Available online at www.sciencedirect.com
SCIENCE DIRECT
Quaternary Research 64 (2005) 407 – 417
QUATERNARY RESEARCH
www.elsevier.com/locate/yqres

The stratigraphy and fire history of the Kutai Peatlands, Kalimantan, Indonesia

Geoffrey Hope [a,*], Unna Chokkalingam [b], Syaiful Anwar [c]

[a] *Archaeology and Natural History, RSPAS, Australian National University, Canberra 0200, Australia*
[b] *Center for International Forestry Research, Bogor, Indonesia*
[c] *Department of Soil Science, Bogor Agricultural University, Indonesia*

Received 1 March 2005
Available online 30 September 2005

Abstract

The equatorial peatlands of the Kutai lowland of eastern Kalimantan are generally 4–10 m in thickness but some sections exceed 16 m in depth. The deposition of peat commenced about 8000 yrs ago after shallow flooding of the basin by the Mahakam River. The earliest vegetation is a *Pandanus* swamp which grades upwards to swamp forest dominated by dipterocarps. The peatland has expanded laterally and rivers have maintained narrow levee-channel tracks through the swamp, which has grown vertically in balance with river accretion. Historical fires are associated with extreme El Niño yrs of drought, but human agency is important. The fires of 1982–1983 and 1997–1998 burnt up to 85% of the vegetation on the peatland. Although charcoal analyses show that fire has occurred throughout the history of the peatland, it is rare in forests remote from rivers until the last 3000 yrs and only common within the last millennium. Fires are earlier and more frequent in sites accessible from waterways, and floodplains have been widely burnt down to water table or below, forming extensive lakes.
© 2005 University of Washington. All rights reserved.

Keywords: Tropical peatland; Fire history; Charcoal analysis; Palaeolimnology

Introduction

Since the 1980s, large-scale fires in the peatlands of western Indonesia have caused serious damage in terms of biodiversity loss and there is global concern over the smoke plumes and carbon emissions arising from peatland burning (Nichol, 1997; Page et al., 2002). The peatlands of the Kutai Lowlands in East Kalimantan province, Indonesia have been subject to repeated burning in the last two decades. Up to 45% of the swamp forest was affected in 1982–1983 and 72–85% in 1997–1998 by fires lit during unusually dry summers. The 1997–1998 fire event removed almost all standing trees over thousands of hectares, leaving scrub and sedge successional communities. How do these recent fires compare with the long-term fire history of these peatlands? Are they unusual events and what are the implications for forest and peatland recovery? This paper reports preliminary observations on the stratigraphy and fire history of the peat, supported by limited palynology and dating. No previous studies of the Kutai peatland sediments have been made although lowland tropical peatlands elsewhere in the region have been studied (e.g., Anderson, 1964; Anderson and Muller, 1975; Anshari et al., 2001, 2004; Morley, 1981a,b; Neuzil, 1997; Page et al., 1999; Rieley and Page, 1997; Staub and Esterle, 1994; Supardi et al., 1993; Taylor et al., 2001; Wüst and Bustin, 2004).

* Corresponding author. Fax: +61 2 61254917.
E-mail address: Geoff.Hope@coombs.anu.edu.au (G. Hope).

Setting of the Kutai Peatlands

The Kutai peatlands differ from those of Central Kalimantan (Page et al., 1999; Rieley and Page, 1997), and Sumatra (Neuzil, 1997) in occupying an inland basin whose hydrology has been controlled by river accretion. The Kutai Lowland (centred on 00° 12′ S, 116° 15′ E) is 80 km inland, bounded to the east by a range of soft sandstone hills (Fig. 1). The lowland is 35 km NW–SE by 130 km SW–NE, rising northwest from its lowest point around sea level on the Mahakam River to ca. 24 m a.s.l. Silty clay channel and levee systems of the Mahakam River and narrower levees of its major tributaries

0033-5894/$ - see front matter © 2005 University of Washington. All rights reserved.
doi:10.1016/j.yqres.2005.08.009

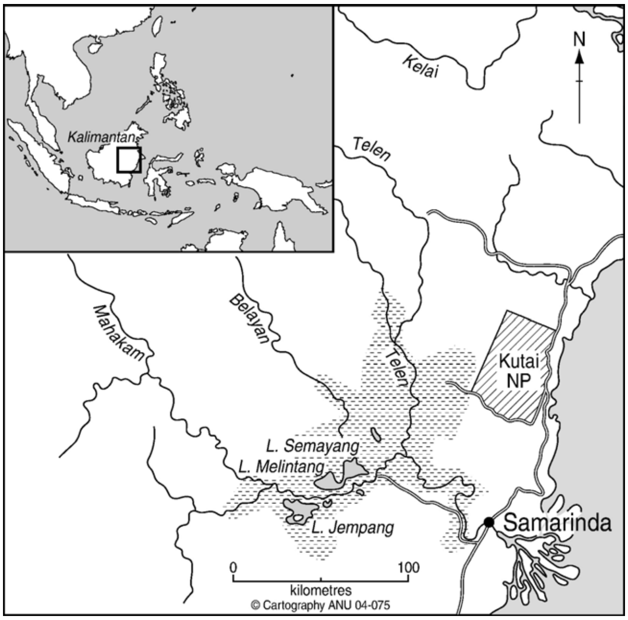

Figure 1. Location of the Kutai study region.

from the north cross the lowland. Behind the levees are a series of large shallow lakes and seasonally inundated peat plains which grade into forested peatlands that rise gently to meet sandy slopes to the northwest and east.

