Indicators complementary to GDP

Ecological footprint and biocapacity of Wallonia *
1st exercise, April 2014

In November 2012, the Walloon Government asked the IWEPS to develop and calculate consolidated indicators complementary to GDP. The priority indicators defined by the Walloon Government include the ecological footprint and biocapacity of Wallonia.

To carry out this task, the IWEPS entrusted the production of an initial estimate of this double indicator for the period from 2002 to 2012 to a consortium of three consultants, EcoRes, EcoLife and the ICEDD.

This document summarises this work. First of all it defines ecological footprint and biocapacity. After that it addresses the steps of the calculation performed for Wallonia, then describes the main results. Finally, the document draws lessons from this first exercise, indicates their limits and potential uses before closing with paths for development.

1. Definition

The ecological footprint provides summary information about certain pressures exerted on the natural capital by an individual or a group according to their means of consumption and production. This indicator is often used as a communication tool to raise awareness among the general public of the pressure exerted on the environment by our lifestyles.

More precisely, the ecological footprint (EF) accounts the demand for ecological services made each year by man on nature. The indicator is a measure of how much area of biologically productive land and water an individual, population or activity requires to produce all the resources he, she or it consumes and to absorb the waste he, she or it generates, using prevailing technology and resource management practices. The EF is calculated using a system of accounts that adds together the consumption of primary products after having expressed them in the same conventional unit, known as the global hectare[1]. Put another way, it is the sum of distinct (mutually exclusive[2]) areas, supplying renewable resources and assimilating waste, which are required to meet the demands of a population (Wackernagel *et al.* 2005. p. 7).

Schematically, the quantities of goods and services consumed are transformed into areas (ha) grouped together by large categories of land (cropland, grazing land, fishing ground, forest, built-up land, land for

* Translated from original French version by DATA-TRANSLATIONS

[1] A global hectare (gha) is a hectare (ha) of land or water, the biological productivity of which is equivalent to the mean global productivity.

[2] To avoid double counting, each area is recognised just once, for its main use, even if this area actually provides multiple ecological services.

capturing CO_2) using yield factors[3], then into global hectares after being multiplied by equivalence factors[4]. Because the EF only records consumption of primary products, derived goods (secondary or tertiary) are weighted in advance by extraction factors or specific conversion rates. However, in the case of production on the territory being studied, the energy required for the transformation process is taken into account in the footprint of the land linked to the emissions of CO_2.

As for biocapacity (BC), it represents the capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies (definition of the Global Footprint Network, 2014). It therefore concerns all the biologically available areas in a territory.

The comparison of the estimated values of the EF (demand) and BC (available supply) provides information about the level of degradation or not of the natural capital. A country or region, the footprint of which exceeds the biocapacity, is in a situation of ecological deficit. Conversely, an excess of biocapacity in relation to the footprint reflects an ecological reserve.

The EF and BC were conceived by Mathis Wackernagel and William Rees (University of British Columbia in Vancouver, Canada). Developed since 1996, they are calculated by country every two years at the instigation of the Global Footprint Network (GFN), which acts as depositary of the calculation protocol of the EF and BC. The latter is constantly evolving, and is the subject of significant research. Since 2003, the GFN has coordinated this work at international level through its programme of National Footprint Accounts (NFA). Due to regular methodological advances, it is therefore important, when comparing EF or BC results, to take account of the year of the protocol used for the calculation.

In addition to the calculations of the GFN, but taking its protocol as a basis, several calculations of ecological footprint and biocapacity have been performed for Belgium and Flanders. For Belgium, the ecological footprint was calculated in 2008, for 2005, using the GFN standards of 2008 (Janssen L., 2008). For Flanders, the ecological footprint was calculated for the first time in 2010, for 2004, with the GFN standards of 2010 (Bruers S. & Verbeeck, B., 2010). An update was carried out in 2013 for Flanders for the years 2004 to 2009, always using the GFN standards of 2010 (Bruers S. & Vandenbergh K., 2014).

2. Method

2.1. Application to the Walloon context

For Wallonia, this study covers the years 2002 to 2012, the comparison of the results over time being one of the preferred objectives of the request of the Walloon Government. The restriction to this period is primarily due to the availability of regionalised foreign trade statistics.

To try and be as up to date as possible, the latest available GFN standards, those for 2012, were used in the exercise. However, an adaptation to 2010 version was also undertaken for one year, serving both as an analysis of sensitivity and as a possible point of comparison with the studies conducted for Flanders.

