

# **Möglichkeiten und Grenzen nachhaltiger Forstwirtschaft in den Tropen und Subtropen**

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# Timber (partly 500 m<sup>3</sup> / house)



# Fuelwood (firewood & charcoal)



# Consequences of Over-Exploitation

- vast areas steppized (i.e. Lüneburger Heide) and karstized (i.e. Ore Mountains, Harz Mountains)
- mining activities due to the lack of timber reduced resp. questioned at all
- mining sector established forestry schools

# Mining and Forestry

1713, first use of the term “nachhaltig” (sustainable) by the mining officer Von CARLOWITZ

- away from pure unplanned exploitation of forest towards a form of forest management for a perpetual and consistent supply of timber and fuelwood



# Forest Management Planning



courtesy of Niedersächsisches Forstplanungsamt Wolfenbüttel

# Sustainable Management: harvest of current (wood) increment





# Sustainable Management (cont.)

Over-use is forbidden but enhancement of wood increment is permitted by suitable means  
(= indirect rise in profits)

→ voluntary limitation of timber/wood utilization  
in favour of succeeding human generations

**PLUS**

→ considerable expenditures of time, money and  
work for the care of the natural production base

# Evolution of the Principle of Sustainability

In ca 300 years of regularized forestry the principle of sustainability was extended more and more

- sustainable timber/wood mass
- sustainable forest area
- sustainable value (tree dimensions & qualities)
- sustainable protection & recreation capacity
  - resource protection
  - species and habitat protection
  - landscape protection

# Definition of Sustainability

„Sustainability is the strive and the claim for continuous and optimal supply of all material and intangible forest services to present and succeeding generations “

(after PETERS & WIEBECKE 1983)

# Sustainability

## German Federal Forests Act

### § 11 Management of Forest

„Within the framework of its general function the forest should be managed according to the rules and **sustainable**. ...“

# Beech Forest

*Fagus sylvatica*

$V_i \approx 6-8 \text{ m}^3 / \text{ha} / \text{a}$



# Veneer Timber “A” ca 1500 € / m<sup>3</sup>



Sawn Timber “B” ca 300 € / m<sup>3</sup>



Fuelwood “C/D” ca 30 € / m<sup>3</sup>





# Sustainability

## German Federal Nature Conservation Act

### § 1 Objectives of nature conservation and landscape conservation

„Nature and landscape in both populated and unpopulated areas are to be protected, cared and developed so that

1. the potential of balance of nature,
2. the utilization capacity of resources,
3. the flora and fauna as well as
4. the diversity, character and beauty of nature and landscape

as livelihood of man and as basis for his recreation in nature and landscape is **sustainably** secured.“

# Balance of Nature



# Flora and Fauna



*Hepatica nobilis*



*Leucojum vernum*

# Close-to-nature Forestry



Limestone - Beech Forest, Juehnde/Lower Saxony

# German Foresters working overseas (prior to 1914)

Cameroon (*Schorkopf, Reder, Eschrich, Wiech, Obermaier, Pfitzenmeyer, Jentsch, Büsgen, Damköhler, Berger, Schultze, Vorbricht, Kümmel, Meyer, Münder*)

Nigeria (*Christ*)

South Africa (*Schöpflin*)

Namibia (*v. Eschstuth, Tressel*)

Togo (*Metzger, Schuppius, Jentsch, Gropp*)

Burma, India, Pakistan (*Brandis, Ribbentrop, Schlich*)

China (*Haas, Thomas, Klimant, Krampe, Prediger*)

Japan (*Mayr, Grasmann, Hefele*)

after MAMMEN (1964)

Cont.

# German Foresters working overseas (prior to 1914)

Malaysia (*Christ, Hummel*)

New-Guinea (*Deiningen, Kempf*)

Java (*Nemnich, Mollier, v.Rössler, v.Hertling, Seubert, Nitzschke, Seibt, Carl, Jost, Eckert, Gresser, Hofmann, Nirschl, Rahm, Sihler, Büsgen*)

Philippines (*Klemme*)

Brasil (*Freise*)

Uruguay (*Müller*)

U.S.A. (*v.Fernow, v.Steuben, Schenck*)

Kanada (*v.Fernow*)

after MAMMEN (1964)

# Dr. Dietrich Brandis



1824-1907

In Burma 1856-1868

Myanmar Selection System (modified BRANDIS Selection System, initiated in 1920 by Myanmar Forest Department)

