Threats to tropical forests

and what we can do about it

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Human activities: dangers and hopes for the future

- Timber production (mostly for export and fuel)
- Slash-and-burn practices:
  - for agriculture and cattle ranches
    - main crops: coffee, cocoa, banana trees, mango trees, papaya, avocado, sugar cane *(250 different fruits originate from tropical rainforests; only 20 from the temperate zone)*
- Tourism – the hope for tropical rainforests?
  - already high and still increasing economic value

Deforestation: the most important problem for tropical rainforests

- **Originally: 14% of the Earth surface**
  → now only 6%!
- **Currentr annual deforestation rate:**
  ca. 50 000 – 100 000 km^2 ***(Poland = 312 000 km^2)***
- **At this deforestation rate:**
  → tropical rainforests will vanish by 2050!
- **Extremely high extinction rate:**
  → up to 50 000 species per year!

Deforestation: eastern Amazon (eye altitude ca. 50 km)

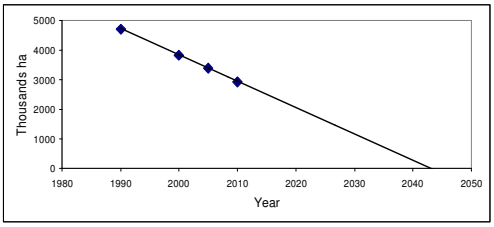
4/22

Deforestation: western Amazon (eye altitude ca. 500 km)

5/22

Deforestation in Uganda

- **Total forest cover 2010: 2,937,000 ha**
- **Losses in 1990 – 2010:**
  - **1,763,000 ha (37.1% of forest cover)**
  - **average of 88,150 ha (1.86% per year)**



6/22

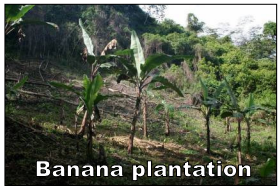
http://rainforests.mongabay.com

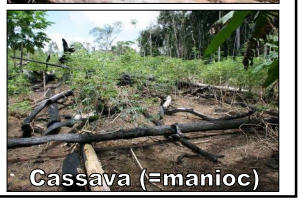
Deforestation: slush-and-burn

Slush-and-burn in Southern Mexico

7/22

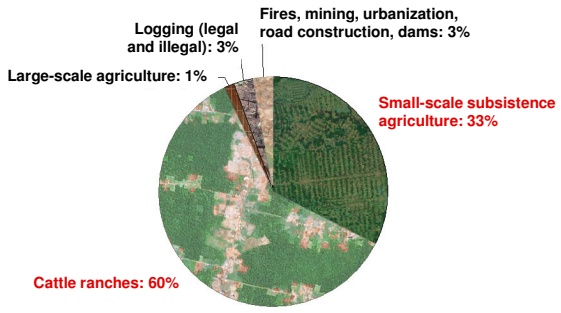
Deforestation – plantations replacing rainforest in Venezuela





8/22

Main causes of deforestation: Brazil, 2000-2005



9/22

What we can do about it?

REDD:

Reducing carbon Emissions from Deforestation and Degradation

10/22

Two useful definitions

- **Deforestation**: "permanent removal of forest cover and withdrawal of land from forest use, whether deliberately or circumstantially" (IPCC) = entire loss of patches of forest via clearing
- **Forest degradation**: "changes in the forest negatively affecting its production capacity"
  - may eventually result in deforestation

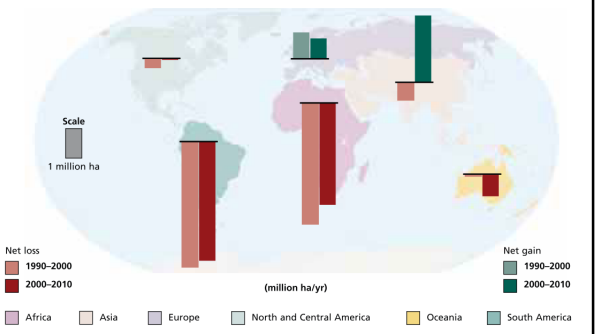
11/22

What is REDD and why do we need it?

