Forests, Climate and Green Economy:

Biomass production and CO_2 sequestration

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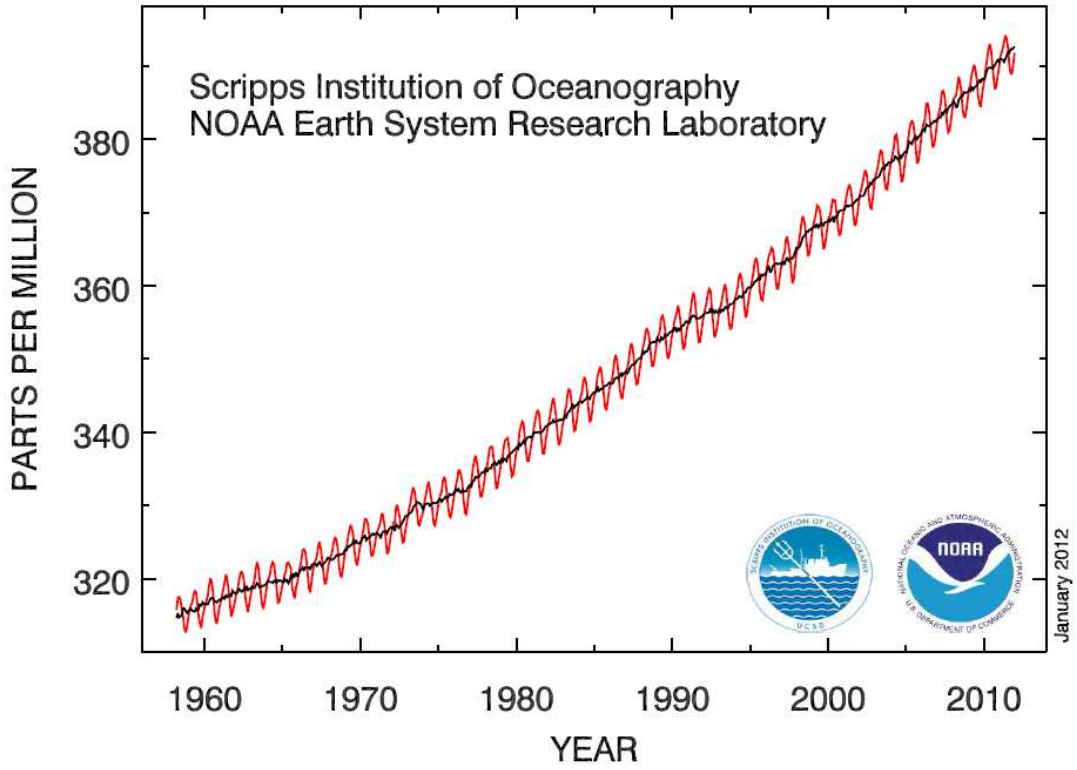
Forests, Climate and Green Economy

Introduction

- Main energy source are fossil fuels (coal, gas, oil)
- C stored in the lithosphere is released
- Leads to an CO_2 increase in the atmosphere
- Additional green house gases (methane, etc.)
- Increase in CO_2 results in an increase in temperature
- Air pollution effects (e.g. ozone)

Fossil Carbon release leads to an increase in global CO_2 concentration

"Dave Keeling" curve



Without natural greenhouse gases:

Mean temprature: -18°C instead of + 15°C

Distribution of anthropogenic C Emission

Canadell et al. 2007, PNAS

45 % of CO_2 emissions stay in the atmosphere

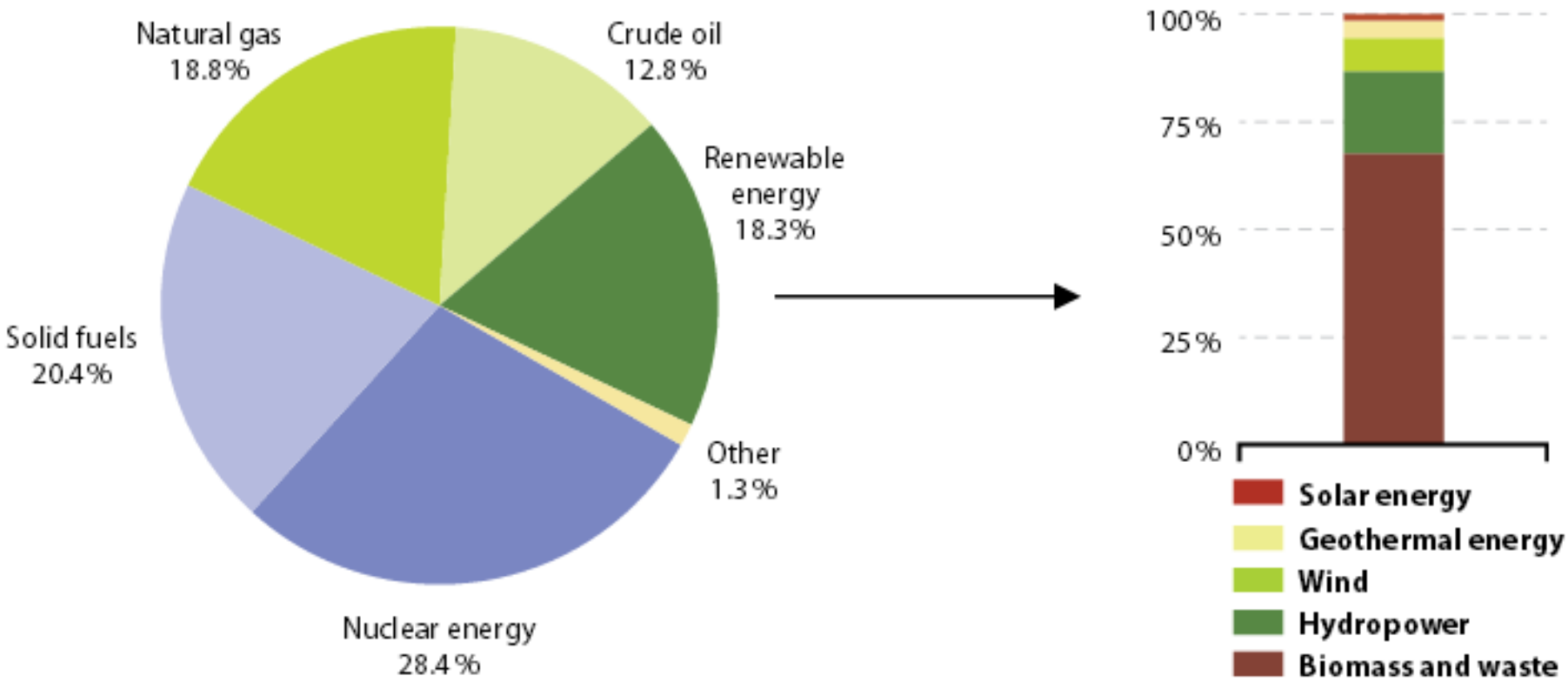
55 % of CO_2 is accumulated

oceans (~ 25 %)

vegetation (~ 30 %)

Energy Production EU-27

Year 2009



Source: EUROSTAT report 2012

EU Strategy for Renewable Energy
The 2020 targets

- **Increase share of renewable energy consumption to 20% (9.0% in 2009)**
- **10% share in transport sector**
- **Limit of food-based biofuel to 5 %**

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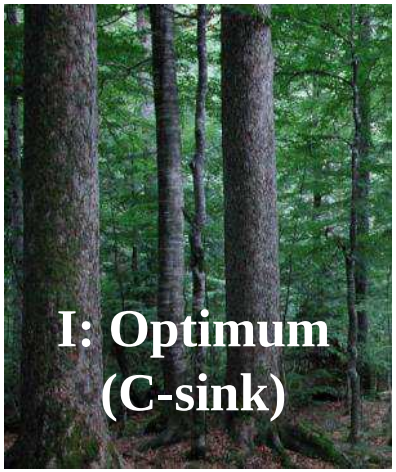
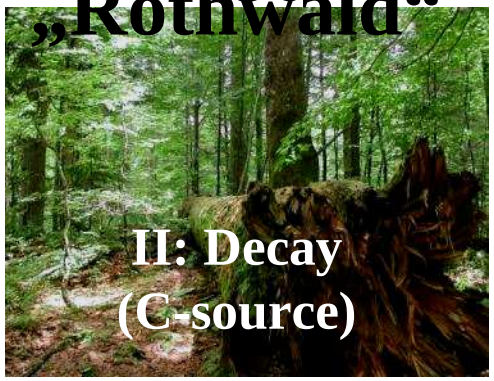
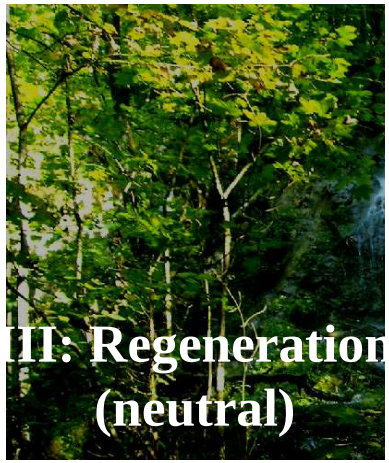
Carbon Cycle