Year	Operations	Activities and explanations
E-3	1) Girdling of teak trees ( <i>Tectona grandis</i> LINN. f.)	- teak trees are marked according to AAC and girdled (Nov. to Feb.) (exploitable dbh limit: 73 cm for moist teak forest and 63 cm for dry teak forest)
	2) Enumeration of all residual teak trees	- all teak trees $\geq 39$ cm dbh left ungirdled are enumerated and recorded
	3) Improvement felling ("O felling")	- climber cutting - felling of <i>Ficus</i> -bound teak trees, and - removing useless species in favour of teak
	4) Thinning and cleaning	- thinning to be carried out within groups of crowded young teak trees, and - removal of undesirable mature trees and bamboos overtopping with the main crop
E-1	1) Selection marking of species other than teak	- commercial species are marked for extraction according to AAC and working plan descriptions, minimum dbh limit varied upon species (Jun. to Sept.)
	2) Enumeration of marketable residual species	- all commercial trees of below 10 cm the exploitable dbh are enumerated and recorded
E	Extraction	- fellings of girdled teak and marked commercial species (Jun. to Aug.) - removal of inferior trees suppressing teak and its valuable associates, and - cutting of dead and moribund trees
E+1	1) Improvement felling ("Y felling")	- improvement felling of seedlings and saplings of undesirable tree species, and opening up of patches of established advanced growth of teak (Jun. to Aug.)
	2) Line enrichment and gap planting	- supplement of natural regeneration of teak and improve proportion of valuable spp., - "special operations are carried out to induce natural regeneration of teak in areas where bamboo flowering occurs"
E+1 to E+5	Fire protection	- weeding and cleaning of undergrowth and controlled burning (Feb. to May) - construction of fire lines in dry season

E: Year of exploitation (using a 30-year felling cycle), AAC: Annual Allowable Cut

# Forest Loss in the Tropics

12.5 Mio ha natural forest / year (FAO 1999)

among these

86-94 % by agriculture (with a 41-49 % share of shifting cultivation)

2 % large-area infrastructure and development projects

2-10 % non-adapted timber utilization

(AMELUNG & DIEHL 1991)



# Sequence of Forest Change

(example: tropical moist deciduous forest, E-Paraguay)

## 1. Selective stem extraction



MITLOEHNER 1998

# Sequence of Forest Change

## 2. Shifting cultivation



MITLOEHNER 1998

# Sequence of Forest Change

## 3. Cultivation of cash crops



# Sequence of Forest Change

## 4. Extensive pasture management



# Sequence of Forest Change

## Understandable Process:

- dependent on salable forest products
- dependent on soil fertility
- dependent on regionally effective market conditions

→ To put forest into value is the condition for **sustainability**

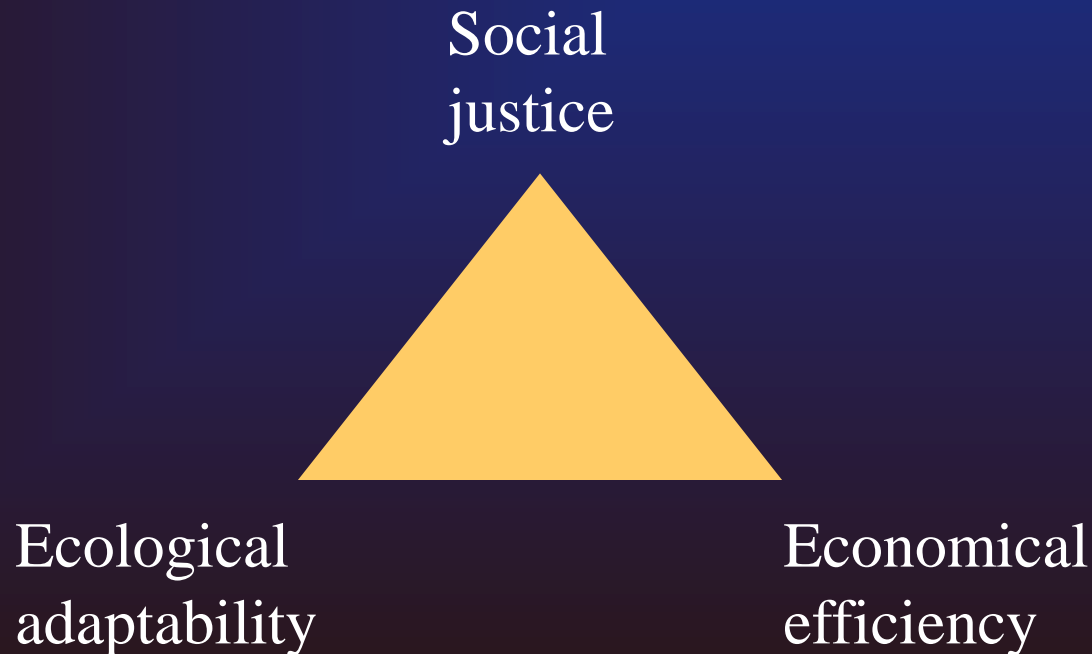
# International Attention

UN-Conference on Environment and Development (UNCED), Rio de Janeiro 1992:

