ForHeal Forestry Higher Education Advancement in Laos

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Structure and Functions of Tropical Forests

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Classification of Tropical Forests according their structure and functions

There appears to be no single classification scheme that is general enough to be of use to everybody

We can distinguish classification based on:

- Forest structure
- Forest function

Forest structure

The idea that forest structure reflects productive potential led the 19th century naturalists to believe that tropical forest regions have great potential for wood and crop production

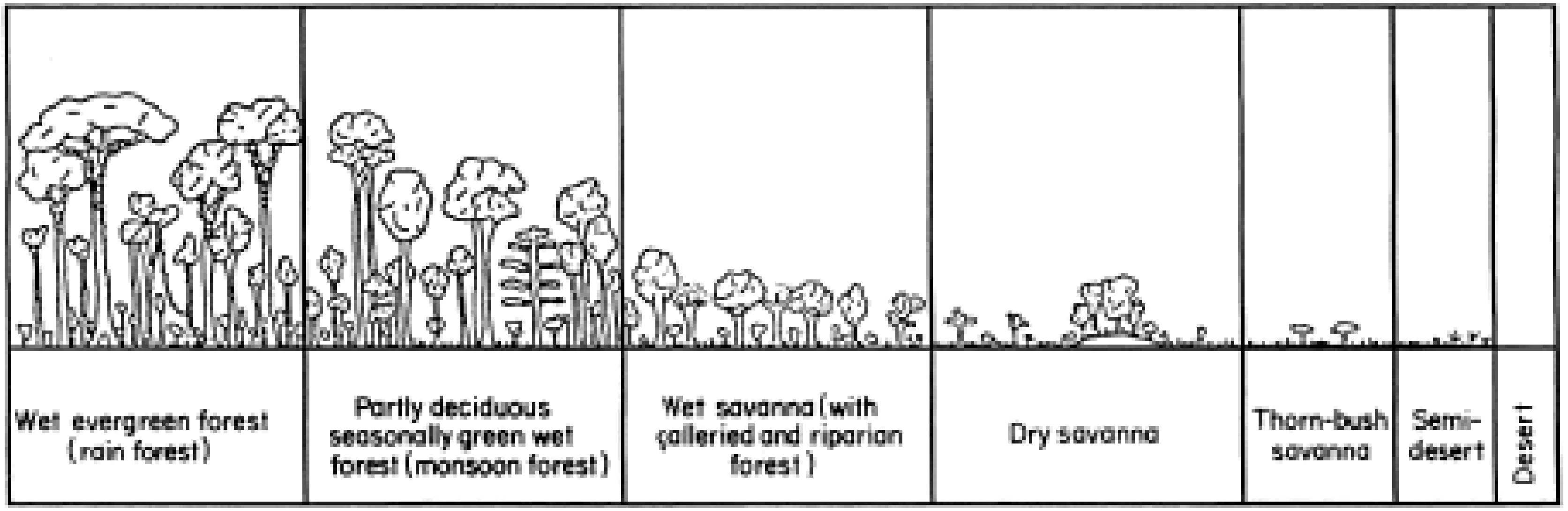


Fig. 3.1. Structure of tropical vegetation along a moisture gradient. (Adapted from Jordan 1985, with permission of John Wiley and Sons Ltd., publisher)

Note: Structure reflects function when moisture for example is a critical factor. Nutrient conserving mechanisms can compensate for low nutrient availability (biomass can differ slightly, wood production differs greatly)

Forest function

- Forest function is more important factor for managing tropical forest for wood production (diversity, mutualisms, nutrient cycling, energy flow)
- Pollination (wind, mutualisms) – forest management may differ
- Nutrient poor soils must be managed much less intensively than forest on nutrient rich soils (minimize disturbances to the root system during logging operations)
- At high elevations logging can not be as frequent (energy flow is low) – undecomposed litter on the forest floor must be preserved,

Note: This classification is in reality problematic (lack of understanding), not commonly used for forest classification of tropical forests

Forest function

More commonly classification by (forest function described indirectly);
commonly based on following criteria:

- A - Climate
- B - Species
- C - Soil type

A – Classification based on climate

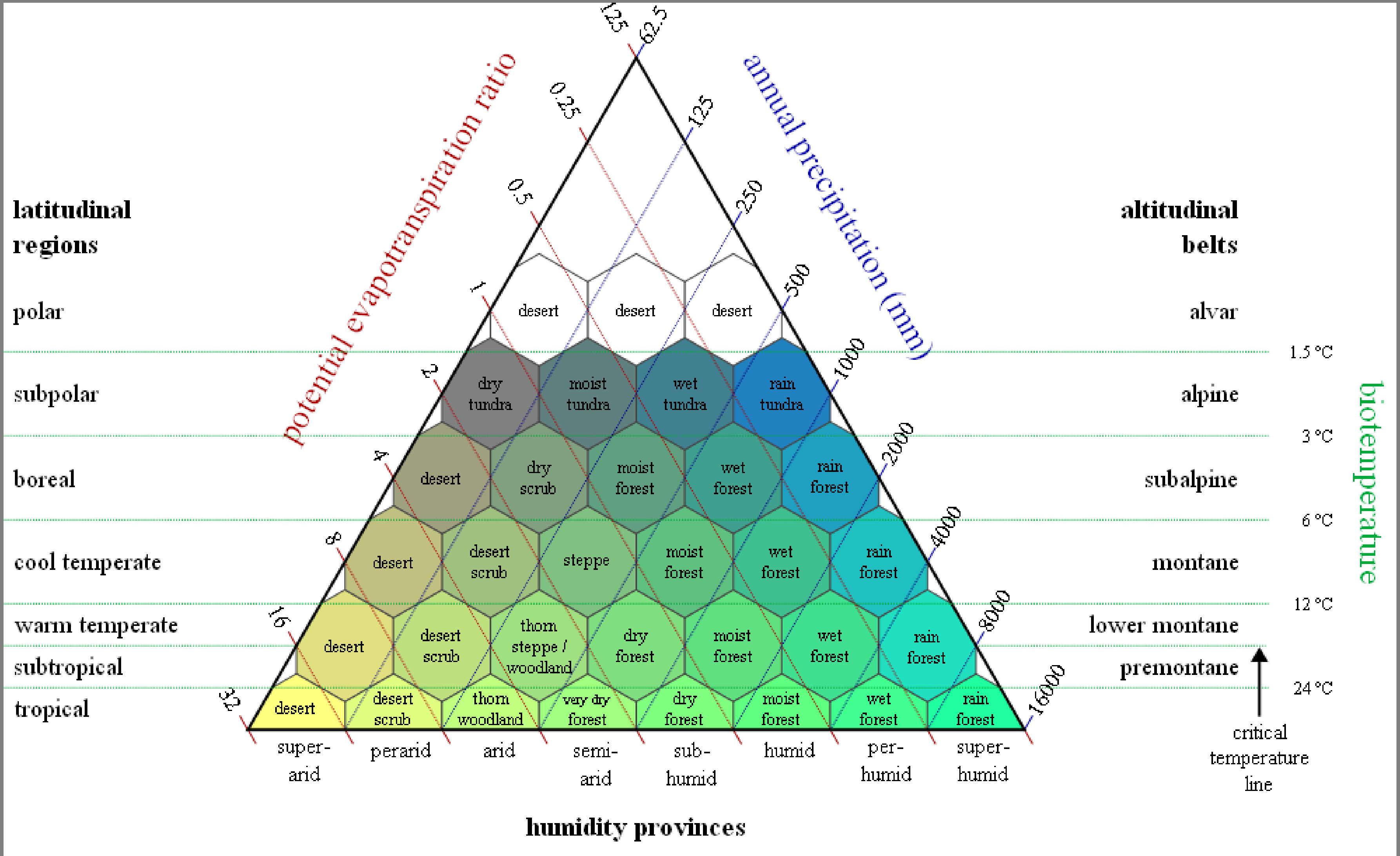
Climate classification is generally useful, where soil conditions are relatively uniform.