Like the aforementioned exercises, the calculation performed for Wallonia is based on a so-called “top-down” approach that is more exhaustive and, in principle, more comparable with the estimates generally made for the countries and regions. This “macro-economic” method consists of deducing the apparent consumption of biological materials of the residents of a territory by deducting from their production and imports the materials they have exported. It contrasts with “bottom-up” approaches, which could, for example, be based on the

[3] The yield factors translate the productivity, or the quantity of biological material per hectare, of the land of the country or region being studied.

[4] The equivalence factors express the relationship between the productivity of a type of area of a country or region and the mean global productivity.

mean consumption data of households; more "micro-economic", these approaches are generally used for smaller groups of people.

In concrete terms, the calculation of the EF of production and the BC is based on regional land use data, on the use of materials and energy by the households, communities and enterprises on Walloon territory. The EF of imports and exports is calculated from regionalised foreign trade statistics for Belgium and on the national biophysical data published by the FAO.

Furthermore, as mentioned in the definition, two weighting factors are used to normalise the different types of area and obtain a conventional unit, known as the "global hectare": yield factors and equivalence factors. As far as possible - in practice for the measurement of the biocapacity of cropland - preference was given to the yield factors specific to Wallonia. Failing this, the estimates for Belgium were used. As for the equivalence factors, they were taken from the GFN standards for 2012.

2.2. The categories of land

The ecological footprint and biocapacity only concern biologically productive areas, grouped into six major categories:

1. Cropland: this represents the area of land required for agricultural production, including crops intended to feed livestock (non-grazing forage) and fish, oilseed crops and sustainable plant crops. Horticultural crops are not considered, but the corresponding areas are still included in the calculation of the biocapacity of cropland.

2. Grazing land (for livestock production): this category measures the area of grassland used for livestock production in addition to crop products. Grazing land includes any type of grassland intended to support livestock, whether wild or semi-natural.

3. Fishing ground: this category, which is relatively marginal in Wallonia, includes the areas required for the production of saltwater and freshwater fish, crustaceans and cephalopods, etc.

4. Forest: this category brings together the areas of forest required to generate the forest products consumed by a population, including those used to produce products made of wood (sawdust, wood panels or fibreboard, paper pulp, paper and card) as well as the wood or its sub-products used as fuel[5].

5. Built-up land: this category includes the area occupied by the private and public infrastructures on which a population depends. It includes the total surface area of the entire built-up environment used for housing, transport, industrial production and the generation of electricity, as well as land made unfit for agriculture.

6. Land for the capture of CO_2 (carbon sinks): this category conventionally represents the area of forest that would be used to capture the CO_2 produced by the burning of fossil fuels in a sufficient quantity to avoid an increase in the amount of CO_2 in the atmosphere. This area is calculated after having deducted from the anthropogenic emissions of CO_2 that portion that has been absorbed by the oceans (around 30%). This category is the only one without an explicitly defined biocapacity.

[5] This category of forest land includes forests currently in use (timber harvesting), regardless of use, apart from the capture of CO_2. Unused forests come under the category "land for the capture of CO_2", since they present a biocapacity potential to absorb excess CO_2. There are therefore forests that determine a forest biocapacity. If they are used, there is an ecological footprint of their use (timber, fuel, etc.). If they are not used, they give a biocapacity margin that could absorb excess CO_2 (for a limited time).

For each of these land uses, an ecological footprint and a biocapacity are calculated, according to various hypotheses.

2.3. Steps, calculation formulae and hypotheses

2.3.1. Biocapacity

To calculate the biocapacity (BC) of a territory, each type of bioproductive area of said territory (cropland, grazing land, forest, interior fishing ground and oceans and built-up land) is multiplied by its yield factor (specific to the territory) and by its equivalence factor (the same for all countries for a given year). Here is the mathematical formula:

$$BC_i(gha) = S_i(ha)\ x\ FR_{iN}(\frac{ha_M}{ha})\ x\ FEQ_i({}^{gha}/_{ha_M}) \qquad (1)$$

Where BC = Biocapacity in gha

S_i = Area of land of type "i" of the country (e.g.: in Wallonia)

FR_{iN} = Yield factor for a type of area "i" for a given country "N"

FEQ_i= Equivalence factor for a type of area "i" for a given year

The total biocapacity of a territory is therefore the sum of the specific biocapacities of each type of area: arable land, grazing land, fishing ground, forest and developed areas.

$$BC = \sum BC_i \qquad (2)$$

Forests have a dual-function biocapacity. They must support the production of forest products and the capture of CO_2 linked to the consumption of energy.

2.3.2. Ecological footprint

Calculations of the ecological footprint are in turn performed in multiple stages:

- The evaluation of consumptions of goods for each type of harvested area (for example, the tonnes of wheat consumed);
- The conversion of these consumptions into specific productive areas (for example, the area of cropland needed for the annual production of wheat consumed in the country where this wheat comes from);
- The conversion of the specific areas into standard areas, to take account of the different production yields of all the productive areas;
- The adding together of all the standard areas, to obtain the total area needed for the production of the goods consumed, which corresponds to the EF.

