Ökosystemanalyse am Beispiel des Kohlenstoffkreislaufes (OG.1)

für Geoökologie Master

Blodau, Matzner, Hauhs

Teil 3: Modellierung

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Gliederung

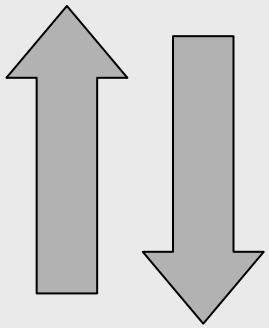
- Allgemeine Grundlagen
  - Kyoto Protokoll
  - Modellansätze
- Inventuren, Emissionen von „GHG“
  - Kohlenstoff im Boden
  - Kohlenstoff in der lebenden Biomasse
- Kombinierte Modelle
  - Skalen und Strategien
  - Vergleich N, S, …
- Ausblick & Zusammenfassung

models on soil carbon stocks and changes

- Context: C-inventory as part of the Kyoto protocol
- Model types and assumptions
- List of some common models
- Classification of models
- Case studies
- the equilibrium assumption and spin-up simulations
- Uncertainty analyses

Der globale Umsatz von CO_2

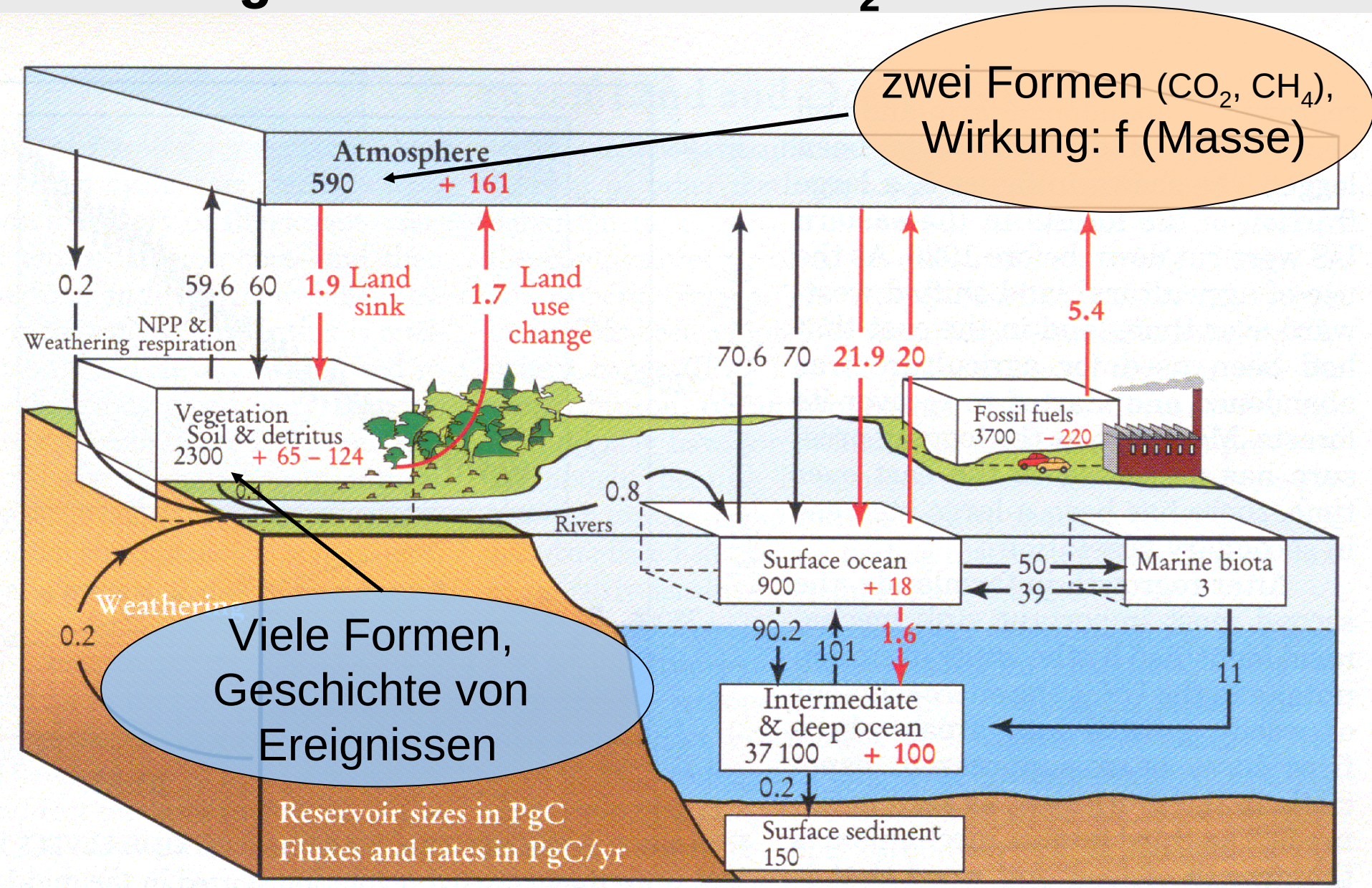
Kohlenstoff
in der Atmosphäre



Kohlenstoff
in terrestrischen und
aquatischen Ökosystemen

Aus: Physics Today 9/2002

Der globale Umsatz von CO_2



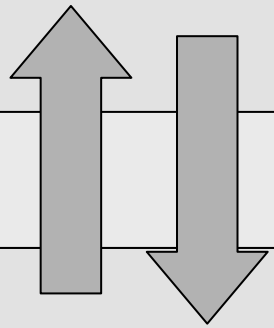
Der globale Umsatz von CO_2

Zustandsmodelle

(understand and predict)

Kohlenstoff
in der Atmosphäre

zwei Formen (CO_2, CH_4),
Wirkung: f (Masse)



Zustandsmodelle ?

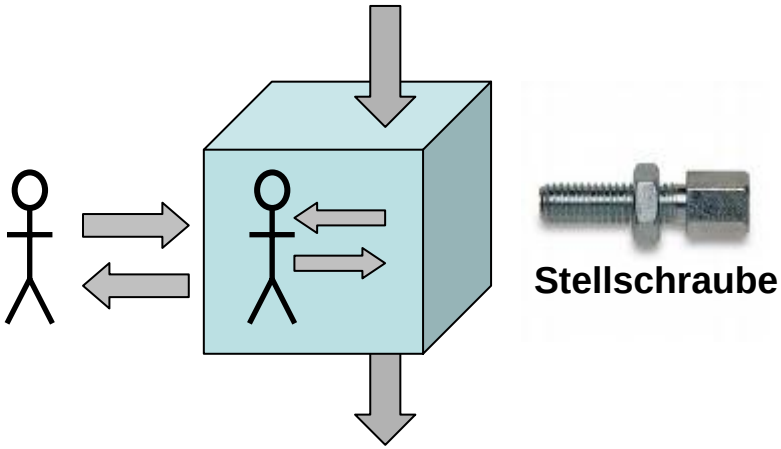
Kohlenstoff
in terrestrischen und
aquatischen Ökosystemen

