HIDDEN IMPACTS

How Europe's resource overconsumption promotes global land conflicts

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EXECUTIVE SUMMARY

This report examines the inter-linkages between our material use and related land requirements and, through demonstrating this link, highlights the very urgent need to scale down our excessive consumption of this resource in the interests of maintaining the regenerative capacity of the biosphere, as well as conserving resources for future generations.

This report is the third of a series which shed light on the relationship between different types of natural resources (after "Overconsumption?"[1] on material use trends and "Under Pressure"[2] linking material and water use). The focus of this report is on Europe and its role as a major user of global land resources.

Land is arguably one of the most taken-for-granted resources, largely due to its unseen role in all of our consumer and food products. It is a fundamental resource necessary to produce our crops, fruits and vegetables, the timber that is required to produce paper and furniture, the minerals we extract to build our houses and roads and the metal ores that form the basis of consumer goods, such as computers and mobile phones. Many people are oblivious to the link between the products that they are consuming in ever greater numbers and the central role that this is playing in land use changes, ecosystem degradation and poor working conditions in other parts of the world.

Land is a limited resource. As demand for land grows, both the pressure on this limited resource and the competition between its different applications will escalate. For instance, around 38 % of the world's land surface is currently used for agriculture. A mix of pressures such as world population growth, rapid increases in the size of the world's middle classes and corresponding changes in diets and energy use, growing consumption of biofuels in the US, EU, Brazil and elsewhere, alongside the current and growing overconsumption of the industrialised nations, will undoubtedly trigger increases in demands for agricultural products. Current demands are generally being met through industrialised agricultural practices, thereby contributing to declining soil quality, and increasing pressure on biodiversity and pollution of the natural environment more broadly.

In all of the products that we consume, we also indirectly consume embodied land that was required along the production chain to produce a particular product. The amount of embodied land traded around the world has increased in line with growing international trade in agricultural products. Already in 2007, 40 % of Europe's land footprint – the land used for crop production and livestock farming which was required to satisfy the demand for products in Europe – was located in other regions of the world, some of which are unable to provide basic food and resource needs for their own people. Note that this figure does not include land for forestry or fibre production – the land used to produce wood, paper, or natural fibres like cotton.

Land footprints differ considerably between different countries and world regions, with the industrialised countries consuming more than their fair share. There are also significant differences in the land requirements for different products along the production chain. For example on a global scale, the production of meat and animal-based products has the largest land footprint, taking into account grains and cereals grown to feed livestock. Hence, societies with a high share of meat in their diets have a larger land footprint.

The increasing hunger for land to satisfy our consumption often becomes manifest in the direct or indirect appropriation of foreign land, often in the form of "land grabbing". This phenomenon, which has seen large increases in recent times, occurs when local communities and individuals lose access to land that they previously used, threatening their livelihoods, as it is acquired by outside investors, including national elites, domestic and international corporations and governments. Biofuel production, which has significant social and environmental consequences, has been identified as the largest driver of land grabbing in the global south in recent times. Unsustainable European consumption levels and European trade and domestic policies – including biofuels targets – are playing a catalytic role in this phenomenon.

To reduce Europe's land footprint, it is essential that we drastically decrease our overall consumption, including changes in our consumption of items such as meat, as well as rethink policies that drive resource depletion in other parts of the world. To improve Europe's and the world's land management, footprint analyses and land use reduction need to be integrated into national, European and global policies in order to be able to set and measure targets that catalyse the creation of markets for products that have a low land footprint. Alliances between net-importers and -exporters of land should be established, for instance in terms of a common strategy, to efficiently administer and reduce the demand for land. Trade policies need to be modified to ensure socially and environmentally responsible use and trade of land, thereby ensuring that communities that are dependent on local natural resources can retain access to land and other natural resources in order to sustain their livelihoods.

It is also imperative that Europe creates domestic and trade policies that encourage alternative, more sustainable methods of production that respect the natural processes of land and surrounding ecosystems, whilst simultaneously decreasing the application of industrial agricultural methods that are causing massive environmental and social harms, such as the application of artificial fertilisers and pesticides. In particular, government interventions in agriculture, such as through farming and trade policies, need to be reformed accordingly. Equally important is the requirement to increase the efficiency of the end use of the harvested crops, for instance by drastically decreasing the amount of food that is wasted. Lastly, efforts to increase general material efficiency, combined with measures to reduce resource demand as well as reuse and recycle resources and products, are urgently required to reduce the pressure exerted on land worldwide.

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1. INTRODUCTION

This report investigates the links between material use and related land requirements. A growing world population, high – and growing – consumption levels in industrialised countries, rapidly increasing middle classes, related increased consumption levels and expanding urban areas are some of the key drivers behind the increasing demand for materials and land. In fact, everything we buy entails weights of materials or hectares of land, litres of water and quantities of energy which were needed in the production process. These components can be measured in order to help us understand the inter-linkages between the different kinds of natural resources. The measurement of these links is becoming increasingly important in enabling us to identify options for a more sustainable use of the planet's limited resources. This report focuses on the role of Europe in the world as a direct user, as well as indirect importer and exporter of land, with specific focus on agricultural land. Europe's use of land outside of Europe and the associated environmental and social impacts in other countries are also discussed.

Worldwide, 38% of the Earth's land surface is used for agriculture. The current trend of expanding agricultural land to increase production of food and animal feed increases pressures on global productive land areas. Land appropriation for human activities is an escalating phenomenon. As a consequence, native woods are cleared, pristine ecosystems destroyed and important habitats for fauna and flora are lost. Feeding our increasing world population is becoming an ever more complex challenge, as on a geographically finite planet, the expansion of the use of one type of land will always be at the expense of another. Land degradation associated with industrial agricultural production is increasing. The worldwide growth of extractive industries is also accelerating the demand for land. Finally, the rapid growth of cities and sub-urban agglomerations leads to additional loss of arable land and ecosystems.

Land is needed for the extraction of all materials and counts as one of the most important planetary boundaries due to its importance in maintaining the resilience of ecosystems – as well as human life. With increasing consumption of food, products and services, our land footprint – the land needed to produce all the products and service we consume – is also growing, and societies around the world are increasingly facing shortages of and competition for land, as well as suffering the social impacts of land overconsumption[3].

In our globalised world the products we consume are increasingly imported from elsewhere, bringing with them a specific amount of embodied land. In fact, Europe does not have enough material and land resources within its borders to maintain current levels of consumption of agricultural and other products. By importing growing amounts of biomass and industrial materials and products from other world regions, we also indirectly import significant amounts of land, which was required elsewhere to grow, extract or process those goods. These interdependencies between the global trade of products and the related requirements for land are often underestimated or ignored but are crucial in understanding developments with regard to current trends in land use.

Increasing land demand on a spatially finite planet calls for a decrease in overall material consumption as well as a concerted strategy on managing the available land resources. If all people world-wide adopted the level of material consumption that is currently prevailing in the rich OECD countries, global material consumption would increase from around 70 billion tonnes today to more than 160 billion tonnes in 2030[4]. This would imply an escalation of pressure on already stretched global land areas. As land is needed for the extraction of all materials, this report argues that an absolute reduction of material consumption is also

needed to lift pressures on land, for instance by reducing production of animal feed or by increasing recycling rates and therefore reducing the need for primary mining of raw materials. The more the world economy is becoming globalised, the more the use of one type of natural resource in one part of the world can directly affect the availability of natural resources in other parts of the globe. Hence it is imperative that resource use strategies at the national, regional and global levels are comprehensive and inclusive of all affected parties, such as governments and industries.

This report is the third of a series of reports on resource use which shed light on different aspects of global resource consumption. "Overconsumption?"[1] provided an overview of current trends in European and global resource use, focussing on biotic and abiotic materials. "Under pressure"[2] covered the inter-linkages between material use and water consumption. The present report turns to the issue of material consumption and land use.

The numbers in this report refer to agricultural land footprints, which include land for crop production and livestock farming, being the largest users of land worldwide. Forestry and industrial land use have not been taken into account due to a lack of data availability and comparability reasons[5]. However to paint a complete picture of land use and societies the case studies cover industrial land uses as well.

THE REPORT IS STRUCTURED INTO FIVE THEMATIC CHAPTERS:

CHAPTER 2

explains that the land surface of our planet is subject to a variety of uses and shows in absolute numbers the different land requirements. It is shown how much land is used for the production of agricultural products as well as the extraction of materials that form the basis of our consumer goods. By focussing on agricultural land use, it is shown how much land is used for different biotic materials in different countries and world regions. This demand often has to compete with local supply of agricultural products as well as with biodiversity. The topic is further illustrated by means of a case study from Chile which highlights the environmental and societal impacts of lithium extraction in the Atacama Region.

CHAPTER 3

describes the concept of land embodied in products. We look at the extent and patterns of global trade of land embodied in particular in agricultural products. A comparison is made between land requirements covered nationally vs. via imports in different regions and how much land is used for products for the national market vs. exports, respectively. The issue of land-grabbing is addressed in order to illustrate some of today's most concerning social and economic impacts of land and water scarcity. A case study from Cameroon shows the role of cotton in the national economy and the influence of the global market at the local level.

CHAPTER 4

analyses the land requirements of European consumption disaggregated by major product groups and shows where in the world the EU is using land directly and indirectly for satisfying its final consumption. Concrete examples of how much land is incorporated in specific products are given and the link of direct and indirect (embodied) land consumption with local impacts is illustrated in a case study on aluminium production in Brazil.

CHAPTER 5

focuses on the interrelationship between land use and material efficiency. It describes the different techniques currently used to increase efficiency in the use of land and shows to what extent increased efficiency in a range of complementary areas could help reduce the pressure exerted on global land resources; for instance via the reduction of food waste or the exchange of best practise examples, as well as an improved distribution of harvested biomass. A case study from cotton production in Togo gives additional insight into the topic.

CHAPTER 6

highlights the fact that the continuous growth of worldwide land demand is already facing severe physical limits. It argues for a targeted European policy towards reducing the direct and indirect land use related to consumption in Europe through measures such as reduced overall consumption levels, a change in diets and green public procurement. It calls for alliances with countries that are net importers or net exporters of embodied land. Thereby, the overall aim is to establish high level, measurable targets that will work towards reducing resource overconsumption.

The annex explains the methodology used to calculate the direct and indirect use of land for Europe's demand. The numbers in this report refer to agricultural land footprints, which include land for crop production and livestock farming, being the largest users of land worldwide. Forestry and industrial land use have not been taken into account due to lack of data availability and comparability reasons[5].

2. LAND USE AND MATERIAL EXTRACTION

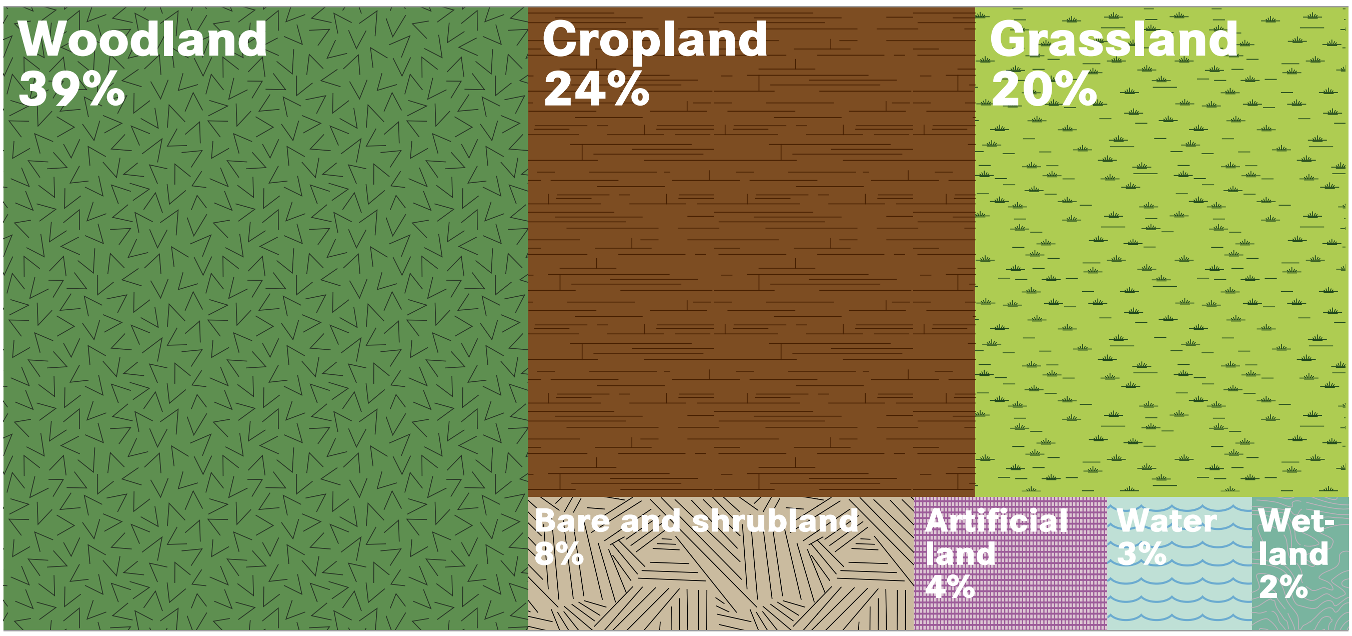
Land is a fundamental and often unseen resource used in almost everything we consume; from the crops, fruits and vegetables we eat, the crops used to feed farm animals and increasingly our demand for bio-energy, to the timber that is required to produce paper and furniture, the minerals we extract to build our houses and roads and the metal ores that form the basis of consumer goods, such as computers and mobile phones. The link between the product, the resource that is extracted and the land required for the production of this product is often neglected, as is the fact that large tracts of wilderness are converted each year in an attempt to satisfy our increasing appetite for food and consumer goods.

Land use describes the modification and management of land for human activities such as agriculture, forestry, mining, settlements and infrastructure. The size of land needed to harvest a certain amount of crop, or to extract a specific mineral, mainly depends on biophysical and geological circumstances, as well as the farming techniques applied.

Large amounts of land are required for the functioning of industrialised societies. Worldwide, 31 % of land is covered by woodland, 26 % by grasslands, 12 % by cropland and 1-2 % by built-up areas[6], with the remaining land consisting of shrubland, bare land (including rocks and mountains), wetland and other natural areas such as deserts and glaciers. Worldwide land covered by cropland equals half the area of the Asian continent. It increased by almost 12 % in the last 50 years[7]. In Europe, the main land-cover types are woodland (39 %), cropland (24 %), grassland (20 %), bare and shrub land (8 %), water bodies (3 %), wetlands (2 %), and artificial land (4 %)[8] (Figure 2.1)[9] with mining covering 0.12 % of land cover[10,11].

The world is running out of land. Global reserves of land for agriculture are constrained by other uses such as housing, mining or protected natural areas that safeguard biodiversity,

Figure 2.1: Distribution of land coverage in Europe in 2009 [(i)]



with the latter category of land often under great pressure caused by consumer demand.

