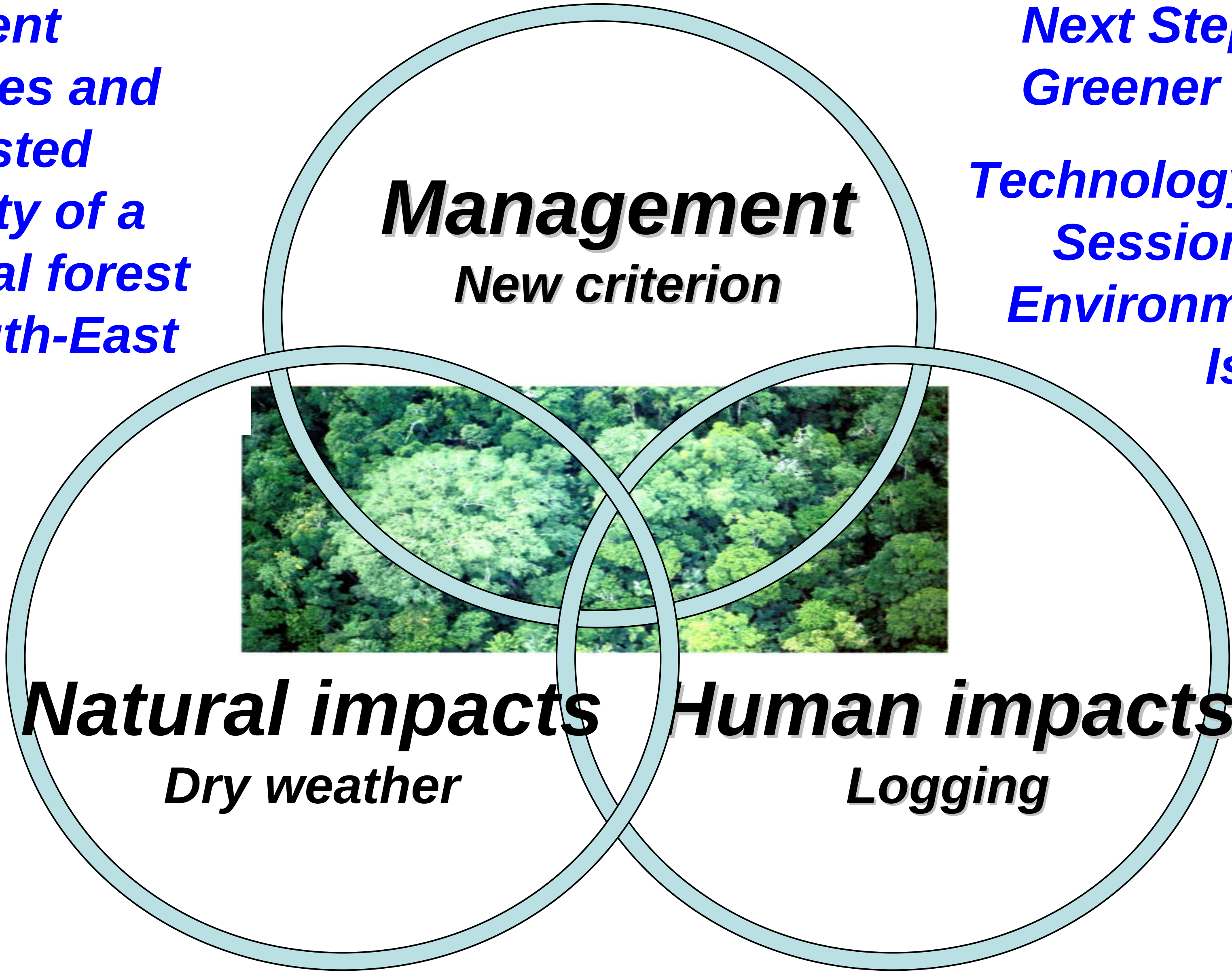
Title:
"Present changes and requested stability of a tropical forest in South-East Asia"

JUNBA 2009 – Next Step to a Greener Earth

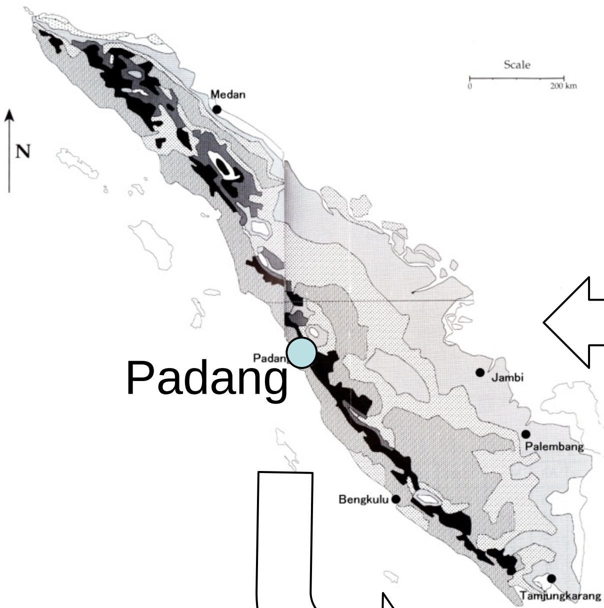
Technology Fair Session B-1: Environmental Issues

