Development of a bottom-up methodology to assess potential C-debt and iLUC risks for woody biomass supply chains on a project level

Martin Junginger, Copernicus Instituut
TKI BBE Bijeenkomst
Disndag 23 Juni 2015, Amsterdam

Universiteit Utrecht

1

Project Duurzame houtketens

Financed by BE-BASIC

Runtime January 2013-December 2013 (but final report finished November 2014)

Project partners: Platform Bio-Energie, RWE Essent, Vattenfall, Eneco, E.On, GDF-Suez, Stichting Natuur & Milieu, WWF, Universiteit Utrecht

Universiteit Utrecht

2

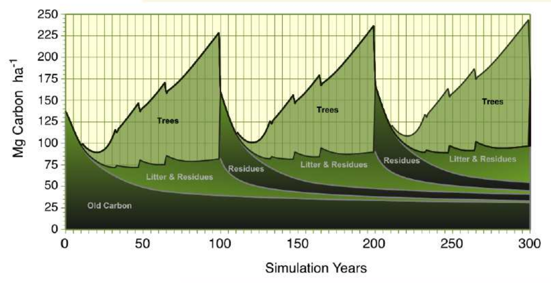
Aims of the study

- to analyse existing biomass supply chains with regard to the **risk of negative effects from Indirect Wood Use Change (ILUC) and carbon debt** and to **develop a bottom-up method & tool to enable energy companies to identify and consequently minimize such risks**
- Joint analysis of the sustainability of concrete biomass supply chains with utilities, NGO's and scientific partner

Universiteit Utrecht

3

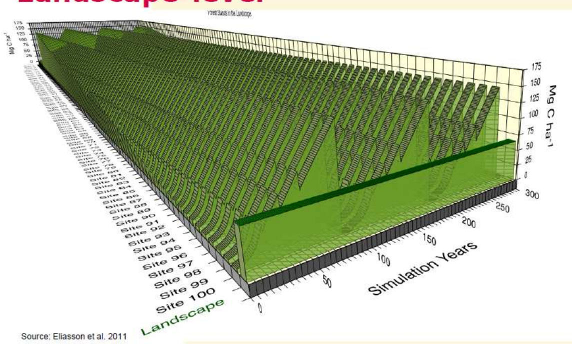
Stand-level



Source: Eliasson et al. 2011

Universiteit Utrecht

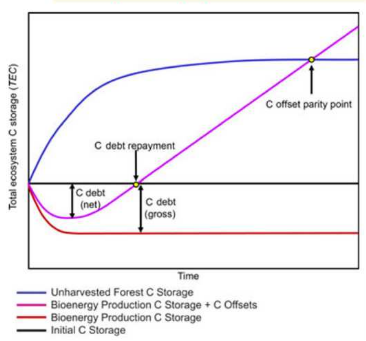
Landscape-level



Source: Eliasson et al. 2011

Universiteit Utrecht

Carbon debt & parity points



Visual representation of the carbon payback period and the carbon offset parity point, taken from Mitchell [2012]

Universiteit Utrecht

Background knowledge from literature

Result depends strongly on methodological choices:

carbon payback time or carbon parity point as indicator, stand level or landscape level, choice of reference scenario (by parity point indicator), low or high productivity forest management, fossil fuel replaced etc.

Payback / parity time →

Table 3. Key influencing factors on carbon payback/parity times.

Key influencing factor	Increasing carbon payback/parity time		
Land-use/ -management	Change involving carbon uptake (e.g. afforestation)		Change involving carbon release (e.g. peatland drainage)
Silvicultural regime[50]	Intensive even-aged forestry (e.g. dedicated replanting with highly productive seeds, fertilization, etc.)		Extensive, close-to-nature ~~or~~ forestry (e.g. natural regeneration)
Plant growth rate	High (e.g. tropical)	Medium (e.g. temperate)	Low (e.g. boreal)
Carbon content of harvested biomass	Low (e.g. branches)	Medium (e.g. stumps)	High (e.g. stems)
Harvest share of living biomass	Low (e.g. higher deadwood share)	Medium	High (e.g. green tree harvest)
Harvesting intensity	Low (e.g. residues only)	Medium	High (e.g. whole-trees)
Fossil fuel conversion efficiency reference	Low (e.g. old coal power plant)	Medium	High (e.g. new gas CHP plant)
Biomass to energy conversion efficiency	High	Medium	Low
Carbon intensity of substituted fossil fuel	High (e.g. coal)	Medium (e.g. oil)	Low (e.g. natural gas)
Share of otherwise decaying biomass	High	Medium	Low

ILUC/IWUC

- Indirect land use change is generally not as important for woody biomass than for agricultural crops used for liquid biofuel production, as woody biomass for energy is typically not a main driver for LUC
- But, if woody biomass used for energy also has a possible application for a material purpose (e.g. fibreboard, pulp & paper), then there *may* be (now or in the future) a risk for competition (indirect Wood Use Change, IWUC), which could ultimately lead to ILUC
- IWUC/ILUC risk depends on the ability of the bioenergy sector to pay for the land/wood compared to the paying ability of other sectors

