EFORWOOD

Sustainability Impact Assessment of the Forestry - Wood Chain

Project no. 518128

EFORWOOD

Tools for Sustainability Impact Assessment

Instrument: IP

Thematic Priority: 6.3 Global Change and Ecosystems

Deliverable PD3.3.6
Stratified partial model on transport

Due date of deliverable: Month 42
Actual submission date: Month 48

Start date of project: 011105
Duration: 4 years

Organisation name of lead contractor for this deliverable: FCBA France

Final version

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

1. Introduction

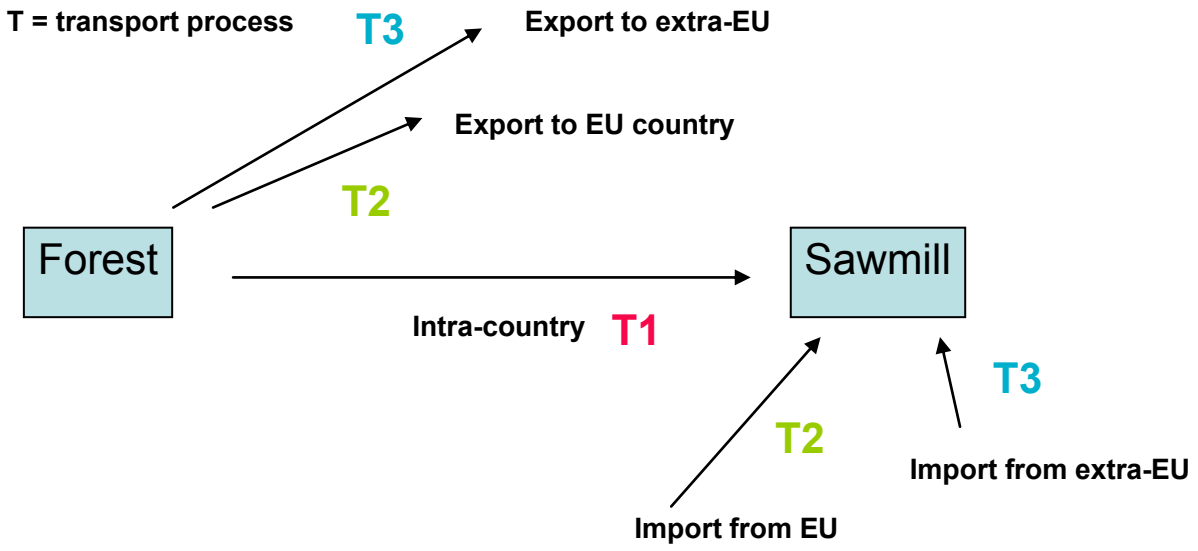
The measure of economic, social and environmental impacts of transport processes in the Forest Wood Chain is an issue which has resulted to a specific methodology on the way to approach the transport in a value chain (D 3.3.3) and on the way to measure indicators values per type of flow and transport mode (PD 3.3.4). This document describes the methodology used to aggregate indicator values per process. Three types are identified: Intra country (T1 in figure 1), intra EU (T2 in fig 1) and extra EU transport processes (T3 in fig 1). Two types of tools [1] have been designed for intra (T1) and extra (T2+T3) national transport processes.

Table 1: Flows coverage and Tools

	Tool 1	*Tool 2*
T1	x	
T1 T2		x

The first tool aggregates indicators values got from three transport modes: rail, road and inland waterways. It allows to get a synthetic indicator value gathering road, rail and inland waterways indicator values generated by one transport process.
The second tool does the same type of aggregation with road, rail, inland waterways and short sea shipping for transport processes generated by extra-national flows.

Figure 1: Transport processes related to intra and extra national flows



Additionally, it does a second aggregation providing average indicators values for a transport process describing a flow from/to a country to/from the rest of World (Intra and extra EU – T2+T3).