The climate of the area is tropical seasonal, with the mean temperature range between 25°–30°C yr round and 1900–2000 mm of rain mostly falling from December to April (Weidemann, 2002). In the wet season the lakes and rivers expand, flooding the neighbouring peatlands to depths of up to 3 m. Rivers and lake levels fall by 5–6 m in the dry season, which extends roughly from July to September. Burning of sedge-grasslands is widespread at this time, and fires can spread into the peatland forests. During marked El Niño yrs the December–April rains fail and the dry season can extend for up to 8–12 months (Brookfield et al., 1995). At such times, the peatland surface can dry and fire hazard is greatly increased.

The natural vegetation of the peatlands is a mosaic of specialised closed forests that reflect the hydrology, nutritional status and disturbance history of a given site. Key taxa in disturbed areas are *Shorea balangeran* (Dipterocarpaceae), *Combretocarpus rotundatus* (Anisopteraceae) and *Syzygium lineatum* (Myrtaceae). Less disturbed forests have a higher diversity of tree species such as *Dactylocladus stenostachys*, *Licania splendens*, *Campnosperma coriacea* and *Shorea teijsmaniana*. Peatland plants are adapted to waterlogging, low pH and poor substrate nutrition with many displaying a mass of rootlets and mycorrhizae that recycle nutrients, and maintain very acid conditions.

Unlike primary rainforests, swamp forest is rarely taller than 25 m with trunk diameters less than 80 cm. The less disturbed forests have very high stem density up to 2000–3000 stems/ha. Plains within 0.5–3 km of rivers and lakes have lost their tree cover due to annual fires and support sedgelands or grasslands. However, a large part of the landscape is now in successional vegetation types following the fires of 1997–1998.

Relatively low populations of Kutai and Banjar ethnic groups live in scattered villages along the clay levees or lake shores. At present, limited cultivation occurs on the alluvial floodplains and levees and the main activity is fishing. Historically, the area was controlled by the sultanate of Kutai. Carl Bock, who visited the area in 1879, described only a very sparse population but noted widespread defoliation resulting from the prominent drought of A.D 1879–80 (Bock, 1985). The peatland forests are very difficult to cross on foot and only the margins are visited regularly for fishing, although in the wet season boats can go some distance into the forest.

Methods

During August–September 2001, line transects covering roughly 24 km were laid out at 18 locations across the slightly domed peatlands, riverine plains and peat lakes. A Russian D section corer was used to take cores at 200-m intervals along these transects (Fig. 2). The transects sampled a range of spectral signatures in a yr 2000 LANDSAT image (Path/Row 117/060) to relate these to site types and disturbance histories. Difficulty of access meant that the marginal peatlands were over-sampled by comparison with the interior sites. Any evidence for recent fire effects such as burnt hollows, charcoal or successional vegetation was noted.

Peat was described in terms of colour, pH, content of fibrous debris and wood, degree of preservation and mineral content. Charcoal in the sections was identified in the field by sieving peat with a 1-mm sieve and examining the debris carefully, crushing possible fragments to check for carbonisation. Care was taken not to misidentify stained wood and dark bark fragments. Where doubt existed, the sample was bagged for later microscopic examination. These visual methods probably only locate fairly marked local fires and may miss some burning events, since charcoal is not preserved everywhere after fire.

Basal clays from eight cores were selected for characterisation with X-ray diffraction. Surface and mid-profile samples of clays were also taken from Lake Melintang. Samples of peat were taken from selected sections in seven cores to allow radiocarbon dating of base and intermediate levels, including those at which macro-charcoal was detected. In the laboratory, radiocarbon samples were sieved and the <1-mm fraction treated with 10% HCl, and NaOH to remove humates and soluble organic debris.

To obtain a rough measure of local fire (Haberle et al., 2001), micro-charcoal was sampled from six cores that represented a range of site types from remote peatlands to near river and sub-lacustrine cores. Core samples of 0.75-ml were sieved through 120- and 10-μm nylon mesh. The >120-μm fraction was retained and examined for macro-charcoal under a low-power microscope. The intermediate sample was suspended in 5 ml of water with a few drops of bleach and 10 μl pipetted out and mounted on a slide. Fifty fields were immediately examined at ×250 using a point-counting technique for microscopic charcoal (Clark, 1982). This provides a quantitative estimate of charcoal concentration

Download English Version:

https://daneshyari.com/en/article/10501267

Download Persian Version:

https://daneshyari.com/article/10501267

Daneshyari.com