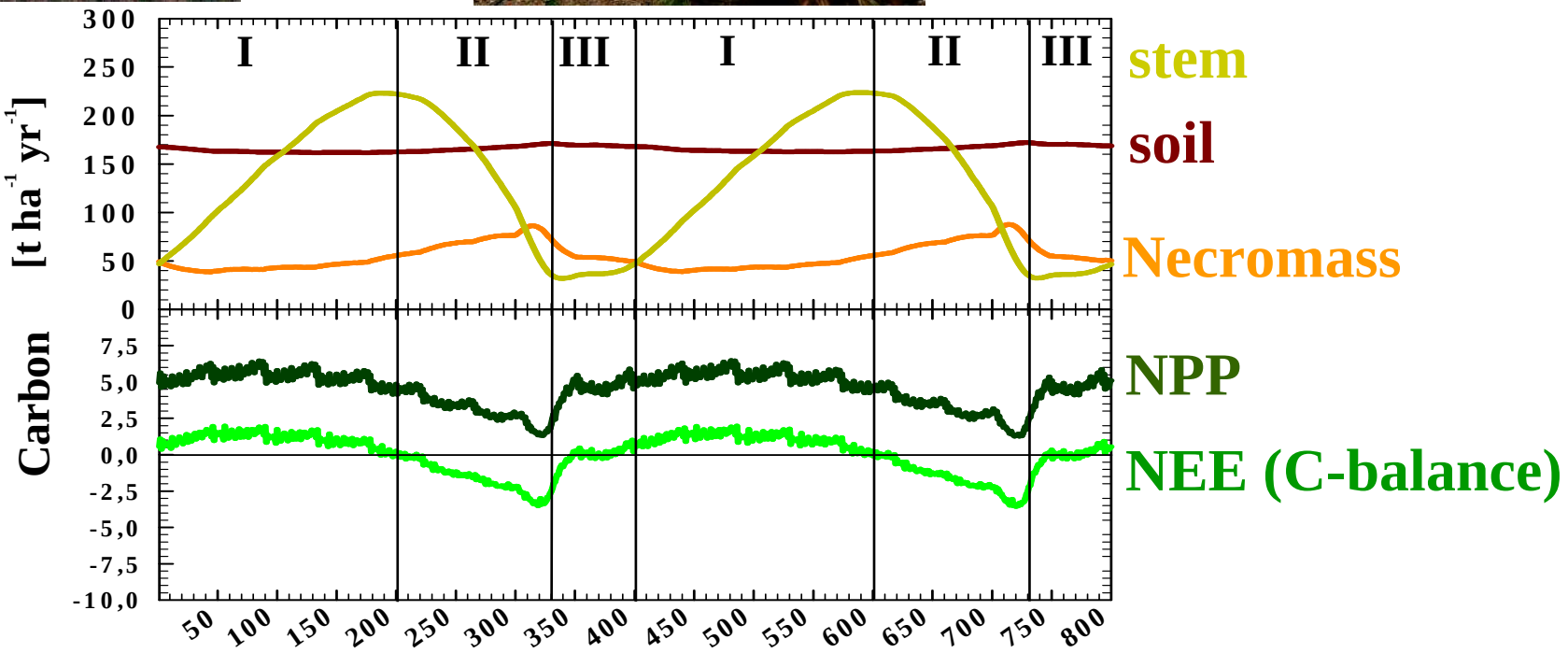
- **Photosynthesis fixes carbon**
- **Forests store large amounts of carbon**
- **Disturbances release carbon**
- **Forests are a renewable “energy source”**
- **Forests are considered to be “carbon neutral”?**
- **Management intensity is expected to increase**

