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Sensitivity of marginal abatement cost curves to variation of G4M parameters

Mykola Gusti, Nikolay Khabarov and Nicklas Forsell

4th International Workshop on Uncertainty in Atmospheric Emissions, Kraków, 7th-9th October, 2015

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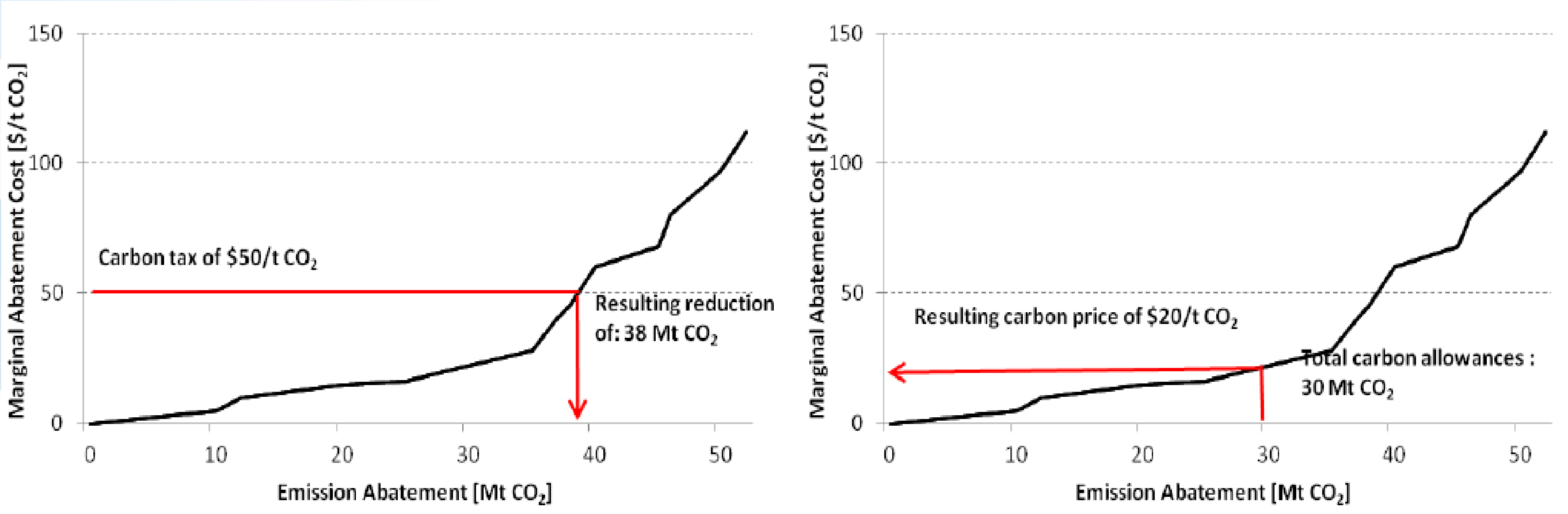
Outline

- Introduction
- Method
- Results and discussion
- Conclusions and Challenges
- Questions and answers

Introduction

- MACC – a "tool" for analysis of mitigation policies

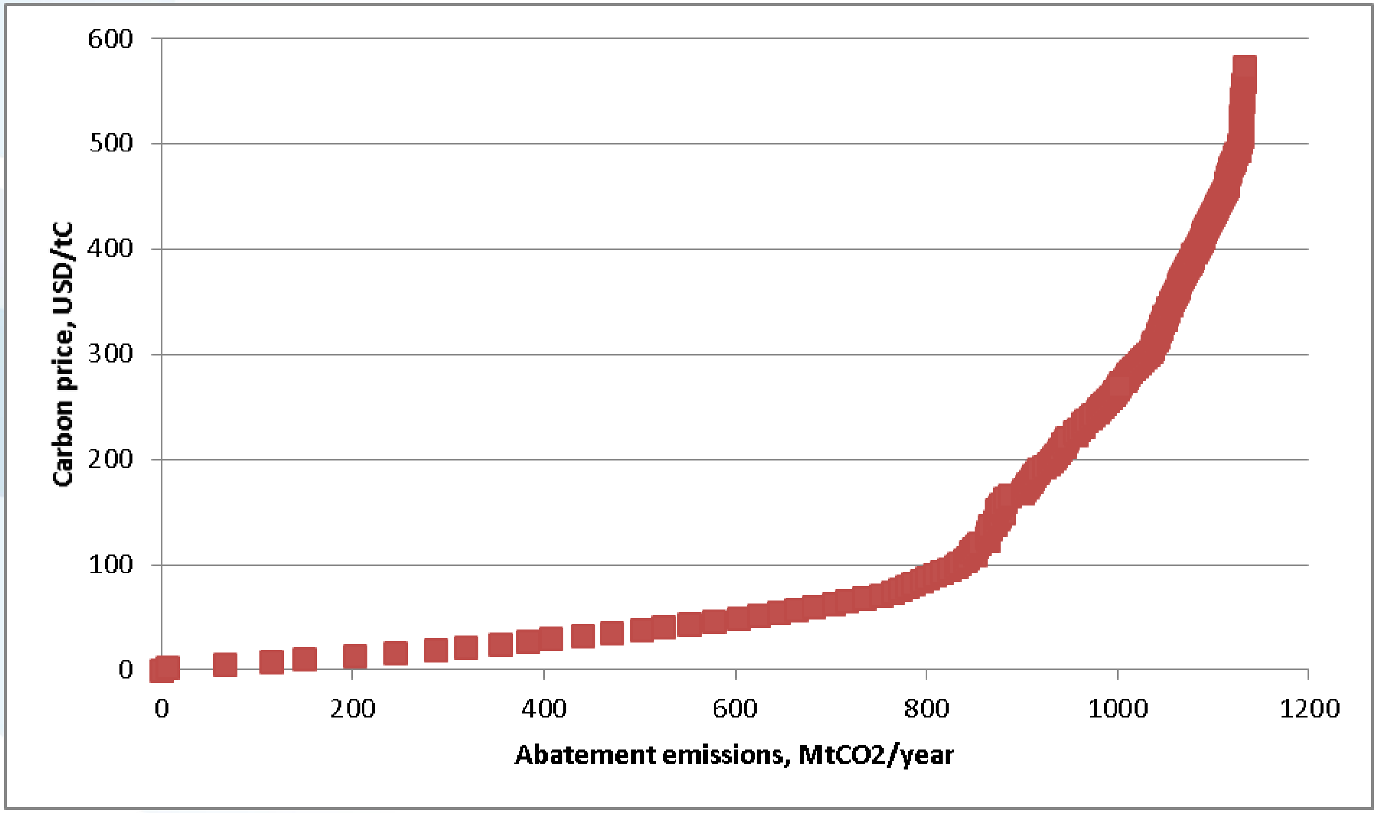


Kesicki (2011)

Introduction

- Model derived MACC:

(BAU emissions – Mitigated emissions) against mitigation costs

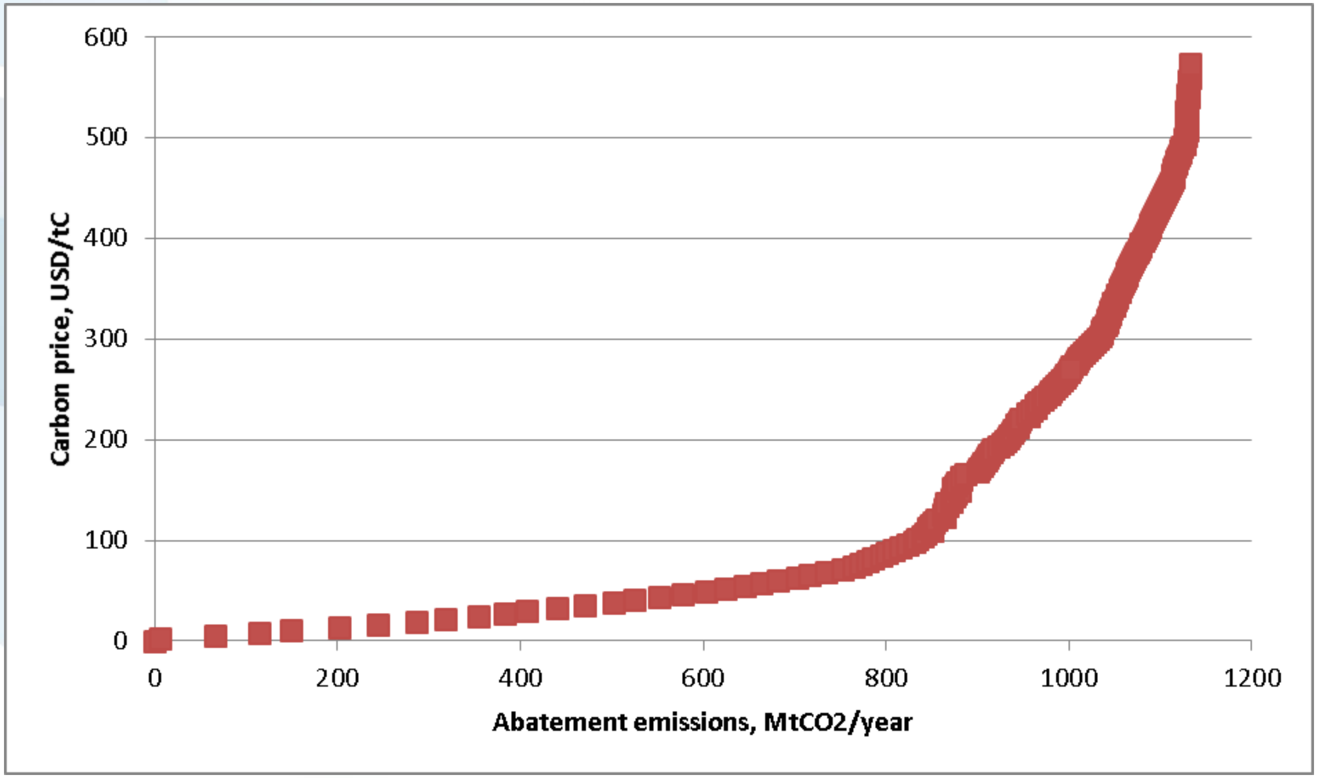


Introduction

- Model uncertainty and MACC:

(BAU emissions + ~~Err~~ – Mitigated emissions - ~~Err~~)

(BAU emissions + Err1 – Mitigated emissions – Err2)



Gusti et al. Sensitivity of marginal abatement cost curves to variation of G4M parameters. 4th IWUAE, Kraków, 7th-9th October, 2015

Introduction

- Model uncertainty and MACC:

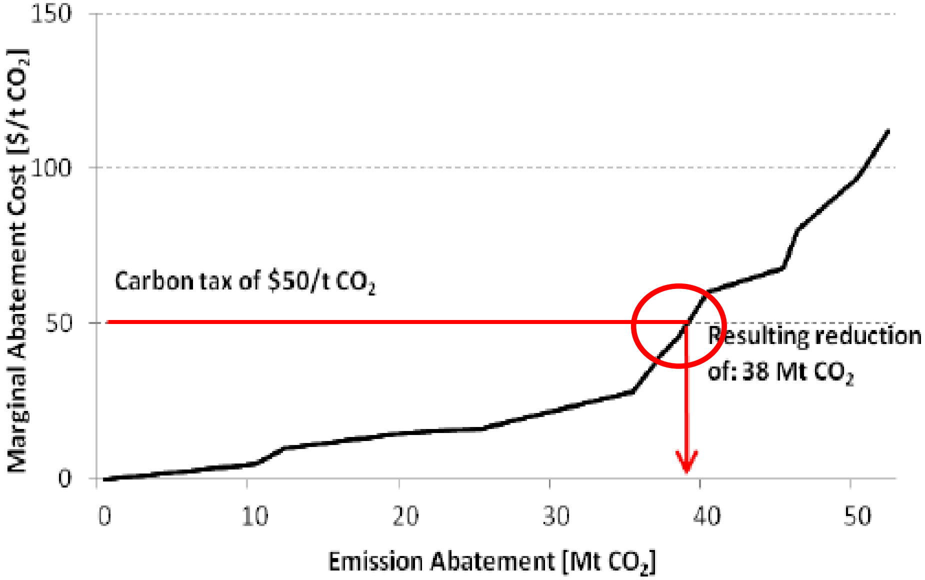
(BAU emissions + ~~Err~~ – Mitigated emissions - ~~Err~~) ?

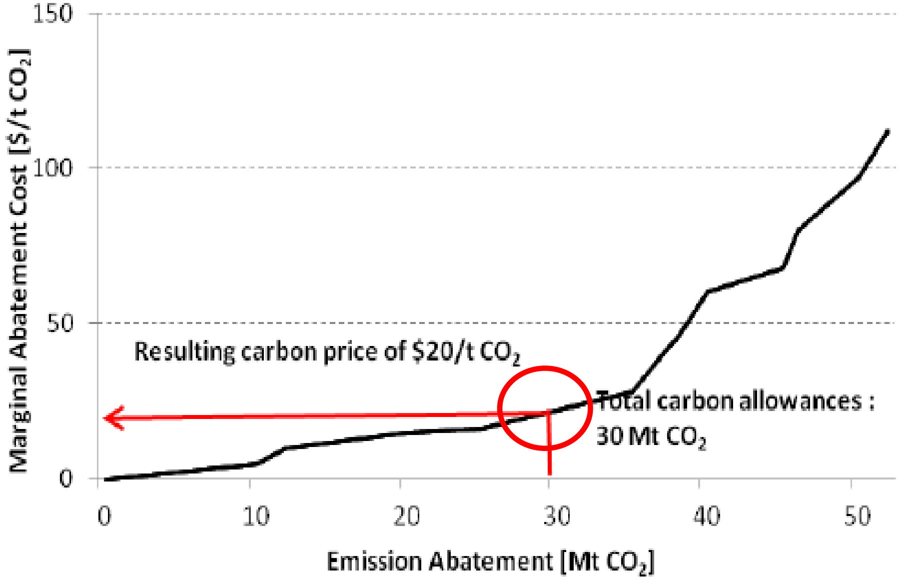
(BAU emissions + Err1 – Mitigated emissions – Err2) ?

What is sensitivity of the MACCs to selected model parameters?

Introduction

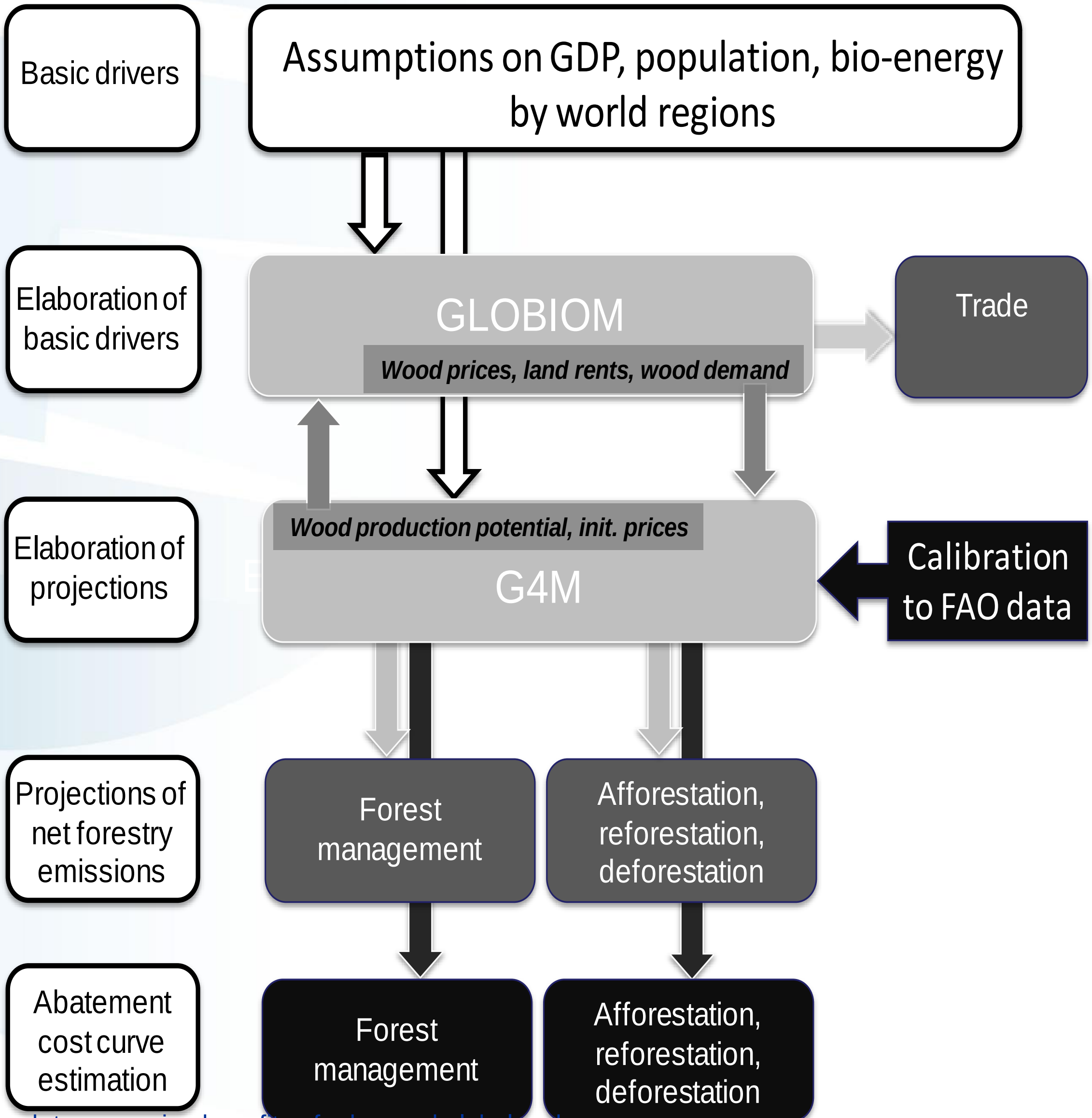
- how the parameter uncertainties can impact GHG abatement policies related to forest sector?



