Pollen assemblages and dinoflagellate cysts in marine sediments as indicators of vegetation and environment changes on SW Kalimantan and NE Java

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Introduction

Pollen and organic walled dinoflagellate cysts (dinocysts) are good palaeoecological proxies widely applied in the reconstruction of past environmental changes, both on the continent and in the marine realm.

In the present work we studied them in order to get a better understanding of the relationship between human activities and changes on land in the vegetation composition of SW Kalimantan and NE Java and in the Java Sea.

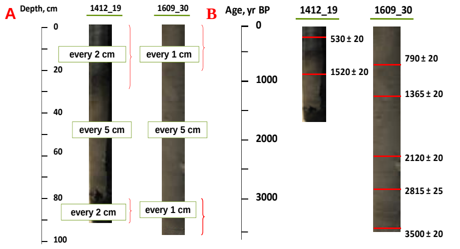

Fig. 2. Scheme of core sampling (A) and age control (B).

Objectives are…

✓ To study vegetation and other environmental changes during the last ca. 3,500 years;

✓ To compare environmental changes on land (pollen and spores) and in the marine environment (dinocysts);

✓ To reconstruct the vegetation and environment conditions in the region of the Java Sea and to get more insight into the late Holocene human impact and a land use in Indonesia.

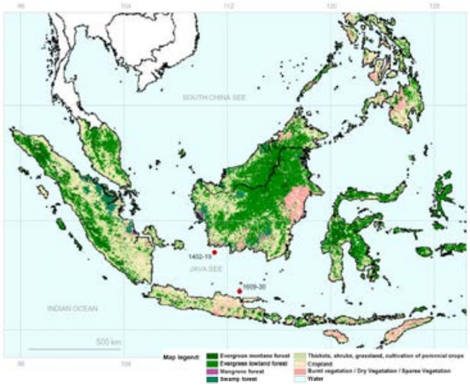

Fig. 1. Schematic map of study area with coring sites (red dots) and main types of modern vegetation.

Material and Methods

Two short shallow water marine sediment cores **1412_19** (3.258° S; 110.649833° E, water depth 9.7 m; length 91.5 cm) and **1609_30** (6.497147°S; 112.47536°E; water depth 7 m; length 96 cm) were retrieved from the Java Sea (Fig. 1) and sampled as it is shown in Fig. 2.

Age control: Radiocarbon dating based on bivalves and benthic material (Fig. 2) was carried out in the Earth System Science Department (Irvine, USA).

Pollen and dinocyst analysis was applied to the subsamples of the cores. Samples were counted up to 200 pollen grains (100 dinocysts) except indeterminate types (cysts); frequencies were calculated on a basis of the pollen (dinocyst) sum.

Pollen taxa were grouped according to their most common source: mangrove, lowland forest, submontane / montane forest, and herbs. Spore taxa are grouped as pteridophyta. Ecological groups for dinocysts are followed Zonneveld el al. (2013). The diagrams (Fig. 3) are subdivided into local pollen / dinocysts zones based on the key-taxa dynamics supported by results of constrained cluster analysis by sum-of-squares using CONISS for TILIA (Grimm, 1987) and bootstrap resembling with MULTIV (Pillar and Orlóci, 1996; Pillar, 1999).

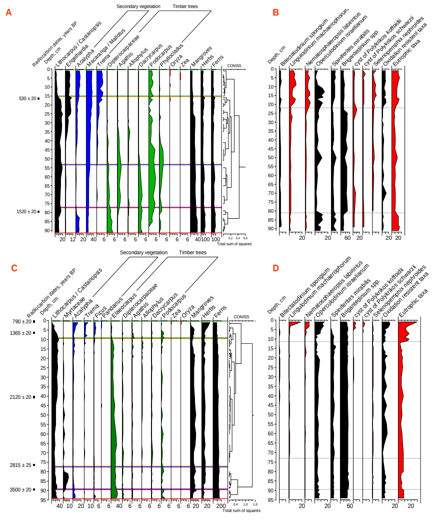

Fig. 3. Diagrams showing selected curves of relative frequencies for the core 1412_19 (A – pollen types; B – dinocyst types) and core 1609_30 (C – pollen types; D – dinocyst types).