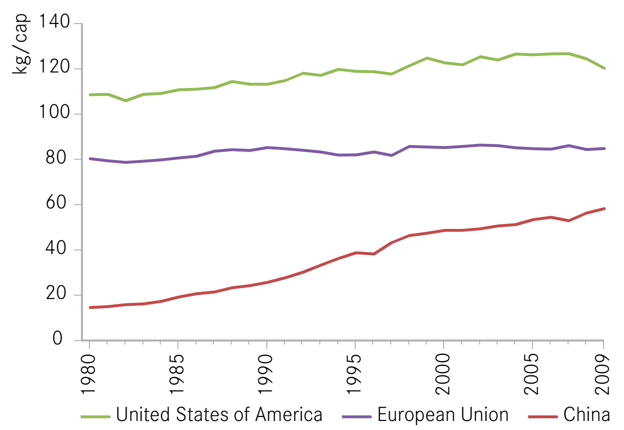
On a geographically finite planet, the expansion of one land use type will always be at the expense of another. Land appropriation for human activities is an escalating phenomenon. As a consequence, native woodlands worldwide are at threat from being cleared for expanding agriculture and mining and pristine ecosystems including wetlands and peatlands are being destroyed. This causes the loss of important habitats for fauna and flora, and emits untenable levels of CO_2 locked in the land. Indigenous peoples and communities reliant on natural resources to sustain their livelihoods are also at threat.

The production of almost all types of food requires land. The world population reached seven billion in 2011 and is projected to hit over nine billion by 2050[12]. Demand for food and fodder will increasingly compete with energy supply demands, as use of biofuels continues to grow in Europe, USA, Brazil and increasingly other areas of the world – driven by policies and targets. Biofuels are high land consumers – currently produced mainly in the USA, Brazil, Germany and France, but also increasingly in developing and middle-income countries. World ethanol production is expected to increase by 44% by 2021, with Brazil, home to the largest part of the Amazon rainforest, expected to contribute 29% to this increase[12].

According to the UN-FAO and OECD, **agricultural production has to increase by about 60% globally and nearly 77% in developing countries by 2050[12]** in order to meet the expected rise in the global population and the increase in daily calorie intake driven by higher incomes in developing countries. Under 'business as usual' consumption pattern scenarios this would mean that between 71 and 300 Mha of global cropland would be required for food supply by 2050[13]; and annual meat production would need to rise by over 200 million tonnes to reach 470 million tonnes by 2050[14] if we are to continue consuming and wasting as much as we currently do. However, these projections are based on current demand curves. As of 2009, nearly half of the world's cereal production was used to produce animal feed. If meat consumption increases as projected until 2050, this would mean that 50% of the total cereal produced may be dedicated to meat production[15]. Therefore, reallocating cereals used in animal feed to human consumption, combined with the development of alternative fodder, waste and discards, could go a long way towards meeting these increased needs. The United Nations Environmental Programme (UNEP) estimates that, even accounting for the energy value of the meat produced, the loss of calories that result from feeding cereals to animals instead of using cereals directly as human food represents the annual calorie needs for more than 3.5 billion people[16].

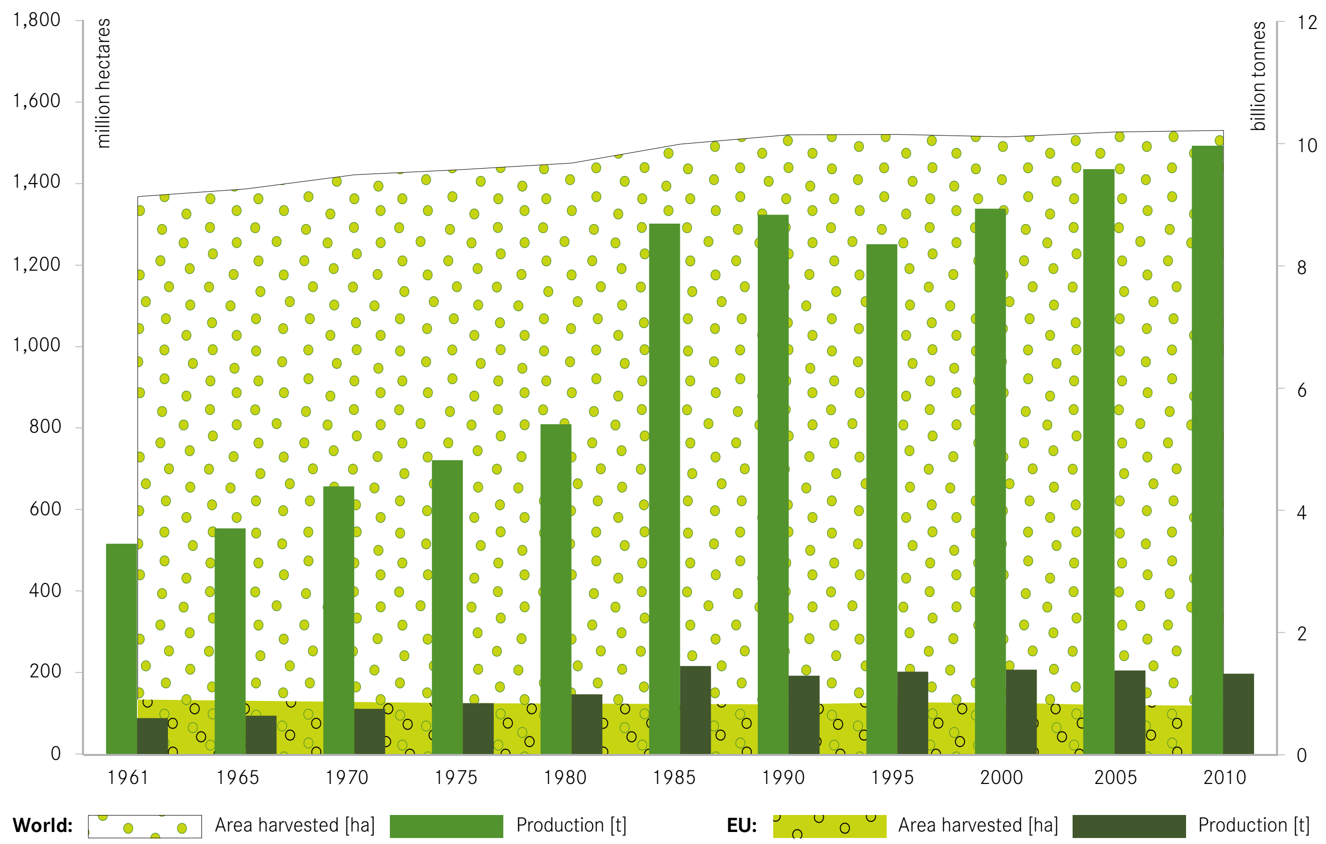
Globally, the size of the middle class could increase from 1.8 billion people to 3.2 billion by 2020 and to 4.9 billion by 2030[17] and with them changes in lifestyle, diets and demographics. Meat consumption in particular plays a symbolic role for the newly wealthy. This is evident, for instance, in China where economic growth in the past thirty or so years is reflected in increases in per-capita meat consumption, with 11.6 kg in 1980, 39.7 kg in 1995 and 52.5 kg in 2012[18]. Adding these increases to the already extremely high levels of meat consumption in industrialised countries is seriously endangering the entire production platform of the planet[19], as ever more land is required to produce these enormous amounts of meat (Figure 2.2). This will enhance competition for current cultivated land in some regions and cause land conversion in others as well as increase global greenhouse gas emissions.

Figure 2.2: Meat production in China, United States of America and the European Union: 1980-2009 (ii)



The amount of land used for the production of a specific crop differs among countries and production areas. Figure 2.3 illustrates the quantities of biomass used for food production harvested around the globe and compares it with the area used for this production. From this it can be clearly seen that worldwide land productivity has increased considerably, reaching 6.5 t/ha in 2010. In comparison, European average intensity is around 10 t/ha. In this context it has to be borne in mind that these are average numbers and values can differ remarkably due to differences in crop and land types, local growing conditions, planting techniques as well as the application of fertilisers and pesticides.

Figure 2.3: Production quantities and area harvested of biomass used for food production (iii)



Some crops are more land-intensive than others. In some countries enormous amounts of land are used for the production of specific crops with large differences regarding scale of plantation and amounts harvested. In the last few decades, in addition to food production, increasing amounts of land are being used for the production of feed for meat production as well as for biofuel production. It is ironic that, while large parts of the world's population don't have enough to eat (nor the land to produce it), others are using precious land resources to "feed" meat consumption or to fuel cars. To give an example, Figure 2.4 illustrates land requirements in specific countries for the production of one tonne of harvest for rapeseed – a crop often used for production of animal feed and agrofuels. Rapeseed is the most predominant biofuel crop in Europe, with a 77% market share[20] of Europe's bio-diesel; bio-diesel currently consumes an estimated 66% of the European rapeseed harvest[21].

Figure 2.4: Total harvested area in the largest rapeseed producer countries in 2010 (iv)

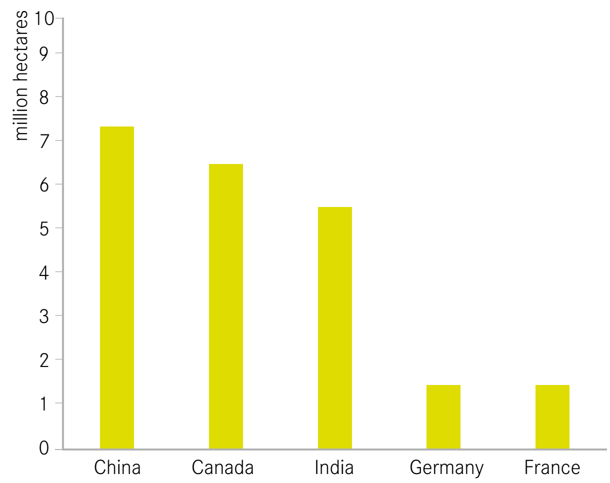


Figure 2.4 demonstrates that China utilises a large amount of land for the production of rapeseed: more than seven million hectares, which is close to the country size of Ireland. However in comparison in Germany, the largest producer of rapeseed in Europe, rapeseed fields cover much less land, at around 1.5 million hectares. Given that biofuel production is

projected to have the largest growth of all agricultural products[12], this will have large impacts on the land allocated for rapeseed production in Europe and around the world, as well as on other oilseed crops imported for biofuels and fodder, that is unless policy measures in the European Union are taken to reduce biofuel use and limit the highest land-using biodiesels from rapeseed, soy and palm oil.

The world's forests are being cut down at rapid rates due to a number of drivers, especially in countries and areas in the tropical regions. Apart from 'traditional' uses for timber, fire wood and paper, the leading cause of deforestation is the conversion of forest land to agriculture, urbanisation and mining[22]. Furthermore, the sustainability of the ecosystem and its habitat in the process of major land-use changes is often not considered, especially in built-up areas with high grey infrastructure (roads and buildings)[23]. Forests provide numerous ecosystem services such as groundwater retention, protection against soil erosion and flooding, climate control and recreational activities and provide habitats for animal and plant life. Moreover, forestry utilises large tracts of land in order to provide humans with firewood, timber for furniture, paper and other applications. But it is not only the demand for wood products but also for arable land which leads to a decrease of the global forest coverage[23]. Globally, gross forest cover loss (GFCL) was estimated to be 1,011,000 km^2 from 2000 to 2005, representing 3.1 % (0.6 % per year) of the estimated total forest area in the year 2000 of 32,688,000 km^2 [24]. Ironically, many forests in developing countries are threatened in part as a result of drivers stemming from industrialised countries, whereas in Europe, forests are expanding, part of which can be attributed to European concerns relating to maintaining their natural environments. This recent trend is now occurring at the expense of land that was previously agricultural land[23].

Built-up areas currently occupy an estimated 150 million ha or 1.1 % of the global land mass (excluding Antarctica)[7]. Built-up land refers to land that has been converted into uses such as housing, infrastructure (such as roads) and industrial areas and other non-agricultural uses. The expansion of urban areas and land required for infrastructure and other non-agricultural purposes is expected to at least keep pace with population growth[19] leading to significant global land conversion and associated rises in carbon emissions and terrestrial and water pollution. This is particularly evident in emerging economies such as China, where cities are growing much faster than in Europe. Similarly, European urban areas have expanded further (with about 0.6 % of annual land take) at the expense of all other land-cover categories with the exception of forests and water bodies[10].

Metals and industrial minerals are the basis of our industries. Their extraction often takes place in large open-pit mining sites. For the construction of buildings and infrastructure we require worldwide more than 30 billion tonnes of construction minerals such as sand and gravel per year. Data on land requirements for mining activities is scarce. However, in relation to other land use categories, land requirements for mining are comparatively small, yet the impacts of resource extraction can be intensive in terms of other resources such as water and clearance of forests causing extensive environmental and social harm as highlighted below.

CHILE: LITHIUM EXTRACTION IN THE REGION OF ANTOFAGASTA

The ethnic Atacama people are the descendants of the ancient Kunza culture of farmers and shepherds who originated from the Central Andes. Their traditional hunter-gatherer lifestyle changed over time into agricultural and livestock farming settlements which became the roots of the classic culture of the people of Atacama or Likan-antay. Today, the population of Atacama is approximately 23,000 people who live mainly in the Antofagasta Region where they continue to have a strong spiritual and economic connection to their ancestral lands.

Their lands, the Atacama desert, are also one of the driest places on earth and are now the site of the world's largest lithium producer. However, lithium mining uses large amounts of water, placing it at odds in the Salar de Atacama's harsh and dry climate, in turn causing conflict between the mining companies and the Atacama as they compete for water and land.

Lithium mining

Lithium is used extensively in a range of devices including mobile phones, flat screens and electric or hybrid car batteries. Annual demand for these products has grown between 7-8% in the last ten years, which in turn has increased the demand for lithium.

As outlined in the report "Under Pressure"[2], the lithium sector at Salar de Atacama produces 58% of the world's lithium, with the largest company producing around 21,000 tons of lithium carbonate per year and an installed capacity which could easily duplicate this figure. Nowadays, some 100,000 tonnes are produced around the world and the Salar de Atacama has the potential to produce some 250,000 tonnes. Experts predict levels of consumption of some 150 – 200,000 tons by 2030 if battery makers do not succeed in improving efficiency in the use of lithium.

The largest producer's current mining extraction plant – which includes the processing, administration, storage and solar evaporation ponds – covers 1,700 hectares.

Producers have requested additional exploitation rights for 145,000 hectares and 26,000 hectares for exploration of the Salar de Atacama[2].

Who owns the resources?

In Chile, the State has the right of eminent domain and therefore compulsory purchase over the minerals and, in general, over any fossil substance. The State is thus allowed by the Constitution to grant concessions to third parties independent of the current ownership of the resource.

Land use and resource rights

Conflicts between the mining industry and the Atacama people relate primarily to differing resource use objectives. The laws that relate to natural resources and Chile's indigenous peoples in practice do not adequately protect indigenous rights in relation to indigenous use and ownership of their traditional resources and land. The "Indigenous Law" provides that the State, through its institutions, is to respect, protect and promote the development of the indigenous populations, their cultures, families and communities, by adopting the adequate measures to attain such "ends that protect the indigenous land, see to its appropriate exploitation, its ecological balance and attempt at its expansion."

