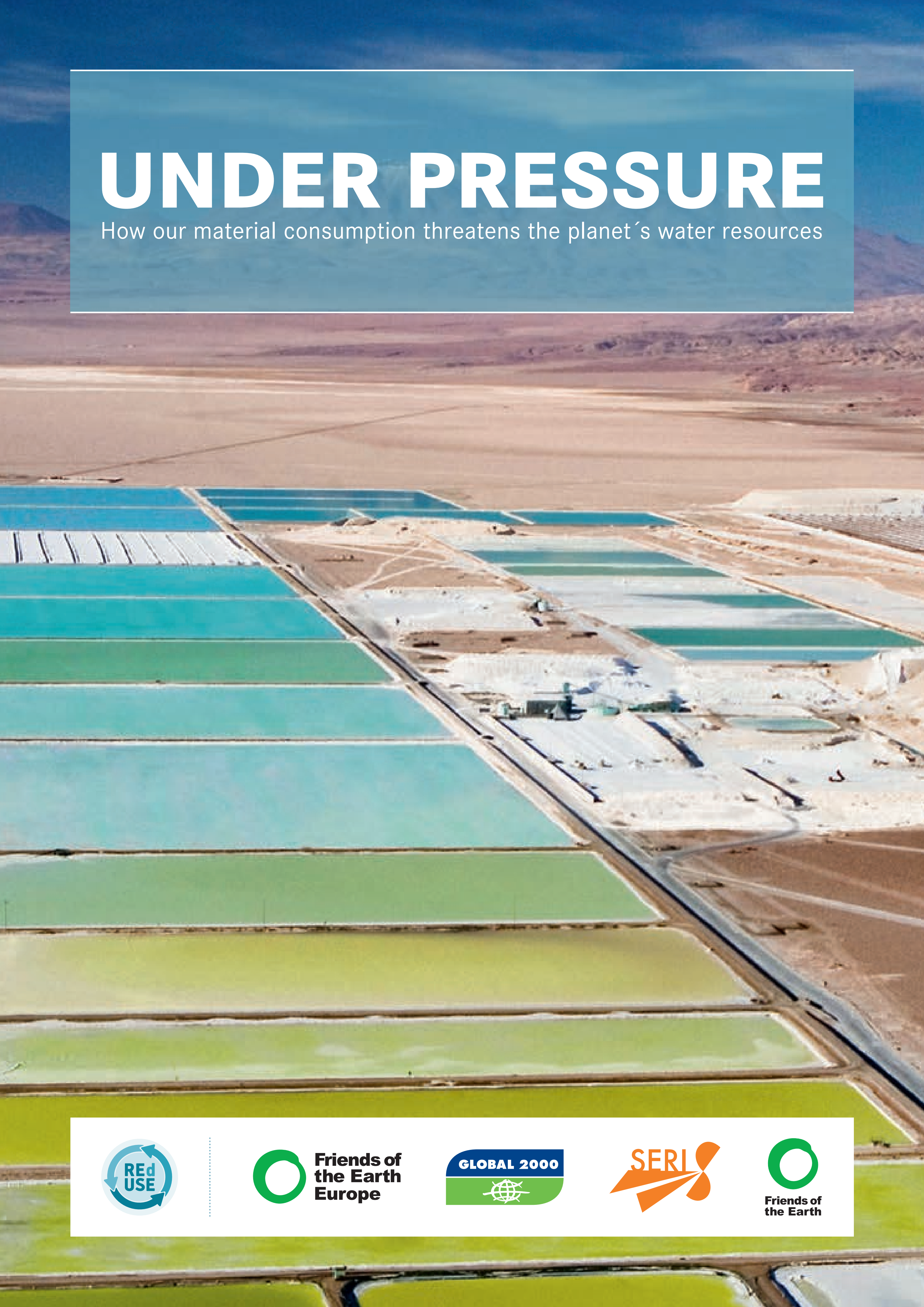
UNDER PRESSURE

How our material consumption threatens the planet´s water resources



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EXECUTIVE SUMMARY

This report looks at material consumption and water use and how they are interrelated. An increasing number of studies look at the levels of material extraction, trade and consumption. Yet, so far, the connection between materials and other resources, such as water, tends to be less well understood. This report, the second in the natural resource consumption series (following the 2009 report "Overconsumption? Our use of the world's natural resources."), aims to raise awareness of these connections, and to contribute to the debate on resource use through various examples illustrating how water is consumed.

Water is required for almost every step of material flow. Around half of all renewable and accessible freshwater is used for growing food, providing drinking water and producing energy and other products. In Europe, almost half of all water abstracted is used for cooling processes by the energy sector. The rest is used for agriculture, public water supply and industry.

There are vast regional differences in material and water consumption. For example, the average North American citizen consumes the largest amount of water (7700l per day) and materials (100 kg per day) in the world. In comparison, the average African citizen is consuming least – 3400l of water and 11 kg of materials per day.

The water footprint from our consumption habits is significantly greater than that from our direct water use. Significant amounts of goods consumed in Europe, such as food and other agricultural products, are grown and produced elsewhere. Paradoxically, many countries with low levels of fresh water use a large part of their water supply on the production of exports to water rich countries.

Rising material extraction and water abstraction is linked to growing international trade in recent decades. As worldwide trade steadily increases, so does the amount of embedded or virtual water used, as many goods require water for their production processes. Industrialised countries and, more recently, emerging economies have increased their net imports of resources, which tend to come from the developing world.

In most cases, the most material-efficient countries also have the highest consumption levels. Resource efficiency improvements alone have so far been insufficient in achieving absolute reductions in resource use. As water resources are becoming increasingly scarce in many regions of the world, it is critical that we use them more efficiently and economically at every level – in industry and agriculture, at home and also in water supply systems.

In a world of finite resources, we must address the link between resource use, economic growth and prosperity in our societies. Our model of growth depends on high levels of continuous consumption. However, this system is characterised by growing inequalities across the world and by alarming levels of resource use by a small minority of the global population. Urgent and fundamental changes are required to the way our economies manage natural resources and the services these provide. It is therefore essential that decision-makers create a policy framework that penalises unsustainable practices and rewards resource-efficient behaviour, making a decrease in resource use both economically and politically more attractive.

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1. INTRODUCTION

The use of renewable and non-renewable resources has always been a cornerstone of human life. This report examines recent trends in resource consumption – including extraction, trade and efficiency.[1] For most of our history, our use of the earth's resources did not generally have a significant impact on the environment. For the past few decades, however, the use of many materials, including metals, minerals, fossil fuels and biomass, has reached alarming levels. This is jeopardising the sustainable functioning of our ecosystems and the services they provide. Strategies for making resource use more sustainable are urgently needed.

The extent and pattern of our material use strongly affects the planet's water resources. This report provides the first combined overview of the links between different aspects of material use and their effects on the planet's water resources. As water-related challenges, such as water shortages and pollution, increase worldwide, the need for us to understand and address these links is becoming increasingly important.

Water is necessary for almost every step of the material flow, from the extraction of raw materials to their processing and recycling or disposal. This report highlights the role of water in these steps, often illustrating this with case studies and examples, and shows how the availability of water determines what and how much we can produce and how production and consumption influence the quality and quantity of our freshwater resources.

In the context of globalisation and ever more complex supply chains, water also plays an important role in trade. As water is usually required for the production of export goods, local problems of water depletion and pollution are closely linked to the local economies' ties to the global market. This report explores virtual water flows, which can help assess the real water situation in different countries.

THE REPORT IS STRUCTURED IN SEVERAL THEMATIC CHAPTERS:

Chapter 2 provides a brief overview of material **extraction** in terms of total global quantities (1980-2007) and water extraction. A case study from Chile illustrates the extraction of lithium and its impacts on the local water resources.

Chapter 3 looks at the extent and patterns of global **trade** in materials. It shows the total amounts of material exports from different world regions and explains which countries are net exporters and net importers of resources. The second part of the chapter focuses on water flows between different countries, especially in the form of virtual water. The main virtual water exporters in the world are identified. A case study describing the journey of a t-shirt illustrates the structure of cotton trade and the water footprint caused along the way.

Chapter 4 compares resource **consumption** levels and patterns and their impacts across different world regions and shows how much water is consumed in Europe by different sectors. It shows how resource extraction can differ considerably from the amounts of resources actually consumed in a country or region.

Chapter 5 shows trends in resource **efficiency** and relative de-coupling of economic growth from resource use in different world regions. It identifies some of the main drivers of resource efficiency and compares the efficiency of resource extraction and consumption across the world. Resource efficiency is also an important issue in water use. This is addressed by showing current trends in water use for agricultural and industrial production, in homes, etc and by identifying areas of significant potential for water savings through increased efficiency.

Chapter 6 sheds light on how to **meet the challenge.** It suggests a policy framework which could ensure that the main identified challenges we are facing are addressed in a feasible and successful manner.

2. EXTRACTION

2.1 MATERIALS

We are mining, fishing and harvesting ever-increasing quantities of natural resources for the production of goods and services. The consequent environmental and social challenges are also escalating, including the destruction of fertile land, over-exploitation of water resources and abuses of workers' rights and social standards. Most resource extraction takes place in Asia (44%). There are wide differences in per capita extraction between the different continents.

Growing world-wide resource extraction. As the world's population and economy continue to grow, we are exploiting our ecosystems and buried resources at an ever increasing rate. In 2007, the total weight of all the materials extracted and harvested around the world was around 60 billion tonnes.[2] This equals around 25 kg each day for each person living on our planet.

The term extraction encompasses mining activities as well as fishing, harvesting and logging trees. The quantity of resources extracted thus includes both non-renewable and renewable materials. Non-renewable resources include fossil fuels, metal ores and industrial and construction minerals. Renewable materials include agricultural products, fish and timber.

Accessing any specific material through extraction or harvesting usually implies that additional materials are extracted or removed from the soil surface, which are not used in production processes themselves – such as overburden from mining activities. Each year more than 40 billion tonnes of such materials are extracted. Hence, altogether we move more than 100 billion tonnes of material each year; around 40 kg per capita per day.

