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# The Ecological Footprint of Luxembourg

## Technical Report

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## The Ecological Footprint of Luxembourg: Technical Report (version 4.0 – extended Scoping Study Report)

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## Contents

Index of Figures .....	5
Index of Tables.....	6
List of abbreviations .....	7
1. Introduction.....	9
2. Working Method.....	9
3. Introduction to the Ecological Footprint Approach and its Application .....	10
4. Verification of the National Footprint Accounts 2008 for Luxembourg .....	14
4.1. Biocapacity and Land Use Statistics.....	16
4.1.1. Database and Data Comparison.....	17
4.1.2. Influence of National Data on Global Footprint Network Results.....	20
4.1.3. Conclusion .....	22
4.2. The Ecological Footprint of Luxembourg by Global Footprint Network.....	24
4.2.1. Built-Up Land .....	25
4.2.1.1. Database, Data Comparison and Influence of National Data on Global Footprint Network Results .....	25
4.2.1.2. Conclusion .....	26
4.2.2. Forest Land.....	27
4.2.2.1. Database and Data Comparison.....	28
4.2.2.2. Influence of National Data on Global Footprint Network Results ..	29
4.2.2.3. Conclusion .....	30
4.2.3. Cropland .....	30
4.2.3.1. Database and Data Comparison.....	31
4.2.3.2. Influence of National Data on Global Footprint Network Results ..	33
4.2.3.3. Conclusion .....	33
4.2.4. Grazing Land.....	34
4.2.4.1. Database and Data Comparison.....	34
4.2.4.2. Influence of National Data on Global Footprint Network Results ..	36
4.2.4.3. Conclusion .....	36
4.2.5. Fishing Grounds.....	36
4.2.5.1. Database and Data Comparison.....	36
4.2.5.2. Influence of National Data on Global Footprint Network Results ..	37
4.2.5.3. Conclusion .....	37
4.2.6. Carbon Uptake Land .....	38
4.2.6.1. Database and Data Comparison.....	38

4.2.6.2.	Influence of National Data on Global Footprint Network Results ..	41
4.2.6.3.	Conclusion .....	44
4.2.7.	Conclusion and Outlook Concerning the 2008 National Footprint Accounts for Luxembourg .....	45
5.	Luxembourg's Biocapacity and Footprint calculation based on national data.....	47
5.1.	Luxembourg's Inhabitant's and Commuter's Footprints based on national data .....	47
5.2.	Luxembourg's Total Consumption Footprint by Categories.....	48
5.3.	Luxembourg's Total Consumption Footprint by Sectors .....	51
5.3.1.	Food Products, Non-Food Products and Services .....	52
5.3.2.	Road Transport / Mobility .....	52
5.3.3.	Inhabitants and Commuters Footprints .....	53
5.4.	Luxembourg's Inhabitant's Consumption Footprint by Land Use Categories .....	54
6.	Transforming Luxembourg's Ecological Footprint based on the National Footprint Accounts into 'One Planet Luxembourg'?.....	56
	References.....	58
A-1.	Glossary .....	61
A-2.	Key Words Translation .....	67
A-3.	Legend for Consumption Mind Maps per Land Type .....	68
A-4.	Forest Consumption Mind Map.....	69
A-5.	Cropland Production Mind Map .....	70
A-6.	Grazing Land Production Mind Map .....	71
A-7.	Fishing Grounds Production Mind Map.....	72
A-8.	Carbon Uptake Land Production Mind Map.....	73
A-9.	Publication List of the Global Footprint Network .....	74
A-10.	Strength and Weaknesses of the Ecological Footprint .....	75
A-11.	Data Comparison for Forest Products (exhaustive list).....	77
A-12.	Waste Land in Luxembourg.....	78
A-13.	Distribution of Total Road Fuel Consumption in 2005 - Calculation Steps.....	79
A-14.	Commuters Consumption Footprint Subcategory Land Use Matrixes (SLUM) .....	80
A-15.	Fuel Tourism and Transit Consumption Footprint Subcategory Land Use Matrixes (SLUM).....	81

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## Index of Figures

Figure 1: Ecological Footprint and Biocapacity equations	12
Figure 2: Extract of the Ecological Footprint Content Mind Map showing the composition of a country's Consumption Footprint	12
Figure 3: Example of the interrelations between Excel sheets for the Forest Production Footprint	13
Figure 4: Data Reporting in Luxembourg	16
Figure 5: Biocapacity equations based on 2008 National Footprint Accounts factors	17
Figure 6: Composition of Luxembourg's Recalculated Biocapacity by land use categories	23
Figure 7: Composition of Luxembourg's Ecological Footprint by land use categories	24
Figure 8: Composition of the forest land category	27
Figure 9: Composition of the cropland category	30
Figure 10: Composition of the grazing land category	34
Figure 11: Composition of the fishing grounds category	36
Figure 12: Composition of the carbon uptake land category	38
Figure 13: Luxembourg's Total Consumption Footprint by Final Consumption Categories	48
Figure 14: Luxembourg's Total Consumption Footprint by Subcategories	50
Figure 15: Luxembourg's Consumption Footprint by Sectors and Categories	53
Figure 16: Composition of Luxembourg's Inhabitants and Commuters Footprints	54

## Index of Tables

Table 1: Land Cover Databases	17
Table 2: Data Comparison of Land use statistics, according to GFN classification	18
Table 3: Data Comparison of Land use statistics, according to Corine 2000 and Corine 2006	18
Table 4: Different Land use categories of the Corine Land Cover database	19
Table 5: Data Comparison of Corine Land use statistics, according to MDDI classification	19
Table 6: Data Comparison of Cropland and Grazing Land, according to national statistics and the Corine database	20
Table 7: Luxembourg's biocapacity according to the 2008 National Footprint Accounts	20
Table 8: Recalculation of Luxembourg's total Biocapacity	21
Table 9: Biocapacity differences, according to NFA 2008 and Luxembourg specific calculations	21
Table 10: Data Comparison for Built-up Land (land use statistics)	25
Table 11: Databases for Forest Land	28
Table 12: Data comparison for Forest Products (summary)	29
Table 13: Databases used for the Cropland Category	31
Table 14: Data Comparison for Cropland: International and National Databases	32
Table 15: Luxembourg's Import and Export Data used for the Calculation in the NFA 2008	33
Table 16: Databases used for the grazing land category	35
Table 17: Data Comparison for Grazing Land (land use statistics)	35
Table 18: Databases used for Fishing Grounds	37
Table 19: Data Comparison for Fishing Grounds (trade statistics)	37
Table 20: Databases for Carbon Uptake Land	39
Table 21: Data comparison for fossil fuel combustion activities (sectoral approach)	40
Table 22: Extract correspondence tables SITC rev. 1 to rev. 4	41
Table 23: Imported products impacting the Footprint of the carbon uptake land category most	42
Table 24: Exported products impacting the Footprint in the carbon uptake land category most	43
Table 25: Embodied Energy Factors	43
Table 26: Glossary of the Consumption Footprint Subcategories	49
Table 27: Total Consumption Footprint SLUM	51
Table 28: Effective Consumption Expenditures by Inhabitants and Commuters in 2005 on Luxembourg's Territory (in million EUR)	52
Table 29: Distribution of Total Road Fuel Consumption in 2005	53
Table 30: Inhabitants Consumption Footprint SLUM	54
Table 31: Comparison of Luxembourg's Total Consumption Footprint with the Inhabitant's Footprint by Land Use Categories	55

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## List of abbreviations

BC	Biocapacity
CEPS-INSTEAD	Centre d'Etudes de Populations, de Pauvreté et de Politiques Socio-Economiques - International Network for Studies in Technology, Environment, Alternatives, Development (Luxembourg)
CLC	Corine Land Cover database
CORINE	Coordination of information on the environment (European programme initiated in 1985 by the European Commission)
CRTE	Resource Centre for Environmental Technologies / Public Research Centre Henri Tudor (Luxembourg)
CSDD	National Advisory Council for Sustainable Development / Conseil Supérieur pour un Développement Durable (Luxembourg)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DM	Dry Matter
EF	Ecological Footprint
e.g.	exempli gratia
EIONET	European Environment Information and Observation Network
EQF	Equivalence Factor
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GFN	Global Footprint Network
gha	global hectares
GHG	Greenhouse Gas
ha	hectare
HDI	Human Development Index
i.e.	id est (that is)
IEA	International Energy Agency
Int.	International
IPCC	Intergovernmental Panel on Climate Change
IPSE	Identités, Politiques, Sociétés, Espaces
LU	Luxembourg / Luxembourg's
m <sup>3</sup>	cubic meter(s)
MA	Ministry of the Agriculture / Ministère de l'Agriculture (Luxembourg)
MDDI	Ministry of Sustainable Development and Infrastructures (Luxembourg)

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MECE	Ministry of the Economy and External Trade / Ministère de l'Économie et du Commerce Extérieur (Luxembourg)
MEV	Ministry of the Environment (Luxembourg)
nes	Not Elsewhere Specified
NFA	National Footprint Accounts
nha	national hectare
rev.	revised
road fuel exports	road fuel consumption of commuters, fuel tourism and transit
SEI	Stockholm Environment Institute
SER	Service d'Économie Rurale
SITC	Standard International Trade Classification
STATEC	Government Statistics Service of Luxembourg
t	tons
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
YF	Yield Factor
yr	year
wha	world hectare

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## 1. Introduction

Luxembourg's National Advisory Council for Sustainable Development (CSDD) commissioned the Resource Centre for Environmental Technologies (CRTE) in December 2008 to conduct a technical study for the establishment of the Ecological Footprint (EF) for Luxembourg.

The Ecological Footprint is a well established tool that measures how much land and water area a human population requires to produce the resources it consumes and to absorb its waste (CO<sub>2</sub> emissions) and is usually expressed in global hectares (gha) per inhabitant of a country or a region. The 2008 edition of the National Footprint Accounts (NFA) published by the Global Footprint Network (GFN) calculates the Ecological Footprint and biocapacity for individual countries and for the world as a whole, including for the first time separate results for Luxembourg.<sup>1</sup> However, the Network invites national bodies to verify and validate their country specific Ecological Footprint calculations and to publish national footprint studies. Ecological Footprint studies have already been carried out for a number of countries, e.g. Switzerland, China, Canada, France, Germany and Belgium, and for regions all around the world, e.g. Europe and Africa.

The motivation of the present study is to analyze the Ecological Footprint calculations for Luxembourg done by Global Footprint Network to give an overview of the significance of the results for Luxembourg with respect to national particularities. The aim is to correctly define the boundaries of the Ecological Footprint assessment for Luxembourg and to address methodological issues which are relevant at the national level, including data quality identification. The outcome shall be the basis for the future yearly calculation of Luxembourg's Footprint by the Global Footprint Network and national bodies.

In the first chapters the working method applied in Luxembourg to achieve the above mentioned aim and outcome is presented, followed by a description of the ecological footprint methodology, as well as its application in general (see chapters 2 and 3). Then, in chapter 4, the Biocapacity and Ecological Footprint of Luxembourg as they were calculated by Global Footprint Network are described and analyzed in detail (a) with respect to the data and data sources used and (b) in comparison to national data. In chapter 5, Luxembourg's Biocapacity and Footprint are calculated based on national data and the share of the commuters and the fuel tourism is illustrated. Finally, in chapter 6, some possible further applications of the Ecological Footprint are mentioned in order to open the discussion if the Footprint can be used as an indicator for sustainable development in Luxembourg.

## 2. Working Method

The calculation of a country's Ecological Footprint requires a substantial set of statistical data and a lot of assumptions have to be made that need to be validated and accepted at a national level. Therefore, the working method in Luxembourg strongly focused on a collaborative approach, involving in addition to the National Advisory Council for Sustainable Development (CSDD) and the CRTE other research institutions, government officials and further stakeholders.

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<sup>1</sup> Until 2003, Luxembourg's Ecological Footprint was assessed together with Belgium's footprint, allowing only a limited evaluation of the national situation.

From the start of the project, a **working group** was established to verify and collect data, apply the Ecological Footprint methodology and interpret the results. This working group met regularly<sup>2</sup> and was composed of researchers and experts from:

- Public Research Centre Henri Tudor (CRTE);
- National Advisory Council for Sustainable Development (CSDD);
- International Network for Studies in Technology, Environment, Alternatives, Development (CEPS-INSTEAD);
- University of Luxembourg, Research Unit Identities, Politics, Societies, Territories (IPSE);
- CONVIS Herdbuch Service Elevage et Génétique.

In addition to the working group, a **steering committee** was in charge of the orientation and validation of the work carried out by the working group. For example, the steering committee validated certain methodological aspects proposed for the Ecological Footprint calculation, intermediate and final results, as well as the interpretation of the results. This group was composed of:

- CSDD members;
- government officials of the Ministry of Sustainable Development and Infrastructures (former Ministry of the Environment and Ministry for Home Affairs and Town and Country Planning);
- government officials of the Ministry of the Economy and External Trade (MECE), represented by:
  - the Observatory of Competitiveness and
  - STATEC (Service central de la statistique et des études économiques).

Members from both the working and the steering committee contributed to the discussions with their very valuable professional knowledge from diverse fields. Their contribution was indispensable for the preparation of this report.

The following chapter introduces the Ecological Footprint methodology and its applications in general to clarify what a country's Footprint represents.

### **3. Introduction to the Ecological Footprint Approach and its Application**

The current Ecological Footprint concept was formally introduced by Mathis Wackernagel and William Rees in the early 1990s [Kitzes et al., 2009a]. Mathis Wackernagel is today the Executive Director of the Global Footprint Network. In summary, the Ecological Footprint measures human consumption of products and services from different ecosystems in terms of the amount of bioproductive land and sea area needed to supply these products and services. In other words, the Ecological Footprint calculates the land area needed to feed, provide resources, produce energy, and absorb the pollution (CO<sub>2</sub> emissions) generated by our supply chains. As this land is today distributed around the world (i.e. products and services in Luxembourg are imported from all around the world), the figure is expressed in

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<sup>2</sup> During the first phase of the study, the working group met regularly once a month. In this phase the chapters 3 (general introduction to the Ecological Footprint methodology) and 4 (analysis of National Footprint Accounts 2008 and verification of the data) of the present report were elaborated. In the second phase, the illustration of Luxembourg's Footprint with respect to the share of the commuters on the total consumption and the impact of the fuel tourism was assessed (see chapter 5). In this phase, the meetings were less frequent.

global hectares (gha) [WWF, 2007], i.e., hectares of land normalized to the world average productivity.

The area of land or sea available to serve a particular use is called biocapacity, and represents the biosphere's ability to meet human demand for material consumption and waste disposal. In other words, the biocapacity represents the capacity of an area or ecosystem to generate an ongoing supply of resources and to absorb its waste (CO<sub>2</sub> emissions). Un-sustainability occurs if the ecological footprint, i.e. the demand on the system, exceeds its biocapacity.<sup>3</sup>

Currently, the Ecological Footprint and biocapacity calculations cover six land use types: cropland, grazing land, fishing grounds, forest land, built-up land and carbon uptake land. According to the 2008 edition of the National Footprint Accounts developed by the Global Footprint Network, humanity demanded the resources and services of 1.31 planets in 2005. This situation, in which total demand for goods and services exceeds the available supply, is known as overshoot. On the global scale, overshoot indicates that stocks of ecological capital are depleting or that waste (CO<sub>2</sub> emissions) is accumulating [Ewing et al., 2008].

The Global Footprint Network merchandises the National Footprint Accounts, necessary to calculate a country's Ecological Footprint and biocapacity. The National Footprint Accounts (NFA) 2008, Excel based templates, include roughly 5,400 data points and 10,000 calculations [Kitzes et al., 2008a]. It is therefore highly important to understand and to reproduce the exact calculation steps of a country's Ecological Footprint (EF). The preparation of easy-to-understand mind maps of the Footprint content (Figure 1 and Figure 2), and the connected calculations (Figure 3), was one of the first steps to get familiarized with the methodology. More comprehensive mind maps can be found in the detailed category analyses (see Chapter 4: Verification of the National Footprint Accounts 2008 for Luxembourg), the annexes (from A-2 to A-8) and are available at CRTE upon request.<sup>4</sup>

The most often reported type of Ecological Footprint is the Consumption Footprint.<sup>5</sup> It is the area needed to support a defined population's consumption. The Consumption Footprint (in gha) includes the area needed to produce the materials consumed and the area needed to absorb the waste (CO<sub>2</sub> emissions). In the National Footprint Accounts, the Consumption Footprint of a nation is calculated as the nation's production Footprint plus the Footprint of imports minus the Footprint of exports, and is thus, strictly speaking, a Footprint of apparent consumption.<sup>6</sup> The national average or per capita Consumption Footprint is equal to a country's Consumption Footprint divided by its population [GFN, 2009b].

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<sup>3</sup> www.science.org.au

<sup>4</sup> A detailed report including descriptions of the mind maps is available at CRTE upon request (cf. MEY, 2009).

<sup>5</sup> The Production, Imports and Exports Footprints could be additionally reported. As explained in the following, these footprints are parts of the Consumption Footprint: Consumption Footprint = Production Footprint + Imports Footprint – Exports Footprint.

<sup>6</sup> The intention is not to distinguish different uses for a good within a country, but only to infer the total that is used there for any purpose.

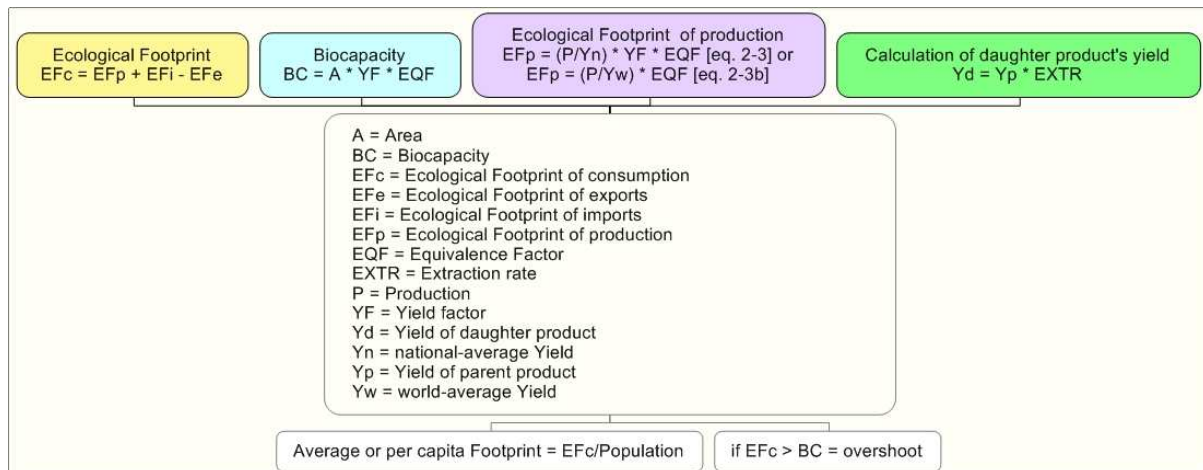


Figure 1: Ecological Footprint and Biocapacity equations

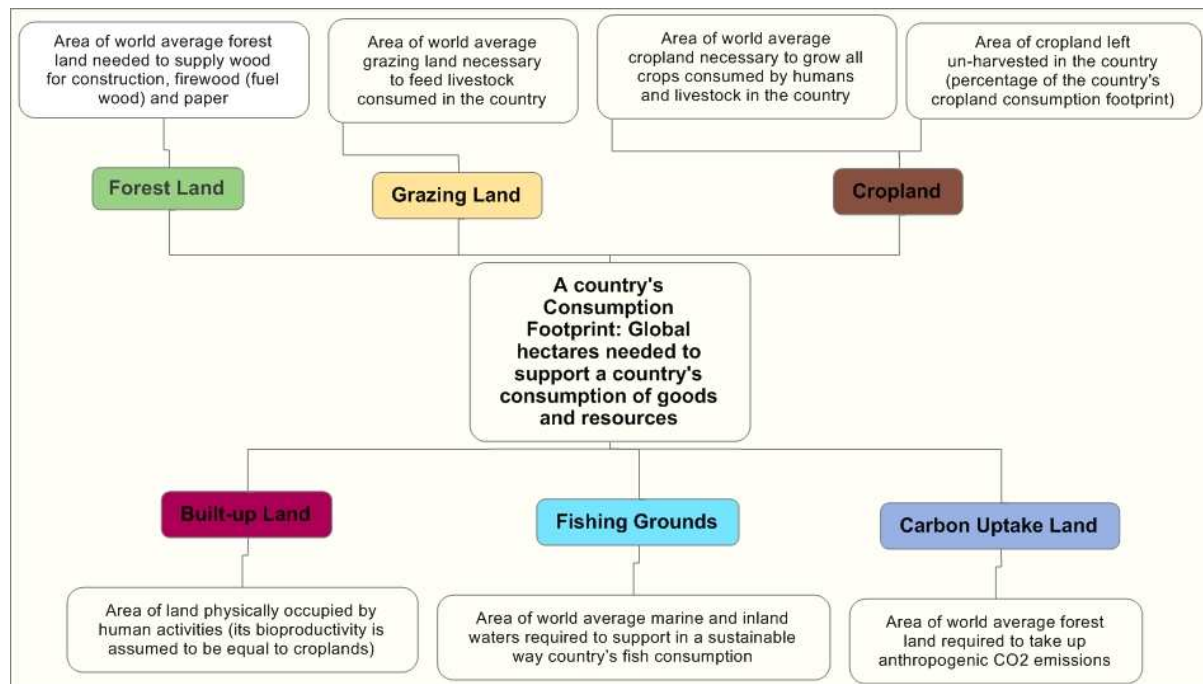


Figure 2: Extract of the Ecological Footprint Content Mind Map showing the composition of a country's Consumption Footprint

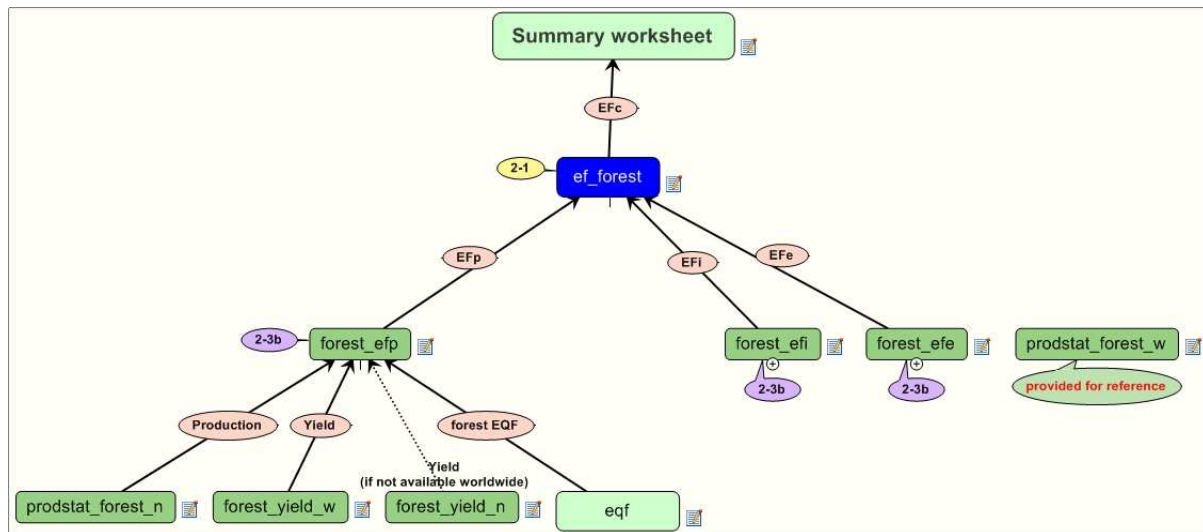


Figure 3: Example of the interrelations between Excel sheets for the Forest Production Footprint<sup>7</sup>

According to the Global Footprint Network, 201 countries were already analyzed in the National Footprint Accounts. These accounts were set up upon the initiative of the Global Footprint Network and are maintained and updated with the support of more than 100 partner organizations. The 2008 edition of the National Footprint Accounts calculates national footprints using database-supported excel templates and is described in the ‘*Guidebook to the National Footprint Accounts 2008*’ [Kitzes et al., 2008a]. A publication list by the Global Footprint Network can be found in the annexes (A-9) and gives a first overview on where to find appropriate information on the Ecological Footprint methodology.

