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# Incorporating a Global Perspective Into Future-Oriented Forest Management Scenarios:
## The Role of Forest Footprint Analysis

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## ABSTRACT

This research serves to integrate the concept of an "ecological footprint" into future-oriented forest management scenarios. Scenarios are commonly used to explore stakeholder perceptions of possible forest futures, and are typically focused on the local impacts of different management choices. This article illustrates how global footprint analysis can be incorporated into scenarios to enable local forest stakeholders in the EU to consider the impacts of their local decisions at national and global levels. This illustration could be helpful to the construction of a forest decision support system that includes wood trade information and social processes (simulation of management decisions under changing political/economic conditions). It finds that different future forest management scenarios involving a potential increase or decrease of the harvested timber, or potential increase or decrease of subsidies for forest protection, combined with various possible changes in local consumption patterns, might have impact on both "internal" (local) and "external" (non-local) forest footprints.

## KEYWORDS

Decision Support, Forest Footprint, Forest Management Scenarios, INTEGRAL Project, Sustainability

## INTRODUCTION

It has been estimated that by the year 2007 humanity was consuming 1.5 times the resources that the earth had produced in a single year (Ewing et al., 2010). Moderate UN scenarios, involving low population growth and small improvements in diet, suggest that by 2050 we will require two Earths to support us over the long term (Ibid). International trade is playing an increasing role in the rise of global consumption. In general, as countries gain in wealth they decrease their relative reliance on domestic resource extraction, while increasing their overall consumption and reliance on foreign imports.

The concept of a global "footprint" has helped to measure and quantify this shift towards export dependence, by translating all consumption into standardized global units. For example, Wiedmann et al. (2013) define "material footprints" (MF)[1] in terms of the global allocation of raw materials

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extracted to produce end products. They find that with every 10% increase in gross domestic product, the average national MF increases by 6% (Wiedmann et al., 2013).

Given the global nature of production and consumption, "sustainable" land use planning requires consideration of global footprints, since decisions to produce or consume locally serve to reduce, replace or displace impacts elsewhere. Area-based measures of global footprint provide perhaps the most intuitive method to link the footprint concept with local land use. These include concepts such as "ecological footprints" and "forest footprints" that translate consumption into standardized units known as "global hectares". The "ecological footprint" measures human appropriation of ecosystem products and services in terms of the amount of bioproductive land and sea area needed to supply these services (Wackernagel & Rees 1996). Six land use types are considered in this calculation: cropland, grazing land, fishing ground, forest land, built-up land, and carbon uptake land[2] (Ewing et al. 2010). Table 1 outlines the Wackernagel and Rees formula for calculating footprints (Wackernagel & Rees 1996, Wackernagel et al., 2004, Nie et al., 2010). The degree to which footprints are sustainable depends, in part, on the overall capacity of the land to support them. Wackernagel & Rees (1996) have coined the term "biocapacity" to refer to the biosphere's ability to meet the human demand for material consumption and waste disposal.

The above details on global ecological footprints highlight the current excess and inequality of global consumption, as well as the increasing reliance on international trade. The relationship between these overall patterns and forests, however, is quite complex. Currently, the leading global driver of forest loss is the expansion of commercial agriculture in tropical countries, and EU consumption plays a significant role in supporting this expansion (Cuypers et al., 2013). In this regard, it is the EU's production and consumption of agricultural products, and to a lesser extent, biofuels, that exerts the greatest impact on global forests. We suggest that participatory forest land use planning can serve as one venue for generating discussion among forest stakeholders about these cross-sectoral linkages and how EU countries and communities might best address it.

Of more direct relevance to the forest sector, trade in wood products plays a significant role in global forest degradation (Cuypers et al., 2013). Forest trade can also be compared relatively easily with

**Table 1. The footprint equation**

$$EF = \frac{\Sigma R_i \left(P_i + I_i - E_i\right)}{Y_i}$$

where:

- **EF (Ecological Footprint):** A measure of how much area in global hectares (gha) of biologically productive land and water an individual, population or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices (measured in global hectares) (global hectare: a productivity weighted area used to report both the biocapacity of the earth, and the demand on biocapacity (the Ecological Footprint).

- **$Y_i$ (Yield Factor in tonnes/ha):** A factor that accounts for differences between countries in productivity of a given land type.

- **$P_i + I_i - E_i$ (Consumption in tonnes of the wood products (i) category):** For this study it used the apparent consumption which calculated as "production plus imports (It includes imports for re-export) minus exports (It includes re-exports) as FAO defines (FAO, 2010).

- **$\Sigma R_j$ (Equivalence Factor in gha/ha):** A productivity- based scaling factor that converts a specific land type (such as cropland or forest) into a universal unit of biologically productive area. j is one of the six specified categories of ecological productive land. e.g. For forest land and for the year 2005 is 1.33 (WWF, 2008).

Source: (Global Footprint Network 2012)

domestic forest production regarding its contribution to forest footprints. Hence, we will concentrate our footprint analysis on wood production and consumption.

Consistent with this logic, Wackernagel & Rees (1996) have defined forest footprints and forest biocapacity in terms of timber production, consumption and trade. From this perspective, the world's total forest footprint is less than half of the biocapacity of its forestlands (Global Footprint Network, 2013). However, all this tells us is that the total quantity of forest products harvested does not exceed the mean annual increment, i.e. the growth, of the world's wood supply. It tells us nothing about the quality of this footprint. That is, it doesn't tell us how the wood was harvested, who benefited from it, and what the impacts were on local communities, biodiversity and other ecosystem services. Forests are clearly valued for more than timber, so we make no claims as to the "sustainability" of current levels of forest product consumption. Rather, we view the assessment of footprint size or quantity as an important first step in considering consumption within the context of planetary, national or ecosystem-level boundaries.

The main focus of this study is to analyze the forest footprints and biocapacities of ten European countries that were included as case studies in the EU-funded project 'INTEGRAL', a project exploring future-oriented integrated management of European forest landscapes[3]. The majority of the INTEGRAL project was focused on the development of future-oriented scenarios and policy back-casting for sustainable forest management within selected forest areas in each of the case study countries. The footprint analysis included in this paper serves to situate these locally-oriented INTEGRAL case studies into global context. In particular, it examines how a global perspective might influence the definition of what is sustainable local forest practice. Since the forestry contexts in the INTEGRAL case studies were highly diverse as well as highly interdependent, this analysis also draws on the INTEGRAL case study scenarios to explore ways to address this interdependence. For this propose, wood trade and footprint information are illustrated in order to support decision making in future sustainable forest management in EU.