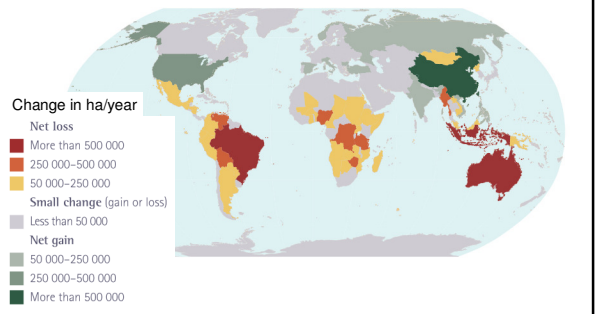
- **REDD** = financial incentives to help developing countries reduce deforestation rates to meet C emission 'baseline'
  - countries can sell 'carbon credits' on the international carbon market
  - over 70 countries eligible
- Tropical deforestation = 1 – 2 bln tonnes C per year = 15-20% global C emission
- In Africa – ca. 70% of total C emission

12/22

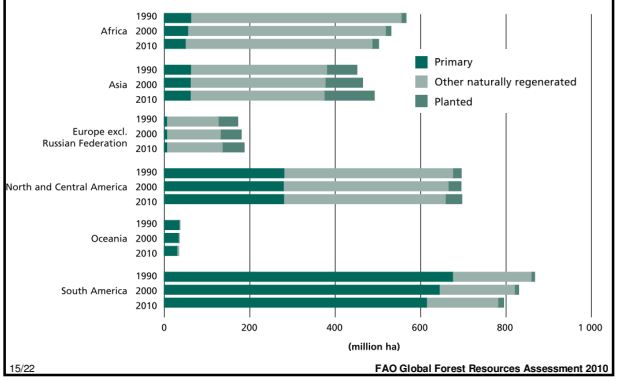
Annual change in forest area by region 1990–2010



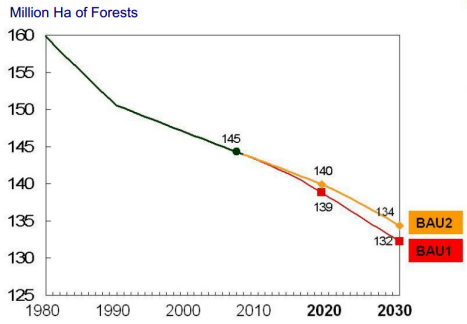
Net change in forest area by country 2005-2010



Trends in forest characteristics by region and subregion, 1990–2010



Historical and future deforestation scenarios in Democratic Republic of Congo



"The REDD+ challenge in DRC" (http://unfccc.int)

16/22

Some intriguing quotes: "Better REDD than dead", *The Economist, 2012*

- Indonesia's peat-based plantations, a quarter of the total, contribute less than 1% to the country's GDP but nearly 20% of the national C emissions.
- Indonesia's National Council on Climate Change puts the opportunity cost of forgoing an oil-palm plantation at $30 a tonne C.
- Capturing and storing emissions from power stations is estimated to cost $75-115 per tonne C.
- $17 billion – 30 billion between now and 2015 could cut deforestation by a quarter. (EU ≈ $17 000 bln)

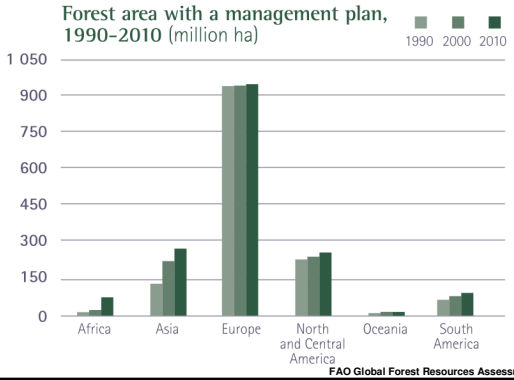
17/22

Doubts and problems

- No trusted estimates of actual deforestation rates in many countries (especially in Africa)
- Lack of trust in keeping the promise by governments in developing countries
- No good control over deforestation and afforestation activities
- "Small scale deforestation on a large scale" – non-commercial deforestation by forest folk
- **Lack of knowledge among local people**

18/22

Forest management plans urgently needed for tropical countries!



