Defining & valuing carbon related services in SEEA-EEA
(Presentation of issues paper)

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Overview

1. Definition and concept

- What exactly is the “service” - just sequestration? Just storage? Or both?
- Is this a final service, or only intermediate?

2. Measurement issues

- Physical quantification issues & system boundaries
- How to obtain data, practically speaking?

3. Valuation issues

- Which valuation method to apply?
- Can carbon sequestration values be applied to carbon stocks, too?

4. (Specific accounting problems -> *see separate presentation by Bram Edens!*)

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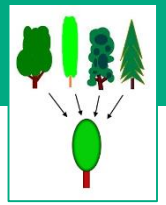
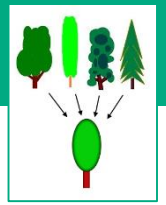
Definition and concept (1)



What exactly is the "service"? (Sequestration? Storage? Both?)

- Physical base: plants sequester carbon from atmosphere & store it for some time (days to centuries) → reduce CO_2 concentration → avoid damages to human societies
  - No mutually consistent definition of service in the science-policy literature (e.g. MEA / IPCC / IPBES / TEEB / CICES / …)
  - Even more confusing: sequestration sometimes also termed "storage" (= the process of storing C)
- *Recommendations:*
  - **distinguish** storage (stock variable) from sequestration (flow variable) *[units: tC vs. tC/a]*
  - Consider the flow variable **(sequestration) as the (only) ecosystem service**
    - Avoids double counting (carbon stored today is last year's carbon sequestered)
    - Measuring all existing C stocks is practically impossible (e.g. oceans? Fossil repositories?)
    - Physical data available (e.g. national emission inventories of UNFCCC member states)
    - Price & cost information: usually pertains to values of stock changes (rather than stock values per se)
  - Stock variable may be included as additional information (condition accounts / carbon accounts)

Definition and concept (2)



Carbon sequestration benefits: "final" or "intermediate" (or just a "process")?

- Distinction necessary for avoiding double counting (or counting irrelevant things)
- Again, different definitions in the literature, depending on context
- 2 aspects relevant for the SEEA-EEA context:
  - Benefit to humans discernible? → yes (reduced CO_2 concentration => avoided damages)
  - Double counting suspected? → no (no separate records for sequestration as input & as final product)

- *Recommendation:*
  - Follow Technical Recommendations for SEEA-EEA @ C sequestration, which **consider sequestration as a "final" service**
  - (even if benefits may be more indirect than in the case of some other ecosystem services)

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Measurement issues (1)

Physical quantification issues & system boundaries

- Various measurements of “sequestration” exist - again depending on context
- Differences: treatment of ecosystem respiration & degree of human influence; scope of ecosystems included; durability
- *Recommendations:*
  - **Use NECB**=„Net Ecosystem Carbon Balance“, i.e. Gross Primary Production *minus* plant & soil respiration *minus* carbon losses from disturbances, land-clearing & harvests *(alternative term: “net-net-sequestration”)*
  - **Concentrate on the 6 durable terrestrial carbon pools** distinguished by IPCC
    - Aboveground biomass; belowground biomass; dead wood; litter; soils; HWP
    - Account for durably stored carbon only (> 1 year)
    - Possibly account for “exports” of HWP (from forest sector to other sectors)
  - **Include non-managed land** (differently from IPCC)
    - According to SEEA’s focus on ecosystems & their services
    - (IPCC instead focuses on direct consequences of human interferences)
  - **(Note: “**Negative [net] sequestration” = “emission” – must be recorded as well!)

Measurement issues (2)

How to obtain data, practically speaking?

- Basically, 2 approaches exist:
  1. Stock-Difference method (comparing stock changes over time)
  2. Gains-Losses method (direct quantification of carbon inflows & outflows)
- *Recommendations*:
  - **Rely on IPCC** numbers wherever possible
    (for managed land: often based at inventories & applying the SD method)
  - Where not possible (e.g., unmanaged land; future developments), different options exist:
    - **Lookup tables** of C sequestration rates in specific ecosystem types
      based at Lit & IPCC guidelines/data (may be only game in town in data-poor situations)
    - Process-based **biophysical modelling** in combination with remote sensing technology (e.g. NDVI)
    - **Direct flux measurements** e.g. from FluxNet
  - Accept remaining uncertainties
    (e.g. measuring/modelling for land-based ecosystems might be more robust than for aquatic ones)

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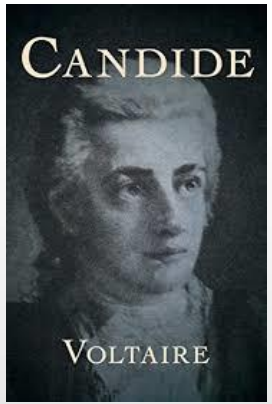
Valuation issues (1)

Which valuation method to apply?