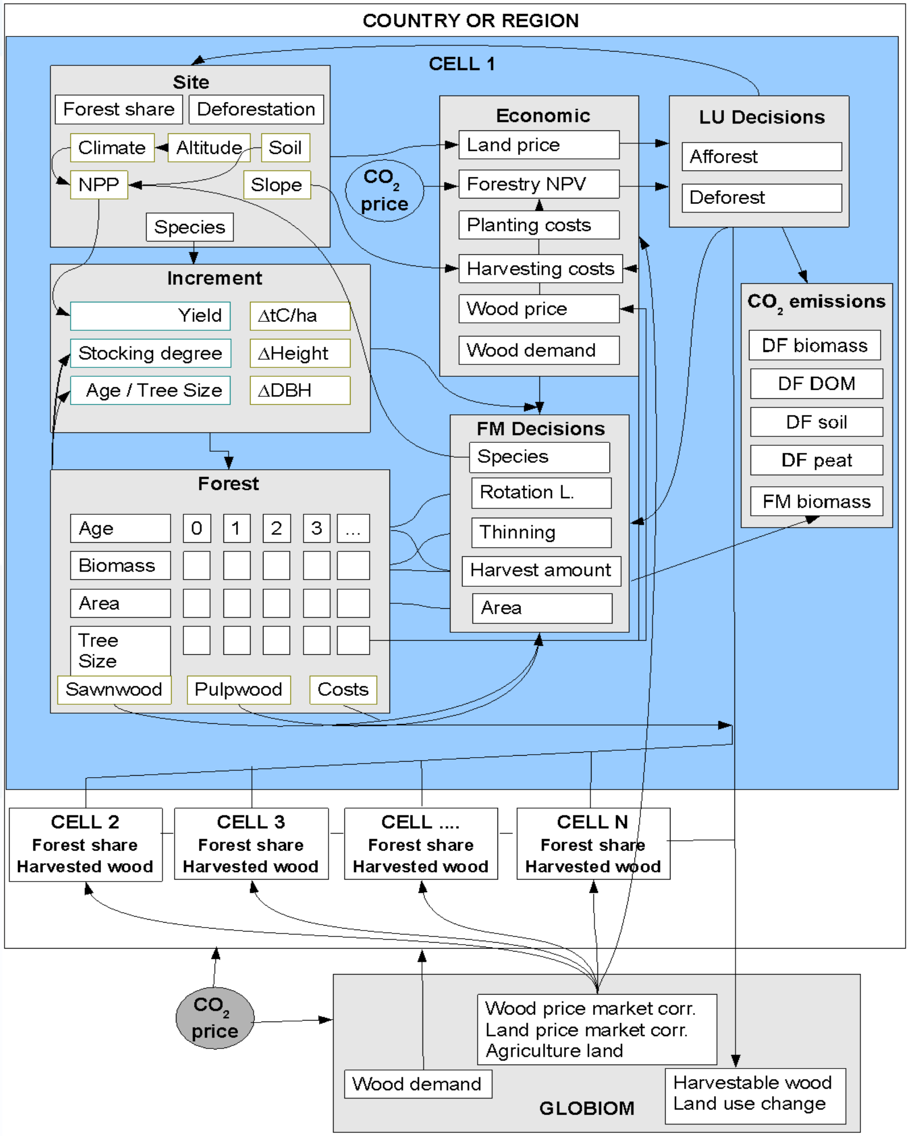


Modified figure from Kesicki (2011)

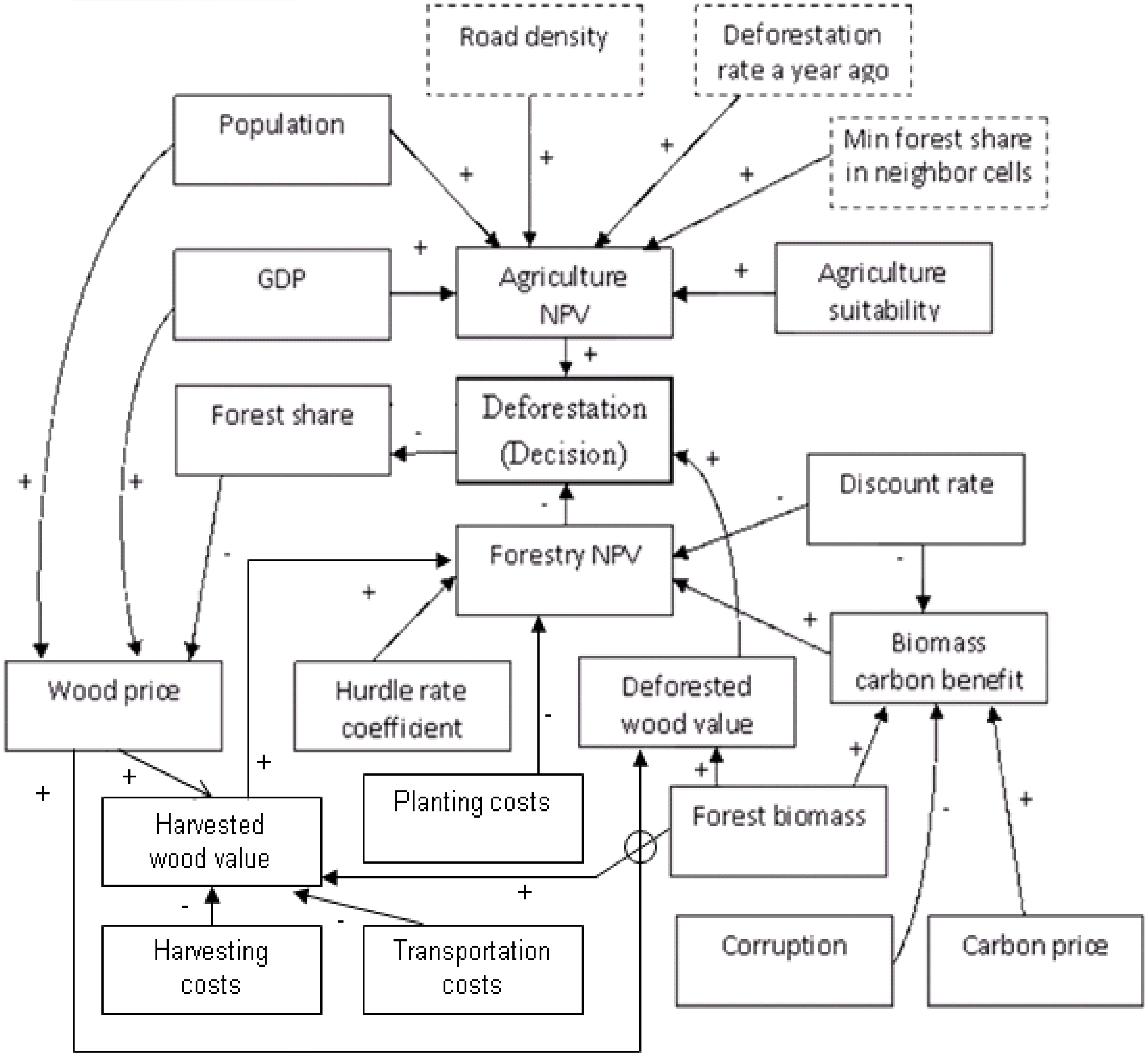
Generating LUC abatement cost curves: Modeling framework



Method: G4M overview



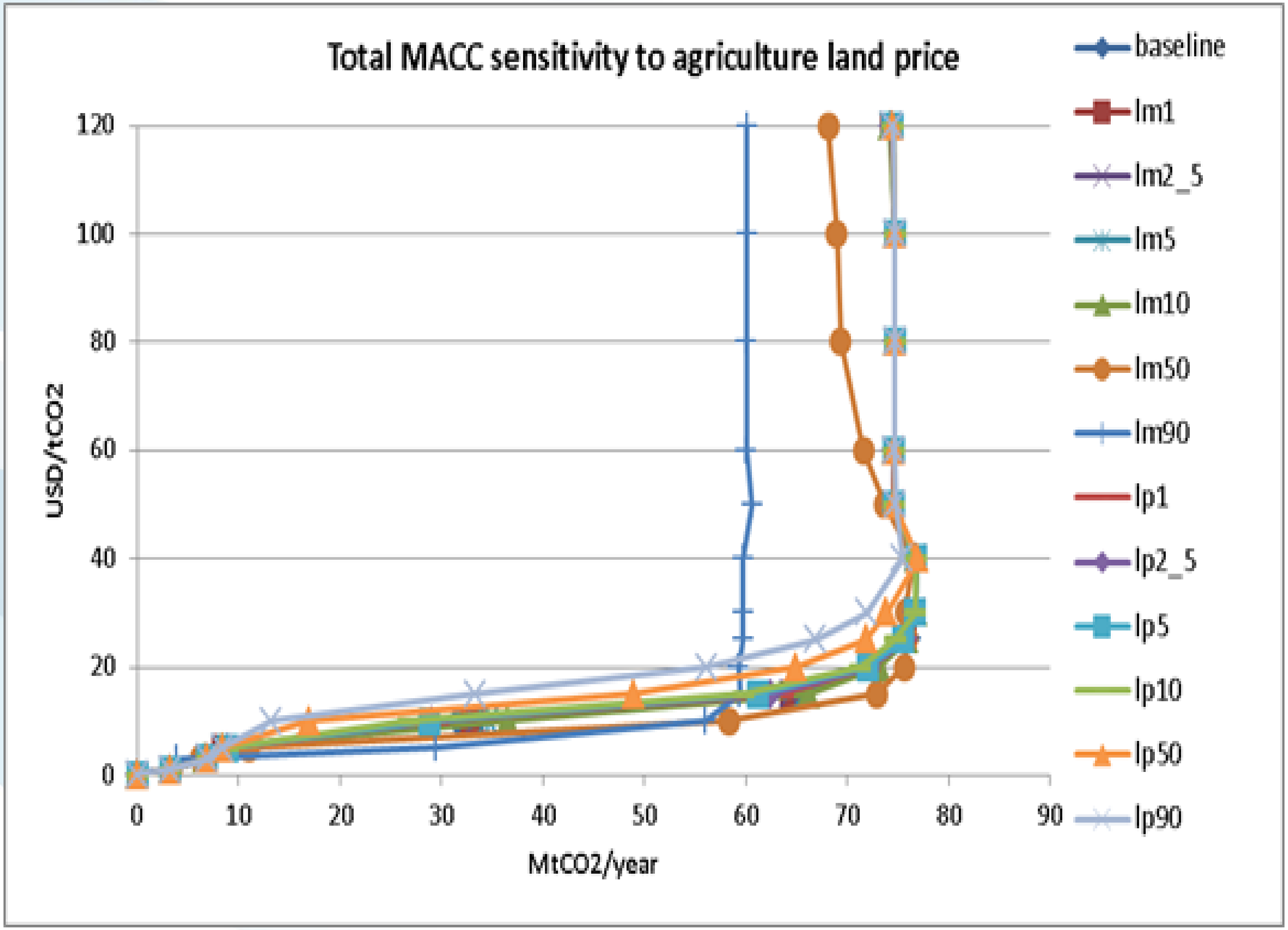
Method G4M: LUC decisions



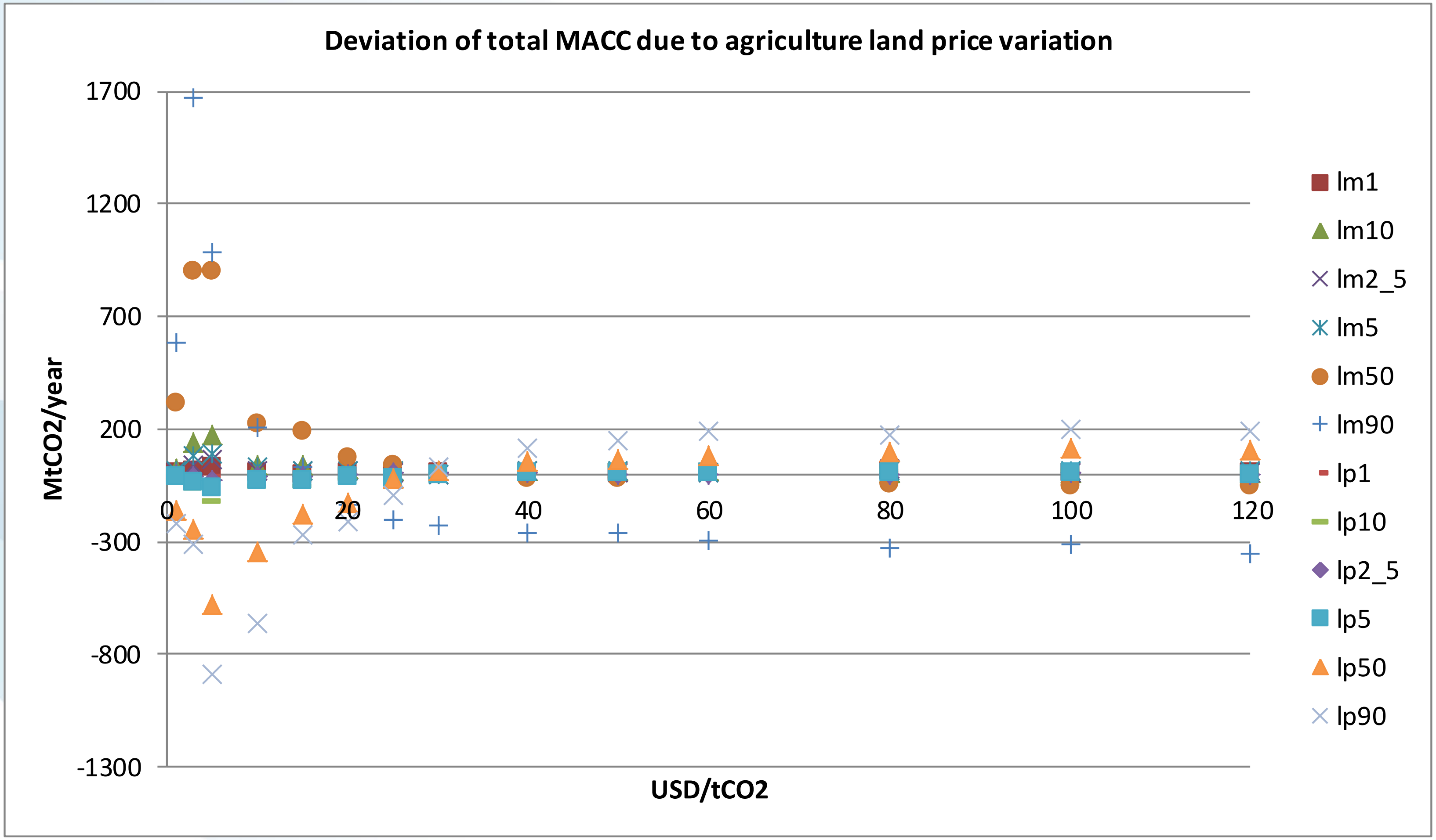
Method

- *“Baseline”:* CO2 initial prices starting in 2020 (0, 1, 3, 5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100, 120 USD/tCO2) and rising 5% / year (CO2 price range: 4-520 USD/ton CO2 in 2050)
- *“Sensitivity”:* decrease/increase **cr**, **w**, and **l** them by 1, 2.5, 5, 10, 50 and 90% one by one for each CO2 price
- Build MACC as a difference of total biomass CO2 emissions at non-zero CO2 price and zero CO2 price in 2030