- **Sustainable** forest management was identified as one of the promising strategies to prevent the serious issue of tropical deforestation.

# UNCED (Rio `92)

Triangle of goals of sustainability:



# Global Concepts of Forestry

- Plantation forestry
- Close-to-nature forestry
- Forest nature conservation

economical  
basis is pre-  
requisite



# Plantation Forestry

**Objective:** Production of largest timber/wood quantity and desired quality in the shortest period of time with reasonable price

Global boom after 1945

- a) internationalism,
- b) recognition of the enormous growth potential,
- c) political independence and pressure for own development (EVANS 1992).

# Plantation Forestry

Research: Denmark, U.S.A., Brazil

<u>Area</u> :	Europe	17 %	}	187 Mio. ha
	Asia	62 %		
	North /Central America	9 %		
	South America	6 %		
	Africa	4 %		
	Ozeania	2 %		

(CARLE *et al.* 2002)

# Production under Plantation Management



*Eucalyptus grandis* -Plantation Klabin, Brazil

# Forest Plantations




- Production (wood increment):  
 $V_i$  of ca 35-50 m<sup>3</sup>/ha/a, industrial assortments
  - Regeneration:
    - use of modified plant material
    - global choice of species/provenances/clones
    - only light demanding tree species (pioneers)
    - (large) clear felling regeneration techniques
  - Site:  
locations ± free of limiting factors (light, temperature, water, nutrients, i.a.)
- only in planar or kolline areas:  
Transportation costs < 20 % of selling price (COZZO 1976)

# Silvicultural System (*Eucalyptus spec.*)

Time Frame*	Measures	Questions
-3 to -1 ↓	seed procurement	species ? provenances ?
-1,5 or less ↓	plant production in nursery	bare rooted ? container plants ?
-0,5 to -0,1 ↓	soil working	intensity ? rate of planting ?
0 ↓	planting	spacing ? fertilizer ?
0 to +3 ↓	maintenance	mechanical ? chemical ? fertilizer ?
+7 to +10	clear felling	maximum stem biomass acc., $dgz_{max}$ ?

\* ) = years before/after planting

# Tree (Plantation) Improvement Program

Operation	Questions	Measures
Tree species selection 	Technical qualities ? Site adaptability?	Wood & w.content analyses Climate and soil comparisons Mapping (spec. site/stand deliniations)
Identification of variability 	Growth performance ? Stem form ? Adaptation capacity ? Wood density ? Fibre length i.a. ?	Inventory system Sample plot design, Permanent observation plots Forest mensuration Yield analyses & predictions Wood, wood content & paper analyses
Isolation of desired qualities 	Site related? Gene related ?	Progeny tests Mating designs

# Tree (Plantation) Improvement Program

<p>Bundling of qualities</p> <p style="text-align: center;">↓</p>	<p>Which qualities ?</p> <p>Within a species or among species?</p> <p>Grade of relation between different species ?</p>	<p>Controlled Pollination</p> <p>Hybridization</p> <p>(„genetic engineering“)</p>
<p>Multiplication</p>	<p>generative ?</p> <p>vegetative ?</p>	<p>Seed collection area</p> <p>Seed production area</p> <p>Seed orchard</p> <p>Micro cuttings</p> <p>Micro propagation</p>
<p>Conservation of genetic base population</p>	<p>in situ ?</p> <p>ex situ?</p> <p>in vitro ?</p>	<p>Seed bank</p> <p>Clone bank</p> <p>Conservation stands</p> <p>Nature conservancy</p>

# Problems of Plantation Forestry



*Eucalyptus*-Hybrids near  
Beisha, Hainan / PR China





# (Forest) Nature Conservation

**Definition:** “An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means”

International Union for Conservation of Nature (IUCN)

# Forest Nature Conservation

Research: United Kingdom, Thailand, Costa Rica

108.000 protected areas worldwide: **3.043 Mio. ha**

Areas of protected tropical moist forests:

Asia **3,6 %**

South/Central America **15,1 %**

Africa **7,6 %**

(FAO 2003)

# Forest Nature Conservation

- Production (wood increment):  
*no timber production* but conservation and procurement of genetic resources (seeds), research on natural forests
- Regeneration:
  - **natural regeneration** of site-adapted growing stock
  - **regional** choice of tree species/provenances
  - **light demanders, shade bearers, gap opportunists**
  - eradication of invasive alien species, control of weeds (e.g. *Imperata* spec.)

