Switzerland's ecological footprint

A contribution to the sustainability debate

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Contents

Foreword

In 1999 Switzerland enshrined sustainable development in the Federal Constitution as a state objective. A few years later the Federal Council developed its "Sustainable Development Strategy 2002", which among other things calls for long-term observation of this country's performance in relation to sustainable development. Monitoring like this is intended to heighten sensitivity among decision makers and the general public, measure progress and thereby lay a foundation for further actions to carry us forward.

Since then the Confederation has developed the MONET sustainable development monitoring system. MONET uses some 120 indicators to capture the numerous national social, economic and environmental factors relevant to sustainability. The challenge remains of compiling this large volume of partial information into an overall picture of sustainable development which can be easily grasped by the general public.

One possible approach to such a comprehensive overview is to select certain particularly informative "key indicators". Thus MONET has for some time focussed on 17 key indicators to make it easier to grasp the information provided by the system. Another approach is to devise additional "synthetic indicators" that summarize the complex reality of sustainable development in one or a small number of figures. One such synthetic indicator is the "ecological footprint", a method in widespread international use which depicts in telling fashion where and how heavily humans impact on the environment.

With a view to its application in Switzerland, the federal agencies publishing this report have undertaken to examine the ecological footprint methodology closely. The foremost consideration in this examination has been data verification, as the ecological footprint is calculated using data from international sources which do not necessarily correspond to official Swiss statistics. This task was taken on by the INFRAS research and consulting agency, which has undertaken the necessary clarifications in close cooperation with the method's originator, the Global Footprint Network.

The outcome of this investigation is a report comprised of detailed technical clarifications. This information is of interest only to specialists and is therefore available only in English and on the Internet. To make the interesting results of the ecological footprint analysis available to a broader audience, however, the publishers have decided to produce the present brochure. The following pages will shed light on the findings relevant to our country and place them in a global context. In this way we hope not only to invigorate the discussion of methodology in relation to sustainability monitoring, but also to stimulate debate on sustainable development in general.

For the publishing federal agencies

Daniel Wachter, Section Head, Sustainable Development, Federal Office for Spatial Development (ARE)

Summary

The study

The publishing federal offices wanted to determine whether the ecological footprint method represents a suitable complement to other indicators of sustainable development. In the first stage, the international database maintained by Global Footprint Network, the originator of the method, was compared with Swiss data. Based on examination of this database, Switzerland's ecological footprint was then calculated in the second stage.

The method

The ecological footprint is a scientific method for determining in what areas, how heavily and where humans impact on the environment. The method uses the magnitude of uses of and stresses on natural capital, such as crop cultivation or energy and wood consumption, to calculate the area that would be required to provide these resources in a sustainable manner. The result – the ecological footprint of a region, a country or of the world as a whole – is expressed in a measure of area called the "global hectare". The larger the footprint, the greater the stress on the environment. Furthermore, the method also calculates "biocapacity", which is the ability of the environment to produce raw materials and break down pollutants. When a region's footprint and biocapacity are equal, the region is in harmony with its natural capacity. It is sustainable.

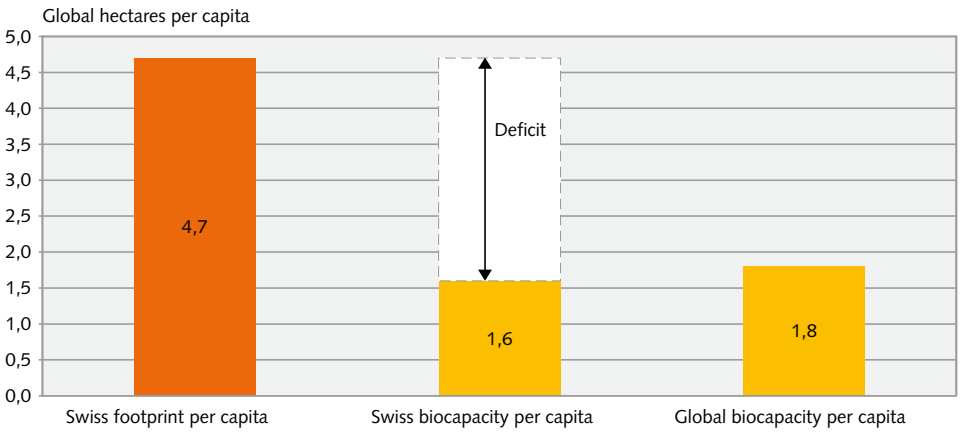
Switzerland's footprint

Switzerland's ecological footprint currently measures 4.7 global hectares per capita. Our country's biocapacity, however, is a mere 1.6 global hectares per capita. Thus Switzerland's footprint is nearly three times as great as its biocapacity. Our country's ecological footprint has exceeded its biocapacity for several decades now. Switzerland's ecological footprint has more than doubled since the 1960s.

The growing imbalance between ecological footprint and biocapacity means that we increasingly import biocapacity to meet our consumption. We do this by importing natural resources from other countries and exporting waste materials such as carbon dioxide. Only in this way is Switzerland able to consume so much without drastically overexploiting its own natural capital.

The main cause of this large footprint is our energy consumption. Energy accounts for two-thirds of the ecological footprint, making it much more important than all other factors. The energy footprint is also the component that has seen by far the greatest growth in recent decades. Use of cropland, forest and green space are also important, together accounting for 26 percent of the total footprint.