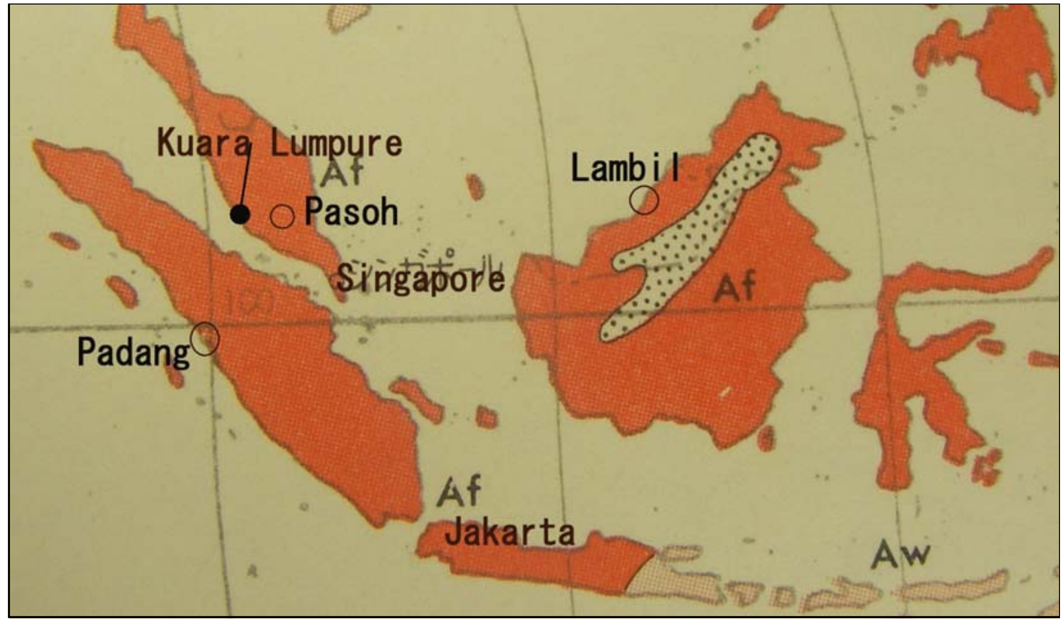


Tsuyoshi Yoneda
Kagoshima University

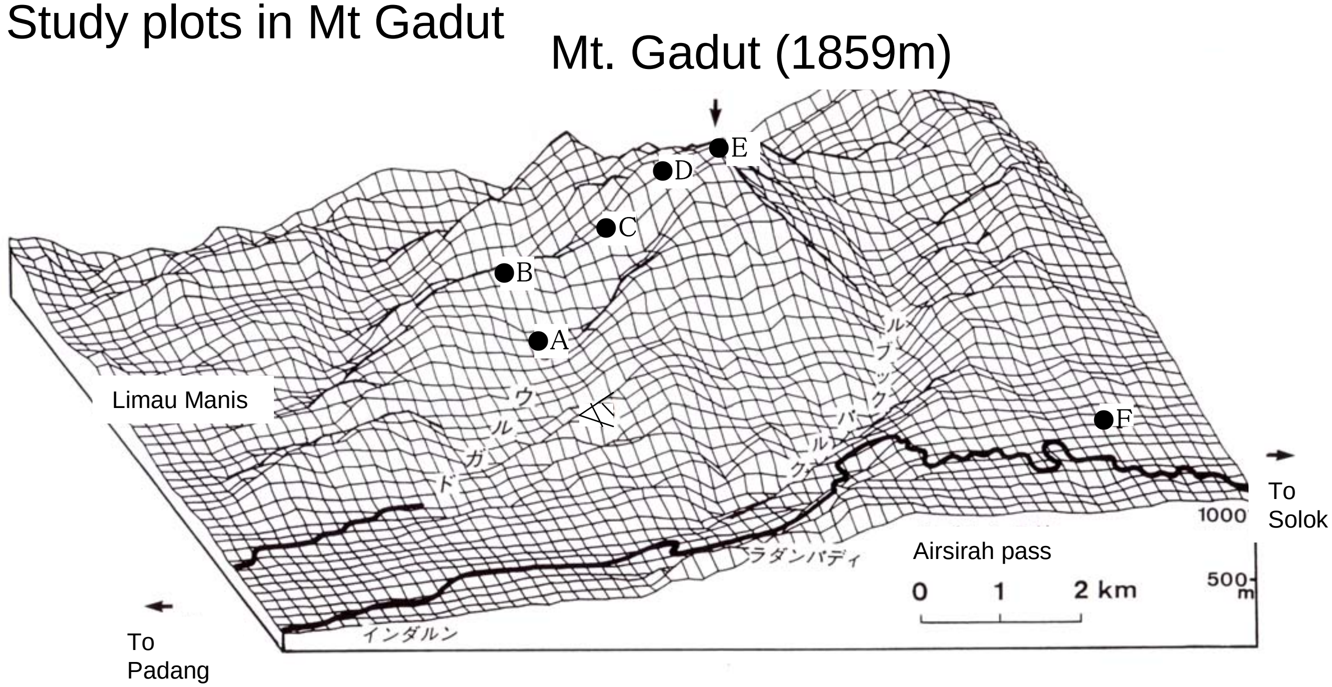
13 January, 2009
Marriott San Francisco Airport, Burlingame