## Site:

Localities **with unique landscapes, vegetations, organisms**  
**PLUS limited human disturbance – planar, kolline, montane**

# Close-to-nature Forestry

Research: France, Austria, Germany

(potential)

<u>Areas</u> :	Europe	27 %	}	3.869 Mio. ha
	Asia	14 %		
	North /Central America	14 %		
	South America	23 %		
	Africa	17 %		
	Ozeania	5 %		

(FAO 2003)

# Close-to-nature Forestry

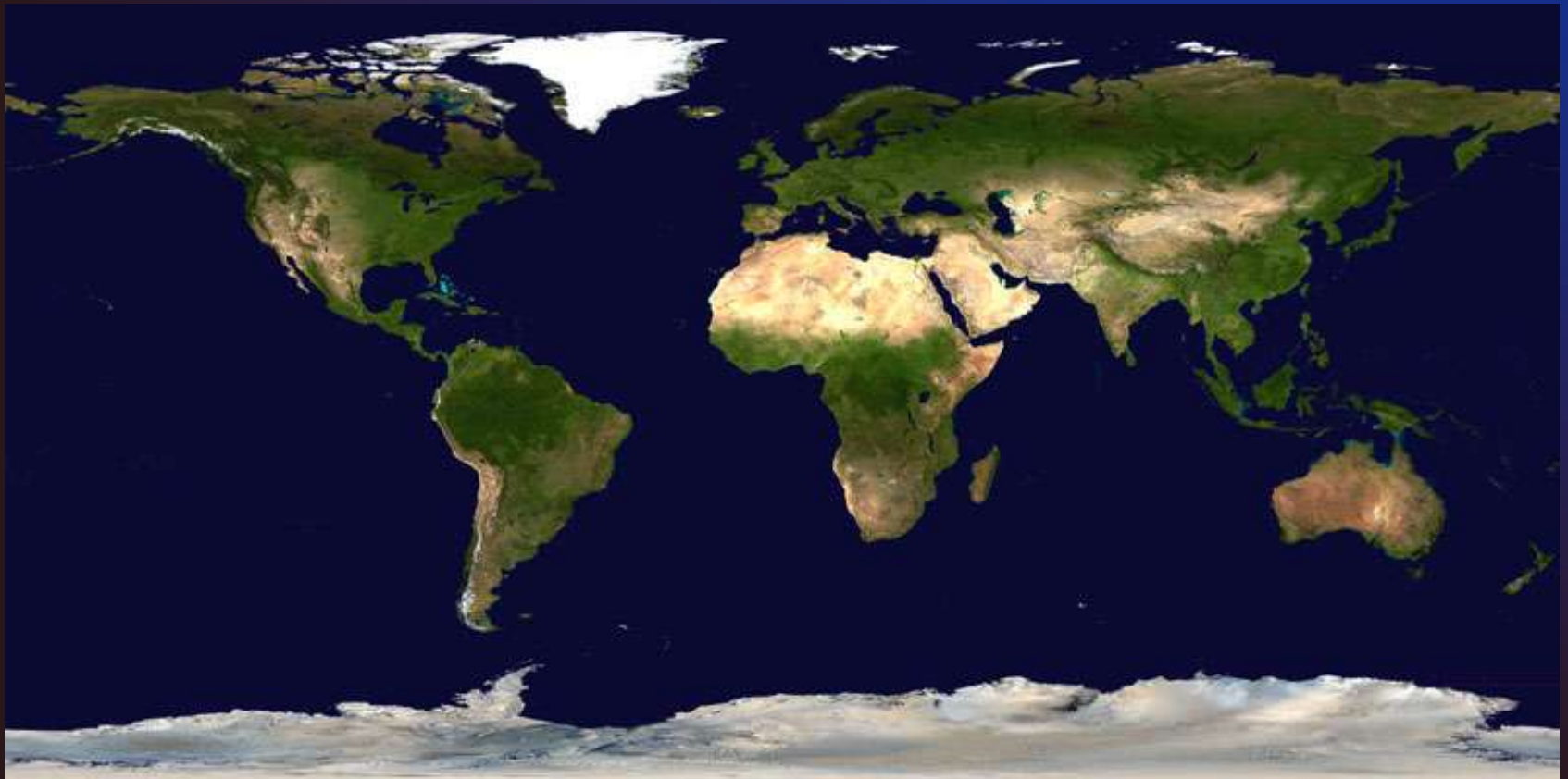
- Production (wood increment):  
 $V_i$  of ca 6-8 m<sup>3</sup>/ha/a, **valuable hardwoods** & industrial assortments
- Regeneration:
  - **natural regeneration** of site-adapted growing stock
  - **regional** choice of tree species/provenances
  - light demanders, **shade bearers**, **gap opportunists**
  - **continuous cover**: edge felling, shelterwood, **femel felling**, **selection felling** regeneration techniques
- Site:  
Localities – **indispensable** where **continuous cover** has to **counteract soil erosion**: steep terrain, mountainous areas, steep terrain, seacoasts, catchment areas, riverine sites