## MATERIAL AND METHODS

This paper draws on the ten case study scenarios developed as part of the INTEGRAL project. Key factors like 'Policies, laws and regulations', 'Forest ownership structure', 'Timber markets', 'Bioenergy markets' and 'Subsidies', and to some extent 'Non-wood ecosystem goods and services', are likely to be the most influential factors shaping future forest management in Europe (Sotirov et al., 2014). Based on these key factors, forest stakeholders in twenty landscape case study areas in ten EU countries[4]developed a range of future scenarios (next 25-30 years) to explore the implications of different management priorities. Scenarios are presented as "Green values" in Sweden, "Romantic nature" in the Netherlands" and "Ecology" in Lithuania. The latter scenarios are presented as "Production++" in Sweden, "liberal future" in the Netherlands and "Maximum potential benefit" in Bulgaria.

This paper examines the implications of ecological versus production-oriented scenarios for "internal" and "external" forest footprints using quantitative methods to collect, organize, interpret and present data. The data about consumption of wood products were received from FAOSTAT (2014) database and the primary data for the footprint figures were received from the Global Footprint Network (2013). We then present a case study from the Netherlands (South-East Veluwe) to diagrammatically and quantitatively illustrate the relationship between different stakeholder scenarios and global forest footprints.

### Results

#### *The Quantity of EU Production, Trade and Consumption*

Europe is a major producer and trader of forest products. Over half of Europe's forests are designated for production – a much higher percentage than the global average of 32 percent (FAO, 2006). The region accounted for almost one-third of global production in 2006 and nearly half of the world's trade in forest products with imports of US$158 billion and exports of US$184 billion (FAO, 2006). Figure 1 and Figure 2 present EU (28) forest products production, exports and imports within the category Forest products + (FAOSTAT, 2014). The graphs highlight how the EU as a whole is currently producing a large percentage of the wood products it consumes, but is also an important trading partner with non-EU countries.

In total, EU production of products that measured in cubic meters (cum) (Figure 1), including roundwood, sawnwood, veneer and fiberboard, fluctuated from 423 million cum in 2009 to 528 million cum in 2007. In contrast, the imports and exports fluctuated at lower levels. The imports ranged from 128 million in 2009 to 159 million in 2006, and the exports from 113 million in 2001 to 151 million in 2007. Production measured in tonnes (Figure 2), including pulp and paper products, increased during the examined period. The production began to increase from 170 million to almost 200 million in 2007, followed by a short decrease in 2009 (174 million) and finally reached the amount of 193 million in 2012. Parallel increases were observed in imports and exports with a small dip around 2009, 2008. However, the rise in exports of pulp and paper products has been greater than the rise in imports. In regard to future projections, the EFSOS (European Forest Sector Outlook Study) model highlights a general tapering off of growth in wood products consumption in Western Europe combined with ongoing dynamic growth in Eastern European markets through 2020, as these markets continue to mature (Kangas & Baudin 2003). In terms of net EU/ EFTA[5]consumption, the greatest increase will be in paper and paper board, rising to nearly 122 million metric tonnes in 2020 from almost 77 million metric tonnes in 2000. They reported that in 2000 the consumption of sawn wood was approximately 90 million cum and will be over 106 million cum in 2020. The consumption per capita of wood-based panels will follow the same trend, from 44 million cum approximately in 2000 to over 63 million cum in 2020. Jonsson (2012) mentioned that according to EFSOS II (UNECE/FAO, 2012) the average annual growth rate of consumption in EU/EFTA countries using A1 scenario (a future world of very rapid economic growth) for the period 2020-2030 would be 1% for sawnwood, 2% for panels and 1,9% for paper and paperboard. Additionally, using the B2 scenario (more emphasis

**Figure 1. EU (28) forest products trade in cum. (Chips and particles, Hardboard, Insulating Board, MDF, Other Indust Roundwd(C), Other Indust Roundwd(NC), Particle Board, Plywood, Sawlogs+Veneer Logs (C), Sawlogs+Veneer Logs (NC), Sawnwood (C), Sawnwood (NC), Veneer Sheets, Wood Residues).**

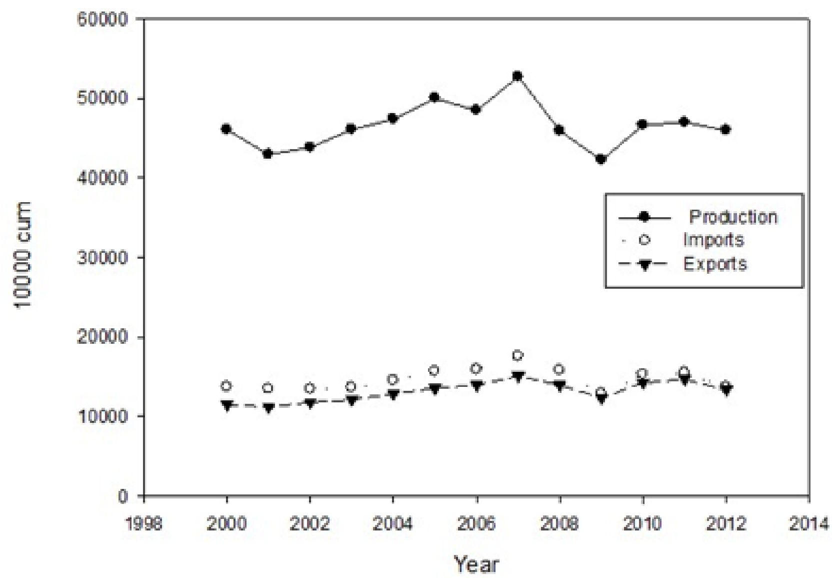
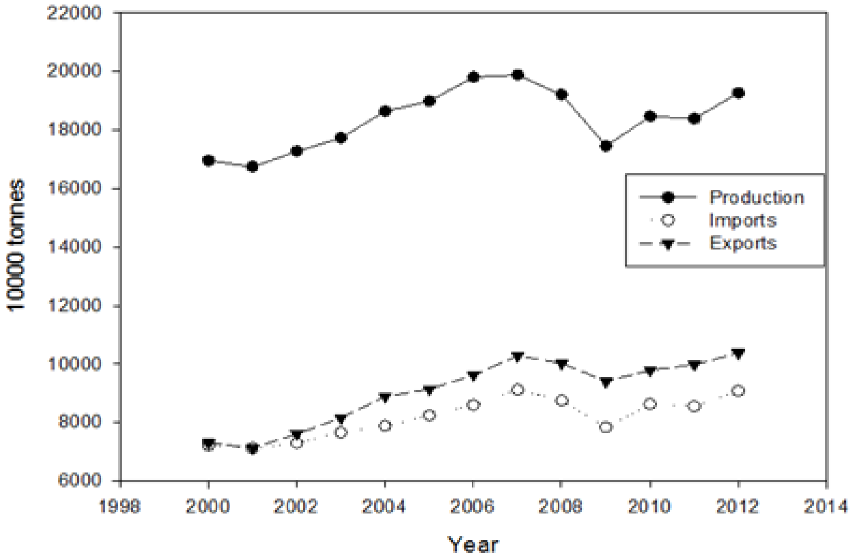


**Figure 2. EU (28) forest products trade in tonnes. (Dissolving Wood Pulp, Mechanical Wood Pulp, Newsprint, Other Fibre Pulp, Other Paper+Paperboard, Printing+Writing Paper, Recovered Paper, Wood Pellets, Wood Charcoal, Semi-Chemical, Wood Pulp).**




is on local solutions to economic, social, and environmental sustainability) the above percentages are 0,5%, 0,9% and 0,9% respectively.