Number of classification schemes developped

One of the most generalized
Holdridge`s Life Zones Classification

- Latitudinal and altitudinal belts based on biotemperature (the average annual temperature using values only between 0°C and 30°C – photosynthesis with net positive value)
- Humidity provinces (from extremely dry to saturated)
- Annual precipitation

Holdridge life zone classification scheme

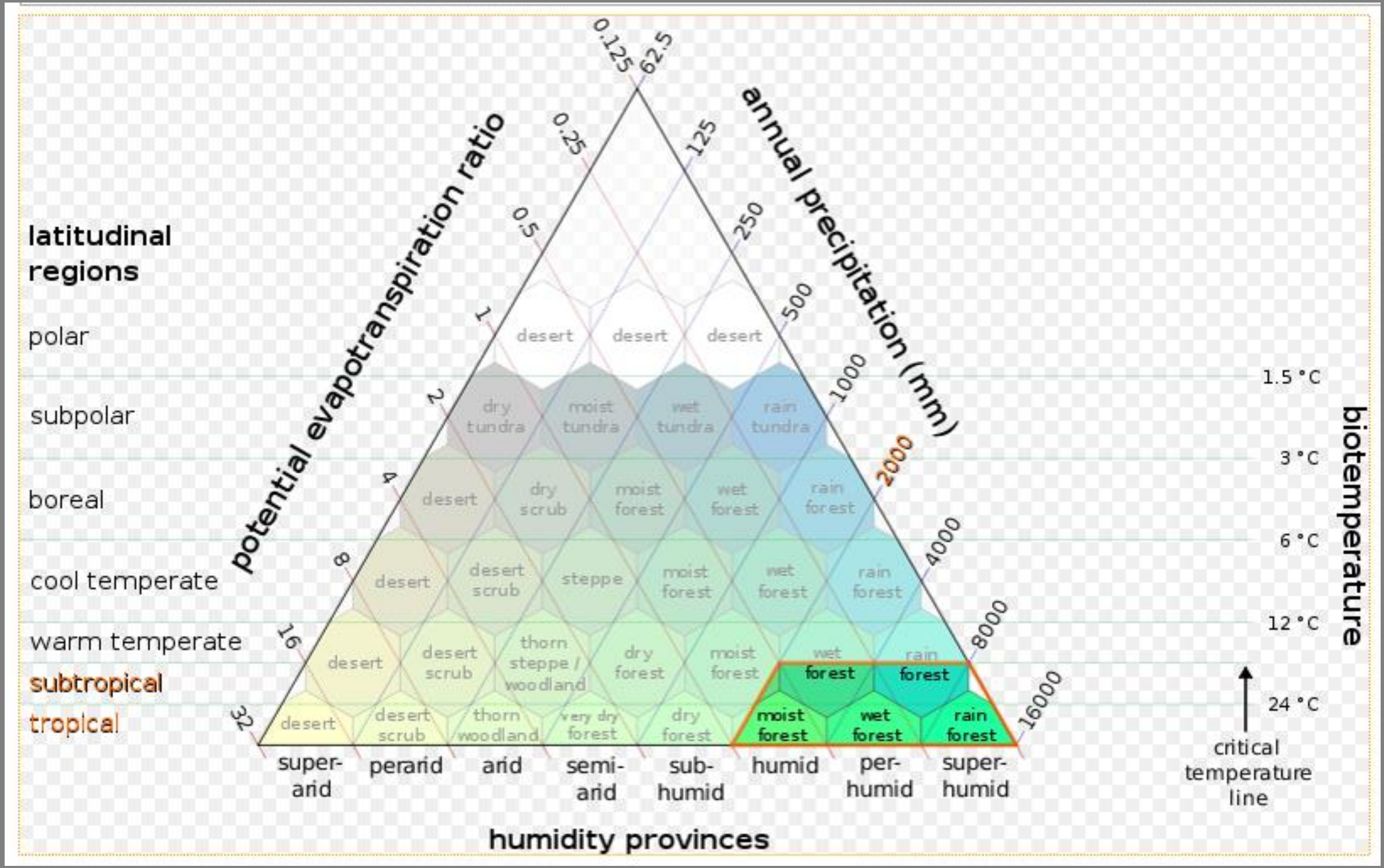


Source: http://commons.wikimedia.org/wiki/File:Lifezones_Pengo.svg

- Biotemperature refers to all temperatures above freezing, with all temperatures below freezing adjusted to 0° C.
- The assumption was that, from the perspective of plant physiology, there is no real difference between 0° C and temperatures less than zero: plants are dormant.
- ***The life zones are thus defined first according to a climatic variable - mean annual biotemperature, precipitation*** (and *not* according to degrees latitude or meters of elevation).
- The Holdridge system was intended to be applicable to the entire globe. However, it is primarily used by investigators in the New World tropics.