Location of research area

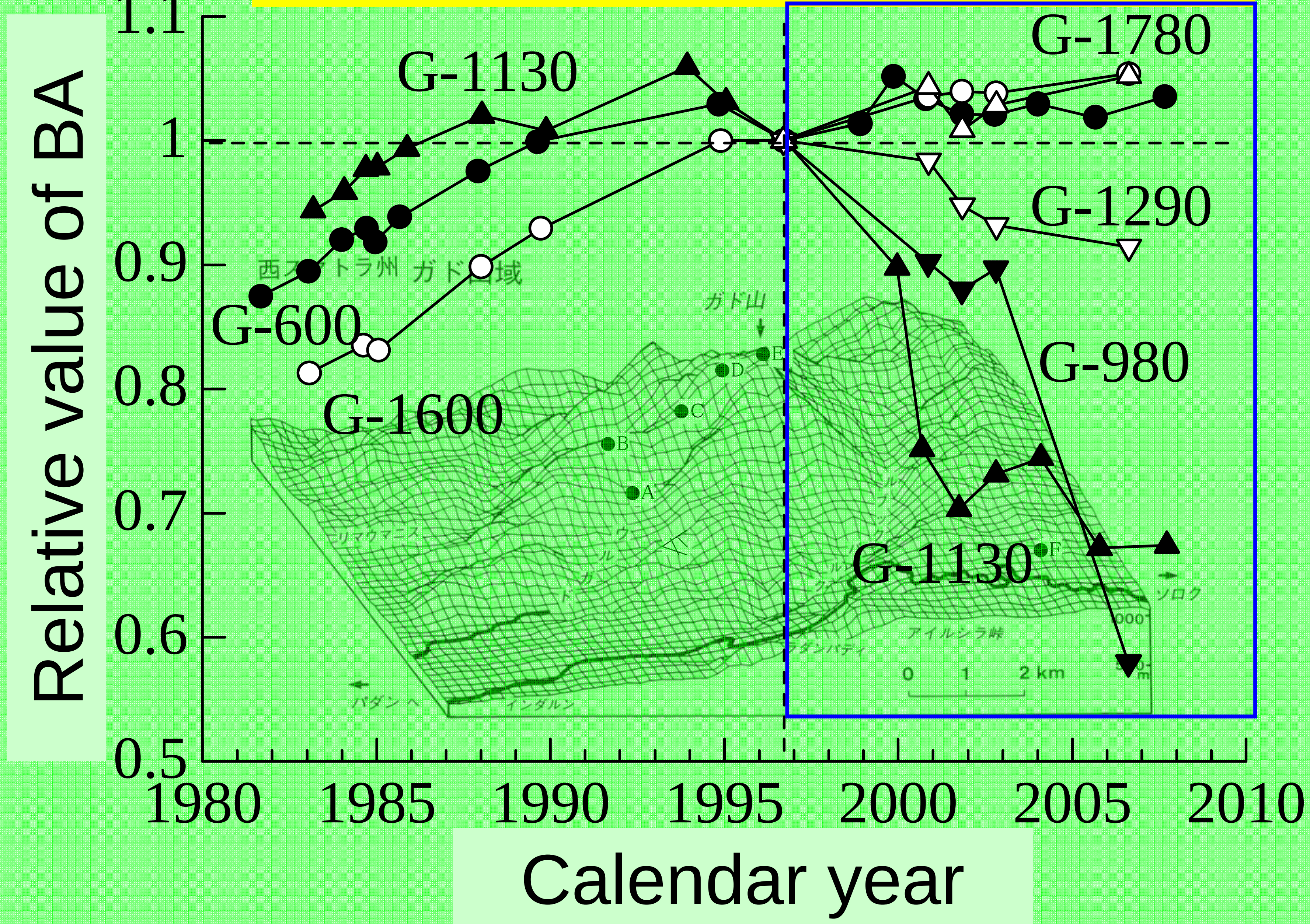




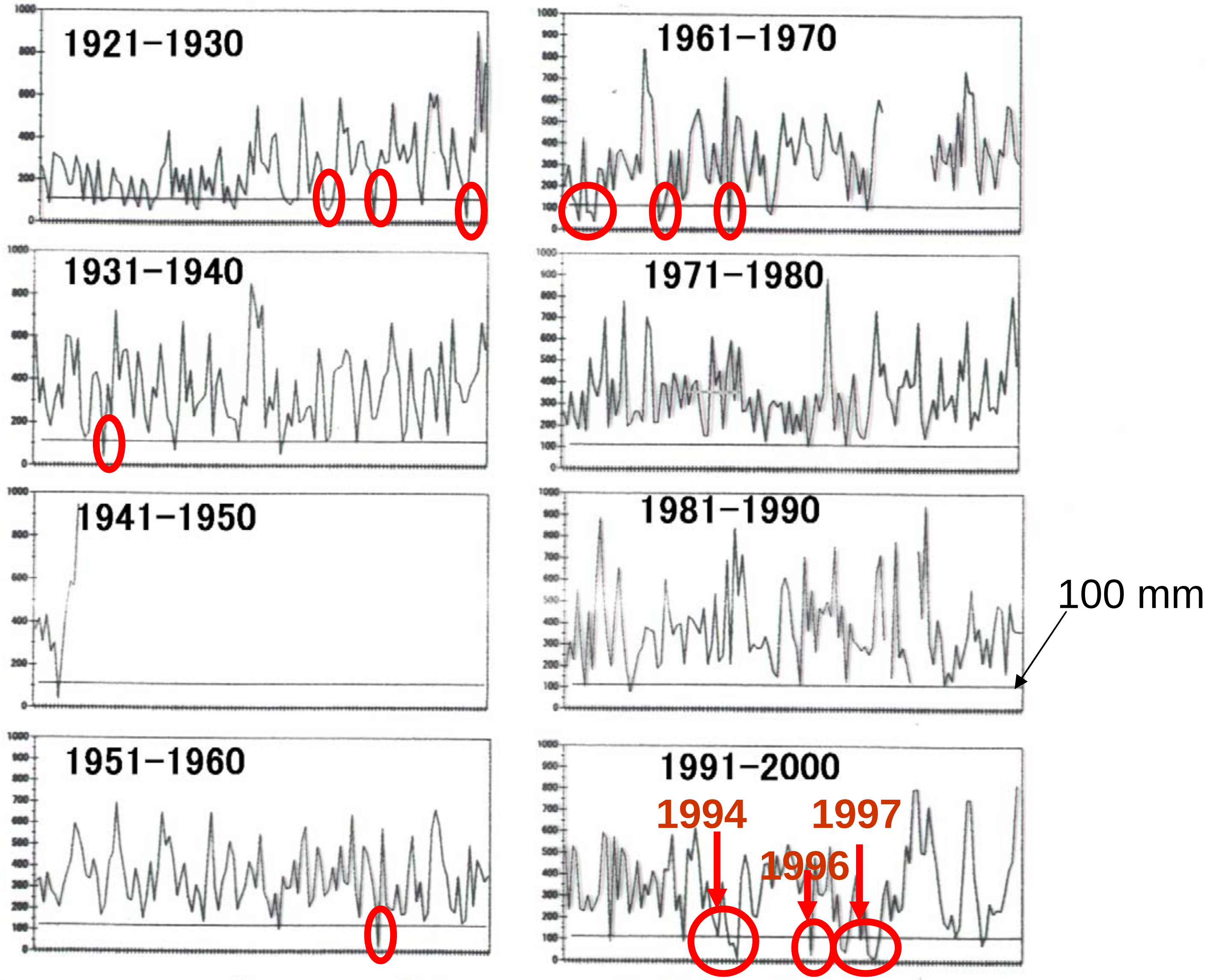
Study plots in Mt Gadut



Recent decline of biomass!