For each type of primary product consumed, the formula of the ecological footprint may therefore be summarised as follows:

$$EE(gha) = \sum Quantity\ (t) * \frac{1}{R\ ({}^{t}/_{ha})} * FR\left(\frac{ha_M}{ha}\right) * FEQ({}^{gha}/_{ha_M}) = \sum Quantity\ (t) * \frac{FEQ({}^{gha}/_{ha_M})}{R_M({}^{t}/_{ha_M})} \qquad (3)$$

The quantity of product used is therefore weighted by the equivalence factor of the corresponding type of land and divided by the global yield.

For secondary or tertiary products derived from a primary product (flour, for example) or from another secondary product (bread, for example), the method is also based on “extraction ratios” or specific conversion rates. Most of the time, these ratios represent the mass ratio between the secondary product and the quantity of primary product that was needed to produce this derived product. The yield factor of the secondary product is thus weighted by the extraction ratio. This weighting is standardised at a global level. They are therefore identical for all countries and are defined in the standard data of the GFN method:

$$FR_{secondary\ product} = FR_{primary\ product}\ x\ EXTR_{secondary\ product} \quad (4)$$

Where $FR_{secondary\ product}$ is the yield factor for the secondary product

Where $FR_{primary\ product}$ is the yield factor for the primary product

$EXTR_{secondary\ product}$ is the conversion rate defined by the GFN to weight the yield factor.

These calculations vary for the different categories of land, such that the total footprint is equal to: $\mathrm{EE} = \sum \mathrm{EE_i}$ (5)

In addition, in line with the top-down approach used, the so-called consumption footprint may be obtained as follows

$$EE(gha) = [production + import\ -\ export\ (t)] * \frac{FEQ(^{gha}/_{ha_M})}{R_M(^{t}/_{ha_M})} \quad (6)$$

In this context, “consumption” should therefore be understood as meaning all the final uses of biological materials made by the residents of the territory being studied, and not only the final consumption of individual households[6].

As for production - estimated on the basis of the regional data on land use[7] and use of materials and energy by the households, public administrations and enterprises that operate in Wallonia - it only recognises primary products, to avoid double counting. Primary products implicitly contain all the secondary and tertiary products. However, the useful energy for the transformation process is taken into account through the calculation of the footprint of land linked to emissions of CO_2[8].

The formula “production+import-export” is valid for all products. In principle, it provides a correct estimate of consumption at national level. However, at regional level, the ideal should be to record as imports and exports those product flows that not only come from or go to a foreign destination, but also those flows that come from or are destined for other regions of the country. But the lack of measurements of these inter-regional flows in the statistics may create a bias in the footprint measurement, a bias the study tried to measure for Wallonia (cf. below).

2.3.3. Sources of data

[6] In this sense, the “consumption” footprint can therefore be compared with the notion of “final domestic demand” taken from economic accounts.

[7] Including the non-productive use of land, or recreational uses and infrastructures, use linked to discharges, to waste management and emissions of CO_2.

[8] For example, if a tonne of sugar beet is produced, it is the footprint of this tonne of beet that will be taken into account, and the imprint of the sugar that will be produced using these beets will not be recognised to avoid double counting. However, the useful energy for the transformation process to produce this sugar will be taken into account through the calculation of the footprint of land linked to emissions of CO_2. This way of avoiding double counting while recognising a complementary value refers, in a manner, to the concept of added value in economic terms. The footprint of production may therefore be juxtaposed with GDP.

The application of the EF on a national scale largely uses public statistics (production, import, export, etc.) available at national level, in particular through the FAO. As mentioned previously, its calculation at regional level is heavily dependent on the existence of statistics with the same level of detail.

The table below presents the various data used in this study and taken from the administration, statistical institutes and other agencies, focusing on regional data where these were available. It also details the hypotheses that had to be made to compensate for the possible absence of data for the period covered by the study.