In addition to documents provided by the Global Footprint Network, different studies on national Ecological Footprints and scientific papers on the methodology in general are available. A literature review, covering ten reports, could highlight some strengths and weaknesses of the Ecological Footprint methodology that are presented in the following. A summarizing table can be found in the annex A-10.<sup>8</sup> Among the studied reports are country studies from Germany and Switzerland, a DEFRA study (United Kingdom) and a report for the European Commission. Furthermore, Luxembourg’s project team built contacts with partners from Belgium and France to address further methodological issues.

The authors of the German country study, the European Commission report and the DEFRA study were particularly satisfied by the communication and education aspects of the Ecological Footprint. The translation of resource depletion into global hectares is easily communicable to the general public. Criticisms on the Ecological Footprint methodology concern the previous lack of transparency<sup>9</sup>, data quality

<sup>7</sup> The legend can be found in annex A-3.

<sup>8</sup> A more detailed report including a literary review on methodological strength and weaknesses is available at CRTE upon request (cf. MEY, 2009).

<sup>9</sup> In response to concerns about transparency, the release of the Global Footprint Network „National Footprint Accounts 2008“ edition includes a new modular excel file and supporting publications such as the Ecological Footprint Atlas [Ewing et al., 2008] and the Guidebook to the National Footprint Accounts: 2008 [Kitzes et al., 2008a].

requirements and the incompleteness of the considered environmental impacts. The Global Footprint Network is aware of these criticisms and put most of them on the research agenda for 2009 [Kitzes et al., 2009a].

Some of the above mentioned reports discuss the Ecological Footprint as an indicator for the assessment of national consumption trends or even for sustainable development [von Stokar et al., 2006; Giljum et al., 2008]. The Global Footprint Network is actively participating in this discussion and plans the institutionalization of the Ecological Footprint in at least ten key countries by 2015 ('ten in ten initiative'), with the hope of putting the use of the Ecological Footprint on par with the Gross Domestic Product (GDP) [Wackernagel et al., 2006]. At the moment, similar discussions are ongoing in Luxembourg. This topic will be further developed in the discussion part of this report (see Chapter 6: Transforming Luxembourg's Ecological Footprint based on the National Footprint Accounts into 'One Planet Luxembourg'?).

To this extend, a comprehensive analysis of the workforce from the neighboring countries was conducted as this helps to identify the amount of resources consumed and waste (CO<sub>2</sub> emissions) generated by non Luxembourg residents therefore allowing for a better estimation of the inhabitant's Footprint (see chapter 5.3.3 Inhabitants and Commuters Footprints).

In the following chapter, the existing National Footprint Accounts 2008 for Luxembourg, developed on the initiative of the Global Footprint Network, are analyzed, starting with an overview of the results, followed by a detailed comparison of (international) data sources used, an analysis of the data quality and a comparison with national data. The outcome of the verification of the National Footprint Accounts 2008 for Luxembourg are then presented and discussed in the 'Conclusion and Outlook Concerning the 2008 National Footprint Accounts for Luxembourg' part of this report (see chapter 4.2.7).

#### **4. Verification of the National Footprint Accounts 2008 for Luxembourg**

The verification of the National Footprint Accounts 2008 was carried out to identify possible data gaps in the Ecological Footprint and biocapacity calculations for Luxembourg provided by the Global Footprint Network. The outcome of this present study includes the data quality assessment and the identification of methodological issues which could be improved to develop a representative Ecological Footprint of Luxembourg's total consumption. This latest point is discussed in the 'Conclusion and Outlook Concerning the 2008 National Footprint Accounts for Luxembourg' as part of this report.

The calculations in the National Footprint Accounts are primarily based on international data sets published by the Food and Agriculture Organization of the United Nations (FAO ResourceSTAT Statistical Database 2007), the International Energy Agency (IEA 2006), the UN Statistics Division (UN Commodity Trade Statistics Database – UN Comtrade 2007), and the Intergovernmental Panel on Climate Change (IPCC 2006). Other data sources include studies in peer-reviewed scientific journals [Ewing et al., 2008]. The accuracy of Ecological Footprint analyses for a country greatly depends on the accuracy of these underlying data [Kitzes et al., 2009a].

As a first step, Luxembourg's biocapacity calculation based on land cover statistics is analyzed. Additionally to the Ecological Footprint, the 2008 National Footprint

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Accounts calculates Luxembourg's available area to supply national consumption (see Biocapacity and Land Use Statistics, chapter 4.1).

As a second step, the Ecological Footprint calculation provided by the Global Footprint Network is analyzed step by step. Luxembourg's Footprint is divided into six land use categories (forest land, cropland, grazing land, fishing grounds, built-up land, and carbon uptake land), which are described individually in the chapters 4.2.1 to 4.2.6.

The analyses of Luxembourg's biocapacity and Footprint both follow the same structure: CRTE analyzed the applied methodology, the data sources used, definitions and system boundaries of the applied statistics. The international data sources used by the Global Footprint Network (GFN) in the 2008 Accounts were identified in order to verify if these databases accurately reflect Luxembourg's statistics.

Then, nationally available statistics and data sources corresponding to the international databases used by the Global Footprint Network were identified. In order to clarify the reporting procedure for statistics from national to international bodies, and to make it transparent for others, a map was drawn up (see Figure 4). This map provides details on which ministries are in charge of collecting statistical data and who submits these data to the international databases.

Finally, both national and international data sets were compared and analyzed. A comparative analysis of international and Luxembourg's statistics for all data points was not feasible within the term of the study. Nevertheless, the most relevant categories were identified in cooperation with the members of the working group. In order to identify these categories, the following questions had to be addressed:

- How much does each category contribute to the Ecological Footprint of Luxembourg?
- Which products and inputs contribute the most to each category of the Footprint?

In order to enable a consistent data comparison, the analysis was conducted with data for Luxembourg from 2005, the reference year for the 2008 edition of the National Footprint Accounts. For the data comparison step, the products and inputs having the most significant influence on the respective land use category (forest land, cropland, grazing land, fishing grounds, built-up land, and carbon uptake land) were extracted from Luxembourg's 2008 National Footprint Accounts and analyzed. Similarly, the data comparison focused on the most relevant products within each category.

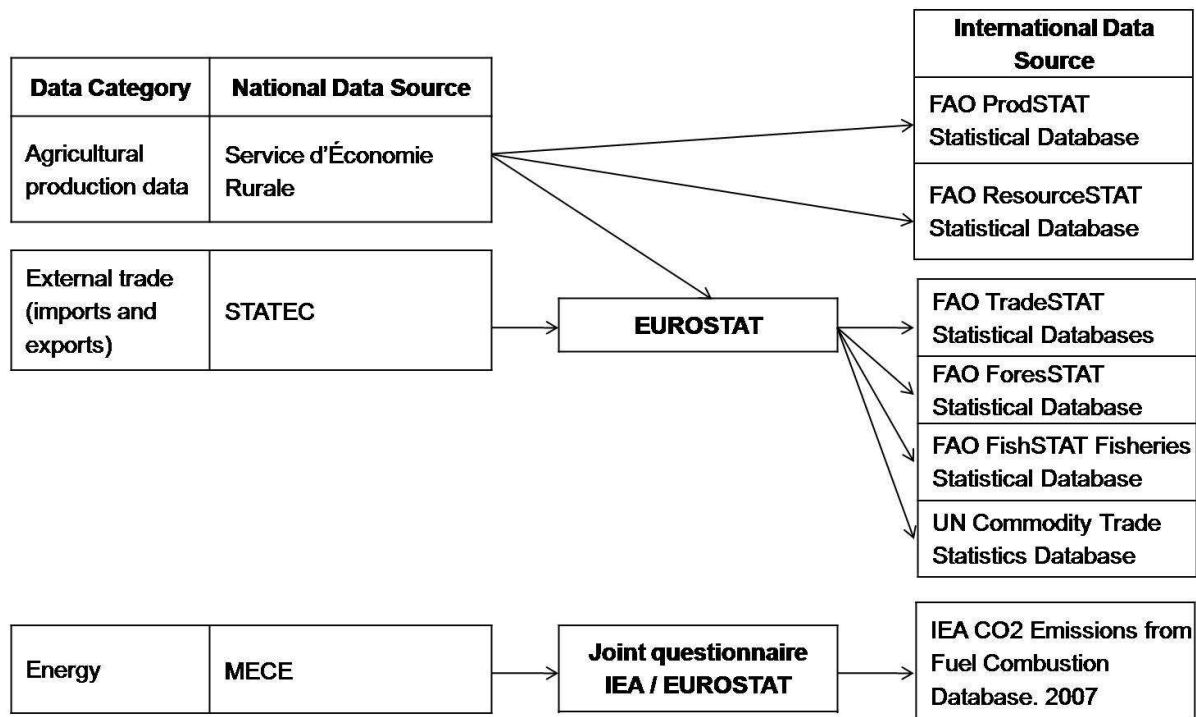


Figure 4: Data Reporting in Luxembourg

#### 4.1. Biocapacity and Land Use Statistics

Land use data are needed for estimating the available biocapacity within a country. The biocapacity has no direct influence on a country's Ecological Footprint (except for grazing land and built-up land). It expresses the capacity of ecosystems to produce biological materials and to absorb waste materials (e.g. CO<sub>2</sub> emissions) generated by humans, using current management schemes and extraction technologies [GFN, 2009b]. The biocapacity of an area is calculated by multiplying the actual physical area by a yield factor (YF) and an appropriate equivalence factor (EQF; see Figure 5). The equivalence factor is a scaling factor based on productivity and converts a specific land use type (such as cropland or grazing land) into a universal unit of biologically productive area, a global hectare. For land use types (e.g. cropland) with productivity higher than the average productivity of all biologically productive land and water areas on Earth, the equivalence factor is greater than 1. As an example, to convert an average hectare of cropland to global hectares, it is multiplied in the 2008 National Footprint Accounts by the cropland equivalence factor of 2.64 (see Figure 5). Pasture lands, which have lower productivity than cropland, have an equivalence factor of 0.5 [GFN, 2009b]. Dividing the total biocapacity by the inhabitants, gives the supply of biologically productive land per person in Luxembourg (see Table 8).

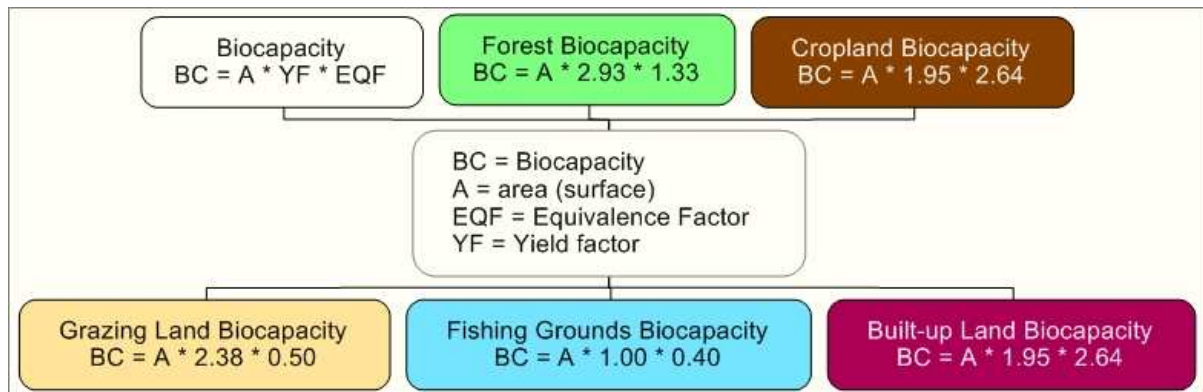


Figure 5: Biocapacity equations based on 2008 National Footprint Accounts factors<sup>10</sup>

#### 4.1.1. Database and Data Comparison

Different databases on land use statistics are available; the first data source used by Global Footprint Network in the 2008 National Footprint Accounts for Luxembourg is the Corine Land Cover database 2000. For calculating Luxembourg's biocapacity, international and national land cover data for Luxembourg were compared; the corresponding databases are listed in Table 1.

Table 1: Land Cover Databases

	Data used in the National Footprint Accounts 2008	Luxembourg data
<b>First data source</b>	Corine Land Cover 2000, European Topic Center on Land Use and Spatial Information, Barcelona: EIONET. <sup>11</sup>	Corine Land Cover 2000. European Topic Centre on Land Use and Spatial Information, 2000. Barcelona: EIONET (map projection done by CEPS-INSTEAD).
		Corine Land Cover 2006. European Topic Centre on Land Use and Spatial Information, 2006. Barcelona: EIONET (map projection done by the Ministry Sustainable Development and Infrastructures). <sup>12</sup>
		Service d'Économie Rurale (cropland and grazing land)
<b>Second data source</b>	FAO ResourceSTAT Statistical Database	-

In a first step, the comparison of international and national data included the verification of the land use categories used by Global Footprint Network according to the Corine land cover database 2000 and was made by the International Network for Studies in Technology, Environment, Alternatives and Development (CEPS-INSTEAD). The surface calculations by CEPS-INSTEAD only showed slight differences compared to the data used by Global Footprint Network (see Table 2).

<sup>10</sup> National forest Yield Factor (YF) based on 2009 National Footprint Accounts

<sup>11</sup> EIONET: European Environment Information and Observation Network

<sup>12</sup> Some technical details: Working scale: 1/1000000, i.e. 1500 standard map sheets produced using 10 different projection systems; Area of smallest mapping unit: 25 hectares; Projection: Gauss Luxembourg.

Table 2: Data Comparison of Land use statistics, according to GFN classification

Land type	Corine 2000 (used by GFN)	Corine 2000 (CEPS-INSTEAD, with GFN classification)	Difference
	Area [ha]		(%)
Cropland	24,121	23,627	-2
Grazing land	118,383	118,792	+0.4
Forest	90,908	90,935	-
Other wooded land	2,647	2,674	+1
Fishing grounds- inland waters	1,028	1,191	+16
Infrastructure	23,089	22,596	-2
<b>Total</b>	<b>260,176</b>	<b>259,815</b>	<b>-0.1</b>

The differences are probably due to different types of map projections in the geographic information system software and to the precision of the demarcation of the boundaries in the map background layer. The differences between the figures used by Global Footprint Network and by CEPS-INSTEAD account for overall 0.1% (see Table 2), when comparing the total amount of hectares.

As a second step, the land cover surfaces according to the Corine database versions of the years 2000 and 2006 were compared, in order to evaluate the evolution of the results (see Table 3). The classification of the land use categories used in the 2006 edition of Corine was determined by the Ministry of Sustainable Development and Infrastructures (MDDI) for the Greenhouse Gas National Inventory Report for Luxembourg for the period 1997-2007.

Table 3: Data Comparison of Land use statistics, according to Corine 2000 and Corine 2006

Land Type	Corine 2000 (used by GFN)	Corine 2006 (MDDI classification)	Difference
	Area [ha]		(%)
Cropland	24,121	80,074	+232
Grazing land	118,383	60,340	-49
Forest	90,908	93,617	+3
Other wooded land	2,647	577	-78
Fishing grounds - inland waters	1,028	1,016	-1
Infrastructure	23,089	24,089	+4
<b>Sum</b>	<b>260,176</b>	<b>259,713</b>	<b>-0.2</b>

It appears that the results cannot be directly compared, for classification reasons. Indeed, big differences occur for the land type categories of 'cropland' (+232%), 'grazing land' (-49%) and 'other wooded land' (-78%), as presented in Table 3. The Ministry of Sustainable Development and Infrastructures has affected the areas corresponding to the '241' and '242' types ('annual crops associated with permanent crops' and 'complex cultivation patterns') into 'cropland' areas, whereas the Global Footprint Network has affected these sub-categories to 'grazing land' (see Table 4).

Table 4: Different Land use categories of the Corine Land Cover database

Type	Legend Level 1	Legend Level 2	Legend Level 3
211	Agricultural areas	Arable land	Non-irrigated arable land
221	Agricultural areas	Permanent crops	Vineyards
231	Agricultural areas	Pastures	Pastures
241	Agricultural areas	Heterogeneous agricultural areas	Annual crops associated with permanent crops
242	Agricultural areas	Heterogeneous agricultural areas	Complex cultivation patterns
243	Agricultural areas	Heterogeneous agricultural areas	Land principally occupied by agriculture, with significant areas of natural vegetation

However, the classification made by the Ministry of Sustainable Development and Infrastructures appears to be more relevant since categories 241 and 242 are definitely more corresponding to cropland areas than to grazing land.

Table 5 shows a comparison between data provided by the Ministry of Sustainable Development and Infrastructures based on the 2006 version of the Corine database and a recalculation of the results for 2000 made by CEPS-INSTEAD using the classification of the Ministry of Sustainable Development and Infrastructures. Thus, a better comparison of the dynamics of the evolution is possible. The changes in the results based on the Ministry of Sustainable Development and Infrastructures classification, show that the surface of agricultural land has decreased between the 2000 and 2006 Corine database version (probably in favour of grazing land, which has increased during the same period). It also appears that some surfaces of the land classified as 'other wooded land' in the 2000 version has changed into 'forest' in the 2006 database version (see Table 5).

Table 5: Data Comparison of Corine Land use statistics, according to MDDI classification

Land Type	Corine 2000 (CEPS-INSTEAD, with MDDI classification)	Corine 2006 (MDDI classification)	Difference
	Area [ha]		[%]
Cropland	86,613	80,074	-7.6
Grazing land	55,805	60,340	+8.1
Forest	90,935	93,617	+2.9
Other wooded land	2,674	577	-78.4
Fishing grounds - inland waters	1,191	1,016	-14.7
Infrastructure	22,596	24,089	+6.6
<b>Sum</b>	<b>259,815</b>	<b>259,713</b>	<b>-0.1</b>

Additionally to land use data from the Corine Land Cover database based on satellite images, the Luxembourg's Ministry of the Agriculture (MA) and the Service d'Economie Rurale (SER) can provide statistics on the surfaces of cropland and grazing land in Luxembourg. It is assumed that these values, updated on a regular basis with surveys of Luxembourg's farmers, are of better quality than the Corine data.

Table 6: Data Comparison of Cropland and Grazing Land, according to national statistics and the Corine database

	Corine 2006 (MDDI classification)	MA / SER	Difference
Land Type	Area [ha]		[%]
Cropland	80,074	61,159	-31
Grazing land	60,340	78,796	+23
<b>Sum</b>	<b>140,414</b>	<b>139,955</b>	<b>-0.3</b>

Table 6 shows that the national statistics and the data based on satellite images only differ by 0.3%. Indeed, the differences in the classification of cropland and grazing land are respectively of -31% and +23%.

#### 4.1.2. Influence of National Data on Global Footprint Network Results

According to the National Footprint Accounts 2008, Global Footprint Network calculated for Luxembourg a total biocapacity of 386,515 gha, a per capita biocapacity of 0.83 gha<sup>13</sup> based on Corine 2000 land cover statistics (see Table 7). The verification of these values showed that the biocapacity of the forest land is missing in the overall results. Thus, the missing yield factor for forests was updated with a value from the 2009 version of the National Footprint Accounts for Luxembourg, leading to a total biocapacity of 741,472 gha, and a per capita value of 1.59 gha<sup>14</sup> (see Table 7).

Table 7: Luxembourg's biocapacity according to the 2008 National Footprint Accounts

	YF	EQF	Area	Biocapacity	
Land Category	[wha / nha]	[gha / wha]	[ha]	[gha]	[gha / capita]
Cropland	1.95	2.64	24,121	124,252	0.27
Grazing land	2.38	0.50	118,383	139,795	0.31
Other wooded land	2.38	0.50	2,647	3,126	0.00
Forest	2.93 <sup>15</sup>	1.33	90,908	354,957	0.76
Fishing grounds	1.00	0.40	1,028	408	0.00
Built-up land	1.95	2.64	23,089	118,934	0.25
<b>Sum (without forest BC)</b>			<b>169,268</b>	<b>386,515</b>	<b>0.83</b>
<b>Sum (with forest BC)</b>			<b>260,176</b>	<b>741,472</b>	<b>1.59</b>

The final recalculation of Luxembourg's biocapacity is based on cropland and grazing land statistics provided by the Ministry of the Agriculture / the Service d'Economie Rurale (Corine 2006 projections), and shows a result of 898,796 gha in total (see Table 8, for more details see chapter 4.1.1). This calculation of the

<sup>13</sup> Calculation based on 465,000 inhabitants (National Footprint Accounts 2008).