# Close-to-nature Forestry



Limestone - Beech Forest, Juehnde/Lower Saxony

Between Tropic of Cancer  $23.5^{\circ}$  N  
& Tropic of Capricorn  $23.5^{\circ}$  S



# Close-to-nature Forestry

## Necessity: Research on Natural Forests



Primary natural forest near Beisha, Hainan / PR China



# Continuous-cover indispensable



Photos: H.-J. Weidelt

# Tropical Forest Formations

(after LAMPRECHT 1986)

**Zonal Formations** (mainly result of climatic factors):

Moist evergreen forest

Moist deciduous forest

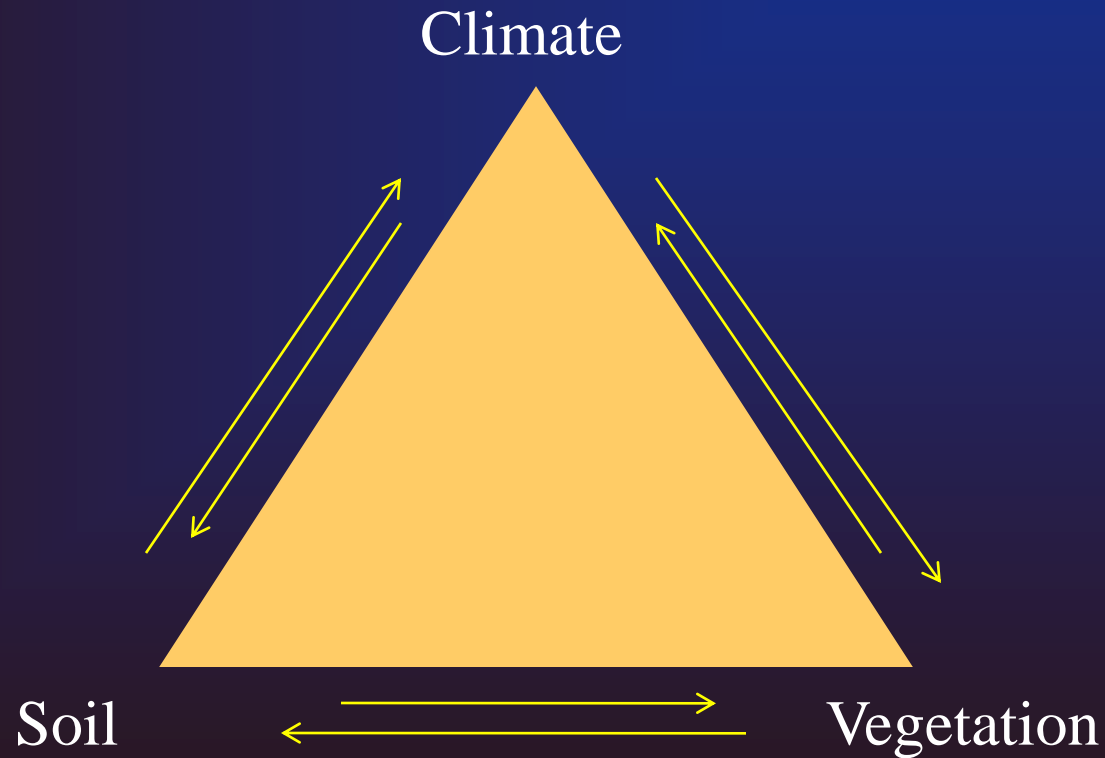
Dry deciduous forest

**Azonal Formations** (mainly result of edaphic factors):

Mangrove forest

Peat swamp forest, i.a.