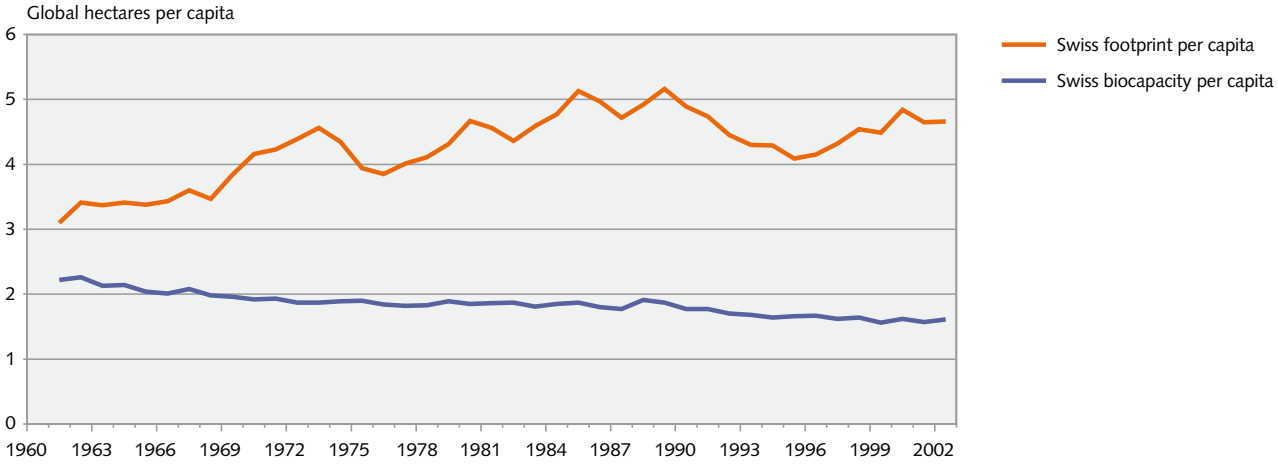
Footprint and biocapacity per capita (2002) S-G 1



Comparison of Swiss footprint per capita and available biocapacity.

Source: Global Footprint Network

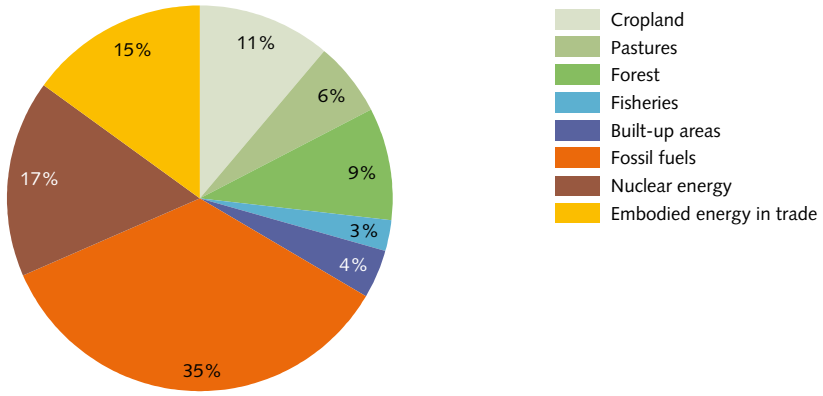
Development of footprint and biocapacity S-G 2



Swiss biocapacity and ecological footprint per capita from 1961 to 2002.

Source: Global Footprint Network

Composition of the ecological footprint (2002) S-G 3



Composition of Switzerland's ecological footprint, 2002.

Source: Global Footprint Network

The global footprint

The average ecological footprint for the world as a whole is 2.2 global hectares per capita. The global footprint has been greater than worldwide biocapacity since the mid-1980s. This means that humans are consuming the earth's natural capital faster than it can be regenerated. The energy footprint has grown enormously in the past forty years, increasing by more than a factor of ten since 1961.

The industrialized countries of the North generate a per-capita burden on nature up to three times greater than their worldwide average fair share. At 9.5 global hectares per capita, North America's ecological footprint is much greater than that of all other regions – for example it is nine times greater than Africa's. The footprint of Western Europe – with Switzerland occupying the middle ground – is also substantially greater than the global average. The countries of the South, by contrast – especially in Africa and Southeast Asia – use up much less biocapacity per capita.

With the economic upswing in populous developing countries such as India, China and Brazil, which are adopting the energy and resource-guzzling economic model of the North, the global ecological footprint will continue to grow rapidly in the coming years.

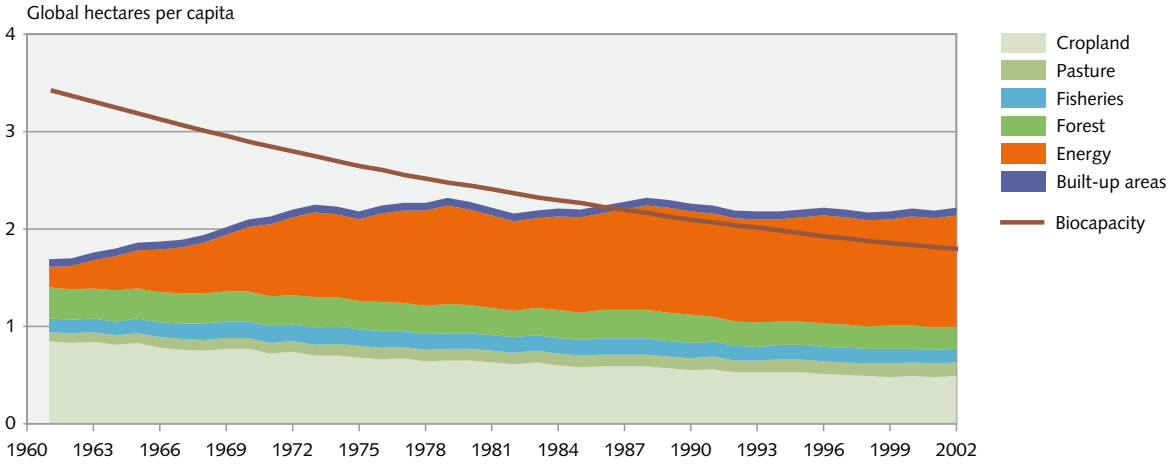
Outlook

Protecting the earth's ecological livelihood while simultaneously creating equal development prospects for all people is one of the greatest challenges facing the world community. The world's economic model needs to develop in a direction that conserves energy and resources. Otherwise, overuse of our planet will result in negative financial effects along with the negative environmental effects. Industrialized nations must lead the way. They are largely responsible for the oversized global ecological footprint in the first place. In addition, they have both the expertise and the economic power to place the production and consumption of resources on a more conservation-orientated footing.

The political approaches to instigating long-term structural change are well-known. The first step is to use resources more efficiently and to replace non-renewable resources with renewable ones. Economically speaking, many resources – and fossil fuels in particular – are currently too cheap. Therefore there is a lack of incentive to use resources efficiently or to use renewable resources. Correcting this would mean giving the market the right price incentives to initiate structural change, such as taxes and certificate systems.