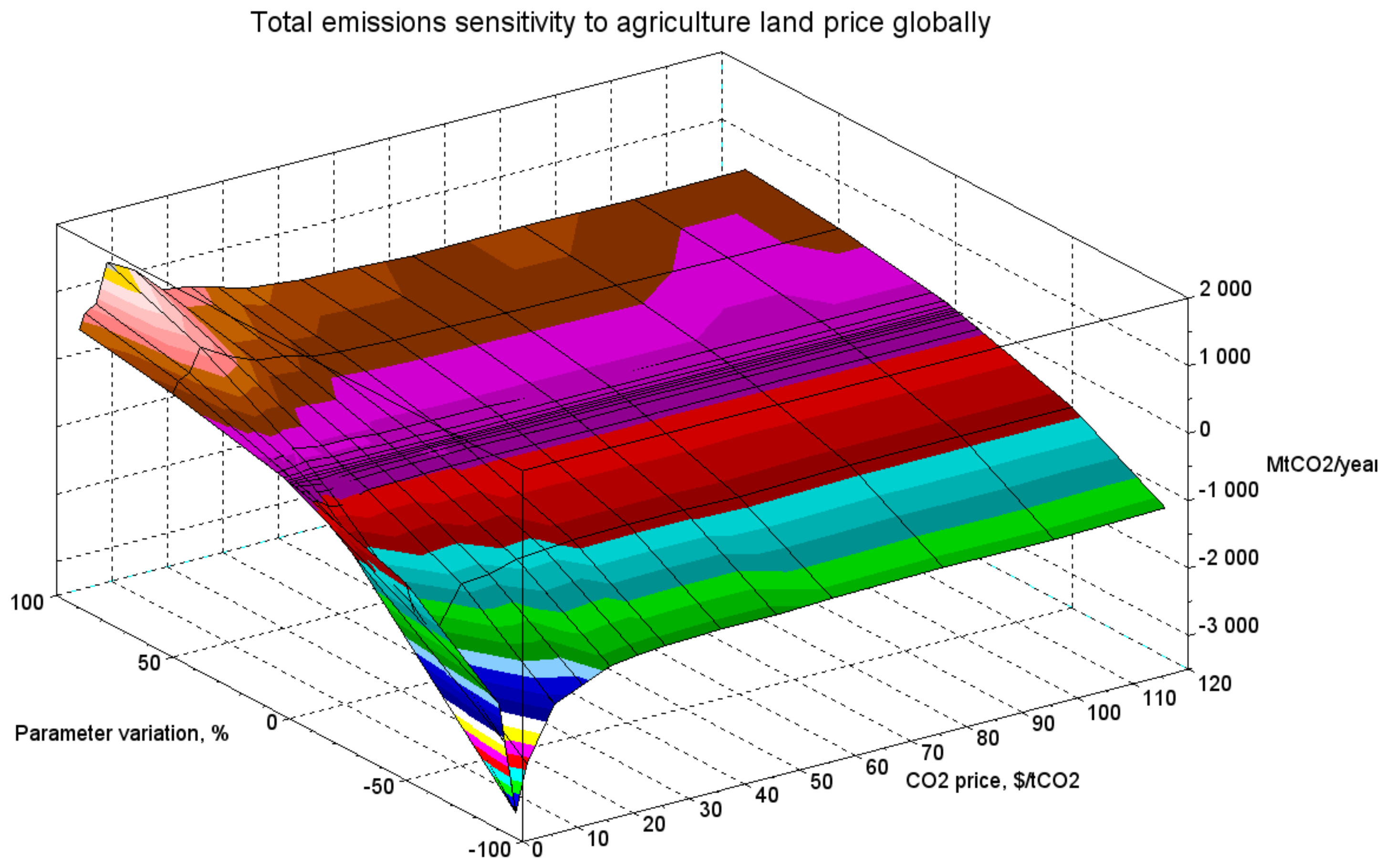
Results and discussion



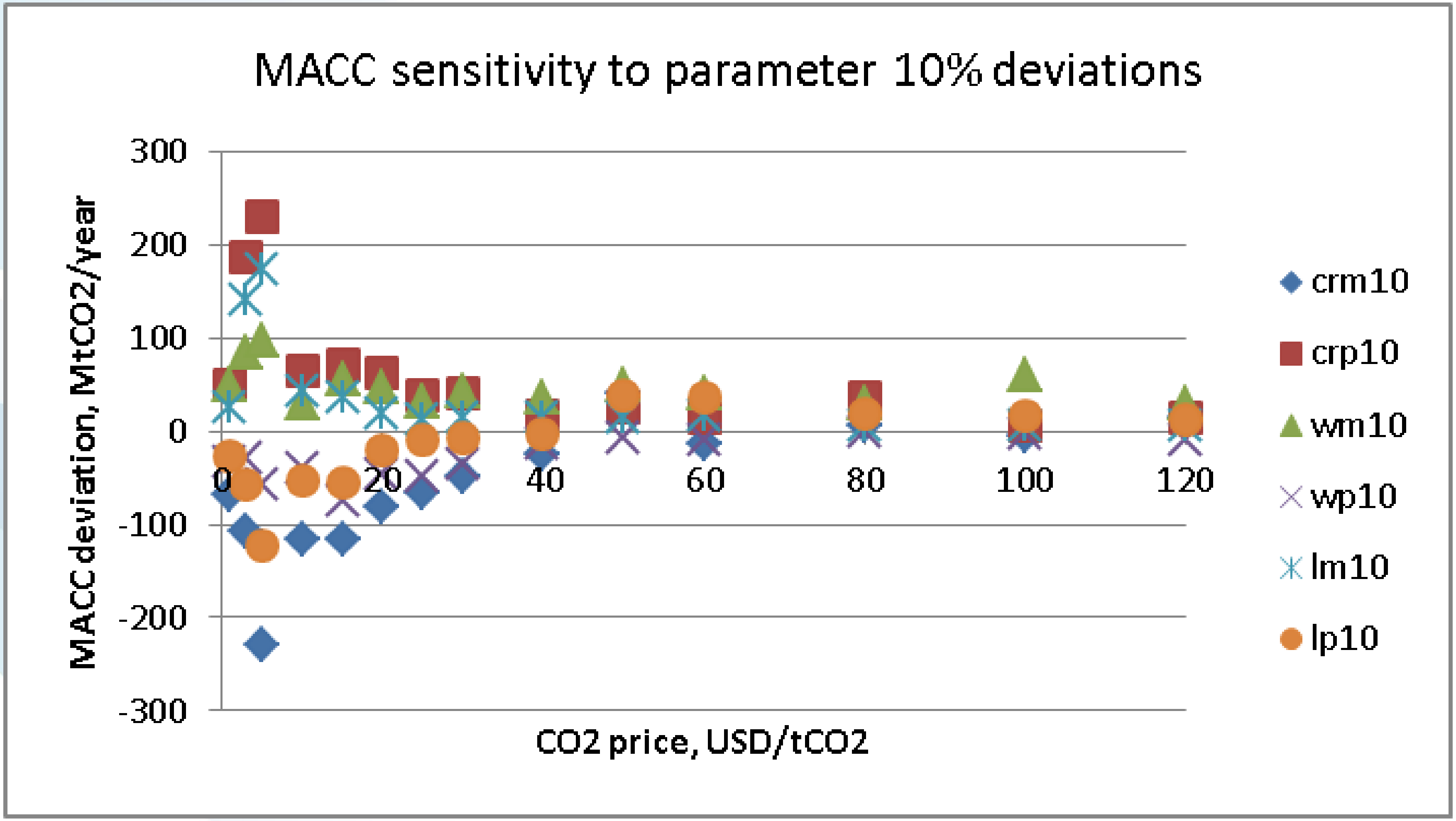
Results and discussion



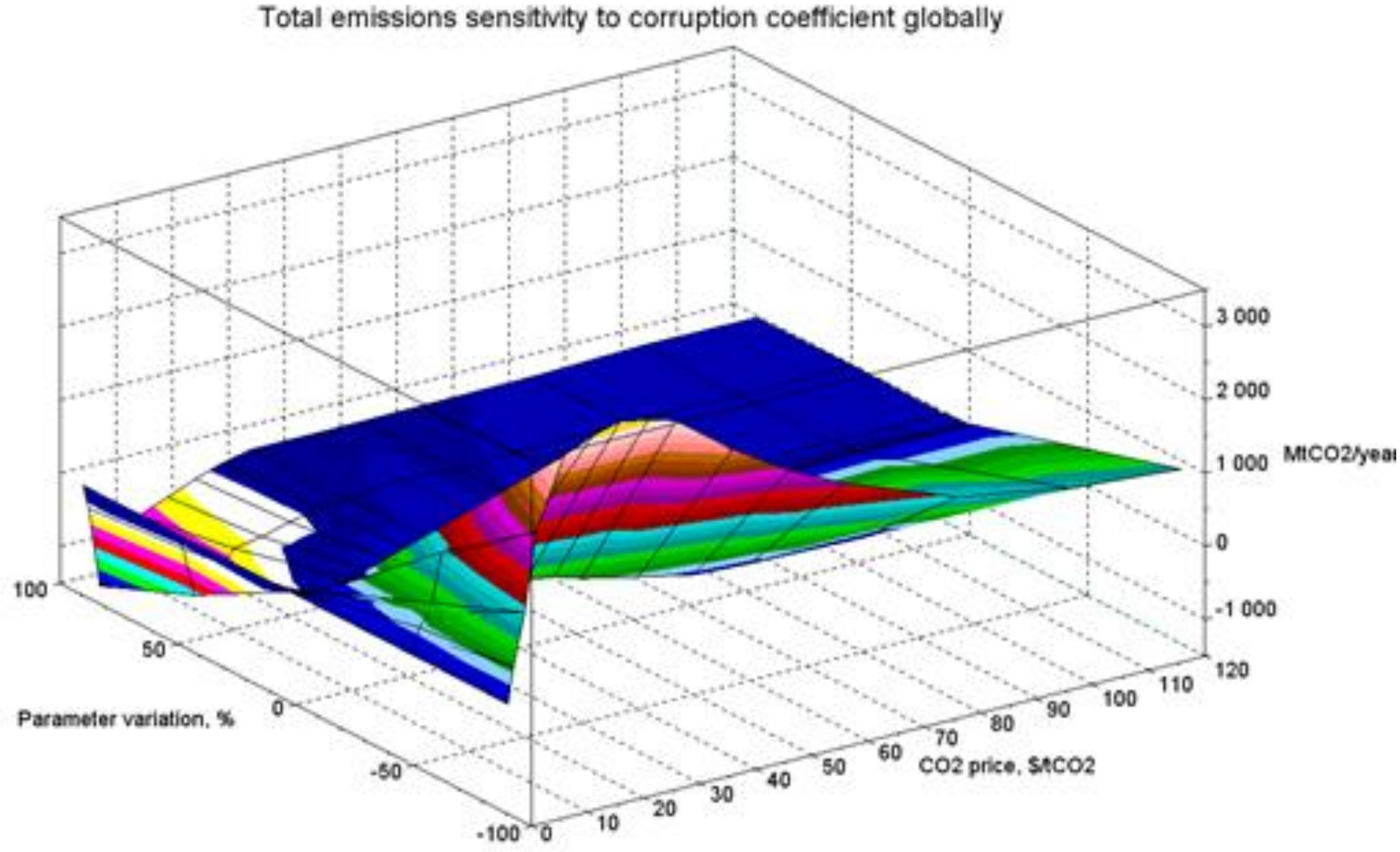
Results and discussion



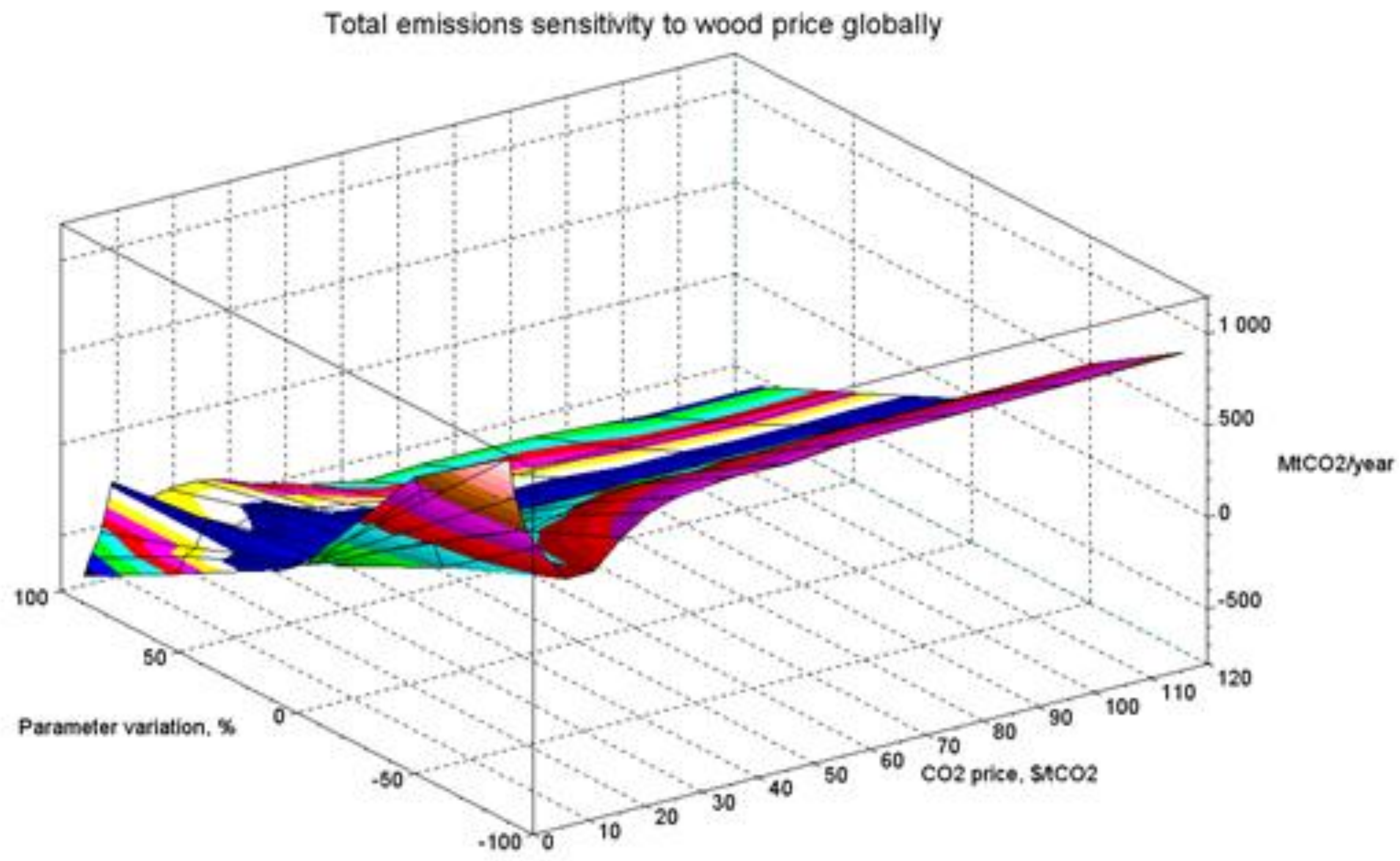
Results and discussion



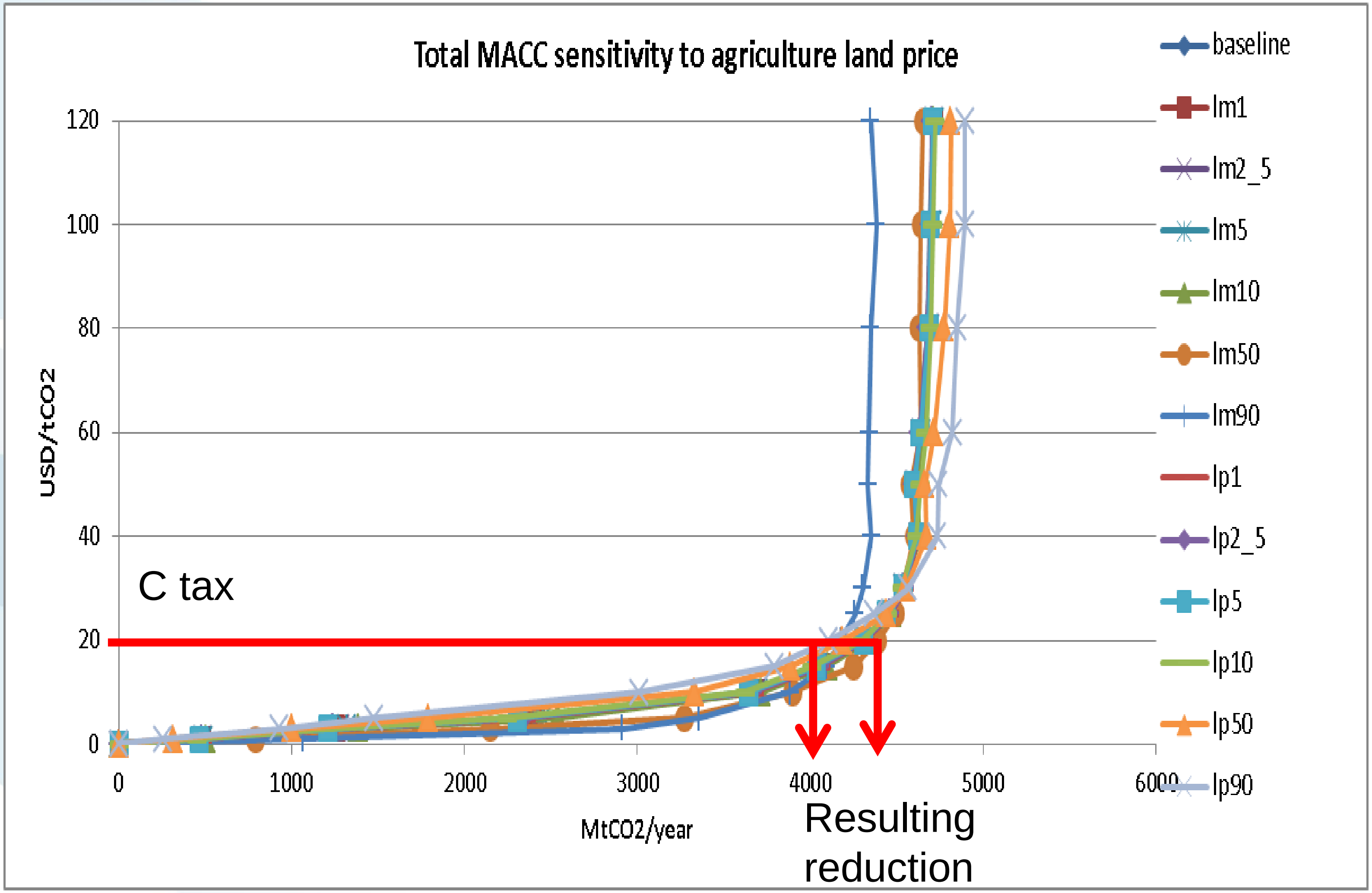
Results and discussion



Results and discussion

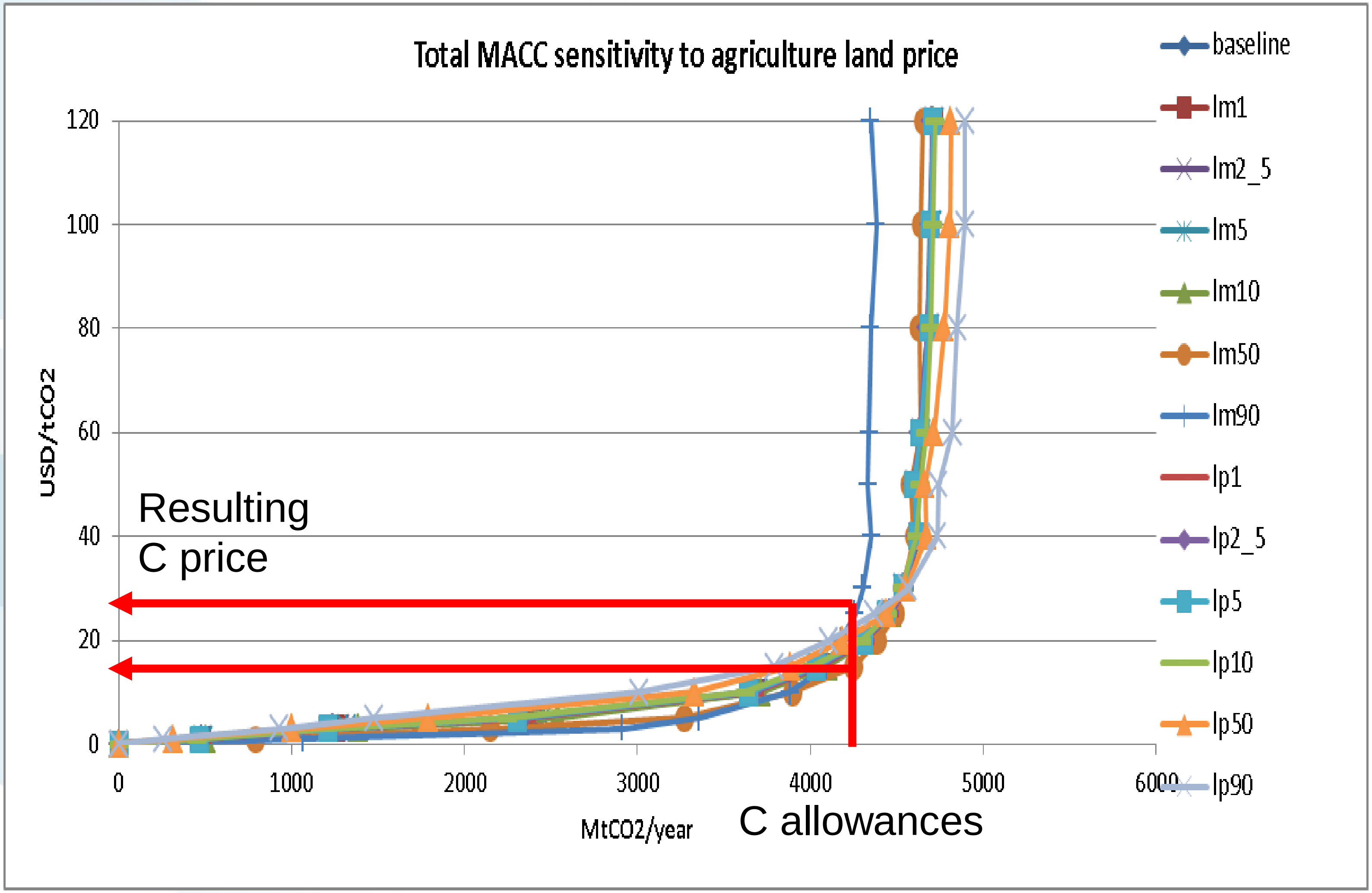


Impact on policy analysis



Gusti et al. Sensitivity of marginal abatement cost curves to variation of G4M parameters. 4th IWUAE, Kraków, 7th-9th October, 2015

Impact on policy analysis



Gusti et al. Sensitivity of marginal abatement cost curves to variation of G4M parameters. 4th IWUAE, Kraków, 7th-9th October, 2015

Final remarks