- Different valuation approaches possible:
  - ***Damage Cost estimates*** (mimic a demand curve of damages avoided by carbon sequestration) ="Social Cost of Carbon"
  - ***Abatement Cost estimates*** (mimic a supply curve of costs for avoiding carbon emissions)
  - ***Market Price observations*** (from mandatory or voluntary markets)
  - ***Consumer Preferences studies*** (WTP)



- Approaches are theoretically linked: In an ideal world (with ideal markets), all approaches are interchangeable (i.e. lead to consistent marginal results)
- In reality, specific problems exist => no unequivocal approach

Valuation issues (2): Cost based methods

- **Damage Cost estimates** (3 main models: DICE, PAGE, FUND)
  - \+ Seem self-evident (as the benefit of C sequestration is damage avoidance); ***but***:
  - – Models rely on very long time forecasts (200-300 years)
  - – Contain myriads of assumptions (technological & economic development, discount rates, etc.)
  - – Some contain damage elements alien to national accounting principles (e.g., values of human life)
  - – Reflecting regional (economic) differences is problematic
  - – Data reliability: results differ by orders of magnitude
  - – Choice of “best” estimate susceptible to political manipulation (cf. different official recommendations!)

- **Abatement cost estimates** (e.g., “McKinsey”-curves)
  - – Rely on same models as above (top-down approach) – or on unclear methods (bottom-up) => same problems
  - – Produce dubious results to some part (i.e. negative costs), caused by unobserved transaction costs
  - – Country and even location dependent, but not available for many countries

Valuation issues (3): Carbon Pricing & WTP

- **ETS prices** (~20 different mandatory trading systems worldwide, covering 15% of emissions)
  - \+ Rely on empirical observations of actual market exchanges
  - \+ Well aligned with SNA/SEEA concept of exchange value
  - \+ reflect different economic situations of countries
  - – Do not cover all countries
  - – Cover selected sectors only (e.g. power sector; forest sector mostly excluded (exception: NZ)
  - – Prices are fairly volatile over time
  - – Price differences between systems reflect different economic conditions, but also different institutional settings

- **Other options** (taxes, prices from voluntary markets, consumer preference studies)
  - – Conceptually, not well comparable to compliance prices
  - – Empirically, very different price levels (might bias comparisons between sectors and/or countries)

Valuation issues (4)

Recommendations

➢ ETS prices

- Seem most viable for countries & sectors where ETS applies
- Other sectors: ETS prices still seem “least biased substitute”
  (even though scarcities might differ across sectors)
- Other countries: CDM & JI prices as substitutes – conceptually best comparable to ETS prices (less preferably, abatement costs)

➢ Damage cost estimates

- May be used as supplementary information
  (care for appropriate model & consistent discount rates)
- But unreliable if used as the single valuation approach

Valuation issues (5)

Can carbon sequestration values be applied to carbon stocks, too?

- **No!** C sequestration values apply to *marginal* quantity changes.
- These values are not valid for different quantities (and specifically, they are not valid for the aggregate value of an asset as a whole)
  reason: demand-curve based values decrease with quantity; supply-curve based values increase

Alternative: estimate discounted flow of all future benefits, & calculate Net Present Value.

Caveats:

- Many assumptions necessary (forecasts of future benefits? discount factors? etc.)
  - susceptible to manipulation, as above
- Still produces nonsense if applied to *essential* (quantities of) resources
  - Monetary valuation implies substitutability; however:
  - *Essential* resources cannot be substituted by something different, if life depends on them.

