the reconstruction of local-scale phenomena. The purpose of this study is to complement palaeoecological information with molecular markers of fire, PAHs, Polyaromatic Hydrocarbons, AAs, Anthracene and chrysene and human presence (FeSt). Fecal Sterols from lake sediments in order to individuate when and how anthropogenic land use started to modify the environment irreversibly.

LAKE KIRKPATRICK and LAKE DIAMOND

The South Island increased far more than its length (350 km) by the Southern Alps, giving rise to many valleys and lakes of glacial origin, which serve as excellent repositories both for atmospheric and terrigenous palaeoenvironmental tracers. Lake Kirkpatrick (45°20’ S, 166°37’E) is a small lake (c. 0.5 km) located at 575 m a.s.l. in a moderate rainfall contrast within the Lake Wakatipus basin, in Otago, close to the Queenstown district and on the main Moa lake trading route. Lake Diamond (44°55’ S, 168°31’, 1.6 km) is located northeast of L. Kirkpatrick at 380 m a.s.l. close to Lake Wanaka, and far from current settlements.

Existing fire records (charcoal) indicate increased fire activity between AD 1350 and 1600 corresponding to the replacement of tall trees (mainly Nothofagus and Podocarpus) by shrubland documented in pollen records [1].

Petrogenic Diagnostic ratios

calculated for PAHs and MAs individuate wood combustion as the major source of fire tracer. In particular, the ratios between levoglucosan (L) and its isomers (M and G) increase with higher temperature and longer fires. They indicate 4 such events at about AD 1350 (1), 1530 (2), 1810 (3) and 1950 (4), which could refer to single wood burning events, first by the Maori and then by the Europeans.

Lake Kirkpatrick multi-proxy results

Different proxies give similar indications and confirm the anthropogenic origin of observed changes.

Fecal Sterols And Population Size

Coprostanol (Cop) and its epimer epico-prostanol (e-Cop) are specific tracers of human feces [5]. They were measured in Lake Kirkpatrick and Lake Diamond. Results show a clear indication of human presence during the Initial Burning Period (IBP) after AD 1500 then decreasing significantly until the post-European increase in population. Population size of New Zealand and Queenstown was compared with Cop and e-Cop fluxes for the European period, resulting in a logarithmic correlation (r² = 0.885) and suggesting possible use of fecal sterols for estimating past population densities.

Kirkpatrick VS Diamond

The comparison of FeSt results for the two lakes reveals an impressive correspondence of the human signal with fire activity. Fluxes were higher at LK closer to human settlements. Interestingly, a temporal shift between proxies is present in both lakes, more markedly at Lake Diamond, fire legs human arrival by one or more decades.