Note: A ratio of 1.00 means that potential evapotranspiration is equal to mean total annual precipitation. As the ratio *decreases* from 1.00, the climate becomes more *humid* (that is, precipitation is greater than potential evapotranspiration). As the ratio *increases* above 1.00, the climate becomes more *arid* (potential evapotranspiration is greater than actual precipitation).

TSMF - Tropical and subtropical moist forests



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Structure of tropical vegetation along an elevational gradient in continental regions

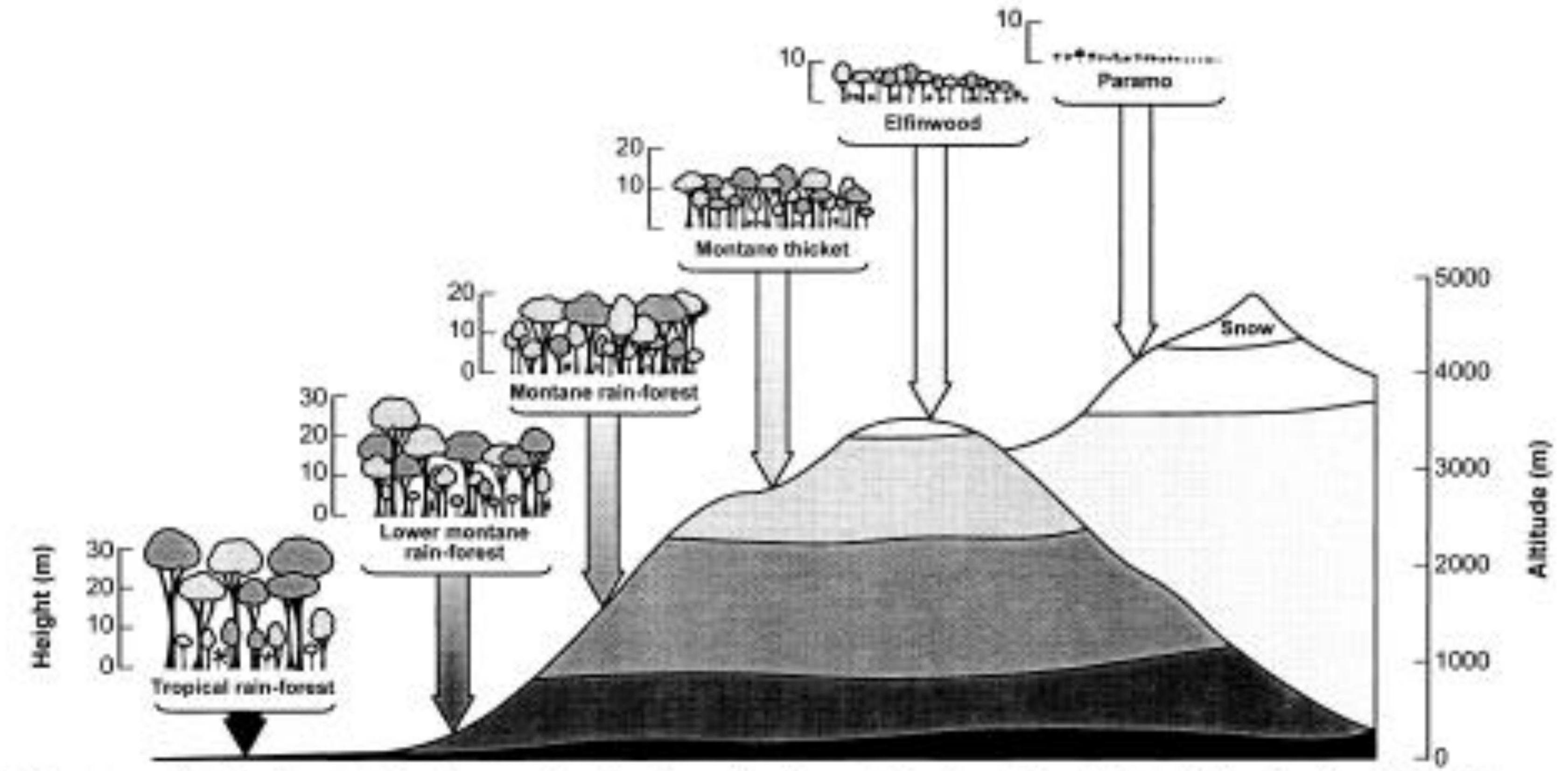

Fig. 3.4. Structure of tropical vegetation along an elevational gradient in continental regions. (Adapted from Jordan 1985, with permission of John Wiley and Sons Ltd., publisher)