To attain this objective, Indigenous Development Areas can be formed, which in theory should provide an opportunity for the Atacama to have greater self-management and greater control over their ancestral lands through providing greater access and rights to their land. However, there are a number of factors that mitigate these rights. For example, the Atacaman "right" to their land only allows them to access their land, and the issue of actual legally-recognised ownership is fraught with ambiguity. This has led to situations where communities have lost control of scarce cultivable land as they were unable to demonstrate that they have the right to exclude others from their lands.

The Chilean Constitution also permits the exploitation and concession of the Atacama heritage and natural resources, providing an opportunity for the private sector to exploit and control the mineral resources found in the region (including the ancestral lands of the Atacama people) as well as to expand into sectors that were the historical domain of the State.

Water also plays a key role in the life of the people of Atacama, as a fundamental element in their agricultural-pastoralist economy, as well as playing a spiritual role. The relevant law on water rights separates the right to water from the right to land, empowering third-party players external to the indigenous communities to acquire the rights of exploitation that historically have been in the hands of the original communities. The law also allows third-party players to register the resource if it is the case that the water has not been registered legally, causing competition and conflict between the local population and the mining companies, since the latter oppose the claims to water rights submitted by the local communities.

Social impacts from lithium mining

A complex situation has arisen where the community has become economically dependent on the mining companies, in addition to any reliance on official employment. In some instances, a quasi-paternalistic relationship has been established between the community and the mining companies, with the former seeking gifts and financial compensation for the exploitation of their lands and water resources. There has also been an increase in immigration to the area to work in the mines and the supportive industries, which is also an additional source of social tension and conflict.

Future developments of lithium mining

The Salar de Pujsa, a salt flat in Los Flamencos National Reserve, has been earmarked for future expansion of the lithium mines, putting at risk an ecosystem of major environmental and cultural relevance, including a lake which is an important nesting site for flamingos. This also has wider economic impacts for local communities whose main economic activity is the tourism industry that is attracted to the area for its natural beauty.

As of March 2012, the Ministry of Economy also proposed the introduction of "Special Contracts of Operation" which will allow foreign companies to exploit the lithium in territories protected and inhabited by the Atacama people. The State, through external consultants, has requested that several surveys be conducted over the Atacama land with a view to attracting future investments and mining operations. Unfortunately, no measures are being discussed internationally which could reduce future lithium mining, such as an effective recycling stream.

In the end, the Atacama people feel that their rights to their ancestral lands and water resources have been ignored, and the relevant laws are ineffective in protecting them from the mining ambitions of the State. It would seem that their future and way of life is as precarious and threatened as the environment on which their lives and culture depend.

3. LAND USE AND INTERNATIONAL TRADE OF PRODUCTS

With every product we consume, we also indirectly consume the land that was required along the production chain of this particular product. This land is referred to as embodied or virtual land as it is not visible in the final product. With increases in agricultural production and international trade in agricultural products, the amount of virtual land being traded around the world has also increased. For example, 40% of the agricultural land required to satisfy the demand for products in Europe – Europe's land footprint – is located in other regions of the world. The increasing worldwide hunger for land has severe environmental and social consequences, including land grabbing, which is occurring predominantly in the global south.

When we consume our daily bread, rice, fruits or other products, we rarely think about the amount of land, water and other resources that were required for their production. These resources are often called embodied or virtual. Embodied land, for example, is the size of land that is needed to produce one unit of a given agricultural good, that is, its land footprint. The international trade of products thus implies a trade of embodied land. To account for the total amount of land embodied in a product, it is necessary to analyse the whole supply chain and the land required in each step of production. Adding up the land needed to produce the goods and services consumed in a country gives the total land footprint of this country.

Worldwide virtual land use has been increasing significantly over the past 15 years due to increasing trade volumes, encouraged by a global drive to remove barriers to the flow of goods and services. In the period 1997-2007, the amount of land embodied in traded biomass used for food and fodder for animals has increased worldwide by 81% – from 382 million ha to 692 million ha. Added together, imports to and exports from the European continent (excl. Russia) increased in this period from 95 million ha to 165 million ha – an increase of 74%. In 2007, 24% of the global land footprint of biomass production was accounted for as related to exported products; hence only 76% of land for biomass production was dedicated to local consumption.

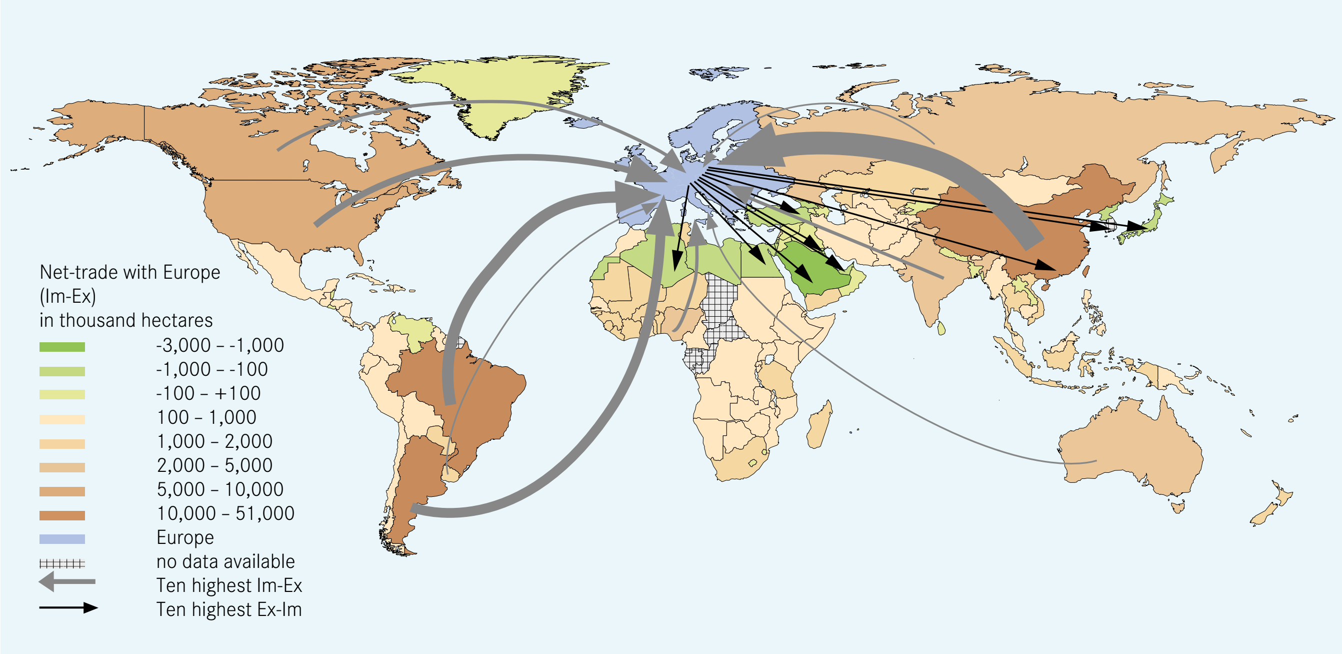
The largest net importers of agricultural land are Japan, Germany and the United Kingdom. The largest net exporters are China, Brazil and Argentina. When allocating the land flows to specific trade flows, it becomes apparent that trade associated with grazing areas, oilseeds and wheat is responsible for the largest embodied land flows (247 million ha, 122 million ha and 115 million ha respectively).

In Europe, external land footprints and internal footprints of agricultural land account for 10% and 90% respectively. Figure 3.1 illustrates the net importers and exporters of embodied land around the globe (colour of countries) and the main land trading partners of Europe (arrows).

Europe is importing around six times more virtual agricultural land than it is exporting. From Figure 3.1 it is apparent that Europe is net importing large amounts of embodied land from China (33 million ha), Brazil (19 million ha) and Argentina (12 million ha). More specifically, European net imports from China are largely embodied in grazing areas (80%); the net imports from Brazil are grazing areas (37%) and oil seeds (30%) while from Argentina grazing areas account for 47% of net import and oil seeds for 40% (Figure 3.2). Note that in reality, Europe is also importing significant amounts of non-agricultural land, in particular through imported forestry products. Earlier research for 2003 estimated that the land footprint of the EU-27 would more than double if these numbers were included[25].

Europe's land exports are divided amongst a large number of countries. The largest land net-exports from Europe to other parts of the world are to Saudi Arabia (2.7 million ha), Turkey (0.9 million ha) and Japan (0.8 million ha). Moreover, exports of 'Other cereal grains' (all grains except rice and wheat), 'Oil seeds' and 'Grazing' have the largest shares within the top net exports (Figure 3.3).

Figure 3.1: Net importers and exporters of agricultural land around the globe and from and to Europe in 2007 [v]



Note: The width of the arrows represents the volume of embodied land trade flows

Figure 3.2: Top five worldwide net imports of land to Europe in 2007 [vi]

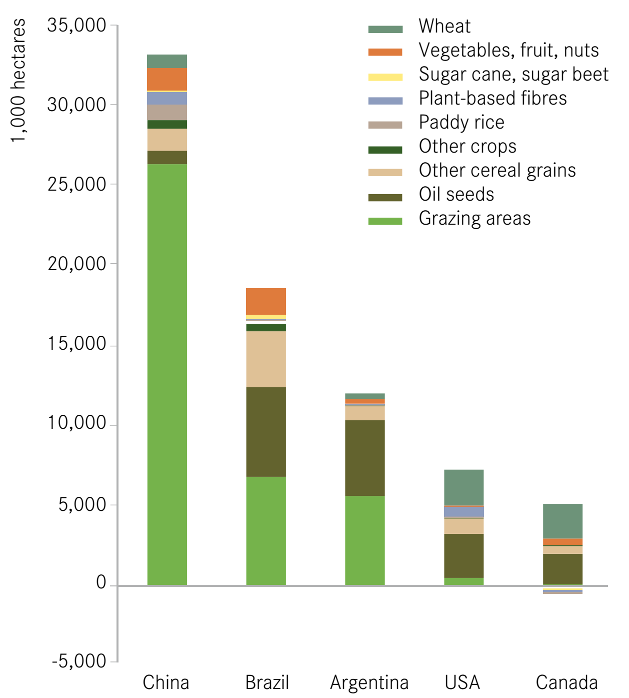
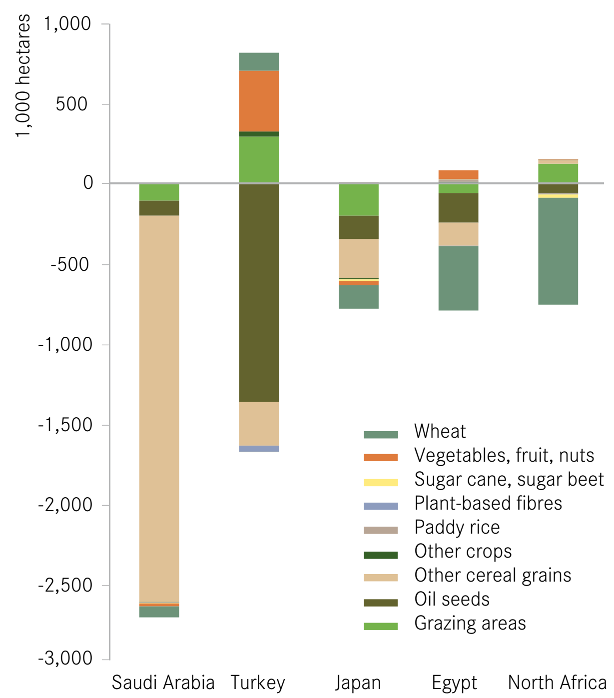


Figure 3.3: Top five worldwide net exports of land from Europe in 2007 [vii]



In addition to the analysis of net-exports and -imports, it is also important to examine trade in embedded land in absolute terms. Table 3.1 illustrates total imports and exports as well as net trade for the EU-27 and other countries. Please note that the table is arranged by the size of the per-capita footprint. Dark-blue shading highlights EU-15 Member States, light-blue shading identifies EU-12 Member States, and green shading represents other countries.

It can be seen that on a per-capita basis industrialised countries are among the largest consumers of land. For instance, overall absolute land consumption of the EU-27 and of China are in a similar range (300 mio hectares and 320 mio hectares respectively). However, in terms of per-capita consumption, the average European consumes three times the amount of land as the average Chinese person (0.6 ha and 0.2 ha respectively), highlighting the disparity and inequalities in global land consumption. The table below also underscores this point, additionally highlighting the land import dependency of the EU-27, being the world leaders at around 120 mio ha.

Table 3.1: Agricultural land indicators for the EU-27 Member States and selected countries (1,000 ha), 2007 (viii)

Country	Land footprint per capita [ha]	Land footprint	Exports (Ex)	Imports (Im)	Net trade (Im-Ex)
Australia	3.2	67,210	47,699	5,426	-42,272
Argentina	1.5	59,376	46,127	1,388	-44,739
Brazil	1.2	219,451	53,073	8,204	-44,869
Russian Federation	1.1	149,218	29,740	22,941	-6,799
USA	1	305,415	80,126	91,749	11,622
Luxembourg	1	480	55	408	353
South Africa	0.9	44,688	4,930	8,101	3,172
Latvia	0.9	2,060	405	773	368
Belgium	0.9	9,527	888	9,053	8,165
Ireland	0.9	3,893	2,843	2,469	-374
Canada	0.9	29,025	44,847	11,479	-33,368
Lithuania	0.8	2,644	964	920	-44
Greece	0.8	8,533	747	4,593	3,846
Estonia	0.8	1,009	225	474	249
Spain	0.8	33,759	7,685	18,316	10,631
Cyprus	0.7	634	45	533	487
Denmark	0.7	3,933	1,658	2,939	1,281
Netherlands	0.7	11,604	1,174	10,869	9,694
Portugal	0.7	7,272	838	4,674	3,836
Mexico	0.7	70,917	8,222	17,707	9,485
United Kingdom	0.7	40,809	3,642	26,834	23,192
Italy	0.6	36,841	3,203	25,913	22,710
Romania	0.6	12,919	1,541	2,087	546
Sweden	0.6	5,422	905	3,223	2,318
France	0.6	36,889	11,862	19,313	7,451
Finland	0.5	2,907	913	1,565	652
Germany	0.5	43,100	6,337	32,530	26,193
Austria	0.5	4,275	1,392	2,714	1,322
Bulgaria	0.5	3,653	1,450	786	-664
Slovenia	0.5	931	139	575	436
Malta	0.4	183	3	176	174
Japan	0.4	54,197	127	49,677	49,550
Poland	0.4	16,138	3,913	3,976	62
Czech Republic	0.4	4,341	1,697	1,850	153
Slovakia	0.4	1,898	721	862	141
Hungary	0.4	3,529	3,226	1,253	-1,973
China	0.2	319,072	125,841	33,088	-92,752
India	0.2	174,967	16,194	11,596	-4,598
EU-15	0.6	249,243	14,820	136,091	121,270
EU-12	0.5	49,940	11,344	11,279	-65
EU-27	0.6	299,183	16,282	137,487	121,205
Europe	0.6	351,548	24,249	141,045	116,796

Weak governance systems, corruption and a lack of transparency in decision-making, tied in with tenure insecurity of poor land users – coupled with Europe's insatiable appetite for more land to satisfy our consumption – are pervasive themes which undercut land grabbing and over-exploitation of resources in many developing countries. Historically, many countries have considered land and associated natural resources that are not formally registered to be property of the state, which the government could dispose of at will[26]. This is at times despite the existing customary ownership by local communities. For example, in Cameroon – a country identified by the European Biomass Association as having increasing biomass harvesting potential[27] – the state does not recognise customary rights in law, allowing the Government to sign contracts without the permission of the customary owners[28].