ILUC/IWUC

From a carbon perspective, IWUC could have two effects:

(1) the wood industry may satisfy its demand for low-cost fibre from other regions (including respective carbon implications); or

(2) wood products, e.g. construction wood, increase in price and will be replaced by other materials, e.g. concrete or steel in construction

ILUC/IWUC

- IWUC/ILUC risks can only be assessed on a landscape level (not for an individual plot)
- But, the demand for woody biomass for material purposes may be highly dependent on the geographical scope: on a local level, pulp & sawmill typically source feedstock within 100 km radius. Demand may vary significantly between local, regional and national scope
- A complicating factor is also that demand for material purposes may (strongly) change over time, e.g. general decline of pulp wood production on Northern hemisphere

Principle ideas behind the bottom-up risk assessment tool

- Evaluation for a specific project level with specific feedstock uses, but taking the regional situation within e.g. a 100 km radius into account
- Based on a 'simple' questionnaire – trade-off between the level of detail & amount of reliable data that can be obtained and user-friendliness
- Focus on wood pellet plants in this (first) phase of the project, but in principle, methodology should ultimately be also applicable to production of wood chips, briquettes, torrefied pellets, pyrolysis oil, 2nd generation biofuels etc.

Definition of feedstock types

A **main product** provides the main (economic) driver that justifies the harvest. Examples could be:

- a short rotation coppice system which was set-up with the purpose of producing wood for bioenergy
- a plantation formerly used to produce solely or mainly pulpwood, and is now used to produce wood solely or mainly for bioenergy
- a former multi-purpose plantation forest, which is now mainly harvested for bioenergy, with small amounts going to high-value applications like sawn-timber

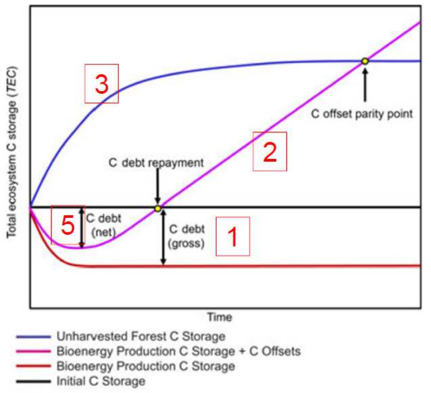
Definition of feedstock types

- **A co-product** is defined as a part of a commercial harvest, which is not the main product, but which does have a potential local alternative use (e.g. for pulp & paper), i.e. that meets the technical requirements for a material use and where there is a local demand for this use.
- Example: A typical pine tree plantation in the US-SE, where the larger fraction of the trees in a stand is used for sawn wood, and the smaller fraction (typically small trees and the tops of larger trees) are of pulp-quality, but are now used for energy instead

Definition of feedstock types

- **A residue** is a feedstock which has (*at the specific location and point in time*) no local alternative material use (e.g. for pulp and paper, OSB, fibreboard, veneer, timber, etc.). It is important that whether something is a residue or not is (in this context) not primarily defined by the fact if the feedstock meets the technical specifications to produce e.g. paper, but whether there is a local demand for this use.
- Three types in model: primary (a residue that remains in the forest, e.g. woody debris, small trees left standing after a partial cut), secondary (process residue, e.g. sawdust) and tertiary (post consumer residues, e.g. demolition wood)

Development of C-debt criteria



1. Carbon Stock change (due to harvest)
2. Speed of carbon accumulation (after harvest)
3. Reference forest system (counterfactual wood / land use)
4. Regional forest carbon stock reference
5. Reference energy system (counterfactual fossil fuel use)

C-debt criteria and preliminary indicators

Criterion	C-debt risk					
	Main product	Co-product	Primary residue (harvesting)		Secondary process residues	Tertiary residues
	E.g. short rotation forestry for bioenergy only	E.g. small pulp-grade trees harvested next to timber-quality larger trees	Dead residues (tops & branches, stumps, roots of harvested trees or whole non-merchantable *dead* trees)	Whole non-merchantable alive trees left standing	E.g. sawdust, wood chips, shavings, bark	E.g. demolition wood
Carbon Stock change due to harvest	Diameter (A1) Δ C stock level before/after forest type change (A4 / C1)	Diameter (A1)	Diameter (A1)	Diameter (A1)		
Speed of carbon accumulation (after harvest)	Forest Biome (A2) Chance of replanting (B2) Potential yield in/decrease (C5) Change in rotation length (B3)	Forest Biome (A2) Chance of replanting (B2) Potential yield in/decrease (C5) Change in rotation length (B3)	Forest Biome (A2) Chance of replanting (B2) Potential yield in/decrease (C5) Change in rotation length (B3)	Forest Biome (A2) Chance of replanting (B2) Potential yield in/decrease (C5) Change in rotation length (B3)		
Reference forest system (wood / land use)	Counterfactual wood use (B4 / B11) Counterfactual land use (CF1)	Counterfactual wood use (B4 / B11)	Counterfactual wood fate (B4)	Counterfactual wood fate (B4)	Counterfactual wood use / fate (B4 / B11)	Counterfactual wood use/fate (B4 / B11)
Regional forest carbon stock reference	Trend C-stock region (A5) AAC (C3)					
Reference Energy system	Reference fuel (C7)	Reference fuel (C7)	Reference fuel (C7)	Reference fuel (C7)	Reference fuel (C7)	Reference fuel (C7)