The earlier the course is set for a sustainable, resource-conserving lifestyle, the more seamlessly the change can be managed and the more opportunities for development will present themselves in both the North and the South.

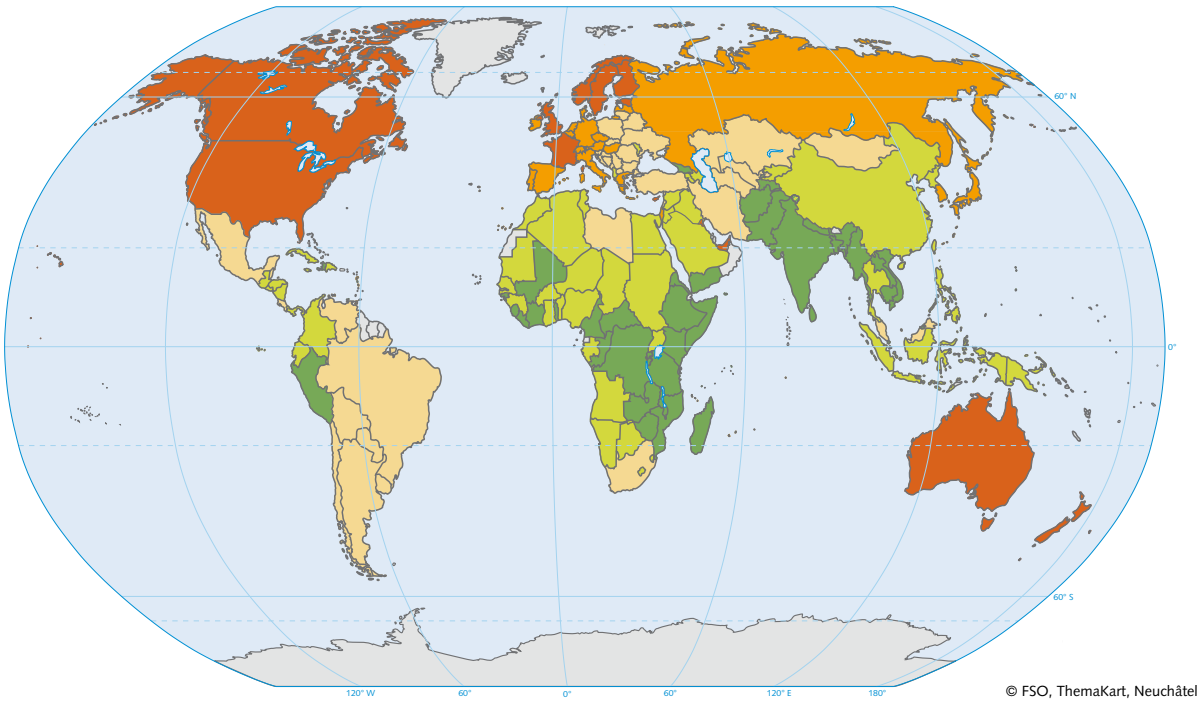
Development of the global footprint S-G 4



Development of the global ecological footprint by category between 1961 and 2002.

Source: Global Footprint Network

Global distribution of the ecological footprint, 2002 M 1



Ecological footprint in proportion to the average available worldwide biocapacity per person, in %

< 50 | 50 – 99 | 100 – 199 | 200 – 299 | ≥ 300 | no data available

Source: Global Footprint Network, 2005

1 Introduction

The world first began to address limits to growth in the well-known 1972 Club of Rome report[1]. In the light of multiplied resource consumption, the report's central idea was once again addressed twenty years later in the concept of sustainable development at the Earth Summit in Rio, where it was put into a broader context. The human race – especially in industrialized nations – uses more resources than our planet can cultivate and renew. In addition, the use of these resources is distributed unevenly between the industrialized North and the economically less-developed South, as well as between the generations (current and future).

Since the global demand for energy and products exceeds the earth's ability to regenerate them, natural resources are steadily decreasing, limiting future generations' options. Since the Earth Summit in Rio, however, the focus has been on continually renewing and building up the world's resources rather than wasting them. Our use of natural resources would be sustainable if we could live on them in perpetuity – on the interest from our natural capital so to speak.

Switzerland has anchored the concept of sustainability in its federal constitution. According to Article 73, the Confederation and the Cantons must strive to establish a lasting equilibrium between nature, in particular its capacity to renew itself, and its use by man. In 2002 the Federal Council's Sustainable Development Strategy set a long-term goal for Switzerland of using its natural resources only to the extent that they can be regenerated naturally. But how can sustainable development actually be measured?

A clear method

In the 1990s an international research group[2] developed an easy-to-communicate system to measure the sustainable use of natural habitat[3]. They called it the ecological footprint. The ecological footprint is a kind of "resource accounting" which gauges how much of the environment's ability to regenerate itself is being affected by humans. The method converts the extent to which natural capital and resources, such as oil, food and wood, are consumed into the area that would be required to provide these resources in a sustainable manner. The ecological footprint therefore expresses any form of consumption in a hypothetical area requirement and indicates whether and by how much the consumption of natural capital exceeds the biosphere's regenerative capacity. Additional explanations of the footprint method may be found in the margins and the appendix.

The intuitive comprehensibility of the ecological footprint as an overall indicator is especially appealing. By expressing our consumption and the earth's biocapacity in the same dimension (land area required), the footprint method correlates the supply and demand of natural resources. The method allows comparisons at a local, national, regional or global level and enables us to pinpoint ecological deficits and reserves. The footprint demonstrates transparently in which areas, how heavily and where humans stress natural capital.

The method does have its disadvantages, however. One basic difficulty is that it generally shows the footprint to be too small and biocapacity too large because qualitative, difficult-to-quantify aspects are not taken into account. Thus, for example, freshwater consumption, pollution damage and the loss of biodiversity are taken into account only indirectly, if at all. In addition, the method is not very sensitive to environmental changes. Overuse is expressed only when it leaves clear traces, for example if productivity falls owing to erosion.

[1] Meadows et al. 1972

[2] Mathis Wackernagel, part of the Global Footprint Network since 2003

[3] Wackernagel/Rees 1996

As a result, the footprint is not a good early warning indicator. Furthermore, the method sometimes falls back on approximations to convert to surface area resource consumption, such as energy consumption, that does not require any actual land usage. Finally, data sources, assumptions and the selection of variables and factors have thus far not been illustrated transparently and there is a lack of a true methodological handbook.