Figure 1: Global extraction of natural resources, 1980 to 2007 [(i)]

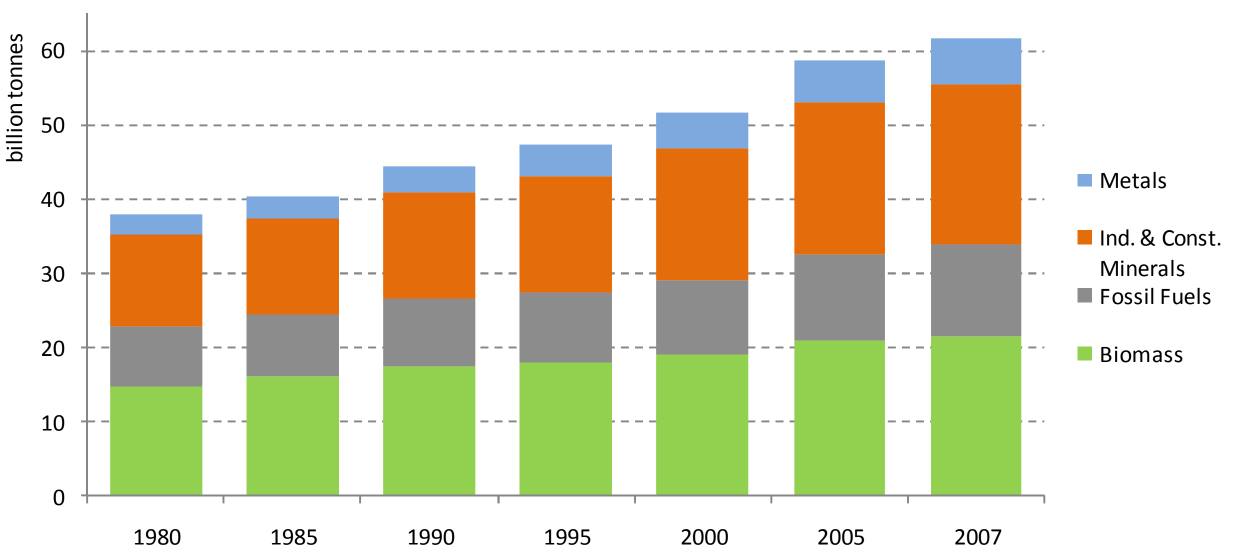
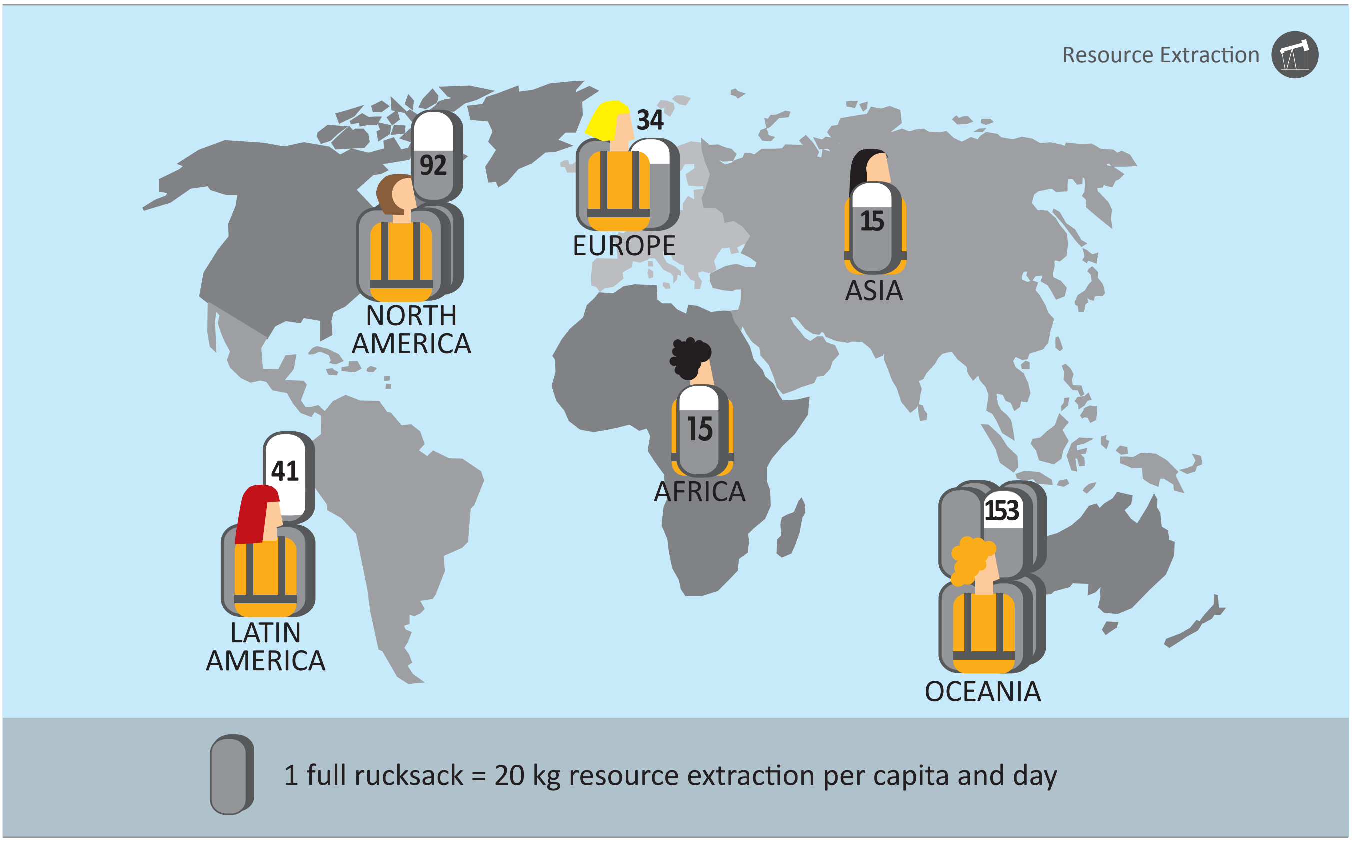


Figure 2: Extraction of resources per capita per day, 2004 (ii)



As a consequence of the increased production of goods and services each year, ever more natural resources are required. In the last three decades worldwide extraction grew by about 60%, from below 40 billion tonnes in 1980 to more than 60 billion tonnes in 2007 (Figure 1). Extraction has increased in all categories: biomass, fossil fuels, metal ores and industrial and construction minerals. While the extraction of gas, sand and gravel doubled, nickel ore extraction tripled. Biotic resources are also in ever greater demand, resulting in declining fish catch rates, deforestation and other environmental impacts.

Material extraction as double exploitation: environmental and social costs. Extracting and processing natural resources often requires further resources, such as energy, water and land. These can either be directly used in the process or affected by it, for example through the destruction of fertile land, water shortages or toxic pollution. In many regions, cheap extraction is only possible at the cost of low social standards, human rights abuses, poor working conditions and inadequate wages.

Uneven distribution of material extraction across the world. The quantity of materials that are extracted on a continent depends mainly on its size, the availability of materials, the size of the population and the level of economic development. In 2007, the largest share of global resource extraction took place in Asia (44%), followed by North America (18%), Latin America (15%), Europe (12%), Africa (8%) and Oceania (3%).

The different continents also vary in per capita resource extraction. Oceania has the smallest share of extraction, but the greatest extraction per capita. In 2004, Oceania extracted 56 tonnes per capita per year, followed by North America (33t), Latin America (15t), Europe (13t) and Africa and Asia (6t each). Figure 4 shows the same data in daily per capita terms.

These relations between per capita volumes have not changed significantly since 1980. Already then Oceania had the largest per-capita extraction worldwide with an increase throughout the years due to Australia's significant expansion of mining operations, for example in coal, iron ore and bauxite. Latin America's per capita extraction was lower than in Europe; however, increased demand for metal ores, timber and agricultural products such as soy around the world and the continent's focus on resource exports led to an increase.

2. EXTRACTION

2.2 WATER

Around half of all renewable and accessible freshwater is used for the provision of drinking water, growing food and the production of energy and other products. In Europe, almost half of all water abstraction goes into cooling the energy sector. The rest is abstracted by agriculture, public water supply and industry. Globally, the largest amounts of water are used in the agricultural sector for irrigation.

Humans currently appropriate more than half of all renewable and accessible freshwater. Some abstract water excessively, while billions still lack the most basic water services.[3] Population and economic growth are the main drivers that increase pressures on water resources. If current trends continue, many world regions will face increasing water scarcity over the next decades.

In the EU, 13% of all renewable and accessible freshwater resources are exploited each year. While this number seems to indicate that droughts and water scarcity are more easily managed in Europe, the uneven distribution of water resources and population across the continent leads to severe scarcity situations in some regions, especially in the south. Many Mediterranean countries are facing enormous

Figure 3: Water extraction in different world regions in 2000, in litres per capita per day (iii)

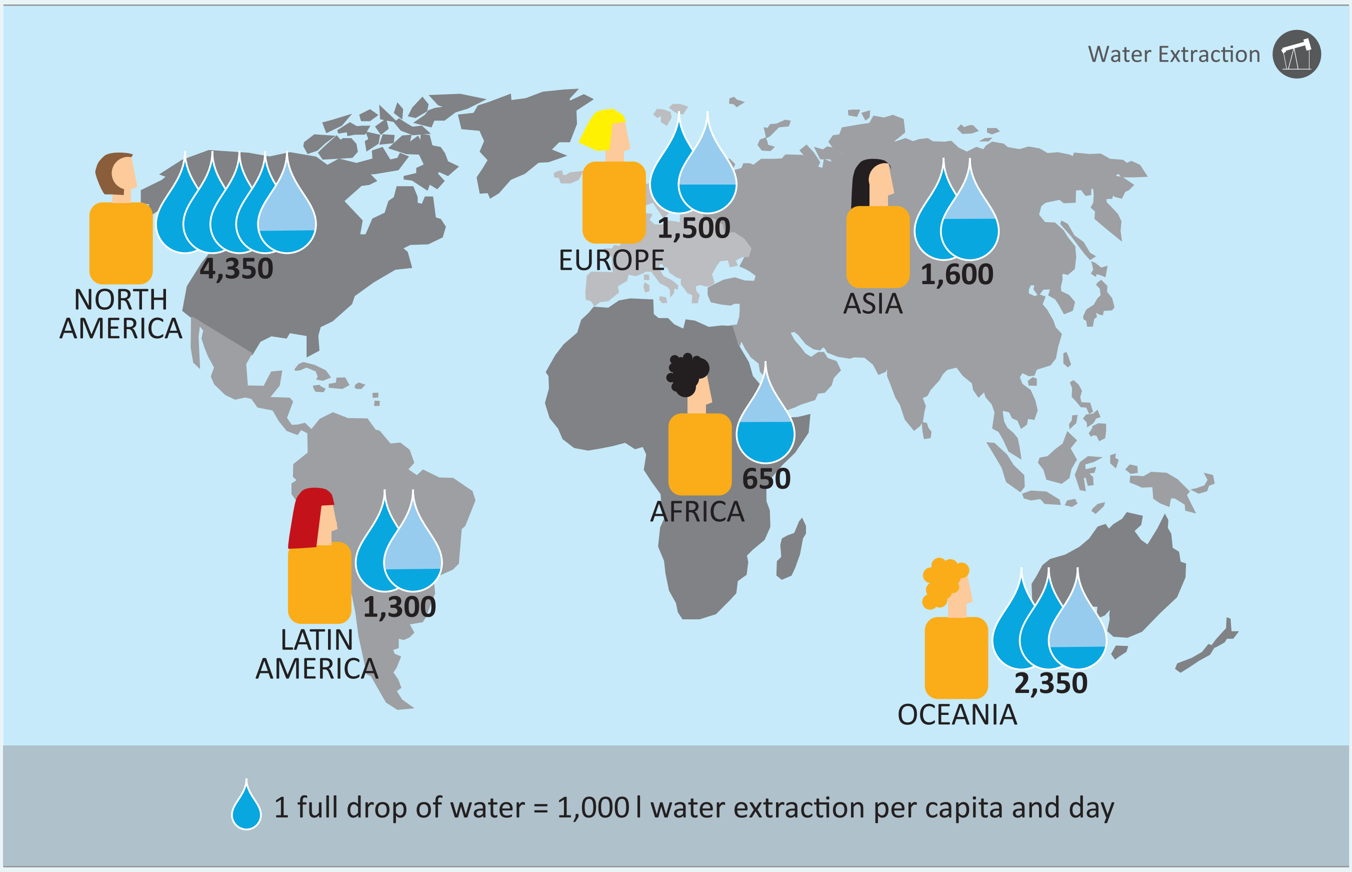
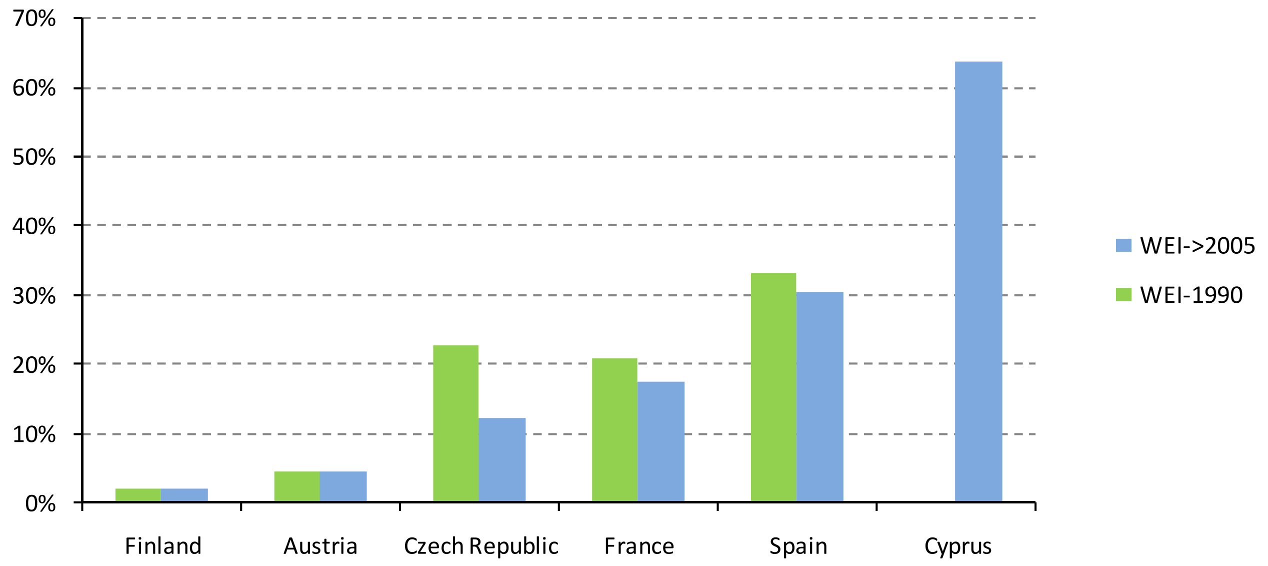