Buongiorno et al. (2012) made one more long-range study with projections obtained with the Global Forest Products Model GFPM (Buongiorno et al., 2003, updated in Buongiorno & Zhu, 2011) giving an outlook for 2030 and 2060 for the world forest and forest industries under different scenarios. Those scenarios concerned the future of population, the GDP growth, the energy use, the land use changes and finally the resource availability. According to the Scenario B2 (medium future changes of the above) it could be calculated that the sawnwood consumption of EU (25) will remain at the levels of 100 million cum in 2030 and a decrease at approximately 95 million cum will take place in 2060. In addition, the estimation of the sum of consumption of newsprint, printing and writing paper, and other paper + paperboard (same as the paper and paperboard reported by Kangas & Baudin, 2003) as a total will reach the amount of approximately 100 million metric tonnes in 2030 and 114 million tonnes in 2060. The EU (25) also expected to keep the levels of wood-based panels (plywood, particle board and fibreboard) consumption at almost 62 million cum in 2030 and approximately 60 million cum in 2060. Similar trends are reported in other studies with long term projections for the forest sector, such as the successor EFSOS II (UNECE/ FAO, 2012), FAO Global Forest Products Outlook Study (Zhu et al., 1998) and ETTS V (Baudin & Brooks, 1995). The EU/EFTA is also expected to increase its production and exports across these product groups. In other words, emerging economies will play an increasing role in both forest product production and consumption. In sum, from the perspective of global footprints, sustainable forest production and consumption has become an increasingly international question.

### *The Total Footprint Calculation for Forest Products*

According to the Global Footprint Network (2013) the EU's per capita forest ecological footprint (FEF) is more than twice that of developing countries, and equals the equivalent of roughly 64% of its per capita forest biocapacity. However, as illustrated by our case study countries, there is considerable variation within the EU both in terms of footprint and forest biocapacity (Figure 3). Figure 3 highlights major variation in the internal surplus or overshoot in the forest footprint of EU countries, ranging from the Netherlands whose forest footprint is over 700% of its forest biocapacity, to countries like Finland and Sweden who consumer only a small fraction of their forest biocapacity. If, on the other hand, one compares countries' forest footprints per capita with global average biocapacity per capita, then the results look quite different. Figure 4 presents these results for the case study countries. In this case, Lithuania and Sweden lead with the highest per capita forest footprints in absolute terms. Perhaps the most important message to take from Figure 3 and 4 together is the need to consider both local and global contexts when assessing forest sector impacts. The sustainability of a country's consumption levels depends on many factors, including the environmental and social costs and benefits of local

**Figure 3. Forest footprint per capita as percent of a country's per capita forest biocapacity (the line highlights the 100% threshold). Source: Global Footprint Network, 2013. National Footprint Accounts, 2011 Edition.**

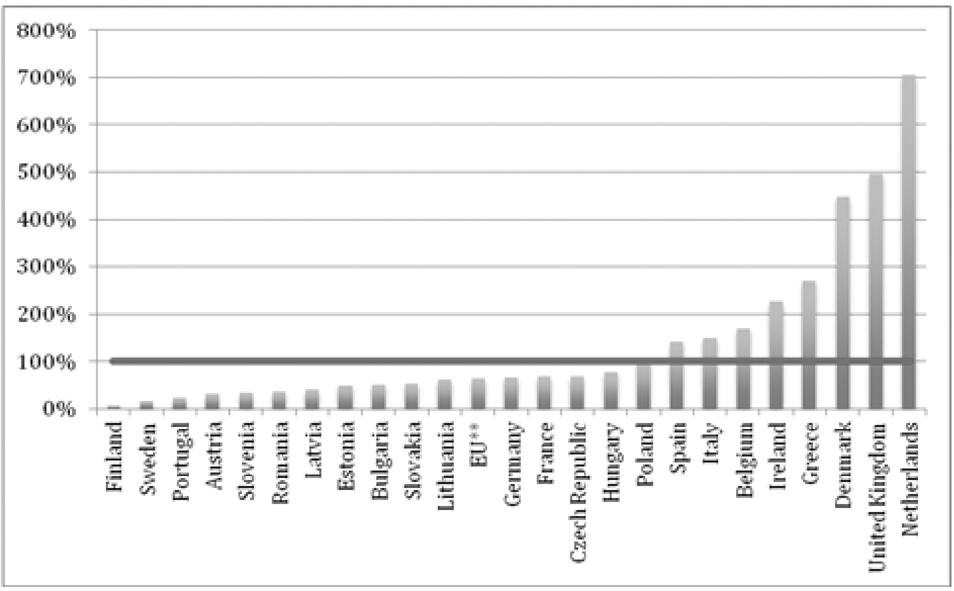
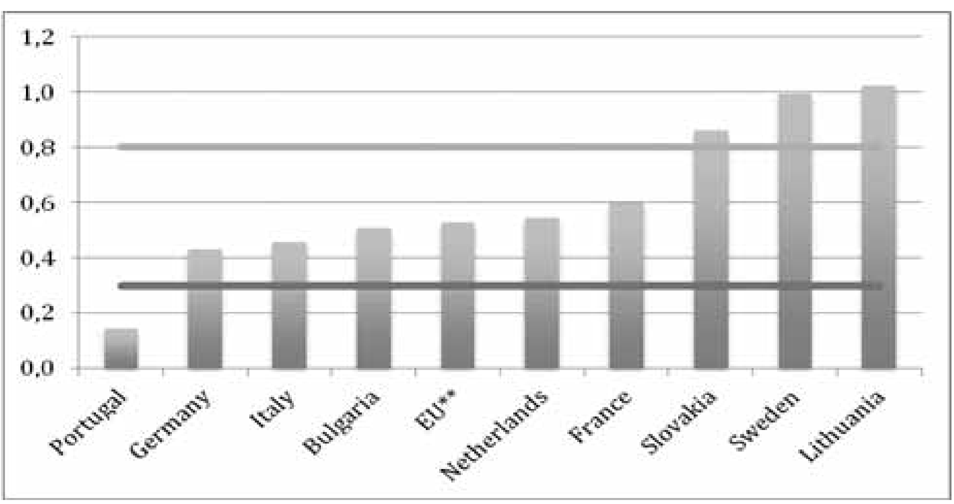



**Figure 4. Forest footprint per capita for INTEGRAL case study countries compared to global average (bottom line) and global biocapacity (top line). Source: Global Footprint Network, 2013. National Footprint Accounts, 2011 Edition.**



wood production versus other substitutable products. For example, it may be relatively sustainable for a country like Sweden that is richly endowed with forest resources to consume more wood per capita than Portugal.