Where customary land tenure is not upheld, and even in cases where it is recognised[28], land grabbing can lead to unsustainable exploitation of the land and human rights abuses[29]. In some cases there are opportunities for customary owners to demonstrate ownership, and this is recognised in law. However there is not always a guarantee that these rights will be fully enforced. For example in Liberia, where customary law has been given formal recognition, government officials and investors have interpreted the law in ways in which customary owners have had their land transferred without compensation[26]. Furthermore, where land rights do exist, a lack of written documentation as well as awareness with regards to their rights can also frustrate communities' ability to have their rights protected against the state and outside investors[26].

There are measures afoot to address tenure insecurity, one of which is the United Nations Food and Agriculture Organisation's voluntary guidelines[30], which set out principles and internationally accepted standards that promote tenure rights and equitable access to natural resources. These can be used as a guide when developing national legislation, policies and programmes, and are a positive step towards clarifying tenure issues. However there is also a lot more that needs to be done in terms of the enforcement of tenure rights once they have been recognised in law.

LAND GRABBING AROUND THE WORLD[31]

The opaque and duplicitous system of resource ownership in many countries and a lack of legal recognition of customary resource ownership lead to issues such as land grabbing and expulsion of smallholder producers from their lands, often without compensation. Land grabbing occurs when land used by locals (and often owned by them under customary laws) is acquired, through various means, by external parties such as national elites, governments and domestic and international corporations amongst others. Land grabbing disenfranchises rural communities from their land and customary resource use, often losing access to grasslands, forests, marshlands and water which are often the basis of their livelihoods. Hence land grabbing plays a decisive role in food insecurity. Affected communities and individuals often lack recourse to the law to be able to have their lands reinstated or to receive adequate compensation, as their customary rights are either poorly defined or not recognised in law.

The 2007-2008 world food crisis and an increase in financial speculation of land commodities has led to an increase in land grabbing in mainly developing countries around the world. 78% of land grabs are for agricultural production, of which three quarters are for biofuels. Mineral extraction, industry, tourism and forest conversion make up the remaining 22%, with carbon offset markets being a growing impetus for increased land grabbing.

Globally there are records of over 203 million hectares of land deals between 2000-2010 (equivalent to over eight times the size of the United Kingdom). The majority are in Africa where 134 million hectares have been acquired, followed by Asia with 29 million hectares, however very many other deals must be presumed to go unreported.

Increasing consumption and trade cause land use changes and related environmental and social impacts abroad. Our ever-increasing demand for land is having a dramatic impact in those countries that export goods to Europe or other regions with high consumption levels. Land uses are changing to satisfy demand, leading to a loss of pristine eco-systems, habitats for flora and fauna and land for local people. In this regard, political initiatives such as the Renewable Energy Directive[32] which states that 10% of all transport fuels are to be delivered by renewable sources (in reality almost all are biofuels) by 2020, are expected to worsen this trend. Although sustainability criteria have been developed to address some of the concerns raised in relation to the Directive, these criteria still face fundamental weaknesses – including weak measures on deforestation, wetlands and peatlands – and do not currently address human rights and indirect land use change[28]. Therefore, increasing biofuel demand from the EU could still lead to more destruction of rainforest elsewhere[33], undermining any sustainability advances made and the greenhouse gas savings of most biofuels.

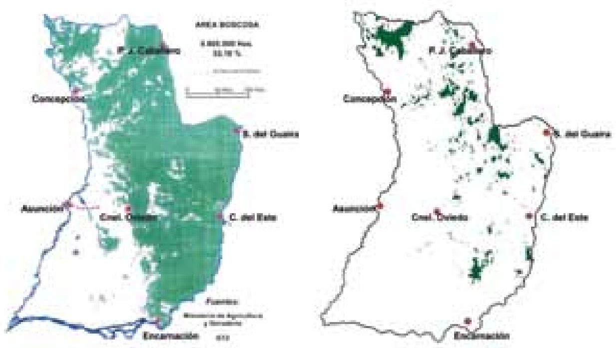
Reacting to increased market demands has in some cases considerable environmental impacts. For instance, in the last 30 years exports of soy beans from Paraguay have increased by a factor of ten[34]. To enable such an increase, the size of the Paraguayan soy fields had to be increased by a factor of five, from 500,000 ha to 2.5 million ha – 6% of the total country area of Paraguay[35]. Soy is only one of many crops planted in Paraguay with the overall impact being a massive reduction in the size of native forest in the country in the last 50 years (Figure 3.4).

International and European trade instruments are promoting policies that have significant negative international ramifications, with impacts felt on the economies, natural environments and the health and livelihoods of the people from countries where these materials are sourced.

Trade in agricultural products has surpassed its original objective – to provide nourishment and exchange food products that may not have been available in a particular country or region. The large scale drive for profit has dramatically altered the global agricultural and trading landscape. Europe in particular has been clear in its objective, as articulated in the Global Europe Initiative which has described the trade in agricultural products as an "engine of national economic growth." By promoting export-oriented programmes, Europe is focussing on the provision of the cheapest possible materials from across the globe for European businesses, ignoring any attempts to promote the objective of sustainable development[36]. These trade-related instruments generally do not integrate social or environmental concerns, which if included and enforced would help to avoid or mitigate societal and environmental harm. World Trade Organisation laws impact on a range of areas that relate to resource use, consumption and in particular, to minerals and agriculture. The laws were developed to reduce inefficient barriers to trade, and to provide equal footing to all members. In practice, however, those with the most political and economic sway tend to influence outcomes to their advantage to the detriment of smaller, developing or emerging economies, as many developing countries do not have the resources and capacity with which to adequately protect their interests against the better resourced, larger and generally more industrialised countries.

The European trade agenda plays a significant role in how land is used globally. It is influencing global production and prices of food and raw materials as well as international trade and related agreements, which in turn have ramifications for sustainable development objectives in developing countries. Europe's flagship agricultural policy, the European Common Agricultural Policy (CAP), is a system of agricultural policies which have the historical objective of reducing Europe's reliance on imported food, taxing food imports and subsidising European food exports[36]. In essence CAP subsidises the European agricultural industry, leading to inefficiencies in the European agricultural market as many European farmers rely on these subsidies in order to make their products competitive on the global market[37]. The CAP has been criticised for encouraging over-production, leading to an over-supply of food causing wastage and EU agribusiness to divert over-supplies into exports[36]. This has been to the detriment of developing country markets which have

Figure 3.4: Comparison of forest area in Paraguay in 1950 and 2005 (ix)



received agricultural products at below-market rates or in various other forms such as food aid, undercutting domestic markets that cannot compete with the scale and subsidised prices of European farmers. This then exacerbates food insecurity in developing countries[37].

Pressure exerted on developing country governments by a variety of international organisations, including the World Bank and major industrialised countries such as the EU and the US, has forced developing country governments to cut their support for domestic agriculture and to switch from staple food production for domestic markets to cash crop cultivation for export to international markets. For example, agriculture in developing countries, particularly in South America, has been diverted to produce animal feed such as soya to feed Europe's cattle, leading to clearing of tropical forests and forced expulsion of people from their lands[38].

In the area of agriculture, the EU has been attempting to pursue a trade liberalisation agenda with developing countries to open up markets and lower their tariffs[39]. Some agreements with a number of African countries have stalled in the negotiating phase due to African claims that the terms are unfavourable for their economic development. This has been supported by the European Parliament Committee on Development which has referred to some provisions in these agreements as being "unacceptable" which could "also damage their emerging economic sectors"[40].

Europe's quest for raw materials to fuel its economy has seen it exert undue pressure on least-developed resource-rich countries, therefore putting further pressure on foreign land resources. The EU released its Raw Materials Initiative in a move to help its large companies and investors ensure secure access to raw materials on world markets, foster the supply of raw materials from European sources and increase recycling of secondary raw materials[41]. By means of the initiative, the EU has been seeking to negotiate new rules on investment that will give the EU the same terms of access as domestic businesses, for instance, via the ban or minimisation of the use of export taxes on raw materials[42]. Consequently, such initiatives encourage unsustainable exploitation of minerals and ores and related to that increased pressure on the land needed for exploitation. As a consequence, European dependence on land in other parts of the world is further embedded.

Instead of focusing on initiatives to dramatically scale back European over-consumption of resources, the overriding objective of European trade policies has been to maintain the international competitiveness of European businesses, seeking to access cheap raw materials and to liberalise markets for its exports[36], in particular its food exports. Critics claim that by doing this the EU is undermining developing countries' ability to protect their natural resources which could exacerbate environmental and territorial conflicts, as well as undermining their ability to sustainably develop their economies[42].

CAMEROON: THE IMPACT OF COTTON PRODUCTION

Cameroon is a country with an area of 475,442 km^2 and a population density of 41.5 inhabitants per km^2 in 2011[43]. Cotton production is the largest user of land in northern Cameroon (where the majority of cotton is grown), covering an area of 85,000 km^2 in the North and Far North regions. The north of Cameroon is known as Africa's bread basket, yet it is increasingly susceptible to drought and desertification caused by poor agricultural practices and conflicts over land. The two main macro-economic factors influencing the Cameroonian cotton sector are the decline in world prices and the appreciation of the CFA Franc (FCFA) against the dollar[44], the impacts of which play out on the farm level at both an environmental level, through fluctuations in synthetic fertiliser use, and at the societal level, with cotton farmers in northern Cameroon generally unable to earn enough money to keep themselves above the poverty line[44].

Before the advent of cotton growing in 1950, land was mainly used for agriculture and livestock farming, the products of which were sold both at the local, regional, national and even international levels. Cotton growing was obligatory between 1950 and 1974 with cotton production being undertaken manually, without fertiliser or pest control. This mitigated negative impacts on the land, however yields were low at an average of 400 to 600 kg/ha. The land allocated to cotton grew considerably over time in response to international and domestic demand for the commodity[44]. In 1970, the land allotted for the growing of cotton was 110,000 ha and in 2002, the area of cotton cultivation increased to 200,000 ha[45]. Production increased rapidly from 1974 to 1988, reaching 165,000 t in 1988, due to the Government's intensification policies. Production then stabilised between 1988 and 1994 due to the devaluation of the FCFA, in response to safeguard policies introduced by the Government and the overvaluation of the FCFA, which made cotton an unattractive investment. However the devaluation of the FCFA gave the sector a new and sustained impetus for growth and production reached a new peak of 300,000MT in 2004, declining thereafter[44].

Land ownership

The State is the majority owner of land in Cameroon. Individuals can only own land by fulfilling numerous conditions that entitle them to a land certificate. In general, cotton fields are owned in the traditional system by local farmers without any land certificate from the Ministry of Land Tenure

existing alongside the legally-recognised ownership of the Cameroonian Government.

In rural areas, communities use land over which they have customary use rights, however, they can be removed at any time from these lands if the State is of the view that the land can be used for other, more profitable uses. The State will then deliver the land certificate to the detriment of local people for little compensation without any guarantee and without entering it in the land register.

Environmental impacts of cotton production

More than 18 million hectares – around half – of the historical forest areas of Cameroon have been cleared in order to promote agriculture and the setting up of villages. When cotton was first introduced, forests and other fields producing food crops were cleared to make way for cotton plantations. Nowadays, continuous cotton cultivation and the intensive application of fertilisers has caused widespread soil degradation[46].

Soil conditions continue to decline due to increasing cultivation and an inappropriate land tenure system[44]. The global financial crisis also had a negative impact on soil production. In response, the Government subsidised the cost of fertilisers in 2010[47], despite the negative impact it is having on soil quality in Cameroon.

Impacts of international commodity markets on the producer

Producer subsidies in richer nations have contributed to depressed global cotton prices, threatening farmers' livelihoods in developing countries[48]. In Cameroon, the peaks and troughs of the international commodity market and the valuing of the FCFA have had major impacts on the livelihoods of Cameroonian cotton farmers and their ability to make a liveable income, and also on the amount of fertilisers used and the environmental pressure exerted on the land. For example, a global fall in the purchase price of cotton from 195 to 175 FCFAs between 2004-2005 and 2005-2006 impacted on the livelihoods of around 350,000 producers. There was also a 35% fall in the number of cotton producers between 2006 and 2009 due to an increase in the cost of fertiliser[49].

As a result of both domestic and international market pressures, the State-owned cotton producer set quality marketable cotton as a key objective with a price differential depending on the quality of the raw cotton produced, with the objective of increasing its competitiveness in the global marketplace. In reality this has lead to additional workloads and has reduced the income of producers who have had to downgrade parts of their production. All these events resulted in a drop in the producer's margin. With a producer receiving around 160 CFA/kg, the value of a workday does not exceed 700 CFA/day[50].

Although Cameroon has many weaving and spinning companies that specialise in the manufacture of clothing textiles, their capacity is inadequate given the available raw material and the increasing demand for processed products every year. Therefore despite increasing cotton production Cameroon has been unable to successfully develop its domestic textile industry. The end of quotas and the issuing of licenses to import secondhand clothes was also detrimental to the clothing industry in Cameroon, which is now overwhelmed by imports from Asia and Europe[51].

Population pressure and migration

There has been a sharp increase in the number of cotton farmers, exerting significant pressure on available land. From 1950 to 2000, the Far North rural population has more than doubled from 720,000 to 1,960,000 inhabitants[52, 53], reducing the availability of agricultural land per-capita from 3.6 ha in 1950 to 1.3 ha in 2000[54, 55]. Consequently, many areas are facing land saturation and a reduction in soil fertility due to the intensive nature of cotton growing. Thus, this situation is forcing people to migrate to more favourable areas[56].

Cotton growing has led to a number of migration flows in the "Grand North" region. These flows have generated strong demand for land and resulted in the loss of customary rights and land to some farmers. Traditional rulers, who exercise their control over land, allocate it to the highest bidder or whichever offer is to their advantage as an individual.

At first tolerated by indigenous farmers, the increasing settlement of farmers from the Far North has resulted in frequent land disputes.

Changes in working conditions

Due to the high cost of inputs such as fertiliser and farming equipment, many farmers are compelled to approach SODECOTON (Société de développement du cotton) in order to obtain credit to grow cotton and other crops. They are forced to focus on the growing and selling of cotton, a crop which they cannot consume. The depletion of soil quality and the competition for land has increased the hardship of farming in general, making farmers chronic SODECOTON debtors.