Carbon cycle in the Primary Forest „Rothwald“









stem

soil

Necromass

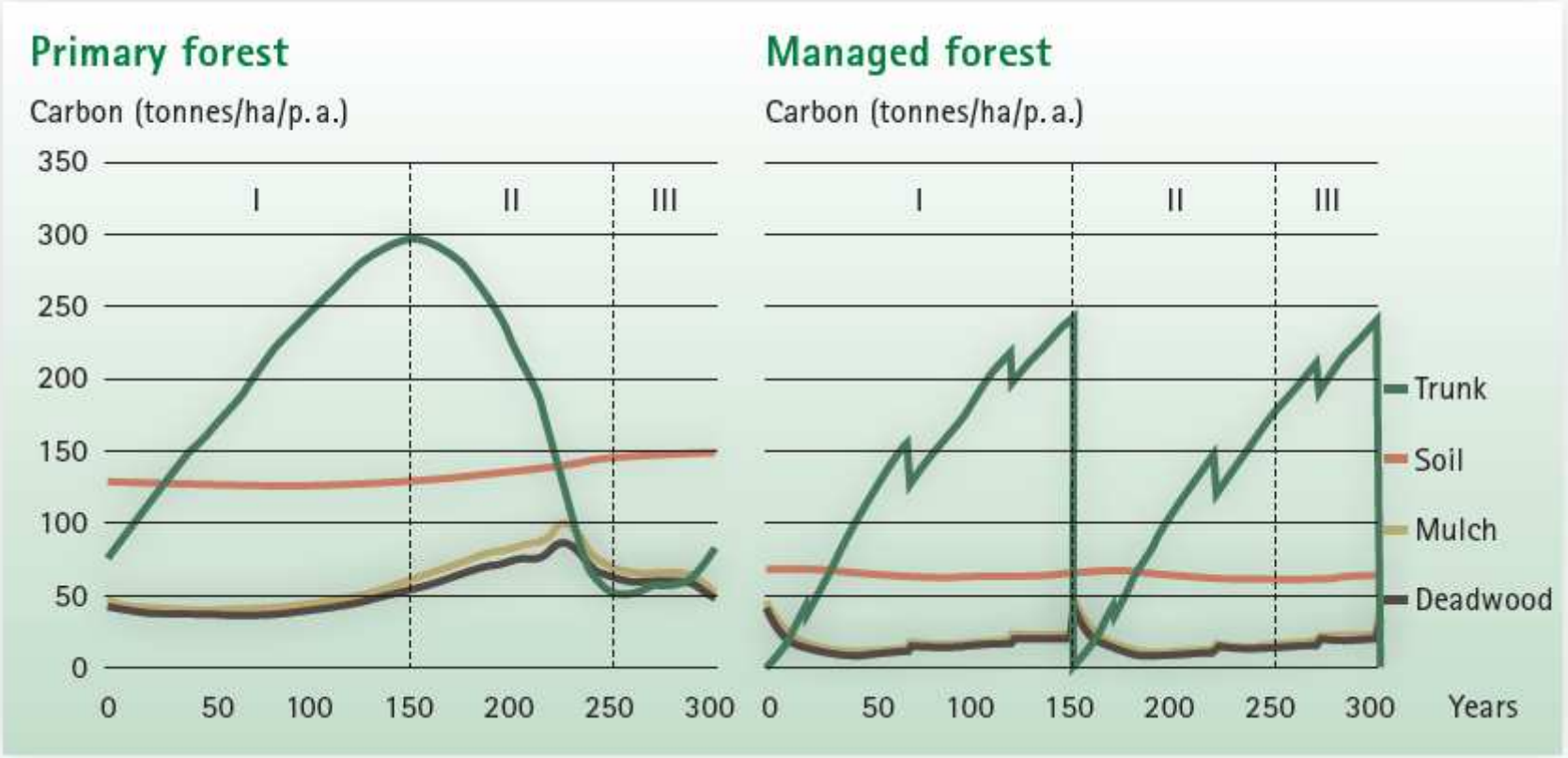
NPP

NEE (C-balance)