Main Messages

- **Focus on carbon sequestration (rather than storage)**

- **@quantification**
  - use NECB=„Net Ecosystem Carbon Balance“ as a measure
  - Rely on existing data as far as possible (IPCC)

- **@ valuation**
  - use ETS prices in countries which have a mandatory ETS
    (CDM, JI prices as substitutes in non-ETS countries)
  - SCC unreliable, possibly misleading & susceptible to manipulation
    (=> if used as supplementary information, care for appropriate model & consistent discount rates)

Thank you for your attention!

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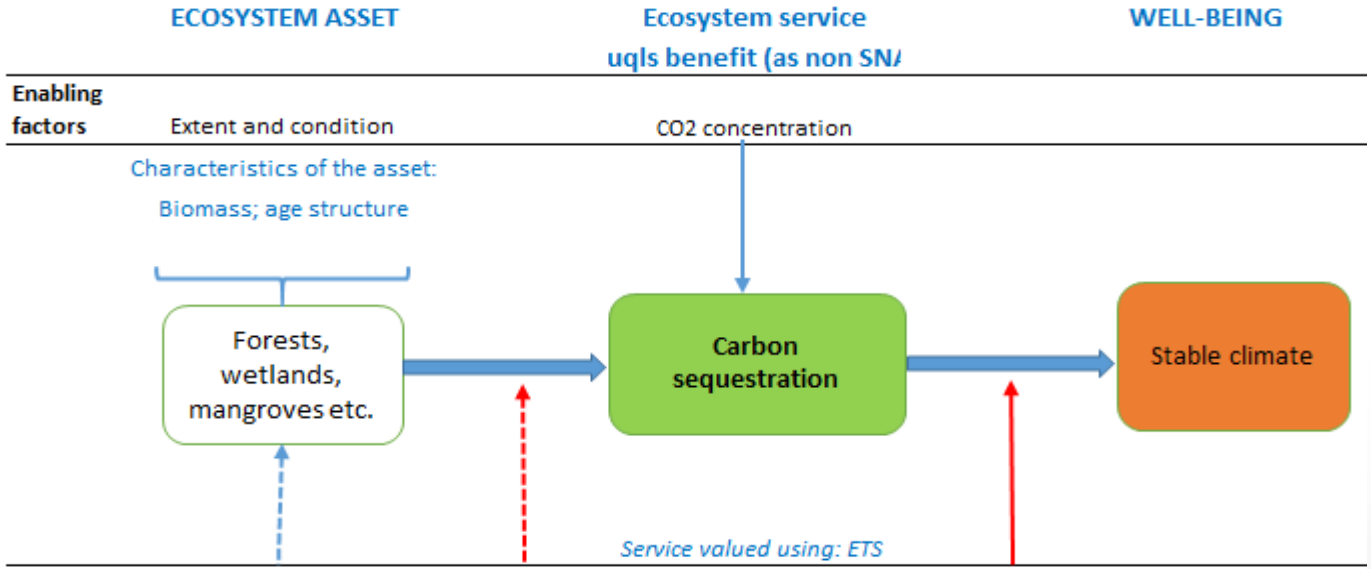
Emil Ivanov

(Specific accounting problems -> see separate presentation by Bram Edens!)

Recommendations:

- Record use of carbon sequestration as intermediate consumption by emitting sectors
- If carbon taxes are being recorded in an economy, adjustments to National Accounts are necessary
- Degradation costs can be defined in respect to changes in the atmospheric CO2 concentration
- Some boundary issues need further discussion (e.g. HWP; soil respiration; energy crops)

Annex: Logic chain of the service



Notes NECB is proposed as key metric to assess carbon sequestration

Annex @ REDD

Q: How does REDD fit into the quantification & valuation approach suggested here?

A: Not at all ☺ (or, more precisely: it does not at all pose specific problems)

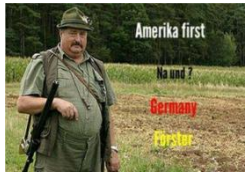
The problem is just that different references (baselines) exist:

- For accounting purposes, the emission/sequestration baseline is zero; for REDD, it is "emissions as usual"
- Therefore, in an accounting framework **any** positive amount of emissions will be counted as an emission, and any sequestration as the same thing but with the opposite sign. In contrast, under REDD the reference is each individual country's allowed baseline emission.
- *In other words, this is merely a matter of the allocation of property rights, i.e. a distributive and political issue, not a matter for accounting; what matters for accounting is just the difference between the baseline and zero (i.e. a country's allowed amount of emissions).*
- *Those countries which finance REDD have transferred a limited amount of emission rights to REDD receiving countries. This transfer has a monetary value and is recorded (like other financial transfers for development aid) in the national accounts. (These transactions may need to be reclassified depending on the accounting treatment chosen for the SEEA EEA).*