As highlighted in Figure 3 bellow, the case study countries vary considerably in the balance of their per capita forest footprints and biocapacity. In general, those countries with the greatest domestic overshoot are those with low per capita forest area—including most notably the Netherlands and Ireland. These differing forest endowments in turn have stimulated high levels of internal EU trade reflecting the interdependence of EU forest footprints. For example, Sweden reportedly exports 69% of its sawnwood production, with top importers including Great Britain and Germany (Edwards et al., 2013). Likewise, 26% of Swedish pulp and 88% of Swedish paper production is exported and the leading markets are Germany, Great Britain, Italy and France (Ibid). Intra-EU trade was also identified as important to the emerging economies of Bulgaria, Lithuania and Slovakia. However, in these latter case study countries, EU and Asian markets for unprocessed wood combined with relatively low technical capacities at the forest and mill levels are reportedly reducing their ability to maximize the value of this trade as well as develop their own internal processing capacities (e.g. Paligorov et al., 2013).

### *The Quality of the EU's Forest Footprint*

In this section, the international dimensions of forest trade are highlighted in order that local stakeholders may consider for themselves what quality of internal and external forest footprint is coherent with their values. Furthermore, this section focuses on identifying some key issues relating to the environmental and social qualities of traded wood. In particular, it considers the countries of origin of total wood products and by product type, and discusses the implications this holds for sustainability. This analysis of implications is far from exhaustive, but is intended to illustrate how stakeholders might adopt a global perspective on the environmental and social issues of importance to them, including those they may identify in future oriented scenario-building processes.

The assessment of whether internationally traded wood products are "sustainable" is clearly a complex endeavor, and one that has fueled a growing body of research (e.g. Buonocore et al., 2014; Mayer et al., 2006; Forest Trends, 2013). Forest practices vary considerably not only among countries and over time, but within each country and among different products and supply chains.

Nevertheless, a simple analysis of trade flows that identifies countries of origin can help to identify key risks in the supply chain. It is well known, for example, that forest tenure and use rights are unresolved or disputed across much of the developing world, and hence wood originating from these regions may have been produced in violation of local rights. International demand for timber can further incentivize appropriation of forest resources from local communities, leaving them without access to or benefit from local forest goods and services. The environmental impacts of forest production and harvest also varies considerably among developed as well as developing countries e.g. (McDermott et al., 2010).

### *Origins (Trade Flows) of Forest Products Across All Categories*

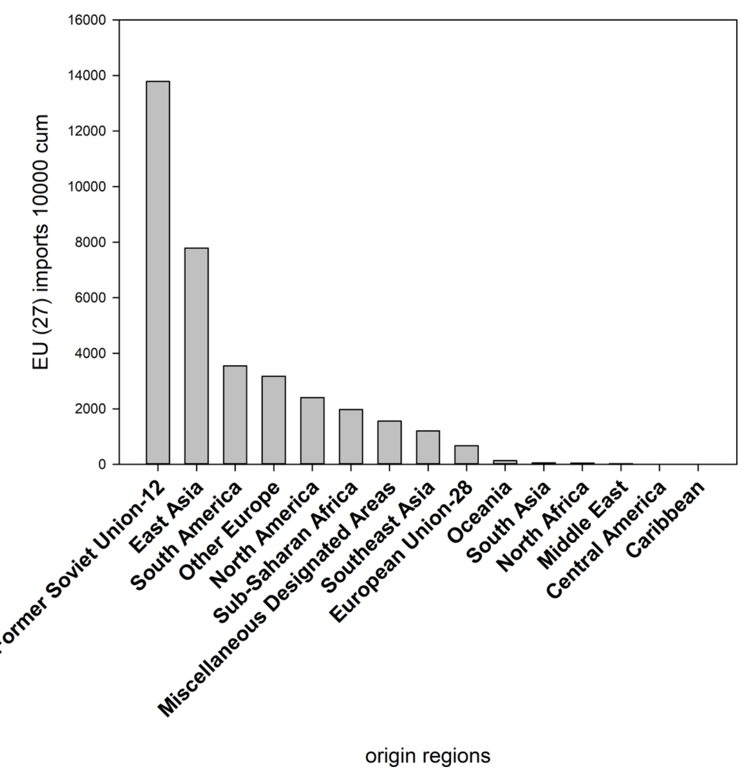
With the enlargement of the EU in 2004 and 2007, illegal logging has become a problem for international trade within the EU, particularly affecting some of the new Member States. The market share of this intra-EU trade from suspicious sources has been estimated at somewhere between 6% and 8% (WWF, 2008).

In regard to the EU trade of wood products with the rest of the world, an estimated 82% of the value of this trade (including furniture) comes from countries with "high risk" of illegal logging (Forest Trends, 2013). This percentage varies by EU member state, reflecting in part the country's relative reliance on wood product imports and their role in intra-regional trade. The leading importers of high risk wood are the UK, Germany, France, Italy, the Netherlands and Belgium. The UK has historically imported the largest estimated quantities of illegal timber, while the Netherlands has served as a leading "first-placer" or conduit of illegal timber destined for elsewhere in the EU (WWF, 2008). Across all of these countries, imports of illegal timber dropped significantly in 2008, due in a large part to the global recession (Lawson & MacFaul, 2010). It is possible that the EU's legality initiatives such as the EU Timber Regulation may be having some effect, but it is too early to draw conclusions in this regard. Figure 5 presents the countries of origin of these high-risk products and the average volumes of select forest products imported from these countries into the EU, over the period 2000-2013.

The biggest portion of EU (27) imports of forest products (HS 44) for the period 2000-2013, on average, is from the former Soviet Union, totaling 138 million cum. The second largest region of origin is East Asia which provided 78 million cum average for the same period. These are followed by South America (35 million cum), the rest of Europe (31 million cum), North America (24 million cum) and Sub-Saharan Africa, South East Africa and others with smaller quantities.

For the above product categories, Russia has recently emerged as the leading source of illegal wood imported into the EU. This wood is mostly in the form of roundwood, but also includes processed products. The main importer of Russian timber among the EU countries is Finland. Nearly half of all (legal and illegal) European timber imports from Russia arrive in Finland, mainly to be processed into pulp and paper and then exported to other EU states (WWF, 2008).

**Figure 5. EU (27) forest products* imports (average) and origin regions for the period 2000-2013. [USDA Foreign Agricultural Service, 2014] * Includes forest products listed under Chapter 44 "wood and wood products" of the Harmonized System (HS) of Commodity Classification. This includes some secondary processed wood products (SPWP), such as builder's joinery, but does not include pulp and paper products (HS 47-49) or furniture (HS 94).**



The other major "high risk" regions of origin include East and South East Asia, South America and Africa. These regions are discussed in the following sections on "tropical wood" and "secondary processed wood products (SPWP)".