[1] The first tool gather three excel sheets, one for 2005 and one per reference future.
Tool 1 - T1:
FCBA_transport_tool_3modesV3.xls for 2005
FCBA_transport_tool_3modesV2_2015-25_A1_V2.xls for 2015-2025 ref future A1
FCBA_transport_tool_3modesV2_2015-25_B2_V2.xls for 2015-2025 ref future B2
Tool 2 - T2 & T3: Matrix_Modal_Distrv8.xls for extra-national flows

The document focuses on intra-national flows in the first section and on extra-national flows in the second section.

2. Intra-national transport processes (T1)

Three transport modes have been identified for this type of flow:

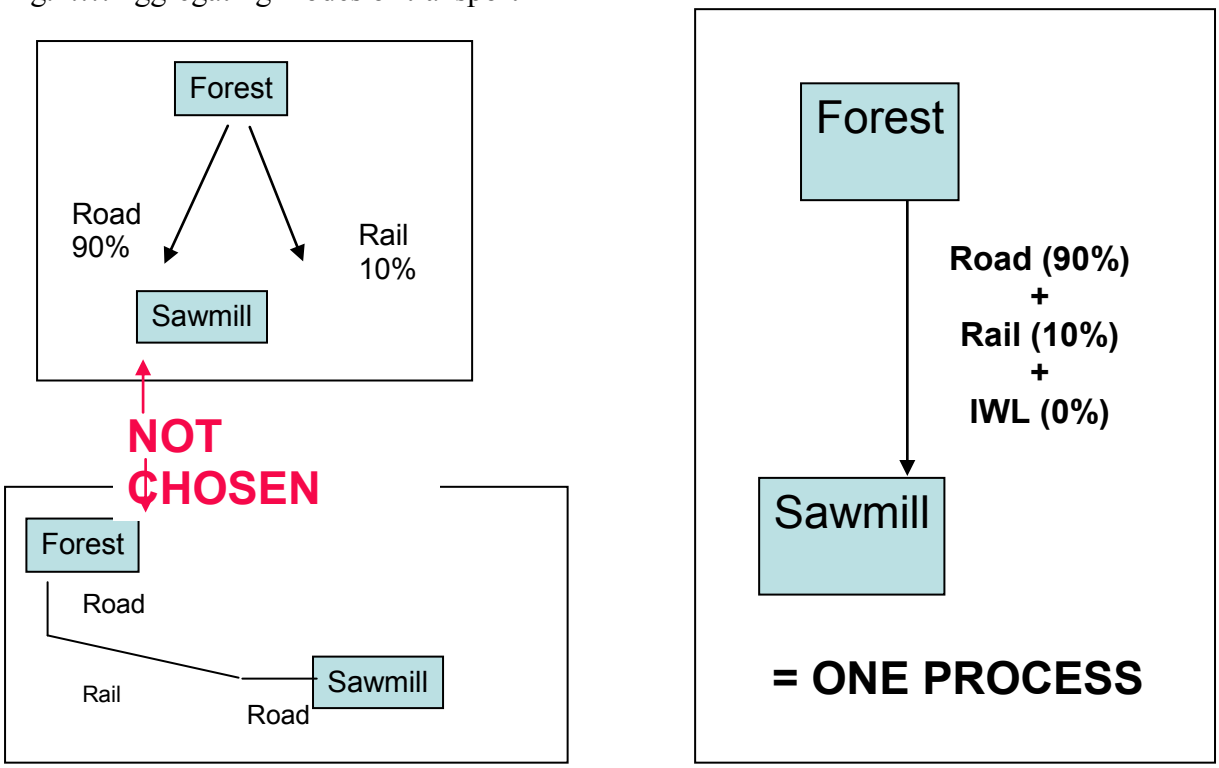
- Road
- Railways
- Inland Waterways (river)

Measuring indicators per transport mode

See PD 3.3..4 for more details.