Viele Formen,
Geschichte von
Ereignissen

Ansätze

1 a/b

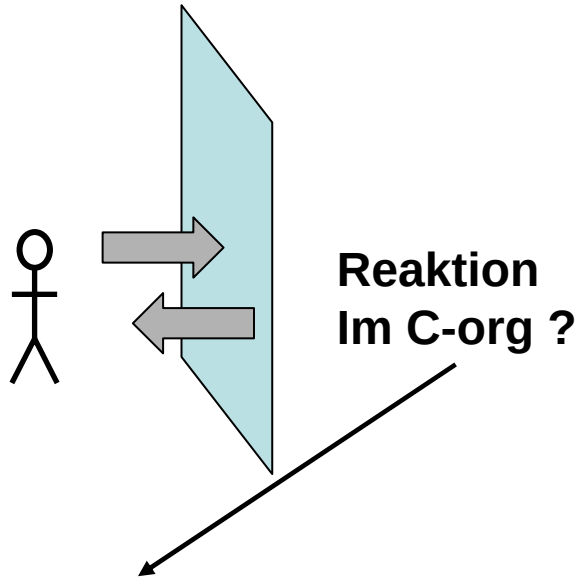
Menge im System steuert die Umsetzung und den Austrag



Austrag: Funktion der Menge

2

Ereignisse steuern die Menge



Menge: Resultat der Eingriffsgeschichte

Störungen

- Wenn die Ereignisse an der Schnittstelle „Störungen“ genannt werden:
  - vermischen sich die Modelle:
  - Störungen sind Ereignisse (Modelltyp 2)
  - Störungen setzen Stationarität mit Stabilitätsbereichen voraus (Modelltyp 1)

Stationäre Zustände (Ansätze 1a und 1b) :

Bewertung ist trivial ?

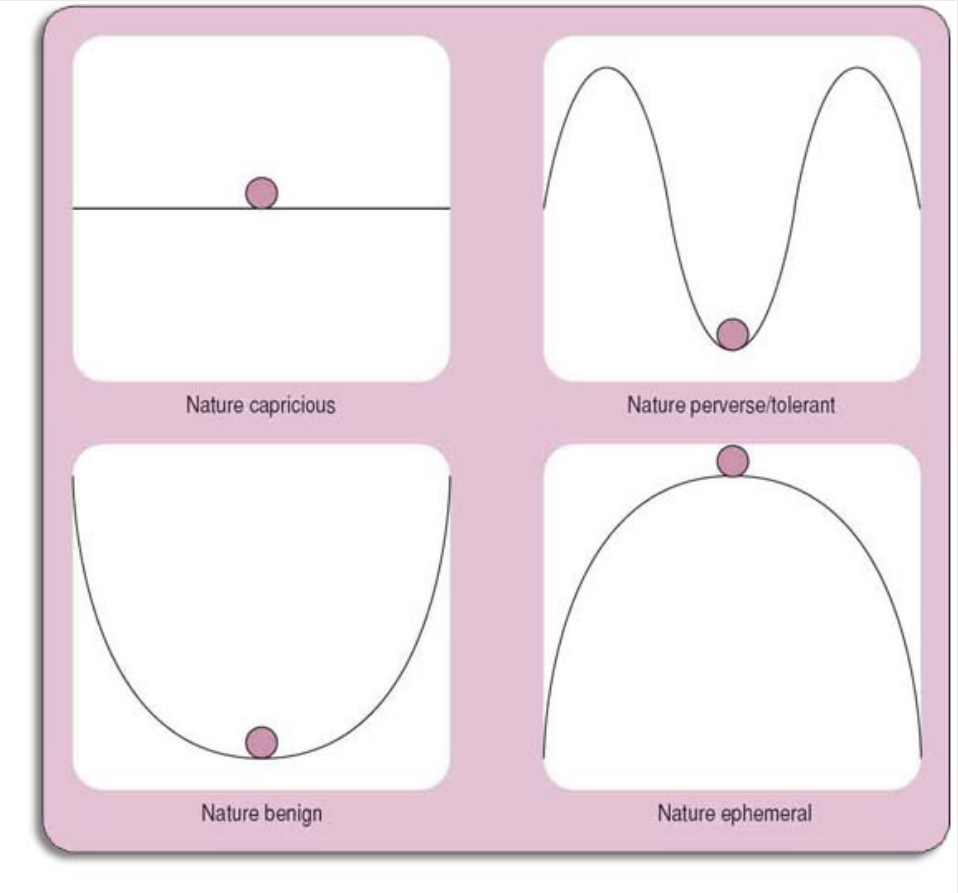


Figure 3: Myths of nature (adapted from Adams, 1995, p.34)