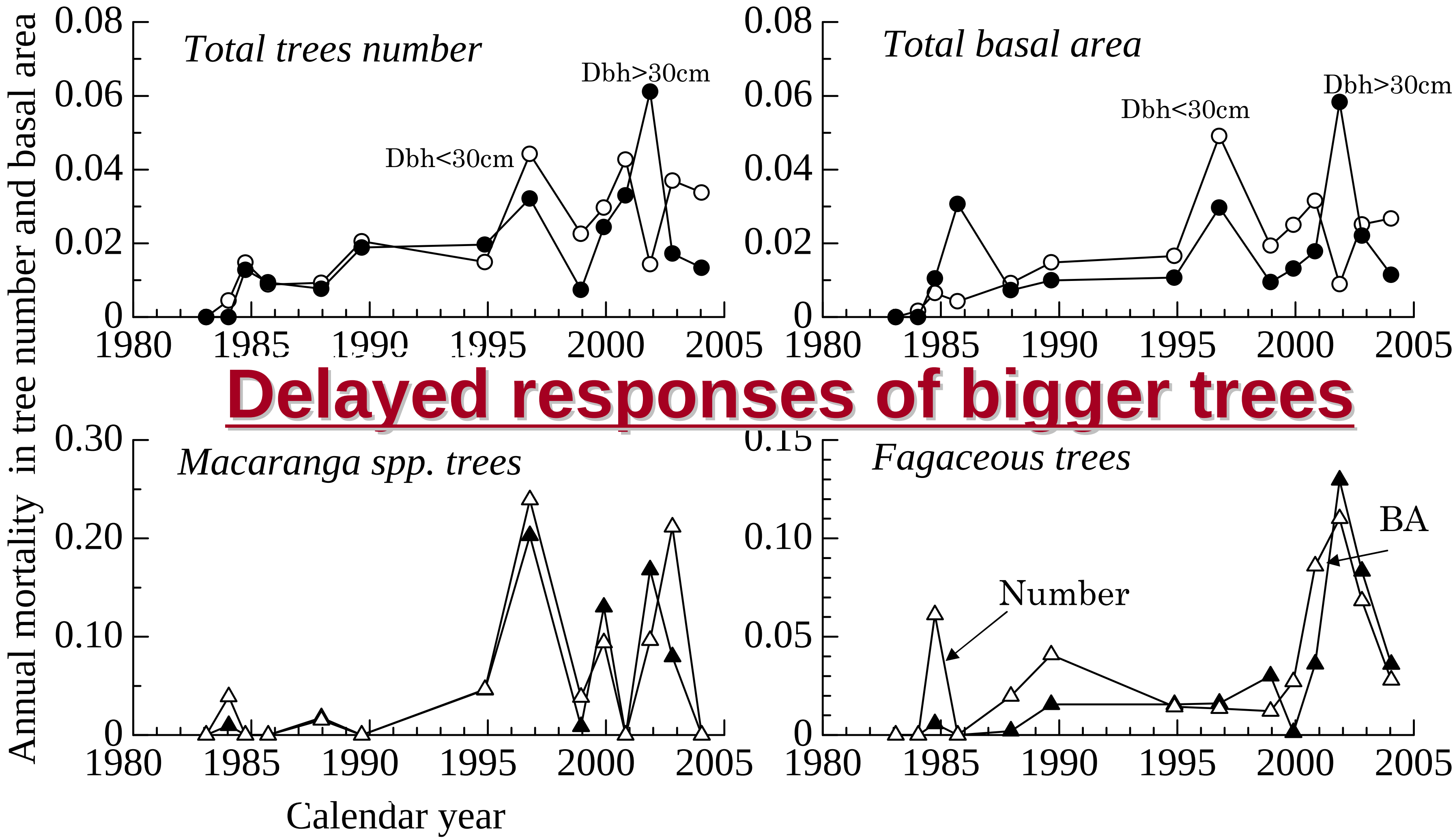


Severe dry weather in 90's



Changes of monthly rainfall at Tabing, Padang

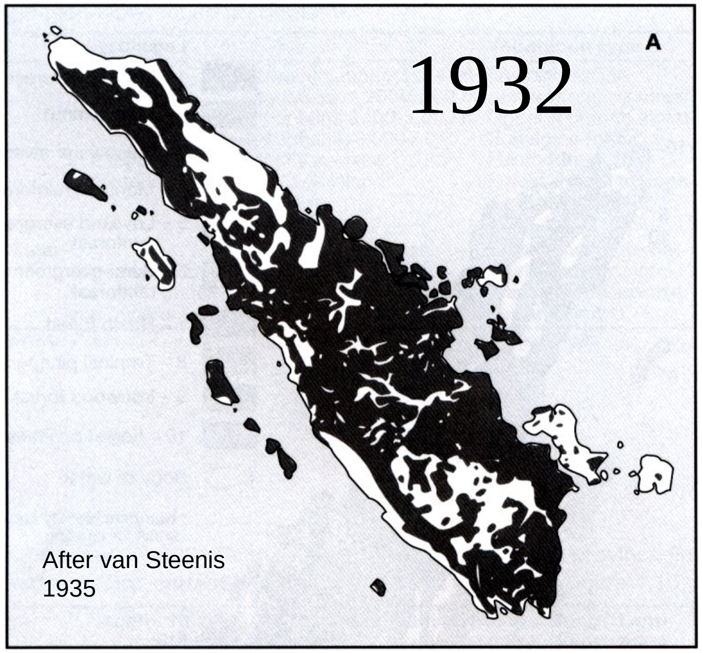
Responses in mortality to dry weather

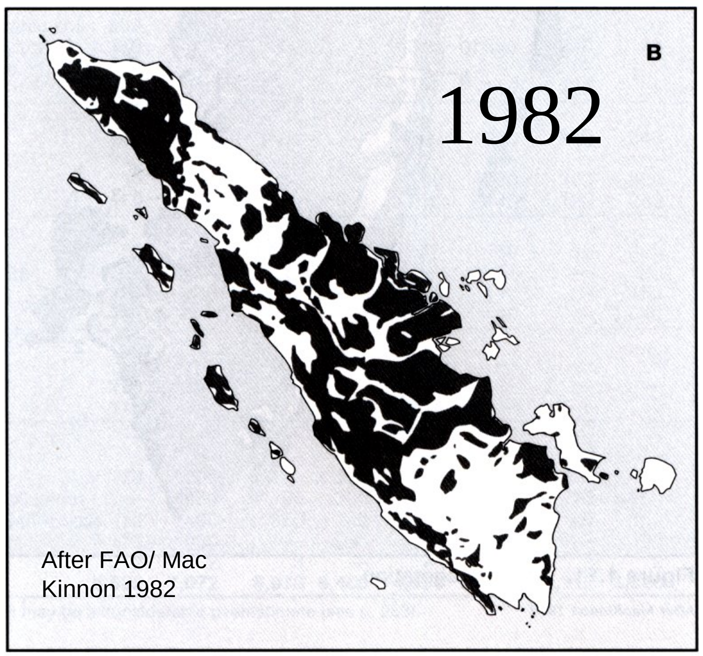


Delayed responses of bigger trees

Quick responses of pioneer species

Fragmentation by logging





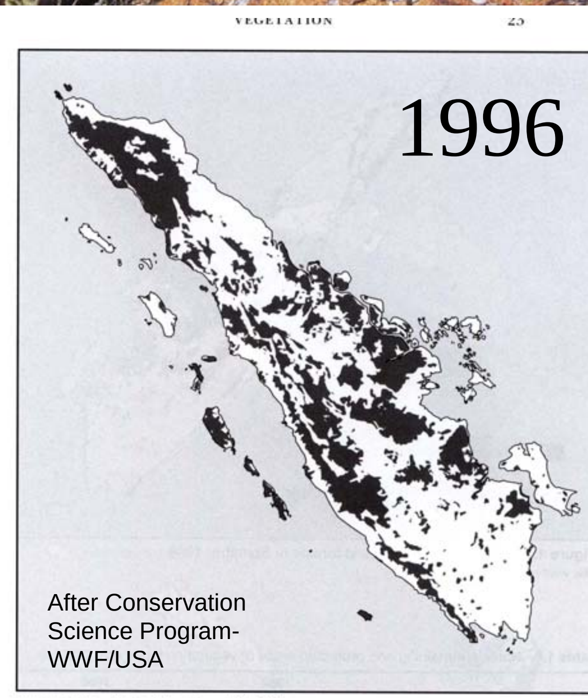