Compare with fig. 3.1. – moisture gradient in lowlands of Africa

Functional variation along climatic gradinet

Functional characteristics of a tropical forest can be implied, to a certain extent, from their climatic classification

Energy flow along environmental gradients

- Energy potentially available to the vegetation increases from moist to dry because of the decreasing cloud cower (higher radiation), nevertheless moisture scarity limits photosynthetic activity = as result primary productivity decreases

- Cloud cover near the top of mountains + temperature below optimum = lower energy available

Nutrient cycling along environmental gradients

- The efficiency with which nutrients are recycled will generally decrease from wet to dry.

- In dry forest ecosystems lower rates of decomposition and less potential leaching

- In mountain cloud forests, nutrient scarity may occur because of slow decomposition of litter and humus horizons (nitrogen is limiting at high elevations becauese it is immobilized in litter)

Note: Efficiency of nutrient cycling is not fully reflected by climatic classification (presence of poor soils). To base management only on climatic classification may be problematic.

Species diversity along environmental gradients

- Species diversity is generally higher in rain forests than in dry forests
- On water saturated soils as swamp forests or mangroves in general low
- On higher elevations on mountainsides species diversity usually lower, nevertheless presence of endemic species of great importance

B - Classification based on species

Species „integrate“ all factors of the environment

(commonly based on communities or dominant species):

- Local climate (not only macroclimate, but also mesoclimate given by topography etc.)
- Physical and chemical properties of the soil
- Previous site history
  - Management, land use, fire, wind disturbances…

Useful classification for forest managers since managers are usually interested in species

Classification based on species

Community level

Example of communities along soil and hydrological gradient in Rio Negro region of Venezuela with local names (classification based on species is useful for foresters interested in commercial use of tree species)