Annex @ blue (and other non-green) carbon

Treatment of carbon sequestration in places A FORESTER would not spontaneously think of

(not yet covered by the issues paper)

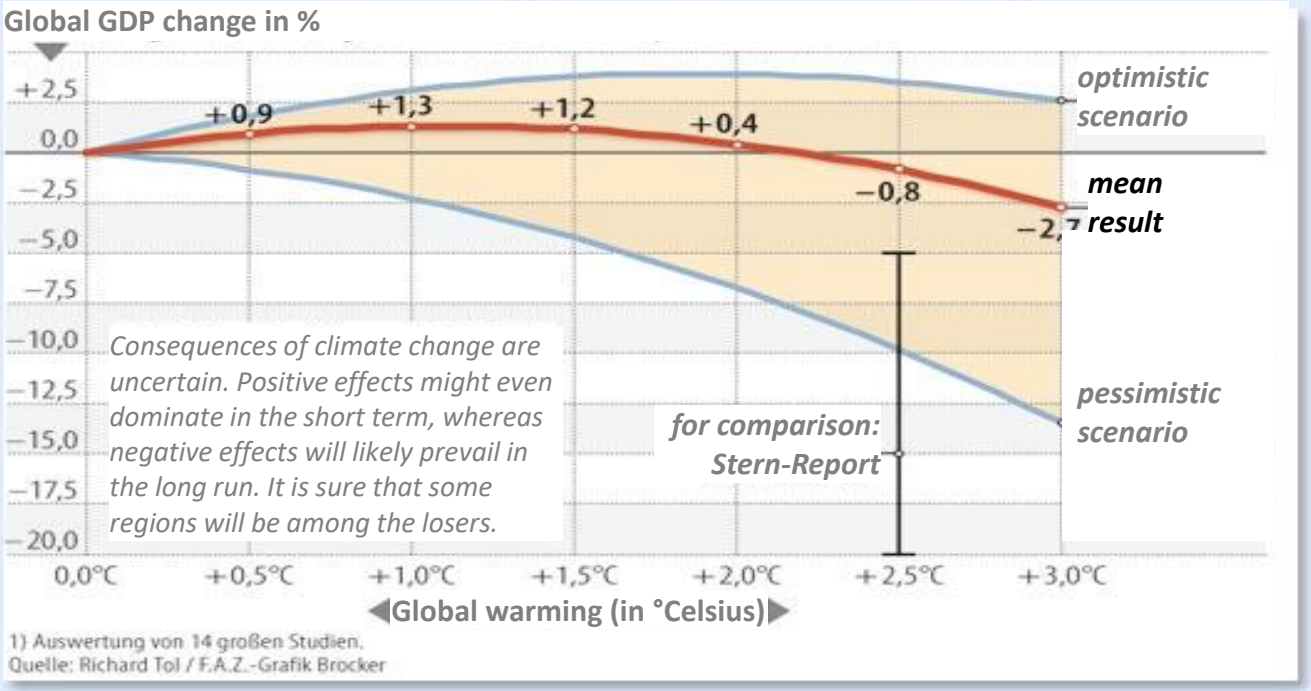


(just some preliminary thoughts)