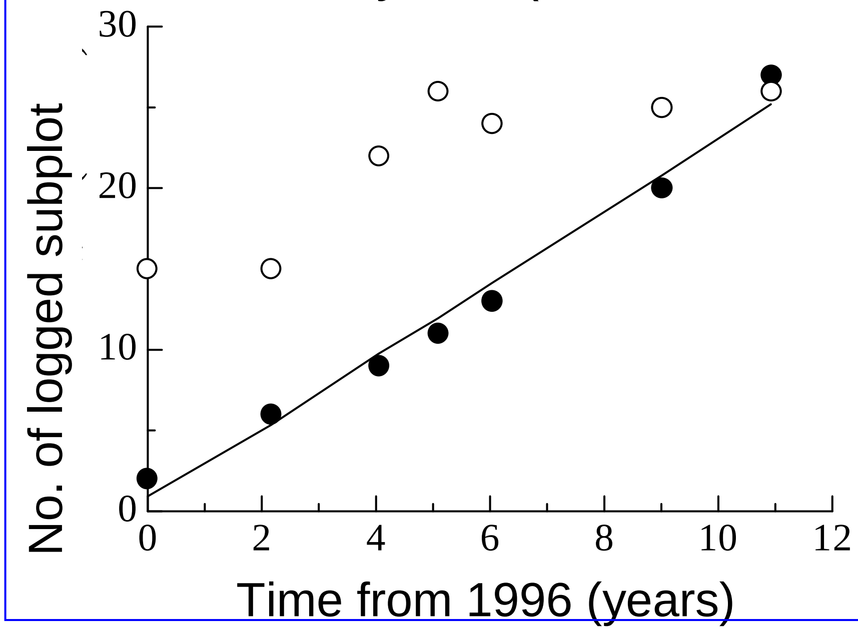


Figure 1.13. Remaining forest in 1996.
After Conservation Science Program—World Wildlife Fund–U.S.A.

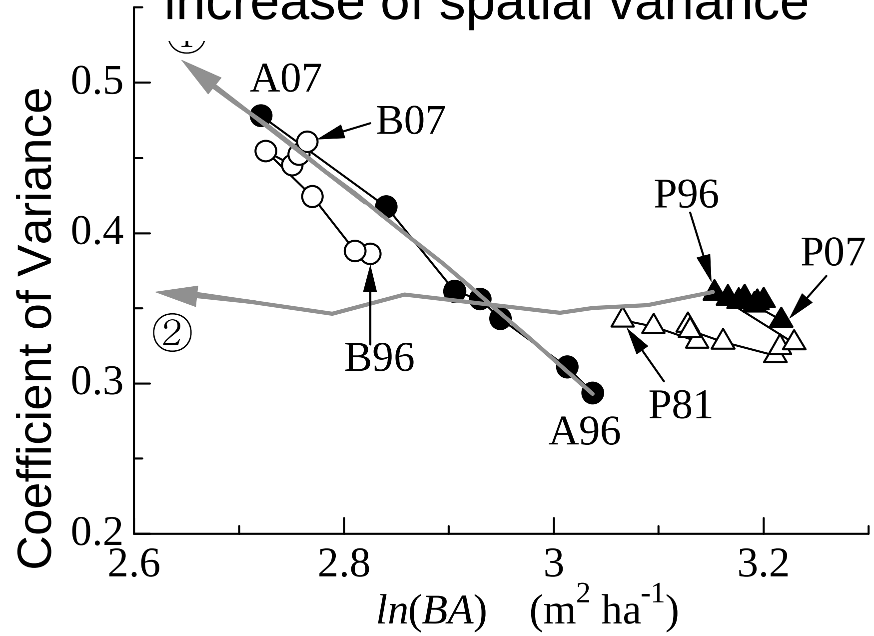
Reduction of forest structure

Observation at 6.6-ha PB plot in Ulu Gadut

Constant logging rates during the last 11 years (●)



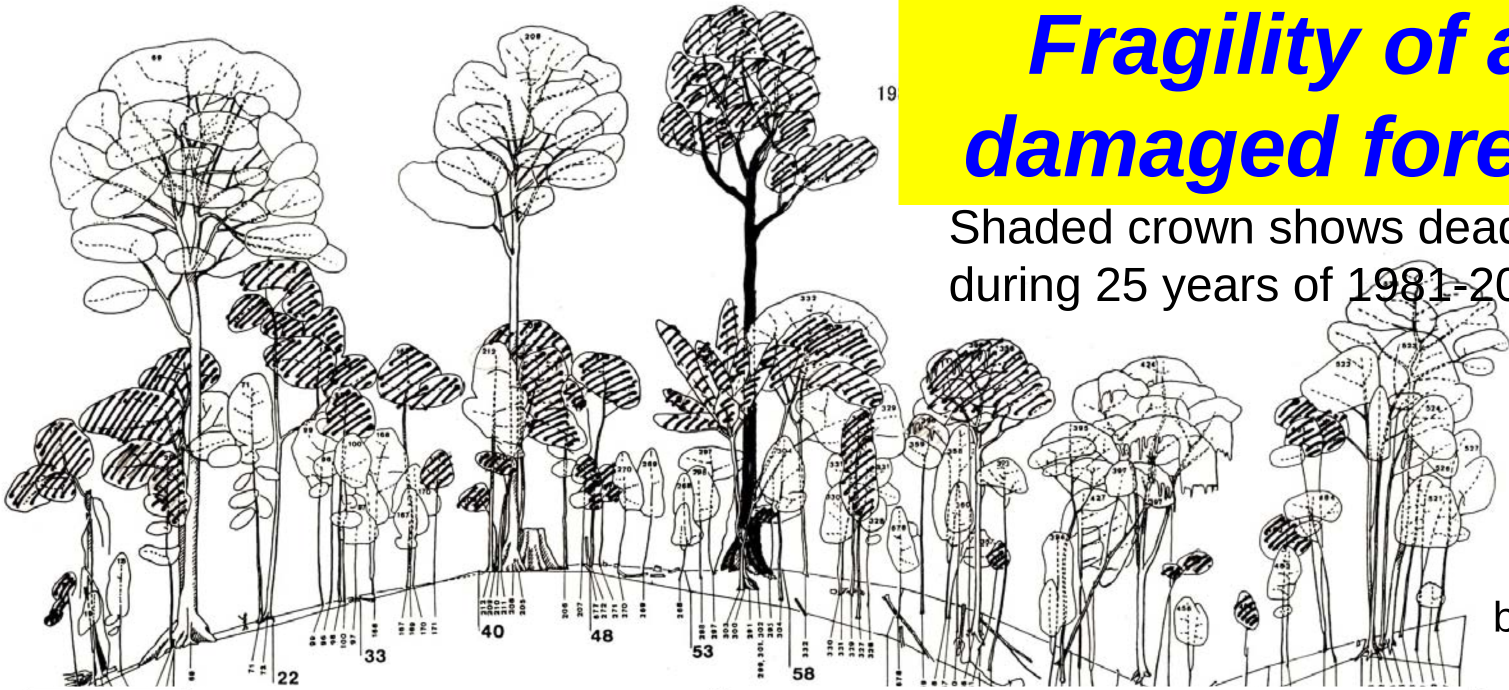
Decrease of average BA and increase of spatial variance