18 spruce-beech stands

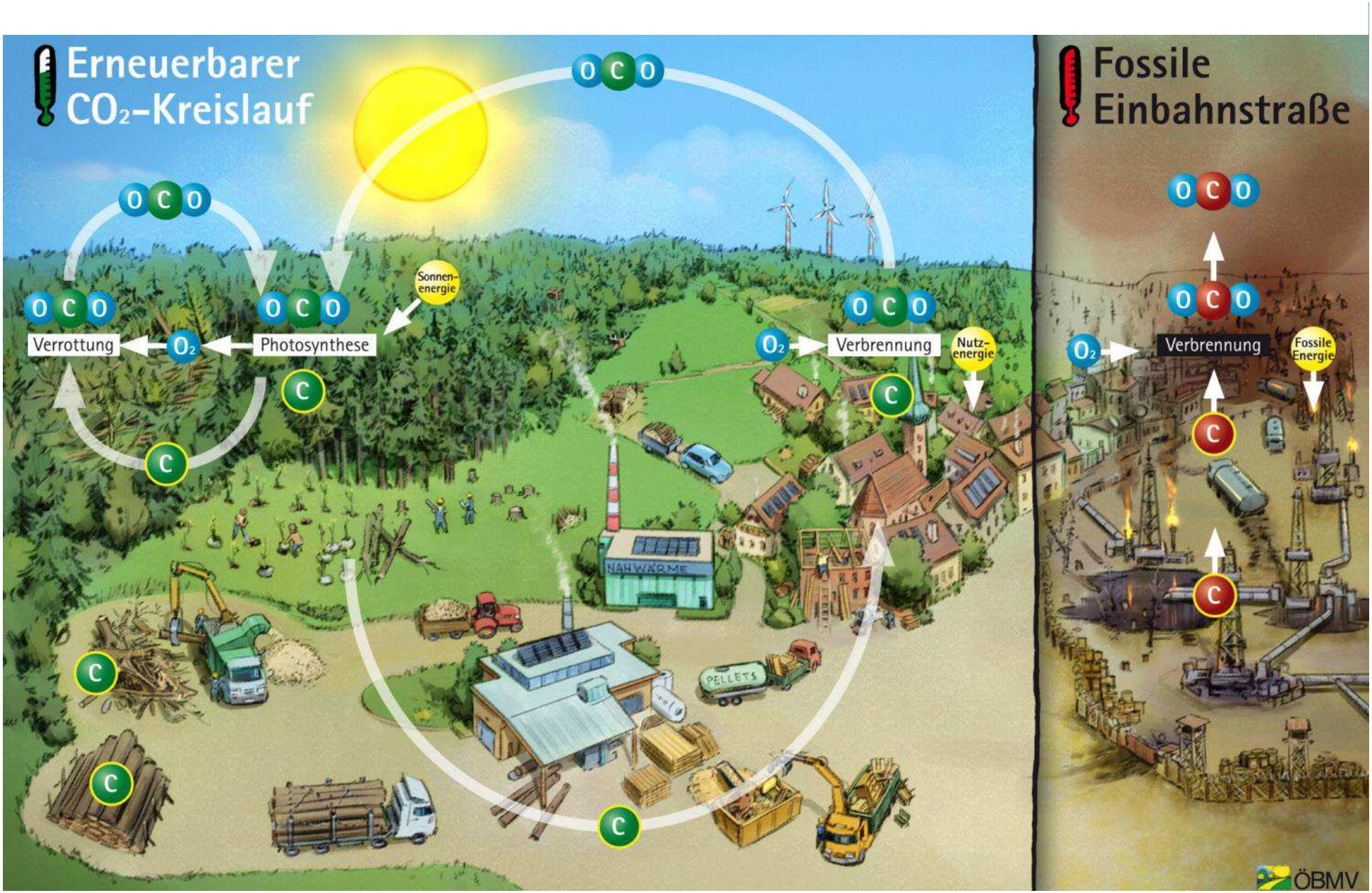
Pietsch & Hasenauer 2006

Comparison of Primary Forest vs. Managed Forest



Source: Hasenauer et al. 2012

What is a full carbon cycle?



There is a Debate going on that Forests are not “C neutral” – WHY?

- **Increasing harvest leads to a reduction in the standing biomass**
- **This adds additional Carbon to the atmosphere**

However …

- **Harvesting triggers growth/ carbon uptake**
- **Benefit of substitution of fossil fuels**
- **A complete life cycle assessment is needed**

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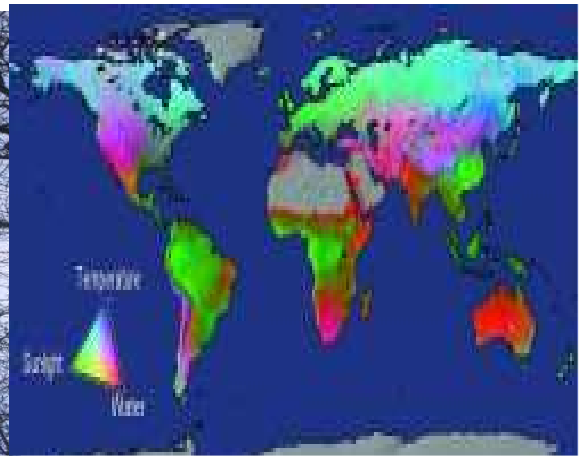
Where do the Carbon Data come from?