Table 1: List and sources of data

Dimensions	Indicators	Units	Sources	Calculations	Available period
Energy consumptions and emissions linked to the consumption of energy	Gross domestic consumption	PJ (petajoule)	ICEDD-SPW.DGO4, Annual Walloon energy audits	ICEDD	2002 to 2011 and provisional data for 2012
Generation of electricity (generation of hydroelectricity, trade balances)	Products or balances of the trade balance	GWh (gigawatt-hour)	ICEDD, SPW.DGO4 Annual Walloon energy audits	ICEDD	2002 to 2011 and provisional data for 2012
Fallow land and usable agricultural area SAU	Areas	Ha	DGSIE, Agricultural statistics	DGSIE	2002 to 2012
Animal husbandry (live and slaughtered animals)	Livestock Mean Belgian weight per slaughtered species applied to Wallonia	Number of animals Tonne	DGSIE, Agricultural statistics	DGSIE	2002 to 2012
	Annual average amount of milk per goat Annual average amount of milk per cow in Wallonia Annual average amount of milk per ewe	Kg	DGSIE, Average milk production of cows, ewes and goats FICOW	DGSIE FICOW	2002 and 2012
Animal husbandry (live and slaughtered animals)	Annual average number of eggs per chicken	Number of eggs	DGSIE, Production of eggs Walloon poultry and rabbit sector	EcoRes, Ecolife, ICEDD calculations	2002 and 2012
	Quantity of cereals produced to feed livestock in Belgium Distribution in Wallonia: number of head per species in Wallonia compared with that of Belgium multiplied by the metabolic rate per species (Kleiber's law)	Tonne/ha	FAOSTAT, Animal feed	EcoRes, Ecolife, ICEDD calculations	2002 to 2009 Hypotheses: 2009 value carried forward to 2010, 2011 and 2012
Forestry products	Volume of timber/products from forestry in Belgium Distribution in Wallonia: - Ratio of Walloon/Belgian employment in the timber sector (NACE 16-18) - Ratio of Walloon/Belgian population -Ratio in need for Walloon coniferous/broad-leaf (lumber industry)	M^3 or tonne	FAOSTAT Belgian forestry production Eurostat Eurostat	ICEDD calculations	2002 to 2012 2002 to 2012 2002 to 2012 2002 to 2012 (Constant)

Fishing products	Volumes captured per species	Tonne	FAO, FishSTAT	EcoRes, Ecolife, ICEDD calculations	Not available Hypothesis: Walloon production = Belgian production (FAOstat) - estimated Flemish production
Aquaculture products	Volumes produced per species	Tonne	FAO, FishSTAT	EcoRes, Ecolife, ICEDD calculations	Not available Hypothesis: Walloon production = Belgian production (FAOstat) - estimated Flemish production
Agricultural products	Area of the different crops Yield of the different crops Production of the different crops	Ha Tonne/ha Tonne	DGSIE, Agricultural statistics	DGSIE	2002 to 2012 (for certain crops, data missing for 2012 therefore 2011 value used) 2002 to 2012 2002 to 2012
	Yield of different crops: berries, flax fibre, grapes, quinces and nuts. For the other products: data for Wallonia cf. above, "agricultural statistics".	Tonne/ha	FAO, ProdSTAT, annual yields of certain crops	FAOSTAT	2002 to 2009 Hypotheses: 2009 value carried forward to 2010-2012
Use of land (arable land, fishing ground, forest, grazing land, built-up areas	Areas by category of land use (GFN definition)	Ha	FPS Finances (General Administration of Heritage Documentation), Land Database based on land registry	IWEPS	Data calculated for the years 2002 and 2006 to 2012 Hypothesis: interpolation for the years 2003-2005 based on trends.
International imports/exports	Import and export by product	Tonne and euros	BNB, Foreign trade statistics	BNB	2002 to 2012
	For the international trade in natural gas, gross domestic consumption	Natural gas in PJ (petajoules)	Annual Walloon energy audits for natural gas	ICEDD	2002 to 2011 and provisional data for 2012
Production of CO_2 linked to products	Tonne of CO_2/tonne product	Tonne	GFN, life cycle analyses	GFN	2002 to 2012 (constant)
Direct emissions of CO_2	Emissions of greenhouse gases	Kilotonne equivalent CO_2	AWAC for UNFCCC Reporting	AWAC	2002 to 2012, 2012 being the provisional data
Ratios and carbon factors	Intensity of the carbon footprint Global carbon intensity of primary energy, Carbon intensity of national and regional electricity	Gha/tonne CO_2 Tonne CO_2/TJ (teraJoule) Tonne CO_2/kWh	AWAC ICEDD	EcoRes, Ecolife, ICEDD calculations	2002 to 2009 Hypotheses: 2009 value carried forward to 2010-2012

Emissions of CO_2 linked to international transport	Ratio of bunker fuels (tonne CO_2) and imported products (tonne)	Tonne CO_2/tonne	GFN BNB	EcoRes, Ecolife, ICEDD calculations	2002 to 2009 Hypotheses: 2009 value carried forward to 2010-2012
Population	Inhabitants	Number of inhabitants	Cytise database	DGSIE_IWEPS and DEMO-UCL	2002 to 2012