- Non-linear IAM - MACCs may be sensitive to variation of the model parameters.
- G4M MACCs are much more sensitive to parameter variation at a certain range of CO_2 prices, usually low CO_2 prices.
- G4M total biomass CO2 MACCs are most sensitive to variation of corruption coefficient and agriculture land price.
- MACC uncertainty can influence outcome of policy analysis.
- Inform experts applying MACCs for policy analysis on MACC uncertainty!

Contact information

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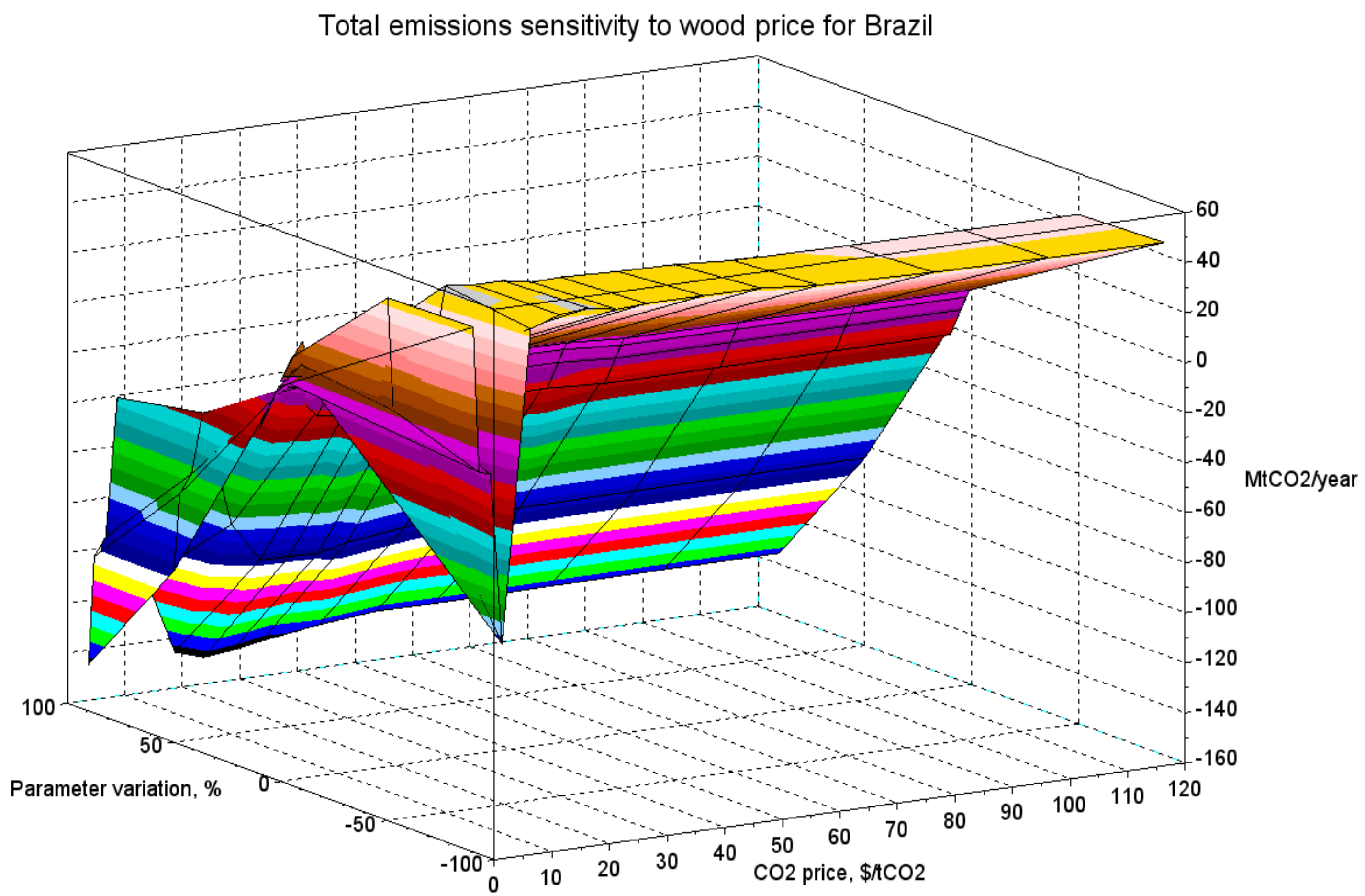
Results and discussion



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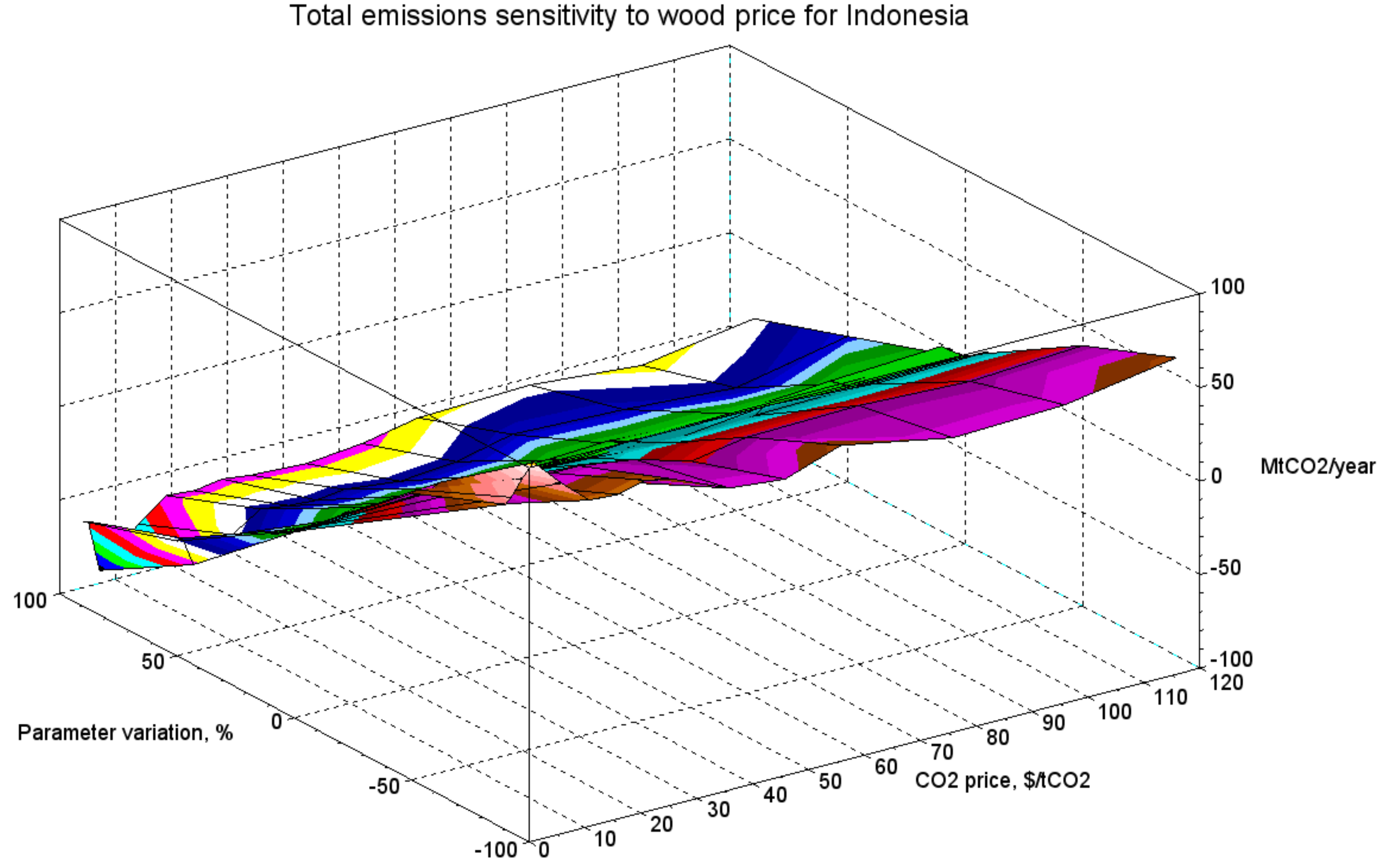

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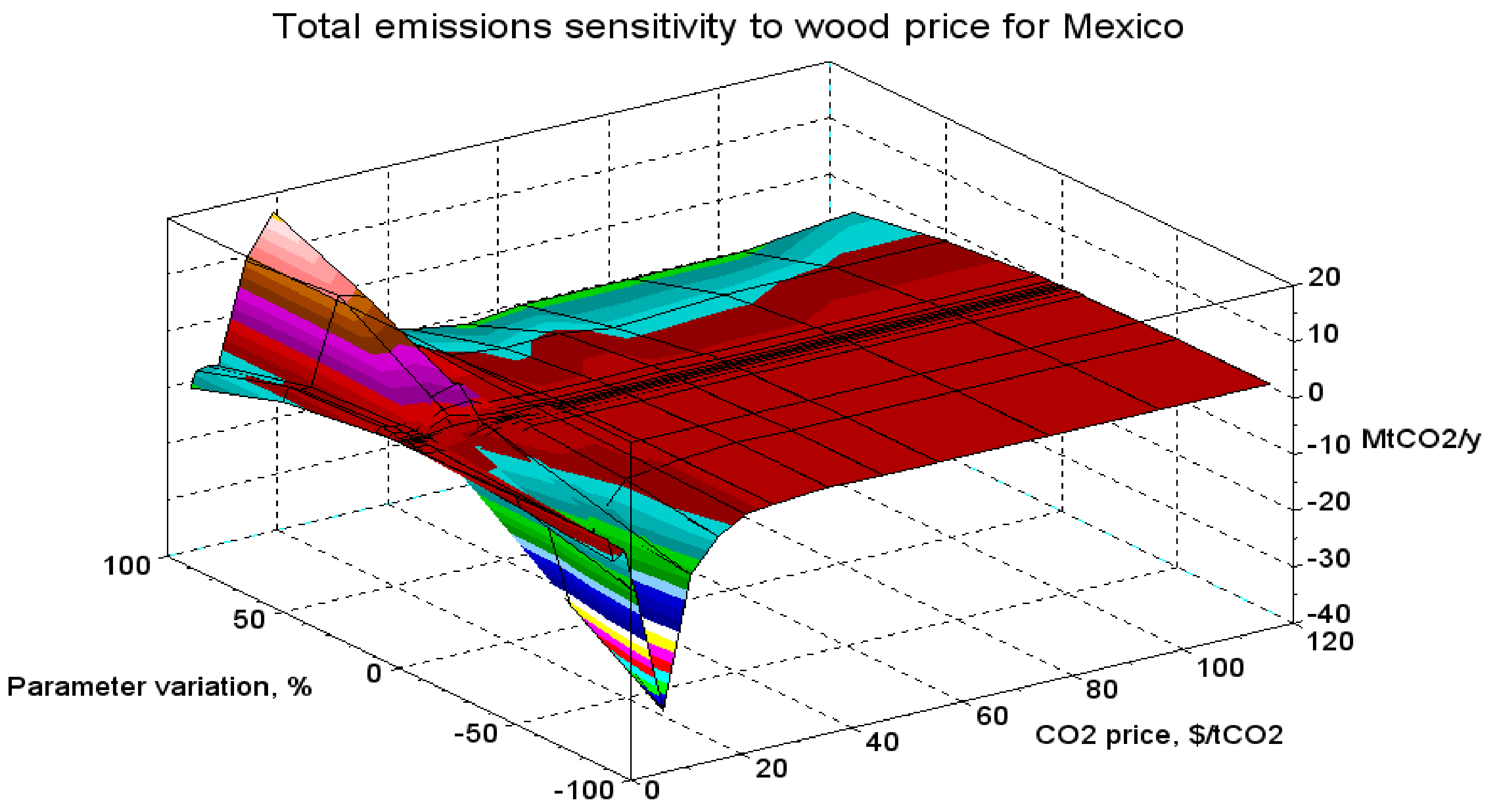