Despite its shortcomings, the ecological footprint allows countries' and regions' resource usage to be shown plainly and compared with one another like no other method. The Global Footprint Network, developers of the footprint, has published a series of respected reports on the ecological footprint of the earth and of its various regions. Last year the European Environmental Agency adopted the approach and participated in calculating an updated version of the footprint[4]. In addition, the ecological footprint is an official indicator for evaluating the 2010 biodiversity target laid down in the United Nations Convention on Biological Diversity and it is also one of the EU's leading indicators in this field[5]. This is because the increasing demand for land for human use is leading to the dwindling of areas with great biodiversity.

Correct figures for Switzerland

The ecological footprint also sparked interest in Switzerland. In 2005 the publishing federal agencies decided to commission a study of the Swiss ecological footprint in collaboration with the Global Footprint Network. The present publication is part of a broader discussion about indicators and monitoring systems for sustainable development in this country. At the federal level, in particular, these are the MONET indicators for monitoring sustainable development as well as environmental accounting, which represents the environmental dimension of the national accounts. The publishers have decided to review the ecological footprint method as a possible supplement to these tools, in particular because the footprint readily lends itself to use as a communication tool and makes clear the global dimension of sustainable development. In addition, the national study is meant to contribute to the modernization of the Sustainable Development Strategy, which is planned for 2007.

The Swiss national study was undertaken in two stages. The first was to review the data used by the Global Footprint Network through a comparison of international and Swiss statistics. This comparison showed that although there may be deviations in individual areas, these deviations are not important overall. The Global Footprint Network will integrate Swiss statistics in some areas when recalculating the footprint in future. This national study has helped develop the methodology further and make it more transparent. The results of the data review are summarized briefly in the appendix and are described in detail in a separate technical report[6].

Our country's ecological footprint was calculated based on the reviewed data, and the results are found on the following pages. The report goes into detail about the composition and development of the Swiss footprint and puts it into a European and global context. The publication also highlights global developments and prospects.

4 "Europe and the Globe: How the Planet and the World's Largest Economy Interact" (European Environmental Agency 2006); http://org.eea.europa.eu/news/Ann1132753060

5 Commission of the European Communities 2006

6 Switzerland's Ecological Footprint: Technical Report.

Ecological footprint

The ecological footprint is a measurement that converts the consumption of all types of natural resources such as fossil fuel, wood and cropland into units of surface area (global hectares, see below). The footprint shows clearly how much land and water a region, country or the entire human race would really need to meet the demand for resources renewably and to absorb the waste it generates. The ecological footprint can be divided by population figures and used as a per-capita measurement, allowing different regions to be compared more effectively.

Biocapacity

Biocapacity is a measure of an area's biological productivity. It encompasses all land, even that which is not used – whether for reasons of geography, economics or conservation. A region's biocapacity grows when productivity per unit of area or the productive areas increase.

Global hectare

The ecological footprint and biocapacity are both measured using the same units, global hectares (gha). One global hectare is equal to one hectare with a productivity equal to the average productivity of the biologically productive hectares on Earth.

Ecological deficit

An ecological deficit exists when the ecological footprint of a certain area (such as a country) is bigger than the corresponding biocapacity; that is, when more is consumed than the area naturally produces. A country's ecological deficit can be made up for by importing products, and thus biocapacity, from other countries. Every part of the deficit that cannot be compensated for, however, leads to the erosion of a country's natural capital (ecological overshoot). It is not possible to compensate for a global ecological deficit.

Ecological overshoot

That proportion of the ecological deficit that cannot be compensated for by importing biocapacity is called ecological overshoot. It means that resources are being used faster than they can regenerate naturally. Natural capital is being used up to cover the ecological deficit.

2 Switzerland's footprint

2.1 Overview

In 2002, Switzerland's ecological footprint totalled 4.7 global hectares per capita. Our country's biocapacity, however, was a mere 1.6 global hectares per capita. Thus Switzerland's footprint is nearly three times as great as its biocapacity. The Global Footprint Network database, on which the Swiss country study is based, includes figures from 1961 to 2002; more recent figures are not available.

A look into the past reveals that Switzerland's ecological footprint was greater than its biocapacity as early as 1961. Since then, the ecological footprint has continued to grow — although there have been some declines, such as during the oil crisis of the 1970s and during the recession in the early 1990s. Switzerland's ecological footprint has more than doubled since the 1960s.

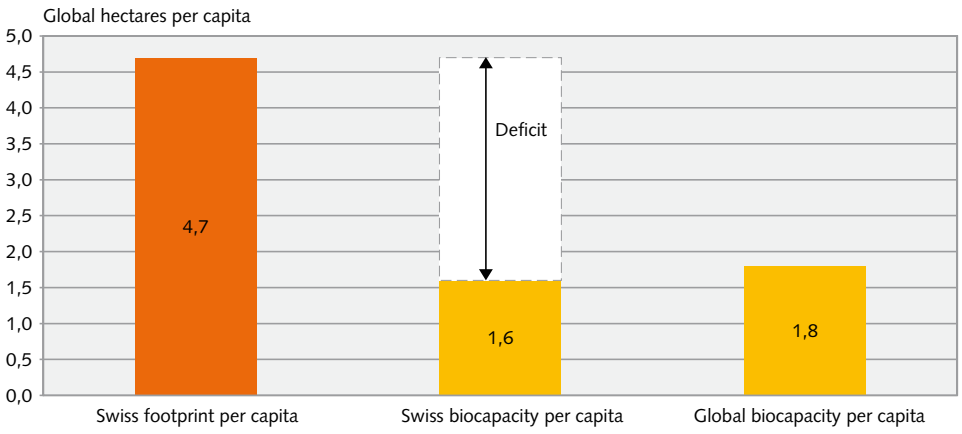
The growing discrepancy between ecological footprint and biocapacity means that we increasingly import biocapacity to satisfy our consumption, importing natural resources from other countries and exporting waste such as carbon dioxide. This is the only way for Switzerland to consume so much without drastically overexploiting its own natural capital.