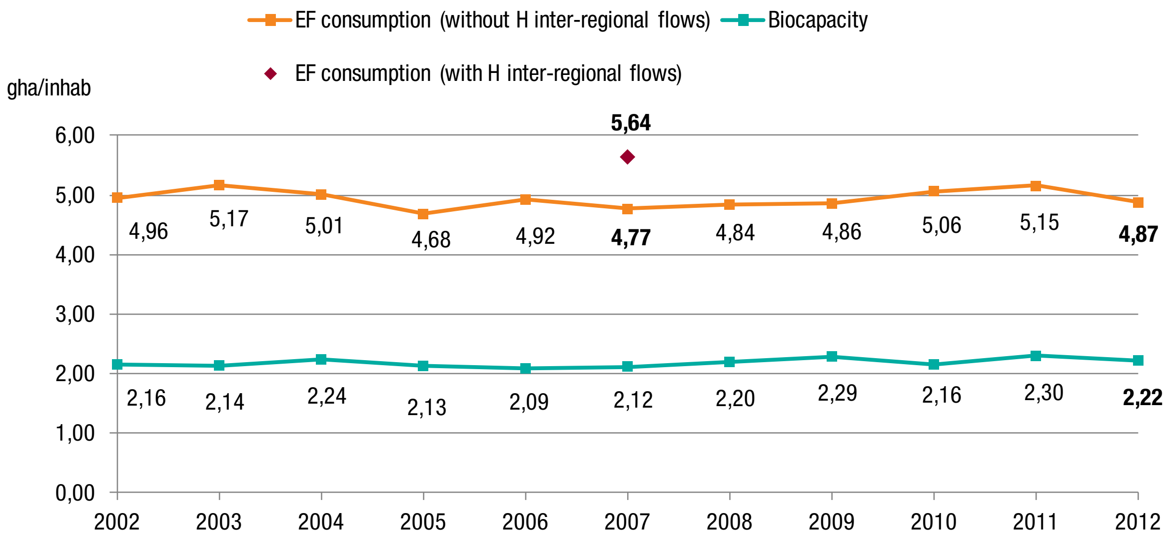
3. Results and analyses

3.1. Results of the EF and BC of Wallonia

Figure 1 shows the results of the ecological footprint of Wallonia (the first exercise), performed for the period 2002-2012, with reference GFN 2012, as well as the methods and data described above.

Figure 1: Evolution from 2002 to 2012 of the EF of consumption and the BC of Wallonia (GFN2012) in gha/inhab

Calculations: EcoRes, Ecolife, ICEDD
[Please read commas in numbers as dots]



The ecological footprint of Wallonia thus reaches 4.87 global hectares per inhabitant in 2012 (17.3 million gha), while biocapacity in 2012 is 2.22 gha/inhab (7.9 million gha). The ecological deficit of Wallonia is therefore almost 2.65 gha/inhab (difference between EF and BC).

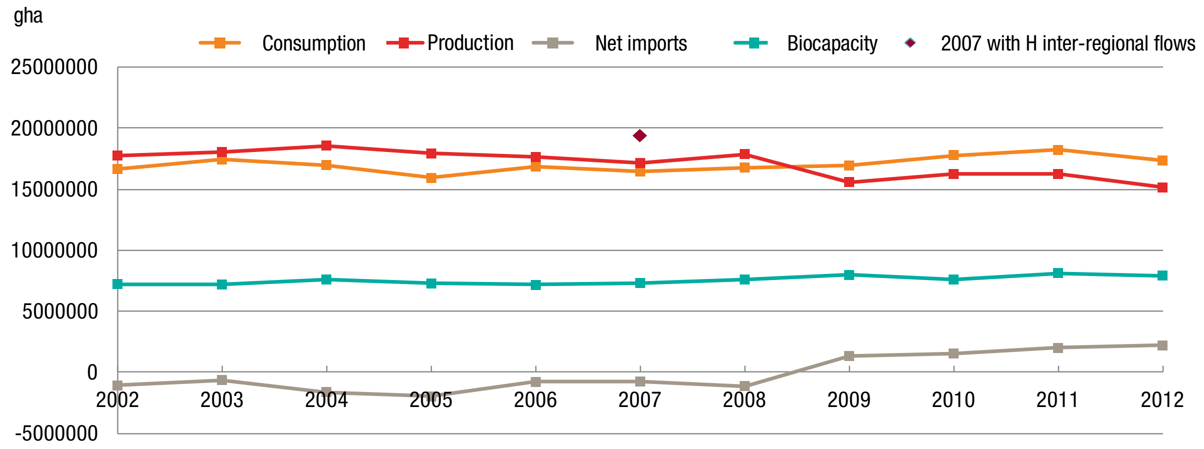
The curves for the evolution over time of the ecological footprint and biocapacity show very small fluctuations over this 11-year period.