Figure 4: WEI in selected European countries for 1990 (iv) and the most recent years available (>2005) (v)



water stress. Even within national borders, the situation can be extremely heterogeneous. In Spain, for example, water shortages are very common in the south (Andalusia), whereas some regions in the north are water abundant (e.g. Galicia).

To monitor and assess the trends of pressure on European freshwater resources, the European Environment Agency uses the water exploitation index (WEI). This is the percentage of total freshwater abstracted annually compared to the total available renewable water resources. A WEI above 10% implies that a water resource is under stress. More than 20% indicates severe stress and clearly unsustainable use.

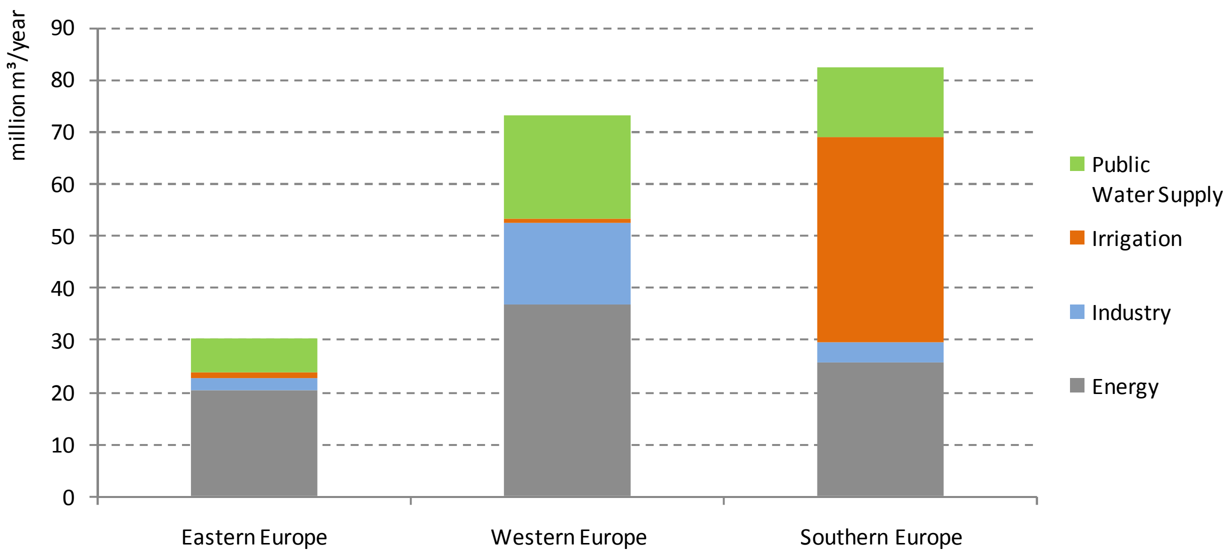
In 2005, Cyprus, Belgium and Spain had the highest WEI in Europe (64%, 32% and 30% respectively). Over the past two decades, the WEI decreased in 24 EU countries, as total water abstraction dropped by 15% (mainly in eastern EU Member States due to the economic decline). Total water abstraction only increased in five countries from 1990 to 2007.[4] Figure 4 shows a selection of six European countries with different WEI.

Water stress in Mediterranean countries and islands is often caused by infrequent rainfall with large variations throughout a year or between years. In the case of islands, geographical isolation and the inability to draw on more distant water sources can also add to water stress.[5]

Who extracts how much water? On the European continent the largest amounts of water are abstracted for the purpose of cooling by the energy sector (45%), followed by agriculture (22%), public water supply (21%) and industry (12%). However, regional or national figures can deviate significantly from these average numbers. In Southern Europe agriculture is responsible for more than 50% (in some countries more than 80%) of water abstraction, whereas in Western Europe more than 50% of the abstracted water is used for cooling purposes in the energy sector. Similarly, water abstraction in the industrial sector accounts for around 20% in Western Europe, but only for around 5% in Southern Europe (Figure 5).[6]

The data on agricultural water use is especially interesting when put into relation with how much of the production is consumed domestically and how much is exported. In many water scarce countries the cultivation of water-intensive food products for exports is the norm. For example, in Spain, these exports contribute only 3% to the national GDP and only 5% to the national employment.[7] Almost two thirds of the water used in the Spanish agricultural sector (60%) is used to irrigate crops which contribute only marginally to the total gross value added in agriculture. For example, Spain mostly produces crops of low value but high water intensity.

Figure 5: Water abstractions for different sectors in three European regions (million m^3/year) in the period 1997-2007 (vi)



Material extraction has a large impact on water resources. Apart from the impact of water abstraction (e.g. residual flows below the minimum environmental flow) for production activities, the extraction of other materials also has an important impact on our water resources. For instance, high volumes of water are required for the extraction processes (eg electrolysis) for many ores, including copper or aluminium. As a result, large amounts of highly contaminated water are produced which should be stored and treated under enormous efforts.

In the agricultural sector, nitrogen and phosphorous emissions from fertiliser application leach into receiving waters such as rivers, ground water bodies and the sea. These not only pollute drinking water reservoirs but are also responsible for the eutrophication (overload of nutrients and consequently "blooming") of down-stream river sections or the shore line.

SHALE GAS EXPLOITATION AND ITS IMPACTS ON WATER

The exploitation of shale gas, a controversial new fossil fuel, is currently making headlines throughout the world. This interest is not only because some regard it as the major energy source for the future, but also because it has been linked to a wide range of environmental problems, notably water pollution, excessive use of water and high methane emissions throughout the extraction process.

Shale gas is a form of unconventional gas found within shale reservoirs. Shale is a sedimentary rock formed from compacted mudstone, claystone and other fine-grained rocks, and is less permeable than other rock formations where gas is found. It can be used as fuel for power plants, micro power plants (homes), cars and trucks.

New drilling techniques have helped to decrease the costs and increase the volume of shale gas extraction. In the 1990s, gas producers developed a technique, known as hydraulic fracturing (or “fracking”), which involves injecting high-pressure water into shale rock formations (non-porous sedimentary rock that mostly lies deep underground, below the groundwater level), allowing the natural gas that is trapped in these formations to be released and brought to the surface.[8] The gas can also be extracted by horizontal drilling.

There are considerable risks involved in the use of shale gas, especially relating to the fracking procedure. There are concerns that the chemicals involved in hydrofracking (e.g. benzene or toluene[9]) contaminate drinking water, either during the drilling process or through the disposal of waste water afterward. One fourth of injected water returns to the surface after the fracking process, this water contains not only chemicals but possibly also high concentrations of salt and methane as well as washed-out natural radioactive materials. These chemicals as well as the gas itself can contaminate local water supplies if not properly treated in a wastewater treatment plant. Further problems relating to the high chemical concentration of the water can occur if an accident happens on the surface, or if the borehole is not properly isolated or plugged after closing the well.

Moreover, the significant volumes of water required could result in severe pressure on water supplies in areas of drilling. Experience from the Barnett shales deposit in the US suggests that horizontal wells can require up to five times the water used by vertical wells.[10]

Emissions associated with additional processes needed for the extraction of shale gas are considerable. Research from Cornell University compared the carbon footprint of shale gas with conventional gas, coal and diesel oil. It was found that shale gas had 1.3 to 2.1 times higher methane emissions than from conventional gas and that the footprint for shale gas is greater than that for conventional gas or oil when viewed on any time frame, but particularly so over 20 years.[11] In the US, about one fourth of methane released already originates from shale gas extraction.[12]

LITHIUM EXTRACTION IN THE CHILEAN NORTH[13]

Occurrence and uses

Lithium is the lightest metal in the world. Its relevance increased dramatically with the development of lithium-batteries, which are both much lighter than conventional nickel-batteries and longer-lasting. These batteries are used in electro cars, cameras, portable computers, mobile phones and many other devices. The main sources of lithium for the batteries are brine and salt lakes.

The main lithium reserves are located in the so-called "Lithium Triangle", composed of Bolivia, Argentina and Chile. The lithium extraction in Chile is located in the far north of the country, in the Salar de Atacama. The Atacama Desert is classified as one of the world's most arid places, with 1 mm of rainfall every 5 to 20 years in certain areas where drainage is practically inexistent.

The main producer of lithium in Chile is SQM, a company controlled by a Chilean entrepreneur and the Canadian Potash Corporation of Saskatchewan (PCS), SQM produces about 21,000 tons of lithium carbonate annually. The second lithium company is the North American Sociedad Chilena del Litio (SCL). Together, they produce 58% of the world's lithium.

For the production of lithium the brine (groundwater with high concentrations of minerals) is abstracted and pumped into evaporation ponds. Through various evaporation steps it is possible to achieve the required concentration of lithium to get lithium carbonate, which is then further processed. Besides lithium, potassium chloride can also be extracted with this method. Depending on the extraction site, either the main product is lithium, and potassium is the by-product, or vice versa.

Impacts of lithium mining in the Chilean north

Lithium mining in the Salar de Atacama brings about substantial direct impacts on the water reserves. The extraction of brine from the groundwater causes the level of groundwater and of the salt plains to drop. The main reason for this is that the water evaporates in the ponds to increase the lithium concentration, without any measure

to capture and re-inject it into the groundwater. Consequently, meadows and wetlands run the risk of drying out, directly affecting fragile habitats for nesting birdlife and for traditional pasture. Consequently, the morphology of the lagoons that characterise these systems is changed dramatically.

The trucks used for transporting materials within the mining area and to the processing plants cause air pollution. Another damaging aspect is the dust clouds created throughout the mining processes. This dust contains high levels of minerals, particularly lithium carbonate, which are carried towards settlements (eg the towns of Socaire and Peine), pasture areas and protected areas. The dust causes health problems and contamination of the soil and water.