Energy consumption is crucial

The ecological footprint method makes it possible to add up various areas of consumption into a comprehensive indicator. But how does each individual domain contribute to the overall results?

The crucial aspect is how we generate and use energy. Our use of fossil fuels, nuclear energy and embodied energy in trade accounts for two-thirds of the ecological footprint, making it much more important than all other factors. Also, the energy footprint has demonstrated the greatest growth by far in recent decades. All the other sectoral footprints have changed comparatively little. Use of cropland, forest and pasture are also important, together accounting for 26 percent of the total footprint. Land use for urban areas and fisheries is of much less significance to the ecological footprint.

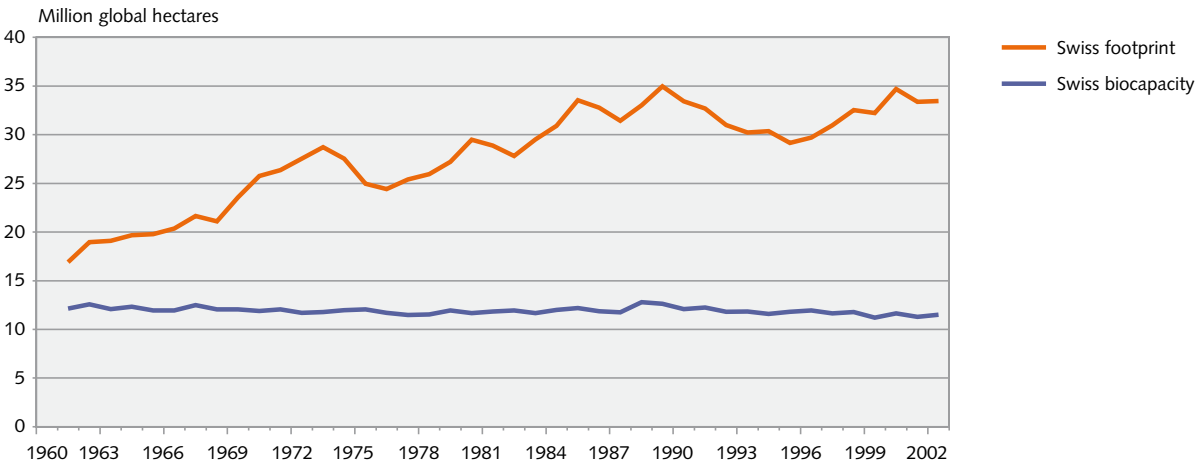
Footprint and biocapacity per capita (2002) **G 1**



Comparison of Swiss footprint per capita and available biocapacity.
The footprint is almost three times as large as the actual biocapacity.

Source: Global Footprint Network

Development of footprint and biocapacity G 2



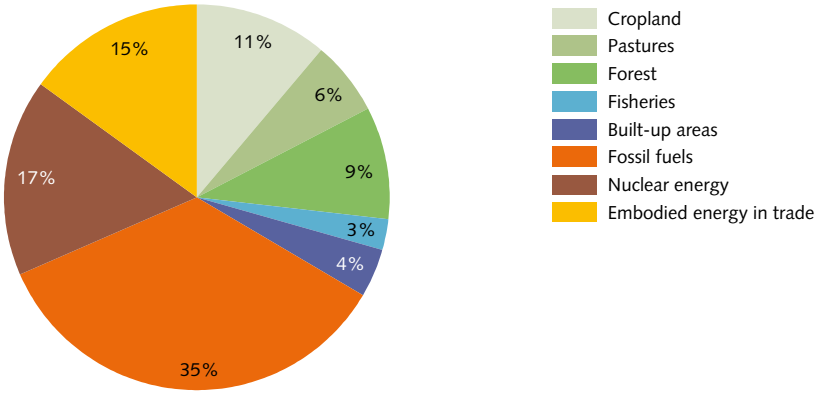
Switzerland's biocapacity and ecological footprint between 1961 and 2002. The difference between the footprint and biocapacity — the ecological deficit — is increasing steadily.

Source: Global Footprint Network

Deficits in almost all areas

If the footprint is larger than biocapacity, there is an ecological deficit. In 2002 Switzerland had a total biocapacity of 11.5 million global hectares (see p. 13), while its footprint was a total of 33.4 million global hectares. Thus there was an ecological deficit of about 22 million global hectares, for which Switzerland primarily makes up for abroad. Our country has an ecological deficit in nearly all areas. Only in forestry does the available capacity more than meet the demand for wood products. In all other sectors there is an ecological deficit.

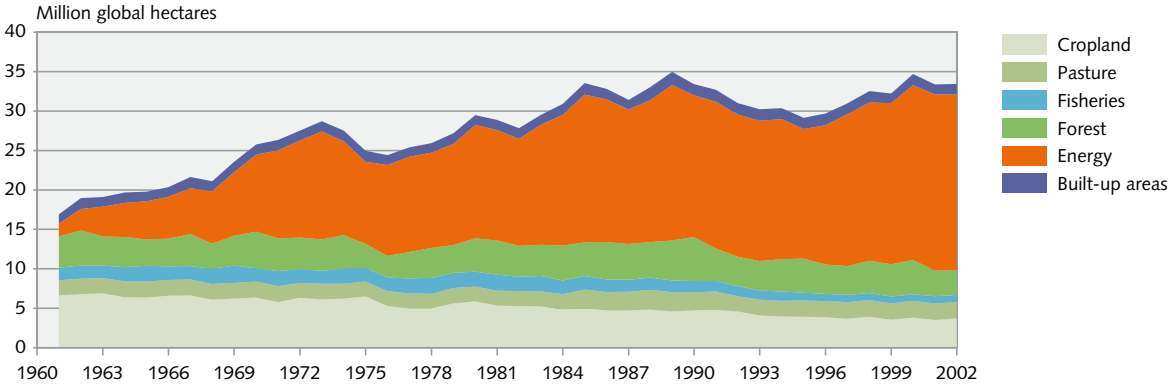
Composition of the ecological footprint (2002) G 3



Composition of the ecological footprint in Switzerland in 2002. Energy consumption (fossil fuels, nuclear energy, embodied energy in trade) contributes 67 percent of the footprint.