4. LAND USE AND MATERIAL CONSUMPTION

Land consumption differs considerably between different countries and world regions. Different products also have very diverse land requirements along the production chain. Globally, the production of meat and animal-based products has the largest land footprint; in terms of absolute land areas –1,2 million ha/year. When looking at the different product groups in detail and set into relation to the economic output produced, bovine cattle, sheep, goats and horses require the most land per Euro gained. Per-capita land footprints differ by a factor of eight, from around 0.3 ha/year in Asia to 2.1 ha/year in Oceania.

In addition to our direct use of land, for example for housing, we also use a lot of land indirectly, which is embodied in the products we consume. In a typical western household, only a limited amount of land is directly used for our accommodation and gardens. In Europe around 400 m^2 (or 0.04 ha) per-capita is used for housing[9]. However, to a much larger extent we consume land indirectly via the goods and services we buy. An average European consumes 0.6 ha of agricultural land per year. Poorer societies with lower consumption levels, which rely more on self-sufficiency, have a higher direct land consumption. However their indirect land consumption is significantly lower, resulting in a lower overall land footprint – such as the land footprint of an average African with 0.5 ha/year or of an average Asian with 0.3 ha per year.

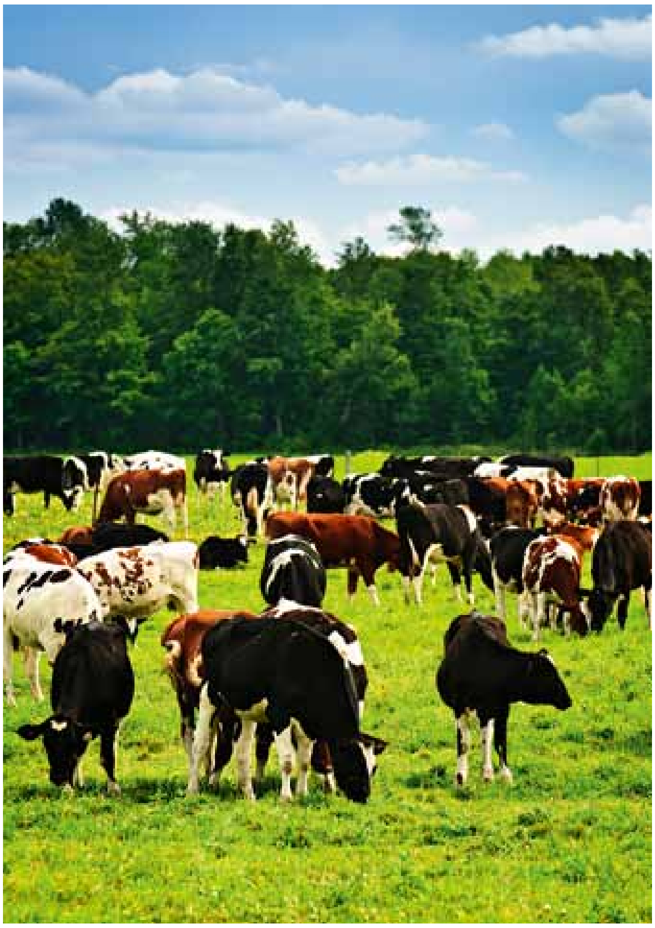


Figure 4.1 shows the agricultural land required to satisfy final consumption on a per-capita basis around the world. It can be seen that per-capita demand differs considerably among countries. It is important to emphasize that in this graph differences in land use intensities are not considered. Hence, agricultural production with low land use intensities and low land productivities (e.g. due to extensive agriculture) results in high land consumption – but may be balanced by reduced consumption of other resources, e.g. water, materials, fossil fuels, chemical inputs. On the other hand, high land use intensities and productivity result in low land consumption but with significant environmental impacts associated with higher consumption of inputs. As shown in the previous chapters, land use does not necessarily correlate with the amount of biomass consumed. A high per-capita land footprint can be the result of either high consumption values or low land use intensities.

Indeed, a high per-capita land footprint is not per se negative, as lower land use intensities (due to extensive agriculture) often go hand in hand with lower pressures on the environment. However, in many developed countries high land use is a synonym of high consumption, rather than low consumption of low land-intensive products (Figure 4.2).

Figure 4.1: Agricultural land required to satisfy final consumption in 2007 (x)

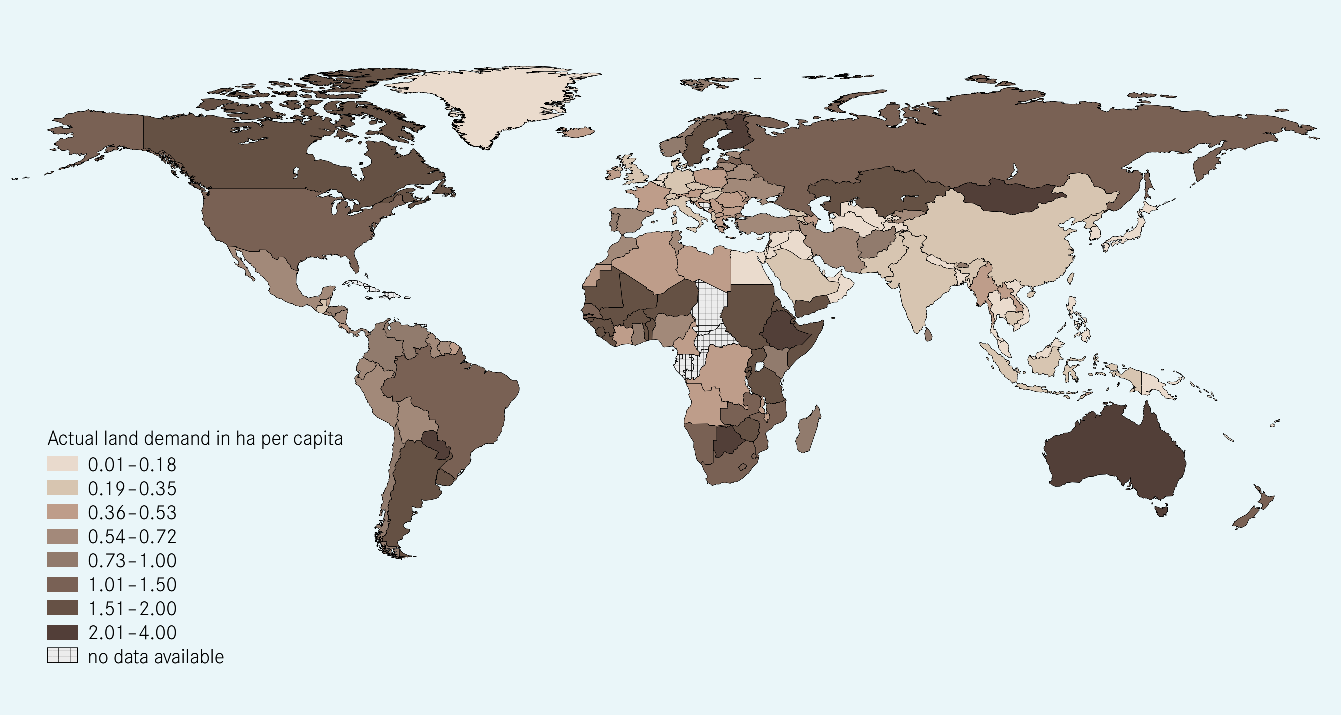
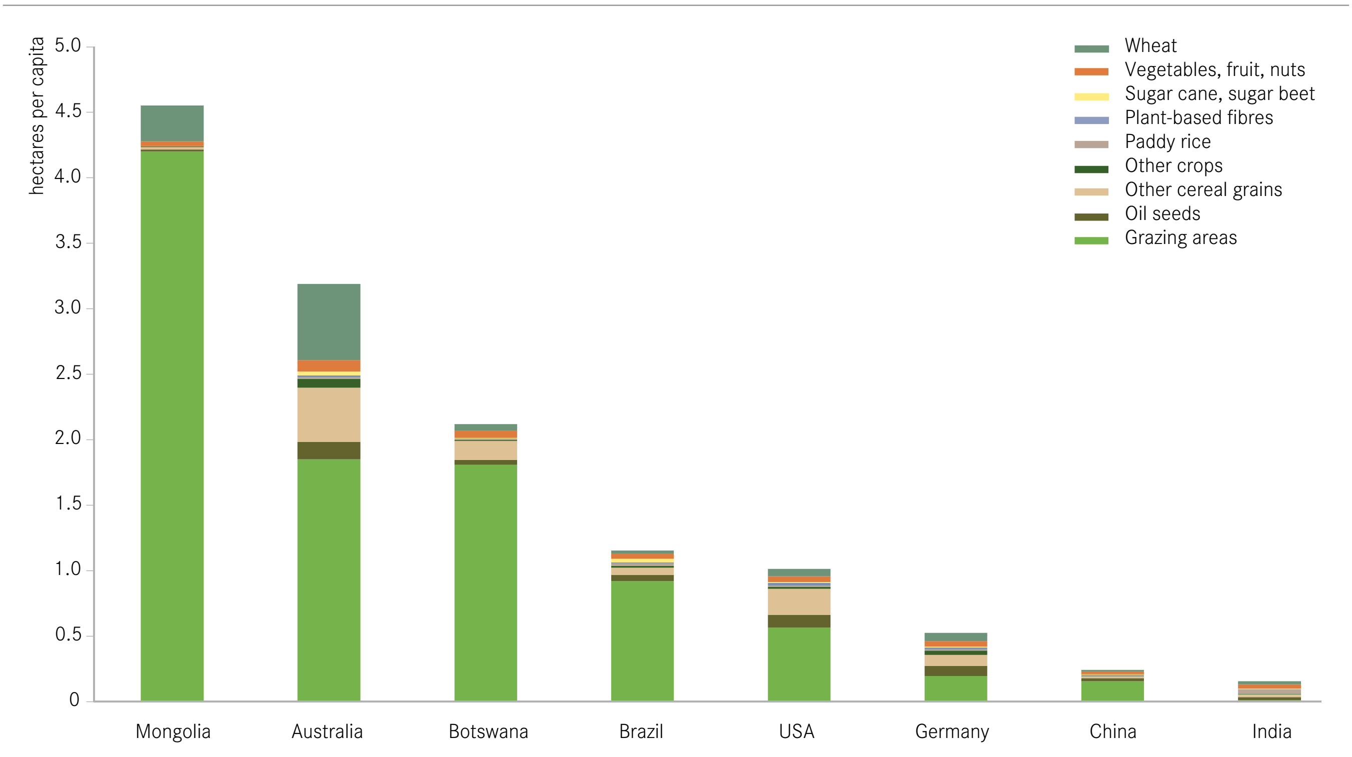


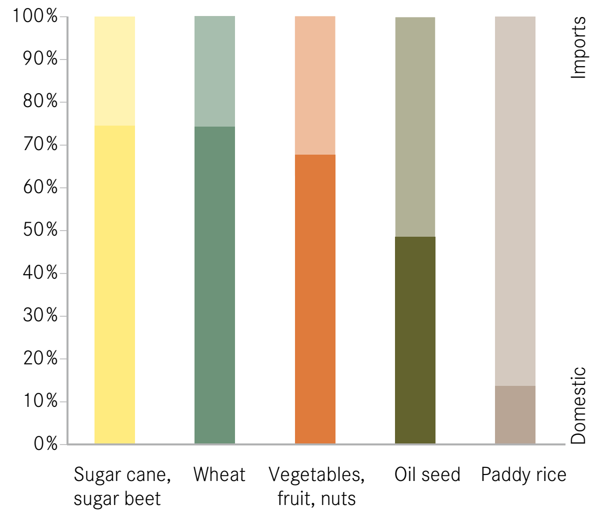
Figure 4.2: Agricultural land required to satisfy final consumption in selected countries by land categories in 2007 (xi)



The countries with the highest per-capita land footprint all have high shares of grazing areas (e.g. Mongolia, with extensive livestock feeding systems, has 92 % grazing and Australia has 58 %). In India, one of the countries with the lowest land footprint per-capita, vegetables and rice have the highest shares.

In Europe, consumption of agricultural land needed to produce the goods and services consumed in Europe is satisfied by land incorporated in domestic products (60%) as well as by land embodied in imported products (40%). Figure 4.3 illustrates how this ratio translates into the main food product groups which are consumed by Europeans. It becomes apparent that consumption of sugar (sugar beet and cane) and wheat is to a large extent (about 75%) satisfied by domestic land use (and production), while products like rice, where growing conditions are less favourable, have a high share of imported embedded land (almost 90%).

Figure 4.3: Comparison of domestic and foreign land incorporated in European food consumption in 2007 (xii)



Land requirements differ considerably between different product groups and also among world regions. In Europe, raw milk has the highest land footprint (62 million ha/year), followed by dairy products and wheat (59 and 54 million ha/yr). In comparison, on a worldwide level meat production has the largest land footprint followed by raw milk (997 and 620 million ha/yr respectively). Please note that these numbers also include the land needed for feed production.

The amounts of land required differ strongly between products. Figure 4.4 shows some examples of product groups and their land footprints in Europe and on a global average. Figure 4.5 shows the land footprint of specific day-to-day products. It can be seen that the everyday products that we consume can be translated into a specific amount of land which was required for its production. While these numbers can differ according to the production technology applied, one is able to receive an impression of the "hot spots" in our personal shopping trolley.