<sup>14</sup> Calculation based on 465,000 inhabitants (National Footprint Accounts 2008).

<sup>15</sup> National forest Yield Factor (YF) based on 2009 National Footprint Accounts

Luxembourg's biocapacity represents a per capita biocapacity of 1.91 gha<sup>16</sup> (see Table 8).

Table 8: Recalculation of Luxembourg's total Biocapacity

	YF	EQF	Luxembourg's recalculated biocapacity		
	[wha / nha] <sup>17</sup>	[gha / wha]	Area [ha]	BC [gha]	BC [gha/capita]*
Cropland	1.95	2.64	61,159	315,041	0.67
Grazing Land & other wooded land	2.38	0.50	79,373	93,729	0.20
Forest	2.93	1.33	93,617	365,534	0.78
Marine	-	0.40	-	-	-
Inland Water	1.00	0.40	1,016	404	0.00
Infrastructure	1.95	2.64	24,089	124,088	0.26
Hydro	1.00	1.00	-	-	-
<b>Sum</b>			<b>259,254</b>	<b>898,796</b>	<b>1.91</b>

NB: The areas of cropland and grazing land come from statistics provided by the Ministry of the Agriculture and the Service d'Economie Rurale; the areas of the other land categories are calculated with Corine 2006 based on the classification from the Ministry of Sustainable Development and Infrastructures.

\* Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31st of December 2005).

Compared to the results provided by the Global Footprint Network, Luxembourg's recalculated biocapacity increased by 133% from 386,515 gha to 898,796 gha (see Table 9). This important increase results primarily from the missing forest biocapacity in the 2008 NFA calculations and secondarily from the different classification of cropland and grazing land in the used Corine database (for more details see chapter 4.1.1).

Table 9: Biocapacity differences, according to NFA 2008 and Luxembourg specific calculations

	YF	EQF	NFA 2008	Luxembourg's recalculated biocapacity	Difference
Land Use Type	[wha / nha]	[gha / wha]	BC [gha]	BC [gha]	[%]
Cropland	1.95	2.64	124,252	315,041	+154
Grazing Land & other wooded land	2.38	0.50	142,921	93,729	-34
Forest	2.93 <sup>18</sup>	1.33	(354,957*)	365,534	(+3*)
Marine	-	0.40	-	-	-
Inland Water	1.00	0.40	408	404	-1
Infrastructure	1.95	2.64	118,934	124,088	+4
Hydro	1.00	1.00	-	-	-
<b>Sum</b>			<b>386,515**</b>	<b>898,796</b>	<b>+133**</b>

\* Luxembourg's forest biocapacity is missing in the 2008 National Footprint Accounts.

\*\* The 2008 National Footprint Accounts do not take into account Luxembourg's forest biocapacity.

<sup>16</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

<sup>17</sup> wha: world hectare / nha: national hectare

<sup>18</sup> National forest Yield Factor (YF) based on 2009 National Footprint Accounts

### 4.1.3. Conclusion

The authors of this report found out that the biocapacity for forest land is not calculated and not taken into account in the total supply of biologically productive land in the 2008 National Footprint Accounts for Luxembourg. A rough estimation of the influence on the total biocapacity in the 2008 National Footprint Accounts shows that the forest land in Luxembourg represents a biocapacity of 354,000<sup>19</sup> global hectares (see Table 7), which would increase the supply of bioproductive area in Luxembourg by 0.76 gha per capita of up to 1.6 gha per capita for year 2005.<sup>20</sup>

The use of more updated national land use statistics for the biocapacity assessment of Luxembourg compared to data used by Global Footprint Network is necessary to have a correct result for the total supply of bioproductive land. A country's biocapacity strongly depends on the soil classification, especially of cropland and grazing land and the availability of updated land use figures help biocapacity to be more robustly estimated. Thus, the biocapacity for Luxembourg was recalculated with following adaptations (see Table 8):

- the forest biocapacity was added;<sup>21</sup>
- the Ministry of the Agriculture / Service d'Économie Rurale data were used for cropland and grazing land (see Table 6);<sup>22</sup>
- the Corine 2006 database was used with the Ministry of Sustainable Development and Infrastructures classification for the land categories other wooded land, inland water areas and the infrastructures (see Table 3).

It appears that the recalculated biocapacity of Luxembourg increases in this case by 133% compared to the Global Footprint Network calculation of up to 898,796 gha in total and 1.91 gha per capita (see Table 8), highly dominated by the natural resources from forest land (41%) and cropland (35%; see Figure 6). The authors of this report recommend using the values presented in Table 8 'Recalculation of Luxembourg's total Biocapacity' for further communications on Luxembourg's biocapacity (see additionally chapter 5 'Luxembourg's Biocapacity and Footprint calculation based on national data'). Nevertheless, Global Footprint will continue to base the biocapacity calculation on the level one Corine 2000 database classification (see Table 4).

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<sup>19</sup> A missing national forest Yield Factor (YF) based on 2009 National Footprint Accounts was added.

<sup>20</sup> Calculation based on 465,000 inhabitants (National Footprint Accounts 2008) and Corine 2000 data used by Global Footprint Network.

<sup>21</sup> National forest Yield Factor (YF) based on 2009 National Footprint Accounts

<sup>22</sup> Approximately 5% of the agricultural surfaces and approximately 3% of the grazing land considered in the national statistics on cropland and grazing land, respectively, are located in the neighbouring countries of Luxembourg (Belgium, France and Germany). (source: Service d'Économie Rurale, M. Pierre Treinen)

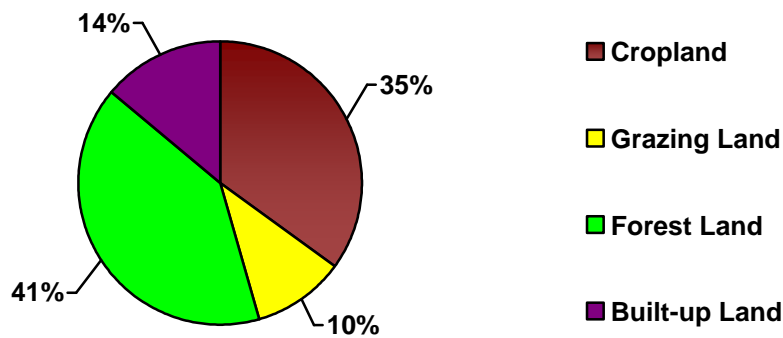


Figure 6: Composition of Luxembourg's Recalculated Biocapacity by land use categories

In addition to the biologically productive area, the biocapacity, the 2008 National Footprint Accounts provide Luxembourg's Ecological Footprint. This Consumption Footprint is detailed in the following chapter of the present report, dealing with the calculation methodology, assessment of data used by Global Footprint Network and the influence of the 2008 National Footprint Accounts results for Luxembourg when using national available data (see chapter 4.2).

## 4.2. The Ecological Footprint of Luxembourg by Global Footprint Network

Luxembourg's total Consumption Footprint is based on the 2008 National Footprint Accounts (NFA)<sup>23</sup> provided by Global Footprint Network and represents 5,549,008<sup>24</sup> global hectares (gha) and a per capita Consumption Footprint of 11.83<sup>25</sup> gha with the following composition (or see Figure 7):

- Carbon uptake land: 85%;
- Cropland: 7%;
- Forest land: 4%;
- Grazing land: 1%;
- Built-up land: 2%;
- Fishing grounds: 1%.

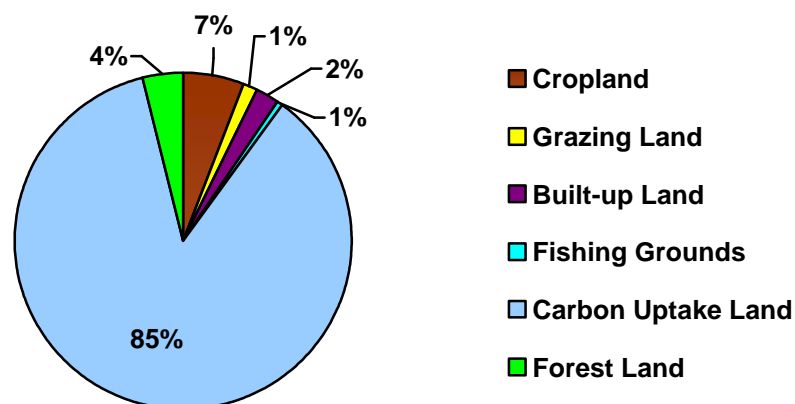


Figure 7: Composition of Luxembourg's Ecological Footprint by land use categories

Additionally to the Ecological Footprint, Luxembourg's biocapacity, the available area to supply national consumption, is calculated: 898,796 gha or 1.9 gha per person.<sup>26</sup> The biocapacity calculation is based on land cover statistics (see chapter 4.1 for more details). At global level, approximately, 2 gha of biocapacity are available per person. Dividing Luxembourg's Footprint per person by the available biocapacity per person at global level, translates the number of planets necessary if everyone on Earth lived like Luxembourg. In this latter case, 5.7 planets would be needed.

The six categories of the Ecological Footprint are individually described in the following paragraphs, as well as the land cover statistics used as reference. They are analyzed in detail, starting with a database and data comparison, including an analysis of the detected differences in the data. Finally, conclusions concerning the data quality in Luxembourg and the identification of relevant aspects for an

<sup>23</sup> The calculation is based on statistics for the year 2005.

<sup>24</sup> National forest Yield Factor (YF) based on 2009 National Footprint Accounts

<sup>25</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

<sup>26</sup> Biocapacity calculation based on 2008 NFA; national forest Yield Factor (YF) based on 2009 National Footprint Accounts; per capita calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

illustration of the footprint results with respect to national particularities (see chapter 5 Luxembourg's Biocapacity and Footprint calculation based on national data).

#### 4.2.1. Built-Up Land

The Ecological Footprint of built-up land refers to the bioproductive land physically occupied by human activities, settlements, infrastructures and areas associated with hydroelectric energy generation. It is assumed by the 2008 National Footprint Accounts that human settlement and infrastructure generally occupy agriculturally fertile regions. The biocapacity of built-up land per hectare is by default considered to be equal to cropland. In Luxembourg, the built-up area accounts for 2% of the total Consumption Ecological Footprint.

It can be assumed that in Luxembourg, some built-up areas are not located on bioproductive land; e.g. the total area of 762 ha of waste land ('friches'). A map of these areas is added in the annexes (see A-12 Waste Land in Luxembourg). After discussions with Global Footprint Network, it was decided not to substitute the area of waste land from the bioproductive land in order to be coherent with the methodology.

##### 4.2.1.1. Database, Data Comparison and Influence of National Data on Global Footprint Network Results

The built-up lands, i.e. the artificial surfaces, are calculated using the Corine land cover database. The compared and analyzed international and national databases on land use statistics are the same as in the previous chapter 4.1 on 'Biocapacity and Land Use Statistics' (Table 1). General differences between the map projections done by the Global Footprint Network and CEPS-INSTEAD, as well as between the 2000 and 2006 databases were already discussed in the previous chapter. With a special focus on the land use category 'artificial surfaces', the map projections of the Corine land cover database 2000 used by Global Footprint Network and by CEPS-INSTEAD show only a slight difference of 2% (see Table 10). Furthermore, between the years 2000 and 2006, the artificial surfaces in Luxembourg grew by 1,000 hectares (4%).

Table 10: Data Comparison for Built-up Land (land use statistics)

	Area of artificial surfaces [ha]	Difference [%]	
Corine 2000 (used by GFN)	23,089	2.1	-
Corine 2000 (CEPS-INSTEAD)	22,596		
Corine 2006 (MDDI classification)	24,089	-	4

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#### 4.2.1.2. Conclusion

From the 2000 Corine land cover database to the 2006 database edition, the built-up area in Luxembourg increased by 1,000 hectares for the year 2005, due to different types of map projections in the geographic information system software and to the precision of the demarcation of the boundaries in the map background layer (see chapter 4.1 on Biocapacity and Land Use Statistics). Consequently, the area of (an)other land use type(s) should be reduced. As mentioned in the previous chapter on 'Biocapacity and Land Use Statistics' (chapter 4.1), the land cover statistics are also used for calculating the biocapacity of Luxembourg. As by default, the built-up area is considered to be equal to cropland, the total biocapacity of Luxembourg will not change, when former agricultural areas are converted into settlements.

In Luxembourg, the conversion of former industrial sites into 'upgraded' areas useable for housing, research and commercial activities is an important issue because the available land in the country is limited. The population density and the land prices are increasing in parallel. However, the current 2008 National Footprint Accounts methodology would not reflect the reconversion of former industrial sites to new uses. If the Ecological Footprint had to show these conversions in land use change, the land cover statistics for Luxembourg would have to be more detailed.

## 4.2.2. Forest Land

The forest land Footprint assesses human demand for the regenerative capacity of the world's forests. It represents the area of world average forest land needed to supply wood for construction, fuel and paper (see annex A-4) [GFN, 2009b]. The forest land Footprint consists of two broad types of primary products:<sup>27</sup> wood used as a fuel and timber used as a raw material to produce secondary<sup>28</sup> timber products (for more details see Figure 8).

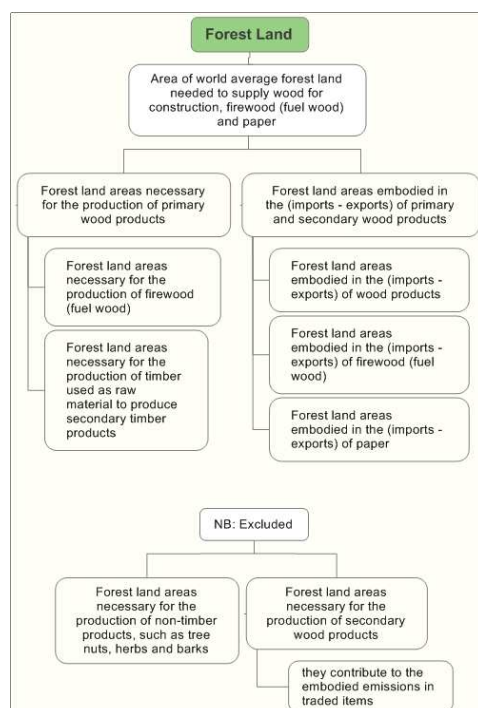


Figure 8: Composition of the forest land category

To calculate the Ecological Footprint of forest products, timber harvests are compared against the net annual growth rates of the world's forests [GFN, 2009b]; in Luxembourg the forest Footprint accounts for 4% of the total Consumption Footprint. Non-timber products such as tree nuts, herbs and bark are not at all considered in the Ecological Footprint calculations. To avoid double counting the consumption of timber used as raw material to produce secondary wood products (e.g. particle boards) are not considered in the forest land Footprint, they contribute to the Footprint of traded items, where the embodied energy<sup>29</sup> is considered and contribute to the carbon uptake land Footprint.

<sup>27</sup> Primary products are raw materials that are 'extracted' from the land or ocean and include products of mining, agriculture, forestry and fisheries. These goods are either sold as is or used as raw materials in processing or manufacturing (Land Information New Zealand: [www.linz.govt.nz](http://www.linz.govt.nz)).

<sup>28</sup> Secondary products are processed or manufactured from primary products.

<sup>29</sup> See for more details the Glossary.

#### 4.2.2.1. Database and Data Comparison

For the calculation of the Ecological Footprint of forest products, production and trade statistics are taken into account. Table 11 gives an overview of the compared international and national databases.

Table 11: Databases for Forest Land

	Data used in the National Footprint Accounts 2008	Luxembourg data
Production data	FAO ForesSTAT Statistical Database	Statistics are not available by now
Imports and exports		Luxembourg's external trade statistics (STATEC)

The data comparison of produced and traded forest products includes 30 different products, including 11 primary forest products, 2 fuel wood products and 17 secondary products (summary: Table 12, exhaustive list: A-11). Regarding import and export data, the comparison of international and national databases shows data inconsistencies which are related (a) to different product classification schemes and (b) to different units. In fact, the 2008 National Footprint Accounts use statistics from the Food and Agriculture Organization of the United Nations (FAO) based on a code system which is not identical to the CTCI 5 scheme used in Luxembourg's external trade statistics. In addition, FAO expresses wood products in cubic meters and paper products in tonnes, compared to Luxembourg's external trade statistics, which are completely in tonnes.

Table 12: Data comparison for Forest Products (summary)

	Production 2005		Imports 2005		Exports 2005	
	[m <sup>3</sup> /yr]	[t/yr]	[m <sup>3</sup> /yr]* or [t/yr]**	[t/yr]	[m <sup>3</sup> /yr]* or [t/yr]**	[t/yr]
	Int. Data	LU Data	Int. Data	LU Data	Int. Data	LU Data
C: conifer NC: non-conifer						
Wood Fuel	12,764	data not available	345*	877	58,000*	41,509
Saw logs + Veneer Logs (C)	75,504		-	-	-	-
Pulpwood, Round & Split (C)	8,787		-	-	-	-
Pulpwood, Round & Split (NC)	112,814		-	-	-	-
Saw logs + Veneer Logs (NC)	60,878		-	-	-	-
Pulpwood + Particles (C)			-	179,341	-	99,034
Other Industrial Round Wood (C)	5,870		-	-	-	-
Industrial Round Wood Wir (C)			312,765*	594,162	264,250*	121,320
Industrial Round Wood Wir (NC)			92,380*	257,235	27,747*	16,306
Sawn Wood (C)	113,000		43,838*	25,263	50,122*	20,612
Sawn Wood (NC)	20,000		14,237*	15,561	4,844*	58,572
Plywood			11,340*	7,727	148*	133
Particle Board	200,000		23,690*	8,129	209,347*	108,723
Hardboard			4,897*	-	1,511*	-
MDF	250,000		4,171*	-	3,053*	-
Fiberboard, Compressed			-	10,254	-	112,806
Insulating Board			5,557*	-	170,766*	-
Wood Charcoal			1,335*	1,225	15*	23
Newsprint			10,901**	13,835	40**	-
Printing + Writing Paper			93,739**	93,731	8,494**	4,625
Other Paper + Paperboard		91,221**	114,239	31,874**	140,211	
<b>Sources:</b>						
Int.: FAO ForesSTAT Statistical Database: <a href="http://faostat.fao.org/site/626/default.aspx#ancor">http://faostat.fao.org/site/626/default.aspx#ancor</a>						
LU: STATEC: Luxembourg's external trade statistics (provided by STATEC on request)						

#### 4.2.2.2. Influence of National Data on Global Footprint Network Results

No analysis of the influence of national data on the Global Footprint Network results could be conducted, due to (i) incompatible product classification schemes and units in the international and national databases concerning import and export statistics, and (ii) unavailability of Luxembourg's production data. Such an analysis is only feasible when data is available in comparable statistical units.

### 4.2.2.3. Conclusion

A more detailed data analysis should be conducted to get a more precise view on the data quality. This present study only covers a rough data comparison in order to detect major data gaps and issues, which require further research. In fact, the recalculation of the forest land Consumption Footprint with the values provided by STATEC is of interest in order to identify the impacts of the forest sector on the total Consumption Footprint of Luxembourg.

### 4.2.3. Cropland

The Footprint of cropland represents the land area needed to grow crops consumed in the following by humans and livestock (see Figure 9): primary, secondary and tertiary agricultural products consumed in Luxembourg; crops and agricultural products needed to feed livestock. In addition, the cropland Footprint accounts the area left un-harvested.

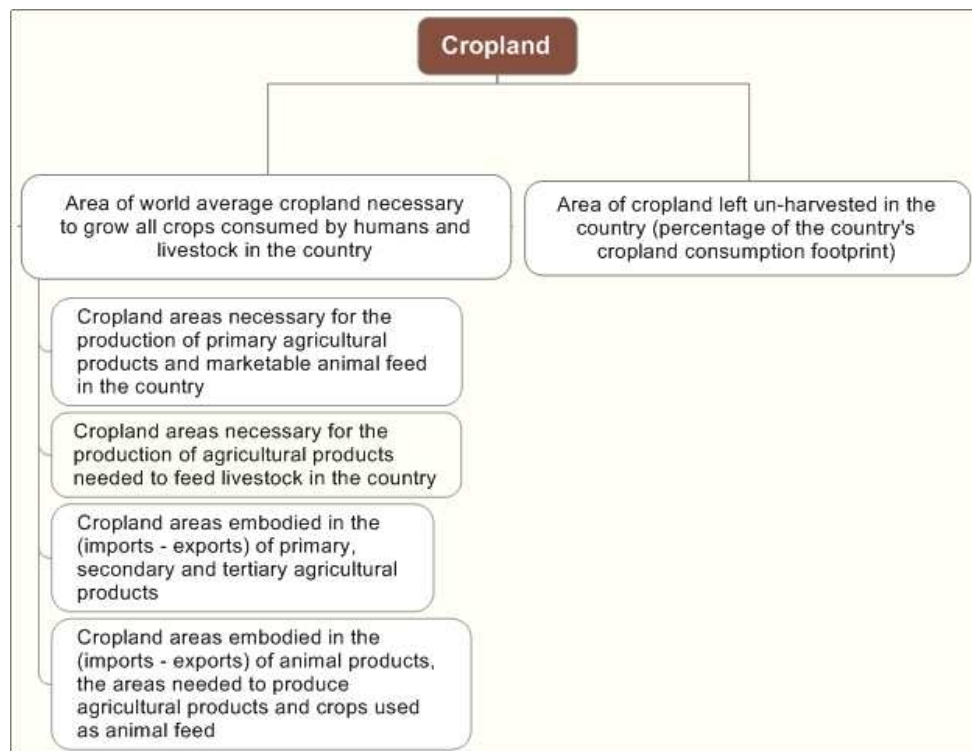


Figure 9: Composition of the cropland category

The 2008 National Footprint Accounts include over 140 crops (primary products) and 29 secondary, respectively tertiary products. Additionally, the cropland Footprint considers the quantity of each product allocated to feed, seed, waste, processing, and non-food uses [Kitzes et al., 2008a]. The cropland Footprint accounts for 7% of Luxembourg's total Consumption Footprint.