### *Tropical Wood*

Tropical forest loss and degradation has become an issue of major global concern (e.g. McDermott, 2014). Timber harvest is not the major direct driver of this loss since harvested areas are generally capable of regrowth, but markets for tropical timber can play a role in financing road-building and other infrastructure that in turn facilitates conversion to agriculture or other land uses (e.g. Meyfroidt et al., 2010; Geist & Lambin, 2002). A consideration of tropical timber imports to the EU therefore sheds some light on where the EU could be playing either a positive or negative role in promoting sustainable forestry. Figures 6 and 7 present the EU imports of tropical wood in tonnes and value.

Based on both volume and value, Indonesia, Malaysia, Cameroon and Gabon are all leading sources of tropical wood products (HS 44) for the EU as a whole. All of these countries are known to face serious challenges in governing forest trade, although estimating the precise nature and extent of these challenges is itself very difficult. Survey-based estimates of illegal logging as a percent of production range from 40-61% in Indonesia, 59-65% in Cameroon and 14-25% in Malaysia (Lawson & McFaul, 2010).

In total, primary processed tropical wood products represent only a small portion of the EU's total wood trade. However, the impact of this trade on the host countries depends also on the relative role the EU plays among international importers (Figures 8, 9, 10).

The leading destinations of the top primary tropical wood products from Indonesia are Japan, China, and the USA (Figure 8).

**Figure 6. EU (28) tropical wood import weights (average) and origin countries for the period 2000-2012. [Source: EUROSTAT, 2014]*.**

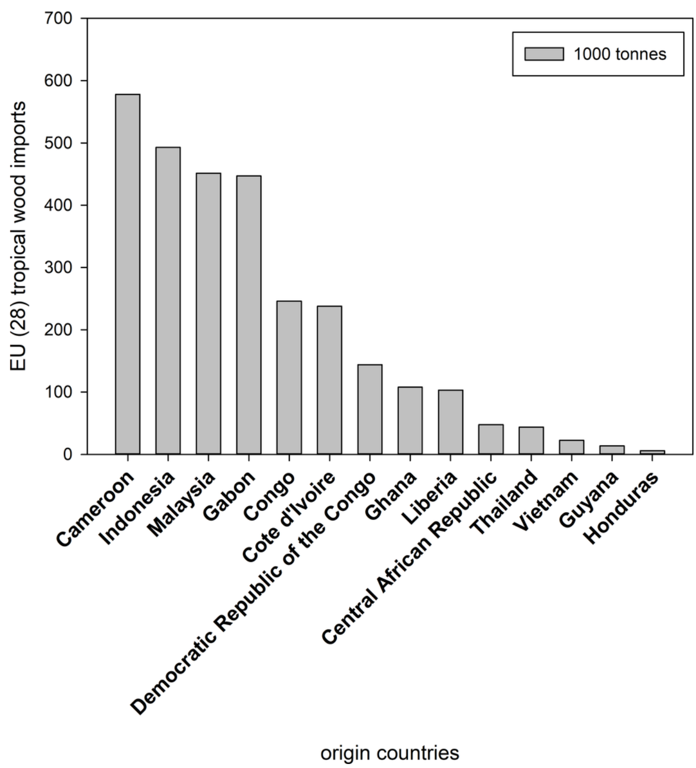


**Figure 7. EU (28) tropical wood import value (average) and origin countries for the period 2000-2012. [Source: EUROSTAT, 2014] * * Includes all tropical wood products listed under Chapter 44 "wood and wood products" of the Harmonized System (HS) of Commodity Classification.**