Internationale Verpflichtungen

- The ultimate objective of the Climate Change Convention (UNFCCC) is to achieve "… stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

- Regelmäßige Inventuren und Berichterstattung
  - Verweis auf Methoden Vorgaben des IPCC

Artikel 5.2 (Kyoto Protokoll)

- Methodologies for estimating anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol shall be those accepted by the **intergovernmental Panel on Climate Change** (IPCC) and agreed upon by the Conference of the Parties at its third session. …

Inhalte des Kyoto Protokolls

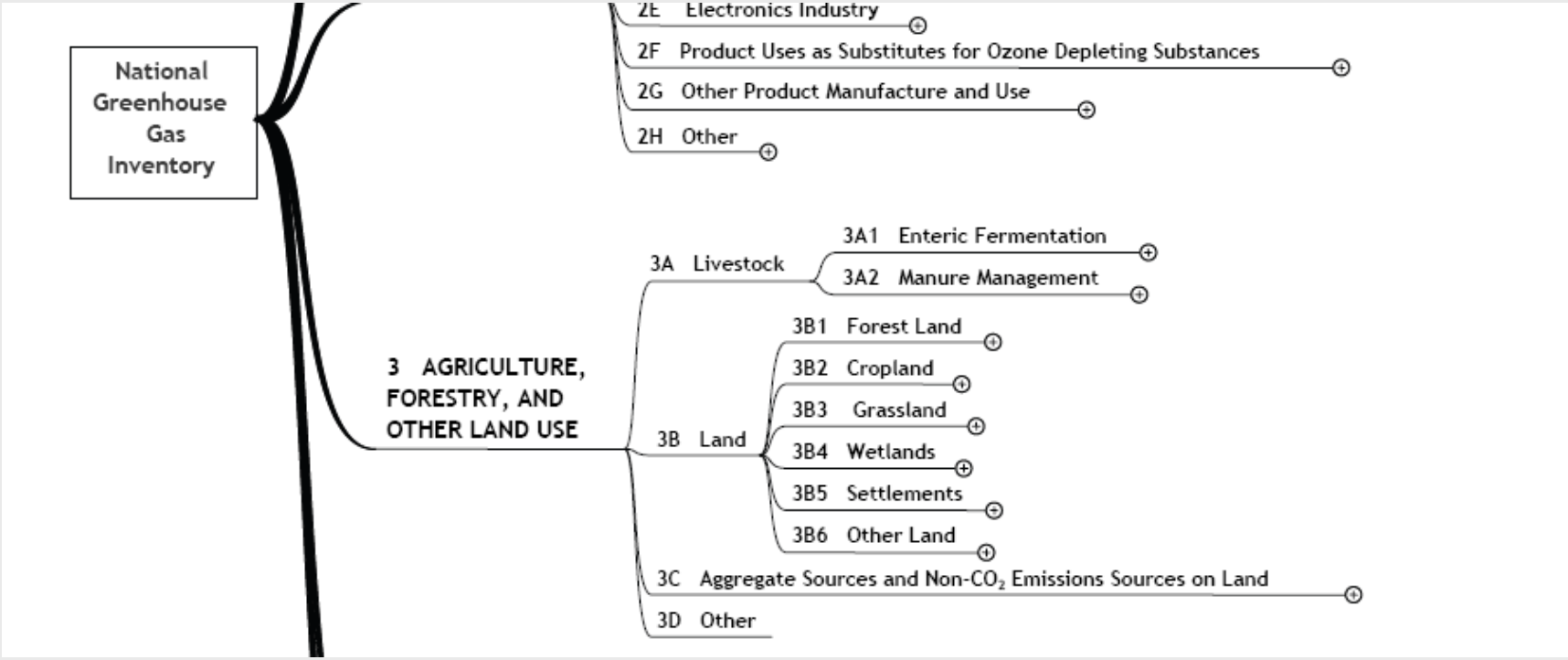
- Article 5 commits Annex I Parties to having in place, no later than 2007, national systems for the estimation of greenhouse gas emissions by sources and removals by sinks (Article 5.1).
- Article 7 requires Annex I Parties to submit annual greenhouse gas inventories, as well as national communications, at regular intervals, both including supplementary information to demonstrate compliance with the Protocol.
- Article 8 establishes that expert review teams will review the inventories, and national communications submitted by Annex I Parties