As we have already emphasised, this method does not take account of inter-regional flows between the three regions of Belgium. However, for 2007, an estimate of these flows, in monetary terms, was made by the Federal Planning Bureau as part of the preparation of regional input-output matrices (Avonds, 2008). Based on this one-time exercise, which provides sectoral details of the flows of inter-regional exports and imports, and complementary hypotheses relating to the relationship between the mass of products and their monetary value, the study enabled net inter-regional imports of supplementary materials destined for Wallonia to be highlighted. Not taking these into account leads to an under-estimation of the ecological footprint of Walloon consumption in the order of 0.87 gha/inhab that year. By including these net inter-regional imports, the ecological footprint would therefore amount to 5.64 gha/inhab in 2007, compared with 4.77 gha/inhab without these flows. At this stage of the exercise, this result taking account of inter-regional flows was not extrapolated beyond 2007.

Figure 2 illustrates the respective evolutions of each of the elements of the formula for calculating the ecological footprint of consumption (cf. formula 6).

Figure 2: Evolution from 2002 to 2012 of the EF of consumption for Wallonia, of production, of net imports and of biocapacity (GFN2012) in gha

Calculations: EcoRes, Ecolife, ICEDD

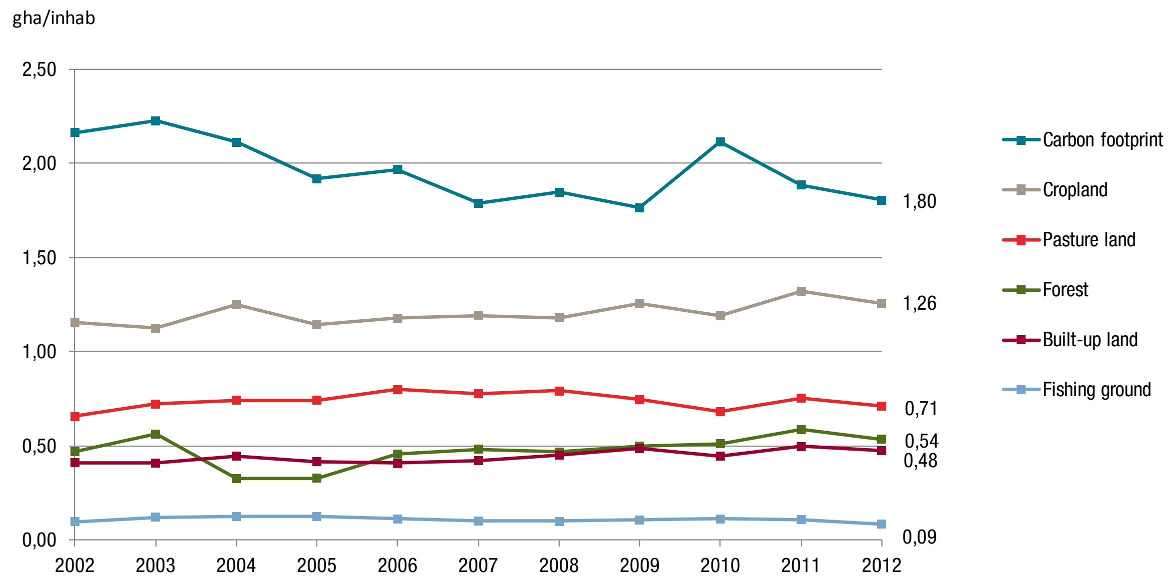


The EF of production for Wallonia is in decline (red curve), whereas the EF of net imports has been increasing since 2005 (grey curve). The period 2004-2005 is distinguished by the lowest EF (of consumption) for the period under review, and can be explained by a decline in the EF of net imports, coupled with that of production. Wallonia's biocapacity is increasing slightly on an almost constant basis (blue curve). This increase is due to the growing use of cultivatable land and an improvement in the productivity of certain crops, leading to greater yields.

The following figure (figure 3) shows the evolution of the different footprints by type of area, the global footprint being the sum of all its components.

Figure 3: Evolution from 2002 to 2012 of the EF of consumption for Wallonia by type of area (GFN2012), in gha/inhab

Calculations: EcoRes, Ecolife, ICEDD - [Please read commas in numbers as dots]



The carbon footprint represents the largest share of the EF of Walloon consumption, namely 36%. By way of comparison, this result is less than the share of the carbon footprint in the global footprint, which represented 55% of the global EF of consumption in 2008. Consumptions of renewable resources (cropland, grazing land, forest and fishing ground) represent more than half the EF of consumption (with a greater share for cropland, 26% of the total EF). The rest corresponds to built-up areas (10%).

