CASTLE

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Evaluating land use impacts on bioproductive land depletion in life cycle assessment

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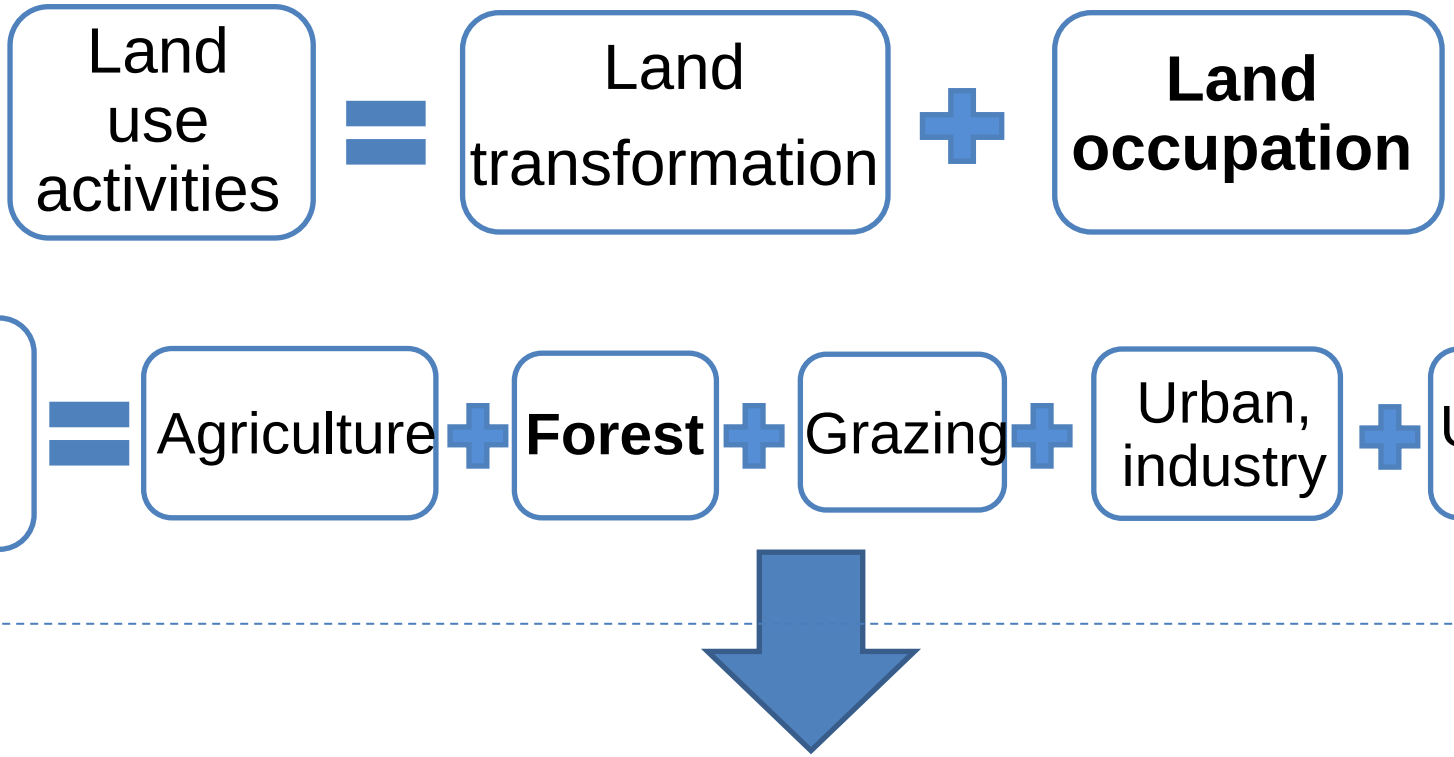
Overview

- Background
- Objective
- Method
- Results and discussion
- Conclusion and recommendation

Background

- **LCA (Life cycle assessment)**
  - is a technique for addressing the potential environmental impacts with respect to the whole life cycle of a product or service.
  - When evaluating the environmental performance of using biotic resources, well-accepted operational LCA method is lacking.