ILUC/IWUC criteria

1. Current risk (2013) aims to quantify the risk of ILUC/IWUC based on a) current technical displacement potential, and - most importantly-, whether the current buying capacity of the bioenergy is = or > than that of any competing existing industry. If the answer is no, than by definition, the current risk for iLUC/iWUC is 0

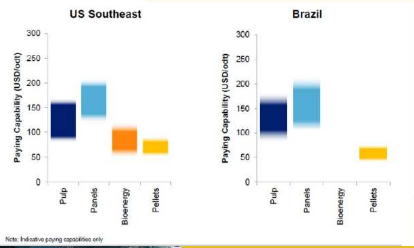
2. Future iLUC/iWUC risk (2020): technical displacement potential & wood buying capacity of bioenergy & other wood-using sectors. Extremely difficult to answer, but also crucial to determine the future iLUC/iWUC risk

3. General availability of land is taken as a third criterion

ILUC/IWUC criteria

Most crucial question: is the wood buying capacity of the pellet mill < or >= of other industries? (now and in 2020)

Difficult to answer, as this information is typically highly confidential, difficult to verify independently and may also depend on specific geographic circumstances



Scoring for each criterion

- The score for each C-debt and ILUC/IWUC criterion is determined by one or several indicators. Scores can vary from 1 (low risk) to 5 (high risk), in some case can also be 0, or can be blank (i.e. not applicable)
- For C-debt, we also included the option to calculate a single, total score, i.e. a geometrical average of the scores for the criteria. Note that if one of the C-debt criteria has a score of 0 the entire score becomes zero (e.g. if counterfactual for residues is burning in the field)
- Aggregate score not done for ILUC/IWUC

Example result: forest residues from boreal forest

- In Canada, using slash to produce pellets to replace coal in the Netherlands

Carbon debt risk:	1,0	Carbon Stock change due to harvest
	2,4	Speed of carbon accumulation(after harvest)
	1,0	Reference forest system (wood / land use)
		Regional forest carbon stock reference
	2,0	Reference Energy system
	1,5	*Total score*
ILUC/ IWUC risk:		Current risk, reference year: 2013
		Future risk, reference year: 2020
		General risk level (land scarcity) in the region

HYPOTHETICAL EXAMPLE: pulp quality trees from Nordic pine plantation

- Assuming that the alternative reference scenario would be that the plantation is left to grow further for another 30 years (NOT realistic / current practice)

Carbon debt risk:	3,0	Carbon Stock change due to harvest
	2,6	Speed of carbon accumulation(after harvest)
	5,0	Reference forest system (wood / land use)
		Regional forest carbon stock reference
	2,0	Reference Energy system
	3,0	*Total score*
ILUC/ IWUC risk:	0,0	Current risk, reference year: 2013
	3,5	Future risk, reference year: 2020
		General risk level (land scarcity) in the region

Methodological discussion points (not exhaustive!)

- Multiple product approach too complex to take into account for our simple tool. =>
- only analyze the C-debt and IWUC/ILUC effects of the biomass used for bioenergy (i.e. not analyze the joint performance of bioenergy and other material use), and
- categorize feedstocks as a residue OR as a main product. The categorization as a residues is justified if there is no local demand for material use at that specific location and time. This means that at least for the current situation, no IWUC/ILUC is assumed for these feedstocks.

this choice may be re-evaluated / changed if the tool is further developed and tested.

Methodological discussion points (not exhaustive!)

- Adequacy of current questions to serve as indicators (e.g. diameter of feedstock removed as a proxy for total C-removal/ha)
- Currently no weighing of several indicators that determine the score for one criterion
- Also, no weighing for the different C-debt criteria when an aggregated score is calculated (i.e. they are implicitly considered as equally important)
- Is an aggregated score actually a useful metric?
- Should C-debt and ILUC/IWUC score be combined to a final, single score?

=> To be discussed...

Follow-up (?)

- Next to further methodological improvements, real case studies should be carried out to test the tool in practice
- C-Debt and IWUC are in the current SER negotiations assessed by a (much) simpler rule: a maximum share of woody biomass can be used for energy purposes, the rest needs to be used for material purposes
- Current tool could still be a useful addition to identify possible risks on a individual mill level

Questions and Feedback

Martin Junginger
h.m.junginger@uu.nl

Universiteit Utrecht

25