As all the lithium plants are located in previously undisturbed natural areas, the increase of human activity in and around the plants (eg noise, construction of roads, traffic of vehicles, machines and personnel) increasingly affects ecosystems and biological corridors and is causing the extinction of indigenous plant and animal species as well as erosion. Additionally, long-established routes of livestock herders are blocked and made impassable.

From the social perspective, these lithium mines have provided work opportunities and a related improvement in the economic income of the regional population. However the type of work available for the local residents is mainly low-skilled. The most specialised work is mainly available to migrants from other parts from Chile and other countries.

Another complex aspect of the social context refers to the use and ownership of the land. Traditionally the territory belonged to the Atacama people. Regarding the use and care of the environment, the indigenous people perceive themselves as part of an open system where the territory should not be fragmented. In opposition to this view, the mining industry has extended into locations such as the Salar de Atacama, which hosts vulnerable biological and cultural diversities with irreplaceable environmental characteristics and of great value to local people.

3. TRADE

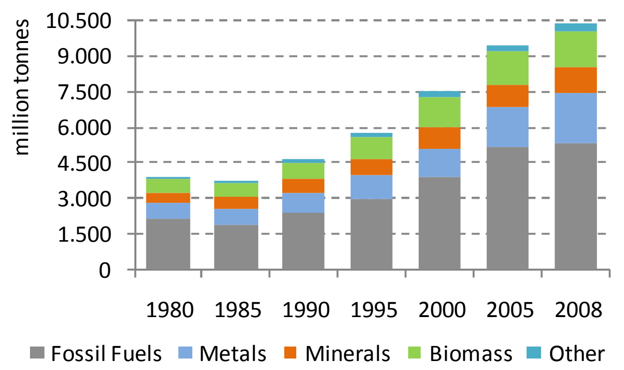
3.1 TRADE OF MATERIALS AND PRODUCTS

The volume of global trade has dramatically increased in recent decades. As the emerging economies have increased their share of global trade, the share of the industrialised European countries has declined. At the global level, the principal trade pattern of whether a country is a net importer or a net exporter of resources has been relatively constant since the early 1960s. Industrialised countries and, more recently, emerging economies have increased their net imports of resources, with growing amounts of resources being provided by developing countries.

Continuing growth in world trade. Since 1980, international trade of raw materials and products has increased dramatically in terms of both physical volume and monetary value. As Figure 6 shows, global direct material trade flows grew from about 3.8 billion tonnes in 1980 to 10.3 billion tonnes in 2008.

Comparing the growth of worldwide trade in physical and monetary terms from 1980 to 2008 reveals a relative but no absolute decoupling between the two (see box below). The volume of trade increased by a factor of 2.7, whereas its monetary value (in current prices) increased almost tenfold (see Figure 7). Global trade increased much more steadily in physical than in monetary terms, reflecting the influence and importance of resource price developments.

Figure 6: Global trade in natural resources, 1980 to 2008, in million tonnes [vii]



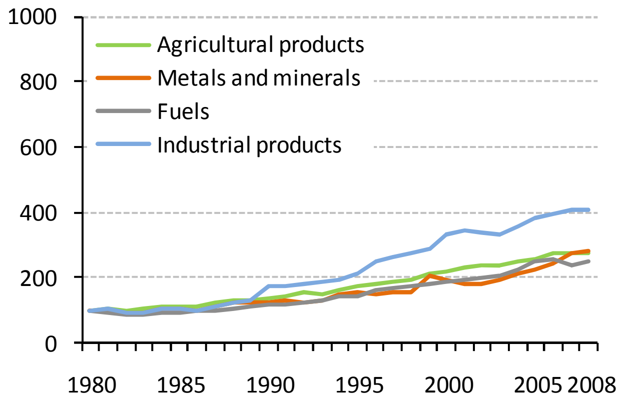
RELATIVE DECOUPLING, ABSOLUTE DECOUPLING AND IMPACT DECOUPLING

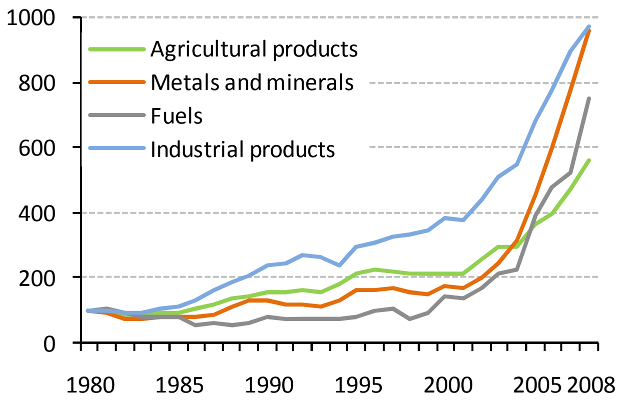
Relative decoupling: the growth rate of economic output (gross domestic product – GDP) is higher than the growth rate of material consumption.

Absolute decoupling: the growth rate of GDP is positive and the growth rate of material consumption is negative.

Impact decoupling: the growth rate of GDP is positive, while negative environmental impacts reduce.

Figure 7: Indices of global physical trade volumes (left) and monetary trade volumes (right), 1980 to 2008, 1980 = 100 (viii)

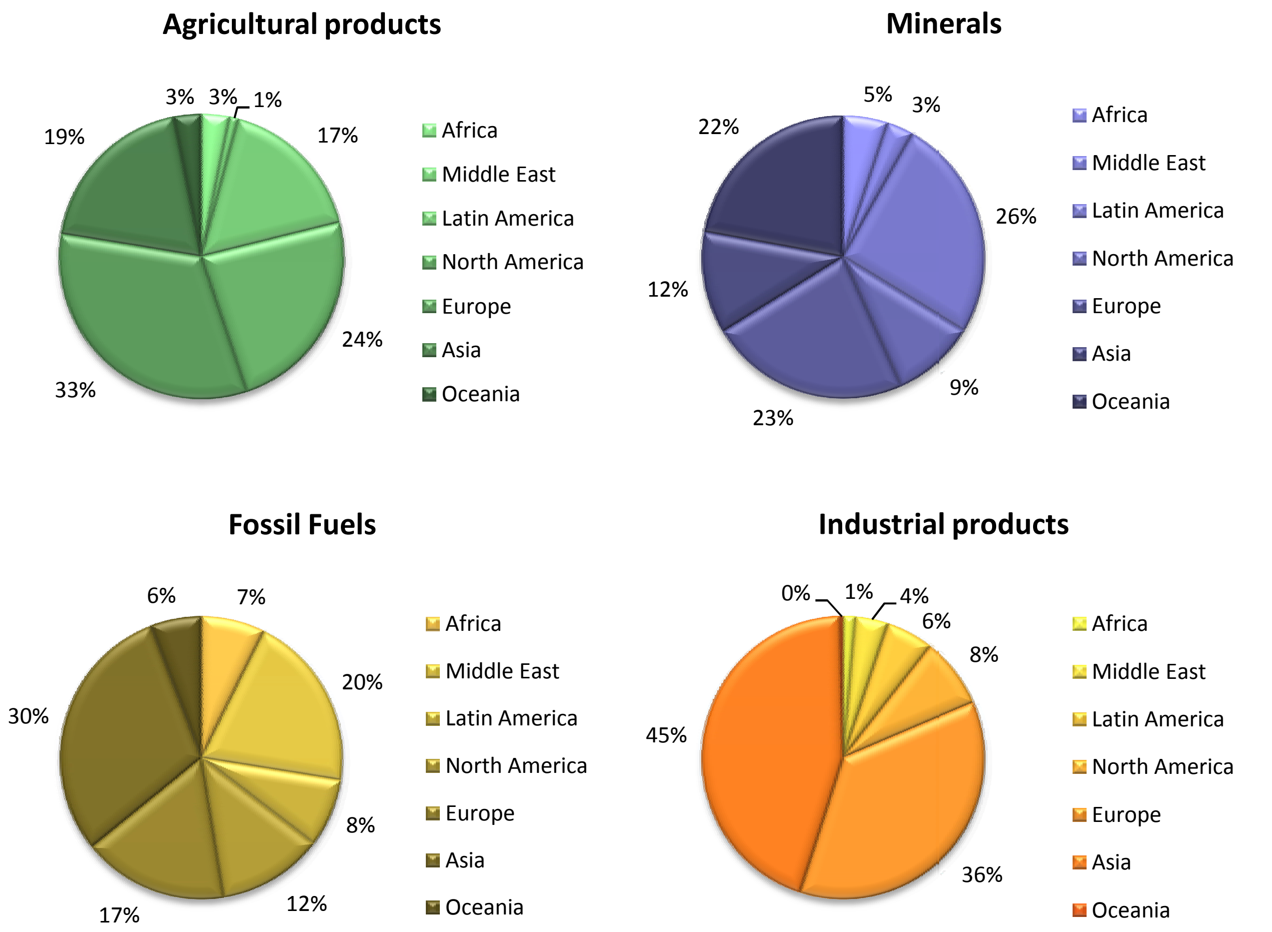




Fast growing emerging economies, such as Brazil, China and India, experienced the highest growth rates in material trade in the world over the past two decades. Their share in global trade volume enlarged, whereas the share of the industrialised European countries declined.[14]

Figure 8 shows which continents supply which resources to the world market, i.e. the shares of global supplies of resources/product groups from different world regions, based on physical units, in 2008. Interestingly, it shows that Asia (especially Russia and Kazakhstan) now supplies more oil, gas and coal to the world market than the Middle East.

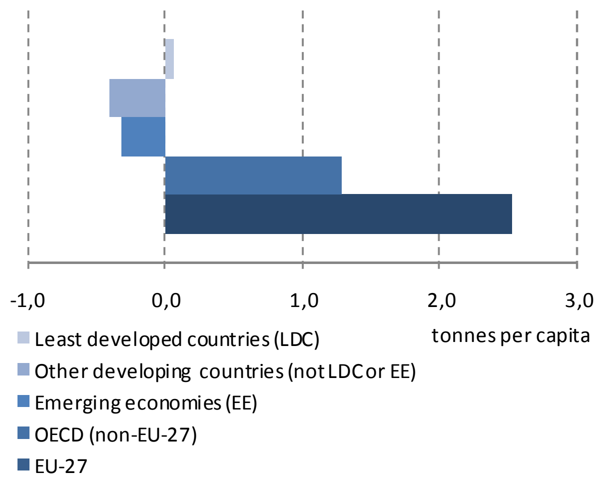
Figure 8: Resource trade and its origins, 2008, shares of different regions in global supply (in %) (ix)



Trade and the global distribution of materials. Trade can help redistribute resources between countries with different resource endowments. Industrialised countries are increasingly net importers of resources, while developing and emerging economies are mostly net exporters. Currently, the EU has the highest net imports per capita of natural resources of all regions (2.5 tonnes per capita), whereas developing countries (excluding least developed countries and emerging economies[15]) have the largest net exports in physical terms (-0.4 tonnes per capita) (see Figure 9). The least developed countries have small net imports of natural resources.

At the global level, the principal trade pattern – whether a country is a net importer or a net exporter of resources – has been relatively constant since the early 1960s (when the UN started compiling trade statistics). Meanwhile, the absolute amounts of net exports and imports have increased.

Figure 9: Physical trade balances of different regions, per capita, 2008 (x)



3. TRADE

3.2 WATER TRADE

With increasing worldwide trade the amount of embedded or "virtual" water used is steadily rising, as many goods require water for their production. Importing water-intensive products can significantly increase a country's water consumption. It can be an additional source of water, lowering the pressure on the national water resources. On the other hand, importing water-intensive goods from water scarce countries can increase the pressure on local water resources.