- **Forest inventories – measure tree volume (V m^3/ha)**
- **Flux towers – measure flow of material**
- **MODIS satellite data – estimate NPP (C t/ha)**



Determining Carbon in Forests

Expansion Factors or Functions

- **Statistical – empirical approach**
  - **(i) Expansion factors for volume into carbon**
  - **(ii) biomass functions to predict carbon**
- **Typical procedure for Forest inventory data and population models**

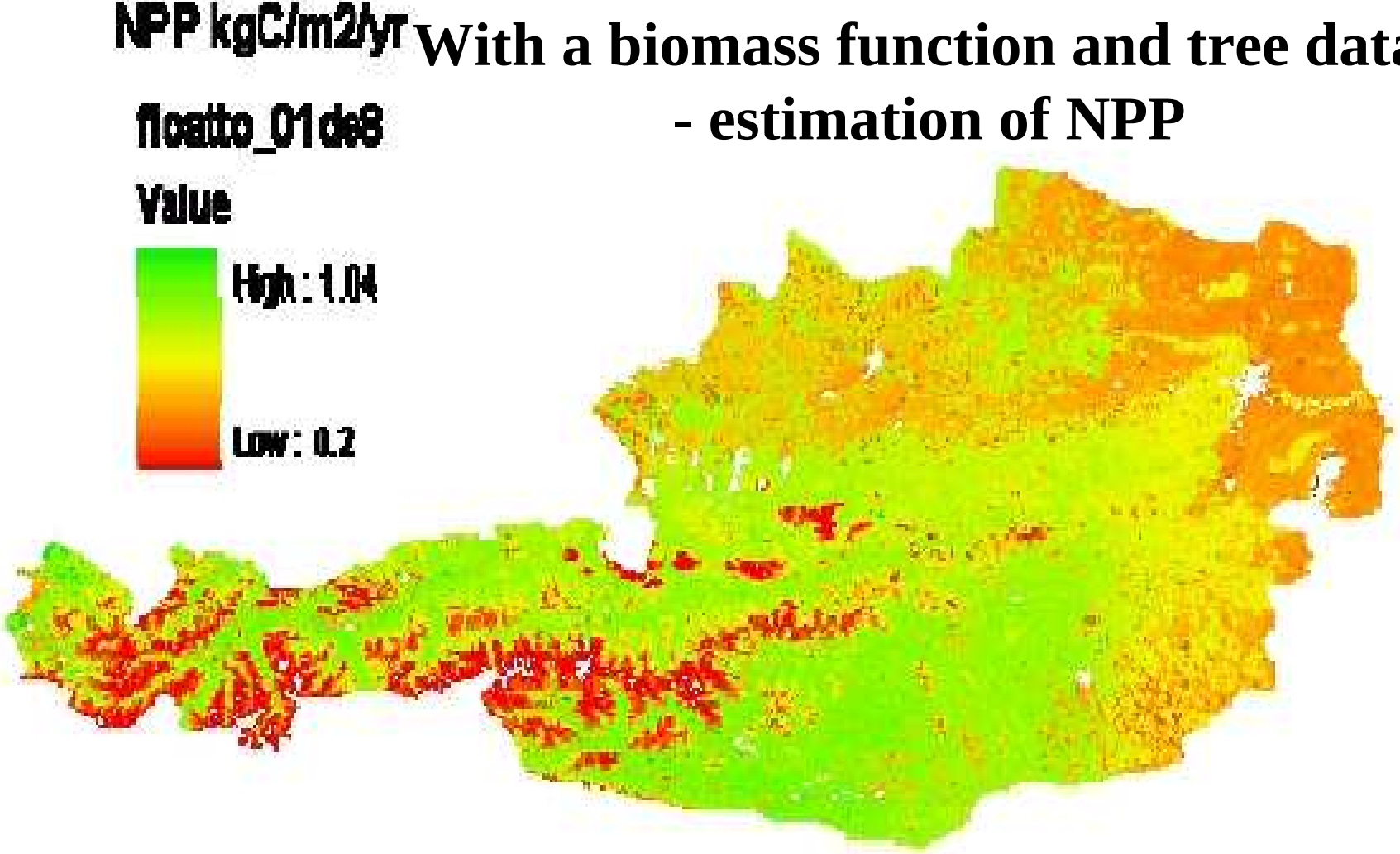
Determining Carbon in Forests

Explicit Carbon Cycle

- **Biogeochemical-mechanistic approach**
- **Photosynthesis routine to assess the flux dynamics (C, Water, N, and Energy Cycle) within forests**
- **Typical procedure in BGC-Models**