#### 4.2.3.1. Database and Data Comparison

To calculate the Ecological Footprint of cropland, production and trade statistics for agricultural and animal products, as well as statistics on livestock, are taken into account. Table 13 gives an overview of the compared international and national databases.

Table 13: Databases used for the Cropland Category

	Data used in the National Footprint Accounts 2008	Luxembourg data
<b>Production data crops and animal products</b>	FAO ProdSTAT Statistical Database	Service d'Économie Rurale
<b>Livestock data</b>	FAO ResourceSTAT Statistical Database	
<b>Imports and exports</b>	FAO TradeSTAT Statistical Databases	Luxembourg's external trade statistics (STATEC)

In the following text, only the most relevant products in terms of their contribution to the Ecological Footprint will be assessed in detail. These are wheat, barley, maize for forage and silage, rapeseed, triticale and oats for their contribution to the national production<sup>30</sup> and soybean cake, shelled cashew nuts, linseed, pastry, virgin olive oil, unprocessed tobacco and wine for their contribution to the trades (see Table 14).

Generally, the international data and Luxembourg's data are consistent with each other. One difference arises from the fact that the national data on crops for forage and silage are expressed in wet matter while the international data is expressed in dry matter. Other inconsistencies could be due to different classification schemes. In fact, the 2008 National Footprint Accounts use statistics from the Food and Agriculture Organization of the United Nations (FAO) based on a code system which is not identical to the CTCI 5 scheme used in the Luxembourg's external trade statistics.

<sup>30</sup> Wine is considered a secondary product and does not contribute to the national production.

Table 14: Data Comparison for Cropland: International and National Databases

	Data source (int. and LU)	Production 2005 (t/yr)		Imports 2005 (t/yr)		Exports 2005 (t/yr)	
		Int. Data	LU Data	Int. Data	LU Data	Int. Data	LU Data
<b>Wheat</b>	Int: FAO [1], [3]; LU: SER [2], [4]	71,745	71,745	27,674	25,464	25,024	25,206
<b>Barley</b>	Int: FAO [1], [3]; LU: SER [2], [4]	52,853	52,853	7,531	7,609	15,401	16,774
<b>Maize for forage and silage</b>	Int: FAO [1]; LU: SER [2]	515,000	184,719*	-	-	-	-
<b>Rapeseed</b>	Int: FAO [1], [3]; LU: SER [2], [4]	14,704	14,704	2,290	1,795	5,005	5,063
<b>Triticale</b>	Int: FAO [1], [3]; LU: SER [2], [4]	18,530	18,530	-	-	3,899	3,899
<b>Oats</b>	Int: FAO [1], [3]; LU: SER [2], [4]	7,734	7,734	507	498	4,368	5,602
<b>Cake of Soybeans</b>	Int: FAO [3]; LU: [4]	-	-	21,578	22,746	2,410	2,373
<b>Cashew nuts shelled</b>	Int: FAO [3]; LU: [4]	-	-	1,607	2,847	-	-
<b>Linseed</b>	Int: FAO [3]; LU: [4]	-	-	2,359	237	-	-
<b>Pastry</b>	Int: FAO [3]; LU: [4]	-	-	9,317	6,582	2,726	1,427
<b>Olive oil, virgin</b>	Int: FAO [3]; LU: [4]	-	-	870	1'690	-	-
<b>Tobacco, unmanufactur ed</b>	Int: FAO [3]; LU: [4]	-	-	12,715	5,622	499	523
<b>Wine</b>	Int: FAO [1], [3]; LU: SER [5]	13,537	13,537	18,459	24,881	4,755	4,138

**Sources:**

[1] FAO ProdSTAT Statistical Database: <http://faostat.fao.org/site/526/default.aspx>

[2] SER: [http://www.ser.public.lu/statistik/pflanz\\_produktion/mengen\\_marktfruchtbau.pdf](http://www.ser.public.lu/statistik/pflanz_produktion/mengen_marktfruchtbau.pdf)

[3] FAO TradeSTAT Statistical Databases: <http://faostat.fao.org/site/535/DesktopDefault.aspx>

[4] STATEC: Luxembourg's external trade statistics (provided by STATEC on request)

[5] SER: [http://www.ser.public.lu/statistik/pflanz\\_produktion/mengen\\_weinbau.pdf](http://www.ser.public.lu/statistik/pflanz_produktion/mengen_weinbau.pdf)

\* Int. Data in t wet matter/yr, LU data in t dry matter/yr; 515,000 t wet matter/ha

#### 4.2.3.2. Influence of National Data on Global Footprint Network Results

Concerning the import and export statistics taken into account in the Footprint calculations of the Global Footprint Network, the 2008 National Footprint Accounts are based on rounded values<sup>31</sup> (see Table 15). These rounded values come from the detailed statistics provided by the Food and Agriculture Organization of the United Nations (FAO) and are presented in Table 15. It would be possible to recalculate the Footprint in the cropland category with the exact external trade data provided (a) by FAO and (b) by STATEC. It is likely that the use of the detailed FAO values, instead of the rounded values, would have no remarkable influence on Luxembourg's Footprint. The national data by STATEC could indeed substantially influence the results, but it is unlikely that they would change the 7% influence of the cropland category on the Luxembourg's Footprint.

Table 15: Luxembourg's Import and Export Data used for the Calculation in the NFA 2008

Products [-]	Imports (NFA 2008) [t / year]	Exports (NFA 2008) [t / year]
Wheat	28,000	30,000
Barley	8,000	15,000
Maize for forage and silage	-	-
Rapeseed	2,000	18,000
Triticale	-	-
Oats	1,000	4,000
Cake of soybeans	22,000	2,000
Cashew nuts shelled	2,000	-
Linseed	2,000	-
Pastry	9,000	3,000
Olive oil, virgin	1,000	-
Tobacco, unmanufactured	13,000	1,000
Wine	18,000	5,000

#### 4.2.3.3. Conclusion

The international statistics correspond relatively well to Luxembourg's statistics in the cropland category concerning agricultural products. The statistics provided by the Food and Agriculture Organization of the United Nations (FAO) and the national body 'Service d'Économie Rurale' (SER) on production volumes are matching very well. This present study only covers a rough data comparison of the most influential products on the cropland Footprint in order to detect possible data gaps and issues, which require further research. In a follow-up project, a further analysis of data inconsistencies in the international and national trade statistics could be done.

<sup>31</sup> The TradeSTAT section of the FAOSTAT website has been modified and updated by FAO recently and after the publication of the NFA. The defined 'rounded values' were not rounded by Global Footprint Network but actually provided in such format by FAOSTAT in the previous version of the web-site. The new exact data will be used in the 2009 edition of the National Footprint Accounts.

Although, it is unlikely that possible inconsistencies between international and national data would strongly change the 7% influence of the cropland category on Luxembourg's Footprint.

#### 4.2.4. Grazing Land

The Footprint of grazing land represents the area needed to produce pasture to feed livestock raised in Luxembourg and the area needed to produce pasture embodied in animal products consumed in Luxembourg (see Figure 10). In the grazing land Footprint, the area needed to produce pasture represents the available area for pasture production in Luxembourg and does not represent the theoretical pasture demand of livestock raised in Luxembourg. Compared to Luxembourg's pasture production (94,000 gha), the embodied grazing land in the imports is negligible because the exports are higher (75,000 gha) than the imports (64,000 gha).<sup>32</sup> The influence of the grazing land on Luxembourg's Consumption Footprint is about 1%.

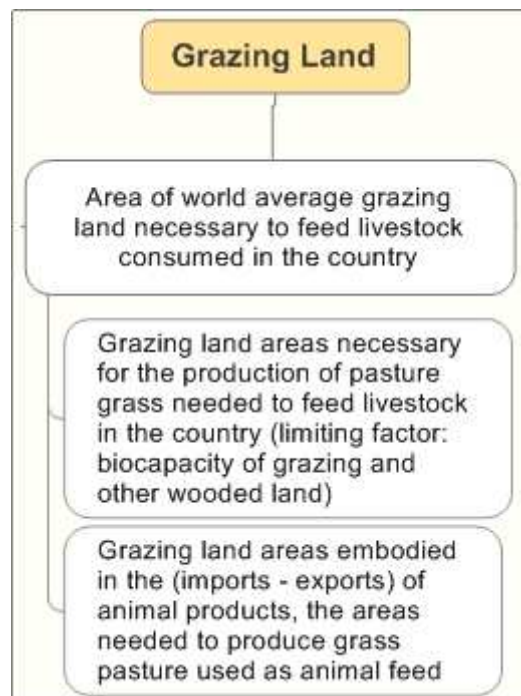


Figure 10: Composition of the grazing land category

##### 4.2.4.1. Database and Data Comparison

For the calculation of the Ecological Footprint of grazing land, production and trade statistics for animal products and statistics on livestock are taken into account additionally to land use statistics. Table 16 gives an overview of the compared international and national databases.

<sup>32</sup> The Consumption Footprint of grazing land = production + imports – exports = 93,729 gha + 64,295 gha – 75,118 gha = 82,906 gha

Table 16: Databases used for the grazing land category

	Data used in the National Footprint Accounts 2008	Luxembourg data
<b>Production data animal products</b>	FAO ProdSTAT Statistical Database	Service d'Économie Rurale
<b>Livestock data</b>	FAO ResourceSTAT Statistical Database	
<b>Imports and exports</b>	FAO TradeSTAT Statistical Databases	Luxembourg's external trade statistics (STATEC)
<b>Land use</b>	Corine Land Cover 2000. European Topic Centre on Land Use and Spatial Information, 2000. Barcelona: EIONET	Ministry of Agriculture
		Service d'Economie Rurale
		Corine Land Cover 2006. European Topic Centre on Land Use and Spatial Information, 2006. Barcelona: EIONET (map projection done by the Ministry Sustainable Development and Infrastructures).

Luxembourg's grazing land Footprint is mainly based on the land use statistics. In coherence with Luxembourg's biocapacity calculation, nationally available land use statistics provided by the Ministry of the Agriculture (MA) and the Service d'Économie Rurale (SER) are used to calculate the grazing land Footprint (for more details, see chapter 4.1 on 'Biocapacity and Land Use Statistics'). Actually, the grazing land Footprint includes the land area categories 'Pastures and Heterogeneous agricultural areas' and 'Scrub and/or herbaceous vegetation associations'. These surfaces are then multiplied by the yield factor and the equivalence factor for grazing land, both provided by the 2008 National Footprint Accounts.

The grazing lands embodied in imports and exports have only a minor influence on the total grazing land Footprint. The comparison of international and national external trade statistics has therefore not been carried out in this present study.

Compared to the land use statistics used in the 2008 National Footprint Accounts, a decrease of 34% of the grazing land areas can be observed (see Table 17).

Table 17: Data Comparison for Grazing Land (land use statistics)

	NFA 2008	National Statistics	Difference
	Area [ha]		[%]
<b>Pastures + Heterogeneous agricultural areas</b>	118,383	78,796 <sup>33</sup>	-33
<b>Scrub and/or herbaceous vegetation associations</b>	2,647	577 <sup>34</sup>	-78
<b>Sum</b>	<b>121,030</b>	<b>79,373</b>	<b>-34</b>

<sup>33</sup> Grazing land statistics provided by the Ministry of the Agriculture (MA) and the Service d'Économie Rurale (SER)

<sup>34</sup> 'Other wooded land' area calculated based on Corine 2006 according to MDDI classification

#### 4.2.4.2. Influence of National Data on Global Footprint Network Results

Using the nationally available statistics, the grazing land Footprint of Luxembourg decreases by 37% from 132,000 to 83,000 global hectares compared to the 2008 National Footprint Accounts. Luxembourg's Consumption Footprint decreased in total by 1%.

#### 4.2.4.3. Conclusion

The assessment of Luxembourg's biocapacity based on nationally available statistics has an indirect influence on Luxembourg's Grazing Land Footprint. National statistics show a decrease by 34% of the grazing land area in Luxembourg compared to the 2008 National Footprint Accounts. Finally, Luxembourg's Consumption Footprint based on national land use statistics decreased by 1% in total; the impact of the grazing land category decreased from 2% to 1%.

#### 4.2.5. Fishing Grounds

The Footprint of fishing grounds represents the area to support a country's consumption of marine and inland water fish species in a sustainable way (see Figure 11). For Luxembourg, the production is equal to zero. Hence, the total fishing grounds Footprint expresses the area embodied in the difference between imports and exports. It accounts for 1% of Luxembourg's Consumption Footprint.



Figure 11: Composition of the fishing grounds category

#### 4.2.5.1. Database and Data Comparison

To calculate the Ecological Footprint of fishing grounds, production and trade statistics for fisheries are taken into account. Table 18 gives an overview of the compared international and national databases.

Table 18: Databases used for Fishing Grounds

	Data used in the National Footprint Accounts 2008	Luxembourg data
Trade statistics	FAO FishSTAT Fisheries Statistical Database	Luxembourg's external trade statistics (STATEC)

Only the eight major fish products in terms of their contribution to the Ecological Footprint are assessed in detail (see Table 19). Their contribution to the total fishing grounds Footprint is about 76%.

Generally, international and national data are matching well for this category. Inconsistencies can be linked to different classification schemes. The 2008 National Footprint Accounts use statistics from the Food and Agriculture Organization of the United Nations (FAO) based on a code system which is not identical to the CTCI 5 scheme used in Luxembourg's external trade statistics.

Table 19: Data Comparison for Fishing Grounds (trade statistics)

	Imports 2005 (t/yr)		Exports 2005 (t/yr)	
	Int. Data	LU Data	Int. Data	LU Data
Fresh or chilled fillets and other fish meat, whether minced or not	1,364	1,204	683	345
Other freshwater and saltwater fish, fresh or chilled	826	990	49	45
Fish fillets, frozen	367	574	185	209
Salmon ( <i>Oncorhynchus spp.</i> , <i>Salmo salar</i> , <i>Hucho hucho</i> ), fresh or chilled	331	777	36	35
Salmon, prepared or preserved	189		1	
Salmon, including fillets, smoked	166		9	
Cod ( <i>Gadus spp.</i> ), dried, whether salted or not, but not smoked	143	149	1	2
Skipjack or stripe-bellied bonito, frozen	69	46	-	-

**Sources:**

Int.: FAO FishSTAT Fisheries Statistical Database.: <http://www.fao.org/fishery/figis>

LU: STATEC: Luxembourg's external trade statistics (provided by STATEC on request)

#### 4.2.5.2. Influence of National Data on Global Footprint Network Results

Using national data for the most strongly contributing fish species (see categories in Table 19), the fishing grounds consumption Footprint would decrease by 10% from 28,900 gha to 26,100 gha.

#### 4.2.5.3. Conclusion

The international statistic match Luxembourg's statistics relatively well in the fishing grounds category. Investigating this category in more detail is not of great interest, due to its small contribution of about 1% to Luxembourg's Footprint.

#### 4.2.6. Carbon Uptake Land

The carbon uptake land Footprint represents the area of forest land required to take up anthropogenic carbon dioxide emissions thus avoiding accumulation phenomena in the atmosphere. The Footprint of carbon uptake land takes into account carbon dioxide emissions from several sources: domestic fossil fuel combustion, embodied emissions<sup>35</sup> in traded items, and a country's share on global international transport emissions (see Figure 12) [Kitzes et al., 2008a].

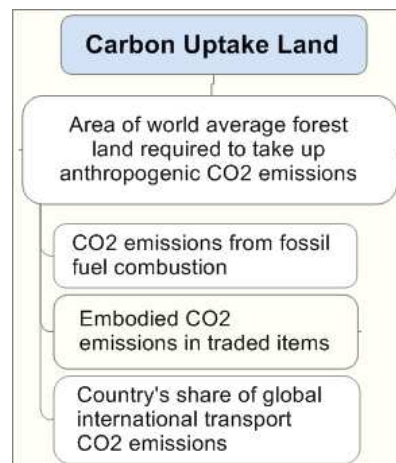


Figure 12: Composition of the carbon uptake land category

The carbon uptake land accounts for 85% of Luxembourg's Footprint calculated in the 2008 National Footprint Accounts provided by the Global Footprint Network. It can be split into three further subcategories: The Footprint of fossil fuel combustion accounts for 57%, the country's share on global transport emissions for 2%, and the embodied emissions in traded items accounts for 26% of Luxembourg's Consumption Footprint.

##### 4.2.6.1. Database and Data Comparison

Different databases are taken into account to calculate the carbon uptake land Consumption Footprint. International data and national data were compared; the databases are listed in Table 20.

<sup>35</sup> In this report often mentioned as 'embodied energy' (see A-1 Glossary).

Table 20: Databases for Carbon Uptake Land

	<b>Data used in the National Footprint Accounts 2008</b>	<b>Luxembourg data</b>
<b>Fossil fuel combustion data (CO<sub>2</sub> emissions)</b>	International Energy Agency (IEA). The IEA produces an annual statistical report on CO <sub>2</sub> emissions from fossil fuel combustion for more than 140 countries and regions. IEA data for Luxembourg is provided by the Ministry of Economy and External Trade (MECE)	Luxembourg Greenhouse Gas (GHG) Inventory, submitted annually by the Ministry of the Environment. <sup>36</sup>
<b>Trade statistics</b>	UN COMTRADE Trade Database	Luxembourg's external trade statistics (STATEC)
<b>Embodied energy<sup>37</sup></b>	Global Footprint Network	National data on embodied energy in traded items is not available in Luxembourg

The fossil fuel combustion emissions of Luxembourg are subdivided into four different activity sectors: energy industries; manufacturing industries and construction; transport; and other sectors. The subdivisions in the statistics from the International Energy Agency (IEA) and the Greenhouse Gas (GHG) inventory of Luxembourg are only slightly different. CO<sub>2</sub> emission data are listed in Table 21 using the national inventory subcategory names.

<sup>36</sup> The Luxembourg Greenhouse Gas Inventory is submitted under the UNFCCC, the United Nations Framework Convention on Climate Change.

<sup>37</sup> See for more details the Glossary.

Table 21: Data comparison for fossil fuel combustion activities (sectoral approach)

	Production 2005 [Mt CO <sub>2</sub> /yr]	
	Int. Data	LU Data
<b>Sum</b>	<b>11.35</b>	<b>11.67</b>
<b>Energy industries</b>	1.33	1.45
Public electricity and heat production	1.33	1.45
<b>Manufacturing industries and construction</b>	1.56	1.69
Iron and steel	0.50	0.46
Non-ferrous metals	0.01	0.05
Chemicals	0.24	0.20
Pulp, paper and print	0.02	-
Food processing, beverages and tobacco	0.02	0.02
Other	0.07	0.96
Other non-specified	0.71	
<b>Transport</b>	7.02	7.02
Civil aviation	-	0.0006
Road transportation	6.98	7.00
Railways	-	0.009
Navigation	-	0.0005
Other transportation	0.03	-
<b>Other sectors</b>	1.44	1.50
Commercial/Institutional	0.02	1.44
Residential	1.37	
Agriculture/Forestry/Fisheries	0.05	0.05

**Sources:**

Int. Data: IEA (International Energy Agency)

LU Data: GHGI (Luxembourg's Greenhouse Gas Inventory 1990-2007, 2009v1.4); <http://cdr.eionet.europa.eu/lu/eu/ghgmm/envsjk7w>

The embodied energy (or embodied emissions) in traded items is based on exports and imports statistics provided by the United Nations (UN) multiplied by an embodied energy factor for each item calculated by the Global Footprint Network. Amounts of traded goods in tonnes are available from international and national statistics for the year 2005. Inconsistencies between the databases could be due to different applied classification schemes. The Global Footprint Network uses trade statistics according to the first revised product classification scheme SITC (Standard International Trade Classification) dating from 1961. Luxembourg's current external trade statistics apply the fourth revised version of the SITC, in use since 2007. A comprehensive comparison between international and national trade statistics was not possible (see Table 22), because conversion tables from SITC revised version 1 to revised version 4 are not available from the United Nations Statistics Division.<sup>38</sup>

<sup>38</sup> <http://unstats.un.org>

Table 22: Extract correspondence tables SITC rev. 1 to rev. 4

Name	SITC rev.1 (1961)	SITC rev.4 (2007)
Iron & steel scrap	S1-2820	2821-28239
Blooms, billets, slabs, etc. of iron or steel	S1-6725	6726-6728
Products of polymerization and copolymerisation	S1-5812	571-573, 575, 579, 582-583
Aluminum and aluminum alloys, unwrought	S1-6841	68411
Machinery and mechanical appliances, nes	S1-7198	72348, 7272, 72822, 7284, etc.
Plates etc of iron or steel uncoated	S1-6743	6734, 6753-6755
Prods of condensation, poly-condensation & poly-addition	S1-5811	5741-5744, 5759, 5822
Builder's woodwork & prefab. Buildings of wood	S1-6324	6353, 8110
Medium plates etc. of iron or steel, 3 - 4.75 mm	S1-6742	6751-6752, 6754, 6756-6757
Articles of artificial plastic materials, nes	S1-8930	8939
Chemical products and preparations, nes	S1-5999	5973, 5984-5989, 5991-5999
Wood simply shaped or worked, nes	S1-6318	2461, 6349
Materials of rubber	S1-6210	6211-6214
...		

#### 4.2.6.2. Influence of National Data on Global Footprint Network Results

Generally, the international data are matching Luxembourg's data well. Differences in the sectoral subdivision of fossil fuel combustion emissions (including national transport / mobility) are of less importance because in the conversion step from emissions into global hectares, no difference is made for activity sectors. Finally, Luxembourg's total emissions of 11.4 Mt CO<sub>2</sub>/yr only differs by 0.6% from the International Energy Agency (IEA) data.

Iron and steel scrap dominate the embodied CO<sub>2</sub> emissions in imports by 24% Table 23 lists the products which together account for 61% of the imports in the carbon uptake land category.