Aggregating Road, Railways and Inland Waterways impacts:

In the EFORWOOD context, it has been decided to get a simplified but representative topology. Indeed, when several modes are used for the transport of a product, only one process is designed. Then the "simplified" process should be able to take into account the modal split. The logic is then to estimate the distance in this process per each transport mode and then to estimate their indicators values. In a second step these values are aggregated.
For instance, the supply of wood from the forest to the mill involves 90km of road and 10km of rail. Indicators are estimated for both transport modes and then summed in order to get one unique value per indicator.
Fig.2:…Aggregating modes of transport



This approach is detailed more formally in the following equation:

$$F\_\mathrm{Ind} = \sum_i \mathrm{Ind}_i \times S_i$$

F_Ind= Final indicator (to fill in the Client)
Ind_i: Indicator value of transport mean i
i: transport mean; *i*=1(Road), 2(Rail) or 3 (Inland Waterways)
S_i: Share of distance covered by transport mean *i*

3. Approach for Import-Export transport processes

Intra-EU flows

Four modes have been identified in the transport of FWC products within Europe:

- Road
- Rail
- Inland Waterways
- Short Sea Shipping

For simplification reasons, flows of FWC products have been limited to 6 groups of products:

- Roundwood (M3):
- Primary conversion wood products (M4)
- Secondary conversion wood products (M4)
- Paper/Board
- Pulp (M4, M5)
- (Bio-)Energy (M3, M4, M5)

Extra-EU flows

The extra EU trade should include Maritime transport[2]. However, it has been decided for technical and timing reasons to limit the estimates for Extra EU-trade only up to EU boarders. Then the methodology in term of indicators aggregation for Intra EU and Extra EU flows are similar. In order to reduce confusion the methodology described below only focuses on Intra-EU flows.

Measuring indicators per transport mode

See PD 3.3.4 for more details.

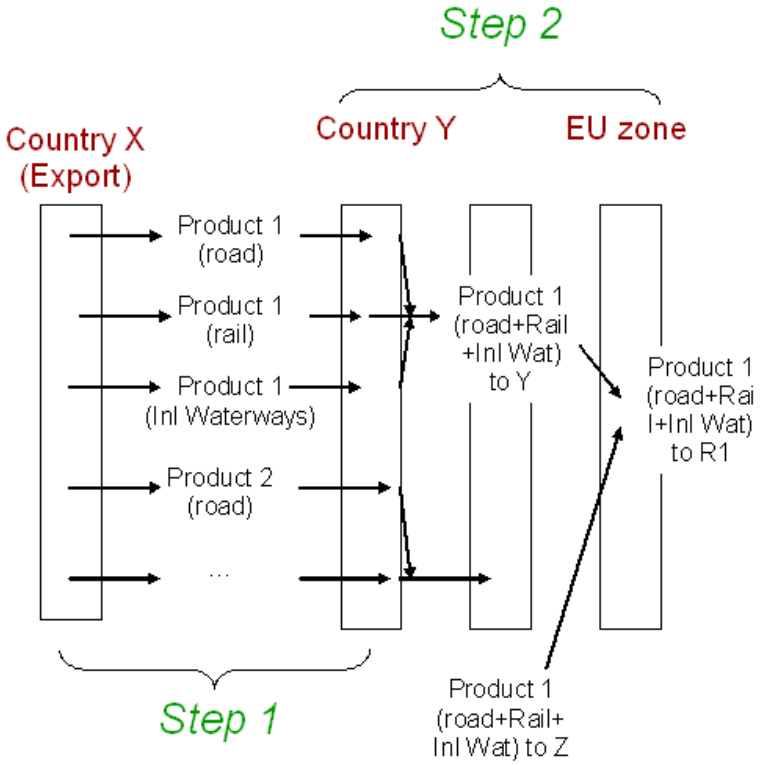
[2] Maritime transport differs from the Short Sea Shipping according to the European commission definition: "*Short Sea Shipping means the movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non European countries having a coastline on the enclosed seas bordering Europe. Short sea shipping includes domestic and international maritime transport, including feeder services, along the coast and to and from the islands, rivers and lakes. The concept of short sea shipping also extends to maritime transport between the Member States of the Union and Norway and Iceland and other States on the Baltic Sea, the Black Sea and the Mediterranean*." (COM 2006)