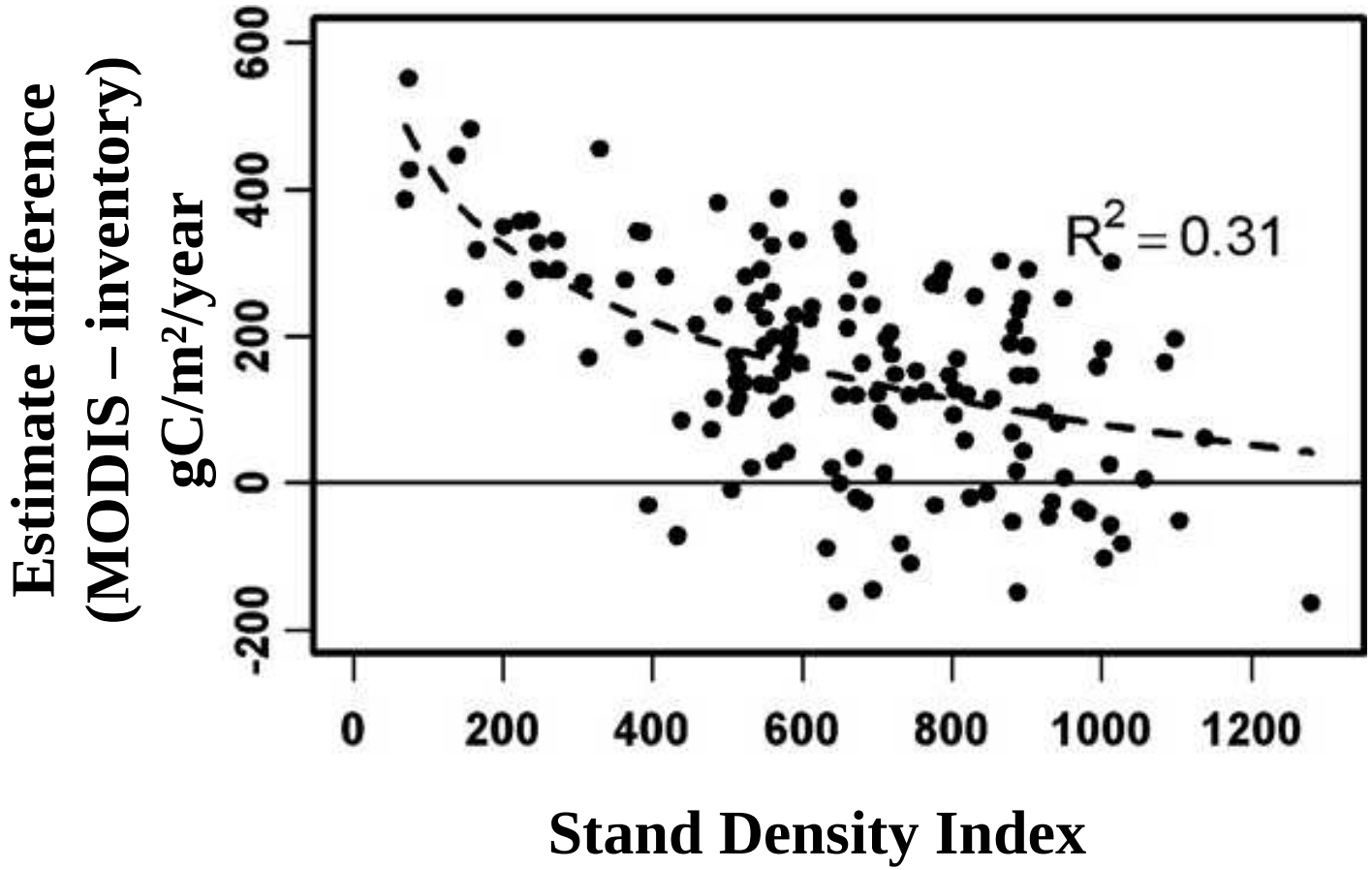
From MOD17 NPP (2002-2007)