19/22

FAO Global Forest Resources Assessment 2010

Estimating forest C pools

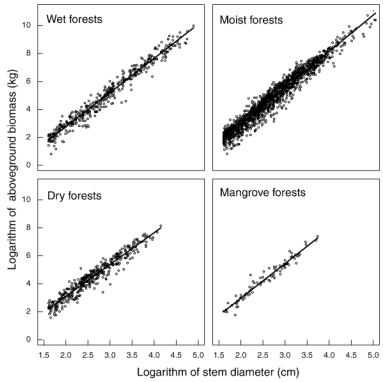
20/22

Forest carbon pools: priorities and costs
1 = lowest priority/cost; 4 = highest

Carbon pool	Method	Priority	Cost
Tree biomass	DBH (H) + allometric equations	4	2
Understory	Destructive sampling	2	4
Dead trees	No-destructive measurements	2	2
Litter	Destructive sampling	2	3
Soil carbon	Destructive (density and C content)	3	4

21/22

Allometric relationships: *AGB = f(DBH)*



Chave et al. (2005) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145: 87-89

AGB = f(DBH): empirical regressions

Dry forest stands:

$$AGB = \rho \times \exp(-0.667 + 1.784\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Moist forest stands:

$$AGB = \rho \times \exp(-1.499 + 2.148\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Moist mangrove forest stands:

$$AGB = \rho \times \exp(-1.349 + 1.980\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Wet forest stands:

$$AGB = \rho \times \exp(-1.239 + 1.980\ln(D) + 0.207(\ln(D))^2 - 0.0281(\ln(D))^3)$$

Chave et al. (2005) Oecologia 145: 87-89

Symbols and units

- ***ABG*** = above-ground biomass; kg dry weight
- ***D*** = tree diameter at breast height (1.3 m);

  = tree *girth*/π ≈ tree *girth*/3.14; cm
- ρ = wood specific gravity = oven-dry wood over green volume; g/cm^3
  - *Reyes et al. 1992. Wood densities of tropical tree species. USDA Forest Service.*
  - *OR: use **0.5 g/cm^3** – the mean for Africa*
- On average, **C = 50%** dry wood mass

Carbon stock in tree roots

Shoot:root ratios

- humid tropical forests on normal soils: **4:1**
- tropical forests on permanently wet soils: **10:1**
- tropical forests in areas with long dry season and soils of very low fertility: **1:1**

How many plots should be sampled?

- Assume the desired precision level (e.g., ±10%, ±20% of the mean)
- Select 5-10 adequate sized plots within each management type (e.g., mature forest, logged, secondary young, secondary medium age, burnt)
- Estimate C stock for each plot, calculate mean and standard deviation
- Calculate the required number of plots

Necessary preliminary calculations

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad s^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1} \qquad s = \sqrt{s^2}$$

n – number of sampled plots

s^2 – sample variance

s – sample standard variation

Calculating the required number of plots

$$n_r = \frac{(N \times s)^2}{\frac{N^2 \times E^2}{t^2} + N \times s^2}$$

n_r – number of required plots

N – number of possible sampling plots

E – allowable error

t – sample statistics from the t-distribution for a chosen confidence levels (e.g., 95%); for unknown sample size t=2

28/22

Example of calculations

- Area = 10 000 ha
- Plot size = 0.1 ha
- N (number of possible sampling plots) = 100 000
- Mean C stock = 150 t C/ha
- Standard deviation = 30 t C/ha
- Desired precision = 10%
- E (allowable error) = 150 x 0.1 = 15

$$n_r = \frac{(100000 \times 30)^2}{\frac{100000^2 \times 15^2}{2^2} + 100000 \times 30^2} = 16$$

29/22

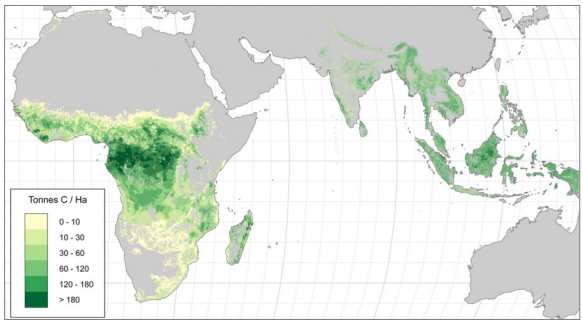
Forest biomass carbon matrix

Forest condition

Forest type	Mature	Logged	Secondary (young)	Secondary (med. age)	Burnt
Moist					
Seasonal					
Seasonal					

30/22

Forest biomass carbon maps for Africa and Southeast Asia produced by using regression-based models to extrapolate forest inventory measurements



Gibbs et al. (2007) Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145: 87-99.

Thank you

Don't forget to prepare for the seminar!