Development of a growth-ring analysis technique for tropical trees

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Although the equatorial atmosphere plays a key role in global climate change, its behavior has not been clarified yet, because long-term ground-based meteorological observations are scarce so far. Growth-ring analysis of tropical trees (dendroclimatology) seems to be a promising technique for reconstructing climate variations. Because precipitation is one of the most significant factors affecting tree growth in the tropics, a growth ring is formed in a tropical forest, having a clear annual dry season when hardwood shed their leaves.

In this study we conducted a survey trip in Indonesia in order to collect various tree samples, and finally selected teak (Tectona grandis) and sungkai (Peronema canescens) for our growth ring analysis. There are only a few reports on dendroclimatology in Indonesia except a pioneering study using teak by H. P. Berlage (1931) and a follow-on researches by G. C. Jacoby and R. D. D'Arrigo (1989-90, 1994). This study applies image processing to analysis of growth ring in a transverse section, and aims at developing an automatic analysis system which enables us to process a large amount of samples taken from, for example, a teak plantation. Firstly a digital camera and scanner are employed to take pictures of tree's transverse section, then, characteristics of growth ring are investigated by adopting image-processing techniques. We estimated tree growth rate from an increment of growth ring area. This is better than the growth ring width, because transverse section of a tropical tree do not normally appear concentric, but are significantly deformed depending on radial directions. We demonstrated the effectiveness of this technique by applying it to teaks from Kertsono, east Java. Consequently, a strong correlation is observed among increments of different transverse sections from the same tree, and also between increments of different trees sampled in a nearby area. This indicates that tropical tree rings could contain meaningful signals about the environment, such as precipitation, drought, etc.

In addition, we analyzed teak and sungkai samples collected from several locations in Indonesia: sungkai from Lampung (southern Sumatra) and Serang; teak from Indramayu. Their tree growth rate is compared with total annual precipitation (May to April), which showed a good correlation especially in the sungkai from Lampung. The tree-ring analysis system developed in our study will, we hope, greatly contribute to the development of dendroclimatology in the tropics..

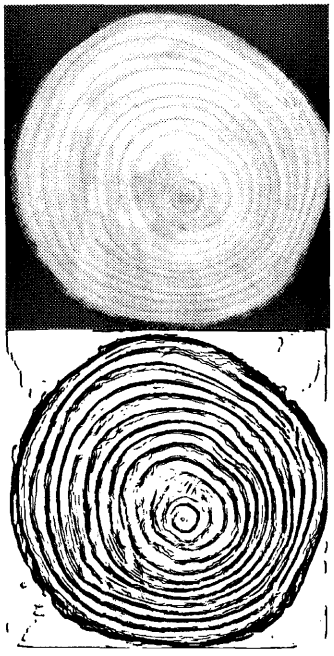

Fig. 1 Original sungkaiimage (top) and processed image with a differential filter (bottom).

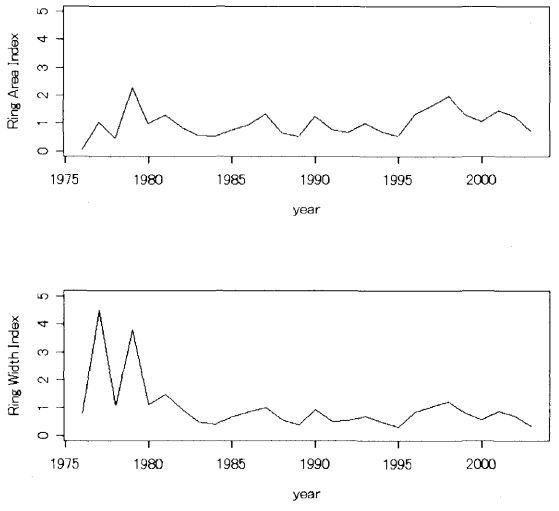

Fig. 2. Comparison between the year-to-year ring area variation as a new technique (top) and the ring width variation as a traditional method (bottom).