Table 23: Imported products impacting the Footprint of the carbon uptake land category most

Name	EFi	Impact on the total EFi
	[gha]	[%]
Iron & steel scrap	2,669,963	24%
Blooms, billets, slabs, etc. of iron or steel	724,211	6%
Products of polymerization and copolymerization	603,691	5%
Aluminum and aluminum alloys, unwrought	431,159	4%
Machinery and mechanical appliances, nes	412,021	4%
Plates etc. of iron or steel uncoated	367,511	3%
Prods of condensation, poly-condensation & poly-addition	345,885	3%
Builder's woodwork & prefab. Buildings of wood	277,358	2%
Medium plates etc. of iron or steel, 3 4.75mm	248,164	2%
Articles of artificial plastic materials, nes	218,518	2%
Chemical products and preparations, nes.	218,201	2%
Wood simply shaped or worked, nes	212,040	2%
Materials of rubber	179,137	2%
<b>Sum</b>	<b>6,907,859</b>	<b>61%</b>
<b>Total EFi</b>	<b>11,302,544</b>	

Iron and steel products as well as aluminum alloys dominate the embodied CO<sub>2</sub> emissions in exports by 29%. Table 24 lists the products which together account for 73% of the exports in the carbon uptake land category.

Table 24: Exported products impacting the Footprint in the carbon uptake land category most

Name	EFe	Impact on the total EFe
	[gha]	[%]
Angles etc. of iron or steel, 80 mm or more	1,643,767	17%
Aluminum and aluminum alloys, unwrought	1,180,016	12%
Other coated iron or steel plates	765,116	8%
Products of polymerization and copolymerization	490,565	5%
Rubber tires & tubes for vehicles and aircraft	489,825	5%
Bars and rods of iron or steel, ex wire rod	443,680	5%
Wire rod of iron or steel	364,403	4%
Aluminum and aluminum alloys, worked	355,067	4%
Iron & steel scrap	303,939	3%
Articles of artificial plastic materials, nes	296,700	3%
Fabrics, woven, of synthetic fibers	235,430	2%
Prods of condensation, poly-condensation & poly-addition	222,002	2%
Chemical products and preparations, nes	213,816	2%
Paper and paperboard in rolls or sheets nes	193,091	2%
<b>Sum</b>	<b>7,197,415</b>	<b>73%</b>
<b>Total EFe</b>	<b>9,854,422</b>	

The embodied energy factor for each traded product is provided by a Global Footprint Network internal database. It seems that the database was provided by the Stockholm Environment Institute (SEI). According to the Global Footprint Network, this database will be updated as soon as possible. In the present study, some embodied energy factors provided by the Global Footprint Network were compared to data from the Swiss ecoinvent database. The differences vary from 17% up to 49% (see Table 25). In fact, the meta data of the factor calculation, including the framework of the embodied energy factor (processes, substances, etc.) are not very transparent and should be reported in the '*Guidebook to the National Footprint Accounts*'.

Table 25: Embodied Energy Factors

Name	SITC rev.1 (1961)	EmbEn (NFA 2008)	Ecoinvent v2.1 (2007)	Difference
		[Gj t <sup>-1</sup> ]	[Gj t <sup>-1</sup> ]	[%]
Iron & steel scrap	S1-2820	30	24	20
Aluminum and aluminum alloys, unwrought	S1-6841	190	128	33
Cement	S1-6612	5.39	2.72	49
Safety glass, toughened or laminated	S1-6647	26.2	21.7	17

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#### 4.2.6.3. Conclusion

The carbon uptake land category has, with 85%, the highest impact on Luxembourg's Footprint. The analysis of the fossil fuel combustion data (59%<sup>39</sup> of the total Footprint) showed that the total emissions estimate is of good quality, but the data quality for the subcategories and the definition of the subcategories themselves have to be improved. Luxembourg's Ministry of Sustainable Development and Infrastructures is working on this issue and the results could be integrated in future yearly calculations of Luxembourg's Footprint.

The analysis of the embodied CO<sub>2</sub> emissions in traded items (26% of the total Footprint) could highlight two major difficulties. The first one is due to different versions of product classification schemes used by the Global Footprint Network and STATEC. This causes problems in the attempt to compare both trade statistics. The second difficulty is due to embodied energy factors, which are not described in a transparent way. The rough analysis of the embodied energy factors applied by the Global Footprint Network showed that an update of this internal database is required. Additionally, an advanced analysis of the entire embodied energy factors is of particular interest for Luxembourg: The internal Global Footprint Network database has to be updated with data from state-of-the-art databases. Then, the impacts of different industrial sectors on the Consumption Footprint of Luxembourg could be analyzed.

Finally, detailed sectoral analyses could be conducted to set reduction targets for Luxembourg's Ecological Footprint and to give recommendations on how these targets could be reached. In this context, existing national action plans should be taken into account, e.g. for energy efficiency in Luxembourg or CO<sub>2</sub> reductions.

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<sup>39</sup> International transports are included (2%).

#### 4.2.7. Conclusion and Outlook Concerning the 2008 National Footprint Accounts for Luxembourg

International statistical input data are generally matching Luxembourg's statistical input data for the year 2005. No major data gaps could be detected in the international databases concerning statistics for Luxembourg. Data discrepancies within the external trade statistics can be attributed mostly to different product classification schemes used by the Food and Agriculture Organization of the United Nations (FAO) and the national body in charge STATEC. A quantification of the differences between national and international data on an aggregated level was beyond the scope of the present study.

There is definitively a need for a follow-up project, analyzing data discrepancies between the international and national external trade statistics, as using the national database substantially influences the imports and exports of the carbon uptake land, cropland, grazing land, forest land and fishing grounds categories. As mentioned by Kitzes et al., the accuracy of Ecological Footprint analyses of a country fundamentally depends on the accuracy of the underlying data [Kitzes et al., 2009a].

It was noted that the embodied energy factors for traded products used by Global Footprint Network have to be updated and to be based on state-of-the-art databases. According to their representatives, the Global Footprint Network is working on this subject. Topics mentioned in the 2009 Research Agenda are therefore more focused on the development of methods to measure the Ecological Footprint in the carbon uptake land category (carbon dioxide emissions) [Kitzes et al., 2009a].

It was also noted that the biocapacity of Luxembourg's forest land is not included in the 2008 National Footprint Accounts provided by the Global Footprint Network. This issue was reported to the Global Footprint Network representatives, who confirmed to correct this in a next version of the National Footprint Accounts. According to the Ecological Footprint Standards Draft 2009 [GFN, 2009a], national adaptations of the Consumption Footprint and biocapacity calculations are in line with the standards if they are reported transparently. In this study, the recalculation of Luxembourg's biocapacity with national data leads to an increase of 133%.

The analysis of the fossil fuel combustion data (59%<sup>40</sup> of Luxembourg's Footprint) showed that the total emission estimates are of good quality (sum of all sector activities). However, the data quality of the statistics for the subcategories (e.g. energy industries, iron and steel industries, transport, residential) and the definition of the subcategories themselves have to be improved. Luxembourg's Ministry of Sustainable Development and Infrastructures is constantly working on this issue; the results could be integrated in future yearly calculations of Luxembourg's Footprint.

Concerning land use statistics, only small data discrepancies were identified by recalculating the surfaces with Corine 2000, the land cover database used in the 2008 National Footprint Accounts for Luxembourg. The land cover surface calculations by the Ministry of Sustainable Development and Infrastructures (MDDI) for the Greenhouse Gas (GHG) National Inventory Report (1997-2007) with the Corine 2006 database show however bigger differences especially for the cropland, grazing land and 'other wooded land' categories. The assessment of the Ecological

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<sup>40</sup> International transports are included (2%).

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Footprint of Luxembourg should take into account these nationally available, more precisely defined surfaces per land category.

Considering the current situation presented in this report, the research priorities for next steps in the improvement of Luxembourg's Footprint could include the following:

- Analysis of the embodied energy factors applied in the 2008 National Footprint Accounts.
- Integration of the detailed Greenhouse Gas inventory study conducted by Luxembourg's Ministry of the Environment.
- Analysis of Luxembourg's external trade statistics together with STATEC.
- Analysis of the trade in electricity.

It could be shown that data accuracy is an important issue in the assessment of the biocapacity and the Ecological Footprint of a nation. Generally, the Footprint of a nation is communicated to reflect the consumption of its population. But in fact, the statistics represent all trade flows within a country including the consumption of non-residents (e.g. tourists and commuters). In the case of small and industrialised countries with a strong economy, the impact of non-residents can be high and should not be neglected. It seems that the methodology as proposed by Global Footprint Network with respect to the 2008 National Footprint Accounts need to be adapted for countries with less than 1 million inhabitants.<sup>41</sup> Luxembourg decided so far to assess and illustrate its Footprint with respect to the residents and non-residents, with a special focus on road fuel exports. These results are presented in the following chapter.

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<sup>41</sup> Global Footprint Network developed the methodology for countries with more that 1 million inhabitants.

## 5. Luxembourg's Biocapacity and Footprint calculation based on national data

Based on the 2008 National Footprint Accounts for Luxembourg, provided by Global Footprint Network (GFN), Luxembourg's biocapacity was recalculated using nationally available land cover statistics (see chapter 4.1 'Biocapacity and Land Use Statistics'). Considering these national data and applying the methodology, Luxembourg has a total biocapacity of 898,796 global hectares (see Table 8). This value was reported to Global Footprint Network representatives, who confirmed that the biocapacity calculation had been partly adapted in the 2009 version of the National Footprint Accounts by applying a national forest yield. Nevertheless, Global Footprint Network (GFN) will continue to base the biocapacity calculation on the level one Corine 2000 database classification in order to apply the same methodology in each country. This means, that the cropland and grazing land statistics provided by the Ministry of the Agriculture and the Service d'Economie Rurale will not be implemented in the National Footprint Accounts so far. The authors of this report recommend for further communications on results based on the 2008 version of the National Footprint Accounts for Luxembourg, to consider the recalculated biocapacity for Luxembourg including forest areas and nationally available cropland and grazing land statistics: 898,796<sup>42</sup> gha representing a per capita biocapacity of 1.9 gha.<sup>43</sup>

Based on the 2008 National Footprint Accounts for Luxembourg a total Consumption Footprint of 5,549,008<sup>44</sup> global hectares and a per capita value of 11.83<sup>45</sup> gha was calculated. The analysis of the methodology revealed that the result covers the consumption of residents and non-residents. The national focus will therefore be to illustrate both consumption Footprints to come to a better estimation of the inhabitant's Footprint and by this allowing a more realistic comparison with other countries on a per capita basis.

### 5.1. Luxembourg's Inhabitant's and Commuter's Footprints based on national data

In 2005, 469,100 inhabitants<sup>46</sup> and 121,200 commuters lived, worked and consumed in Luxembourg according to the Government Statistics Service of Luxembourg (STATEC). The share of the commuter's, about 26% compared to the inhabitants, is included in the per capita Footprint calculated by Global Footprint Network with the 2008 National Footprint Accounts. In the following, Luxembourg's total Consumption Footprint will be illustrated with respect to national specifications:

- A subdivision into overall consumption categories;

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<sup>42</sup> Biocapacity calculation based on 2008 NFA; national forest Yield Factor (YF) based on 2009 National Footprint Accounts.

<sup>43</sup> The per capita calculation is based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

<sup>44</sup> The grazing land Footprint was indirectly influenced by the consideration of nationally available statistics on land use (see chapter 4.1 for more details).

<sup>45</sup> The per capita calculation is based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

<sup>46</sup> The National Footprint Accounts 2008 per capita calculations are based on 465,000 inhabitants.

- A subdivision into sectors, an allocation of the shares of the inhabitants and the commuters with a special focus on road fuel exports (fuel consumption of commuters, fuel tourism and transit; see glossary p.66).

For this purpose, studies on the consumption patterns of both inhabitants and commuters were investigated, analysed and finally used to illustrate Luxembourg's Consumption Footprint.

## 5.2. Luxembourg's Total Consumption Footprint by Categories

In a first step, Luxembourg's Footprint by land use categories proposed by Global Footprint Network (see chapter 4, p.14) is allocated with respect to final consumption categories with the greatest overall impacts after the European Commission-funded Environmental Impact of Products (EIPRO) project undertaken by the Joint Research Centre: food and beverages; private transport; housing, including heating and hot water, electrical appliances and structural work [European Commission, 2006].

In a second step, the final consumption categories proposed by the European Commission are adjusted to Luxembourg's specification: In the context of Luxembourg, the total Consumption Footprint is allocated to four categories. The Footprint can be allocated to: the consumption of non-food products and services (45%), road transport / mobility (35%), food products (14%) and housing (6%; see Table 11).

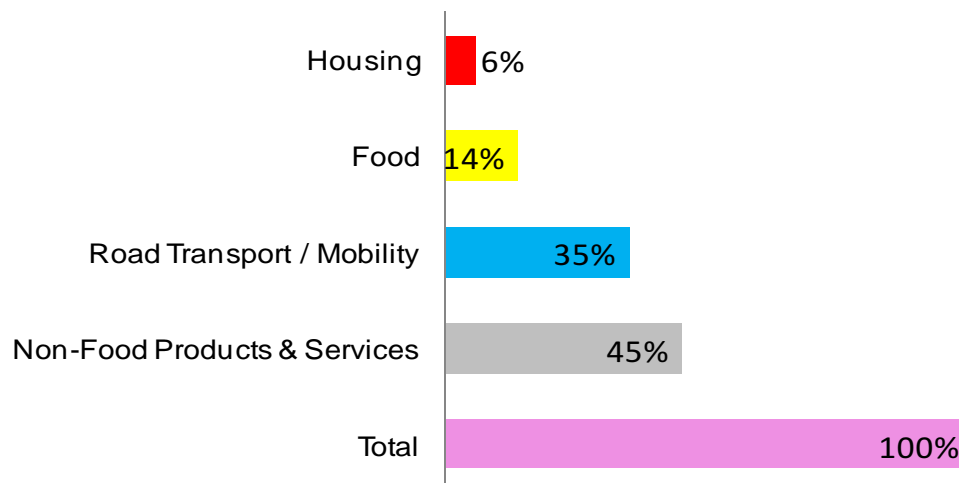


Figure 13: Luxembourg's Total Consumption Footprint by Final Consumption Categories

Luxembourg's Footprint allocation to final consumption categories (Figure 13) by reallocating the Footprint by land use categories (see chapter 4, p.14) necessitates the redefining of the scope of the Ecological Footprint methodology. Generally, the Ecological Footprint measures how much land is needed to provide the resources consumed and to generate the waste (CO<sub>2</sub> emissions) produced by a nation. With respect to the final consumption categories, the footprints represent (see Table 26):

The category of **non-food products and services** covers the land needed to provide raw and processed wood and to uptake the embodied CO<sub>2</sub> emissions in non-food products and the direct CO<sub>2</sub> emissions due to the transport of non-food products, and due to the energy consumption of businesses and producing industries.

The category of **road transport and mobility** covers the land needed to uptake the direct CO<sub>2</sub> emissions due to fossil fuel consumption in the road transport sector.

The **food** category includes the water areas needed to provide fish products, and the land areas necessary for providing agricultural, meat and dairy products, to uptake the embodied CO<sub>2</sub> emissions in food products and the direct CO<sub>2</sub> emissions due to the transport of food products and the energy consumption of the agricultural sector and the food industry.

The **housing** category covers the built-up land and the land needed to uptake the direct CO<sub>2</sub> emissions due to residential energy consumption.

Table 26: Glossary of the Consumption Footprint Subcategories














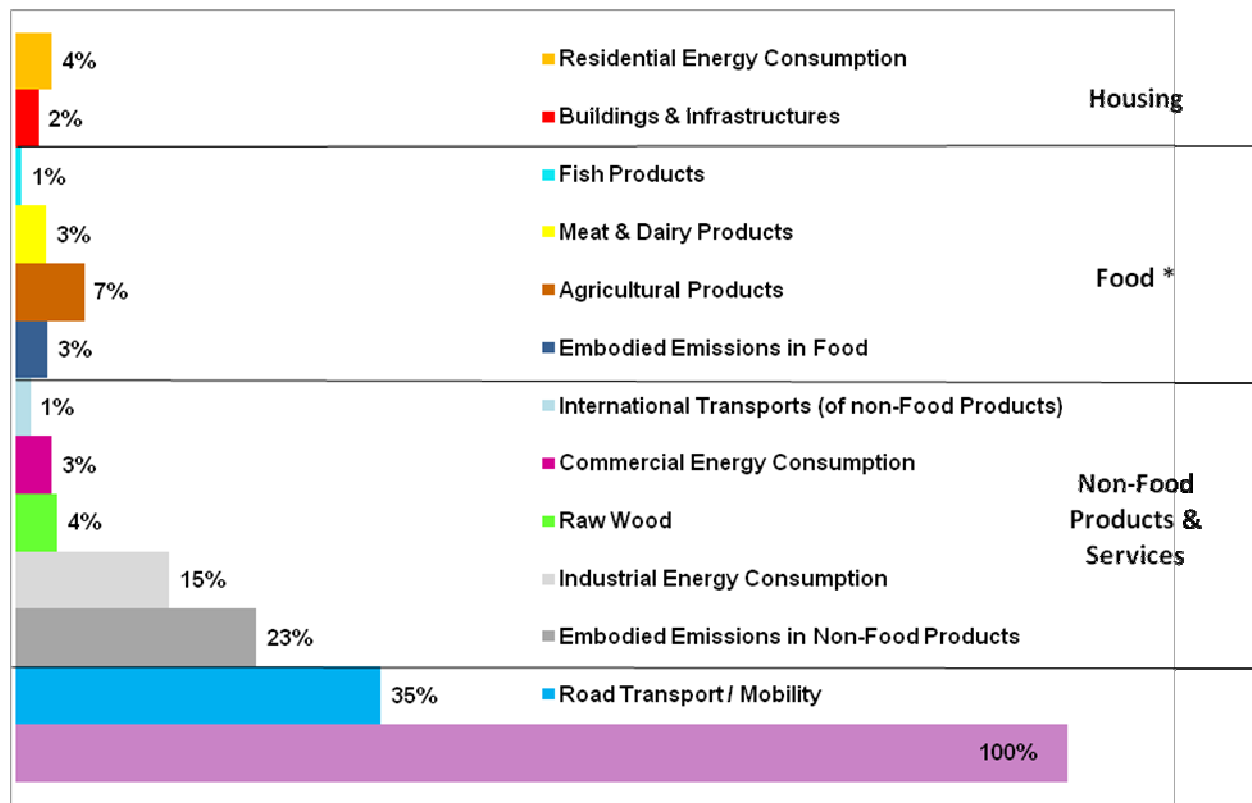
Building & Infrastructures		Land physically occupied by human activities
Residential Energy Consumption		CO <sub>2</sub> emissions due to residential energy consumption
Fish Products		Fish products consumed in Luxembourg
Meat & Dairy Products		Grass and crops necessary to produce meat & dairy products consumed in Luxembourg
Agricultural Products		Crops consumed in Luxembourg
Embodied Emissions in Food Products		CO <sub>2</sub> emissions embodied in food products consumed in Luxembourg
Energy Consumption: Food Industry & Agriculture*		CO <sub>2</sub> emissions due to agriculture and food industry activities in Luxembourg
International Transports		Transport of goods consumed in the country (ship, aviation, lorry): food products and non-food products*
Commercial Energy Consumption		CO <sub>2</sub> emissions due to commercial energy consumption
Raw Wood		Raw wood consumed in Luxembourg
Industrial Energy Consumption		CO <sub>2</sub> emissions due to industrial activities in Luxembourg (except: food industry)
Embodied Emissions in Non-Food Products		Embodied CO <sub>2</sub> emissions (grey energy) in non-food products consumed in Luxembourg
Road Transport		CO <sub>2</sub> emissions due to road transport in the country: national consumption and road fuel exports (commuters + fuel tourism)
* Categories <1% are not presented in the graph on the slide before, e.g.: International Transports (Food Products) and Energy Consumption Food Industry & Agriculture.		

Figure 14 resumes the composition of Luxembourg's Footprint by final consumption categories clarifying the different subcategories included.



\* Categories <1% are not listed, e.g.: International Transports (Food Products) and Energy Consumption Food Industry & Agriculture.

Figure 14: Luxembourg's Total Consumption Footprint by Subcategories

The total Consumption Footprint of Luxembourg can be presented additionally in a Subcategory Land Use Matrix (SLUM) summarized in Table 27. These matrices highlight that the consumption categories 'road transport / mobility' and 'non-food products & services' are contributing most to the carbon uptake land category and by thus to Luxembourg's total Footprint (with respectively 35% and 43%).

Table 27: Total Consumption Footprint SLUM

in [gha]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	124,086	-	-	-	<b>124,086</b>
CO <sub>2</sub> (Carbon Uptake Land)	190,055	214,108	1,936,615	2,359,495	<b>4,700,273</b>
Cropland	-	392,832	-	-	<b>392,832</b>
Grazing Land	-	82,907	-	-	<b>82,907</b>
Forest Land	-	-	-	220,024	<b>220,024</b>
Fishing Grounds	-	28,886	-	-	<b>28,886</b>
<b>Total</b>	<b>314,141</b>	<b>718,733</b>	<b>1,936,615</b>	<b>2,579,519</b>	<b>5,549,008</b>
in [%]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	2%	-	-	-	<b>2%</b>
CO <sub>2</sub> (Carbon Uptake Land)	3%	4%	35%	43%	<b>85%</b>
Cropland	-	7%	-	-	<b>7%</b>
Grazing Land	-	1%	-	-	<b>1%</b>
Forest Land	-	-	-	4%	<b>4%</b>
Fishing Grounds	-	1%	-	-	<b>1%</b>
<b>Total</b>	<b>5%</b>	<b>13%</b>	<b>35%</b>	<b>47%</b>	<b>100%</b>
Luxembourg's Footprint in [gha/capita] <sup>47</sup>	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	0.26	-	-	-	<b>0.26</b>
CO <sub>2</sub> (Carbon Uptake Land)	0.40	0.46	4.13	5.03	<b>10.02</b>
Cropland	-	0.84	-	-	<b>0.84</b>
Grazing Land	-	0.18	-	-	<b>0.18</b>
Forest Land	-	-	-	0.47	<b>0.47</b>
Fishing Grounds	-	0.06	-	-	<b>0.06</b>
<b>Total</b>	<b>0.66</b>	<b>1.54</b>	<b>4.13</b>	<b>5.50</b>	<b>11.83</b>

### 5.3. Luxembourg's Total Consumption Footprint by Sectors

The sector analysis of Luxembourg's Total Consumption Footprint consists in an analysis of the shares of Luxembourg's inhabitants and the commuters' consumption. The analysis of the consumption patterns is based on a study about the consumption expenditures of the inhabitants and the commuters for food products as well as non-food products and services. The analysis of the fuel consumption of the road transport sector is based on an emission calculation model of the national road fuel consumption and the road fuel exports. The distribution of

<sup>47</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

the road fuel exports into the consumption by commuters, fuel tourism and transit is then based on an empirically calibrated simulation model for tax revenue and the Laffer-curve [Thöne, 2008].