2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES

TABLE 1
CONTENTS OF 2006 GUIDELINES

Volumes	Chapters
1 - General Guidance and Reporting	1. Introduction to the 2006 Guidelines 2. Approaches to Data Collection 3. Uncertainties 4. Methodological Choice and Identification of Key Categories 5. Time Series Consistency 6. Quality Assurance/Quality Control and Verification 7. Precursors and Indirect Emissions 8. Reporting Guidance and Tables
2 - Energy	1. Introduction 2. Stationary Combustion 3. Mobile Combustion 4. Fugitive Emissions 5. CO_2 Transport, Injection and Geological Storage 6. Reference Approach
3 - Industrial Processes and Product Use	1. Introduction 2. Mineral Industry Emissions 3. Chemical Industry Emissions 4. Metal Industry Emissions 5. Non-Energy Products from Fuels and Solvent Use 6. Electronics Industry Emissions 7. Emissions of Fluorinated Substitutes for Ozone Depleting Substances 8. Other Product Manufacture and Use
4 - Agriculture, Forestry and Other Land Use	1. Introduction 2. Generic Methodologies Applicable to Multiple Land-use Categories 3. Consistent Representation of Lands 4. Forest Land 5. Cropland 6. Grassland 7. Wetlands 8. Settlements 9. Other Land 10. Emissions from Livestock and Manure Management 11. N_2O Emissions from Managed Soils, and CO_2 Emissions from Lime and Urea Application 12. Harvested Wood Products
5 - Waste	1. Introduction 2. Waste Generation, Composition and Management Data 3. Solid Waste Disposal 4. Biological Treatment of Solid Waste 5. Incineration and Open Burning of Waste 6. Wastewater Treatment and Discharge

2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES



Band 4: „managed land“ as reference

- *Integration between agriculture and land use, land-use change and forestry*:
  - *Managed land is used in these guidelines as a proxy for identifying anthropogenic emissions by sources and removals by sinks*.
  - *Consolidation of previously optional categories*: Emissions by sources and removals by sinks associated with all fires on managed land are now estimated, removing the previous optional distinction between wildfires and prescribed burning.
  - *Harvested wood products (HWP)*: The *2006 IPCC Guidelines* provide detailed methods that can be used to include HWP in greenhouse gas inventories using any of the approaches that are currently under discussion within the UNFCCC process.
  - *Emissions from managed wetlands*: The *2006 IPCC Guidelines* now contain methods to estimate CO2 emissions due to land use change in wetlands.

Band 5: Abfall

- *Potential release of methane* in the year of placement, has been replaced by a simple first order decay model that provides the option to use data available from the UN and other sources.
- *Carbon accumulation in landfills*: This is provided as an output from the decay models, …
- *Biological treatment and open burning of waste*: Guidance on estimation of emissions from composting andbiogas facilities has been included to ensure a more complete coverage of sources.