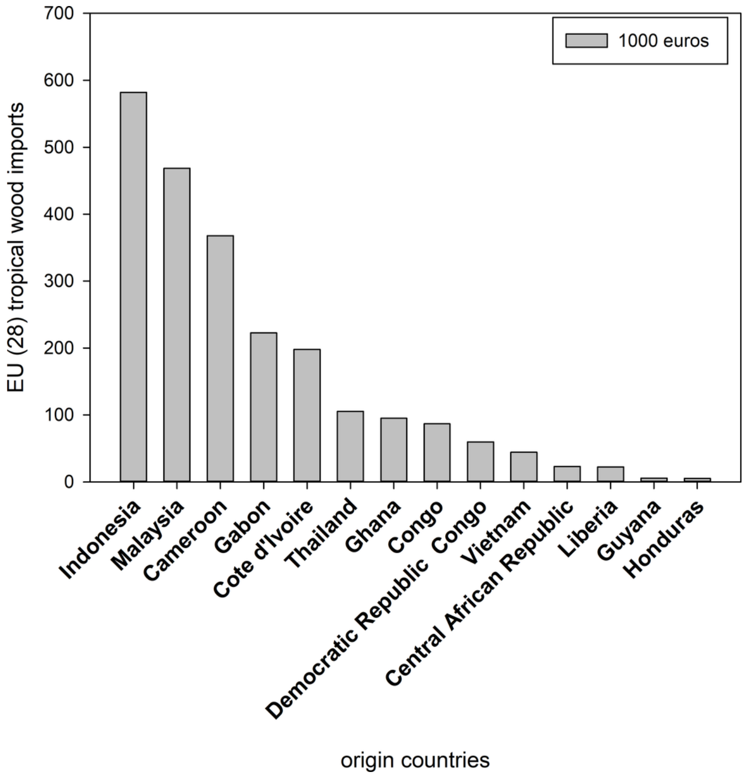



**Figure 8. Top five importers of primary wood products from Indonesia, 2010 Source: (ITTO, 2011)**

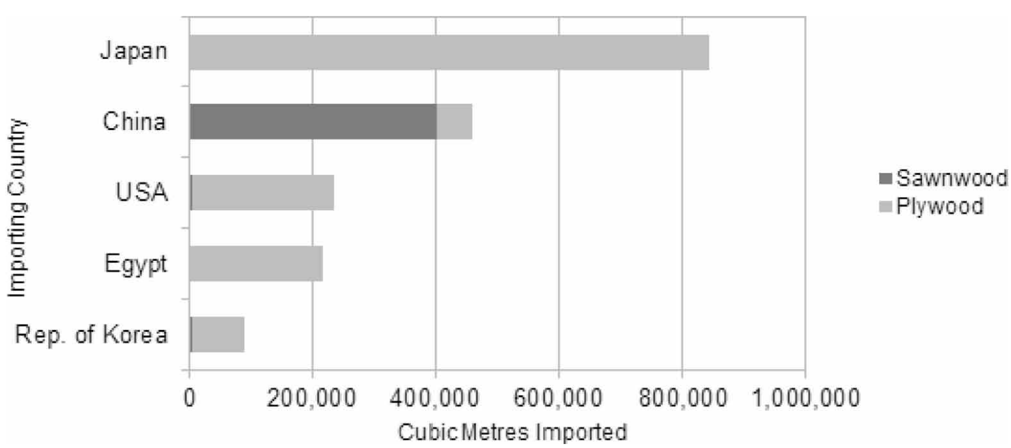


**Figure 9. Top five importers of primary wood products from Cameroon, 2010, Source: (ITTO, 2011)**

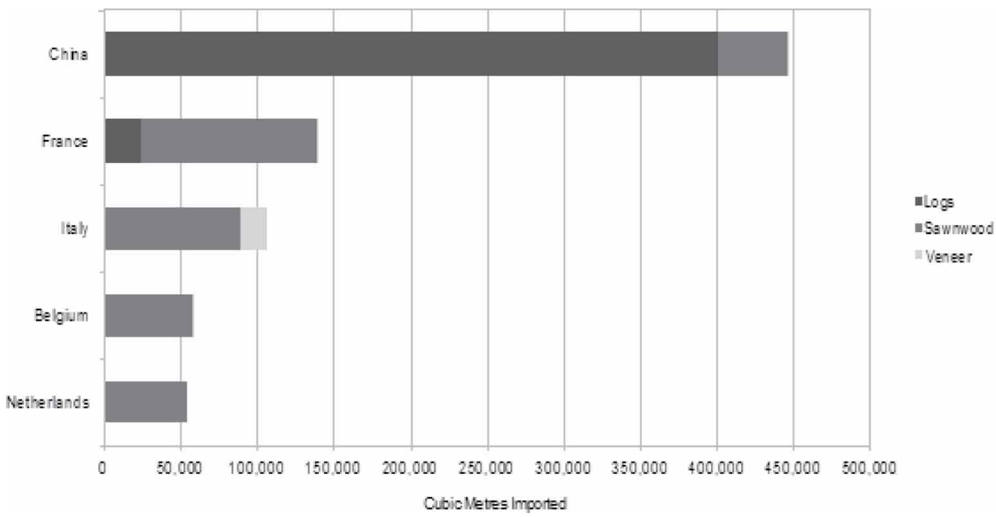
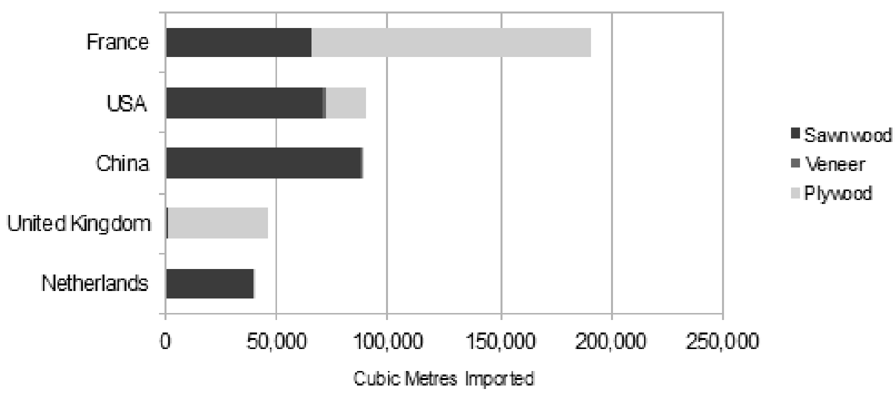



**Figure 10. Top 5 importers of primary wood products from Brazil, 2010, Source: (ITTO, 2011)**




China is the lead importer of primary tropical wood products from Cameroon (Figure 9), followed by four different EU countries including the INTEGRAL case study countries of France, Italy and the Netherlands.

Tropical wood from Brazil (Figure 10) is sourced from the Brazilian Amazon, the historical leader in tropical forest loss and a region still experiencing major problems with illegal logging and forest degradation (e.g. Matricardi et al., 2013). The case study France is a leading buyer of tropical plywood from Brazil while the Netherlands is the fourth largest buyer of Brazilian tropical sawnwood.

In sum, Figures 8,9,10 reveal major variation in the relative importance of the EU as a direct trading partner. However, as will be discussed in the next section, a significant portion of the tropical wood imported into non-EU countries may be reprocessed and sold back to the EU as Secondary Processed Wood Products (SPWP).

### *Secondary Processed Wood Products (SPWP)*

Secondary processed wood products (SPWP) are forming an increasingly large percentage of global trade, reflecting the trend in developed countries towards importing goods manufactured elsewhere, and thus outsourcing the associated ecological footprint (e.g. Wiedmann et al., 2013). SPWP covers a wide range of manufactured goods, including wooden furniture and parts, builder's joinery and woodwork (e.g. windows, door frames, etc.), wooden crates, etc. By 2020 SPWP are expected to surpass pulp and paper as the leading traded product, totaling some 40% of all internationally traded forest products by value (ACPWP, 2007). The largest category of SPWP is furniture, which was valued globally at US $450 billion in 2012 (UNECE, 2013). Furniture production in emerging market economies is growing at a rate of 18% per year, and China is currently the world's largest furniture producer [ibid].

The majority of furniture consumed in the EU is European-made, and Germany, Italy, the UK, Poland and France are the leading producers (ITTO, 2013). However, the EU has a significant global impact as the largest international buyer of furniture from China (McDermott et al., 2009) and a major importer from Vietnam, Indonesia, Malaysia and other developing countries (ITTO, 2013).

Finished products – and especially relatively complex product assemblages such as furniture – may have very complex supply chains. For example, a single living room couch may contain multiple parts, both visible and hidden, sourced and manufactured within a wide range of countries. All of these factors make it challenging to consider both the quantity and the quality of the environmental and social footprint.

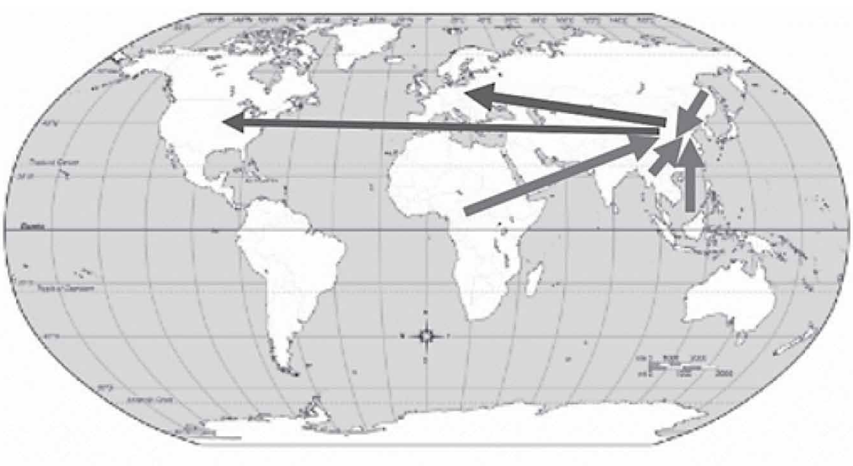
Nevertheless, existing knowledge of global supply chains is adequate to begin to assess the risks involved in imported SPWP. For example, research has revealed that a large portion of the furniture made in China includes wood from imported from regions facing major governance challenges, such as eastern Russia and Southeast Asia. According to a global study of wood trade from six priority ecoregions worldwide, China is the largest buyer of hardwood logs from four of these regions, including the Amur (in the Russian Far East), the Congo Basin, central Borneo, and the Mekong region (including Myanmar, Cambodia and Laos) and many of these logs are processed to produce furniture sold to the EU and US (McDermott et al., 2009) (see Figure 11).