### 5.3.1. Food Products, Non-Food Products and Services

In 2005, more than 13 million Euros were spent on Luxembourg's territory by inhabitants and commuters [STATEC, 2007]. The share of the commuter's consumption was about 18% compared to 82% of the inhabitants (see Table 28<sup>48</sup>). This share is applied in the following to distribute Luxembourg's Consumption Footprint of the categories food and non-food products and services into the inhabitants' and commuters' footprints.

Table 28: Effective Consumption Expenditures by Inhabitants and Commuters in 2005 on Luxembourg's Territory (in million EUR)

	Million Euro / Year <sub>2005</sub>	%
<b>Residents</b>	10,774	82
<b>Commuters</b>	2,409	18
<b>Total</b>	<b>13,183</b>	<b>100</b>

A more detailed splitting of the expenditure share between inhabitants and commuters was not applied because the consumption categories developed for the Ecological Footprint and the expenditure survey are not matching.

### 5.3.2. Road Transport / Mobility

According to Luxembourg's national inventory of greenhouse gas emissions, 22% of totals CO<sub>2</sub> emissions due to road fuel consumption in 2005 are attributed to the inhabitants, 78% are considered as emissions linked to road fuel exports [De Brabanter, 2009<sup>49</sup>; see glossary p.66]. The emissions of residential road fuel consumption and exports are calculated with the COPERT IV emission calculation model based on statistics on total road fuel sales and Luxembourg's car fleet composition.

The road fuel exports are additionally divided into commuters' consumption and consumption due to fuel tourism and transit after a study commissioned by the Ministry of Sustainable Development and Infrastructures published in 2008 [Thöne, 2008]. The road fuel consumption and thus, the Consumption Footprint of the road transport / mobility category, can be finally attributed by 22% to the inhabitants, by 15% to the commuters and by 63% to fuel tourism (see Table 29; for more details see A-13).

<sup>48</sup> [http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=189&IF\\_Language=fra-&MainTheme=4&FldrName=7](http://www.statistiques.public.lu/stat/TableViewer/tableView.aspx?ReportId=189&IF_Language=fra-&MainTheme=4&FldrName=7) (consulted 3<sup>rd</sup> of June 2010)

<sup>49</sup> De Brabanter, E.; Schuman, M. (2009). *Luxembourg's National Inventory Report 1990-2007*. Luxembourg, 12 June 2009: Ministry of the Environment / Environmental Agency. Section 3.2.7.2, Table 2-8, p. 91.

Table 29: Distribution of Total Road Fuel Consumption in 2005

Consumer after [Thöne, 2008]	%		Consumer after [De Brabanter, 2009]
Inhabitants	22		Inhabitant's Consumption
Commuters	15	78	Road Fuel Exports
Fuel Tourism	63		
<b>Total</b>	<b>100</b>		<b>Total</b>

### 5.3.3. Inhabitants and Commuters Footprints

As mentioned above, the shares of Luxembourg's inhabitants and the commuter's consumption concerning the final consumption of food, non food products and housing is assessed with expenditure statistics. The road fuel consumption distribution is based on an emission calculation model. Effectively, Luxembourg's total Consumption Footprint can be attributed by 62% to the inhabitants, by 16% to the commuters and by 22% to fuel tourism and transit (see Figure 15).

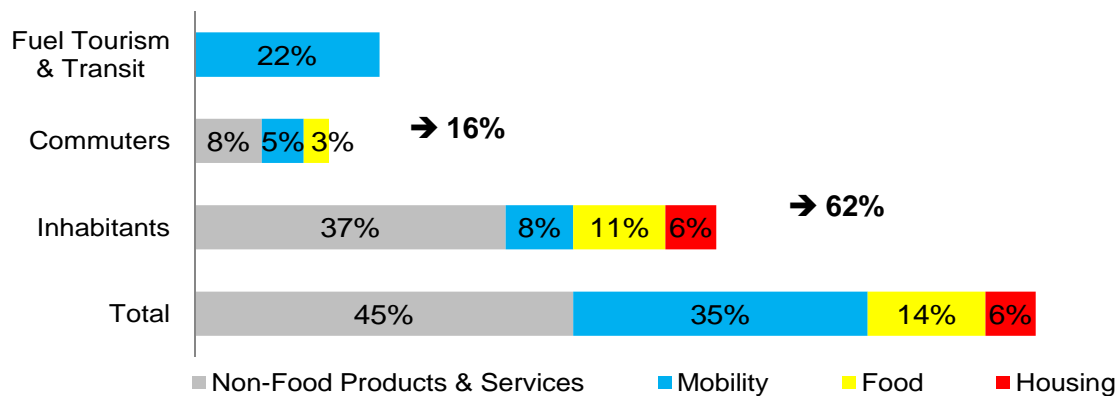


Figure 15: Luxembourg's Consumption Footprint by Sectors and Categories

The Inhabitant's footprint is dominated by 61% of non-food products and services; food, mobility and housing are responsible respectively by 18%, 12% and 9% (see Figure 16). The commuter's footprint is dominated by non-food products and services too with a contribution of 52%; food and mobility are contributing respectively with 16% and 32% (see Figure 16).

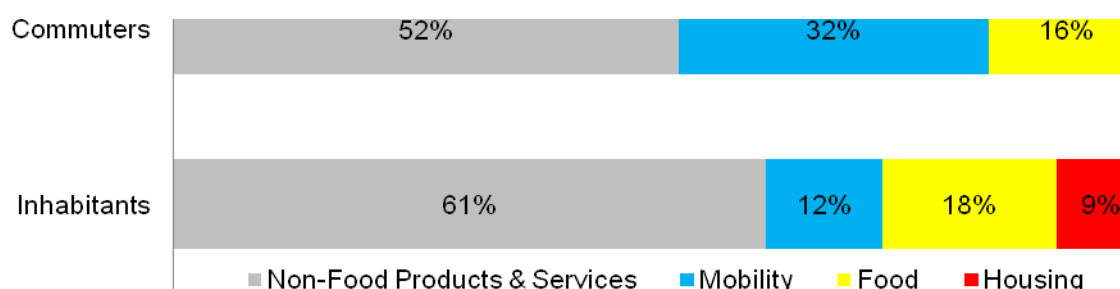


Figure 16: Composition of Luxembourg's Inhabitants and Commuters Footprints

#### 5.4. Luxembourg's Inhabitant's Consumption Footprint by Land Use Categories

In the 2008 National Footprint Accounts (NFA), Luxembourg's Total Consumption Footprint is divided into six land use categories: carbon uptake land, cropland, forest land, grazing land, build-up land and fishing grounds. The composition of these land use categories is presented in detail in the chapter 4.2 of this report.

After an in depth analysis of the different consumer groups (or sectors) contributing to Luxembourg's Total Consumption Footprint, developed in chapter 5.3 of this report, the inhabitants' share was identified. With respect to the six land use categories mentioned in the Ecological Footprint methodology, the carbon uptake land use category is with 79% most contributing (see Table 30).

Table 30: Inhabitants Consumption Footprint SLUM

in [gha]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	124,086	-	-	-	<b>124,086</b>
CO <sub>2</sub> (Carbon Uptake Land)	190,055	174,983	424,412	1,928,332	<b>2,717,782</b>
Cropland	-	321,048	-	-	<b>321,048</b>
Grazing Land	-	67,757	-	-	<b>67,757</b>
Forest Land	-	-	-	179,818	<b>179,818</b>
Fishing Grounds	-	23,607	-	-	<b>23,607</b>
<b>Total</b>	<b>314,141</b>	<b>587,395</b>	<b>424,412</b>	<b>2,108,150</b>	<b>3,434,098</b>
in [%]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	4%	-	-	-	<b>4%</b>
CO <sub>2</sub> (Carbon Uptake Land)	6%	5%	12%	56%	<b>79%</b>
Cropland	-	9%	-	-	<b>9%</b>
Grazing Land	-	2%	-	-	<b>2%</b>
Forest Land	-	-	-	5%	<b>5%</b>
Fishing Grounds	-	1%	-	-	<b>1%</b>
<b>Total</b>	<b>5%</b>	<b>13%</b>	<b>35%</b>	<b>47%</b>	<b>100%</b>

Inhabitant's Footprint in [gha/capita] <sup>50</sup>	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	0.27	-	-	-	<b>0.27</b>
CO <sub>2</sub> (Carbon Uptake Land)	0.40	0.38	0.90	4.11	<b>5.79</b>
Cropland	-	0.69	-	-	<b>0.69</b>
Grazing Land	-	0.14	-	-	<b>0.14</b>
Forest Land	-	-	-	0.38	<b>0.38</b>
Fishing Grounds	-	0.05	-	-	<b>0.05</b>
<b>Total</b>	<b>0.67</b>	<b>1.26</b>	<b>0.90</b>	<b>4.49</b>	<b>7.32</b>

The 'Commuters Consumption Footprint SLUM' and 'Gasoline Tourism & Transit Consumption Footprint SLUM' can be found in the appendix (see A-14 and A-15).

The comparison of Luxembourg's Total Consumption Footprint by land use categories with the inhabitant's footprint shows slight variations (see Table 31). The inhabitant's footprint is composed by 79% of the carbon uptake land use category compared to 85% of the total consumption footprint. This decrease is due to the commuter's share on the road fuel consumption. The increased relevance of the built-up land category in the inhabitant's footprint (4% compared to 2%) is linked to the fact that this category is entirely allocated to the inhabitants. Increases in the categories cropland, forest land and grazing land can be explained with the consumption shares of 82% and 18%, respectively for the inhabitants and the commuters (see Table 26).

Table 31: Comparison of Luxembourg's Total Consumption Footprint with the Inhabitant's Footprint by Land Use Categories

	Total Consumption Footprint	Inhabitant's Consumption Footprint
Carbon uptake land	85%	79%
Cropland	7%	9%
Forest land	4%	5%
Grazing land	1%	2%
Built-up land	2%	4%
Fishing grounds	1%	1%

Compared to the composition of Footprints worldwide, a high contribution of the carbon uptake land category can only be observed in countries with less than 1,000,000 inhabitants ('small' countries according to GFN) with high developed infrastructures like the United Arab Emirates or Kuwait [WWF, 2008]. In European countries, the carbon uptake land category generally accounts for about 60%; cropland and forest land categories are contributing more strongly to the total Footprint than in Luxembourg.

<sup>50</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

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## 6. Transforming Luxembourg's Ecological Footprint based on the National Footprint Accounts into 'One Planet Luxembourg'?

The Ecological Footprint translates the consumption of a country, a region or a city in the area needed to support its population's consumption in a global perspective. It includes the area needed to produce the materials consumed and the area needed to absorb the waste (CO<sub>2</sub> emissions). The area is expressed in so called global hectares (gha) [GFN, 2009b]. According to the 2008 edition of the National Footprint Accounts developed by the Global Footprint Network, humanity demanded the resources and services of 1.31 planets in 2005. This situation, in which total demand for goods and services exceeds the available supply, is known as overshoot. On the global scale, overshoot indicates that stocks of ecological capital are depleting or that waste (CO<sub>2</sub> emissions) is accumulating [Ewing et al., 2008].

The Ecological Footprint can be used as a tool to take into account the impact of national consumption patterns on the rest of the world. The communication of resource depletion using a global area (in gha) is effective and commonly accepted [Best et al, 2008; Giljum et al., 2007; DEFRA, 2007]. Global hectares can be understood as a currency. Indeed, in comparison to money, global hectares express a physical unit: Actually, physical national hectares are translated into theoretical global hectares. The Ecological Footprint highlights the responsibility of developed countries and their citizens by showing how much land is consumed worldwide due to their way of life. This should raise the awareness of global resource depletion and the individual responsibility for global problems.

Stakeholders and researchers recognize the need for further development of indicators to trace sustainability [Kitzes et al., 2009a]. The policy application of the Ecological Footprint as an indicator for sustainable development is discussed at national and European levels [von Stokar et al., 2006; Giljum et al., 2007; Best et al., 2008;]. In this context, the Ecological Footprint could be combined with the Human Development Index (HDI) to show how sustainably countries behave.<sup>51</sup> The Ecological Footprint is discussed as part of a basket of sustainability indicators by the Directorate-General for the Environment of the European Commission. Nevertheless, it does not allow for an assessment of environmental impacts as comprehensively and as detailed as e.g. life cycle assessments do. Different studies on the Ecological Footprint are discussing the incompleteness of the method concerning the assessment of environmental impacts related to the consumption of a country. Sector based bottom-up inventories of product categories based on Life Cycle Assessments (LCA) could be combined with the Ecological Footprint. Life Cycle Assessment takes into account comprehensive environmental impacts (greenhouse effect, eutrophication, acidification, ecotoxicity, etc.) of e.g. a product over its entire life cycle, from its production to its disposal (from cradle to grave). In this perspective, economic input and output tables<sup>52</sup> are extended and linked to environmental impacts.

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<sup>51</sup> The HDI combines normalized measures of life expectancy, literacy, educational attainment, and the Gross Domestic Product (GDP) per capita for countries worldwide.

<sup>52</sup> Tables that indicate how much each industry requires of the production of each other industry in order to produce each dollar of its own output.

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Similar to the Welsh<sup>53</sup> approach, Luxembourg could work on a long term 'One Planet Luxembourg' strategy. The 'One Planet' strategy aims to reduce the national Footprint to 1.3 gha per person, the assumed fair 'earth share' by 2050. The National consumption patterns of the inhabitants and the commuters in Luxembourg are detailed with respect to housing, mobility and the consumption of food, goods and services. Additionally, the key sectors such as industry, construction and services should be analyzed. Based on these analyses, short term recommendations on how to reduce Luxembourg's environmental impacts and thus its Footprint could be given. Public awareness of global issues as resource depletion due to national consumption and behaviour should be raised.

To achieve the 'One Planet Luxembourg' goal, real political vision and ambition is required. The government of Luxembourg should step up and scale up the transformation to a One Planet Luxembourg as soon as possible.

In preparation to future communication campaigns on Luxembourg's Ecological Footprint, a table in the annexe proposes translations of key words in English into German, French and Luxembourgish (see A-2).

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<sup>53</sup> WWF Cymru in Cardiff published the report 'One Planet Wales - Transforming Wales for a prosperous future within our fair share of the Earth's resources' in October 2007.

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## A-1. Glossary

The following glossary on relevant terms related to the assessment of a country's Ecological Footprint was elaborated by the Global Footprint Network for the participants of the technical training in Brussels the 14<sup>th</sup> and the 15<sup>th</sup> of May 2009. [GFN, 2009b] Please notice that this glossary is not fully integrated here; in case of any substantial adaptation, the changes are mentioned. According to the Draft Standards 2009 [GFN, 2009a], it is appropriate to incorporate definitions originally provided by the Network. The glossary has been updated with relevant terms for Luxembourg; the new references are mentioned.

**biological capacity or biocapacity:** The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. "Useful biological materials" are defined as those used by the human economy, hence what is considered "useful" can change from year to year (e.g. use of corn (maize) stover for cellulosic ethanol production would result in corn stover becoming a useful material, and so increase the biocapacity of maize cropland). The biocapacity of an area is calculated by multiplying the actual physical area by the yield factor and the appropriate equivalence factor. Biocapacity is usually expressed in units of global hectares.

**biological capacity available per person (or per capita):** There were 13.4 billion hectares of biologically productive land and water on this planet in 2005. Dividing by the number of people alive in that year, 6.5 billion, gives 2.1 global hectares per person. This assumes that no land is set aside for other species that consume the same biological material as humans.

**biologically productive land and water:** The land and water (both marine and inland waters) area that supports significant photosynthetic activity and biomass accumulation used by humans. Non-productive areas as well as marginal areas with patchy vegetation are not included. Biomass that is not of use to humans is also not included. The total biologically productive area on land and water was approximately 13.4 billion hectares in 2005.

**carbon uptake land:** The demand on biocapacity required to sequester (through photosynthesis) the carbon dioxide (CO<sub>2</sub>) emissions from fossil fuel combustion. Although fossil fuels are extracted from the Earth's crust and are not regenerated in human time scales, their use demands ecological services if the resultant CO<sub>2</sub> is not to accumulate in the atmosphere. The Ecological Footprint therefore includes the biocapacity, typically that of unharvested forests, needed to absorb that fraction of fossil CO<sub>2</sub> that is not absorbed by the ocean.

**consumption:** Use of goods or of services. The term consumption has two different meanings, depending on context. As commonly used in regard to the Footprint, it refers to the use of goods or services. A consumed good or service embodies all the resources, including energy, necessary to provide it to the consumer. In full life-cycle accounting, everything used along the production chain is taken into account, including any losses along the way. For example, consumed food includes not only the plant or animal matter people eat or waste in the household, but also that lost during processing or harvest, as well as all the energy used to grow, harvest, process and transport the food.

As used in Input Output analysis, consumption has a strict technical meaning. Two types of consumption are distinguished: intermediate and final. According to (economic) System of National Accounts terminology, intermediate consumption refers to the use of goods and services by a business in providing goods and services to other businesses. Final consumption refers to non-productive use of goods and services by households, the government, the capital sector, and foreign entities.

**consumption components (also consumption categories):** Ecological Footprint analyses can allocate total Footprint among consumption components, typically food, shelter, mobility, goods, and services, often with further resolution into sub-components. Consistent categorization across studies allows for comparison of the Footprint of individual consumption components across regions, and the relative contribution of each category to the region's overall Footprint. To avoid double counting, it is important to make sure that consumables are allocated to only one component or sub-component. For example, a refrigerator might be included in the food, goods, or shelter component, but not in all.

**Consumption Footprint:** The most commonly reported type of Ecological Footprint. It is the area used to support a defined population's consumption. The consumption Footprint (in gha) includes the area needed to produce the materials consumed and the area needed to absorb the waste (CO<sub>2</sub> emissions). The consumption Footprint of a nation is calculated in the National Footprint Accounts as a nation's primary production Footprint plus the Footprint of imports minus the Footprint of exports, and is thus, strictly speaking, a Footprint of apparent consumption. The national average or per capita Consumption Footprint is equal to a country's Consumption Footprint divided by its population.

**Consumption Land Use Matrix:** Starting with data from the National Footprint Accounts, a Consumption Land Use Matrix allocates the six major Footprint land uses (shown in column headings, representing the five land types and carbon uptake land) to the five Footprint consumption components (row headings). Each consumption component can be disaggregated further to display additional information. These matrices are often used as a tool to develop sub-national (e.g. state, county, city) Footprint assessments. In this case, national data for each cell is scaled up or down depending on the unique consumption patterns in the state, county or city.

**conversion factor:** A generic term for factors which are used to translate a material flow expressed within one measurement system into another one. For example, a combination of two conversion factors—"yield factors" and "equivalence factors"—translates hectares into global hectares. The extraction rate conversion factor translates a secondary product into primary product equivalents.

**daughter product:** The product resulting from the processing of a parent product. For example wood pulp, a secondary product, is a daughter product of round wood. Similarly, paper is a daughter product of wood pulp.

**ecological debt:** The sum of annual ecological deficits. Humanity's Footprint first exceeded global biocapacity in the mid-1980s, and has done so every year since. By 2005 this annual overshoot had accrued into an ecological debt that exceeded 2.5 years of the Earth's total productivity.

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**ecological deficit / reserve:** The difference between the biocapacity and Ecological Footprint of a region or country. An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's Footprint. If there is a regional or national ecological deficit, it means that the region is importing biocapacity through trade or liquidating regional ecological assets. In contrast, the global ecological deficit cannot be compensated through trade, and is therefore equal to overshoot.

**Ecological Footprint:** A measure of how much biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste (CO<sub>2</sub> emissions) it generates using prevailing technology and resource management practices. The Ecological Footprint is usually measured in global hectares. Because trade is global, an individual or country's Footprint includes land or sea from all over the world. Ecological Footprint is often referred to in short form as Footprint (not footprint).

**Ecological Footprint Standards:** Specified criteria governing methods, data sources and reporting to be used in Footprint studies. Standards are established by the Global Footprint Network Standards Committee composed of scientists and Footprint practitioners from around the world. Standards serve to produce transparent, reliable and mutually comparable results in studies done throughout the Footprint Community. Where Standards are not appropriate, Footprint Guidelines should be consulted. For more information, consult [www.footprintstandards.org](http://www.footprintstandards.org).

**embodied energy / embodied emissions factor:** Embodied energy is the energy used during a product's entire life cycle in order to manufacture, transport, use and dispose of the product. Footprint studies often use embodied energy when tracking trade of goods. In the context of this study, the terms 'embodied energy' and 'embodied emissions' are equivalent. In fact, the 'embodied energy' is translated into 'embodied (CO<sub>2</sub>) emissions' by a carbon intensity factor (the amount of carbon emitted per unit of power produced).

**equivalence factor:** A productivity based scaling factor that converts a specific land type (such as cropland or forest) into a universal unit of biologically productive area, a global hectare. For land types (e.g., cropland) with productivity higher than the average productivity of all biologically productive land and water area on Earth, the equivalence factor is greater than 1. Thus, to convert an average hectare of cropland to global hectares, it is multiplied by the cropland equivalence factor of 2.64. Pasture lands, which have lower productivity than cropland, have an equivalence factor of 0.5. See also yield factor.

**extraction rate:** A processing factor comparing the quantity of a parent product to the quantity of the resulting daughter product. When a parent product is processed its mass changes. For example, when wheat is processed into white flour, the bran and germ are stripped lessening its mass. Therefore, in order to calculate the number of hectares needed to produce a given mass of flour, an extraction rate is needed. This extraction rate in this example is the ratio of tonnes of flour divided by the tonnes of wheat processed to produce the flour.