Methodology:

The methodology estimating the sustainability impact of transport processes generated by extra-national flows of FWC products can be developed in two steps:

1. *Measuring Indicators value per product and transport mode between countries.* The PD 3.3.4 has shown how indicator values were collected and estimated. However the formal explanation allowing a measure of transport process per country flow is described in this document.
2. *Aggregating of transports Indicators per region.* The value of indicators per transport mode and country flow has to be aggregated in order to get only one value for the transport of one group of product from a country to the rest of the world. Flows are firstly distinguished between intra EU and Extra EU trade and then gathered into the same flow: "Rest of the world".

Fig.3: Aggregating of transports Indicators per region



Indicators – Step 1

1. *Estimation of country flows in Tkm per flow, and transport mode:*

Transport Matrix (Modal Distribution)=T
Distance Matrix=D
Flow matrix=F
Process matrix=P

P=T*D*F

The « Process » Matrix allows the identification of ton km of product b (pulp for instance) from country i to country j.

Tables 2, 3, 4 and 5 illustrate the forms of the "Transport", "Distance", "Flow" and "Process" matrices.

Table 2 : « Transport » Matrix (Modal Distribution)= D

Country of unloading		BE				CZ		
Country of loading	BE	4,77%	54,57%	7,30%	33,36%	5,64%	94,09%	0,26%
	CZ	15,27%	81,68%	3,05%	0,00%	8,49%	91,38%	0,13%
	DK	0,56%	67,07%	0,00%	32,38%	1,53%	98,47%	0,00%
	DE	5,56%	50,88%	38,32%	5,24%	27,46%	70,22%	2,32%
	EL	0,00%	74,11%	0,00%	25,89%	4,65%	95,35%	0,00%
	ES	9,58%	76,56%	0,00%	13,86%	2,19%	97,81%	0,00%
	FR	13,50%	64,66%	11,12%	10,72%	2,87%	96,94%	0,20%
	IT	46,88%	39,72%	0,00%	13,40%	6,03%	93,97%	0,00%

Rail
Road
Inland waterways
Shipping

Table 3 : Distance matrix =D

Destination Country / Origin Country	Belgium	Czech Republic	Denmark
Belgium		905 km	967 km
Czech Republic	948 km		834 km
Denmark	928 km	765 km	
Germany	240 km	666 km	….

Geodesic distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important cities/agglomerations (in terms of population) for the distance variable. Adjustment coefficients have been identified for road and rail but not for inland waterways and short sea shipping. Indeed it is not possible to have a such coefficient for these transport means as long as European coasts are anything but homogenous.

Table 4 : Flow matrix = F

Destination Country / Origin Country	Belgium	Czech Republic	Denmark
Belgium	0 tons	2 123 tons	2 449 tons
Czech Republic	4 578 tons	0 tons	166 tons
Denmark	0 tons	0 tons	0 tons
Germany	24 662 tons	69 590 tons	26 770 tons

Table 5 : « Process Matrix » : *P=T*D*F*

Origin country \ Destination country			France	Germany	Spain
France				....	...
Germany			...		...
Pulp	Spain	Road	X1tons km	Y1tons km	
		Rail	X2tons km	Y2tons km	
		ILW	X3tons km	Y3tons km	
	Italy	Road	...	...	...
		Rail	...	...	...
		ILW	...	...	...