Aus: Guidelines Band 4

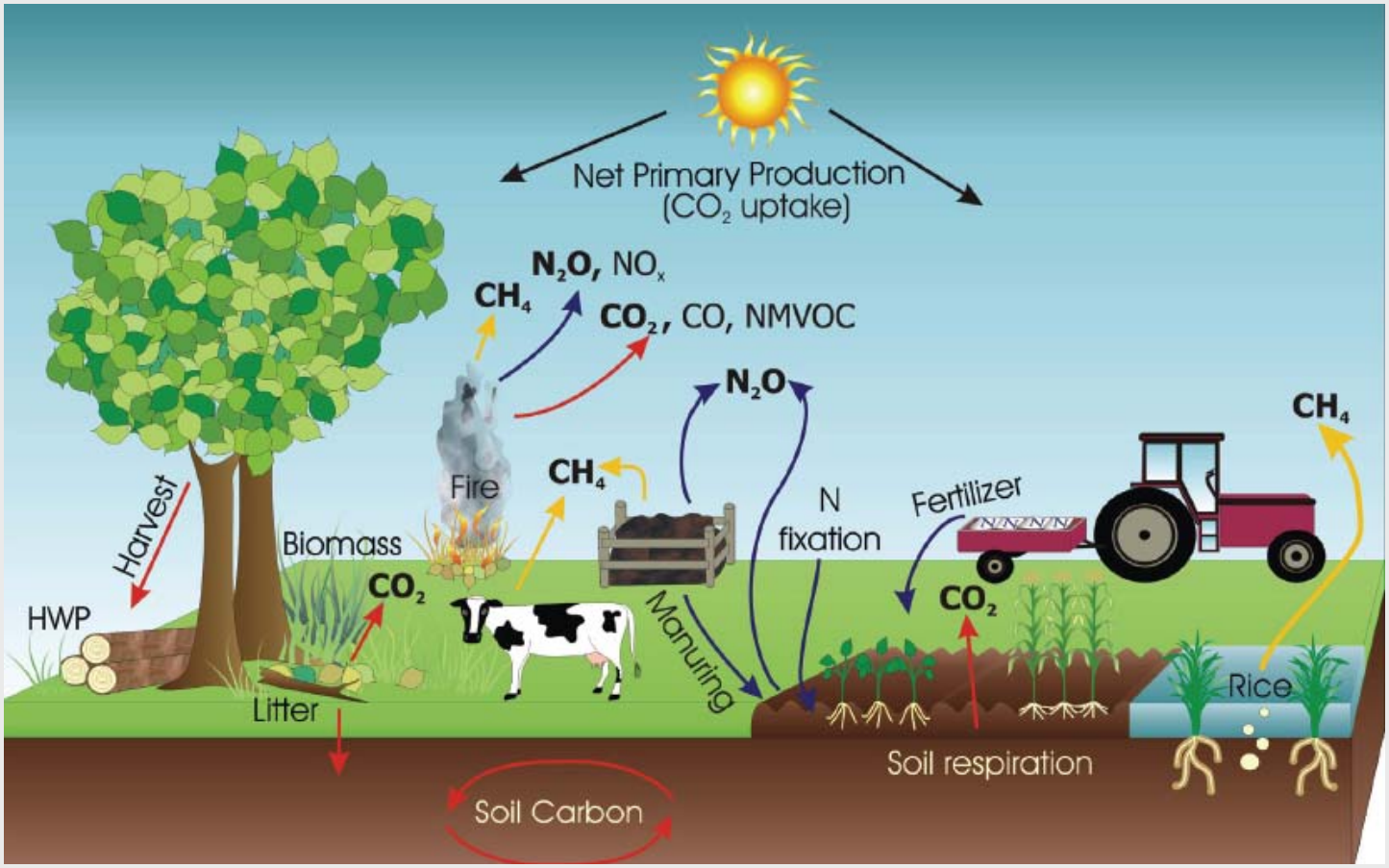


Figure 1.1 The main greenhouse gas emission sources/removals and processes in managed ecosystems.