# Triangle of Dependencies (after WALTER 1968)



# Limiting Environmental Factors

limit (a) tree growth (i.e. wood increment) and  
(b) tree regeneration

→ the basis of forestry

- 1) **Light**
- 2) Temperature
- 3) Water
- 4) Nutrients (N, P, K),
- 5) Soil salinity
- 6) Wind (Hurricanes, Typhoons)
- 7) ...

# Forest Structures

## (a) **Species richness** in tropical evergreen moist forests

Asia: 100-120 spp. /ha ( $\geq 10$  cm dbh)

Latin America:  $\approx 80$  spp./ha

Africa:  $\approx 60$  spp./ha

## (b) **Tree dominant heights ( $h_{\text{dom}}$ )**

Moist evergreen forests:  $\approx 50$ -60 m

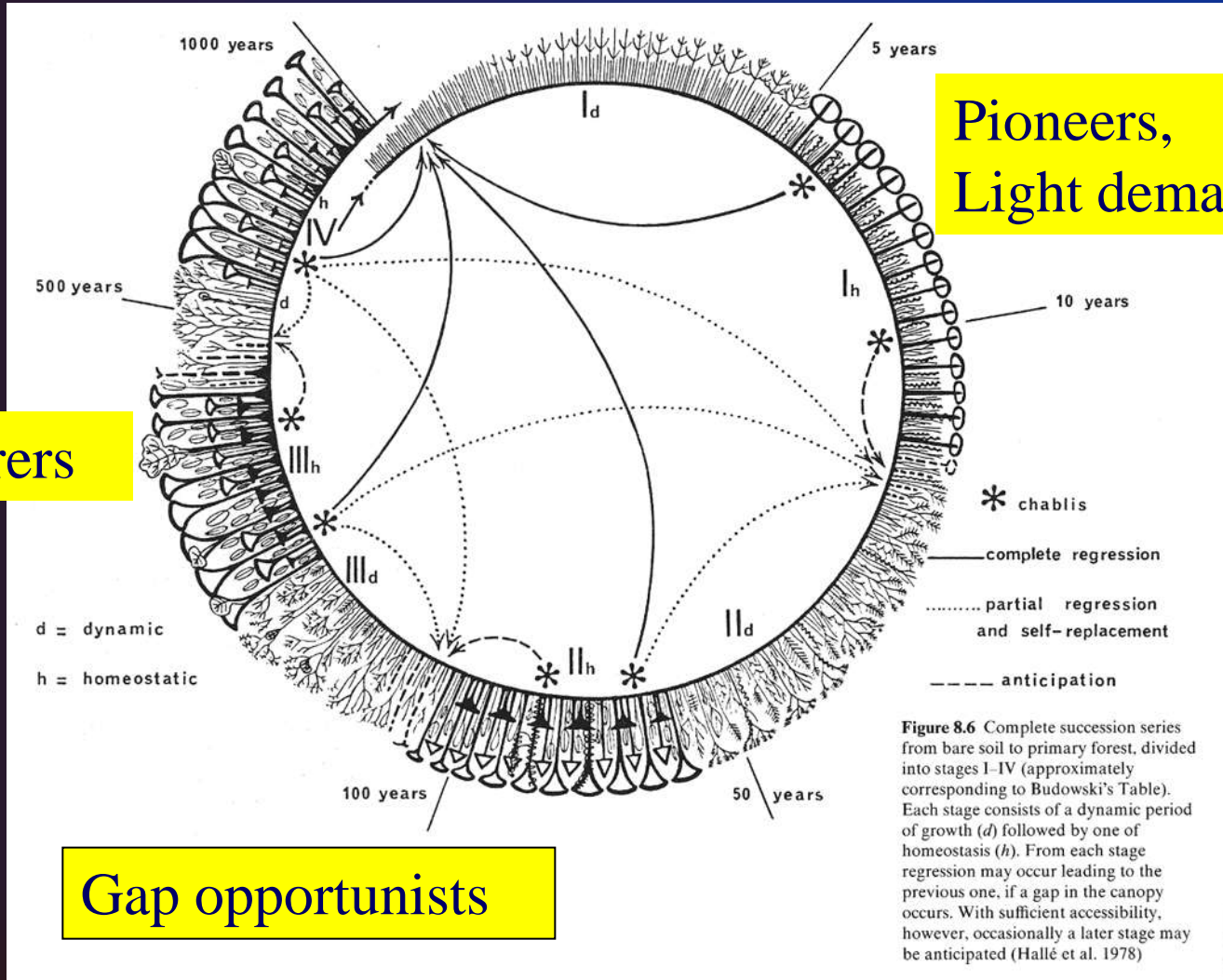
Moist deciduous forests:  $\approx 40$  m