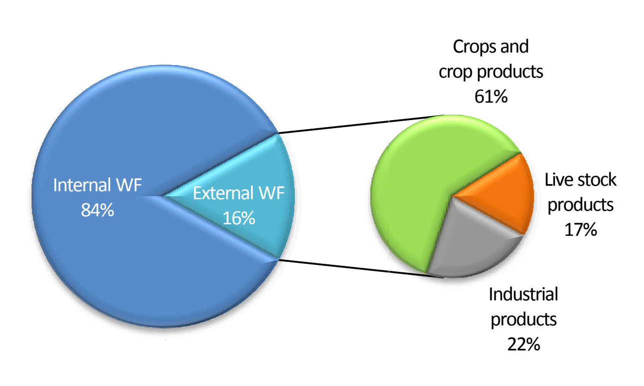
Water embedded in products: the water footprint. National water use is normally derived from statistics on water withdrawals by sector. This information is important, especially in relation to nationally available water resources, but it does not reflect how much freshwater is needed to satisfy people's consumption habits. A country's (or person's) Water Footprint[16] is defined as the total volume of freshwater that is used to produce the goods and services consumed by the inhabitants of that country (or by the individual).[17]

Water embedded in products ("virtual water") is of high relevance when looking at the impacts of our consumption on the environment. When countries import many water-intensive products, their Water Footprint can be much higher than the national water withdrawals. By contrast, a country with large exports of virtual water can have a lower demand to satisfy domestic consumption than the withdrawals would suggest.[18]

Water flows between countries. With increasing trade flows, the amount of embedded virtual water has also increased substantially. Water use for the production of exports has contributed considerably to changes in regional water systems.[19] Our consumption can thus put indirect pressure on water resources in other countries. For countries with limited water resources, virtual water imports (for example, embedded in food imports) can be important, as they may provide alternative sources of water and relieve pressure on domestic water resources.[20]

It is possible to quantify virtual water flows between basins, regions or nations, using the methodology of water footprinting.[21] A study for the period 1997-2001[22] encompassing all the countries in the world showed that 16% of global water use is dedicated to the production of export goods and not used for domestic consumption. Out of this share, 61% can be allocated to the trade of crops and crop products, livestock products contribute 17% and industrial products 22% (Figure 10).

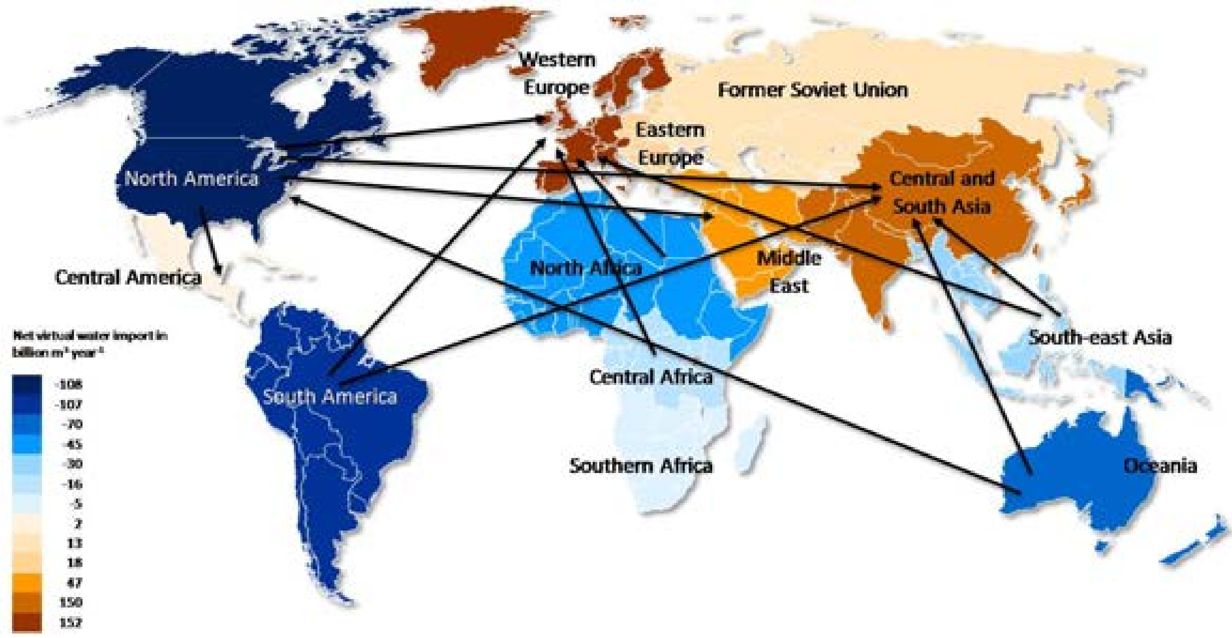
Figure 10: Global distribution between external and internal water footprints (WF), 1997-2001 [(xi)]



The main virtual water exporters in the world are the US, Canada, France, Australia, China and Germany. The major water importers are the US, Germany, Japan, Italy and France (Figure 11).[23] Due largely to differences in economic structures, some countries are both large exporters and importers of virtual water. Germany, for example, imports large quantities of crop products and exports large amounts of water-intensive industrial products. In some countries virtual water imports are even higher than the available renewable water resources. Jordan imports 287 mill m³ – five times more water than is available within the country.

Similar to a monetary trade balance of a country, it is possible to calculate a water trade balance by subtracting the export volume from the import volume. Figure 11 illustrates flows of virtual water between different world regions. Most of the Americas, Australia, Asia and Central Africa have net exports of virtual water, whereas the main net importers of virtual water are Europe, Japan, North and Southern Africa, the Middle East, Mexico and Indonesia. Australia has the largest net export of virtual water due to its large exports of crop and livestock products (73 bn m³).[24]

Figure 11: World regions as net importers and exporters of virtual water (xii)



Countries with limited water resources should ideally focus on producing goods with non-water-intensive production processes and import water intensive products, whereas a country with abundant water resources should specialise exporting water intensive products. Paradoxically, our globalised economic system and the run for ever cheaper products has led many water rich countries into dependency on virtual water imports from countries with limited water resources. Consequently, local scarcity situations may become aggravated, and competition for water increases. In order to ensure a fair distribution of water resources, producing as well as consuming countries will have to assume greater responsibility for developing better global water management.

JOURNEY OF A COTTON T-SHIRT ON THE GLOBAL MARKET

A cotton t-shirt usually travels a long way around the world before reaching our shops, starting as cotton growing in a field, then undergoing various processes, including harvesting, processing to lint, carding, spinning, weaving, bleaching and dyeing before it finishes as printed cotton textile on the shelves. Looking into the main industries of cotton and textile production reveals a complex web of material and water flows and a classic illustration of global trade.

The average cotton t-shirt has a water footprint of 2,700 litres.[25] Getting 1 kg of final cotton textile requires on (global) average 11,000 litres of water.

The journey starts at the point of cotton production. Cotton plants are shrubs that are native to tropical and subtropical regions around the world. In 2009, China and India were the largest producers of cotton. In 2008, the United States was the largest exporter of cotton (3.9 million tonnes), whereas Asia was by far the largest importer (5.6 million tonnes of cotton, followed by Latin America with only 0.6 million tonnes).

About 45% of the water embodied in cotton textile is irrigation water consumed (evaporated) by the cotton plant, 41% is rainwater evaporated from the cotton field during the growing period, and 14% is water needed to dilute the wastewater flows that result from the use of fertilisers in the field and the use of chemicals in the textile industry.

The textile industry has almost disappeared in the developed countries and moved its mills and factories to developing and emerging economies in Asia, which is by far the largest importer of cotton. Dhaka, the capital of Bangladesh, has around of 3,000 textile factories, where textile workers (usually women) produce around 250 t-shirts per hour and earn on average 42 Euro a month.[26] The industry is characterised by high levels of electricity consumption and environmental pollution, and low social and environmental standards. Not surprisingly, the final price the final consumer pays for a t-shirt is usually significantly below the social, environmental and economic cost of the journey.

THE ROLE OF COTTON TRADE IN CAMEROON AND TOGO

Cotton is an important export commodity for many West African countries. The region produces about 5% of the world's cotton and accounts for 15% of the global cotton fibre trade. Cameroon and Togo are two countries for which cotton is an important export commodity. Both mainly export their cotton to other southern countries, including China, Pakistan, Malaysia and Morocco.

Yet West African cotton farmers are among the poorest in the world. Many of them are completely dependent on cotton for their livelihoods. In Cameroon and Togo, cotton is grown on numerous small (family) farms, where child labour is widespread. It would not be possible to make a profit from cotton growing without the involvement of (unpaid) family labour. The fertilisers used for production are very expensive, and world market prices for cotton are being depressed by a large amount of subsidised cotton from industrialised countries. This makes it difficult for African farmers to compete.

In Cameroon and Togo, the development of cotton production has also brought benefits for the rural economy. It has supported the development of rural infrastructure (such as roads, schools, clinics, boreholes and wells) and enabled farmers gain access to social services (eg education and health centres).

Cotton production involves serious environmental and health risks. Cotton is typically cultivated as a monoculture and requires fertile land and a lot of input, such as mineral fertilisers, herbicides, insecticides and fungicides, having an increasing impact on the workers' health. In many parts of West Africa, cotton cultivation has been spreading at the cost of clearing trees and various species of grasses. This has led to a loss of biodiversity and soil fertility, soil erosion and desertification.

In Cameroon and Togo, cotton yields have declined over the past 5-10 years. Many years of using chemical fertilisers and pesticides are responsible for this phenomenon. The use of organic manure instead of chemical fertiliser might provide relief for the soils, but so far is not widespread.

Cotton production and its impacts on water resources. More than 80% of the water footprint of cotton consumed in the European Union is located outside Europe,[27] with major impacts in producing countries. Water resources can be affected by water depletion and/or pollution. In West Africa countries such as Cameroon and Togo, cotton farming is essentially rainfed, so the main problem is water pollution caused by the use of chemical fertilisers and pesticides.