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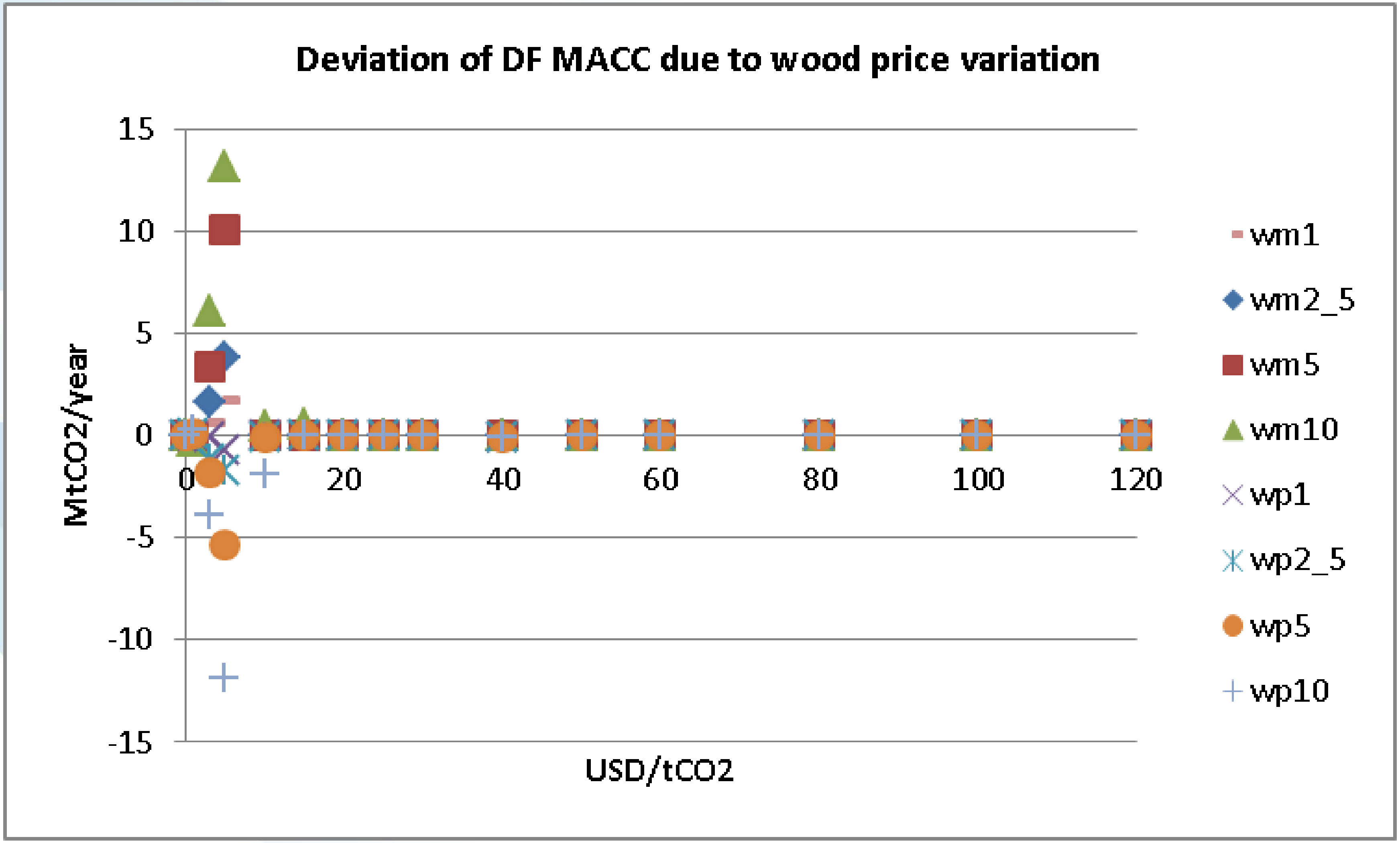

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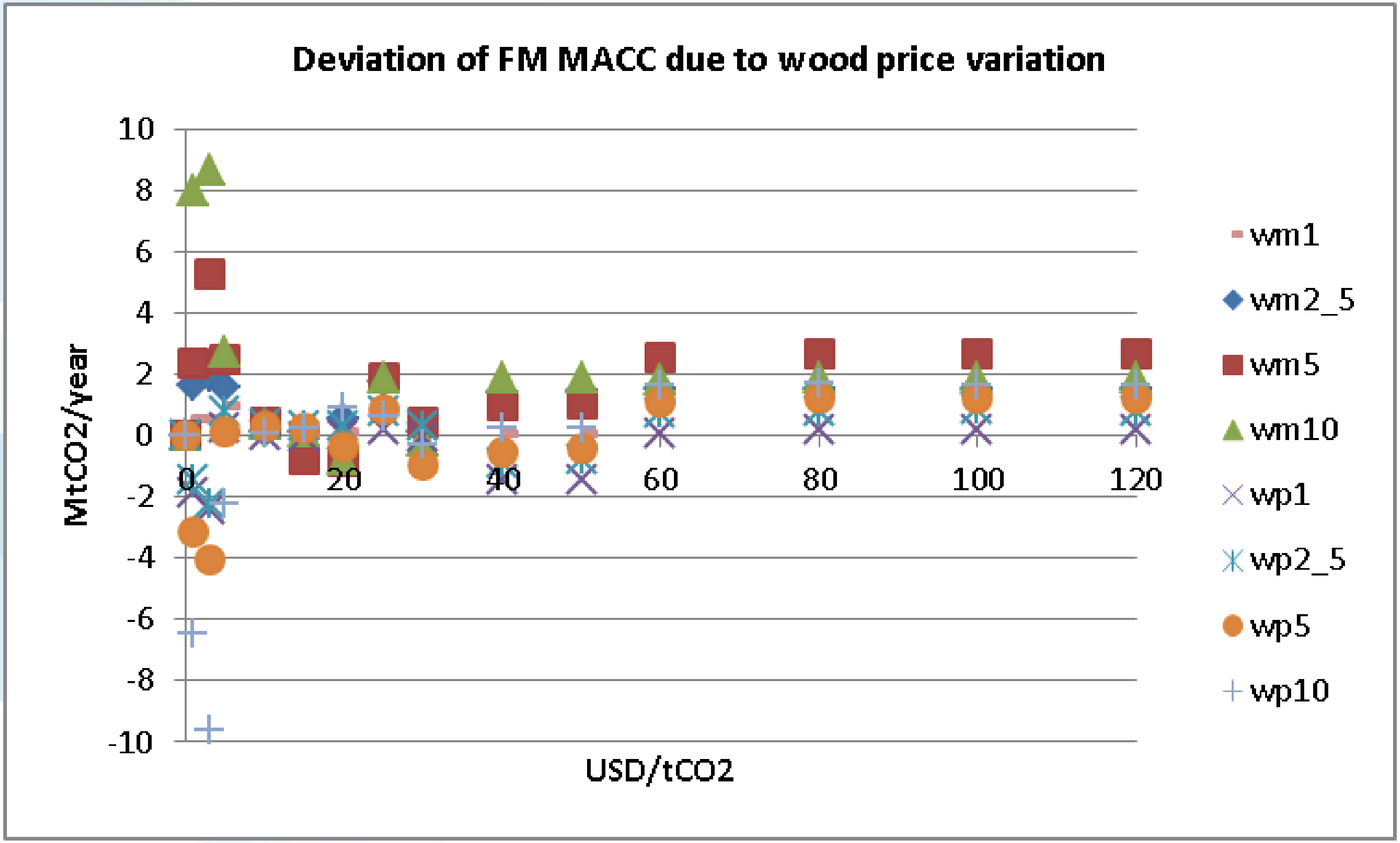
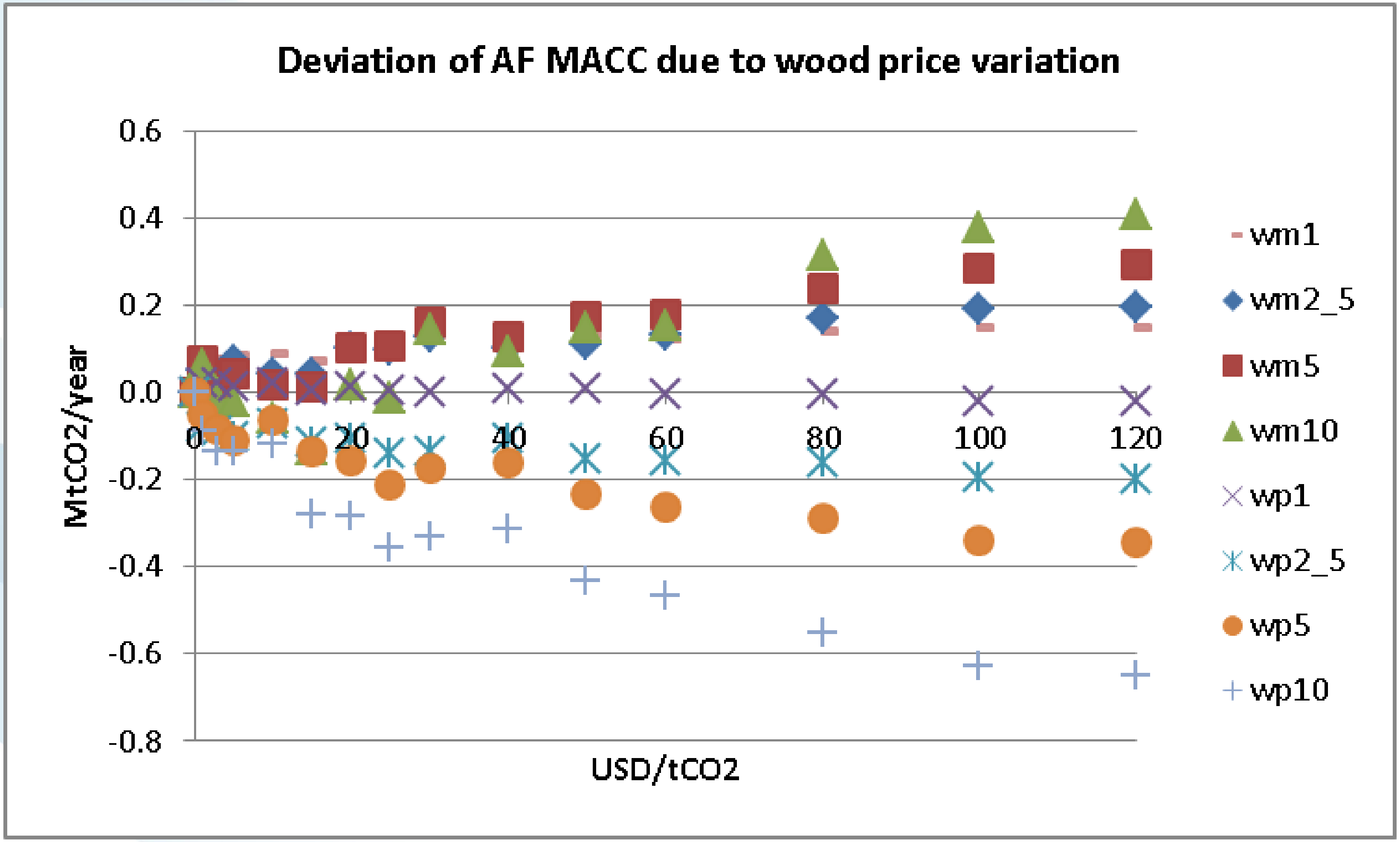


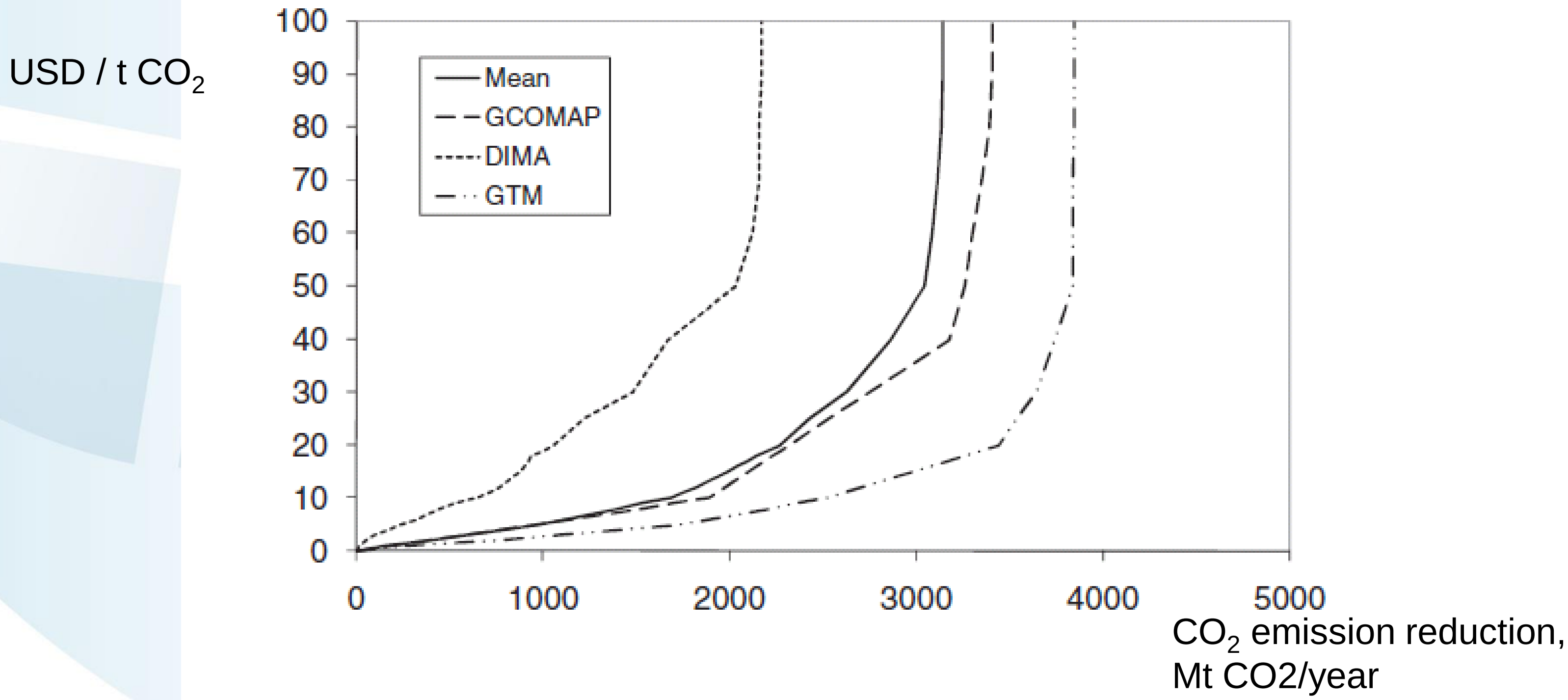
Results and discussion



Model comparison

Kindermann et al. 2008: Global emission reduction

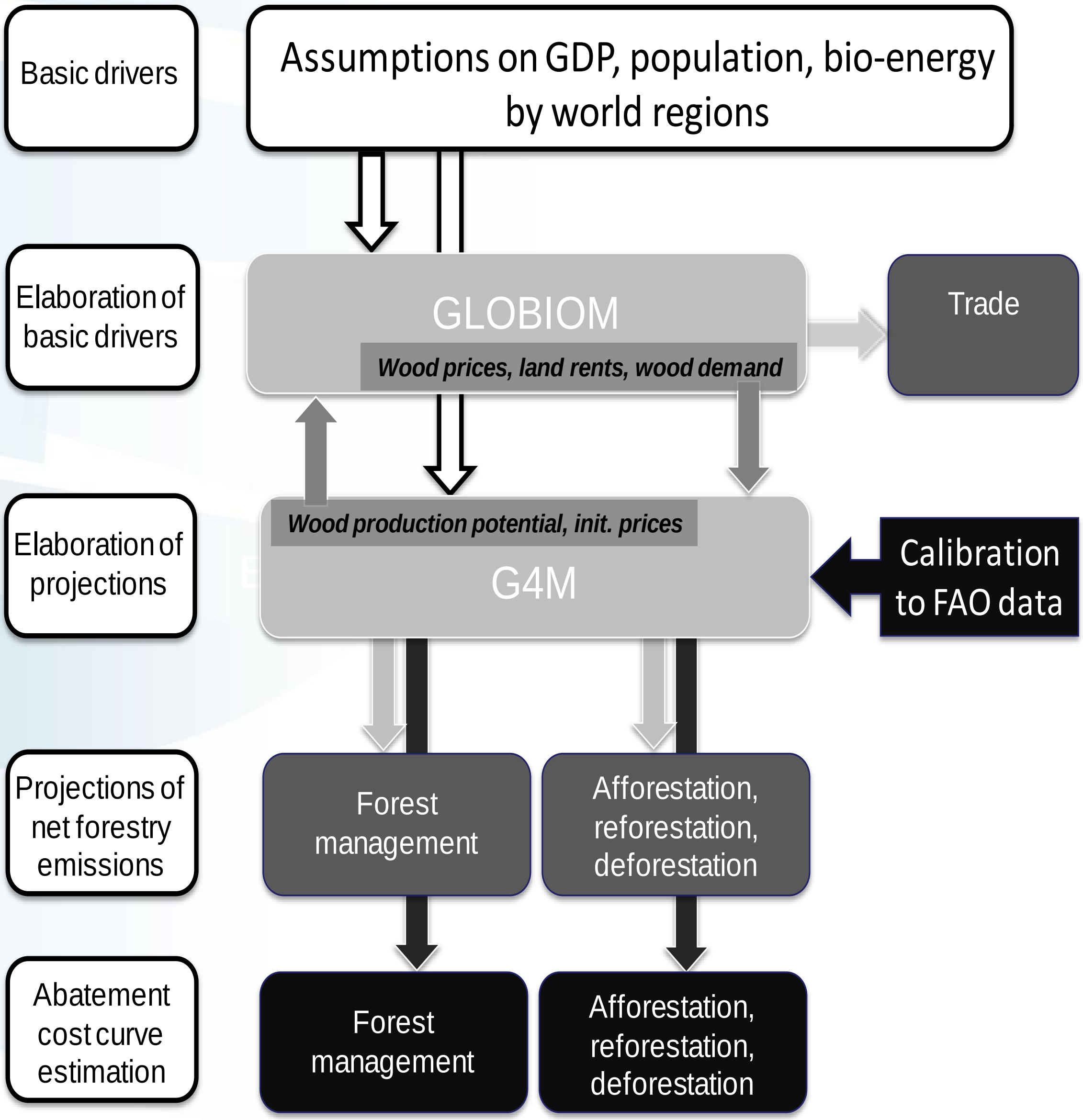
(avoided deforestation)