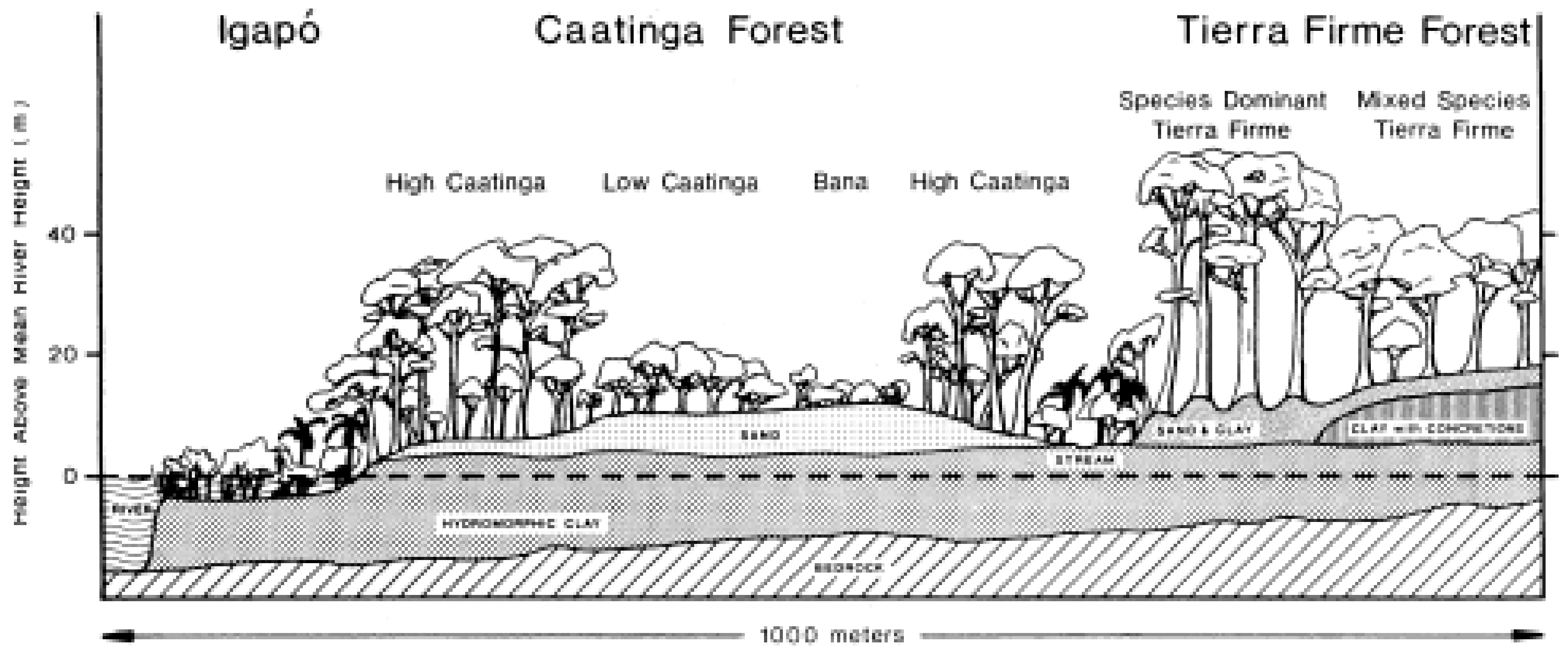

Fig. 3.5. Structure of tropical vegetation along a soil and hydrologic gradient in the Amazon lowlands. (Adapted from Jordan 1985, with permission of John Wiley and Sons Ltd., publisher)

Caatinga and bana soils low in N content – nitrogen conserving **function** of the vegetation (production of sclerophyllous leaves)

http://daac.ornl.gov/LBA/guides/LC05_BDFF_Biomass_Soils.html

- *"Igapó"*: it is periodically flooded areas by black and clear water rivers, with poor annual cycles in suspended and dissolved materials (they do not carry sediment), producing low soil fertility. With this, it has poor vegetation, low biomass, low diversity of vegetation species (Prance, 1980; Ayres, 1995).

- *"Várzea"*: it is periodically flooded areas by white water rivers, with rich annual cycles in suspended and dissolved materials (they carry great amount of sediments), producing high soil fertility. With this, it is constantly renewed by nutrients, therefore it is submerged for almost six months by year. It has great diversity of vegetation species, with high biomass, great trees and fast growth. It is the most common of all types of flooded areas of the Amazonia (Sioli, 1967; Prance, 1980; Junk, 1989; Ayres, 1995).

1. Classification based on „temperament“ of species

In forest management is also useful classification based on growth and reproductive pattern of individual species **within closed forest**.

„Gamblers“ produce large numbers of seedlings that need light gap in which they can grow rapidly

„Strugglers“ produce small numbers of very persistent tree species growing slowly within the densely shaded understorey

Example: Selection system is particularly suitable for species that are shade-tolerant but respond to opening up of a light gap (harvest of trees mimics the naturally occurring gaps)

2. Classification based on successional stage

- Communities that invade recently abandoned land or pasture, or other disturbance that destroy the structure of the mature forest, are called succesional forest
- Early successional species are often characterized as fast growing. These species are desirable for reclamation quickly forming canopy that protect the soil from erosion (*Cecropia, Musanga, Macaranga, Ochroma, Trema*)
- Pioneer species produce large numbers of viable „orthodox“ seeds (forming seedbanks in many forests) easily to transport
- Clear-cut as tool of relatively simple management

Plantation forestry often uses pioneer tree species

Terminalia superba and *Cordia alliodora* in pacific lowland of Ecuador

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- Management for species of the mature forest is often difficult due to seed characteristics („recalcitrant seed“) - most of them will spread and establish very slowly
- Specific procedure to preserve, store and germinate must be developed for each individual species
- Slower growth but often higher wood price

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Early pioneers can modify the environment in such a way as to make establishment of later species more feasible

- nitrogen enrichment by nitrogen fixing bacteria – Leguminoseae *Inga, Acacia, Albizia*)
- Provision of shade,
- Increasing soil moisture
- Decreasing soil temperature

C - Forest classification based upon Soil Nutrient Status

- Net primary productivity increases along the gradient from oligotrophic to eutrophic (also species diversity may increase in this gradient)
- Decomposition is lower on nutrient poor soils
- Loss of organic matter in the humus horizons on poor soils will quickly deteriorate the productive potential
- Oligotrophic forests are less productive – might serve better as nature reserves than source of timber

Conclusion: there is no single classification general enough (useful for all local conditions)

Correlation between species and forest function based on local knowledge are the best basis for small scale forest management