In sum, the footprint quality of the EU's imported SPWP is an issue of significant concern. At the same time, recent projections suggest the quantity of that footprint is also likely to grow, as will the percentage of that growth supplied by emerging, high risk sources (ACPWP, 2007).

### *Case Study Contexts*

As highlighted in Figure 2 above, the case study countries vary considerably in the balance of their per capita forest footprints and biocapacity. In general, those countries with the greatest domestic

**Figure 11. Top export pathways of tropical raw logs. Grey: top tropical log trade, Black: Top furniture trade. Source: (McDermott et al., 2009).**



overshoot are those with low per capita forest area—including most notably the Netherlands and Ireland. These differing forest endowments in turn have stimulated high levels of internal EU trade reflecting the interdependence of EU forest footprints. For example, Sweden reportedly exports 69% of its sawnwood production, with top importers including Great Britain and Germany (Edwards et al 2013). Likewise, 26% of Swedish pulp and 88% of Swedish paper production is exported and the leading markets are Germany, Great Britain, Italy and France (Ibid). Intra-EU trade was also identified as important to the emerging economies of Bulgaria, Lithuania and Slovakia. However, in these latter case study countries, EU and Asian markets for unprocessed wood combined with relatively low technical capacities at the forest and mill levels are reportedly reducing their ability to maximize the value of this trade as well as develop their own internal processing capacities (e.g. Paligorov et al., 2013). The Irish case study, in contrast, reports positive impacts from EU trade. In this case, EU demand for wood from the growing plantation base has helped compensate for the drop in domestic demand that resulted from the crash in building construction brought on by global recession (Bonsu & Dhubháin, 2013). Intra-EU wood trade is not only impacting forest economies, but their ecologies as well. The Eastern European case studies in particular note problems with excessive, destructive and/or illegal forest harvest practices driven in part by growing international demand for timber (Brukas et al., 2013, Paligorov et al., 2013). Meanwhile, in France and Portugal the international competitiveness of eucalypt and Northern spruce and fir, combined with recent hurricane damages and fires, are contributing to the loss or conversion of once-profitable maritime pine forests (Sergent et al., 2013, Sottomayor et al., 2013). The growing international market for biofuels is also seen as impacting forest practices in many case study countries, although there is no clear consensus on how it will do so. For example, stakeholders in Italy variably view growth in demand for biofuels as a potential environmental threat that will drive intensified forest production, or as an incentive to "clean" the forest through thinning and the removal of deadwood which will help prevent forest fires (Pettenella et al., 2013). In sum, the forestry contexts in the INTEGRAL case studies are not only highly diverse, but also highly interdependent. The following subsection explores ways to address this interdependence in the process of future-oriented scenario building.

### Case Study Scenarios

The following Figure 12 and Figure 13 draw on the Southeast Veluwe (Netherlands case study) scenario as an example to explore how one might examine the implications of ecological versus production-oriented scenarios for "internal" and "external" forest footprints. "Internal footprint" in this context refers to the extent of their local impacts on forest biocapacity, while "external footprint" refers to the displacement of this impact elsewhere to other watersheds, regions and/or countries. As illustrated in Figure 12, the "Romantic nature future" scenario involves subsidizing forest protection, strong public interest in protecting non-timber forest values and matching public policies along with little development of the timber sector. This would likely lead, in turn, to decline in timber production and a decrease in the internal forest footprint. The impact of different scenarios on external footprints would depend on whether there were any corresponding changes in local demand for timber products. If demand remains at current levels, then reliance on imports would increase to accommodate the shortfall leading to an increase in external footprints. If, however, local demand for wood products decreased an amount equivalent to the drop in local production, then the external footprint would remain stable. The above "Liberal future" scenario (Figure 13) contrasts with the "Romantic nature future" scenario. Here subsidies for forest protection decrease which increases pressure on forest owners to generate income from forestlands. At the same time, an increasingly urbanized public loses interest in recreation and nature protection and the profitability of timber harvest is enhanced by lower management costs and higher timber prices. All of these factors contribute to an increase in timber harvest resulting in a larger internal (local) forest footprint. As with the Romantic nature future scenario, the impact this has on external footprints depends on changes in consumer demand. If demand is stable, then it could lead to a decrease in imports which would reduce the external

Figure 12. Driver Scenario - Romantic nature future (Southeast Veluwe, Netherlands)