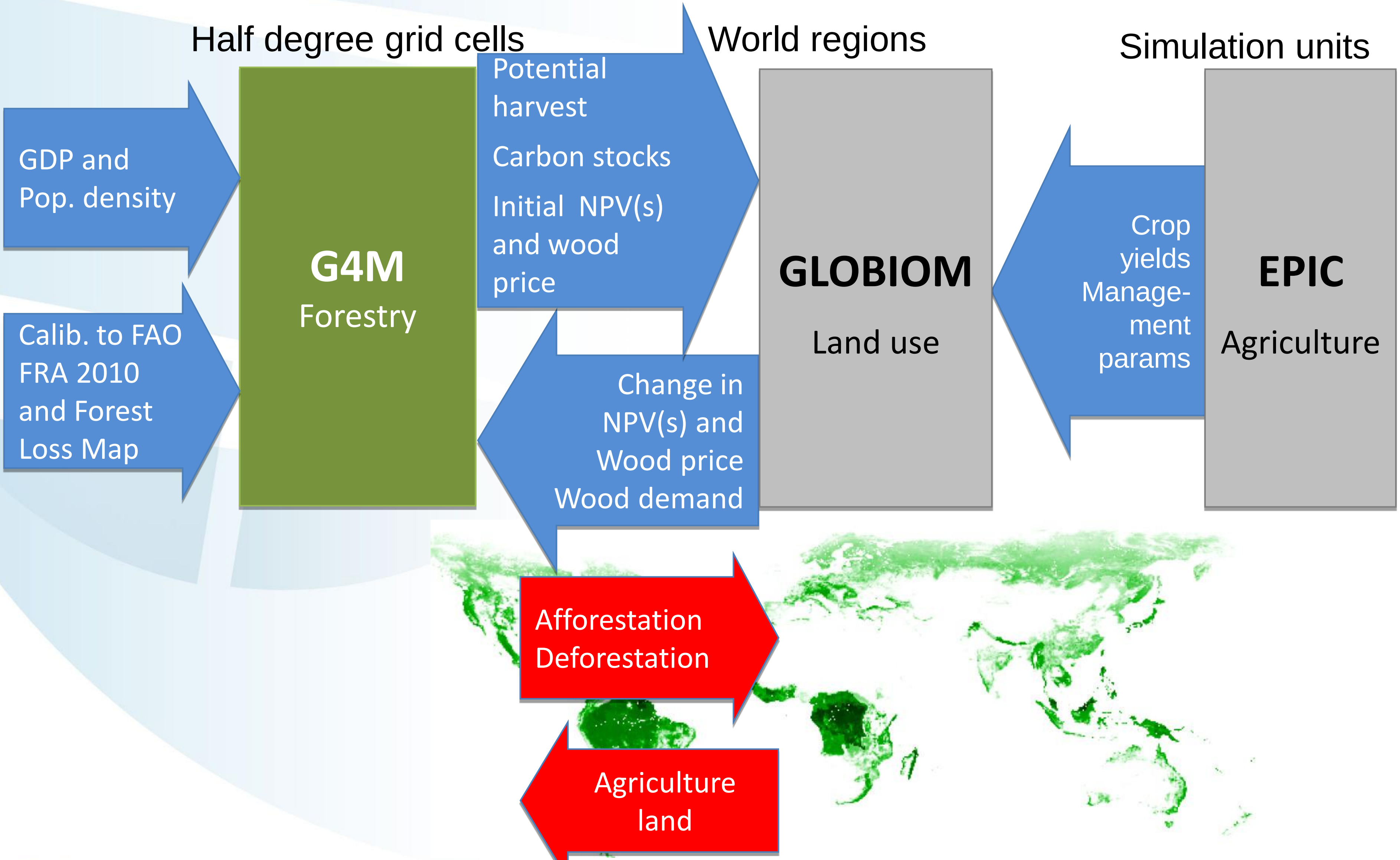
Method (details*)

*Gusti et al., 2012, Simulation of REDD+ options using IIASA model cluster, iEMSs-2012

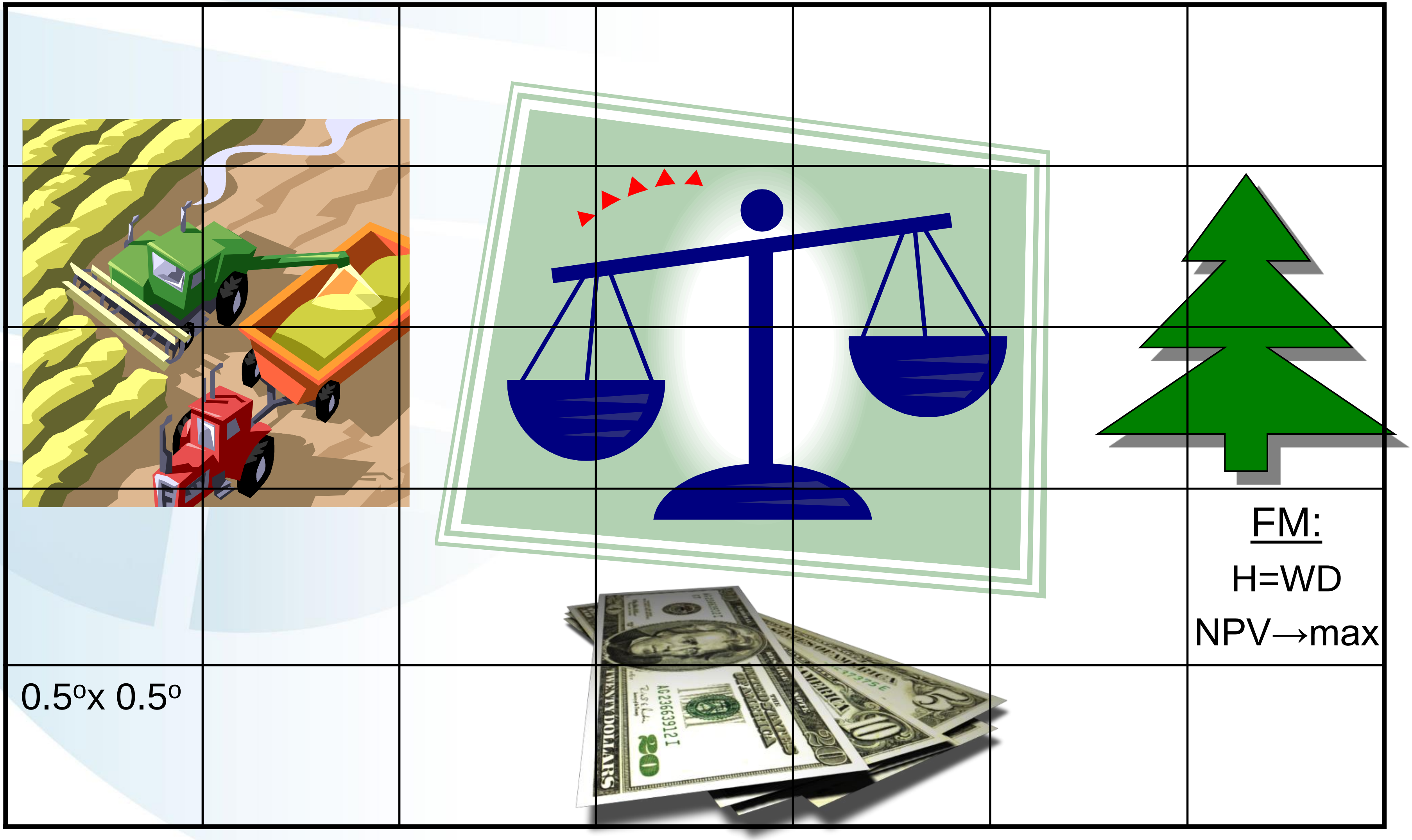
Modeling framework



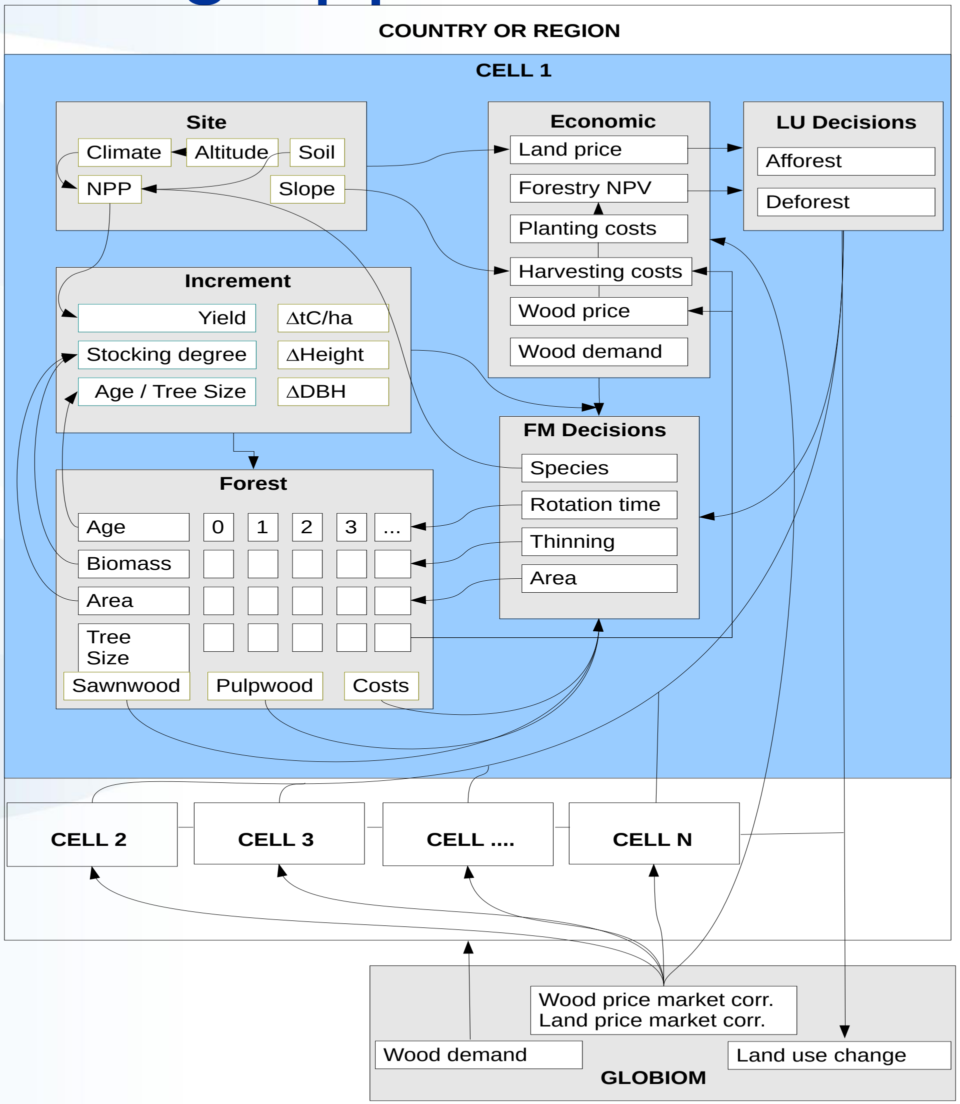
Modeling approach



G4M: Modeling approach



G4M: Modeling approach



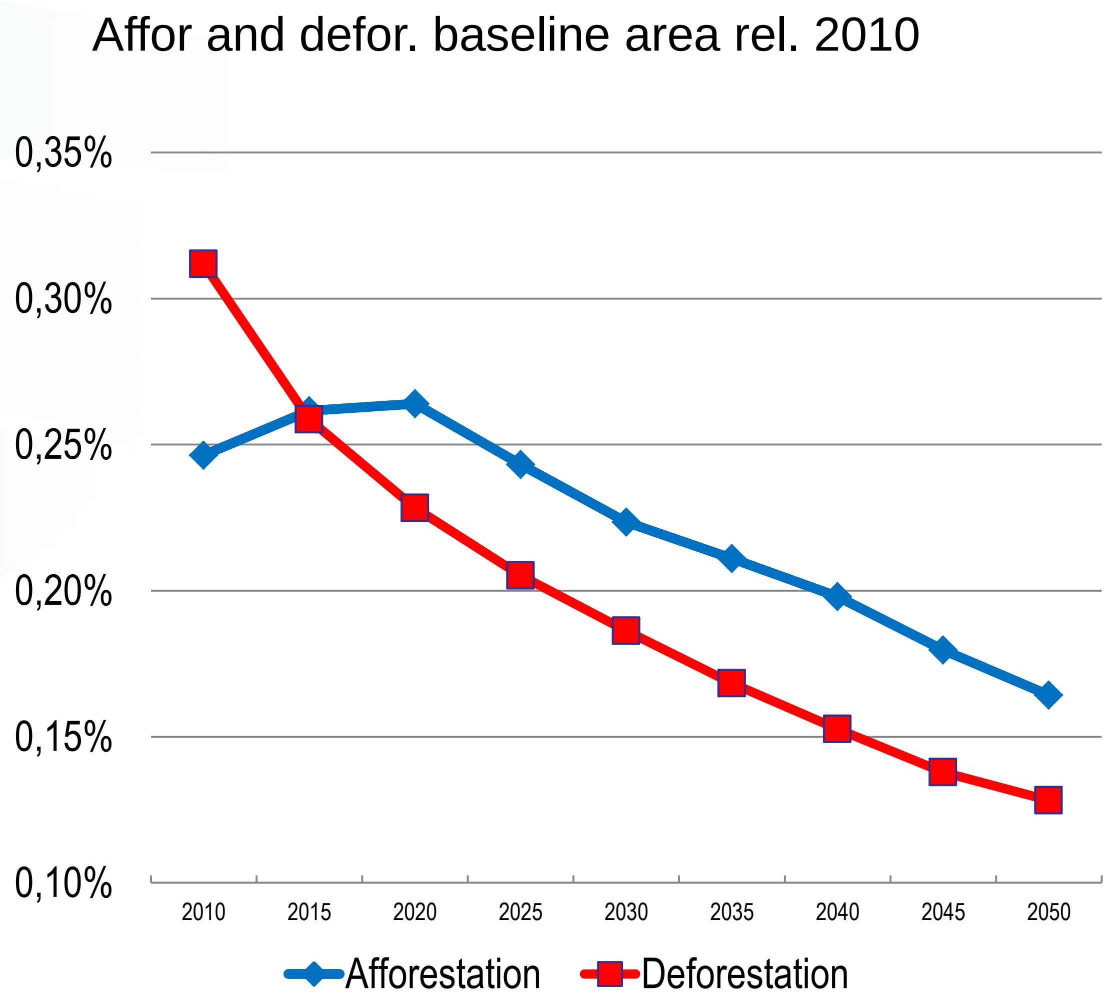
G4M: FM targets and options

- FM targets:
  - Harvest demanded amount of wood on country scale
  - Harvest demanded amount of wood + maximize biomass comparing to baseline (NPV->max)

- FM options:
  - Tune rotation length: max MAI – max biomass
  - Change harvest location (depending on CAI)

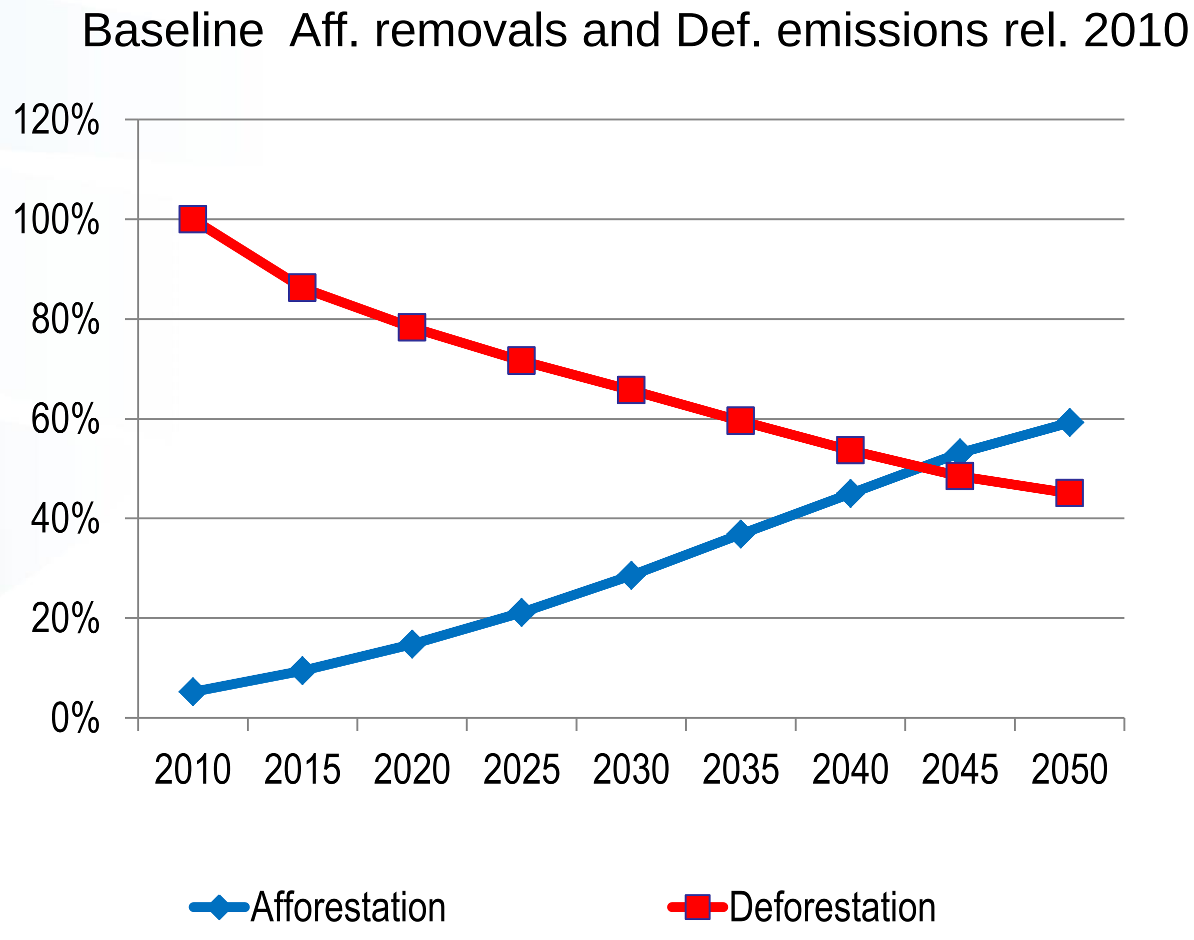
Results: Global forest area change (baseline)