Figure 4.4: Examples of average land footprints of product groups in Europe and the world in 2007 (xiii)

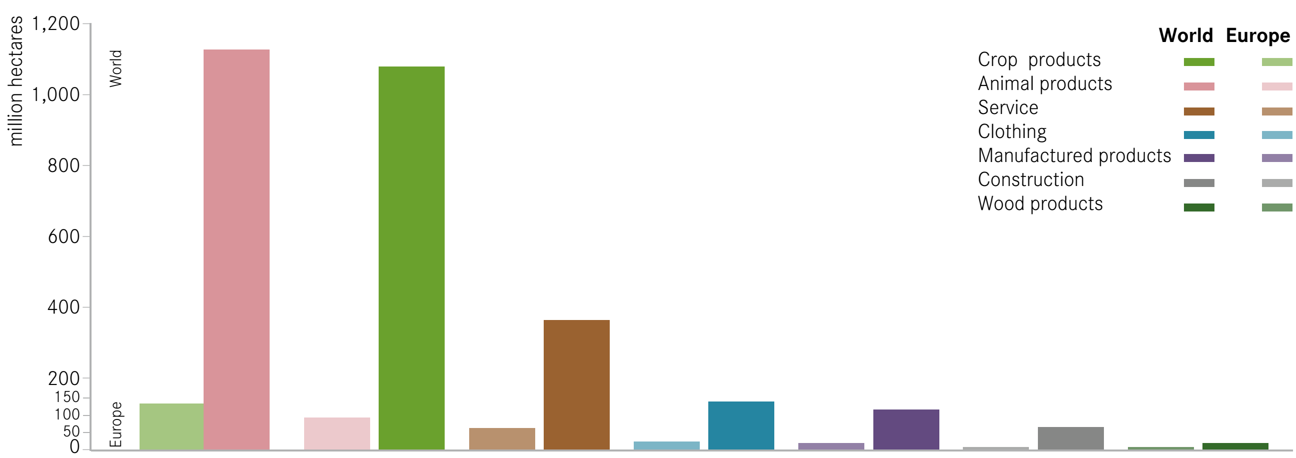
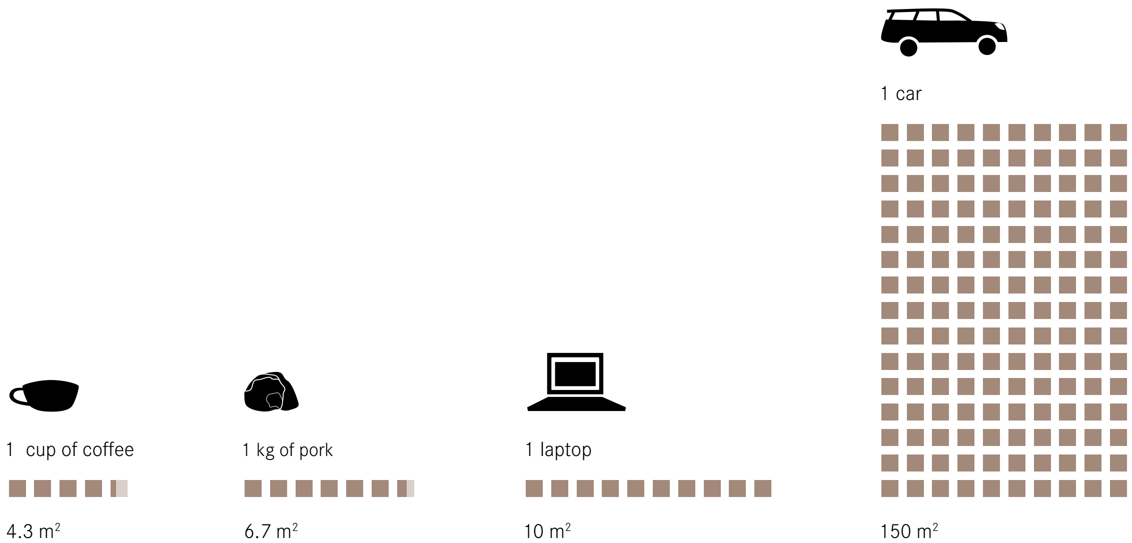


Figure 4.5: Land footprint of specific day-to-day products (xiv)



1 full square = 1 m² land

Europe's indirect land imports have product specific origins. To satisfy Europe's consumption, large amounts of land are used all around the globe. Figure 4.6 shows an analysis of the different product groups consumed in Europe and the geographical origin of the land necessary for production in 2007. The rows illustrate the different product groups, while the columns allocate the land demand in the different product groups to world regions of origin. It can be seen that while cattle-breeding and crop production is done to a large extent in Europe itself, the service sector, the production of manufactured goods and the production of clothes demand a large amount of indirect land from Asia, which is consumed in sectors such as public administration, the defence sector, education health or the production of motor vehicles and electronic equipment.

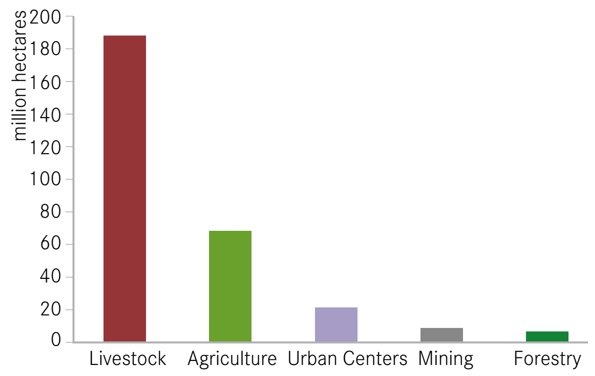
Figure 4.6: Depiction of geographical location of land used to satisfy European consumption in 2007 (xv)

[million hectares]	Oceania	Asia	North America	Latin America	Europe	Africa	Total
Crop products	1	12	7	14	92	11	137
Animal products	2	3	2	12	74	3	96
Wood products	0	0	0	0	0	0	1
Manufactured products	0	13	1	1	4	1	21
Construction	0	3	0	1	3	1	8
Service	1	11	4	8	35	5	64
Clothing	1	17	1	2	2	2	25
Total	6	59	15	38	211	23	352

BAUXITE MINING AND ALUMINIUM PRODUCTION IN BRAZIL

With more than 8.5 million km^2, Brazil is the fifth largest country in the world and the largest in South America, sharing borders with all other countries of the continent except for Chile and Ecuador. Land use is diverse in Brazil. Figure 4.7 estimates the distribution of different land uses in Brazil.

Figure 4.7: Allocation of land in Brazil for the main sectors of the national economy and urban areas in 2010 [xvi]



By far the largest share of Brazil's land mass is used for livestock farming. More than 200 million animals[57] require a terrain of up to 1.9 million km^2 [58] – almost a quarter of the whole country. Around 680,000 km^2 is used for crop production[59] – more than one third of this for soybean production[60]. This is equivalent to the entire land mass of the United Kingdom. Around 210,000 km^2 of Brazil's land mass is comprised of urban areas[61] in which around 84% of Brazil's population live, a result of migration from rural to urban centres, largely caused by social inequalities in rural areas due to the Green Revolution[62, 63]. The Brazilian mining sector occupies more area than planted forests (70,000 km^2 [64]). More than 80,000 km^2 – about the size of Austria – is used for mining activities[65].

Brazil is the world's third largest producer of bauxite – the material used to create aluminium. As a widely used material, aluminium is found in many every day products such as soft drink cans, bicycles and in the automotive and construction industries. Similar to developments at the global level, the production of aluminium in Brazil is growing on a yearly basis (Figure 4.8). Over the last ten years Brazil has extracted around 240 million tonnes of bauxite, while the mineable reserve is around 1.1 billion tonnes. The ownership of aluminium production in Brazil is dominated by foreign multinational companies. This production model consolidates a pattern of economic development in which Brazil remains a commodity exporter, while the aluminium ingots are sent to Norway, USA, Canada and Japan for processing. As a consequence, the largest share of added value is created outside of Brazil.

In terms of land use, it is estimated that bauxite mining and the aluminium chain in Brazil occupy around 16,000 km^2 (including infrastructure such as pipelines, etc[66]) – a bit less than the area covered by New York. This number becomes even more critical when taking into account that Brazil's bauxite reserves are located in the middle of the Amazon. Consequently, the bauxite mines are located in remote areas of rainforest which are populated by traditional and indigenous communities. These people are dependent on the natural resources and wildlife that the forests and rivers provide, and have created a harmonious relationship with nature in which their impact is minimal.

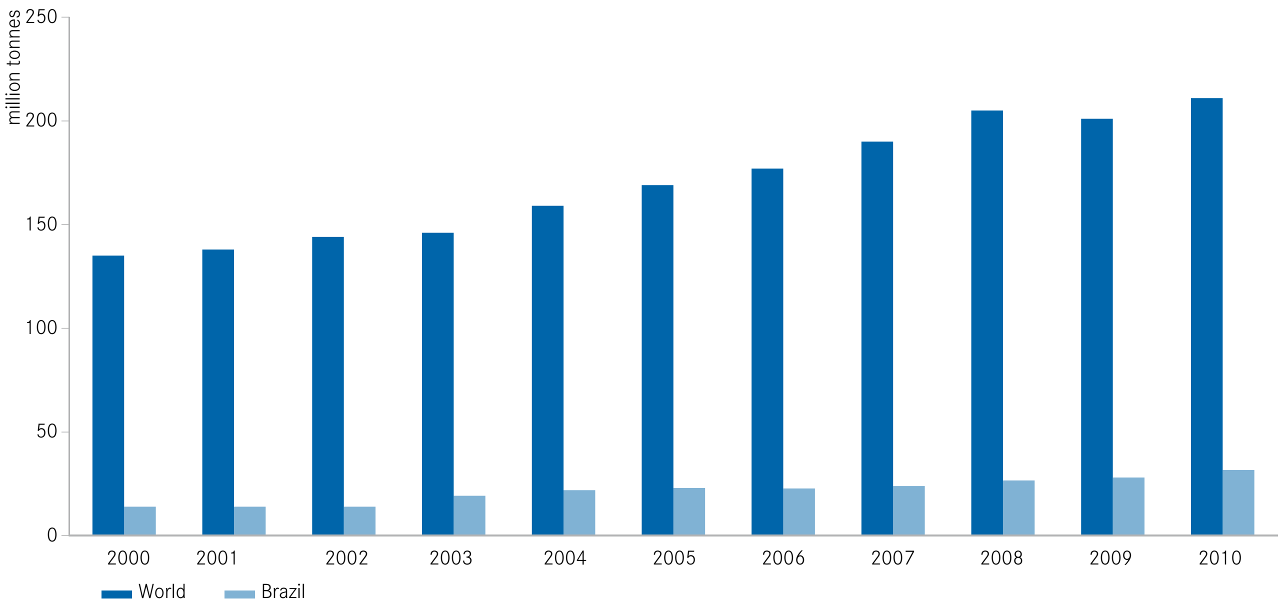
The bauxite mines cause significant environmental degradation such as land and water pollution and deforestation, depriving indigenous communities of the resources they need for their survival, and diminishing their ability to survive and retain their traditional way of living.

It has often been the case in Brazil that there has been conflict between the mining companies and the indigenous people, with pressure exerted by the former on the latter to leave their land and relocate to other areas.

An additional factor forcing people from their land is the creation of ecological reserves, which the Brazilian Government has legislated in response to the requirements of donors like the World Bank. While critics suspect that this is in order to protect the area for future exploitation, as a result of these legislative requirements, hundreds of hectares have been bought by the mining companies for biodiversity conservation. However, the indigenous communities are not allowed to live in these areas, nor to hunt or fish. This means that families have their land expropriated, and are then prevented from carrying out any of their traditional practices on lands that were formerly theirs.

As a consequence of mining activities and the creation of reserves, the local people depend on social assistance grants from the federal government, and many families end up migrating to the urban periphery in search of better living conditions. The search is generally in vain, as unemployment, a lack of education, poor sanitary conditions and child and adult prostitution are common among indig-

Figure 4.8: Bauxite extraction in Brazil, 2000-2010 (xvii)



enous communities living on the outskirts of urban areas. Where formerly indigenous people were largely self-sufficient, being able to source food such as game, nuts and fish from the forests, they now have to buy food, resulting in changes to their diets, such as increased consumption of eggs, sausages and chicken.

Families also often lose planting areas of cassava and "acai" (a typical fruit of Brazil), one of the few sources of income and food for rural families in the Amazon. The end result is grave for the affected communities who feel that the State has misled them in support of the mining corporations. Those who organise and fight this reality are fully aware that they are putting their lives and their families at risk.

The environmental impacts of land use change from native forest to bauxite mining are significant. The loss of biodiversity associated with the use of land for bauxite mining is mainly linked to deforestation. Deforestation is necessary to start mining (stripping), to build railways and ports (transport of ore), for the installation of processing plants and for the construction of mega dams required to supply the energy demand, mainly for the casting process. Soil or forest recovery is carried out only in a minimum of cases.

Another significant impact of the deforestation of the Amazon is its impact on the local, regional and world climate, with diminished capacity for CO_2 absorption and an increasing weakening of the world's "green lung". Additionally, it is estimated that the production of methane (CH_4) in the reservoirs of the hydro power plants is quite significant. Often, when filling the artificial lake, the standing trees are not felled, resulting in the decay of large amounts of biomass and the emission of large amounts of methane. Finally, depending on the production process between 1.8 and 8.7 tonnes CO_2 per tonne of aluminium is emitted during the aluminium production.

Deforestation and greenhouse gas emissions are just some of the impacts caused by bauxite mining and aluminium production in the Amazon. In addition, one of the waste products from the production of aluminium is toxic red sludge which seeps into surface waters, killing fish and other marine life, reducing their rates of reproduction. Ground vibrations caused by machinery in the mine area also affect wildlife, unbalancing the terrestrial ecosystem by repelling small animals and birds in the region surrounding the mine.

It is ironic that some of the largest deposits of bauxite in the world – the raw material of one of the most important metals of the world – are found in an area of crucial significance, not only for the local people, but also for the world as a whole. Each can of drink adds to the pressure on this vital environment. Buying fewer cans as well as a more efficient design of products and much higher rates of aluminium recycling in European countries and elsewhere would help to reduce this pressure.

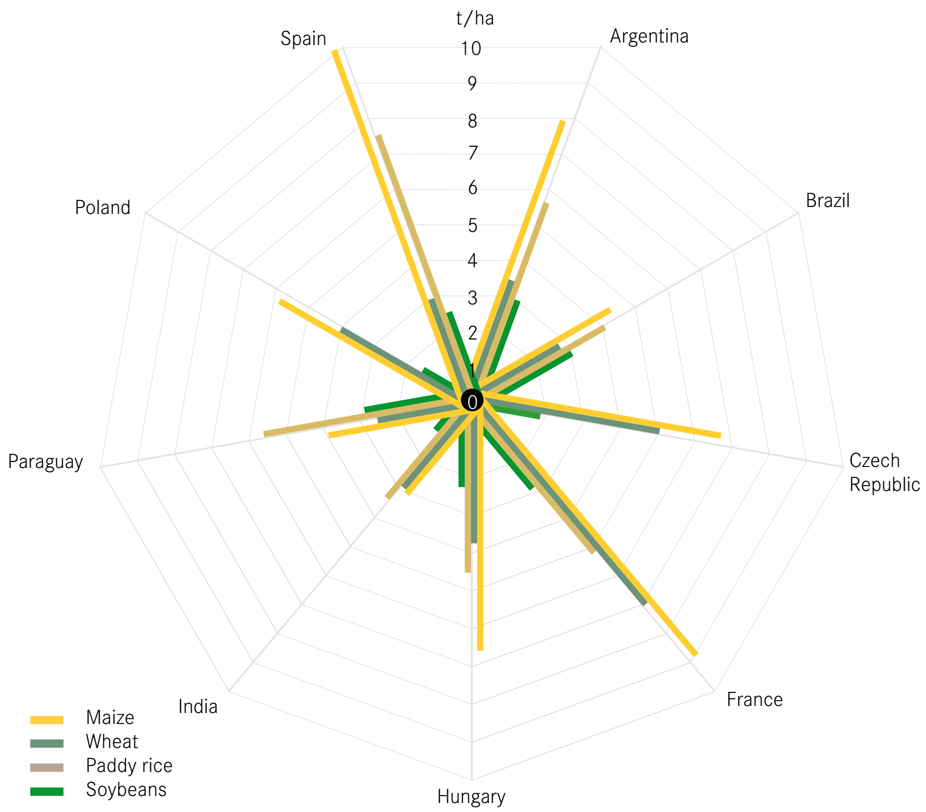
5. LAND USE AND MATERIAL EFFICIENCY

Our use of the world's land resources is closely tied to the efficiency with which we use the goods and services we derive from land. As land resources are limited and yields can only be increased to a limited extent without harming the environment, it is imperative that we are smarter in the way in which we produce and consume harvested products.