Source: Global Footprint Network

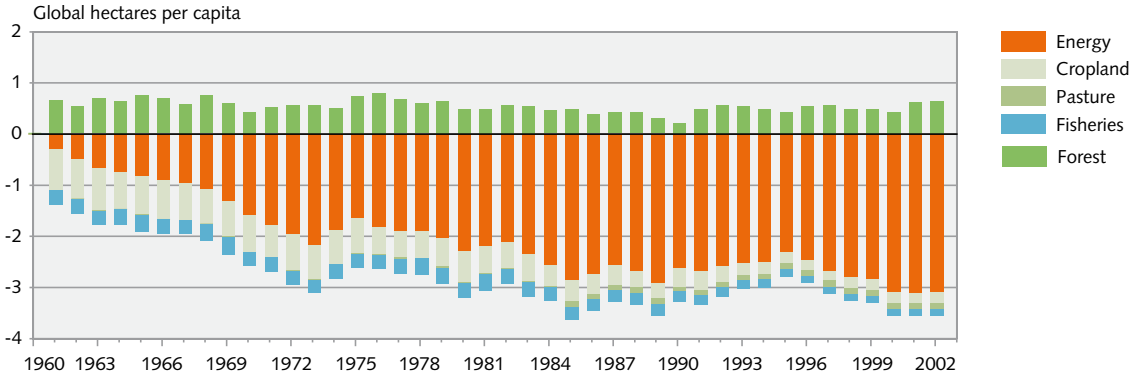
Development of the ecological footprint **G 4**



The development of the ecological footprint in Switzerland by individual categories between 1961 and 2002. The entire footprint has more than doubled since 1961, primarily because of increasing energy consumption. See Chapter 2.2 for more on the development of the individual areas.

Source: Global Footprint Network

Deficit and reserves **G 5**



The development of the ecological deficit in Switzerland (biocapacity minus footprint) by individual domain between 1961 and 2002. A reserve exists only in forestry. Built-up area is not shown because biocapacity and footprint correspond by definition in this domain. In all other areas there is an ecological deficit.

Source: Global Footprint Network

2.2 The various areas

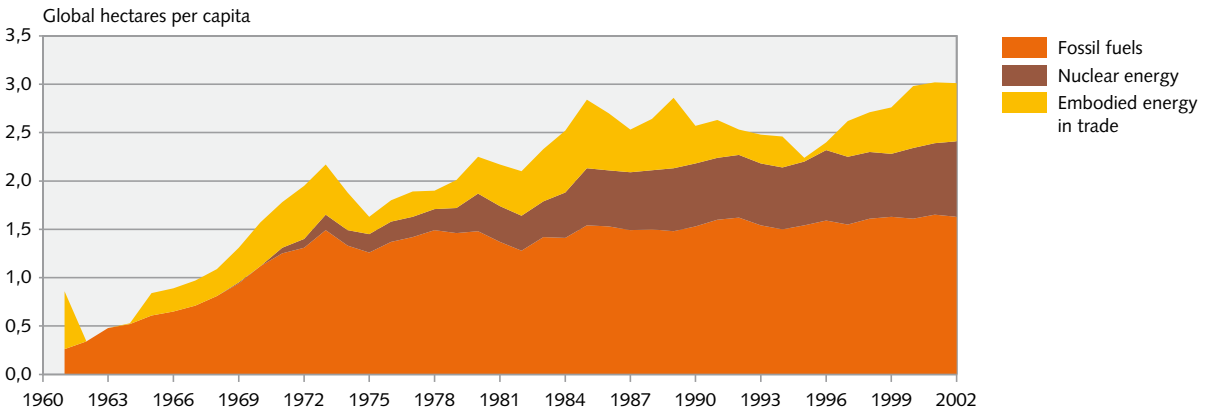
Energy

The ecological footprint for energy consumption, or the energy footprint, takes into account energy requirements for fossil fuels, nuclear energy, embodied energy in trade and hydropower. In Switzerland the proportion of energy consumption as part of the total footprint is by far the most significant, at about two-thirds. Between 1961 and 2002 the per-capita energy footprint more than trebled – and this trend is not likely to reverse. With a share of 35 percent of the total ecological footprint, the consumption of fossil fuels is the most significant single component. Consumption of these fuels has gone up by 600% since 1961.

As energy production is not necessarily tied to land utilization, the footprint method converts energy consumption into hypothetical surface area. The energy footprint for fossil fuels does not, for example, reflect the surface area of oil fields and coal deposits. Instead, it shows how much surface area is required to absorb carbon dioxide emissions resulting from combustion so that concentration of this greenhouse gas does not increase. The basis for the calculation is the capacity of forests and oceans to absorb carbon dioxide.

Nuclear energy production releases much less carbon dioxide into the atmosphere, comparatively speaking. Nevertheless, the method treats nuclear energy in the same way as fossil fuels, because which form of energy has a greater impact on the environment is a scientifically

Development of the energy footprint **G 6**



Development of the energy footprint in Switzerland from 1961 to 2002. Between 1961 and 2002 the per-capita energy footprint more than trebled – and this trend is not likely to reverse.

Source: Global Footprint Network *© Federal Statistical Office (FSO)*

controversial issue. Furthermore, fossil fuels often serve as an alternative to nuclear energy (for further information, see appendix).

The Beznau, Mühleberg, Gösgen and Leibstadt nuclear power plants went online in Switzerland from around 1970 to 1985, leading to a steady enlargement of the footprint from nuclear energy during this period. Today, nuclear energy accounts for about 17 percent of our country's overall ecological footprint.

Since energy production from hydropower releases hardly any carbon dioxide and produces no lasting waste, the footprint from hydropower corresponds exclusively to the productive surface area of dams and reservoirs. The majority of reservoirs in Switzerland are in the alpine region, in areas with a low degree of biological productivity. This is why the footprint is correspondingly small and does not enter into the calculation at all.

The concept known as embodied energy in trade is taken into consideration, however. This is that amount of energy required to produce, transport and dispose of products. The footprint includes the embodied energy in imported and exported products. An analysis based on trade statistics shows that more embodied energy is involved in imported products overall than in exported ones. This means that, overall, Switzerland imports embodied energy, a great deal of which is imported in the form of plastics, chemical products, cars and furniture. Conversely the pharmaceutical products exported by Switzerland, for example, contain significant amounts of embodied energy[7].