- Net forest area decreases until 2015
- But increases after 2020

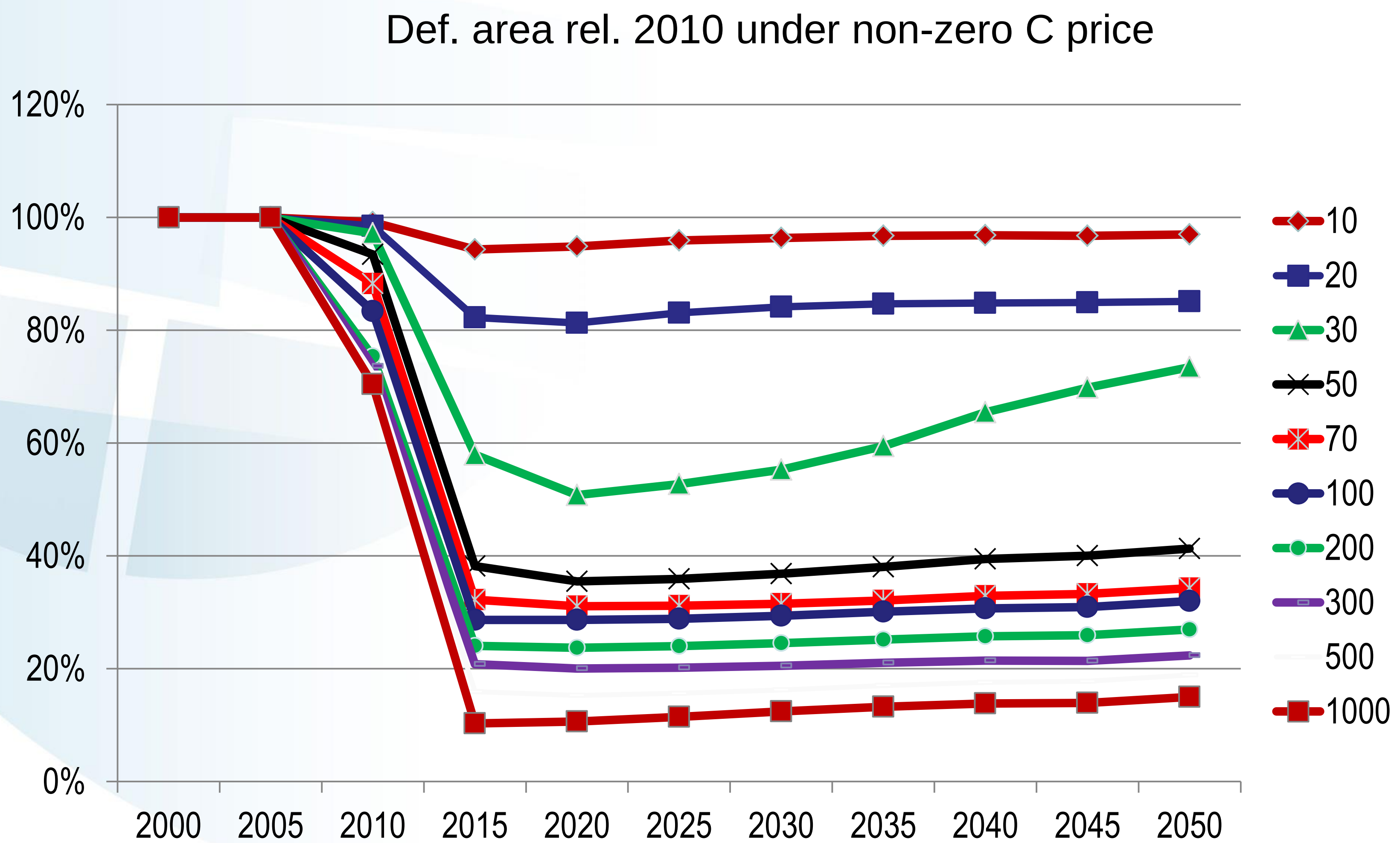


Results: Global LUC removals and emissions (baseline)

- Afforested areas accumulate carbon slowly
- Net LUC emissions > 0 until 2045

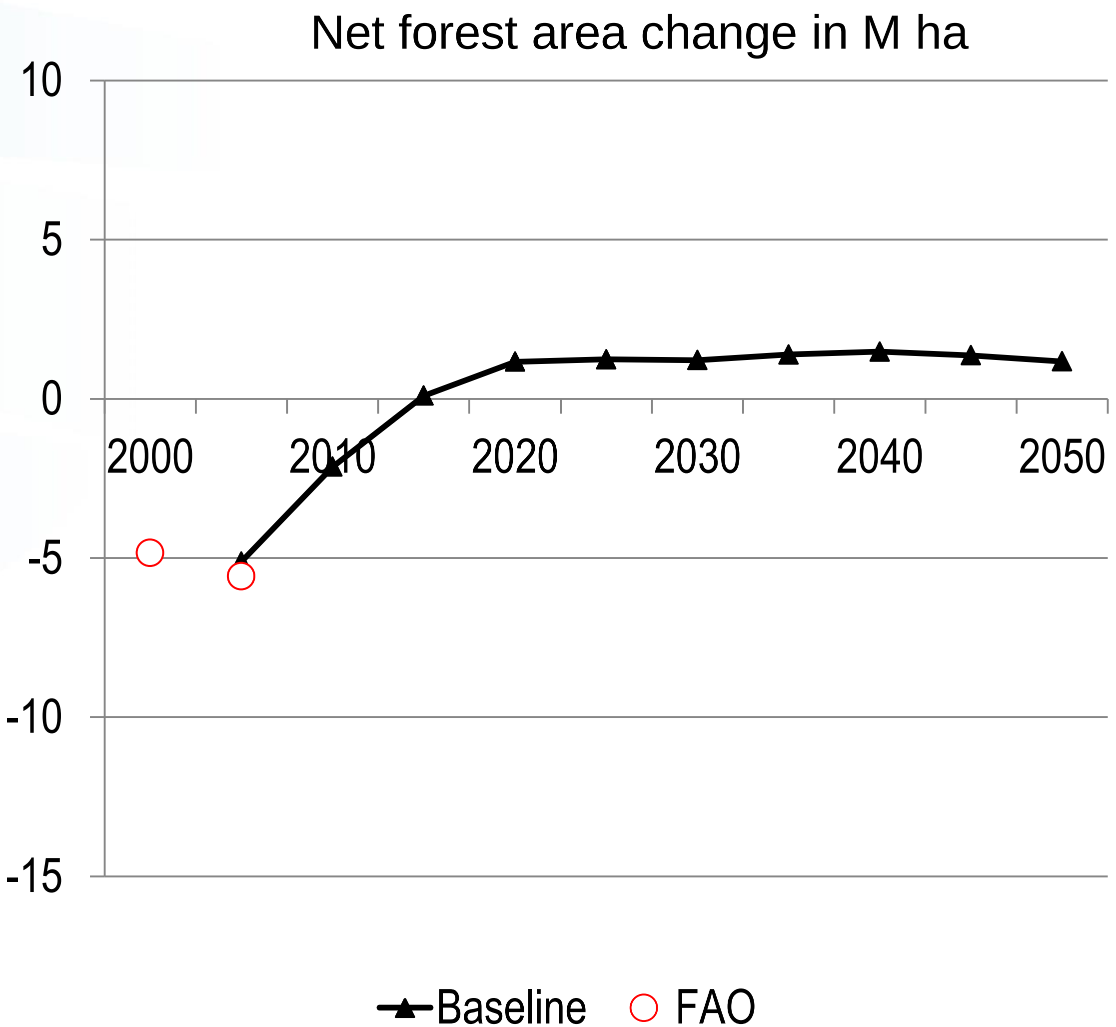


Results: Global forest area change



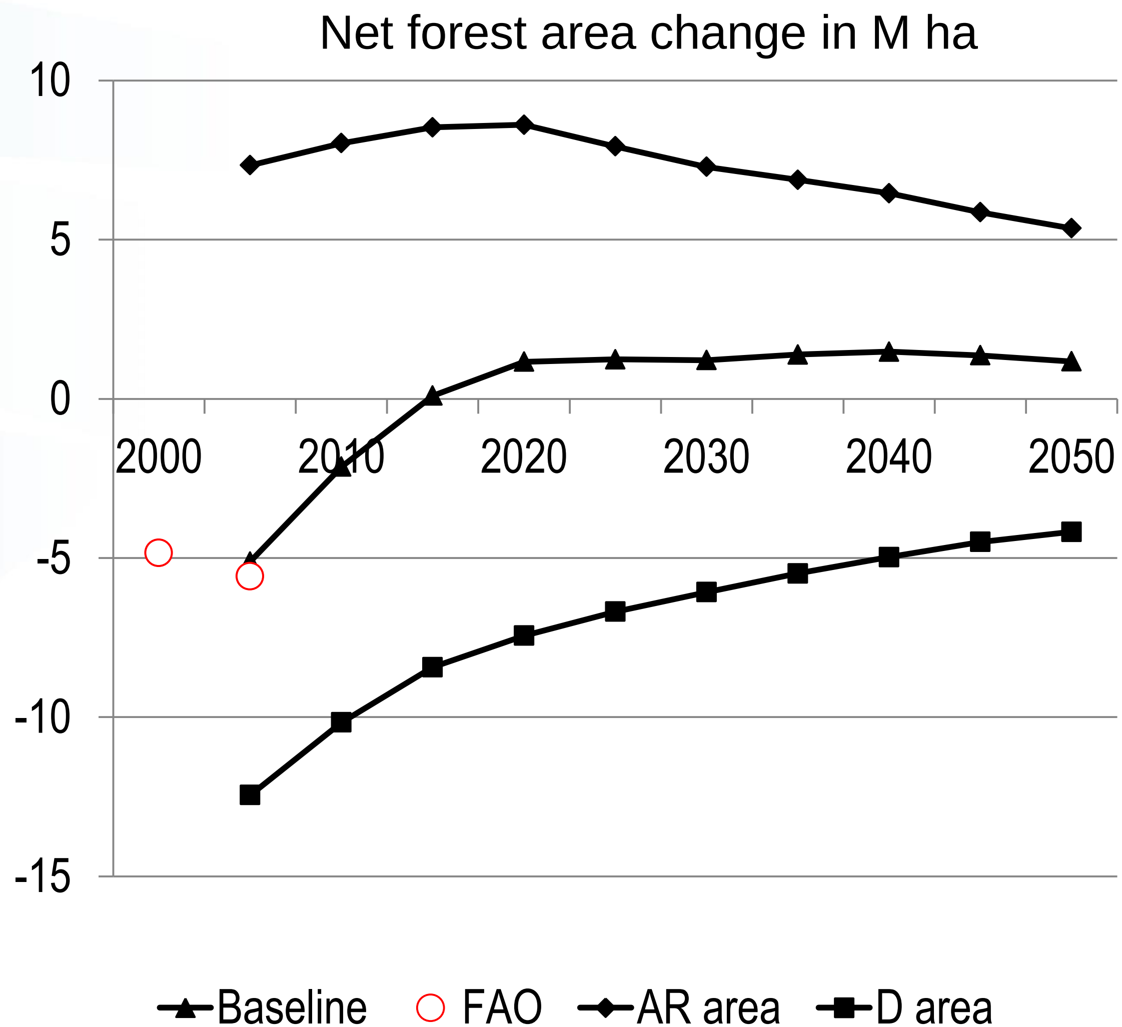
Results: Global net forest area change

- FAO level is met but trend is different
- Already in baseline global forest area increases after 2020



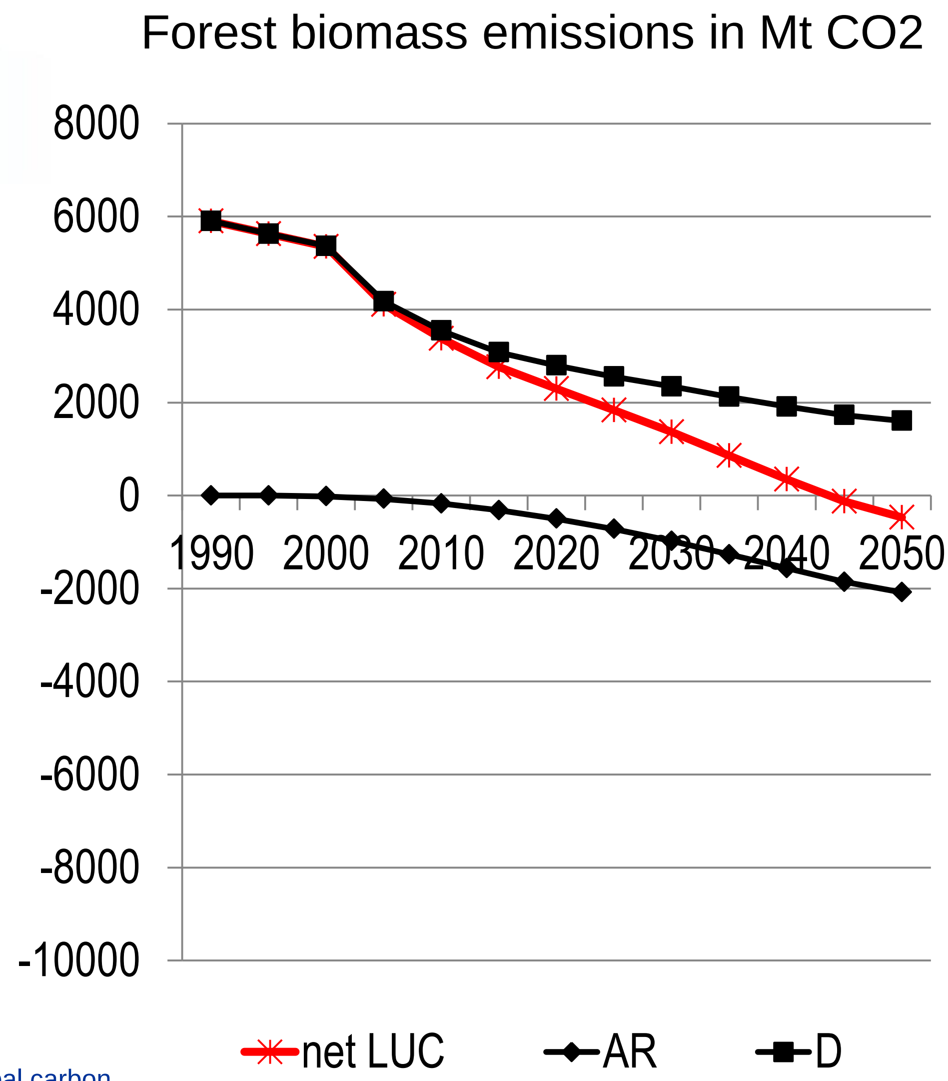
Results: Global net forest area change

- FAO level is met but trend is different
- Already in baseline global forest area increases after 2020
- Afforestation stays rather constant, declining after 2020
- Deforestation decreasing