**Footprint Intensity:** The number of global hectares required to produce a given quantity of resource or absorb a given quantity of waste, usually expressed as global hectares per tonne. The National Footprint Accounts calculate a primary Footprint Intensity Table for each country, which includes the global hectares of primary land use type needed to produce or absorb a tonne of product (i.e., global hectares of cropland per tonne of wheat, global hectares of forest per tonne carbon dioxide).

**Footprint neutral or negative:** Human activities or services that result in no increase or a net reduction in humanity's Ecological Footprint. For example, the activity of insulating an existing house has a Footprint for production and installation of the insulation materials. This insulation in turn reduces the energy needed for cooling and heating this existing house. If the Footprint reduction from this energy cutback is equal to or greater than the original Footprint of insulating the house, the latter becomes a Footprint neutral or negative activity. On the other hand, making a new house highly energy efficient does not by itself make the house Footprint neutral, unless at the same time it causes reduction in other existing Footprints. This Footprint reduction has to be larger than the Footprint of building and occupying the new house.

**fuel tourism:** The fuel taken up by cars that specifically go to Luxembourg for the purpose of filling up [MEV, 2008].

**global hectare (gha):** A productivity weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint). The global hectare is normalized to the area-weighted average productivity of biologically productive land and water in a given year. Because different land types have different productivity, a global hectare of, for example, cropland, would occupy a smaller physical area than the much less biologically productive pasture land, as more pasture would be needed to provide the same biocapacity as one hectare of cropland. Because world bioproductivity varies slightly from year to year, the value of a gha may change slightly from year to year.

**Guidelines (for Footprint studies):** Suggested criteria governing methods, data sources and reporting for use when Footprint Standards are not appropriate or not yet developed.

**hectare:** 1/100th of a square kilometre, 10,000 square meters, or 2.471 acres. A hectare is approximately the size of a soccer field. See also global hectare and local hectare

**IO (Input-Output) analysis:** Input-Output (IO, also I-O) analysis is a mathematical tool widely used in economics to analyze the flows of goods and services between sectors in an economy, using data from IO tables. IO analysis assumes that everything produced by one industry is consumed either by other industries or by final consumers, and that these consumption flows can be tracked. If the relevant data are available, IO analyses can be used to track both physical and financial flows. Combined economic-environment models use IO analysis to trace the direct and indirect environmental impacts of industrial activities along production chains, or to assign these impacts to final demand categories. In Footprint studies, IO analysis can be used to apportion Footprints among production activities, or among

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categories of final demand, as well as in developing Consumption Land Use Matrices.

**IO (Input-Output) tables:** IO tables contain the data that are used in IO analysis. They provide a comprehensive picture of the flows of goods and services in an economy for a given year. In its general form an economic IO table shows **uses**--the purchases made by each sector of the economy in order to produce their own output, including purchases of imported commodities; and **supplies**--goods and services produced for intermediate and final domestic consumption, and exports. IO tables often serve as the basis for the economic National Accounts produced by national statistical offices. They are also used to generate annual accounts of the Gross Domestic Product (GDP).

**land type:** The Earth's approximately 13.4 billion hectares of biologically productive land and water are categorized into five types of surface area: cropland, grazing land, forest, fishing ground, and built-up land. It is also called 'area type'.

**Life Cycle Analysis (LCA):** A quantitative approach that assesses a product's impact on the environment throughout its life. LCA attempts to quantify what comes in and what goes out of a product from "cradle to grave," including the energy and material associated with materials extraction, product manufacture and assembly, distribution, use and disposal and the environmental emissions that result. LCA applications are governed by the ISO 14040 series of standards (<http://www.iso.org>).

**local hectare:** A productivity weighted area used to report both the biocapacity of a local region, and the demand on biocapacity (the Ecological Footprint). The local hectare is normalized to the area-weighted average productivity of the specified region's biologically productive land and water. Hence, similar to currency conversions, Ecological Footprint calculations expressed in global hectares can be converted into local hectares in any given year (e.g., Danish hectares, Indonesian hectares) and vice versa. The amount of Danish hectares equals the amount of bioproductive hectares in Denmark – each Danish hectare would represent an equal share of Denmark's total biocapacity.

**National Footprint Accounts:** The central data set that calculates the Footprints and biocapacities of the world and roughly 150 nations from 1961 to the present (generally with a three year lag due to data availability). The ongoing development, maintenance and upgrades of the National Footprint Accounts are coordinated by Global Footprint Network and its 70 plus partners.

**overshoot:** Global overshoot occurs when humanity's demand on nature exceeds the biosphere's supply, or regenerative capacity. Such overshoot leads to a depletion of Earth's life supporting natural capital and a buildup of waste. At the global level, ecological deficit and overshoot are the same, since there is no net-import of resources to the planet. Local overshoot occurs when a local ecosystem is exploited more rapidly than it can renew itself.

**parent product:** The product processed to create a daughter product. For example wheat, a primary product is a parent product of flour, a secondary product. Flour, in turn, is a parent product of bread.

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**Planet Equivalent(s):** Every individual and country's Ecological Footprint has a corresponding Planet Equivalent, or the number of Earths it would take to support humanity's Footprint if everyone lived like that individual or average citizen of a given country. It is the ratio of an individual's (or country's per capita) Footprint to the per capita biological capacity available on Earth (2.1 gha in 2005). In 2005, the world average Ecological Footprint of 2.7 gha equals 1.3 Planet Equivalents.

**primary product:** In Footprint Studies a primary product is the least processed form of a biological material that humans harvest for use. There is a difference between the raw product, which is all the biomass produced in a given area, and the primary product, which is the biological material humans will harvest and use. For example, a fallen tree is a raw product that, when stripped of its leaves and bark, results in the primary product of round wood. Primary products are then processed to produce secondary products like wood pulp, paper, and so on. Other examples of primary products are potatoes, cereals, cotton, or forage. Examples of secondary products are kWh of electricity, bread, clothes, beef, or appliances.

**primary production Footprint (also primary demand):** In contrast to the consumption Footprint, a nation's primary production Footprint is the sum of the Footprints for all of the resources harvested and all of the waste generated within the defined geographical region. This includes all the area within a country necessary for supporting the actual harvest of primary products (cropland, pasture land, forestland and fishing grounds), the country's built-up area (roads, factories, cities), and the area needed to absorb all fossil fuel carbon emissions generated within the country. In other words, the forest Footprint represents the area necessary to regenerate all the timber harvested (hence, depending on harvest rates, this area can be bigger or smaller than the forest area that exists within the country). Or, for example, if a country grows cotton for export, the ecological resources required are not included in that country's consumption Footprint; rather, they are included in the consumption Footprint of the country that imports the t-shirts. However, these ecological resources **are** included in the exporting country's primary production Footprint.

**productivity:** The amount of biological material useful to humans that is generated in a given area. In agriculture, productivity is called yield.

**road fuel exports:** The Luxembourg's Ministry of Sustainable Development speaks about 'road fuel exports' when considering fuel emissions of non-residents. By definition of the Ministry, 'road fuel exports' include the commuters' part, gasoline tourism and transit. [MDD, 2009]

**secondary product:** All products derived from primary products or other secondary products through a processing sequence applied to a primary product.

**transit:** transit traffic passing through Luxembourg [MDD, 2009]

**yield:** The amount of regenerated primary product, usually reported in tonnes per year, that humans are able to extract per area unit of biologically productive land or water.

**yield factor:** A factor that accounts for differences between countries in productivity of a given land type. Each country and each year has yield factors for cropland,

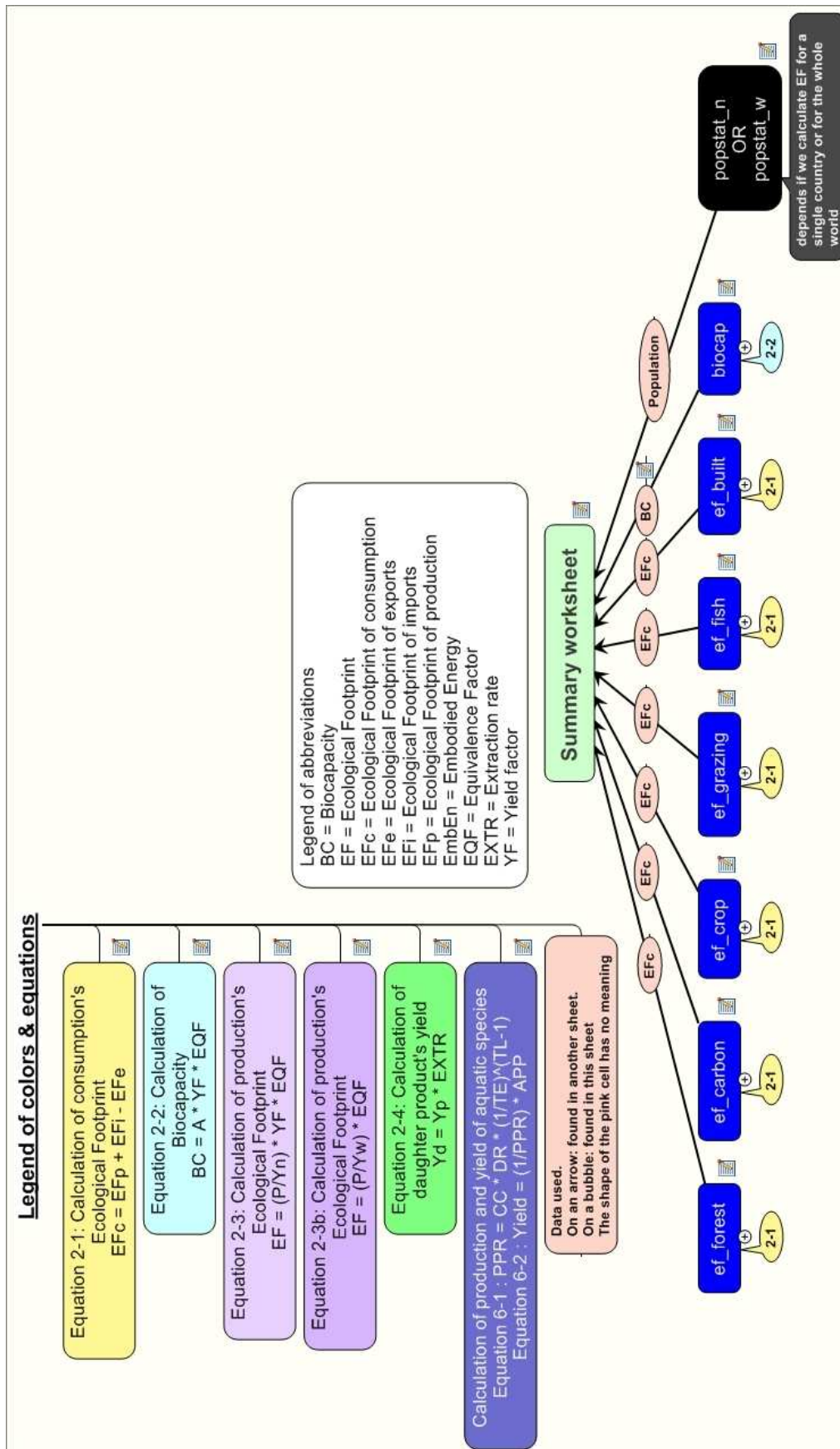
grazing land, forest, and fisheries. For example, in 2005, German cropland was 2.3 times more productive than world average cropland. The German cropland yield factor of 2.3, multiplied by the cropland equivalence factor of 2.6 converts German cropland hectares into global hectares: one hectare of cropland is equal to 6.0 gha.

Note that primary product and primary production Footprint are Footprint specific terms. They are not related to, and should not be confused with the ecological concepts of primary production, gross primary productivity (GPP) and net primary productivity (NPP).

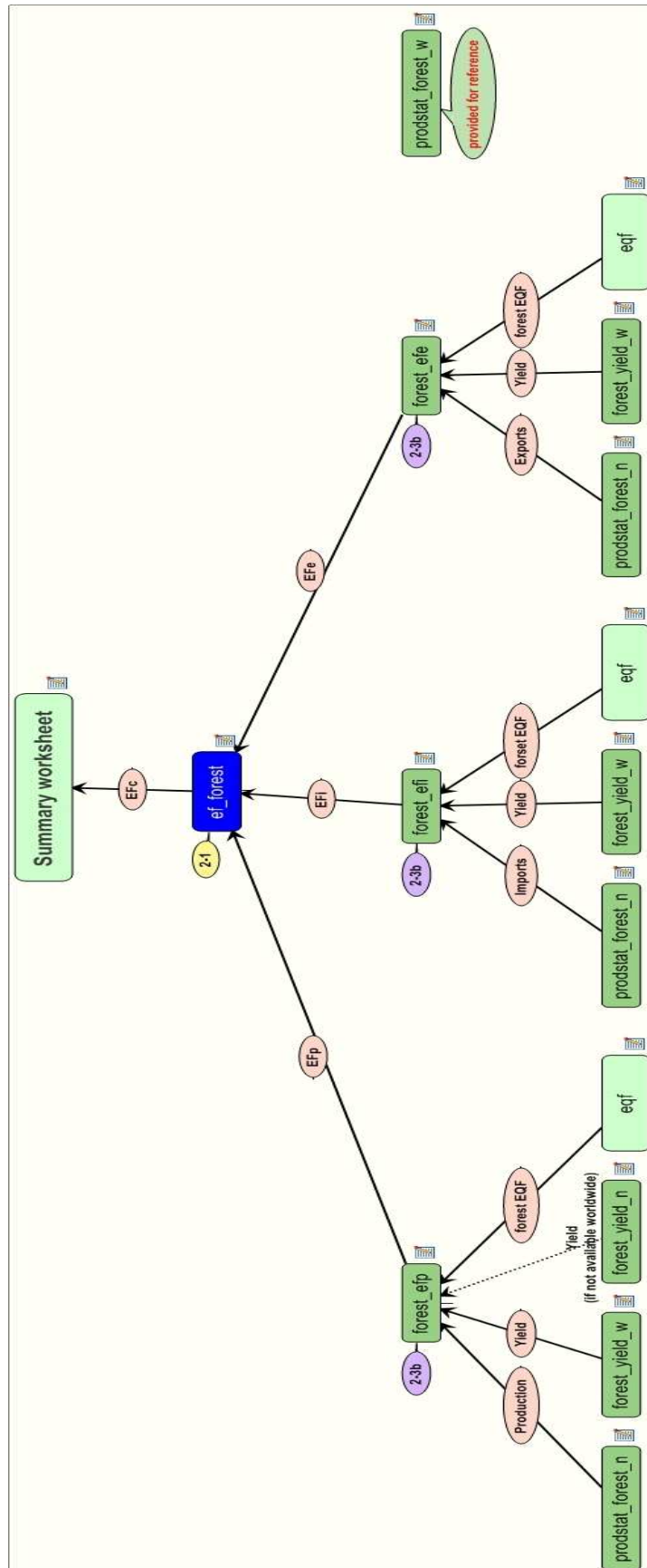
## A-2. Key Words Translation

English	German	Luxembourgish	French
Biocapacity	Naturkapital / Biokapazität	Naturkapital	Capital naturel / biocapacité
Ecological Footprint	Ökologischer Fußabdruck	Ökologesche Foussofdrock	Empreinte écologique
Consumption Footprint	Verbrauchsfußabdruck / Konsumfußabdruck	Verbrauchs-foussofdrock / Konsumfoussofdrock	Empreinte du consommateur / Empreinte de la consommation
Production Footprint	Produktionsfußabdruck	Produktiouns-foussofdrock	
Food Footprint	Fußabdruck Ernährung / Nahrungsmittel / Lebensmittel	Nahrungsméttel Foussofdrock / Foussofdrock Ernährung	Empreinte de la nourriture
Non-Food Products & Services	Non-Food Produkte & Dienstleistungen	Non-Food Produkter & Servicer	Produits non-alimentaires & services
Transport / Mobility	Transport / Mobilität	Transport / Mobilitéit	Transport / Mobilité
Road Fuel Exports	Kraftstoffexport	Bensinsexport	Export de carburant
Fuel Tourism	Tanktourismus	Bensinstourissem / Tanktourismus	Tourisme à la pompe

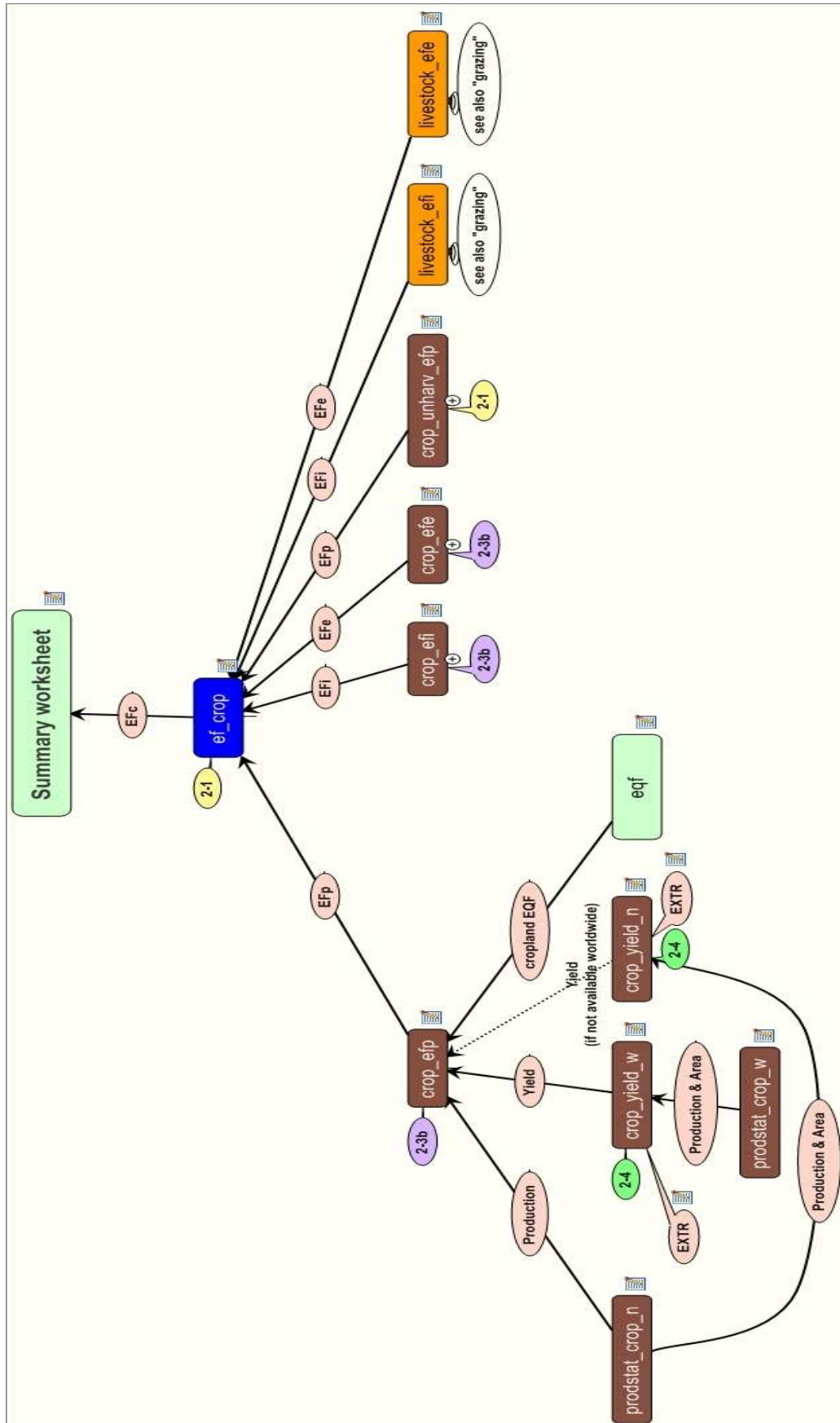
### A-3. Legend for Consumption Mind Maps per Land Type