Detailed analysis of the components of each of the areas provides some explanation of the evolution of the curves:

1. The reduction in emissions of CO_2 from production (chiefly in industries and the energy sector) is offset by the increase in emissions linked to net imports, which in the end stabilises the carbon footprint of Walloon consumption.

2. For areas of cropland, we see an increase of 15% in the EF between 2002 and 2012. During this period, improved crop yields (at both Walloon and world level) led to an increase of almost one quarter in yield factors.

3. The EF of built-up land also depends on these yield factors, and consequently shows an increase of 23% over the eleven years in question.

4. The EF of grazing land (animal production) reveals a major responsibility on the part of net imports. This means Wallonia is increasing its consumption of animal products without significantly increasing its production capacity. The footprint of grazing land increased by 15% between 2002 and 2012.

5. For areas of forest, an increase in paper exports brought about a net reduction in the EF of the sector during the years 2003 to 2004, the footprint of Walloon production remaining constant.

6. The EF of fishing areas is mainly due to net imports, Walloon production being very low in this sector.

3.2. Sensitivity analysis of the results

Several specific sensitivity analyses were carried out to evaluate the possible impact of biases linked to the quality or absence of standardised regional data and to evaluate the robustness of the results based on key hypotheses.

It first appears from these tests that measurement of the ecological footprint is highly sensitive to whether or not inter-regional trade flows are taken into account. Their inclusion, at the beginning of a one-time exploratory methodology[9], leads to an increase in the EF of 18%. This comes mainly from cropland, which is apparently the most under-estimated, and land for the capture of CO_2.

The analysis also reveals a high degree of sensitivity of the footprint to import-export data vis-à-vis abroad, data that are highly variable and sometimes missing entirely, notably as regards the measurement of volumes (compared with values) or certain headings (for example energy)[10].

If the results are also highly sensitive to the data for agricultural yields, it must nevertheless also be acknowledged that these data seem to be of good quality, presenting little variability (less than 10%) compared with the source of information or from one year to another.

[9] The inter-regional flows deduced from the input-output matrix of the BFP were only available for a single year. Furthermore, their estimation is not based on data strictly speaking, but is the result of a modelling exercise, in which the hypotheses relating to trade between regions favour the use of local inputs, which tends to minimise the importance of inter-regional flows.

[10] We should stress that this study has already addressed these difficulties by correcting the implausible data on volume (in relation to the data on values) or by replacing this source with others for certain headings (notably the energy audits for natural gas).

Conversely, the estimates of the Walloon footprint appear relatively insensitive to the source of land use data (variation of 0.2% in EF and 2.8% in BC), despite a certain variability in the global results of these data (17% deviation between the area of cropland estimated by the DGSIE and that produced by processing land registry data, for example).

Similarly, measurement of the footprint is fairly insensitive to the uncertainty that persists regarding the hypothesis of the share of broadleaf forest consumed covered by Walloon production, which remains approximate and unreliable.

4. Lessons, precautions for use and limits

The results presented above must be interpreted with caution due to the methodological and statistical difficulties encountered. They clearly show an ecological deficit in Wallonia, but this could prove to be even greater if inter-regional flows were taken into consideration. Taking into account the slow evolution of the indicators obtained, it is also difficult to conclude a possible trend of the Walloon EF over time.

The results obtained require a certain number of precautions, in the comparison, for example, which are linked to the limits - statistical, methodological or conceptual - of the indicators. These elements are illustrated below, in non-exhaustive fashion.

4.1. On the comparability (or not) of the results

Because inter-regional flows were not included, Wallonia's EF cannot be considered in the same way as that of a country where all flows crossing the borders are recognised as standard. Furthermore, one must be aware that the Walloon exercise was based in part on data specific to Wallonia and on the 2012 version of the GFN standards.

As for the comparison with the exercises performed for Flanders, this is also not recommended.

Indeed, the latest exercise performed for Flanders (Bruers & Vandenberghe, 2014) was still based on the 2010 version of the GFN standards. Nevertheless, by way of illustration, Wallonia's EF was recalculated using these same GFN 2010 standards, for 2007. The EF of Wallonia thus amounts to 4.42 gha/inhab (instead of 4.77 according to the 2012 standards). This estimate is therefore in the same ballpark as the Flemish exercise, which reports an EF of 9.41gha/inhab for Flanders. Part of the difference is clearly due to inter-regional flows not being taken into account in both exercises. This absence, according to our initial estimates, leads to an underestimation of net imports and the Walloon footprint, and conversely to an overestimation of the Flemish footprint.

