FLOW PROPERTY-BASED ASSESSMENT OF LAND USE IMPACTS ON BIODIVERSITY USING GIS IN LCA

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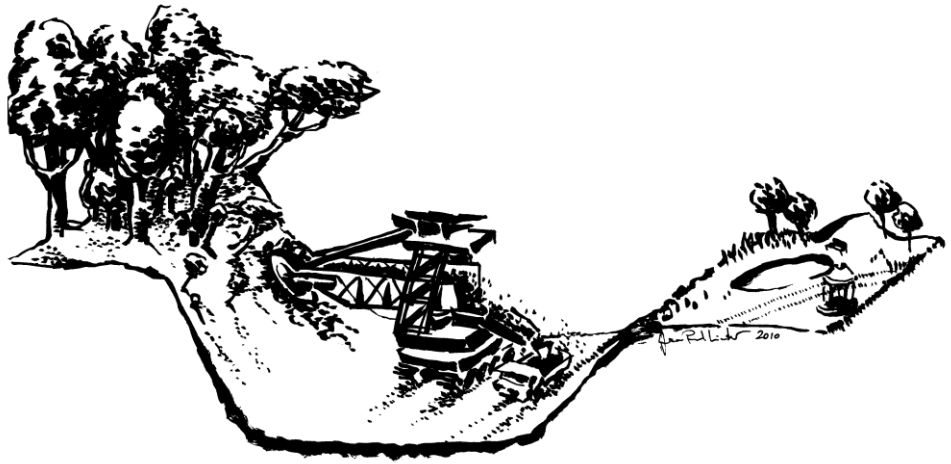
UNEP framework for Land Use in LCA

- Current land use frameworks build on findings of UNEP setacs LULCIA project
- Land use is specified in elementary flow name for “occupation” [m²a] and “transformation from/to” [m²]
- Land use impacts are calculated using characterization factors on country level

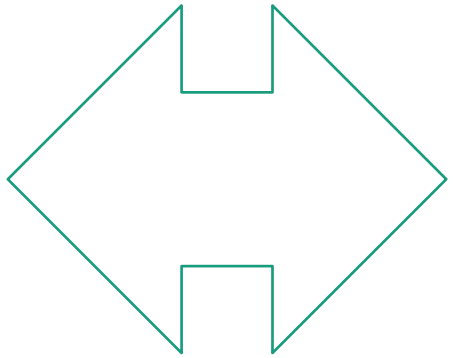


- Land use impact assessment (Soil Quality index based on LANCA®) is required for environmental footprint studies and optional for environmental product declarations
- No biodiversity method recommended yet
- Implementation and interpretation issues in many cases

Model requirements in land use impact assessment

LCIA models for land use need to ensure

- Global applicability
- Compatibility to softwares and databases
- Consistency with UNEP framework
  - Flow nomenclature
  - Temporal assumptions
  - Positioning in inventory and impact assessment



Land use models for LCIA need to ensure

- Robustness of impact models
- Completeness of considered ecosystem services
- Robustness of input data
- Adequacy of level of detail

Foreground and background application

- In foreground systems
  - information of high granularity and robustness
  - Assessment needs to represent the specific conditions
  - Results need to reflect information granularity

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- In background systems
  - No or few specific information is available
  - Consistent assessment on global level across all sectors
  - Results include global value chains and full life cycles

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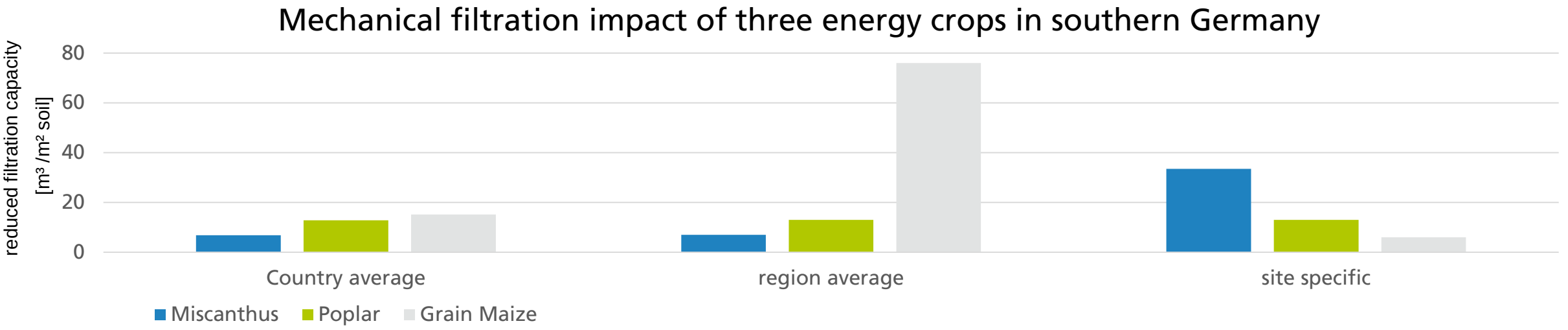
- Land use models need to consistently cover back- and foreground

Is a different land use framework necessary?