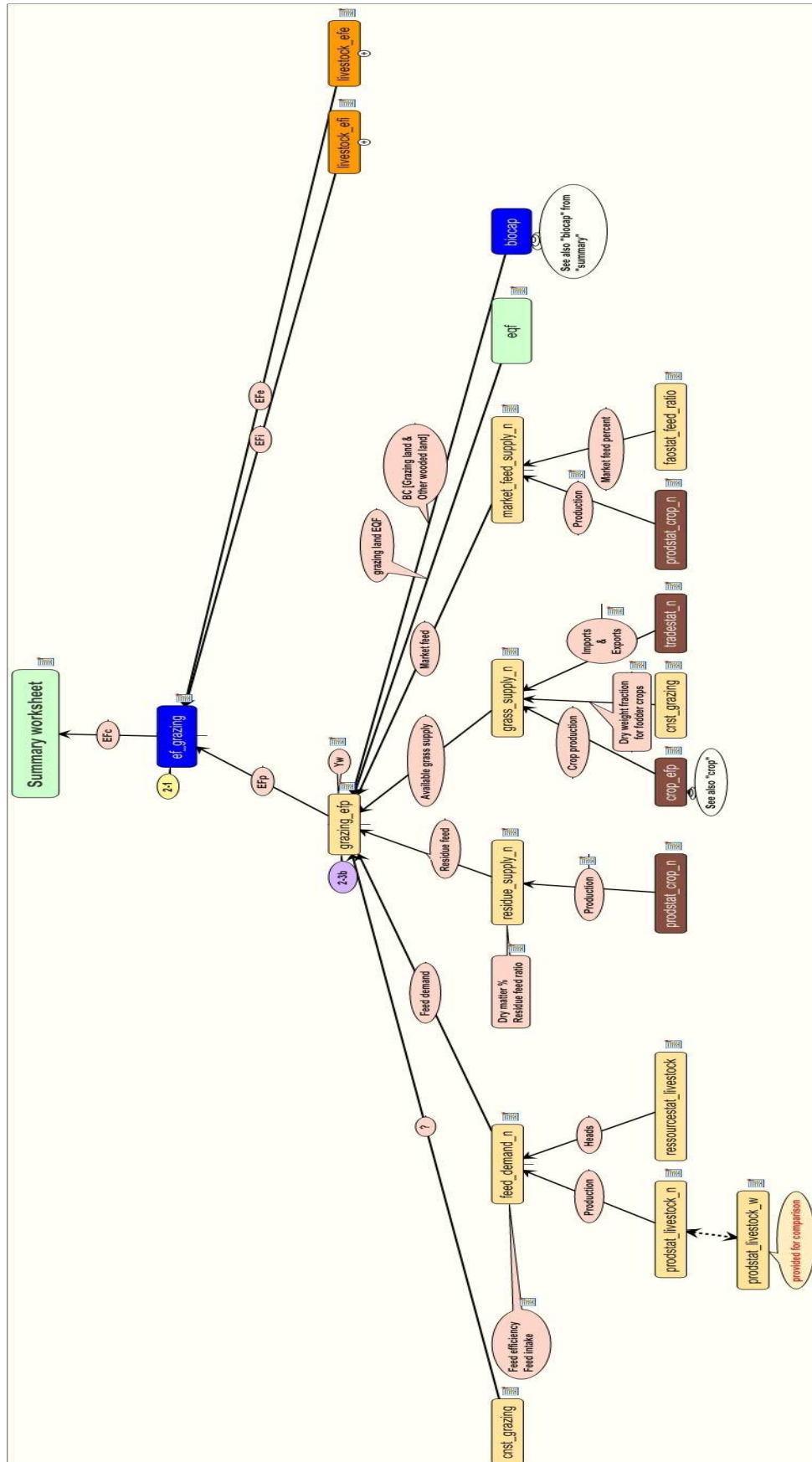
## A-4. Forest Consumption Mind Map



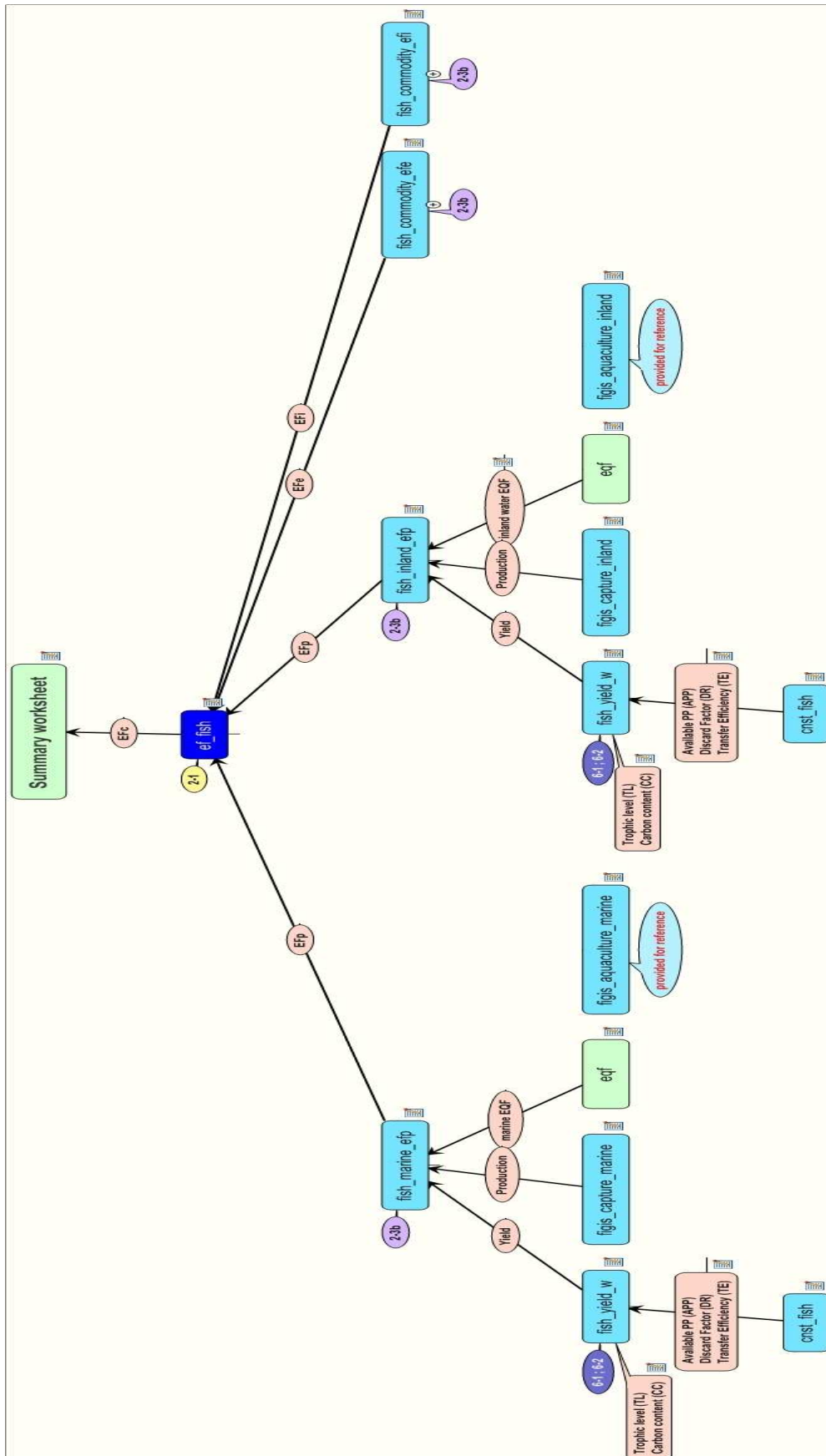
## A-5. Cropland Production Mind Map



## A-6. Grazing Land Production Mind Map



## A-7. Fishing Grounds Production Mind Map





## A-9. Publication List of the Global Footprint Network

The mentioned reports are freely available at:

[http://www.footprintnetwork.org/en/index.php/GFN/page/reading\\_and\\_references/](http://www.footprintnetwork.org/en/index.php/GFN/page/reading_and_references/)

Year	Title and Content
2008	<b>Calculation Methodology for the National Footprint Accounts, 2008 Edition</b> Description of the Ecological Footprint methodology
2008	<b>Guidebook to the National Footprint Accounts: 2008</b> Detailed description of the National Footprint Accounts, including content, structure and data sources
2008	<b>A research agenda for improving national Ecological Footprint accounts</b> 26 research topics reflecting the major concerns and suggestions of the Global Footprint Network
2009	<b>Ecological Footprint Standards 2009</b> Standards for Ecological Footprint studies of countries, cities, businesses and products

## A-10. Strength and Weaknesses of the Ecological Footprint

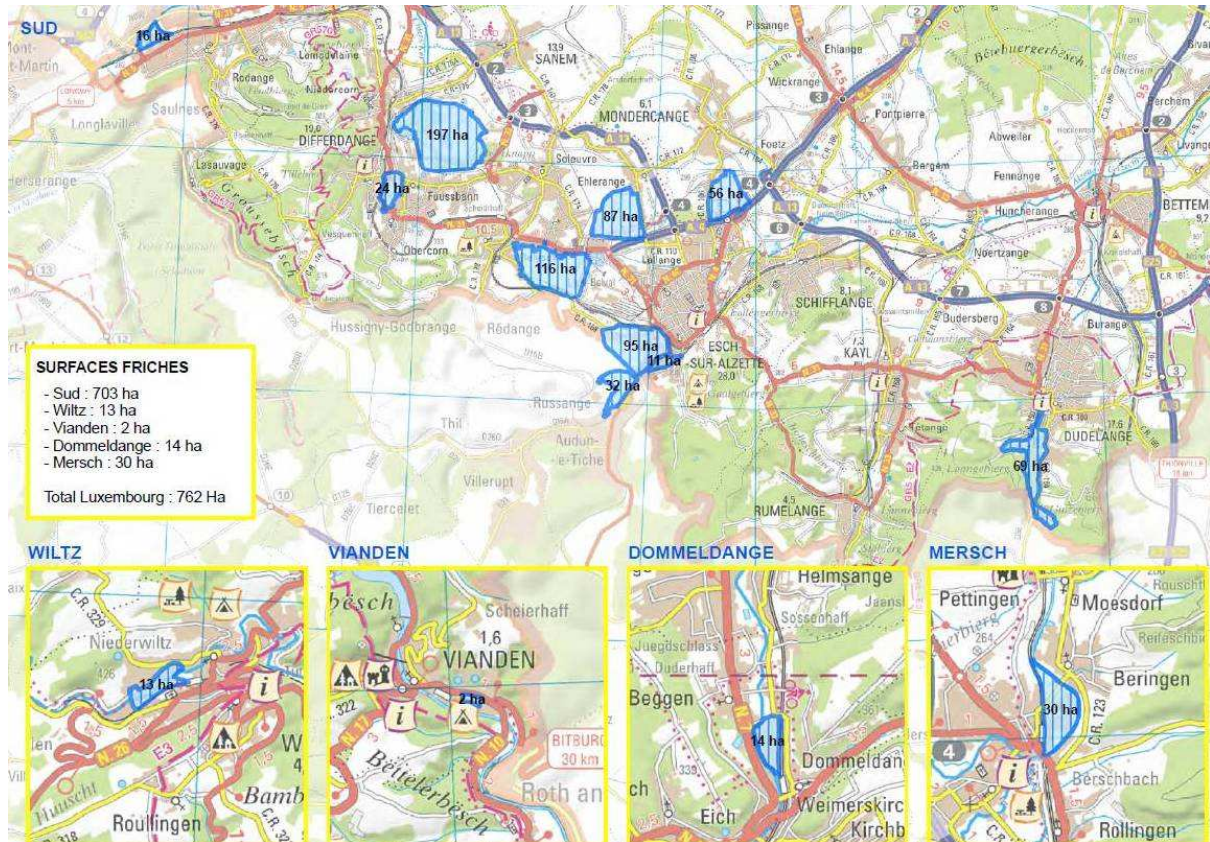
Legend not accounted in the Ecological Footprint not well enough accounted very well accounted causes problems in the calculation  Sources →	European Commission Study (Best et al., 2008)	Germany Study (Gijlum et al., 2007)	Current methods for calculating national EF accounts (Kitzes et al., 2007)	Research Agenda 2009 (Kitzes et al., 2009a)	Answers to common questions in Ecological Footprint accounting (Kitzes et al., 2009)	Shared producer and consumer responsibility (Lenzen et al., 2007)	Measuring sustainable development – Nation by nation (Moran et al., 2008a)	United Kingdom Study (DEFRA, 2007)	Switzerland Study (von Stokar et al., 2006)	Living Planet Report (WWF, 2008)
<b>STRENGTH</b>										
Communication and education	x	x						x		
World-wide environmental implications	x									
Macro perspective		x								
Comparison of different levels of social activities	x	x			x					
Comparison of data through time	x	x								x
Testing different scenarios	x									x
Consumption Footprint	x	x		x		x				x
Human consumption vs. ecosystems' available capacity	x	x					x			x
Production Footprint	x					x				
Exported goods' Footprint		x								
<b>METHODOLOGY WEAKNESSES</b>										
Greenhouse gases other than CO <sub>2</sub>	x	x	x	x				x		
Wetlands, estuaries, lands not useful for humans	x	x		x	x			x		
Toxic substances, eco-toxicity	x			x	x					x
Other pollutants due to fossil fuel combustion	x								x	
Pollutants due to crop use (nutrients leaching,...)	x			x						
Environmental damages (freshwater, overuse...)	x	x	x	x	x			x	x	x
Unsustainable activities (persistent pollutants)	x		x	x	x			x	x	
Non-renewable resources	x	x		x	x				x	
Toxic substances, eco-toxicity	x			x	x					x
Local/real land-use (global vs. national hectare)	x	x		x				x		
Different land-uses on a same real land	x	x			x			x		
Controversial carbon (and nuclear) Footprint	x	x	x	x				x	x	x
Biocapacity left for wild species	x	x		x	x				x	x
Producer's responsibility				x		x		x		x
Built-up land's productivity		x		x				x		
Lack of transparency	x	x							x	
Using national factors		x							x	
Capping factor to grazing land		x						x		
Footprint tends to be too small			x						x	
Non-fossil energy sources		x								
Methodological inconstancy				x						
Fishery yields: assumptions	x	x		x				x		
Aggregates different environmental categories	x	x		x	x					
Macro perspective	x	x						x		
Based upon assumptions	x	x								
Over-simplicity	x				x					
Animal feed volume and energy contents: assumptions		x						x		
Crops grown marginal/primary cropland: assumptions								x		
<b>DATABASE</b>										
Footprint due to tourism	x	x	x	x				x	x	
Data quality and completeness	x	x		x				x	x	
Need of additional data for sub levels calculation	x									

Greenhouse gases other than CO <sub>2</sub>	x	x	x	x				x		
Greenhouse gases other than CO <sub>2</sub>	x	x	x	x				x		
Data quality and completeness	x	x		x				x	x	
Toxic substances, eco-toxicity	x			x	x					x
Crops excluded (honey, hops...)		x						x		
Other pollutants due to fossil fuel combustion	x								x	
Pollutants due to crop use (nutrients leaching, ...)	x			x						
TO BE CORRECTED										
Calculation factors heterogeneous, subjective, unclear	x	x						x	x	
Fishmeal calculation: known bug		x						x		
Milk footprint: known bug		x						x		
Fish oil in animal products: known bug		x						x		
Energy from feed based on human digestion								x		
Calculation of embodied CO <sub>2</sub> /primary products	x	x		x		x		x	x	
Trades (production vs. imports vs. consumption)	x	x						x	x	
OUT OF SCOPE										
Future	x	x	x	x	x			x		x
Loss of biodiversity	x			x	x			x	x	x
Socio-economic aspects	x				x				x	x
Environmental benefits of concentrated population								x		
Unsustainable activities (persistent pollutants)	x		x	x	x			x	x	
Non-renewable resources	x	x		x	x				x	
Environmental damages are indirectly accounted	x		x	x					x	x
Sustainable footprint: necessary but not sufficient	x									
ANALYSIS										
No sensitivity analysis has been done	x	x		x						
No quality control	x	x								

## A-11. Data Comparison for Forest Products (exhaustive list)

	Production 2005		Imports 2005		Exports 2005	
	[m <sup>3</sup> /yr]	[t/yr]	[m <sup>3</sup> /yr]* or [t/yr]**	[t/yr]	[m <sup>3</sup> /yr]* or [t/yr]**	[t/yr]
	Int. Data	LU Data	Int. Data	LU Data	Int. Data	LU Data
Wood Fuel (C)	5,371		-	-	-	-
Wood Fuel (NC)	7,393		-	-	-	-
Wood Fuel Traded	-		345*	877	58,000*	41,509
Saw logs + Veneer Logs (C)	75,504		-	-	-	-
Pulpwood, Round & Split (C)	8,787		-	-	-	-
Pulpwood, Round & Split (NC)	112,814		-	-	-	-
Saw logs + Veneer Logs (NC)	60,878		-	-	-	-
Pulpwood + Particles (C)			-	179,341	-	99,034
Pulpwood + Particles (NC)			-	680	-	80
Other Industrial Round wood (C)	5,870		-	-	-	-
Other Industrial Round wood (NC)	1		-	-	-	-
Industrial Round wood Wir (C)			312,765*	594,162	264,250*	121,320
Industrial Round wood Wir (NC) Tropical			428*	28	59*	11
Industrial Round wood Wir (NC) Other			92,380*	257,235	27,747*	16,306
Sawn wood (C)	113,000		43,838*	25,263	50,122*	20,612
Sawn wood (NC)	20,000		14,237*	15,561	4,844*	58,572
Veneer Sheets			237*	191	2*	-
Plywood			11,340*	7,727	148*	133
Particle Board	200,000		23,690*	8,129	209,347*	108,723
Hardboard			4,897*	-	1,511*	-
MDF	250,000		4,171*	-	3,053*	-
Fiberboard, Compressed			-	10,254	-	112,806
Insulating Board			5,557*	-	170,766*	-
Wood Charcoal			1,335*	1,225	15*	23
Semi-Chemical Wood Pulp			-	71	-	-
Chemical Wood Pulp			28*	28	-	-
Newsprint			10,901**	13,835	40**	-
Printing + Writing Paper			93,739**	93,731	8,494**	4,625
Other Paper + Paperboard			91,221**	114,239	31,874**	140,211
<b>Sources:</b>						
Int.: FAO ForesSTAT Statistical Database: <a href="http://faostat.fao.org/site/626/default.aspx#ancor">http://faostat.fao.org/site/626/default.aspx#ancor</a>						
LU: STATEC: Luxembourg's external trade statistics (provided by STATEC on request)						

## A-12. Waste Land in Luxembourg



Source: Ministry of Sustainable Development and Infrastructure

## A-13. Distribution of Total Road Fuel Consumption in 2005 - Calculation Steps

Fuel Type	Consumption (GJ)	Percentage
Gasoline	21,721,390 GJ	23%
Diesel	74,219,704 GJ	77%
<b>Total</b>	<b>95,941,094 GJ</b>	<b>100%</b>

Consumer Category	Percentage
Inland Road Fuel Consumption	22%
Road Fuel Exports	78%
<b>Total</b>	<b>100%</b>

Road Fuel Exports per Consumer	Gasoline	Diesel	Total
Commuters	18% <sup>55</sup>	60% <sup>56</sup>	78%
Gasoline tourism			
Transit			

Consumer	Gasoline		Diesel		Reference
Inhabitants	24%		11%		Thöne, M. (2008), p.43
Commuters	14%	76%	17%		Thöne, M. (2008), p.44
Gasoline tourism	25%		10%	89%	Thöne, M. (2008), p.45
Transit	37%		62%		72%
			100%		100%

Consumer	Gasoline	Diesel	Total (factors applied in this study)
Inhabitants	-	-	22%
Commuters	3% <sup>57</sup>	12% <sup>58</sup>	15%
Gasoline Tourism	6% <sup>59</sup>	6% <sup>60</sup>	12%
Transit	9% <sup>61</sup>	42% <sup>62</sup>	51%
<b>Total</b>	<b>18%</b>	<b>60%</b>	<b>100%</b>

<sup>54</sup> Source: Copert IV, excel file sent by Eric De Brabanter (MDDI), 26<sup>th</sup> of November 2009

<sup>55</sup> Total gasoline consumption x road fuel exports:  $0.78 \times 0.23 = 0.18$

<sup>56</sup> Total diesel consumption x road fuel exports:  $0.78 \times 0.77 = 0.60$

<sup>57</sup> Proportion of commuter's gasoline consumption x gasoline exports:  $0.14 / 0.76 \times 0.18 = 0.03$

<sup>58</sup> Proportion of commuter's tourism consumption x diesel exports:  $0.17 / 0.89 \times 0.60 = 0.12$

<sup>59</sup> Proportion of tourism's gasoline consumption x gasoline exports:  $0.25 / 0.76 \times 0.18 = 0.06$

<sup>60</sup> Proportion of tourism's diesel consumption x diesel exports:  $0.10 / 0.89 \times 0.60 = 0.06$

<sup>61</sup> Proportion of transit's gasoline consumption x gasoline exports:  $0.37 / 0.76 \times 0.18 = 0.09$

<sup>62</sup> Proportion of transit's diesel consumption x diesel exports:  $0.62 / 0.89 \times 0.60 = 0.42$

## A-14. Commuters Consumption Footprint Subcategory Land Use Matrixes (SLUM)

in [gha]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	39,125	286,792	431,163	<b>757,080</b>
Cropland	-	71,784	-	-	<b>71,784</b>
Grazing Land	-	15,150	-	-	<b>15,150</b>
Forest Land	-	-	-	40,206	<b>40,206</b>
Fishing Grounds	-	5,278	-	-	<b>5,278</b>
<b>Total</b>	-	<b>131,337</b>	<b>286,792</b>	<b>471,369</b>	<b>889,498</b>
in [%]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	4%	32%	48%	<b>84%</b>
Cropland	-	8%	-	-	<b>8%</b>
Grazing Land	-	2%	-	-	<b>2%</b>
Forest Land	-	-	-	5%	<b>5%</b>
Fishing Grounds	-	1%	-	-	<b>1%</b>
<b>Total</b>	-	<b>15%</b>	<b>32%</b>	<b>53%</b>	<b>100%</b>
Commuter's Footprint in [gha/capita] <sup>63</sup>	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	0.08	0.61	0.92	<b>1.61</b>
Cropland	-	0.15	-	-	<b>0.15</b>
Grazing Land	-	0.03	-	-	<b>0.03</b>
Forest Land	-	-	-	0.09	<b>0.09</b>
Fishing Grounds	-	0.01	-	-	<b>0.01</b>
<b>Total</b>	-	<b>0.27</b>	<b>0.61</b>	<b>1.01</b>	<b>1.89</b>

<sup>63</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).

## A-15. Fuel Tourism and Transit Consumption Footprint Subcategory Land Use Matrixes (SLUM)

in [gha]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	-	1,225,412	-	<b>1,225,412</b>
Cropland	-	-	-	-	-
Grazing Land	-	-	-	-	-
Forest Land	-	-	-	-	-
Fishing Grounds	-	-	-	-	-
<b>Total</b>	-	-	<b>1,225,412</b>	-	<b>1,225,412</b>
in [%]	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	-	100%	-	<b>100%</b>
Cropland	-	-	-	-	-
Grazing Land	-	-	-	-	-
Forest Land	-	-	-	-	-
Fishing Grounds	-	-	-	-	-
<b>Total</b>	-	-	<b>100%</b>	-	<b>100%</b>
<b>Gasoline Tourism's and Transit's Footprint in [gha/capita]<sup>64</sup></b>	Housing	Food	Road Transport / Mobility	Non-Food Products & Services	Total
Built-up Land	-	-	-	-	-
CO <sub>2</sub> (Carbon Uptake Land)	-	-	2.61	-	<b>2.61</b>
Cropland	-	-	-	-	-
Grazing Land	-	-	-	-	-
Forest Land	-	-	-	-	-
Fishing Grounds	-	-	-	-	-
<b>Total</b>	-	-	<b>2.61</b>	-	<b>2.61</b>

<sup>64</sup> Calculation based on 469,100 inhabitants (STATEC data for the year 2005, 31<sup>st</sup> of December 2005).