Aus: Guidelines Band 4

- .“.. Generally, management-induced C stock changes are manifested over a period of several years to a few decades, until soil C stocks approach a new equilibrium. In addition to the influence of human activities, climate variability and other environmental factors affect soil C dynamics (as well as biomass and DOM).“

Kategorien für Kohlenstoffinventuren

(in der Landnutzung)

- Oberidische Biomasse
- Unterirdische Biomasse
- Totes Holz
- Streu (>2mm)
- Tote Biomasse im Boden (<2mm, soil organic matter)

TABLE 1.1
DEFINITIONS FOR CARBON POOLS USED IN AFOLU FOR EACH LAND-USE CATEGORY

Pool		Description
Biomass	Above-ground biomass	All biomass of living vegetation, both woody and herbaceous, above the soil including stems, stumps, branches, bark, seeds, and foliage. Note: In cases where forest understory is a relatively small component of the above-ground biomass carbon pool, it is acceptable for the methodologies and associated data used in some tiers to exclude it, provided the tiers are used in a consistent manner throughout the inventory time series.
	Below-ground biomass	All biomass of live roots. Fine roots of less than (suggested) 2mm diameter are often excluded because these often cannot be distinguished empirically from soil organic matter or litter.
Dead organic matter	Dead wood	Includes all non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots, and stumps, larger than or equal to 10 cm in diameter (or the diameter specified by the country).
	Litter	Includes all non-living biomass with a size greater than the limit for soil organic matter (suggested 2 mm) and less than the minimum diameter chosen for dead wood (e.g. 10 cm), lying dead, in various states of decomposition above or within the mineral or organic soil. This includes the litter layer as usually defined in soil typologies. Live fine roots above the mineral or organic soil (of less than the minimum diameter limit chosen for below-ground biomass) are included in litter where they cannot be distinguished from it empirically.
Soils	Soil organic matter[1]	Includes organic carbon in mineral soils to a specified depth chosen by the country and applied consistently through the time series[2]. Live and dead fine roots and DOM within the soil, that are less than the minimum diameter limit (suggested 2 mm) for roots and DOM, are included with soil organic matter where they cannot be distinguished from it empirically. The default for soil depth is 30 cm and guidance on determining country-specific depths is given in Chapter 2.3.3.1.

[1] Includes organic material (living and non-living) within the soil matrix, operationally defined as a specific size fraction (e.g., all matter passing through a 2 mm sieve). Soil C stock estimates may also include soil inorganic C if using a Tier 3 method. CO_2 emissions from liming and urea applications to soils are estimated as fluxes using Tier 1 or Tier 2 method.

[2] Carbon stocks in organic soils are not explicitly computed using Tier 1 or Tier 2 method, (which estimate only annual C flux from organic soils), but C stocks in organic soils can be estimated in a Tier 3 method. Definition of organic soils for classification purposes is provided in Chapter 3.

Vorgaben zur Methode : Rang 3

- „At **Tier 3**, higher order methods are used, including **models** and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national level. These higher order methods provide estimates of greater certainty than lower tiers. Such systems may include **comprehensive field sampling** repeated at regular time intervals and/or GIS-based systems of age, class/production data, soils data, and land-use and management activity data, integrating several types of monitoring. … **Models should undergo quality checks, audits, and validations and be thoroughly documented.“**

Biomasse Inventur im Wald

- **Rang 3**
  - Tier 3 approach for biomass carbon stock change estimation allows for a variety of methods, including **process-based models**. Implementation may differ from one country to another, due to differences in inventory methods, forest conditions and activity data. Transparent documentation of the validity and completeness of the data, assumptions, equations and models used is therefore a critical issue at Tier 3. Tier 3 requires use of detailed national forest inventories when the stock-difference method is used (Equation 2.8). They may be supplemented by allometric equations and models (for example, Chambers *et al.* (2001) and Baker *et al.* (2004a) for the Amazon; Jenkins *et al.* (2004) and Kurz and Apps (2006) for North America; and Zianis *et al.* (2005) for Europe), calibrated to national circumstances that allow for direct estimation of biomass growth.

- Leseaufgabe bis 23.6.:
  - Einleitung und Diskussion aus dem Review von Peltoniemi et al (2007)