Dry deciduous forests:  $\approx 10$ -15 (20) m

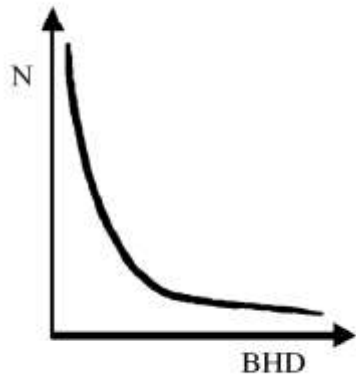
## (c) **Stand basal area (G)**

Tropical mean: 30 m<sup>2</sup> /ha

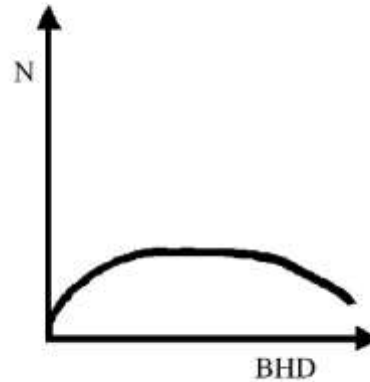
# Complete Succession Series



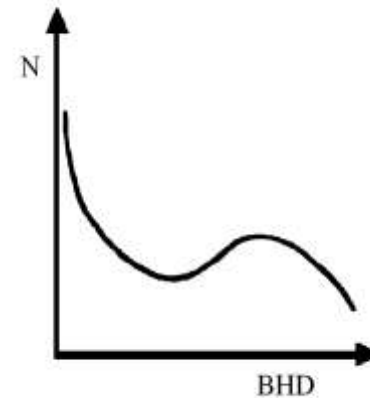
# Diameter Distributions in Primary Forests (BHD = dbh)



