Implementing IPCC methodology in model CASMOFOR to estimate the forest carbon sink

Zoltan Somogyi

National Agricultural Research and Innovation Centre

Forest Research Institute
Budapest, Hungary
somogyiz@ijf.hu
www.scientia.hu/casmofor

IPCC Expert Meeting: Application of 2006 IPCC Guidelines to Other Areas
1-3 July 2014, Sofia, Bulgaria
WGIII Report of AR5:

„energy use reductions ... will not be sufficient by themselves to constrain GHG emissions”

• „mitigation scenarios indicate a potentially critical role for land-related mitigation measures”
• „the potential of afforestation is limited”
• „there is a wide uncertainty in the role of afforestation and reforestation in mitigation”
### Some mitigation options in forestry

<table>
<thead>
<tr>
<th>Measure</th>
<th>Relative importance</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Preserving current forests (=preventing deforestation and degradation)</td>
<td>⬤⬤⬤⬤⬤</td>
<td>●</td>
</tr>
<tr>
<td>Increasing forest area</td>
<td>⬤⬤⬤</td>
<td>⬤⬤⬤⬤⬤</td>
</tr>
<tr>
<td>Increasing the C-density of the current forests</td>
<td>⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Increasing the amount of carbon in wood products</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

---

A potentially useful, IPCC-compatible tool to model forest carbon dynamics: www.scientia.hu/casmofor
Issues addressed by using CASMOFOR so far:

What is the potential of AR projects?
Are methodologies good enough to persuade stakeholders?

How much is the projected sink of the AR category? Informing the Initial Report of Hungary

- *results affected domestic policy choices for the 1st CP*

- *compatibility with inventory estimates* was essential

- projections depend both on the assumptions for future afforestations with respect to species, site and evolution of total area over time, but also *on models applied*

- *guidance for projections was (and is still) missing*

Estimates of average annual sink in CP1 (MtCO$_2$yr$^{-1}$):

- CASMOFOR (2005): 1.1
- GHG inventory (2014): 1.22

Net cost of AR: model estimates for the scenario of 10,000 hayr\(^{-1}\), fast growing species on good site

Comparing 32 afforestation scenarios

Estimates by CASMOFOR

How can FMRL estimate be validated?

Differences were due to: • incomplete modeling • methodological inconsistencies

Projections for the mitigation sections of National Communications (1997-2013)

Estimates by CASMOFOR

Research on how climate change may affect the carbon balance of forests

(graph shows baseline scenario, i.e. assuming no climate change, for beech forests in Zala country, Hungary; Somogyi Z. 2014, ongoing research)
Possible additional questions by decision makers that could be answered by CASMOFOR

- how much \textit{C} can be fixed on a given area?
- how much \textit{area} is needed to fix a given amount of \textit{C}?
- how \textit{quickly}?
- for how much \textit{money}?
Possible additional questions by decision makers that could be answered by CASMOFOR

- which species is worth using from a sequestration point of view?
- what are the effects of site and other factors?
- how permanent is C sequestration?
Methodologically, mitigation projects, projections and NGHGIs are different

- NGHGIs: historical data; projections: scenarios; projects: both
  
  *how to develop projections of activity data? how to deal with changing EF/RF?*

- methodologies can be different
  
  *under what conditions can NGHGI methods or already existing project methodologies (e.g. under the CDM) be applied?*

- NGHGI models are partly covered by IPCC report of 2010 „Use of Models ... in Greenhouse Gas Inventories”
  
  *what criteria should projections meet?*
CASMOFOR: an IPCC-compatible model

- based on **IPCC 2006 Guidelines** (Tier 2-3-1)
- *cohorts* by species/varieties and site of appropriate data (can be changed in regenerations)
- ~40 equations of dynamics of *all carbon pools* plus forestry and carbon economics (all in website)
- calculations in *annual steps*
CASMOFOR models balanced processes

AIR \rightarrow tree growth \rightarrow BIOMASS: wood, leaves, roots
CASMOFOR models balanced processes

AIR

$\text{tree growth}$

$\text{decomp-}
\text{osition, burning}$

$\text{DEAD WOOD LITTER SOIL}$

$\text{BIOMASS:}
\text{wood, leaves, roots}$

$\text{death, disturbance}$
CASMOFOR models balanced processes

- AIR
- tree growth
- BIOMASS: wood, leaves, roots
- death, disturbance
- timber, harvest
- decomposition, burning
CASMOFOR models balanced processes

- **AIR**
- **tree growth**
- **DEAD WOOD LITTER SOIL**
- **BIOMASS: wood, leaves, roots**
- **TIMBER IN FOREST**

- decomposition, burning
decomp-

- death, disturbance
death, disturbance
timber harvest

harvest
CASMOFOR models balanced processes

AIR $\rightarrow$ tree growth $\rightarrow$ BIOMASS: wood, leaves, roots

dead, disturbance $\downarrow$

SOIL $\leftarrow$ decomposition, burning

dead, disturbance $\uparrow$

TIMBER IN FOREST $\leftarrow$ timber harvest

burning $\rightarrow$ FIREWOOD

decomposition, burning $\rightarrow$ WOOD PRODUCTS
CASMOFOR models balanced processes

AIR

tree growth

Biomass: wood, leaves, roots

Dead wood

Soil

decomposition, burning

Timber in forest

decomposition, burning

Firewood

Wood products

Substitution
Methodological issues of using models

• what *project boundaries* to apply?

• are project and national level methods *consistent*?
  (=could projected sink be regarded as potential additions to AR?)

• consistency between *gain-loss method* and *stock change method*?
CASMOFOR: a forestry data warehouse for Hungary

• yield tables
• silvicultural models
• 22 factors of carbon dynamics

• economic model of costs and revenues (including carbon credits)

for 18 species/species group, and often by 6 yield groups
CASMOFOR: an adaptable and transparent framework

- fully customizable database: both local („country-specific”) or IPCC default data could be used
  which IPCC default data / under what conditions?

- the application of data can be checked during simulations

- the model was successfully adapted in South Africa
• growth rate + silvicultural regime + disturbance regime must be known / simulated / assumed

• changing parameter values over time is possible

  *guidance on the methodology to estimate growth rate, disturbance and other parameters under changing climate?*
CASMOFOR in a model comparison

CASMOFOR predicted with higher accuracy the carbon ... than [other] ... models.... This is largely because the model meets all five of the characteristics of modifiability, reliability, efficiency, integrity and usability (McCall et al., 1977 cited by Ortega& Rojas, 2003) which are important in the success of any software or model.”

CASMOFOR: an accurate, transparent, simple framework

• calculations compatible with the Law of the Conservation of Mass and Energy

• Uncertainty analysis is possible using the built-in Monte Carlo module

• extended help both in English and Hungarian

• system in MS Excel + its VBA to keep everything simple
Should IPCC work on methodological issues of (AFOLU) mitigation?

Managing climate change requires:

**Assessment – Mitigation – Adaptation**

so a TF GGP might not only need to include:

- **NATIONAL LEVEL**
- **SUB-NATIONAL LEVELs**

(past) (future)
Should IPCC work on methodological issues of (AFOLU) mitigation?

Managing climate change requires:

**Assessment – Mitigation – Adaptation**

**a TF GGP might need to include:**

- **SUPRA-NATIONAL LEVEL**
- **NATIONAL LEVEL**
- **SUB-NATIONAL LEVELs**

(past) → (future)