Results: Baseline development global forestry emissions

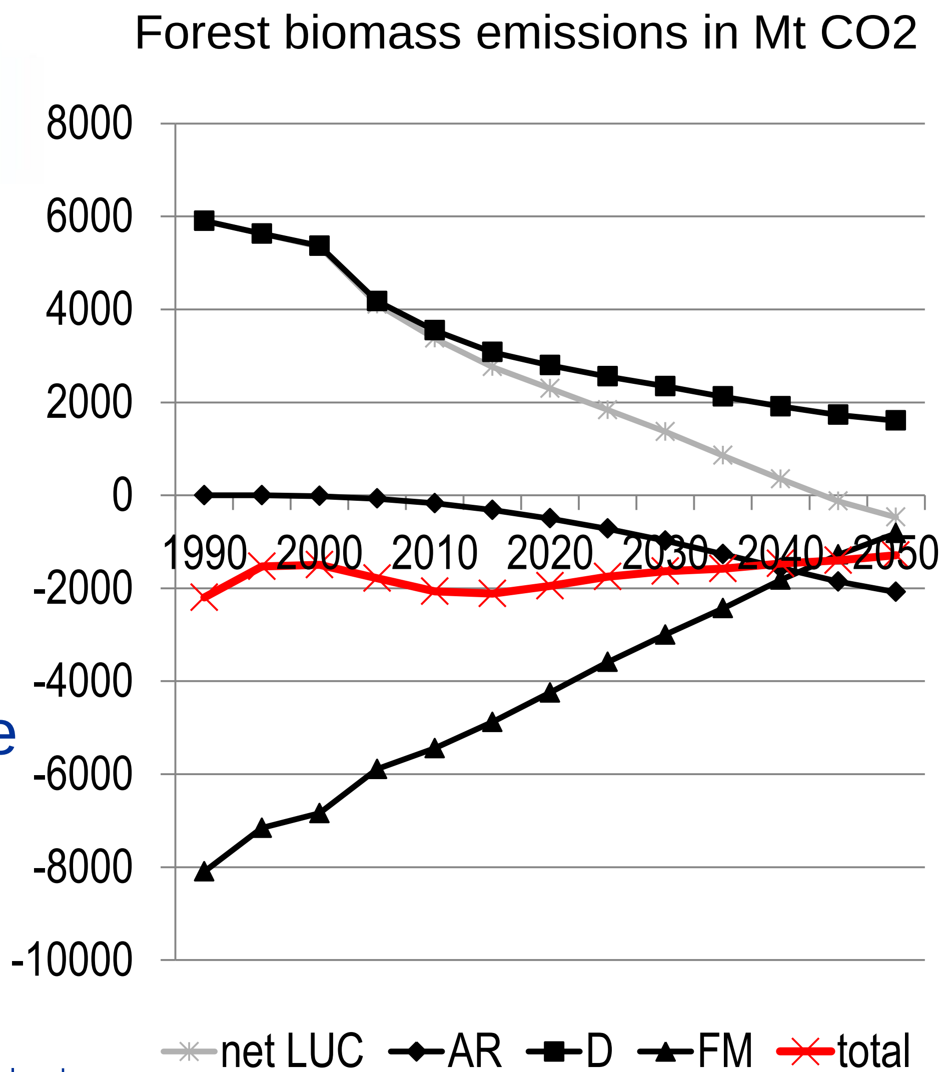
- Deforestation emissions expected to decline constantly
- Afforestation (start in 2000) kicking in late
- Therefore net land use change emissions negative only after 2040



Fuss et al. An approach to assessing benefits of advanced global carbon observation system. ICDC 2013 - Beijing – 3-7 June 2013

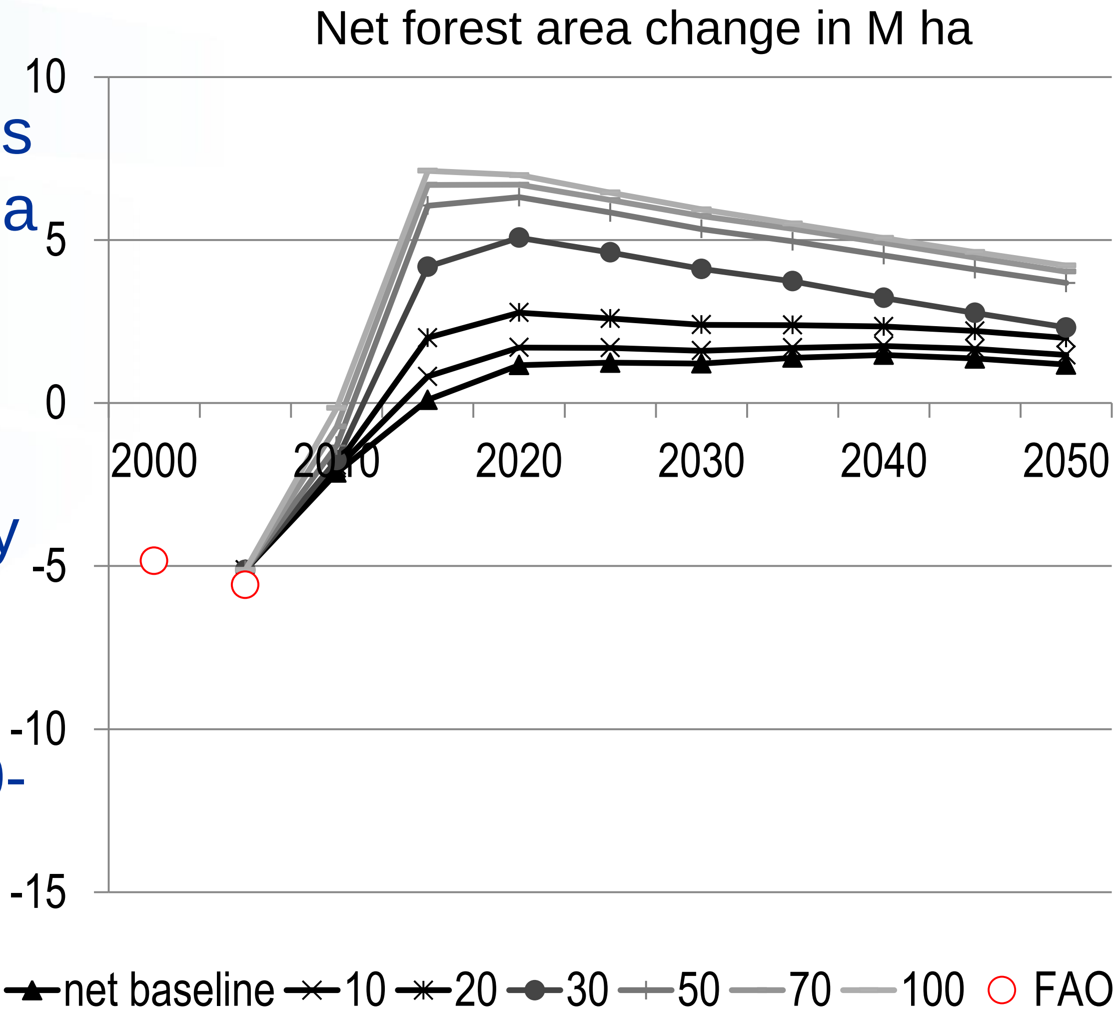
Results: Baseline development global forestry emissions

- Deforestation emissions expected to decline constantly
- Afforestation (start in 2000) kicking in late
- Therefore net land use change emissions negative only after 2040
- Forest sink declining due to ageing forest
- Overall emissions rather stable



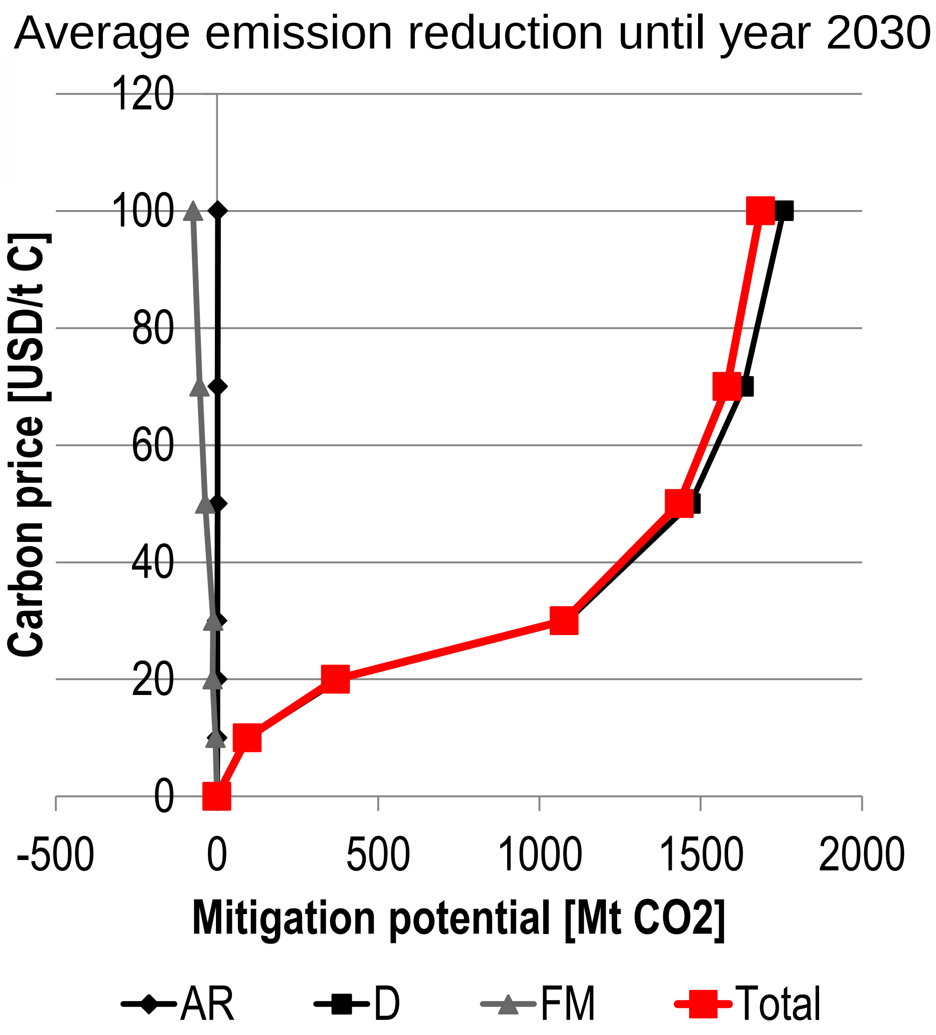
Results: Global net forest area change under different C prices

- If carbon has a price net area loss declines more rapidly and area gain after 2020 is higher
- A price of 30 USD increases net gain by factor four
- Strongest effects at medium C prices (20-50 USD)



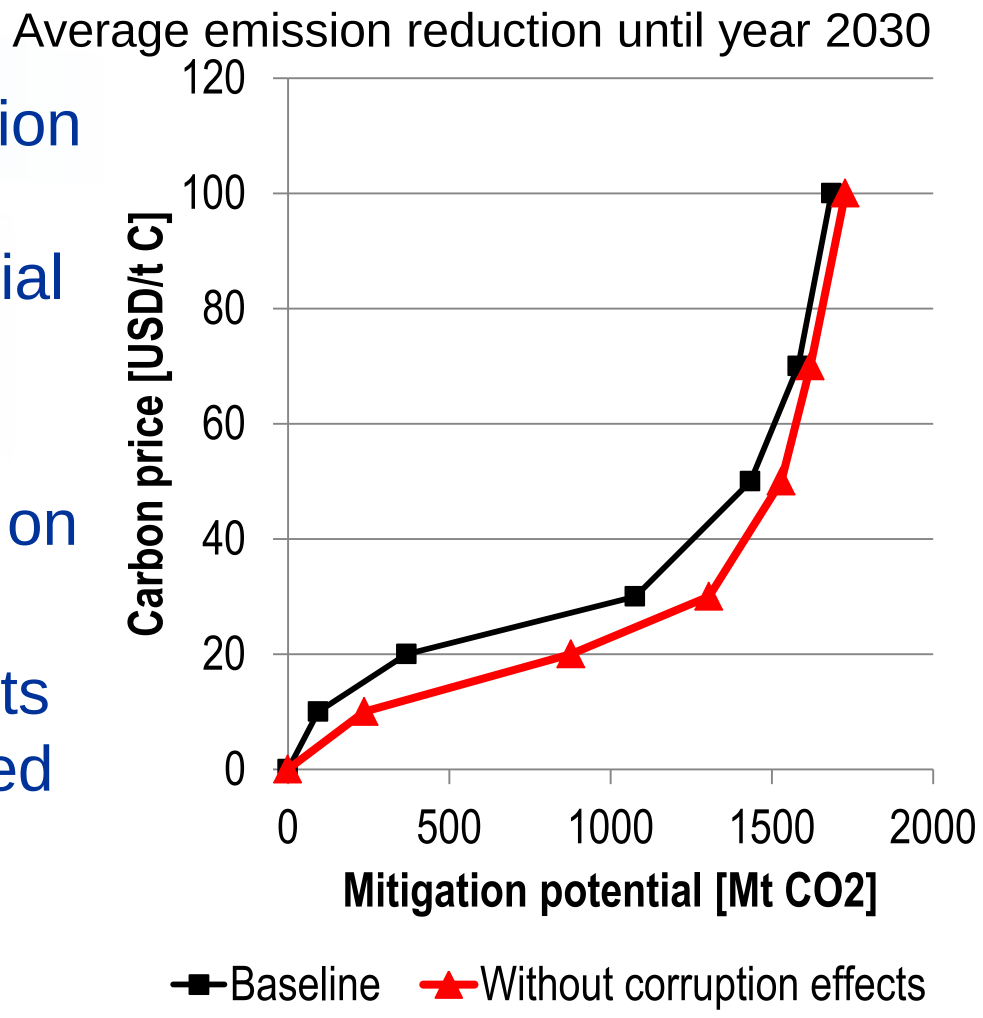
Results: Potential and costs for additional storage in non-Annex I

- CO_2 storage in comparison to baseline at different C price levels
- Afforestation potential negligible (high baseline, time lag)
- Reduced deforestation puts pressure on remaining forest (harvest increases) resulting in negative cost curve

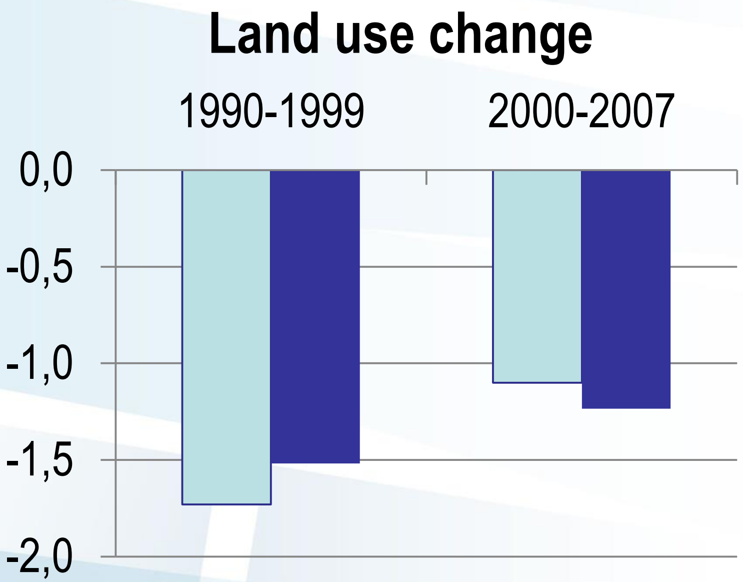


Sensitivities: Corruption factor effects for non-Annex I

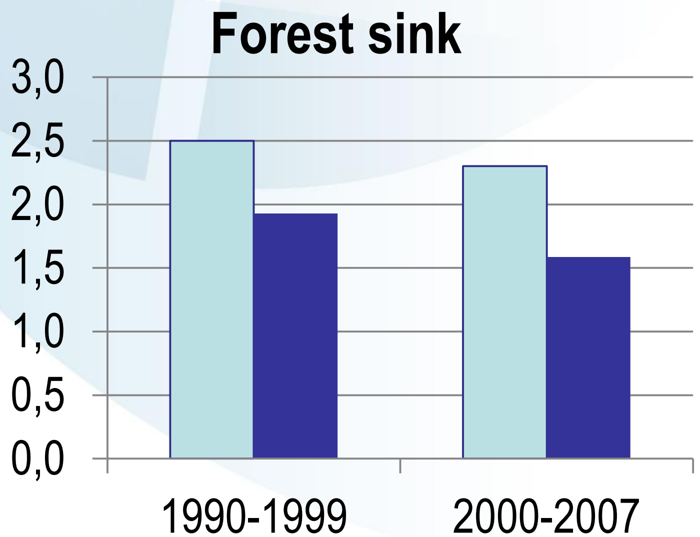
- Country specific corruption factors (based on World Bank data) lower potential in baseline
- To be interpreted as efficiency of USD spent on emission reduction
- Without corruption effects potentials can be doubled for lower carbon prices

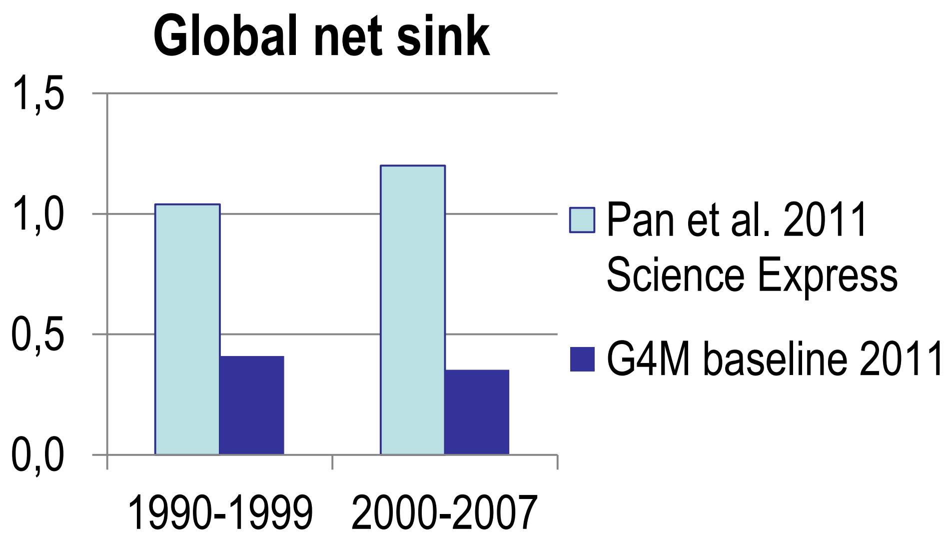


Comparison to historic estimates



- Global emissions (Pg C)
- Similar estimates for land use change emissions
- Underestimation of sink by G4M
- Opposing fluxes lead to big difference in net flux





Results: Effect of integrated MACC curves in Annex I countries

Average emission reduction until year 2030