Shade bearer

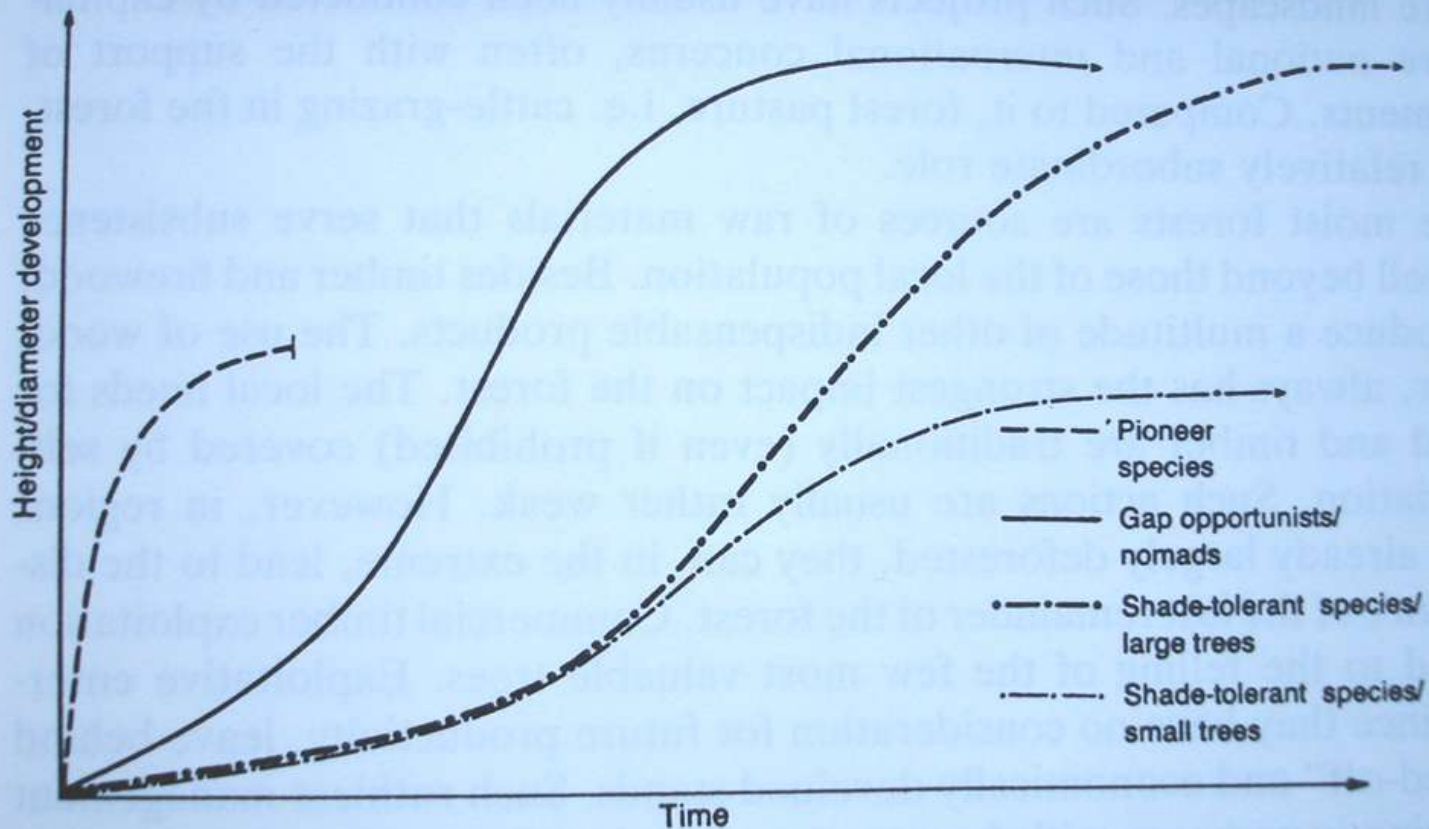


Light demander



Gap opportunist

# Growth Dynamics of Light demanders, Shade bearers and Gap opportunists in Primary Forests

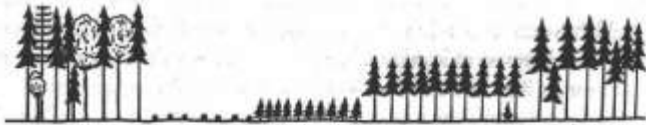


from LAMPRECHT (1993)

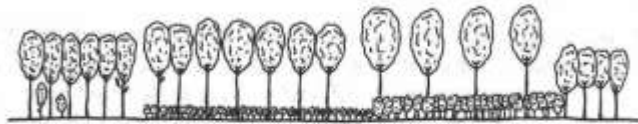


# Regeneration Techniques

clear cutting



shelterwood cutting



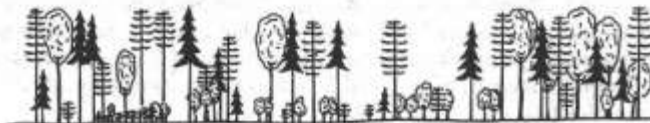
strip cutting



group selection cutting



selection cutting



after KNUCHEL & KOSTLER  
from MAYER (1977), modified

# International Regulatory Framework

## (a) Forest Certification by third-party

(FSC, PEFC, > 50 programs), since 1989-1993

Protection of biodiversity, sustainable harvest levels, publicly available, multi-stakeholder involvement, complaints and appeals process;

Core Requirement: Forest Management Plan

271 Mio. ha forest were certified update Jan. 2006  
(= 7% of all global forests),

critique: 95% of all certified forests in N-America & Europe

# International Regulatory Framework

## (b) UN Framework Convention on Climate Change

(UNFCCC, Bonn), 195 contracting states, since 1992

Addresses major sources of greenhouse gases, compensations for greenhouse gas reductions or inputs; trade with certificates

Mechanism in context of Forestry:

Reducing Emissions from Deforestation and Forest Degradation (REDD), since 2005;

Land use change, deforestation, forest degradation = 17-29% global greenhouse gas emissions

# International Regulatory Framework

**REDD+** refers to

„reducing emissions from deforestation and forest degradation in developing countries, and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries“

# International Regulatory Framework

## (c) UN Convention on Biological Diversity

(UNEP/CBD, Montreal), 168 contracting states, since 1993

Goals:

Conservation of biological diversity (species, genes, ecosystems),

sustainable use of biological diversity,

access and benefit sharing to genetic resources and traditional knowledge

Mechanism:

National strategies, Germany: Bundesamt für Naturschutz (BfN)

Thank you