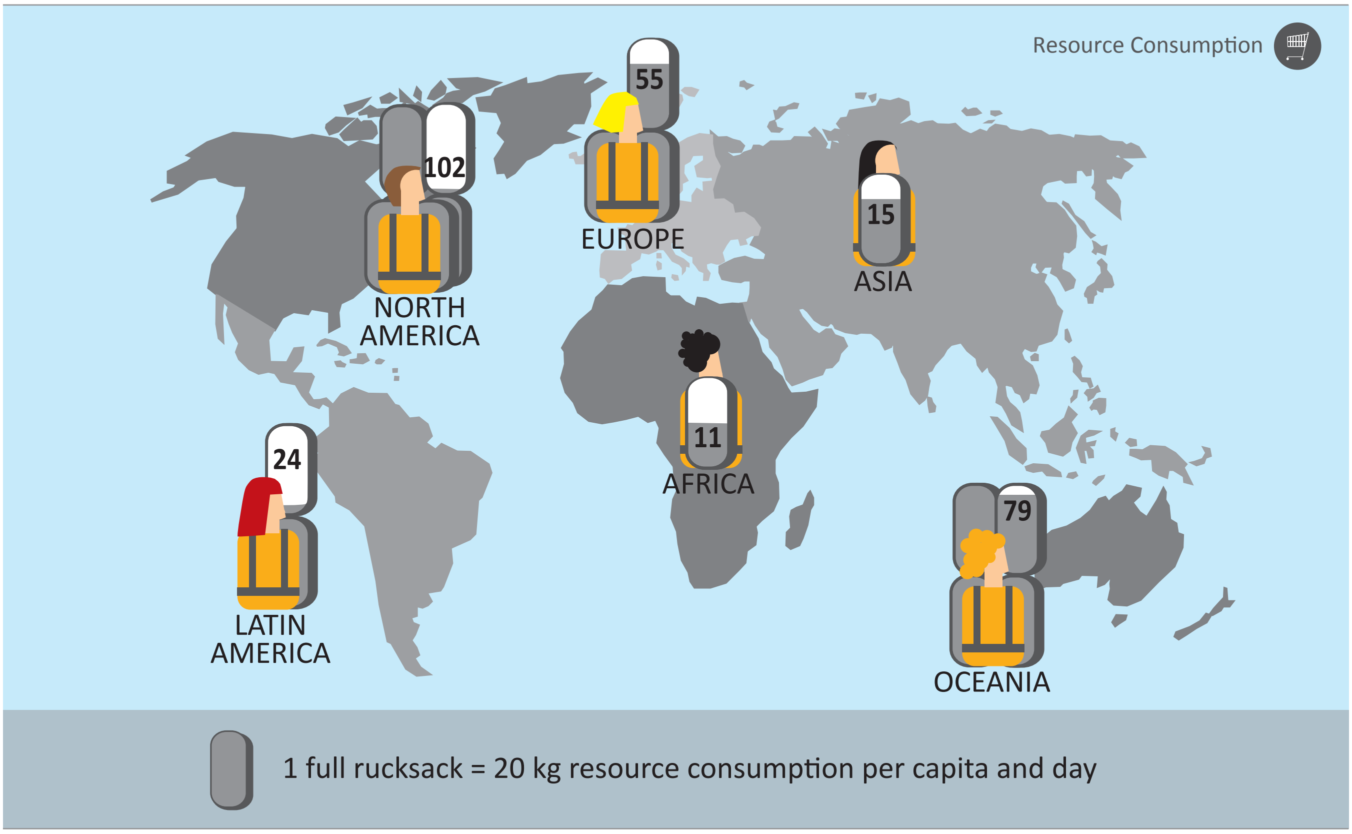
4. CONSUMPTION

4.1 MATERIAL CONSUMPTION

In line with extraction and trade, material consumption has risen substantially over the past decades, causing environmental and social harm. However, material consumption per capita differs by a factor of almost ten between the different continents. While there is some debate about sustainable consumption levels, there are no agreed per capita targets.

Material per capita consumption inequalities around the world. Comparing per capita extraction and consumption figures around the world, it is clear that Europeans, North Americans and inhabitants of Oceania are most reliant on importing resources from other world regions in order to maintain their level and composition of consumption (compare Figure 2 and Figure 12). In Europe, around 34 kg of resources were extracted and 55 kg were consumed per capita per day in 2004. North Americans and inhabitants of Oceania consumed even more resources per capita per day (around 102 and 79 kg respectively). The contrast with other continents is sharp. In Asia, around 15 kg of resources were extracted and consumed per capita per day. In Africa, around 15 kg of resources were extracted and 11 kg were consumed per capita per day.

Figure 12: Consumption of resources per capita per day, 2004 (xiii)



Over the last decade, the largest rise in per capita resource consumption has occurred in the industrialised world. In 1997, North America consumed around 95 kg of resources per capita, followed by Oceania (74 kg) and Europe (48 kg). By contrast, in the same year, Latin America consumed 30 kg, Asia 14 kg and Africa 12 kg per capita.

Patterns of resource consumption. These differences in per capita resource use are clearly reflected in the different lifestyles and consumption patterns of people living on these continents, for example the types of houses they live in, the size of their cars and the amount and types of food they eat. More than 60% of overall European resource use is a result of housing and infrastructure (31%), eating and drinking (25%) and mobility (7%).[28] These three areas also cause the most environmental pressure.[29]

Sustainable levels of resource use. Given the large inequalities in per capita resource use between different countries and world regions, there is some debate among scientists regarding a global per-capita target for the sustainable use of non-renewable resources (note that Figure 12 depicts levels of both renewable and non-renewable resources).[30] Ekins et al. (2009) suggest a target of six tonnes of annual per capita consumption of non-renewable resources by 2050, which would imply a significant absolute reduction from current consumption levels in European countries. However, this suggestion is not backed up by scientific evidence.

Impacts of consumption levels and patterns on the environment. Industrialised countries have long ago reached per capita levels and patterns of consumption that are causing significant environmental pressure. These patterns are largely characterised by the use of materials and energy sources that are difficult for nature to renew, except in a very small part. One familiar consequence of overconsumption is climate change. Other major problems include the overconsumption of chemical fertilisers in agriculture, resulting in changes to the nitrogen and phosphorus cycles and excess nitrogen and phosphorus polluting our rivers, lakes, oceans and atmosphere. We have already passed the tipping points of climate change, biodiversity loss and nitrogen levels, and we are about to reach the tipping points of freshwater consumption, ocean acidification, land use and phosphorus levels.[31]

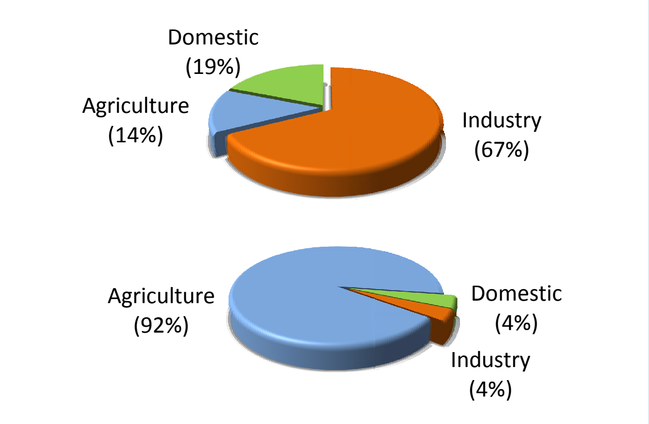
4. CONSUMPTION

4.2 WATER CONSUMPTION

Water consumption is unequally distributed between different sectors as well as between world regions. On a global level, the agricultural sector consumes the most water. The amount of water we consume directly or indirectly mainly depends on our volume and patterns of consumption, as well as the climatic conditions and agricultural practices in the producing country. While an average North American consumes the largest amount of water (7,650l/day), the average African consumes less than half of it – 3,350l/day.

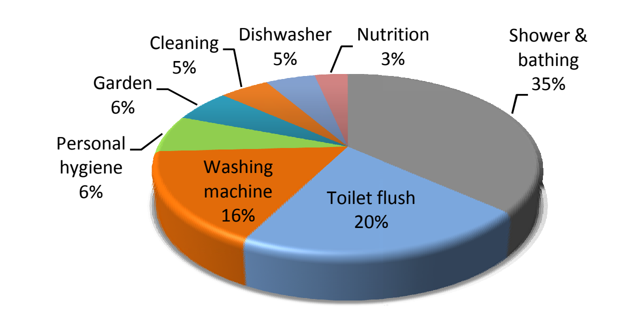
From a hydrological point of view, water consumption accounts for the amount of water actually lost from the ecosystem throughout a production process (it equals the difference between the abstracted water and the water which is returned to the same ecosystem after its use). In Europe 67.4% of total water consumption is consumed by industry, followed by the domestic sector (18.9%), and agriculture (13.7%). However, on a worldwide level these values differ completely: here 92.2% of the water consumed is used in agriculture, 4.1% is used by the domestic sector, and only 3.7% of the water consumed is used by the industrial sector (Figure 13).

Figure 13: Water consumption by sector in Europe (below) and the World (above) [xiv]



In our daily life, we use water both directly and indirectly. We use water directly for activities such as cooking, drinking, bathing and cleaning. In the industrialised countries daily water use per capita is far above the worldwide average. As an example, Figure 14 shows for domestic water use for different activities in an average household in Austria. We also consume a lot of water indirectly, through the use of products and services that required water for their production (e.g. growing cotton, production of electricity, electronics – see chapter 3).

Figure 14: Distribution of domestic water use in an average Austrian household in the year 2010 [xv]

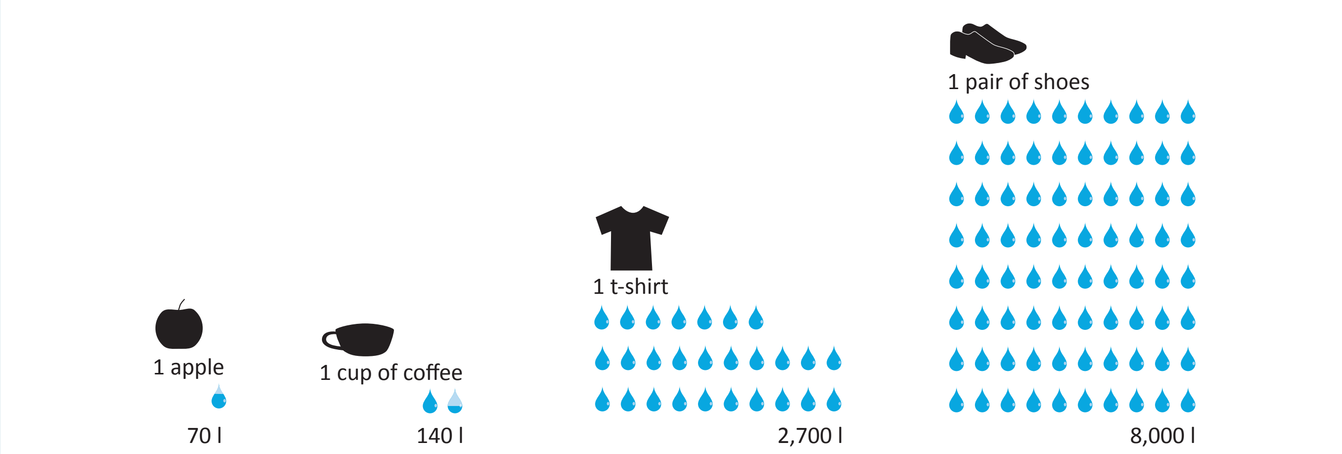


Our water footprint and that of our country depends on four main factors:[32]

- **How much we consume:** The richer a country, the more goods and services are consumed, leading to a higher water footprint.
- **Our pattern of consumption:** The higher the consumption of meat and industrial products, the greater the water requirement.
- **Climatic conditions in our country:** Climatic conditions unfavourable for agriculture due to high evaporation increase the water footprint of the crops produced.
- **The efficiency of water use in agricultural practices:** The more efficient the irrigation systems used the higher the water savings.