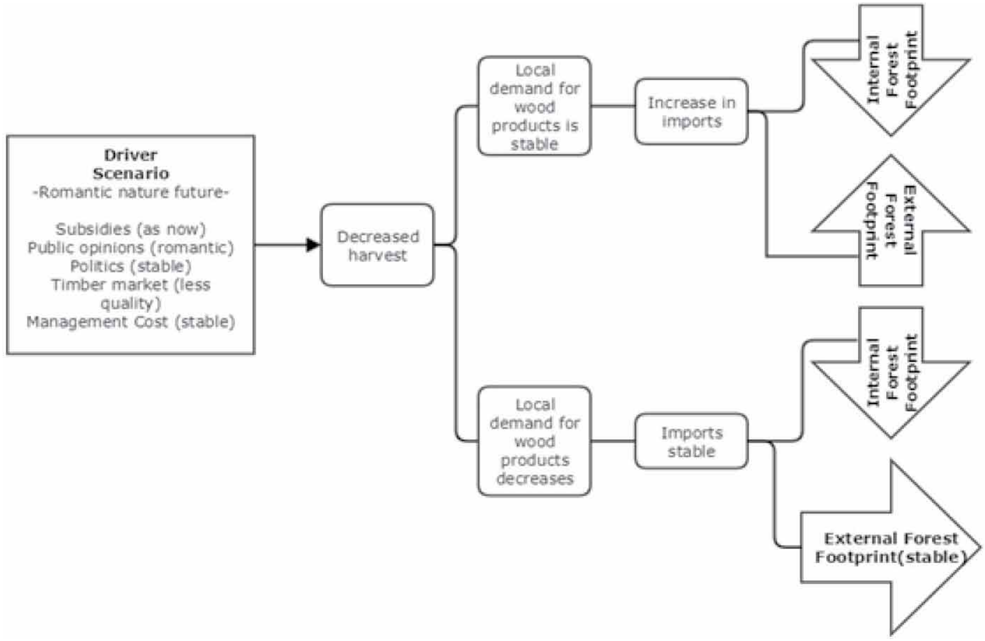
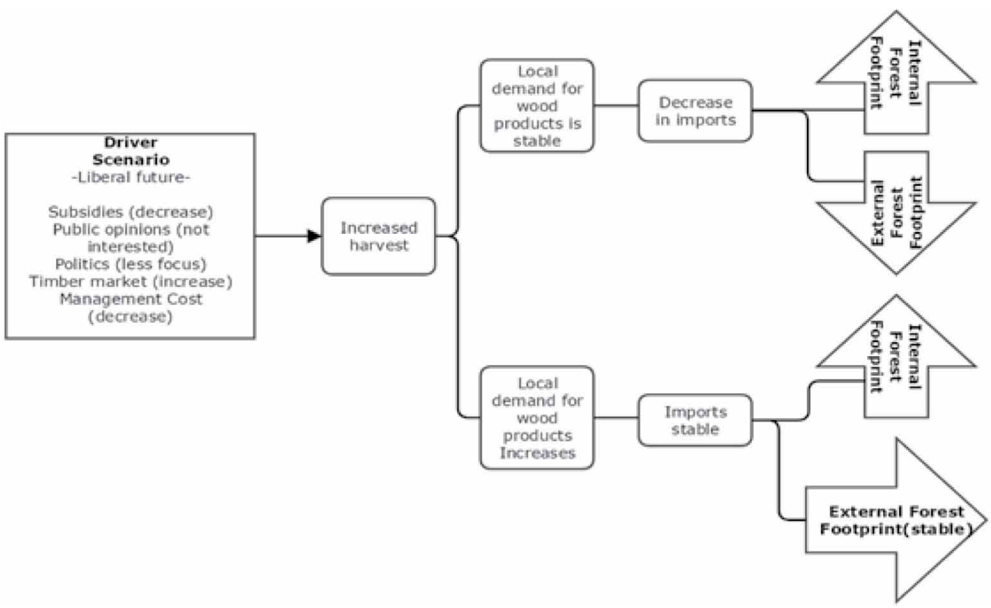



Figure 13. Driver Scenario - Liberal future (Southeast Veluwe, Netherlands)




footprint. If local demand increased equally with increases in production than reliance on imports would remain stable.

The issue of energy impacts is also relevant to the case study scenarios in regards to their treatment of biofuel production. In fact, a number of different European case study scenarios include trends in fuelwood and biofuels as a major defining element. Biomass production in these scenarios is often associated with more intensive management and shorter rotation forestry. In some scenarios an increase in intensive biofuel production is associated with “utilitarian” or production-oriented futures (e.g. in the “Utilitarian future” scenario in Southeast Veluwe, Netherlands) while in others biofuel product is combined with strict set-asides for nature conservation and/or carbon storage. (e.g. in the Climate change mitigation scenario in Suvalkija, Lithuania). Assessing the footprint effects of these different biofuel scenarios is a complex and controversial endeavour which requires evaluating tradeoffs for biodiversity and other forest values as well as calculating global forest and carbon footprints. This again highlights the need for further research.

## DISCUSSION AND CONCLUSION

As our world becomes increasingly globalized, decisions about forest and land use in one part of the world have increasingly greater impacts elsewhere. The concept of global footprints provides one tool for local forest stakeholders to begin to think about the impacts of their local decisions across scales. This includes quantitative calculations which can be applied at various scales to compare apparent consumption of forest products to the earth’s “biocapacity” to supply those products. Likewise, similar calculations can be made to assess “carbon footprints” based on the amount of “uptake land” required to supply the energy consumed in producing, transporting and trading products. As we illustrated in the previous section, it is then a relatively straightforward matter to link these quantitative footprint concepts to the scenarios created by the case study stakeholders. The last figures provide a graphic illustration of how scenarios involving an increase or decrease timber in harvest, combined with various possible changes in local consumption patterns, might together affect both “internal” (local) and “external” (non-local) forest footprints. The concept of “footprint”, however, can also be interpreted more broadly to extend beyond biocapacity and carbon to encompass all of the forest values identified by forestry stakeholders. For this purpose, the concept of “footprint quality” for the identification of the sources of EU forest products is really important in terms of consumption and sustainable forest management. Fully “integrated” forest planning and scenario processes would involve not only identifying what values are locally important but considering how those values might be coherently promoted at national, EU and global scales.

The analysis of the international wood trade highlights how significant quantities of wood products traded and consumed within the EU originate from countries where the risks of illegal or unsustainable logging are high. Thus the ecological and social impacts of buying a cubic meter of wood from these sources, i.e. the “quality” of the footprint this generates, may be quite different from a cubic meter of wood produced locally. For example, eastern Russia is a region with relatively high rates of illegal and/or unsustainable logging and is also a major source of primary processed wood for the EU. Likewise, Secondary Processed Wood Products (SPWP) are increasingly sourced from China, and much of the wood used to produce these products originates in eastern Russian and high risk tropical countries. Thus decisions to reduce local production, without a concurrent decrease in local consumption, could contribute to an increase in reliance on high risk imports with a net negative impact on sustainability. While the concept of “footprint quality” thus helps call attention to the global significance of local actions, there is need for further research to inform local stakeholders about the precise nature of their external impacts. For example, researchers such as Lindner et al. (2010) are exploring methodologies that integrate a wide range of social, environmental, and economic variables and energy use to assess the relative impacts of different wood supply chains. On-going research is also needed to inform consumers and consuming countries how they might transform their consumption policies and practices in ways that support improved forest governance worldwide (e.g. Lesniewska & McDermott, 2014). A modern decision support system could surly be based on this kind of analysis giving attention to variables related to the stakeholders or to the consumers. Given predictions of ever-increasing globalization and rising global consumption, the need for further research of this kind is likely to grow ever-larger and more urgent over time.

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## ENDNOTES

1. The material footprint of nations calculated by multiplying the final demand of a country for goods and services with multipliers representing all upstream global material requirements associated with one unit (dollar) of product.
2. The uptake land to accommodate the carbon Footprint is the only land use type included in the Ecological Footprint that is exclusively dedicated to tracking a waste product: carbon dioxide" (Buonocore et al., 2014).
3. This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grand agreement No 282887 (Hinterseer et al., 2014).
4. Bulgaria (Teteven and Yundola), France (Pontenx), Germany (Munich South and Upper Palatinate), Lithuania (Suvalkija and Zemaitija), Portugal (Chamusca, leiria and Vale de Souza), Slovakia (Kysuce and Podpolanie), Sweden (Helge a and Vihelmina)), Italia (Asiago, Etna, Molise), The Netherlands (South-East Veluwe) and Ireland (Newmarket and Western Peatland).
5. EU/EFTA countries refer to 15 European Union member countries and Iceland, Norway and Switzerland (Kangas & Baudin, 2003).

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