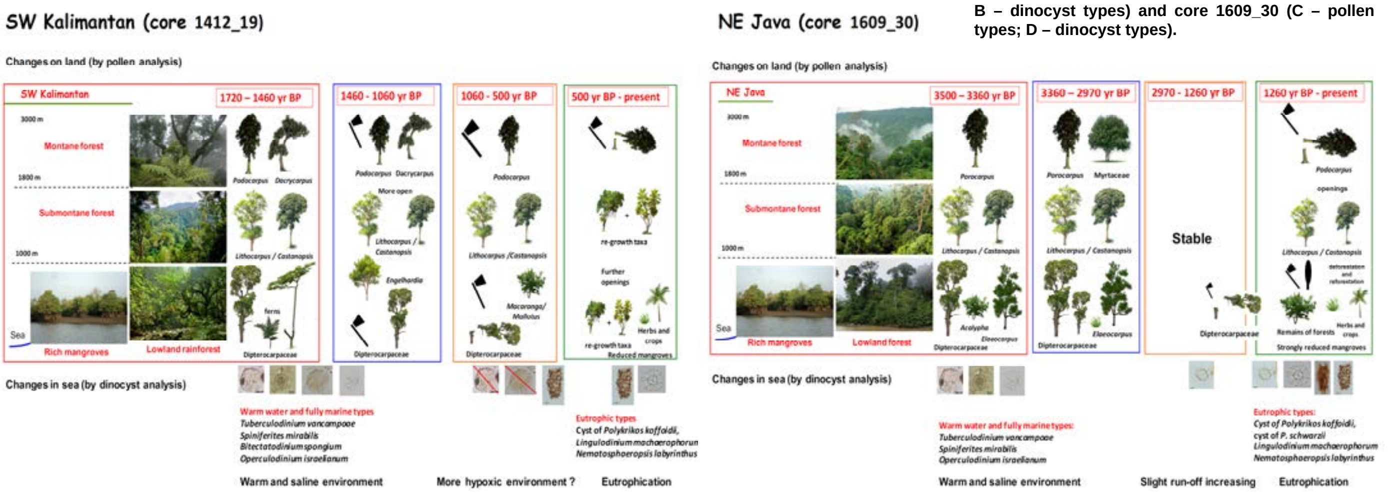

Fig. 4 Reconstruction of the vegetation and environmental changes on land (SW Kalimantan and NE Java) and in the Java Sea inferred from pollen and dinocyst analysis. Altitudinal structure follows Stuijts (1993).

Results

The total period covered by the marine core 1402-19 (SW Kalimantan) starts from ca. 3,500 ± 20 yrs BP and by the core 1609-30 (NE Java) - from ca. 1,720 ± 20 yrs BP. The dynamics of selected pollen (Fig. 3 (A, C) and dinocyst (Fig. 3 (B, D) types is shown in diagrams. The vegetation change, both in Kalimantan (Fig. 4, left) and in Java (Fig. 4, right), has a trend to more open forest canopy. At modern times, those changes are probably a consequence of logging and/or forest fires. The human impact is evident, particularly with the increase in re-growth woody taxa (Macaranga-Mallotus, Acalypha, Ficus, Trema) and herbs (Poaceae especially) as well as in marked decrease in timber trees (Dipterocarpaceae, Agathis, Allophyllys) and coniferous (*Podocarpus, Dacrycarpus, Phyllocladus*). The increased role of *Engelhardia* between ca. 1400 and 1060 yrs BP in Kalimantan may point to the maintenance of peatland forests. Large amount of tree-ferns (e.g. *Cyathea*) suggest wet and stable conditions.

The most intensive vegetation changes took place from at least 1400 -1200 yrs BP and were likely coupled with forest disturbance (logging, and/or forest fires) and resulted during the last 400 years in a reduction of lowland and submontane rainforest in Kalimantan. Strong changes from the forest to an open landscape on Java are supported by the shift from relatively well ventilated to somewhat more hypoxic and eutrophic condition in the marine environment. Additionally, dramatic reduction of mangroves was noted on Java. Evidences of crop breeding were found since ca. 360 yr BP (pollen grains of *Zea mays* type) – ca. 240 yr BP (first pollen grain of *Oryza* type).

Conclusions

✓ Different vegetation types in SW Kalimantan and NE Java are well reflected in the marine sediments. Environmental changes can be clearly detected by the pollen record.

✓ Both in Kalimantan and Java, wet climatic conditions are suggested since last ca. 3,500 years.

✓ Marked influence of human activity from at least 1400 -1200 yrs BP is indicated by pollen data. The strongest anthropogenic impact in the study region started at around 400 years ago and was more intensive in NE Java (excessive deforestation resulted in changes from the forest to an open landscape and reduction of mangroves) than on SW Kalimantan.

✓ Changes in the vegetation (opening of the forest canopy and development of the secondary forest) coupled with logging and/or forest fires are corresponding with changes in the sea (shift from relatively well ventilated to more hypoxic and to eutrophic condition, increase of river run off).

✓ The crop cultivation is evidenced since 360 yr BP (rice) and since 240 yr BP (maize).

✓ According to dinocyst data, changes in the marine environment took place with a slight delay compare to changes on land.

References

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