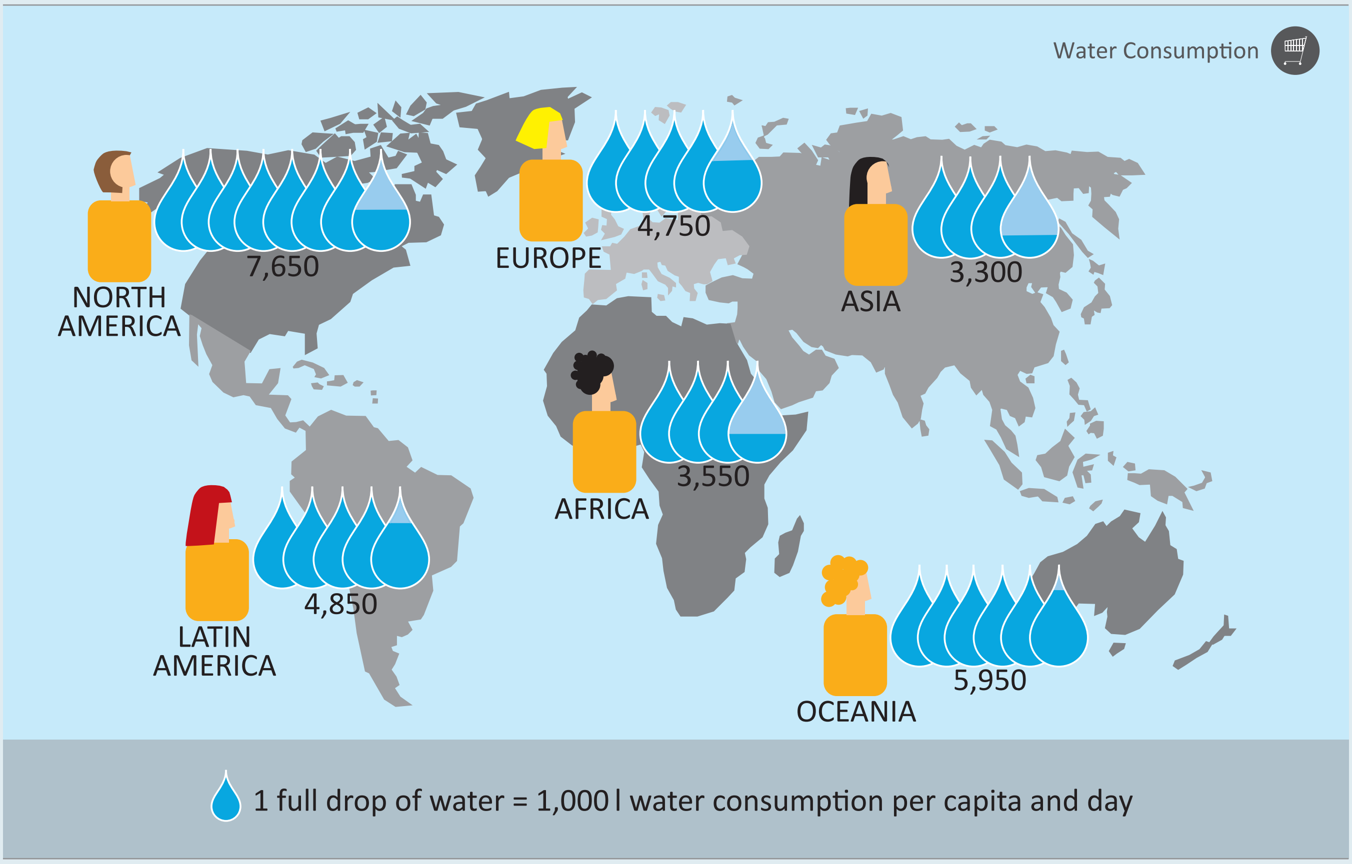
Figure 15 gives some examples of the water resources required for the production of different items.

Figure 15: Water footprints of different products (xvi)



The water footprint resulting from our consumption habits is significantly larger than our direct water use. Its size is largely determined by the consumption of food and other agricultural products which not only require irrigation water but also water acquired through rainfall. The world's average annual per capita water footprint is around 1,400m³, but average water footprints differ significantly from country to country: 2,840 m³ in the United States of America, 1,380m³ in Japan, 1,070m³ in China.[33] On a daily basis, the average North American has the largest water footprint (7,650l/cap), the average African has the lowest (3,350l/cap) (Figure 16).

Figure 16: Consumption of water per capita per day, 2004 (xvii)



CONSUMPTION OF BOTTLED WATER

Bottled water has become a global billion-dollar industry. The commodity – water – doesn't differ much from treated tap water and has not changed since the business was in its infancy 40 years ago. Today it has enormous markets in the richest and also the poorer countries. Bottled water has become a symbol of choice, of capitalism and of our busy, rushed lifestyles.[34]

Strikingly, in some countries water is bottled and transported to people in areas that have enough water resources, having a considerable environmental impact brought about by the bottling process as well as by transportation. The bottling process consumes large amounts of water, energy and materials and produces emissions. For instance, to create one litre of bottled water, 9 litres of water are needed in the bottling process.[35]

Unless they are recycled, the disposal of plastic bottles also has enormous environmental impacts. If they are incinerated, they release fossil-fuel derived carbon dioxide into the atmosphere, causing climate change. As litter on the ground or in the sea, plastic is degraded by the sun into many tiny pieces. Consequently, it can be found everywhere on our planet. A one litre bottle could break down into enough small fragments to put one on every mile of beach in the entire world.[36] Today, plastic outweighs surface plankton six to one in the middle of the Pacific Ocean.[37] This area is called the "The Great Pacific Garbage Patch" – it's an estimated 3.5 million tonnes of rubbish, 90% of which is plastic (containing everything from shoes and takeaway containers to bottle caps).

Every year an estimated 100,000 sea mammals and over one million sea birds die after mistaking plastic for food. The use of plastic bottles also has uncertain health impacts on humans due to chemicals in the plastic. Alternatives to bottled water include the provision of more public drinking fountains, free tap water in bars and restaurants and greater use of refillable water bottles.

THE BELO MONTE DAM IN BRAZIL

Worldwide consumption of energy is rising, and between 1974 and 2009 it doubled. Recently, hydro-power has increasingly been considered one of the cleanest ways to satisfy this demand. However, hydro-power can also have significant negative environmental impacts. The Belo Monte Dam in Brazil is a hydroelectric dam project on the Xingu River, in the middle of the Amazon region (in the state of Pará). The envisaged maximum capacity of the dam is around 11 gigawatts (GW) (the capacity of around 11 nuclear power plants), which would make it the third largest in installed capacity, behind the Three Gorges Dam in China and the Brazilian-Paraguayan Itaipu Dam. However, due to the long dry season in the area (causing the rivers to dry out), the guaranteed capacity generation from the dam would only account for around 4.5 GW, 39% of its maximum capacity. The electricity generated by the dam is intended for both public consumption (up to 70%) and industries such as mining and mineral transformation, which have already acquired the necessary concessions for the installation of the respective plants close to the construction side.

Strong critiques of the dam project have been expressed nationally and internationally since the beginning of the first plans. The Xingu River is located in the middle of a virgin area, which contains a rich biodiversity of enormous value and is home to a large number of indigenous tribes. With the construction of the dam, the river would run considerably lower, away from the banks, for around 100 km downstream, hindering fishing as well as navigation and so impacting on the life of thousands of people.

A study on the environmental impact of the project concluded that 130 mill m^3 of earth and 45 mill m^3 of rock will have to be moved for the construction of the dam – about the same quantity as for the construction of the Panama Canal. The destiny of these materials is still unknown. So far, no proposal has been presented for the handling of the residues as well as for the provision of basic services (education, health, alimentation, security, etc) in the construction area, once the immigrant workers have settled – estimated at around 100,000 people.

Apart from these negative consequences, critics argue that the economic viability of the project has not been assessed sufficiently, and that the energy generation is extremely inefficient. It is further assumed that the construction of the Belo Monte Dam will be only the first step towards other dams upstream with even greater environmental and social impacts.

The conflicts between the local communities and the Norte Energia consortium that is building the dam are just beginning. Belo Monte will be built to meet the demands of energy-intensive industries, including aluminium producers. As a result of this hydroelectric plant, land in the State of Pará has been granted for mining speculation, projects of further expansion of existing industries and iron and steel industry installations. Allowing this plant suggests a questionable management of the Amazon territories – justifying the exploitation of people and nature through a restricted idea of development. Despite the social and environmental damage caused by the plant, it may be permitted to sell carbon credits through the "Clean" Development Mechanism (CDM) of the Kyoto Protocol.

5. EFFICIENCY

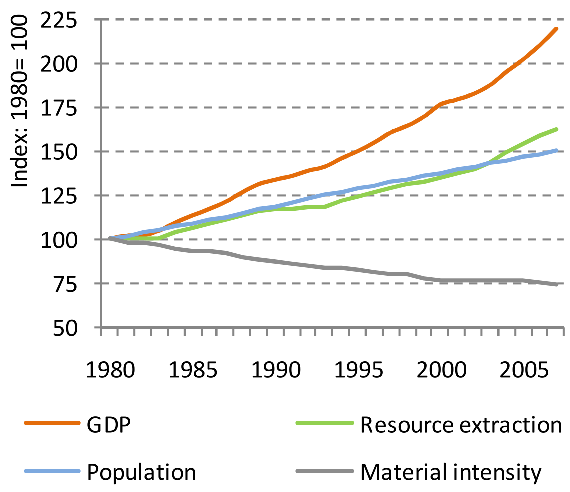
5.1 MATERIAL EFFICIENCY

Material efficiency improvements alone have so far not been sufficient to reach absolute reductions in resource use. The most material efficient countries in the world are in most cases also the ones which consume the most.

Material efficiency, economic development and sustainability. Material efficiency can be achieved by using fewer resources to achieve the same or improved output.[38] The material efficiency of a country is strongly related to its economic structure and level of income, but does not accurately reflect the country's overall environmental performance or sustainability. The most material efficient countries in the world are usually the ones which extract and consume the most. Low material efficiency is common on continents with small industrial and service sectors (Africa) or on continents that specialise in the extraction and export of materials (Latin America, Oceania). This phenomenon of countries or regions with abundant availability of natural resources having lower levels of productivity and human development than places with fewer resources is known as the "resource curse" or the "paradox of plenty".

Doing better in relative terms, but not in absolute terms. Material intensity (materials used to produce one Euro or Dollar) has been improving over the last decades, as illustrated in Figure 17. The decoupling of resource extraction from economic growth is a positive trend and shows that we are improving our resource efficiency in relative terms. In the EU, relative decoupling was primarily enabled by growth in the service sectors (which need fewer resources than primary sectors such as agriculture and mining) as well as changes in the energy production systems of many countries (using less material intensive energy carriers such as gas or renewable energies instead of coal).[39] However, at the global level, the absolute amounts of resource extraction and resource use are still rising.

Figure 17: Relative de-coupling of economic growth from resource use, 1980 to 2007 [(xviii)]



Resource efficiency, however, is not the ultimate goal. While there is potential to increase resource efficiency levels across the world, this would only result in fewer resources needed to produce the same amount of goods and products for our consumption. Although this is a positive trend, and one which is already happening, the result would be an improvement in resource efficiency levels in relative terms but not in absolute terms. In other words, although we would be using fewer resources more efficiently, the continued growth of our economies would still lead to a net increase in resource use.

5.2 WATER EFFICIENCY

Our ever increasing demand for freshwater cannot be endlessly satisfied, as water resources are scarce. It is essential that we start using our water resources more efficiently on all levels – in industry, agriculture, at home as well as in water supply systems.