- **land use impacts in LCA, according to UNEP-STEAC's guideline (Canals, 2007)**
  - Biodiversity
  - Ecological soil quality
  - **Land productivity → indicated under HANPP approach**



Problems:

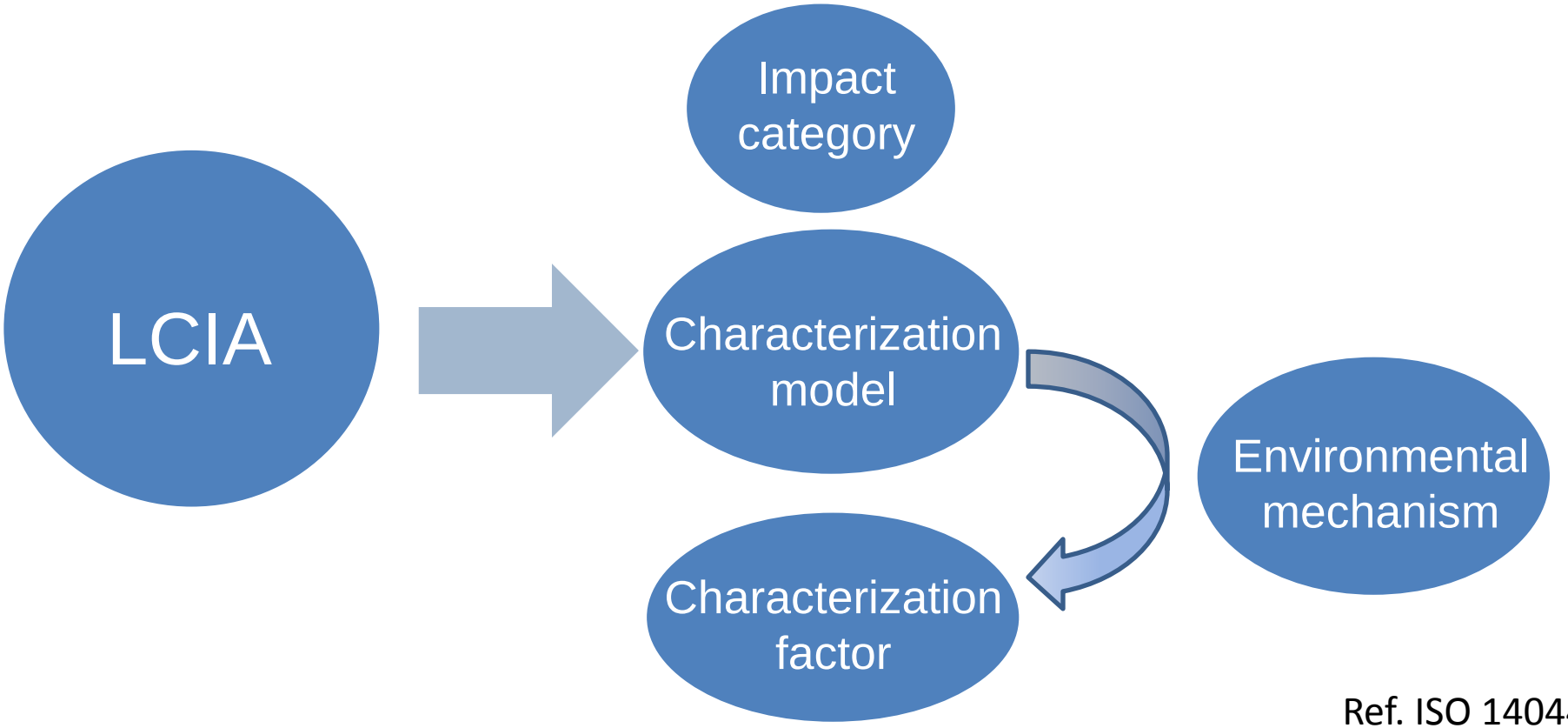
- More from land occupation
- Agriculture-based, not suitable for forest value chain.