Although the net import of embodied energy fluctuates wildly from year to year according to the flow of goods, the significance of the traded embodied energy is increasing overall. This trend is a result of the shift in the Swiss economy from manufacturing to services. In particular, industrial products for which manufacturing is very energy-intensive, such as metals, vehicles, basic chemical products and pulp, are produced less and less in Switzerland and must therefore be imported.

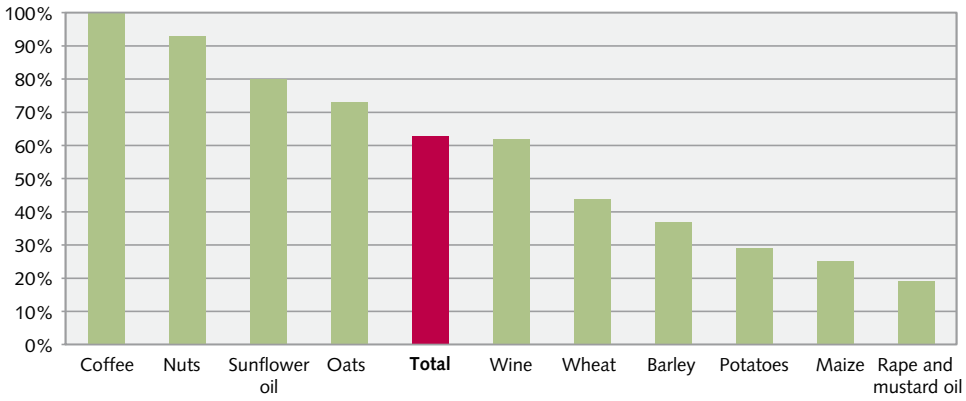
Cropland

The ecological footprint of cropland corresponds to the surface area required to cover the consumption of a total of 85 different agricultural crops and processed products. In 2002, Switzerland's cropland footprint per capita was 0.52 gha, with a corresponding biocapacity of 0.31 gha. In other words, Swiss crops alone are not enough to feed the country. The footprint has been growing steadily smaller since the 1960s, while biocapacity has stayed about the same. This trend can be seen all over the world and can be explained by more intensive farming and the attendant higher yields. The higher the yields, the less surface area is needed to produce the same volume of crops. On the other hand, intensive farming uses more energy, which is reflected in a larger energy footprint.

The most important vegetable foods included in calculating the cropland ecological footprint are wheat, barley, sunflower oil, maize and coffee. Their consumption accounts for nearly 44 percent of the cropland footprint. While Switzerland can largely meet its own needs for barley, potatoes and maize, for example, where other

[7] For the 2006 edition, the ecological footprint method used to calculate grey energy will be revised (see attachment 2). For Switzerland, this means that exports of grey energy in the form of pharmaceuticals and other goods will be considerably lower. This, in turn, will result in higher overall net imports of grey energy.

Import shares of major vegetable products (2002) **G 7**



Proportion of imports for the most important vegetable products and share of imports for all agricultural products in 2002. Switzerland can meet its own needs for barley, potatoes and maize, for example. Where other crops are concerned, it depends heavily on imports. For precise figures see Table 1.

Source: Global Footprint Network

T 1 Share of imports of major vegetable products (2002)

Product	Share of cropland footprint	Share of net imports in total consumption	Major countries of origin
Wheat	21%	44%	Canada, USA, France
Barley	10%	37%	France, Germany, Hungary
Sunflower oil	6%	80%	EU, Argentina
Maize	4%	25%	Hungary, France, Argentina
Coffee	3%	100%	South America, Central America, East Africa, Southeast Asia
Nuts	3%	93%	Turkey, USA, Italy, Spain
Wine	3%	62%	Italy, France, Spain
Rape and mustard oil	3%	19%	Germany
Potatoes	3%	29%	EU, Israel
Oats	2%	73%	Finland, Germany, France

Share of imports for the most important agricultural produce included in the footprint. The share of net imports in total consumption indicates what percentage of the consumed amount we import. The net import rate is high for coffee, nuts and sunflower oil, and rather low for rape oil and potatoes. The most significant countries of origin for agricultural products are the EU countries. Information about countries of origin is from the 2002 Swiss foreign trade statistics (Swiss Customs Office (Eidgenössische Oberzolldirektion), 2003).

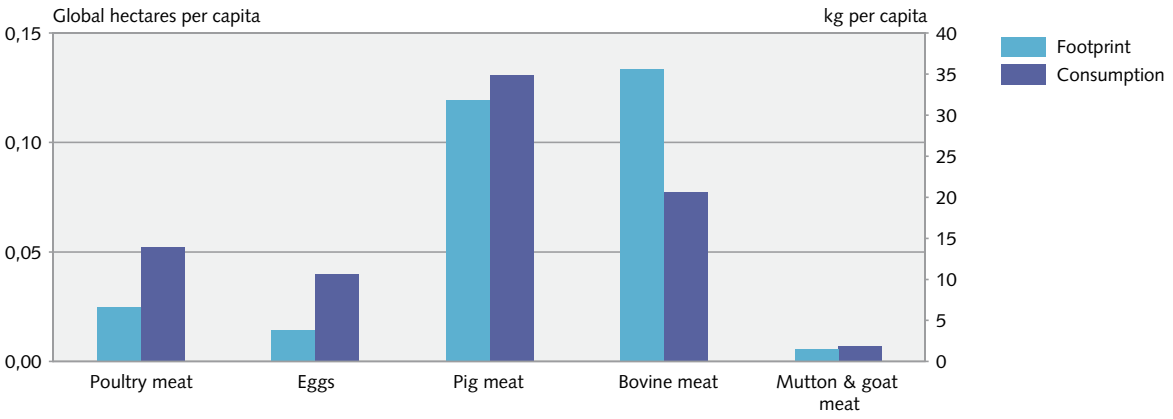
crops are concerned it is heavily dependent on imports. Increasing global agricultural trade requires the use of more and more cropland around the world.

The majority of the cropland used abroad is in EU countries, and significant amounts of food are also imported from North and South America. Measured in terms of the value of goods, 79 percent of agricultural and forest imports came from the EU in 2002. The top supplier countries were France, Germany and Italy (foreign trade statistics for agriculture and forest products).