Table 6 : Data source per Matrix

Data Source	Matrix
Eurostat	Transport
Cepii	Distance
EUROSTAT	Flow

2. *Measure of indicators per flow and transport mode:*

Now that the "process" matrix is known, a multiplication with indicators values per tkm has to be done. Firstly, a matrix expressing the value of each indicator and transport mode for 1 tkm is set up :
$\boldsymbol{I} = [a_{i,1}]_{m\times 1}$, where i=1 (GVA), i=2(Production cost), i=3… The determination of the matrix I_m is described in the PD 3.3.4.

Indicators value change per "country of reference". How does the tool deal with it? A strong assumption is taken: the departure country in an international trade flow is used as a reference.
Ex: Labour cost (labour cost for a flow from France to Spain will be based on the French labour cost value).

Using this "indicator" matrix, it is then possible to estimate the values of indicators for each flow and each transport mode:

$$\boldsymbol{R = I*P}$$

R: indicators value matrix per country flow
P: Process matrix
I is the indicator matrix (per tonne km)

Example: Estimation of Rail average cost

Rail transport cost of pulp from France to Spain
=
*France-Spain Distance * Pulp flow from France to Spain * French rail cost per Ton Km*

Indicators – *Step 2*: Aggregation of indicators (Transport modes and flow)

Now the value of indicators is known for each transport mode and each flow, an aggregation is necessary in order to drop the transport mode distinction per flow.

$$A_{m,i} = \frac{\sum_j \sum_k R_{m,i,j,k}}{\sum_j F_{i,j}}$$

R: indicators value matrix per country flow
F: Product flow matrix
m is the indicator (GVA, prod cost…)
i is the origin country
j is the destination country,
k is the transport mode

Example: Estimation of the Gross Value Added from country *i* to the rest of the world (Intra and extra EU, reported per ton), GVA_i:

$$GVA_i = \frac{\sum_j \sum_k GVA_{i,j,k}}{\sum_j F_{i,j}}$$

4. Conclusion

This paper has shown the methodology used to get synthetic indicators able to assess the sustainable impact of transport within the FWC. Two types of indicators can be distinguished:

- Indicators measuring the impact of the transport of a wood product within a country, whatever the transport modes involved (road, rail and inland waterways).
- Indicators measuring the impact the transport of a wood product from/to a country to/from the rest of the world (Intra EU & extra EU) whatever the transport modes involved (road, rail, inland waterways and short sea shipping).

The aggregation of indicators values is relatively straightforward in the intra-national case as it only concerns transport modes within one flow. In the case of extra-national flows, several remarks have to be made:

- Distances are measured using the Great circle and no distinction is made between transport modes. Then the tool assumes that a distance between two countries is

similar by road, rail, sea or inland waterways. This assumption is very strong but unfortunately data on international distances per type of transport mode are not publically available.

- The use of the origin country as a reference for indicators is also problematic as several transport companies from different countries can be involved in a single transport process. For instance, some international road transport companies come from Eastern European countries where labour force is cheaper and can deal with the transport of goods from Germany to France.
- The aggregation of both intra and extra European flows prevents a measure of the distinction of sustainability impacts explained by European trade and Extra-EU trade.
- The limitation of European boarders in the measurement of indicators for extra EU flows lowers considerably the economic, social and environmental impacts of extra EU-trade. As such for a imported from Brazil to Luxembourg, we just take into account the transport from Antwerp to Luxembourg and exclude the shipping from Brazil to the European port. This important point should be noticed to ToSIA users in order to avoid any misunderstanding.

5. Reference

EFORWOOD, 2008, D3.3.3, *Assessment of logistics concepts to sustainability: development of a common approach to transport issues*.

EFORWOOD, 2009, PD3.3.4*, Data collection of transport processes to TosIA at case study and EU level.*

Eurostat, 2007, *Panorama of Transport*, Eurostat Statistical Book
http://www.cepii.fr/anglaisgraph/bdd/distances.htm

Mayer, T, Zignago, S, 2006, *Notes on CEPII's distances measures,* CEPII