With a biomass function and tree datas - estimation of NPP



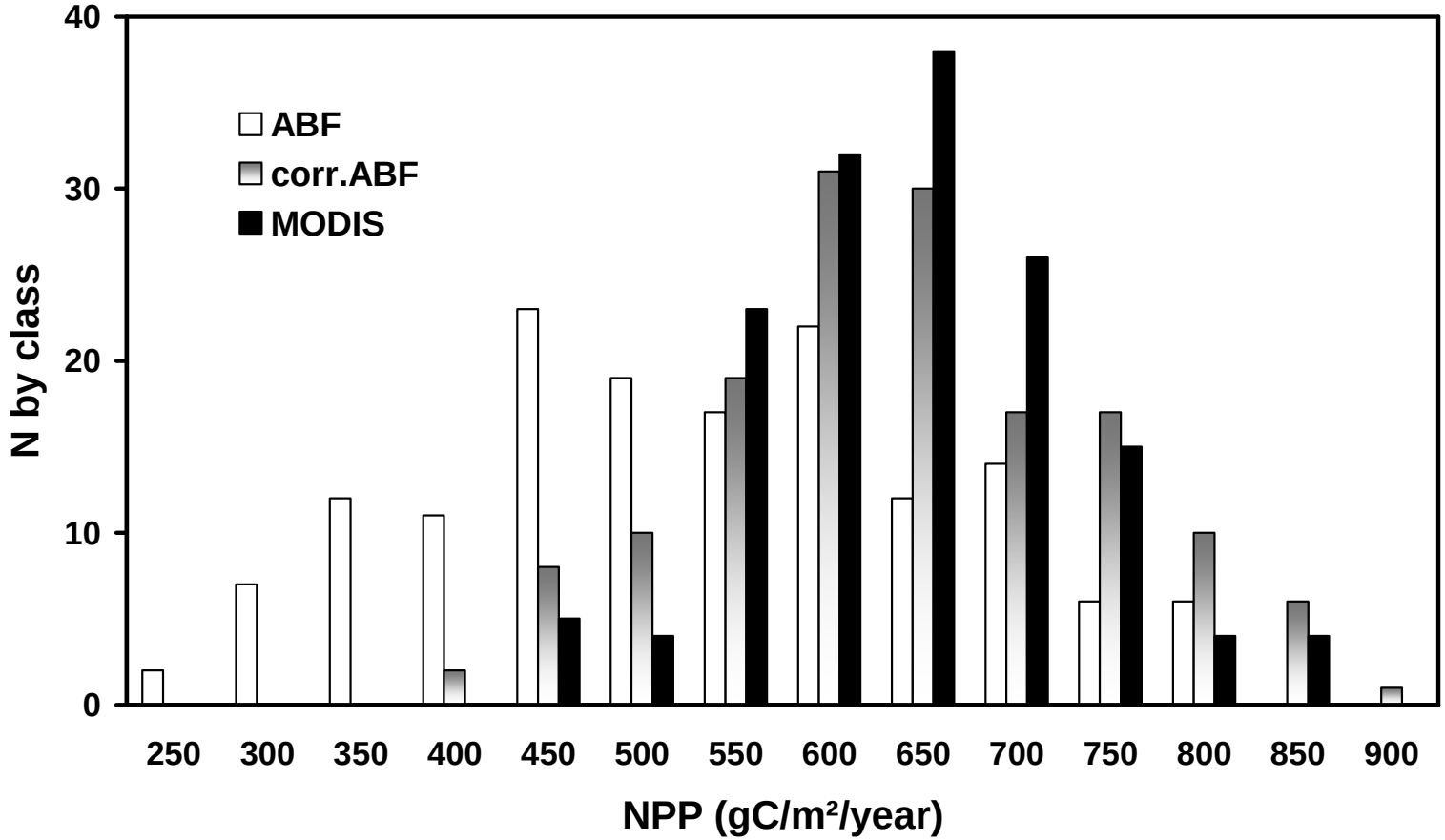
Hasenauer et al. 2012

Difference of MODIS NPP and NPP from inventory data



Hasenauer et al. 2012

After consideration of stand density, NPP estimations are consistent



Hasenauer et al. 2012

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Why Forest biomass – Summary ?

- **Use of biomass substitutes fossil carbon sources**
- **CO_2 release will be fixed through photosynthesis**
- **Annual biomass increment is higher then annual cut**
- **Generates income in rural areas**