Objective

- Method development of LCA:
  - in land use impact assessment
  - on land productivity change
  - from forest biomass cultivation

Method – LCIA method

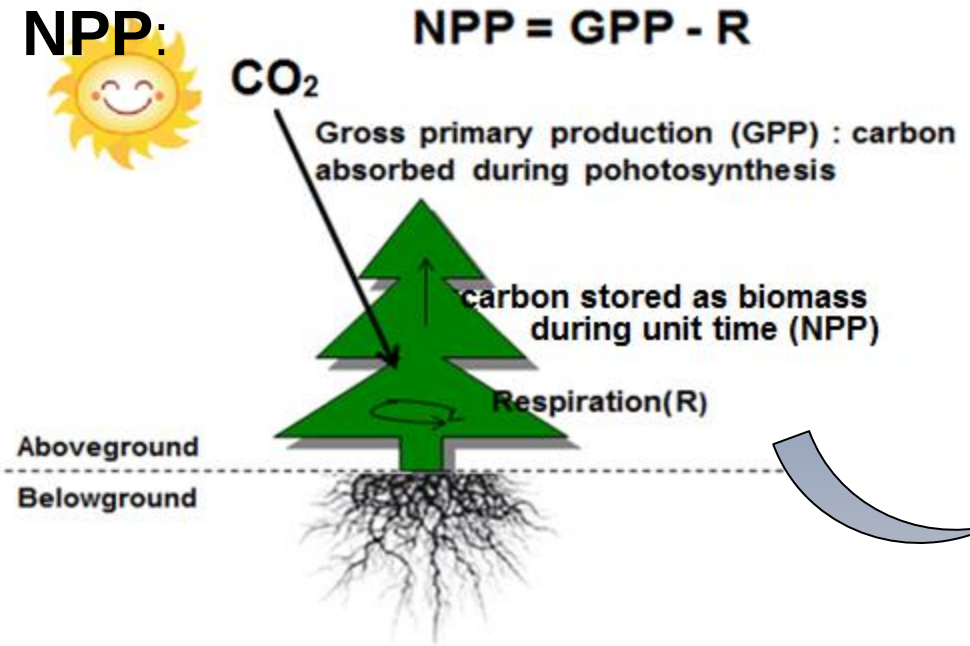
- Life cycle impact assessment (LCIA) method



Ref. ISO 14044

Method – NPP

- Human appropriation of **net primary production** (HANPP) approach is used for reflecting the land use induced land productivity change (Haberl, 2007).
- **NPP**:



NPP indicates the amount of trophic energy available to be transferred to other levels.

Not straightforward applied in LCA yet.

Method – $HANPP_{LUC}$

- $HANPP_{LUC}$ is served as a midpoint level characterisation factor (CF), expressed as:

$$\boldsymbol{CF_{i,j} = HANPP_{LUC_{i,j}} = NPP_{pot_{i,j}} - NPP_{act_{i,j}}}$$

i denotes location, **j** denotes land use type, with unit as *g C/ m^2a*

  - NPPpot is the natural potential vegetation, which without human intervention;
  - NPPact is the vegetation under current occupied land use type, i.e. forest.

Method – NPP_{pot}

- NPP_{pot} can not be directly measured, as it is a hypothetical situation.
- It is evaluated by three different approaches:
  - **LPJ model**
    - *dynamic global vegetation model.*
    - *consider ecological parameters from site-specific research.*
  - **Miami model**
    - *empirical model, simplified relation between NPP, temperature and precipitation.*
  - **Results from literatures**

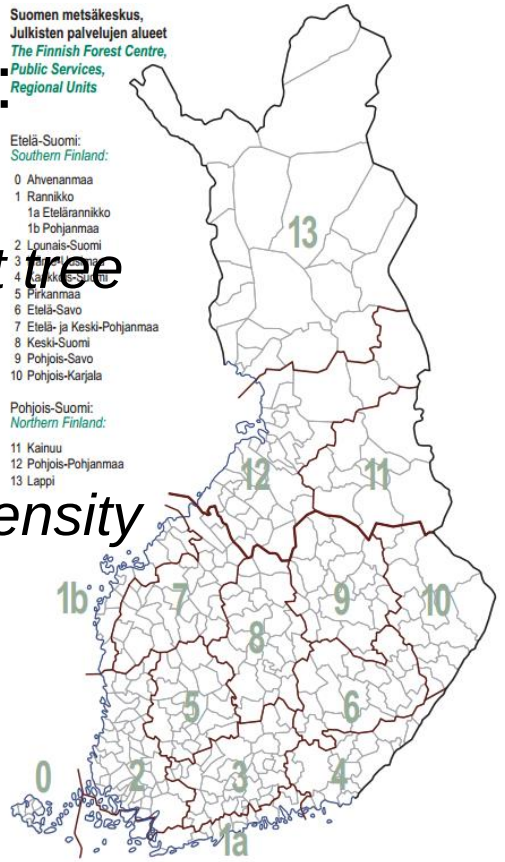
Method – NPP_{act}

- NPP_{act} is calculated by using data from:
  - Finnish National Forest inventory