Material efficiency can be achieved by using fewer resources to achieve the same or improved output. In the case of agricultural land use, in recent decades land efficiency has been increased by increasing field yields, often using large amounts of fertilisers and pesticides. However, this augmentation of yields cannot continue forever as it often results in increased pressure on the environment and, consequently, in the loss of biodiversity and the pollution of groundwater.

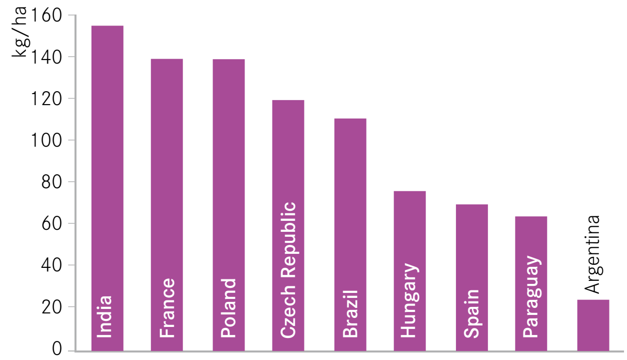
Figure 5.1 shows yields of different crops around the globe. The closer to the centre of the spider web the less amount of crop is produced per hectare. For instance, the yield of maize ranges from 3 t/ha in India to 10 t/ha in Spain. Note that the differences can be caused by a variety of factors, such as soil quality, amounts of fertiliser used, machinery used, etc. The figure does not reflect the impact on the environment brought about by different agricultural techniques.

Figure 5.1: Yields of different food commodities around the globe in 2010 [xviii]



Augmenting agricultural yields can result in increasing environmental pressure. While more intensive agriculture might result in a decrease in land demand for food production, depending on the techniques applied, this intensification also often results in increased negative environmental impacts. These are caused by the fact that fields become larger and more fertilisers and pesticides are used to ensure higher yields and avoid pests respectively (see Figure 5.2). Such measures also endanger the health of people working on the field. A comparison of different agricultural practices can be found in the box below.

Figure 5.2: Fertiliser use per hectare of agricultural land in selected countries of the world in 2009 (xix)



AGRICULTURAL PRACTICES

As worldwide demand for food is increasing, agricultural systems have been searching for ways to augment agricultural production. Though approaches differ according to world region, soil qualities, traditions, etc, two general trends can be identified: intensification and industrialisation. The general aim behind these trends is to increase yields – to produce more per hectare. To reach this aim, various measures are applied:

a) Mechanisation (increasing the size of the agricultural fields and planting the same crop on the same field in many consecutive years resulting in monocultures)
b) Regional specialisation in specific crops (less crop rotation)
c) Cultivation of new species (which are mainly genetically modified crops)
d) Increase in use of artificial fertilisers and pesticides
e) Increased irrigation

When comparing different agricultural systems, industrialised, intensive agriculture is found to be the most harmful for ecosystems. The same crop (in many cases cash crops like maize, wheat, and oilseed rape) is grown as long as possible on the same land with the overall aim of maximising profits. The use of synthetic fertilisers has made this possible over years, as otherwise the soil would not be able to deliver over a long time period of time. This method exerts a significant amount of pressure on the soils and results in the annual use of around 165 million tonnes of fertiliser worldwide.

Besides the widespread application of damaging fertilisers in large-scale agriculture, chemical pesticides are used which increase the pressure on ecosystems. This method used by large-scale agriculture often results in the loss of topsoil, decrease in soil fertility, the non-reversible pollution of surface and groundwater, and the loss of genetic diversity.

There are also economic and social disadvantages to this method of crop production. Cultivating highly hybridised non-native and genetically modified crop species also leads to increased pesticides application and the introduction of new plant diseases and pests. Pests are adapting to new plant toxins of Bt plants (GM-plants), and weeds are increasingly resistant to pesticides and so require enhanced application of these same pesticides in order to be controlled. The use of particular seed varieties are increasingly restricted by agro-industrial companies who control the seed market through use of patents. These new plant varieties generally do not have resistance against new and unpredictable environmental conditions that native varieties have developed over time. These factors contribute to the requirement for the application of more pesticides instead of reducing them. While these costs add on to investments for irrigation, machinery and seeds, yields tend to stagnate or even decline after a certain time. Additionally, the more industrialised the system is, the lower the demand for labour. Hence, people are often squeezed out of their traditional livelihoods.

Such a context results in the increasing dependency of farmers on agro-industrial companies as the former often buys the latter's seeds and is often contractually obliged to use their pesticides and fertilisers. This is a growing problem in many countries of the world, and in particular in poorer countries. Many farmers are unable to manage these demands, with many of them incurring large amounts of debt leading to them having to give up their land[67].

In contrast, sustainable small-scale and organic agriculture has a different approach to agricultural production. In addition to aiming at economic profitability, this approach focuses on preserving the quality of the environment and on understanding the environment as a complex ecosystem where every single organism plays an important role. Organic agriculture seeks to use these ecological interactions for the production of food and other goods, e.g. beneficial insects are used for biological pest control. Crop diversity and rotation are fundamental concepts that are applied in organic agriculture. Organic agriculture uses knowledge derived from traditional agricultural practices, but differs in some respects as agricultural research has played an important role in improving today's methods. It is therefore crucial to continue research in order to improve organic agricultural practices such as the seed varieties used, and the utilisation of biological pest management with beneficial and antagonistic species, etc.

It is a commonly held opinion that high yields are central to food security. Supporters of the industrialised method of agricultural production as described above argue that conventional farming, as well as the use of genetically modified crops, are necessary to feed the world as they claim that other systems are not able to produce the same yields. In fact, as a number of studies attest[68, 69] organic farming methods can produce even higher yields than conventional methods, as well as halt the degradation of arable land and maintain soil fertility. A key factor in designing such an agricultural system that ensures a healthy ecosystem and which also promotes "sustainable development" is knowledge about managing an entire ecosystem. In this knowledge-intensive farming system, achieving high yields goes hand-in-hand with respect for the existing natural processes of the ecosystem.

To reach the goal of satisfying the world's basic nutritional requirements in a sustainable way, an integrated strategy is needed: in industrialised countries agriculture has to be less intensive, using less inputs and producing (and consuming) less meat. In some developing countries agriculture can be enhanced through utilising systems that respect the ecology, i.e. using agro-ecological methods, by combining the traditional knowledge of farmers with research, etc[70]. Finally, in countries with unfavourable land tenure conditions (e.g. where land ownership is ambiguous or lacks official recognition by the law) inclusive and transparent agrarian reforms are necessary to ensure the development of a sustainable agriculture.

What we harvest is what we eat? Currently, the worldwide harvest of grains equal an average of around 300 kg per person each year[17]. While this suggests that enough crops are grown around the world to satisfy everybody's hunger, a large share of the world's population still does not have enough to eat (see box below). Hence, it is not only a question of the world's quantitative capability to produce enough food to feed its inhabitants, but also of the distribution of the resources and the unequal consumption of them.

Increasingly agricultural areas around the globe are used for the production of export goods such as animal feed or even biofuels for the global north or emerging economies. As a consequence, there is a reduced supply of local food, particularly in the global south[28]. Therefore, while on the one hand industrialised countries harvest or import more than they can eat, poor countries are often not able to harvest enough to survive, and cannot afford to import food. An improved and just distribution of food resources is therefore essential. This is especially true in the context that crop yields around the globe are plateauing[71-72]. Hence, relying on ever-increasing crop yields to nourish an increasing world population is not the solution.

Increasing utility instead of yields. An important means to reduce the pressure exerted on the environment and increase land efficiency is to raise the efficiency in the use and consumption of harvested products. This can be achieved by directing the crops designated for fodder and feedstock for agro-fuels to direct human consumption, and focusing resources on the expansion of methods that do not harm the environment or compete with food crops, in particular by utilising agro-ecological methods to conserve biodiversity and soil fertility. This needs to be supported by efforts from governments to ensure that food resources are equally distributed, whilst introducing policies that prevent food waste, with the overriding objective of ensuring that the world's population receives its daily nutritional requirements.

FOOD WASTE

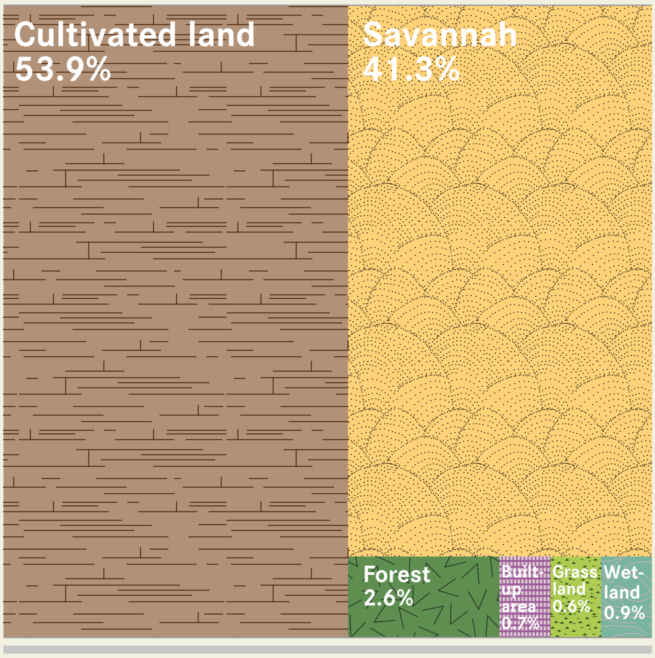
Like water, food is essential to human survival. On average, each person needs about 2,100 kilocalories every day to maintain a healthy life[73]. Eradicating extreme hunger is one of the Millennium Development Goals, yet in 2010, 925 million people did not have enough to eat, 98% of whom live in developing countries. In other words, 1 in 7 people in the world goes to bed hungry every night, 1 in 4 children in developing countries is underweight, and 10.9 million children under 5 die in developing countries each year[74]. Malnutrition and hunger-related diseases cause 60% of these deaths[75]. In stark contrast, in 2008 more than 1.4 billion adults were overweight and in 2010, more than 40 million children under 5 were overweight, in particular in industrialised countries[76].

The world currently has enough food to feed itself. However, feeding the world is a question of making nutritious food affordable and accessible in all countries. But at the same time food waste and overproduction have to be curtailed in all countries. A recent report from the Food and Agriculture Organisation of the United Nations[77] found that around a third of food produced for human consumption is lost or wasted globally, which amounts to around 1.3 billion tonnes per year, through production, processing and consumption. An easy gain for resource efficiency would be to drastically minimise the amount of food that is lost. In this context, more must be done by individuals, governments, business and individuals to minimise food waste.

TOGO: THE IMPACT OF COTTON PRODUCTION

Located on the Gulf Coast of Guinea in West Africa, Togo covers an area of 56,790 km² and has a population of 6.3 million inhabitants[7]. There are two dominant types of land cover prevailing in Togo – cultivated land (54 %) and savannah and forest areas (44 %). The remaining land cover types are wetlands, built-up land (buildings, infrastructure, etc), and prairies (Figure 5.3).

Figure 5.3: Distribution of land coverage in Togo in 2010 [(xx)]



Forest areas have been facing a strong decline in Togo for several years. Between 1979 and 2010, the total area of natural forests in Togo decreased from around 25,000 km² to 15,000 km² – an annual decrease of 3.5 %. Current deforestation is estimated at around 200 km²/year due to population pressures, the expansion of cash crops, bush fires and the demand for energy wood and timber. This degradation is accentuated by climatic disturbances recorded in recent years (irregular rainfall, late arrival and early end of the rainy season, etc). In contrast, reforestation initiatives are only gaining 10 km²/year of forest.

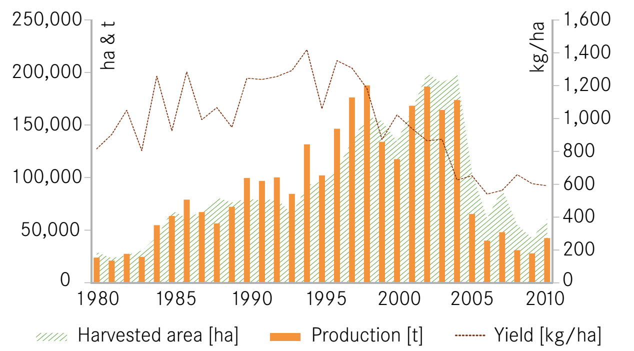
The introduction of cotton cultivation in Togo dates back to the middle of the 20th century with the creation of a specific cotton station (l'Institut de Recherches du Coton et des Textiles Exotiques; IRCT) in Kolo-Cope, in the area of Anié in 1948. Modern cotton is cultivated mainly on family farms, which are often very small (less than one hectare). The period from 1980 to 2010 saw a considerable rise and fall of the cotton industry in the country. While from 1980 to 2004 the area used for cotton production increased from 290 km² to 2,000 km², since then it has decreased to about 610 km² by 2010.

In parallel, the annual production of cotton initially increased considerably in the last few decades. It went from some 24,000 tonnes in 1980 to a peak of 187,700 tonnes in 1998. However, production later declined, in particular since 2005 to 42,000 tonnes in 2010 (Figure 5.4). Both the increase and decrease in production was mainly a result of changes in the size of the area cultivated, which was determined by the number of producers.

Before the creation of a state-owned cotton company, cotton was sown in combination with other crops, including yams, without fertiliser or insecticide and with a yield of 200 to 300 kg/ha. The yields have increased significantly since then; from about 650 kg/ha in 1974 to 1,400 kg/ha in 1994, after which it fell to remain on average below 1,000 kg/ha, with some plots making up to 2,000 kg/ha.

The drop in recent years can be explained by the crises in the sector in 2005, 2006 and 2007 which were caused by a combination of the rising cost of inputs such as fertilisers, the removal of subsidies, a fall in world prices, delays in payment to farmers, delays in payments for seed cotton, the non-distribution of rebates and poor rainfall conditions. In response to the aforementioned crises, farmers have been abandoning plots or switching to crops such as corn, yams, millet and sorghum, which were widely grown prior to the introduction of cotton. Since 2005, following the crises experienced by the cotton industry, there has been a lack of interest from producers in growing cotton, and therefore a strong trend of diversification into cash crops such as soybeans, palm oil, peanuts and pineapple all over the country. Though driven by economic factors, this development can be regarded as positive, as it is leading to less impact on the soil, groundwater, etc due to less intensive production methods.

Figure 5.4: Areas, production volumes and yield of cotton in Togo, 1980-2010 (xxi)



Food crops in Togo are grown by farmers using the practice of long fallow, which means that after having planted a specific crop, the fields are left without cultivation for a certain time to allow the soil to recover. From the early years of the introduction of the cotton crop in Togo, cropland was more abundant and long fallows were possible. However today, with population growth and the search for larger profits, production areas have expanded and long fallow is no longer used as a farming practice. The possibility of expansion of cultivated areas from one year to another is very limited as the area available for each farm is already fixed.