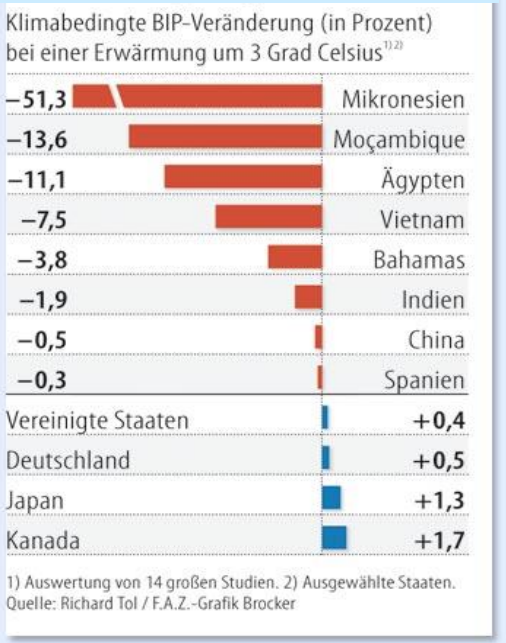
- Aquatic (continental waters, oceans)
  - Problems with oceans (~2/3 of Earth surface)
    - Virtually impossible to get reliable data about sequestration (let alone storage)
    - Exchange between oceans & atmosphere not well understood & hard to measure
    - Ownership problem: Mostly international, partly national (12-miles-zone etc.)
      (in which county's accounts would oceans appear? To which portion?)
    - Oceans sequester carbon also in weird forms (e.g. plastic & microplastic)
- *Ad-hoc-suggestion:*
  - Do not consider oceans separately (i.e. treat atmosphere & oceans as if they were one single system, with an "inner" boundary between water and air, where carbon exchange is just an "internal" ecosystem process)
  - (at no cost: The "internal process" might be tackled later, when better data are available)

Annex @ Monetary Valuation: Cost estimates

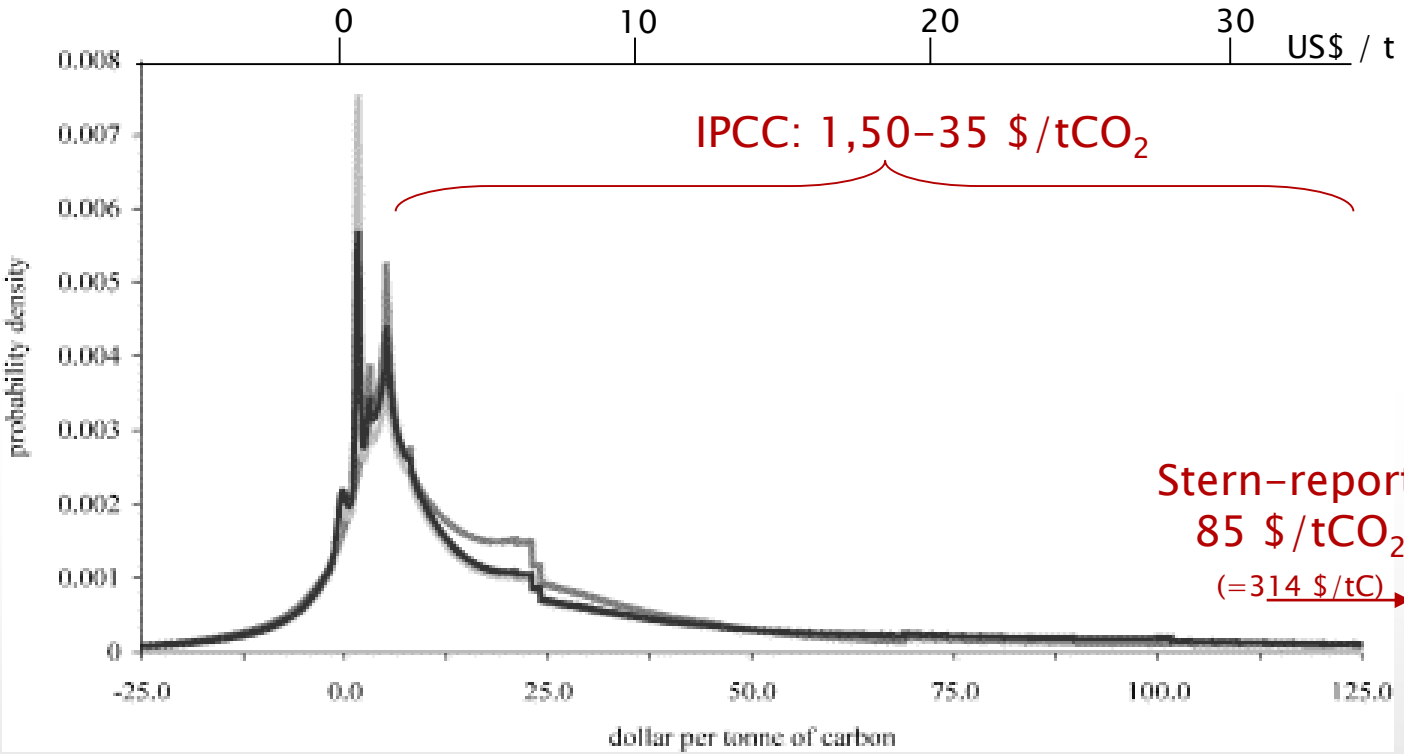
Economic consequences of global warming (Metaanalysis R. Tol)