    → *annual increment and area data for different tree species*
  - IPCC report

    → *biomass extension factor (BEF) data and density data.*
  - Literature (e.g. Gower, 2001)

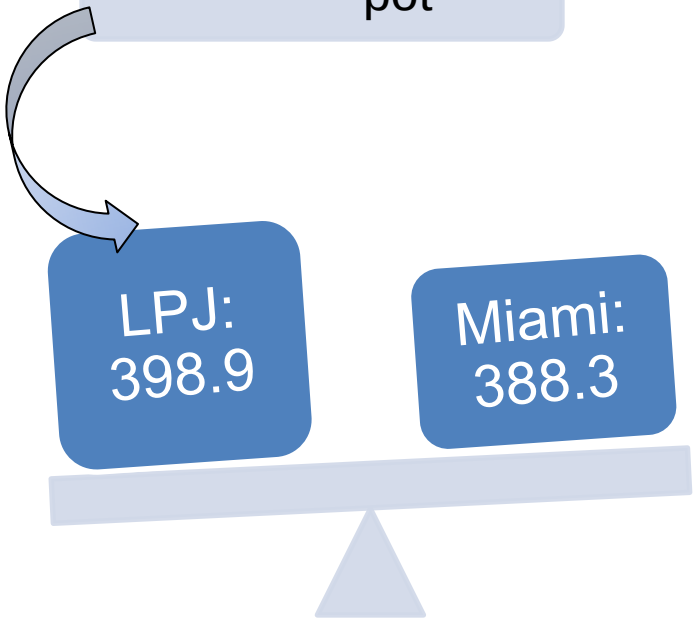
    → *belowground part, understory part biomass production data*.



Results – situation in Finland

NPP_{pot}

NPP_{act} = 221.2



Miami model underestimates the NPP_{pot} for boreal forest. This result also coincides with Del Grosso (2008), Zaks (2007).

Results for forest based on different models, with unit as g C/ m^2a

Results – induced NPP reduction

$HANPP_{LUC}$

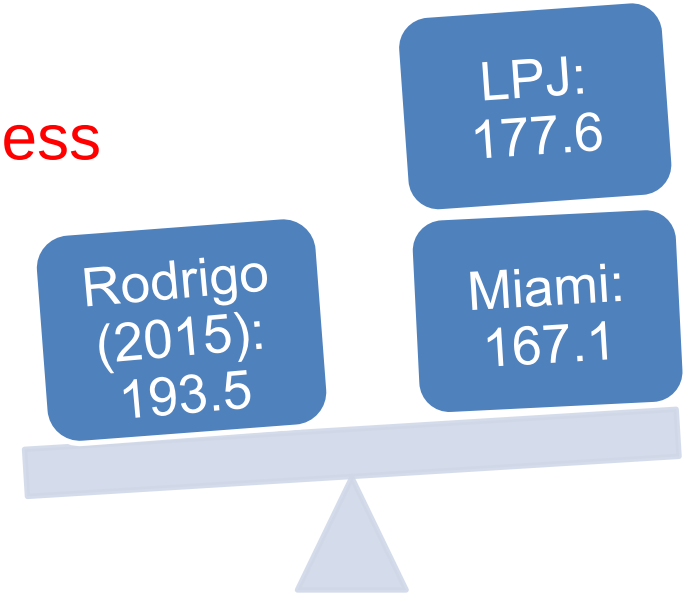
$$HANPP_{LUC} = NPP_{pot} - NPP_{act}$$

Agriculture

Forest

Impacts from forest just slightly smaller than what from agriculture, so forest land use impacts should be assessed.

~ 10% less



Results for forest based on different models, with unit as g C/ m^2a

Conclusion & recommendations

- HANPP integrate into LCA? Possible, but

  →i.e. tropic forest, temperate forest, all types of grazing land…

- Impacts resulting from forest land use should not be omitted regarding sustainable bioeconomy.

  → spatially consistent data-set covering all types of forest are needed for NPP simulation.

Conclusion & recommendations

- The method need to be further evaluated in practice as the choice of NPPpot simulation method matter.

  → ***a LCA case study with products containing different forest-based raw materials.***

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MARIE CURIE ACTIONS

UNIVERSITY OF HELSINKI