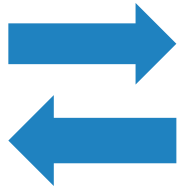
- Current framework complexity and robustness is criticized
- Nomenclature partially ambiguous, details arbitrary
- Intensity and management practices can only partially be specified
- Additional specificity (such as geolocation) would allow for adequate foreground characterization, but lead to infinite number of flows (currently already ~15,000 flows due to country information)



Land use modelling based on flow properties

- Base flows complemented by flow properties on instance level in foreground systems
- Background impact assessment (base flow CFs) directly available in LCA software
- Foreground impact assessment in GIS

Base flow		Flow properties			
Land use type, Sub type	Country	Land use intensity	Land use intensity value	Management parameters	Geolocation
Cropland, C4 perennial	e.g. Finland	Intense	0.8	e.g. fertilizer, mechanization, pesticides, set aside area, crop rotation	e.g. region/ XY coordinate

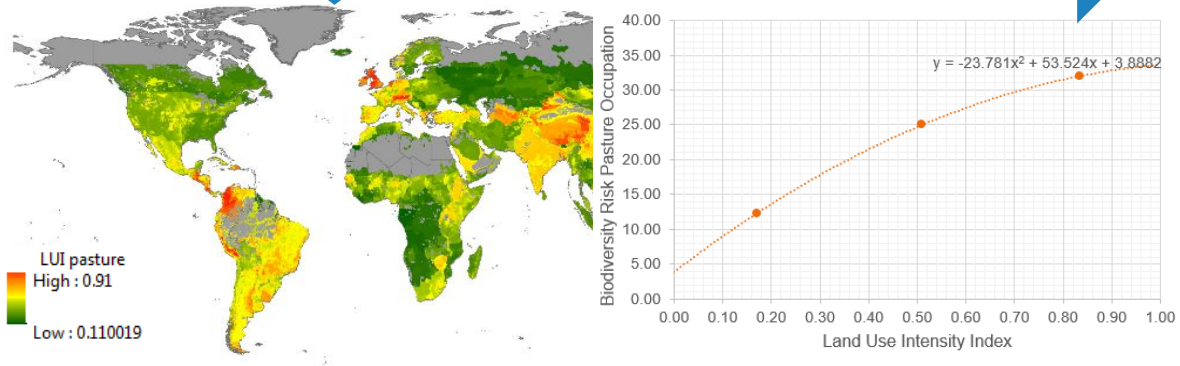


Impact assesment
Characterization factor
Local, global, regional biodiversity risks

Example: land use intensity and biodiversity risks

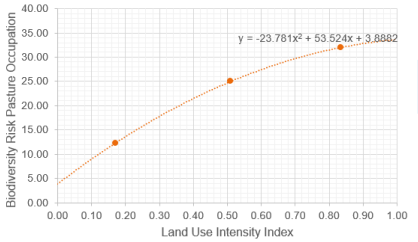
- Operationalization: calculation of global land use intensity indices – example pasture

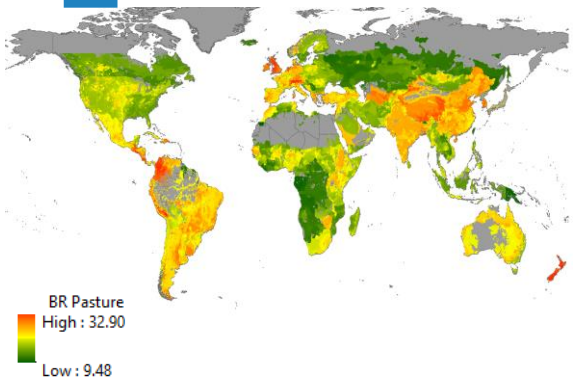
Management parameter	Indicator [unit]	Data Type	Global data source
Manure on Pasture Leaching	Amount of manure leaching [$kg_{N\text{-}leaching}$/(ha*a)]	Global maps, primary data	[182]
Livestock intensity	Tropical livestock per area [tropical livestock units/(km^2*a)]	Global maps sheep, goat, cattle, buffalo distribution, primary data	[262]
Pesticide	Pesticide application rate [$t_{active\ ingredients}$/(ha*a)]	Global maps, FAO statistics, primary data	[189]
Mechanization	Number of machines [$No_{tractor/harvester}$/(ha*a)]	FAO statistics, primary data	[190]
Set-aside areas/ecotones	Ratio set-aside area per field area [%]	Primary data, satellite images	N/A



Land use intensity pasture

Adjustment of management parameters





% change in local species richness and abundance due to pasture management

Adjusted grid cell average for foreground CF

Grid cell average for foreground CF

Country average for Background CF

(Maier, submitted)

Discussion and outlook

- Flow properties could resolve the opposing requirements through
  - Consideration of complex impact models
  - Spatially adequate scopes
  - Foreground/background calculation with one consistent approach
  - Reduction of base flows
- However, there are some remaining issues
  - GIS integration not yet available in LCA softwares
  - Reproducibility and comparability are challenging
  - Consistency between ecosystem services
  - Overlap of intensity and management practices

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