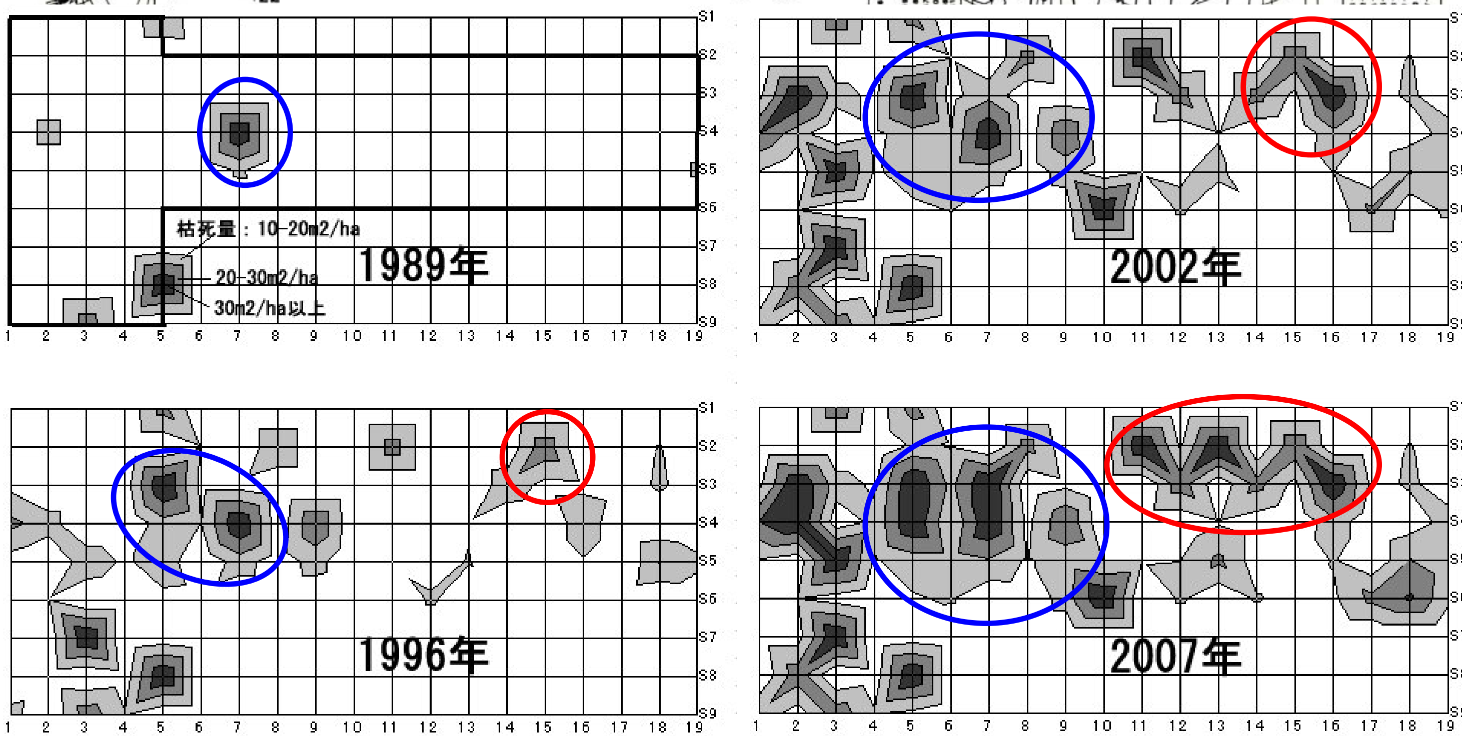
<u>Reduction of biomass in an average value and its spatial homogeneity</u>