Problems created by the cultivation of cotton in Togo

Conventional cotton production in Togo has negative effects on the environment as well as on people working on the fields. In the following, we have highlighted the most significant impacts:

Regarding the effect of cotton cultivation on **soil**, for the farmers it is undeniable that cotton "kills" the ground. The extension of cotton cultivation leads to a rapid loss of soil fertility which requires the practice of shifting cultivation, and causes soil erosion and the destruction of vegetation. Consequently, there is a decline in agricultural productivity due to increases in desertification, reduced seepage and increased runoff with sediment transport in rivers and water bodies.

Furthermore, the indiscriminate use of pesticides and mineral fertilisers is contributing to pollution of the soil, ground water and air quality, leading to an increase in animal disease through food contamination. Usage of fertilisers increased rapidly from the 70's to the 80's, and it is estimated that all farmers use them today. Between 1990 and 2010, more than 8 million litres of insecticides and more than 300,000 tons of fertiliser were spread on the fields. Before the introduction of cotton in Togo, the use of mineral fertilisers and pesticides was almost non-existent. With the introduction of cotton, producers also started to fertilise food crops with mineral fertiliser.

Another major problem is the impact of applying pesticides on the worker's **health**. The immediate symptoms workers experience during each treatment session are headaches, stomach aches, skin irritation, vomiting, dizziness, diarrhoea, nausea and pain. It should be noted that there is no standard personal protective equipment for workers, and each of them dress the best way they can to protect themselves. The low level of education amongst farmers contributes to their lack of awareness of the dangers of insecticide use.

Changes of **ownership** can occur by means of sale or gift to another person. This law is very ambiguous in those cases where the producer operates a rented field. In the absence of production, the landowner can take back his land at any time as the leasing of land occurs without a written contract. Indeed, the owners are often keen to take back the land or evict the tenant without notice, and can rent the same land to another producer without the approval of the tenant. These conflicts of use in land are very common, especially in the prefectures of Tone and Haho.

The pressure exerted on forests due to extensive practices of growing cotton leads to overexploitation and deforestation which in turn affects the **climate**, as natural sinks of carbon dioxide are reduced. The associated consequences include reports of increasingly dry weather in this region.

6. THE LIMITATIONS OF GLOBAL LAND RESOURCES

Consumption levels in Europe are causing unsustainable land consumption within Europe and high land imports from other world regions which are embodied in traded products. As worldwide consumption levels rise, land is already facing severe physical limitations. To reduce Europe's land footprint, it is essential that we change our consumption patterns and even our lifestyles, including reducing our meat consumption and avoiding food waste across the supply chain. Footprint analysis and agreed land use reduction targets need to be integrated into government policies.

Land is a limited resource. We only have one planet and the amount of land that can be used is not expandable. Land has a great number of uses and functions which are increasingly in competition with each other, but as competition for land grows stronger, the pressure on this limited resource increases. Countries with high levels of consumption, such as those in Europe, are using an increasing amount of land from other world regions, which is creating direct competition with local land requirements. Additionally, climate change is having an increasing impact on the availability of land – deserts are expanding, sea levels are rising and droughts and floods are making agricultural areas in some countries unusable.

Europe is heavily dependent on land from other countries, in particular China and India, making it the world's most land import-dependent continent. A total of 40% (120 mio hectares) of land consumed by Europe every year is sourced from outside of its boundaries; this is the equivalent of about the size of Scandinavia. The countries with the highest absolute land imports are Germany with around 26 million ha and the UK with around 23 million ha.

Land dependency means vulnerability. The use of land from other countries is economically relevant for Europe. Dependency on foreign land resources makes Europe vulnerable to price fluctuations and increases, especially when they originate in politically or economically unstable countries. Consequently, the extraction and export of land resources bears a high risk of instability, local conflicts and supply interruptions.

Paying back the resource debt. Europe has been enjoying a large and uninterrupted supply of land and other resources at the expense of other countries. Consequently, with increasing scarcity of land around the globe, Europe has to assume its responsibility in paying back this debt. This can be achieved by becoming a frontrunner in developing and implementing strategies that focus on reducing land footprints within Europe.

Europe needs to decrease its per-capita land footprint in absolute terms. In order for Europe to reduce the amount of land that it consumes, it needs to start by measuring it. The concept of calculating Europe's land footprint, which incorporates the amount of land that Europe is consuming both outside and inside its boundaries, provides a robust framework to introduce resource reduction targets and to identify the exact stages of the production system at which resource savings can be made.

The analysis and reduction of actual land demand need to be integrated into government policies. It is essential to do so holistically and in conjunction with the other main resource categories: materials, water and carbon. This can be achieved through utilising a range of policy options by means of a policy "toolkit" which could help to integrate land footprints in agricultural, energy, trade and food policies. Policy or legal frameworks can also facilitate footprint labelling of products. It is also essential that policy makers take into account land demand analysis when developing new policies in areas such as renewable energy.

Consuming less and producing less intensively. Seeking ways to feed the world's population whilst at the same time highlighting the urgent need to reduce Europe's land footprint is not to be interpreted as support for intensified food production, nor is it per se anti-globalisation. Rather it is a call for a reduction of overall consumption volumes in Europe, especially in land-intensive areas such as meat production or agro-fuels. It is a call to increase the application of localised and organic agriculture and to strengthen local and regional rather than global material flows. Today's intensive agriculture is often neither sustainable nor resilient as enormous inputs of mineral fertilisers and pesticides destroy biodiversity and soil fertility. Applying the international environmental law principle of intergenerational equity means that we must not undermine future generations' ability to feed themselves. Instead, agriculture must preserve biodiversity and soil fertility as resources closely linked to land use. Consequently, it is of great importance to encourage best-practice in sustainable agricultural production. This could be done through, for instance, changes in Europe's Common Agricultural Policy (CAP), in particular higher environmental standards for CAP beneficiaries, schemes to exchange skills among farmers within a region and between regions and by incentivising proven environmentally friendly production techniques like organic farming.

Less waste means less land. Reducing waste, especially food waste, is essential in order to further relieve pressure on global land resources. Opportunities for action in this regard are the improvement of food supply chains as well as (especially in industrialised countries) an improved management of food demand and supply to reduce the enormous amounts of food that are discarded due to overproduction. Also, regarding secondary materials, increased recycling and reuse rates, prevention of waste, design of goods for durability and preference of recycled over primary materials will decrease demand for materials and land.

Abandon biofuel targets. The European Union has set itself the target of meeting 10% of road transport fuel needs from renewable energy, with 8.6% from first generation biofuel (fuel produced from biomass), by 2020. Though argued for as a carbon mitigation measure, in fact the majority of biofuels consumed in Europe entail CO_2 emissions equivalent or higher than conventional fuels, when indirect effects of expansion of land for biofuels is taken into account. Instead of aiming to provide new fuel sources for an inefficient carbon dependent transport system, real savings of energy through structural changes are necessary in the European transport sector – and in the energy sector in general.

Buy better for the environment. By rethinking our buying habits, every one of us can reduce her or his personal land footprint. Options range from reducing meat and dairy consumption to looking for ecologically produced food. With regards to consumer goods, buying only things that we need, using recycled products or joining a local reuse network can be other options to reduce the amount of land we consume.

Green procurement as a milestone towards a resource friendly society. Obviously governments and companies can also play a key role in the process of achieving a reduction of land use by, for example, maximising reuse of items or using recycled materials in products. Other ideas include the reduction of meat in menus and a move towards more plant-based food by setting concrete targets of land footprint reduction.

In essence, in order to reduce our own, as well as the global, land footprint we need to drastically decrease our overall consumption, including changes in our meat consumption. We also urgently need to rethink the policies that drive resource depletion in other parts of the world. To improve Europe's and the world's land management, footprint analyses and land use reduction need to be integrated into national, European and global policies. This would make it possible to set and measure targets that catalyse the creation of markets for products that have a low land footprint.

ANNEX: MULTI-REGIONAL INPUT-OUTPUT MODEL: METHODOLOGY

This study applies "multi-regional input-output" (MRIO) analysis to calculate the direct and indirect (embodied) land demand of products consumed in different countries and regions of the world. MRIO analysis is a methodology to assess the national and international environmental consequences of a country's consumption of goods and services. It combines economic data (i.e. data on the sectoral structure of economies linked via international trade data) with physical information (e.g. the land use for the production of different commodities in different parts of the world). The model captures the upstream impacts on global land use caused by a country's consumption. This means that the amount of land used for the production of different goods is allocated to the country where the products are finally consumed. In this way, the extent to which a country's lifestyle is dependent on foreign land resources can be assessed. MRIO can also be used to identify whether a reduction in domestic land use is merely a consequence of outsourcing production processes to other countries.

SERI's global MRIO includes all trade relations between the countries and regions in the model and is extended by land use data measures in hectares. Global harmonised sets of input-output (IO) tables and bilateral trade data are required for constructing MRIO-based environmental accounting models. The data sourced for this analysis is taken from the Global Trade Analysis Project (GTAP) v5 and v8[78], a data set covering 57 economic sectors and up to 129 countries and world regions. The calculations cover the years 1997 and 2007 with 66 and 129 countries and regions respectively.

Land use data and categories

The model outlined above is then extended by land use data. We differentiate the nine land use categories (1) paddy rice; (2) wheat; (3) other cereal grains; (4) vegetables, fruit, nuts; (5) oil seeds; (6) sugar cane, sugar beet; (7) plant-based fibres; (8) other crops; and (9) grazing areas. Forestry areas were not considered in this study due to inconsistencies of reported wood production data from the FAO forest resource assessment and the economic sectoral output reported by GTAP. Due to this circumstance, as well as because of improvements made with regard to the grazing data, comparisons with the results presented in the 2011 publication of SERI and Friends of the Earth are not possible[25].

Land use data for the land use types (1) to (8) are provided by the Statistics Division of the UN Food and Agriculture Organisation[7]. The land use data for the category (a) "arable land and permanent crops" were obtained from FAOSTAT and disaggregated according to the land use types (1) to (8) in relation to the harvested areas per crop or group of crops reported by FAOSTAT. In this way both fallow land and intercropping are considered in order to ensure consistency and comprehensiveness and to avoid double counting.

Grassland is also reported by the FAO, however, not all land areas reported as meadows and pastures are used for grazing purposes and productivities vary tremendously. Therefore, global grazing data in tonnes was obtained from the SERI Global Material Flow Database[79] and converted into hectares. For these data a yield of 3.71 t per hectare and year was assumed, corresponding to the average European grassland productivity[80]. Crop production and trade data used in the results section are also taken from FAOSTAT. For the calculations, each hectare of used land was allocated to the economic sector which makes direct use of it.

As productivity is not considered in the calculations, with the exception of grazing, land is accounted for in actual hectares without any weighting. A hectare of the most fertile arable land equals a hectare of dry land if reported as pasture. This implies that if a country's land use per tonne of wheat is ten times higher than that of another country, ten times more land is allocated to the consumer of the wheat from this country. The model thus always represents the real land use occurring in the different countries, without performing any weighting with regard to different productivities, as is done in the methodology of the Ecological Footprint.

Model uncertainties

While being able to fully cover direct and indirect production requirements for an infinite number of upstream production stages, environmentally extended input-output analysis suffers from uncertainties arising from the following sources: (1) reporting and sampling errors of basic data – both the main data sources, GTAP and FAO, are subject to possible uncertainties of a substantial magnitude; (2) the proportionality assumption – monetary and physical flows originating from a sector are always in exactly the same proportion; (3) the aggregation of IO data over different regions – yields across a country's regions are assumed to be equal; and (4) the aggregation of IO data over different products (homogeneity assumption) – price-land use ratios across different crops supplied by one sector are assumed to be equal, while they may vary substantially.

However, it was shown that the overall uncertainties of input-output-based assessments are usually lower than truncation errors in extensive process analyses up to the third order[81].

SOURCES FOR FIGURES

(i) EUROSTAT 2012. Land cover/use statistics (LUCAS).
Available from: http://epp.eurostat.ec.europa.eu/portal/page/portal/lucas/data/database

(ii) FAO 2012. FAOSTAT – ProdStat. Available from: http://faostat.fao.org/

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(iv) FAO 2011. FAOSTAT – ProdStat. Available from: http://faostat.fao.org/

(v) Own calculations based on SERI's multi-regional input-output model

(vi) Own calculations based on SERI's multi-regional input-output model

(vii) Own calculations based on SERI's multi-regional input-output model

(viii) Own calculations based on SERI's multi-regional input-output model
The various EU aggregates explicitly exclude internal trade in the export and import values and only add up trade with countries not included in the respective country group. Note that this table only covers agricultural land footprint, not e.g. forestry.

(ix) Ministry for agriculture and stock farming Paraguay

(x) Own calculations based on SERI's multi-regional input-output model

(xi) Own calculations based on SERI's multi-regional input-output model

(xii) Own calculations based on SERI's multi-regional input-output model

(xiii) Own calculations based on SERI's multi-regional input-output model

(xiv) Swiss Center for LCI 2009. EcoInvent 2.1 Swiss Center for Life Cycle Inventories, Zurich, Switzerland. (Numbers include built-up land.)

(xv) Own calculations based on SERI's multi-regional input-output model

(xvi) (a) IBGE 2010. Press Room: Results of the 2010 Census.Brazilian Institute of Geography and Statistics.
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WHO WE ARE

REdUSE is a project involving GLOBAL 2000, the Sustainable Europe Research Institute (SERI), Friends of the Earth Europe and national Friends of the Earth member groups in England Wales and Northern Ireland, Czech Republic, France, Italy, Hungary, Brazil, Cameroon, Chile and Togo. It aims to raise awareness of the amount of natural resources that Europe consumes and the negative consequences of overconsumption on the environment and societies in the Global South.

For more information see: www.reduse.org

Friends of the Earth Europe is part of Friends of the Earth International, the world's largest grassroots environmental network. The network unites European national member organisations and thousands of local activist groups in more than 30 European countries. As the people's voice at the heart of the European Union, we campaign for sustainable solutions to benefit the planet, people and our future, influencing European and EU policy and raising public awareness on environmental issues.

For more information see: www.foeeurope.org

Friends of the Earth England, Wales and Northern Ireland is the UK's most influential national environmental campaigning organisation – a unique network of campaigning local groups, working in more than 200 communities. We believe the environment is for everyone. We want a healthy planet and a good quality of life for all those who live on it. We inspire people to act together for a thriving environment. More than 90% of our income comes from individuals so we rely on donations to continue our vital work.

For more information see: www.foe.co.uk

GLOBAL 2000 was founded in Vienna in 1982 and has been a member of the Friends of the Earth International network since 1998. With 60,000 members, GLOBAL 2000 is the largest and most well-known Austrian environmental protection organisation. Through its work, GLOBAL 2000 not only uncovers environmental scandals and advocates Austria's responsibility to contribute to solving global environmental problems, but also offers sustainable solutions.

For more information see: www.global2000.at

The Sustainable Europe Research Institute (SERI) is a private research and consulting institution aiming to explore sustainable development options for European societies. SERI is one of the leading European institutes in the fields of environmental and resource use accounting, modelling of sustainability scenarios, indicators for sustainable development and policies for sustainable resource use.

For more information see: www.seri.at