4.2. Limits linked to the availability of data

Generally speaking, the macroscopic approach of the GFN is based on the physical statistics produced by the FAO, and those for imports and exports of agricultural products in particular. This method is based on data for production, imports and exports that are generally available and standardised for a country. This approach is harder to reconcile with regions such as Wallonia for which this information is non-existent (notably for inter-regional flows), unreliable (major fluctuations in chronological series, for example) or not systematically standardised, in contrast to international flows (the regionalised data for Belgian foreign trade are not established in compliance with economic accounts, for example).

Furthermore, especially in small countries/regions or areas with major ports or airports, it is difficult, using existing statistics, to respect the concept of residence that lies at the heart of the ecological footprint. Biases may appear, for example, in the distribution of fuels linked to the international transports of different countries.

Even on a national scale, the method also has its limits in the monitoring of complex processing operations (prepared food products, imported and exported conserves). Product processing (using extraction factors) is based on empirical knowledge (for example, x litres of milk give x litres of butter). For marketed products, the quantities (tonnes) are converted into footprints (gha) using life cycle analysis (LCA) studies. But there are still too few studies of this type, and either they are not conducted with sufficient frequency or they limit themselves to a small scope (valid for a specific company, a region or a particular situation, for example).

4.3. Limits linked to hypotheses

Like other indicators, the ecological footprint utilises a number of simplifications and hypotheses that should be borne in mind when interpreting the results of the EF. These include the following:

- The EF makes the hypothesis that it is possible to measure, in terms of biologically productive areas required for their maintenance and management, most of the flows of resources and waste. Consequently, what is not measurable is therefore excluded, for example underground reserves (excluding fossil fuels), minerals and water. This limit is not unimportant in the Walloon context.
- The different areas can be expressed in terms of mean productive hectares, with each area being weighted in proportion to its productivity of "usable" biomass. These productive hectares, known as global hectares, represent the hectares that have a productivity of usable biomass equal to the global mean for the year. The term "usable" refers to the portion of biomass potentially used by man, reflecting the anthropocentric hypotheses of the footprint measurement.
- The areas represent mutually exclusive uses. To guarantee a consistency and retain cumulative figures, each area is in fact recognised only once to avoid double counting, even if this area provides several ecosystemic services.
- By extension, in contrast to products, services only have a production footprint, in terms of built-up area in the territory studied, even if their production meets a demand from non-residents. Imports and exports of services are therefore not taken into account in the GFN method. For Wallonia, this limit reinforces that linked to the lack of measurement of inter-regional flows because, based on the regional input-output flows for 2007, it is likely that the import of services is the most underestimated component of net inter-regional imports.

4.4. Limits in terms of evaluating impact on the global environment

Finally, on a more basic level, it is worth reiterating that the ecological footprint measures the state of land use over a given time. It does not take into account its impact on the environment in years to come.

Among the criticisms and limits of the EF, it is important to stress that this indicator does not address the question of the quality of the environment (namely withdrawals of water, soil erosion, the impact of pesticides and fertilizer on the quality of the environmental components of air, water, soil, etc.), or biodiversity, or underground resources (cf. above). Moreover, emissions other than CO_2 are ignored, together with materials that do not come directly from ecosystems (such as chemical products, toxic synthesis products, heavy metals, etc.).

The EF cannot be regarded as an indicator of sustainability in itself, since it does not measure all impacts on the environment. In essence, the EF allows us to inform and indicate whether our consumption exceeds the biophysical limits associated with renewable resources, if we are feeding an ecological debt, but it does not in and of itself allow us to indicate whether our way of life is sustainable.

Therefore, this indicator only presents one facet of environmental pressure. It will be compared with other environmental indicators currently being developed by the IWEPS in cooperation with other departments of the administration active in the sectors of the environment and environmental health.

5. Perspectives for development

The study on which this report is based represents an initial exercise to evaluate the ecological footprint for Wallonia. While it does already provide some useful results, it also shows how much progress still has to be made to reach an even more relevant calculation of this regional footprint.

Certain limits of the measurement of the EF are inherent to the very concept of ecological footprint or to the methodological choices made at international level and coordinated by the GFN. This methodology is constantly evolving, and its development should therefore be monitored to improve the regional exercise gradually and at the same rate as international advances.

Certain issues more specific to Wallonia nevertheless arise out of the weaknesses revealed by the sensitivity analyses carried out in connection with this study. Particular attention should therefore be paid to measuring the inter-regional flows of primary products and to taking service activities into account. In the medium term, these improvements could be based on new exercises to establish monetary regional input-output matrices and on the improvement in the underlying hypotheses behind them. In the longer term, the development of physical measurements of these flows should be considered, although the sources are currently lacking.

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