Fragility of a damaged forest

Shaded crown shows dead trees during 25 years of 1981-2006

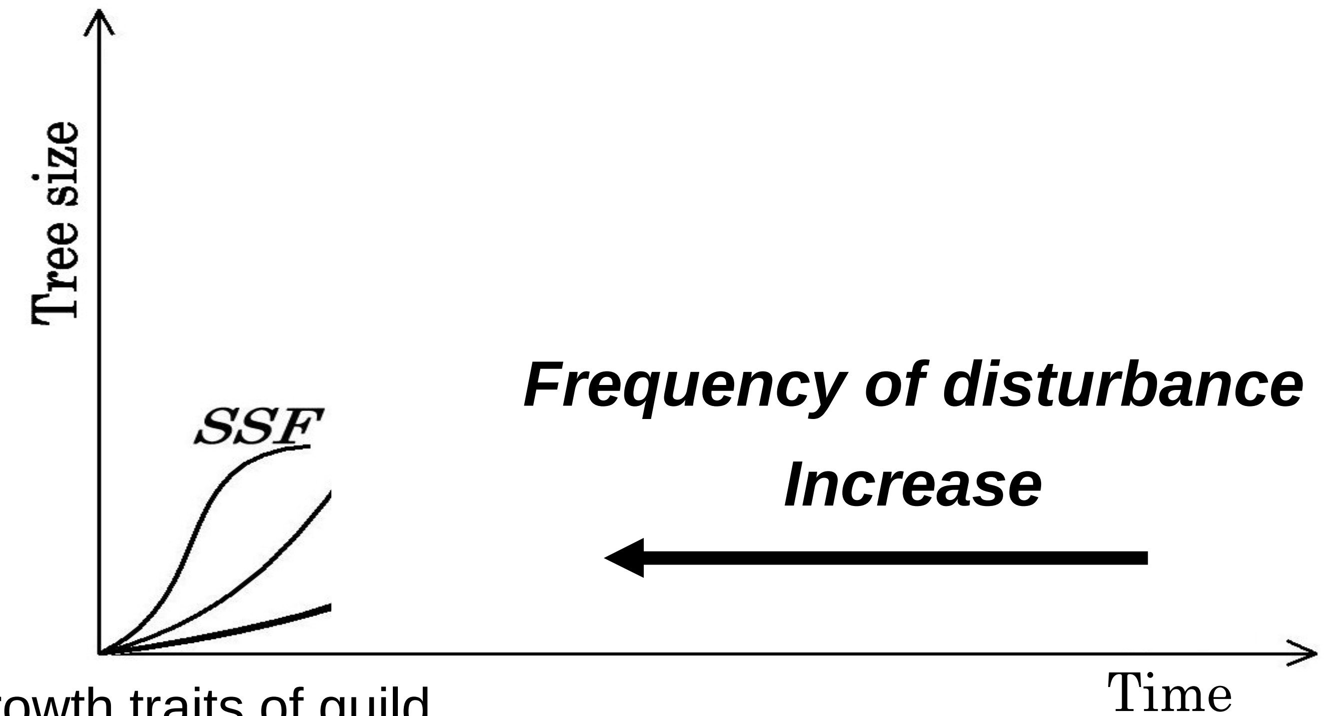


by M. Hotta



Access mortality autonomously

Deterioration of guild compsition



Growth traits of guild

SSF : Soft wood + Small tree in max. size + Fast growth rates
SBF : Soft wood + Big tree in max. size + Fast growth rates
HBS : Hard wood + Big tree in max. size + Slow growth rates
HSS : Hard wood + Small tree in max. size + Slow growth rates

Frequent disturbance could cause loss of HBS and HSS species adapting to long-life span under the stable conditions.

New logging rotation basing on economical and environmental functions

Biomass (carbon) assimilation rate

Biomass (carbon) accumulation

$$E(t)=\underline{G(t)/Gmax}+\underline{c}\times\underline{B(t)/Bmax},$$

$E(t)$: an integrated new parameter of economic and environmental functions of a forest named E-Index

$B(t)$: biomass at t years after clear cutting

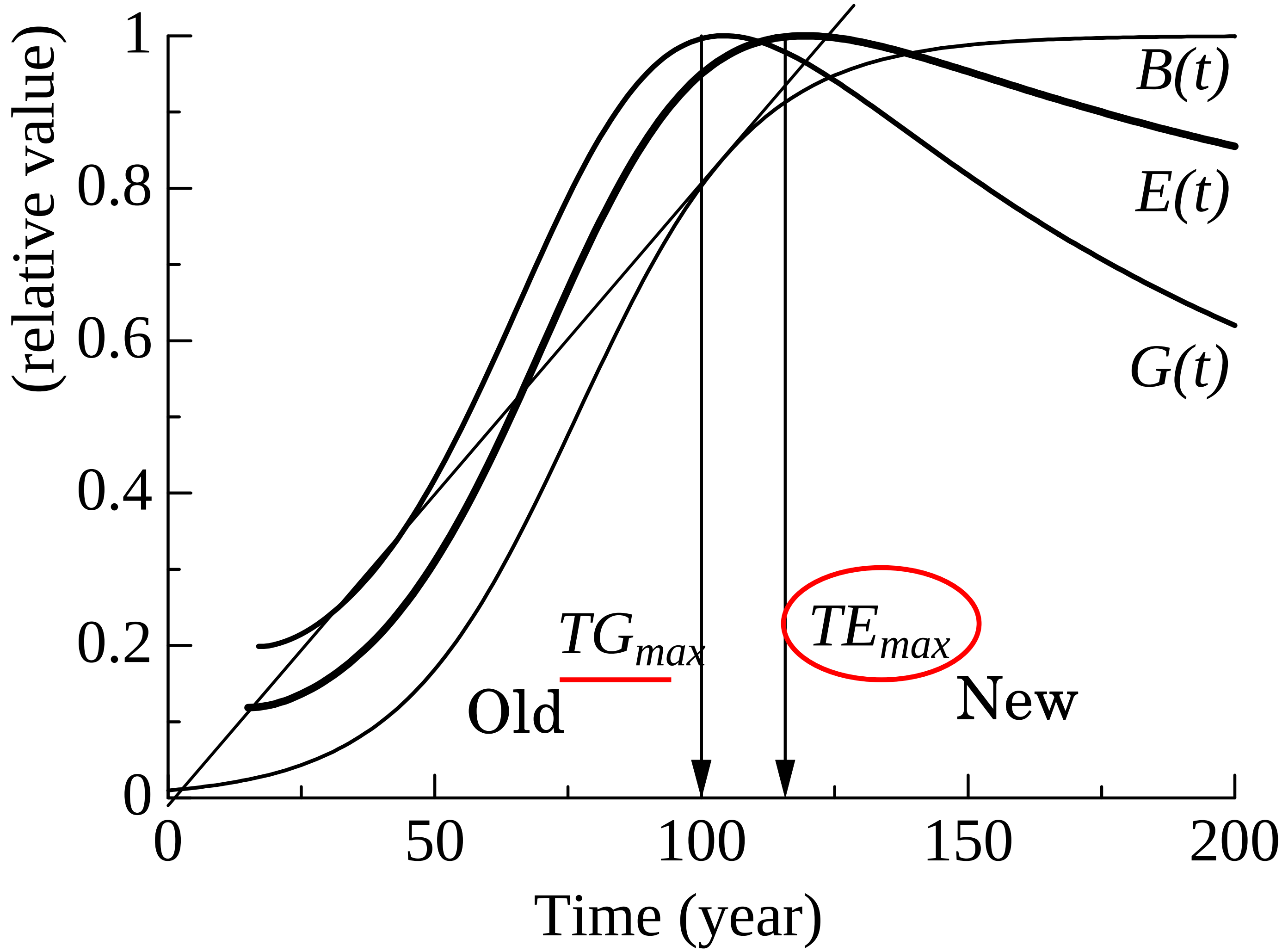
$B_{\max}$: the maximum value of $B(t)$ throughout the growth process

$G(t)$: an average growth rate of biomass during t years after clear cutting as $G(t)=B(t)/t$