Managing supply and demand. So far, the response to increased demand for freshwater has focused on increasing supply through measures such as additional wells, dams and reservoirs, desalination and large-scale water-transfer infrastructures.[40] Yet, with climate change and water scarcity, possibilities to increase water supplies are reaching their limits in many regions, even within the EU. Consequently, managing supply must be complemented by improved demand management and a reduction in water use.[41]

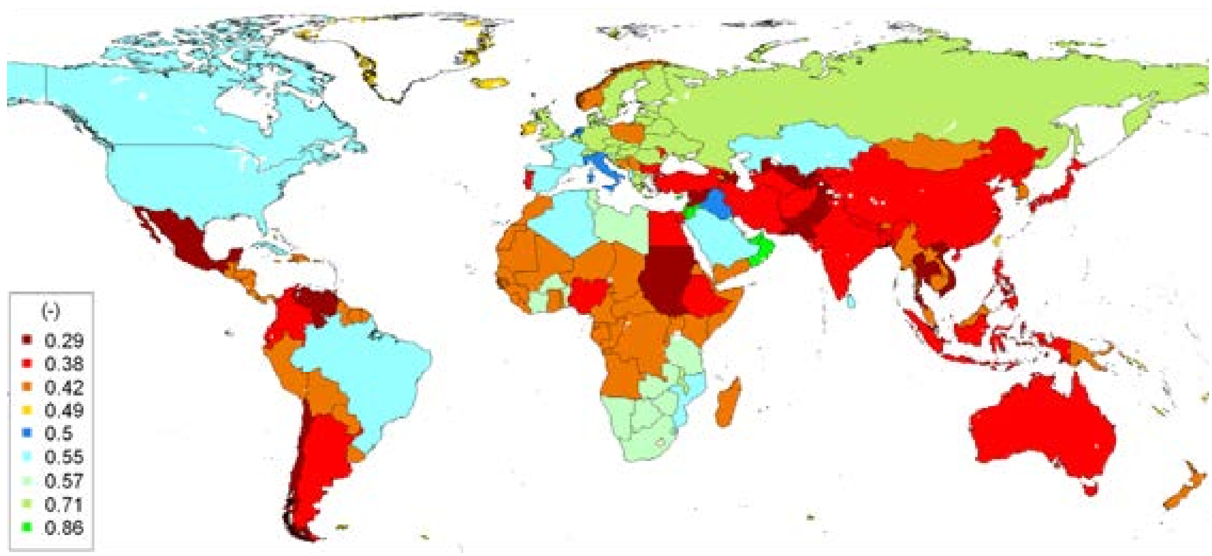
Some estimates suggest that in the EU, up to 40% of total water quantity could be saved through technological improvements alone. Changes in human behaviour or production patterns could further increase such savings.[42]

Producing the same with less water. The potential for water savings in manufacturing industries is large, for example through recycling and re-use, changing production processes and using more efficient technologies and introducing measures to reduce leakage.[43] However, as the price of water is normally reasonably low, these measures have not yet received adequate attention.

A study of the difference between organic cotton and conventional cotton in terms of resource use shows that one kilogramme of organic cotton has half the virtual water content of the same amount of conventional cotton. This difference is mainly due to different methods of cotton cultivation and to the indirect water use of the electricity used in yarn production.[44]

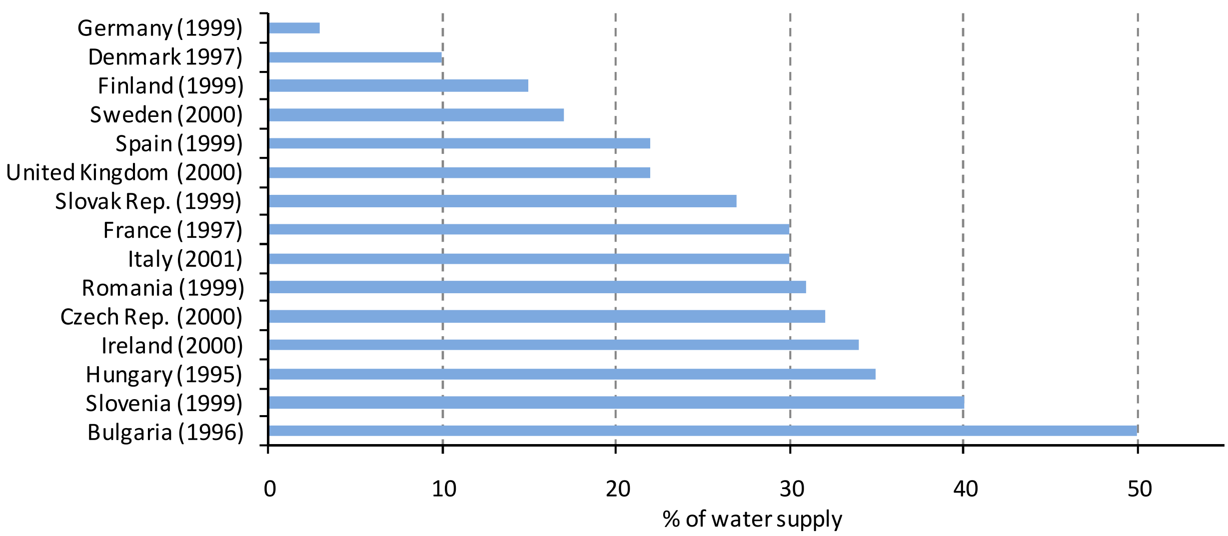
The contribution of agriculture to water efficiency gains. On a worldwide level, agriculture is by far the biggest water consumer (especially when considering not only water abstraction but also the uptake of rainwater).[45] Figure 18 gives an overview of average irrigation efficiencies around the world. Increasing efficiency in this sector would make a large difference to overall water use. One option is to shift towards more efficient irrigation techniques (e.g. sprinkler and drip or underground irrigation systems) and to schedule irrigation according to the water requirements of crops. Another approach is to change the planted crop type in order to adapt to water availabilities and climatic conditions. The plantation of specific crops could be localised in areas where crop water requirements are lowest.

Figure 18: Average irrigation efficiencies around the world (xix)



Losing our precious water – water leakage. Around the world water loss due to leakages in water supply systems is extensive, but varies significantly. Some European countries have reached technical and economical limits, for example in Germany and Denmark leakage rates are less than 10%. However, losses from public water supplies in Spain, France and Ireland are around or above 20%,[46] while in Bulgaria, 50% of the water is lost due to leakage. Figure 19 gives an overview of the losses of water due to leakage in selected European countries.

Figure 19: Losses from urban networks (xx)



Increased water efficiency as opportunity. Water efficiency can be improved by increasing the productivity per volume and by wasting less water. This requires technological development as well as enhanced water governance, which can build on solid monitoring methodologies and data. Increasing water efficiency is not only essential for adapting to climate change, it is also an opportunity for economic benefits and environmental protection.

IMPROVING OUR MATERIAL AND WATER EFFICIENCY

There are many steps we can take to improve our use of materials and water:

MATERIAL USE:

- **Better waste management:** Adopting zero waste policies can achieve quick wins, for example minimising waste and maximising re-use and recycling.
- **Ecological fiscal reforms:** Shifting from taxes on labour to natural resources. This would incentivise increased material efficiency and a reduction in the overall use of materials.
- **Eco-innovation for materials:** Developing products, techniques, services and processes that use materials efficiently. There is a big potential for companies to make better use of resources in production processes while also making economic savings.
- **Increasing green public procurement:** As major consumers of products and services, public authorities can be a driver for change. By implementing procurement standards, authorities can stimulate demand for products and services with a low resource input and drive companies to reduce their environmental impact.
- **Changing consumption patterns:** In countries with high per capita consumption, consumers can contribute to a fairer share of global resource use. For example, they can reuse and recycle wherever possible, and opt for goods that are durable or have a low resource input. Consumer choice may be assisted by the use of easily understandable product labels, indicating the resources (material, water, land and carbon emissions) used over the product’s life cycle.
- **Research and development:** Supporting research and development, especially in the field of materials and water research and strategies, will help to find solutions for reducing resource.

WATER USE:

- **Improving water management:** Integrated Water Resources Management (IWRM) tackles the management of both water demand and supply. This approach requires that the needs of different users and the demand for water by ecosystems are taken into account in a participatory manner, and that supply systems are improved.
- **Eco-innovation for water:** There are various areas where innovation in industrial processes would lead to less pressure on our water resources, eg shifting towards less water-intensive production, exploiting alternative water sources (e.g. desalination) or improving water treatment practices.
- **Reducing personal water footprints:** There are various strategies to achieve a significant reduction in our direct and indirect water consumption. Examples include showering instead of having a bath, using flow controllers on taps and using water efficient washing machines. Our indirect water consumption can also be reduced, for instance by choosing to avoid or reduce the consumption of products that have high water footprints, such as meat.

6. MEETING THE CHALLENGE

We live in an age characterised by high consumption patterns, which exceed the capacity of the world's ecosystems to cope and regenerate. While human population growth is a contributing factor in the increasing demand for natural resources and regeneration, it is not the main cause of the global environmental problems we face today. In fact, a relatively small proportion of the global population consumes most of the world's resources and is responsible for the related problems of pollution, climate change and the degradation of ecosystems and the services they provide.

Urgent action is needed as there is increasing pressure on the availability of resources needed for our economies to grow. Those who consume more than their fair share of resources will have to significantly reduce their consumption per capita in order to allow current and future generations to achieve certain living standards. One solution proposed by the UN is to impose a resource use cap on developed nations in order to allow those living in the Global South to continue with development processes.

Europe's current model of economic growth is inherently linked to high levels of continuous consumption and therefore high levels of resource use. Not only is this system unsustainable in a world of finite resources, it also highlights the need to address the link between resource use, economic growth and prosperity in our societies. Various studies and initiatives have already explored this relationship and have stressed the differences between high economic growth and widespread wellbeing.

In order to meet the current challenge, an overall reduction in Europe's consumption levels is needed. For this to happen, fundamental changes in the way that societies produce and consume are essential. Some examples could be to reduce meat and dairy consumption, promote leasing business models, where by companies provide ser-

vices rather than goods, ban planned obsolesce and reduce private car and plane travel. It would also mean moving away from the idea that material wealth is intrinsically linked to an individual's happiness and well being.

Decreasing our levels of resource use is not only an environmental necessity, it is also an economic opportunity. The rapid increase and fluctuation in resource prices demonstrate that we are no longer in an age of cheap resources. Europe's dependency on resources from overseas makes its economy extremely vulnerable. Companies must therefore adapt by reducing their resource use, which will in turn deliver cost savings and leave them better placed in terms of competitiveness worldwide.
To make the most of this opportunity, it is imperative that both the EU and its member states provide a policy framework that makes a decrease in resource use both economically and politically attractive. Only then would we be able to move to a sustainable future where Europe's consumption is not a burden for other nations. This framework should be based on two pillars:

1. A global perspective to ensure that policy solutions are credible. Although resources are mostly consumed in developed nations, globalised supply chains mean that the impacts are felt elsewhere. Credible policies must take a holistic approach. They must ensure that localised solutions do not increase resource consumption at another stage of the life cycle. Policies must also avoid risking the availability of resources for future generations. By ensuring that synergies are maximised and trade-offs are avoided, opportunities will be found at various stages of the process to impact positively on the economy, the environment and society more broadly.

2. A policy framework that incorporates the interconnected nature of resources. As we have seen in this report, material extraction, production and consumption are intrinsically linked to water use with different ecological and social consequences. Similar examples can be seen across entire production systems. For example, increasing biofuels consumption will result in a huge increase in both land and water use. We need to measure Europe's resource use taking account of the embedded resources of products and services, allowing us to better see their interdependent and inseparable nature. In this way it will be possible to avoid trade-offs and to set meaningful resource reduction targets.

The political and economical importance of resource use is widely recognised and discussed on different political levels. Nevertheless negative environmental and social consequences of resource use are often underrepresented in political discussions and actions. Unfortunately so far global political answers to this pressing challenge are missing or are inadequate to deal with the urgent challenges that we currently facing. The few piecemeal and disjointed policies that do exist are insufficient to deal with the urgent challenges that we currently face. Europe has a unique opportunity to lead the way in resource use policy, and to create a more sustainable future for us all. If we take advantage of this chance, we can realise great benefits for people, the economy, governments and businesses, while lessening the pressure on the world's natural resources.

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(ii) SERI Global Material Flow Database. 2008 Version. See: www.materialflows.net

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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 per cent 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