Many losers, some winners



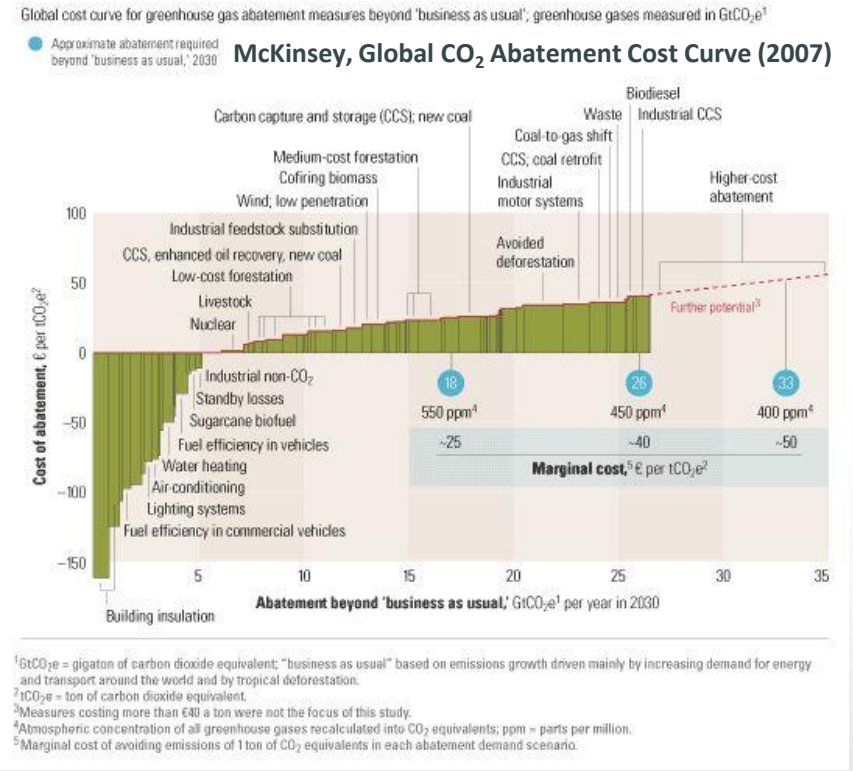
Annex @ Monetary Valuation: Cost estimates in $/tCO$_2$



- Broad range of cost estimates:
  - -7…+35 (+85) $/tCO$_2$
  - Highest prob. density: 0…+7 $/tCO$_2$
- Again, based at myriads of assumptions
  - Physical changes
  - VOSL
  - Time preference rate
  - etc. pp.

→ ***Prone to political manipulation!***

Annex @ Monetary Valuation: Abatement costs



[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] tCO_2e = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

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SEEA-EEA Expert Forum, Glen Cove NY

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Annex @ Monetary Valuation: Carbon Prices

Mandatory carbon markets, e.g. EU-ETS (European Union Emission Trading Scheme)

- Highly volatile
  - Max: 29,75 (4/2006)
  - Min: 0,01 (3/2008)
  - Recently stabilised
- Politically influenced
- Covers stationary & big plants; excludes
  - transport sector
  - land use sector

  → ***Half of the emissions!***

Annex @ Physical quantification problems: e.g. forests

carbon is stored …

→ In **trees**

→ In **other parts of the ecosystem**
(soils, flora & fauna, etc.)

→ In **Harvested Wood Products**
(sawnwood, furniture, paper etc.)

wood may substitute …

→ energy intensive **materials**
(e.g. aluminium windows)

→ <u>fossil</u> **energy** sources
(gas, coal, oil; <u>not</u> renewables/nuclear)

⇒ *System boundary definition influences C accounting results*

Example: Kyoto Protocol

- *2008-12: only forests*
- *>2012: forests & HWP*
- *(substitution in other sectors)*