$G_{\max}$: the maximum value of $B(t)$ throughout the growth process

c : a parameter showing the relative importance of biomass against growth rates

New logging rotation vs old one



TG_{max}: Rotation of Maximum Volume Production

TE_{max}: Rotation of Maximum Eco-Function

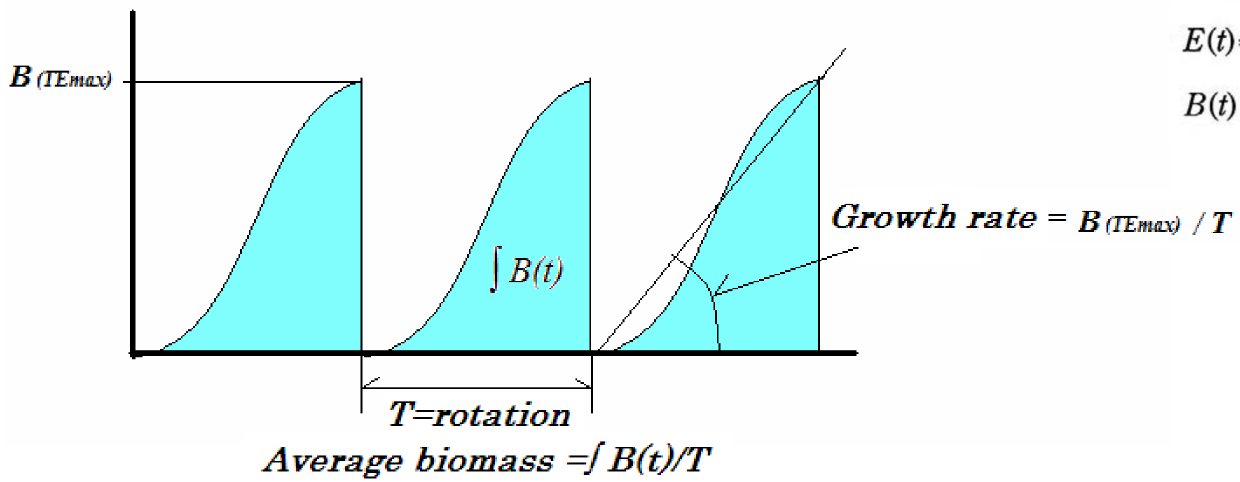
Evaluation of proposed logging rotation

Comparison between properties of the E-Index at TE_{max} and TG_{max}. Ratio of the properties at TE_{max} and TG_{max} is shown for different conditions of parameter c, relative importance of biomass against growth rate. TE_{max} was determined by numerical calculation from Eqs. (2) and (3) at $k = 99$. These ratios tend to be constant irrespective of λ value of Eq. (3).

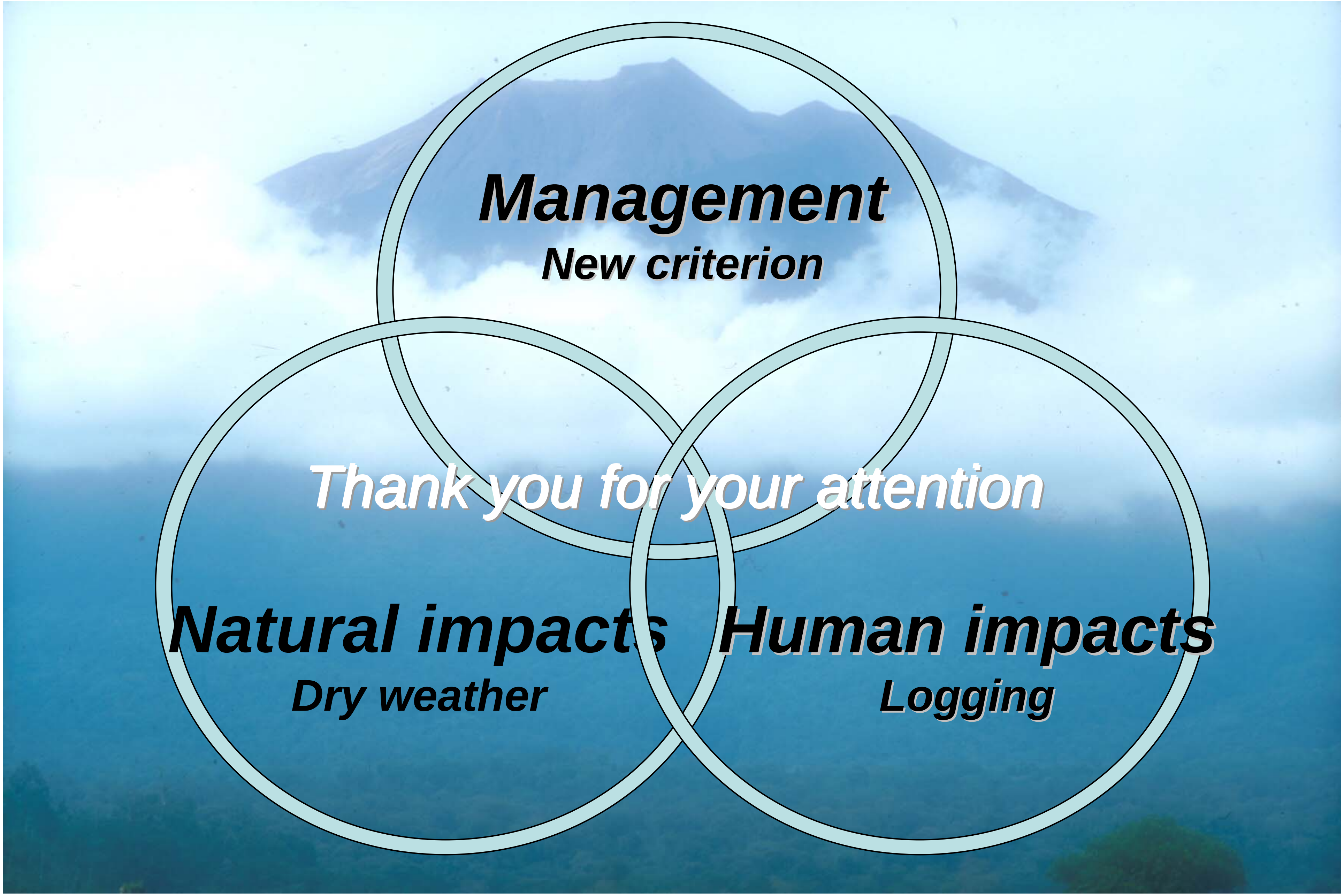
Properties	$c = 0$	$c = 1$	$c = 2$	$c = 10$
Cutting age, TE_{max}/TG_{max}	1	1.14	1.24	1.50
Biomass, $B(TE_{max})/B(TG_{max})$	1	1.10	1.14	1.18
Growth rate, $G(TE_{max})/G(TG_{max})$	1	0.97	0.92	0.79
Average biomass, $\dfrac{\int_0^{TEmax} B(t)dt}{TEmax} / \dfrac{\int_0^{TGmax} B(t)dt}{TGmax}$	1	1.23	1.36	1.67

$$E(t) = G(t)/G_{max} + c \times B(t)/B_{max}, \quad (2)$$

$$B(t) = B_{max} / \{1 + k \exp(-\lambda t)\} \quad (3)$$



<u>When we evaluate environmental functions with average biomass, new rotation at c=1 could produce 123% environmental functions at only 3% economic expenses.</u>



Mt. Kerinci: the highest mountain in Sumatra Island (3805m)