Livestock

The production of animal products like meat, leather, wool and milk requires grassland and pasture, which determine the ecological footprint. In 2002, pasture in Switzerland accounted for a good six percent of the entire footprint. The pasture footprint has stayed about the same since 1961. At the same time the Global Footprint Network assumes declining biocapacity in this area because the volume of pastureland in Switzerland has shrunk.

Footprint and consumption of meat and eggs (2002) **G 8**



Footprint for the consumption of animal products per capita in 2002 (excluding milk products and horsemeat). Animal feed and hay and grass are taken into account equally. Measured in terms of their ecological footprint, beef and veal are the most significant products.

Source: Global Footprint Network

The production of animal products is based on more than just pasture, however. Animals are often grain-fed, which means that both pasture and cropland are needed to generate animal products. If feed is taken into account in animal husbandry, the share of animal products in the entire ecological footprint comes to almost nine percent[8].

The production of beef and veal results in the biggest ecological footprint, although Swiss people eat more pork. This is because producing pork requires significantly less field and pasture area. Poultry requires even less surface area. Nevertheless, the consumption of roughage-eating livestock such as cattle is environmentally sound, because many areas in Switzerland can be used only as pasture.

Fisheries

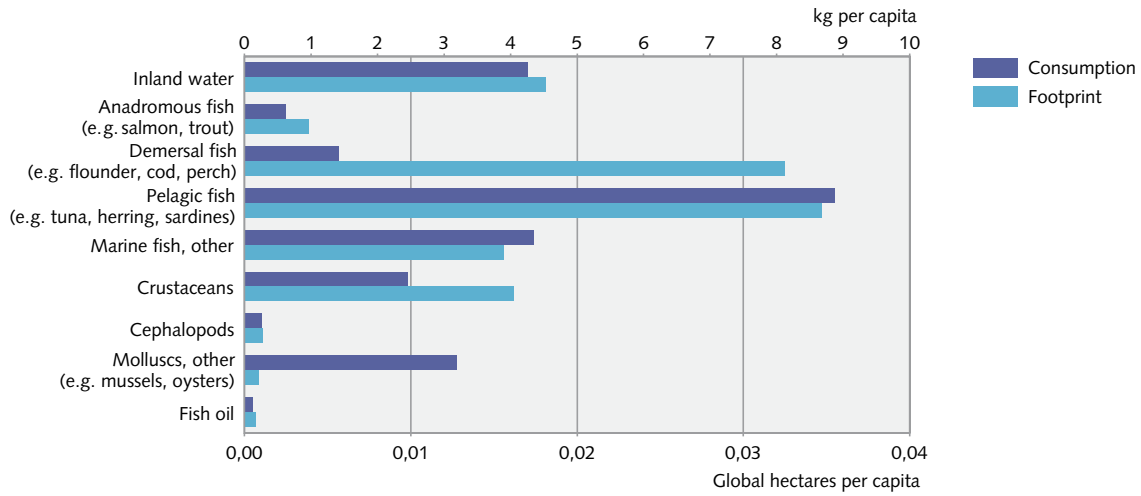
The footprint from fisheries shows how much area is needed to cover our consumption of fish and seafood. The method takes into consideration the place of each type of fish in the food chain. The consumption of such predatory fish as tuna, for example, causes a footprint approximately ten times larger than the consumption of mackerel does.

The share of fisheries products in the entire Swiss footprint amounts to only three percent. Our biocapacity (freshwater fish) is negligible compared to imports of saltwater fish. The per-capita footprint has decreased by more than 40 percent since 1961. One reason for this is the fact that consumption of some kinds of fish has decreased, especially demersal fish, such as flounder, cod and perch, as well as such pelagic fish as tuna, herring and sardines. Another reason is that new fishing methods are far more effective. Increasing overfishing, however, means that hauls and therefore yields have been falling since the 1990s (see also Chapter 4).

Pelagic and demersal fish make up a large proportion of the fisheries footprint. Although Switzerland imports about six times more pelagic fish than demersal fish, the ecological footprint for both categories is approximately the same size. The environmental area required to produce a kilogram of fish is significantly higher for demersal fish than for pelagic fish. Therefore the yields for flounder, cod and perch are significantly lower than for tuna, herring and sardine. Mussels and oysters are quite the opposite. Despite relatively high consumption, their ecological footprint is minor because the yields per unit of area are extremely high.

[8] In the overall footprint, pasture-based agriculture includes only animals that are fed with hay and pastured. The footprint from animal feed falls under the cropland category.

Footprint and consumption of fishery products (2002) **G 9**



Footprint and consumption of fisheries products in Switzerland in 2002. The footprint (light blue) is shown in gha per capita and consumption (dark blue) in kg per capita. Fish types in the same category are not necessarily at the same level on the food chain. For example, tuna is much higher up on the list than herring, although both are pelagic fish.

Source: Global Footprint Network

Forestry

The footprint corresponds to the area needed to cover the consumption of primary wood products like roundwood and firewood, as well as secondary products like planks, paper and pulp. Forestry is the only sector in Switzerland in which biocapacity exceeds demand. The footprint has stayed about the same since 1961. Today, nine percent of Switzerland's footprint can be attributed to the consumption of wood products. The most important products in terms of their share of the entire forest products footprint are roundwood, sawnwood, pulp, paper and cardboard. Wooden structural components and firewood are less important.

Since forests in Switzerland are expanding, their biocapacity has again reached the level of the early 1960s, having fallen slightly in the interim.

Built-up areas

The ecological footprint of built-up areas corresponds exactly to the area occupied by infrastructures such as buildings and transportation routes in Switzerland. Urban areas have expanded steadily in our country in recent decades. Between the two census periods of 1979-1985 and 1992-1997 our towns and cities grew by about 13.3 percent[9]. Accordingly, the ecological footprint of built-up areas is increasing as well. Today built-up area accounts for about four percent of Switzerland's ecological footprint. Although this share is relatively low, highly productive agricultural areas generally fall victim to new infrastructure, resulting in a loss of biocapacity. In addition, greater urban sprawl leads to greater energy consumption, in particular as a result of transportation. This is reflected in an upsurge in the energy footprint.

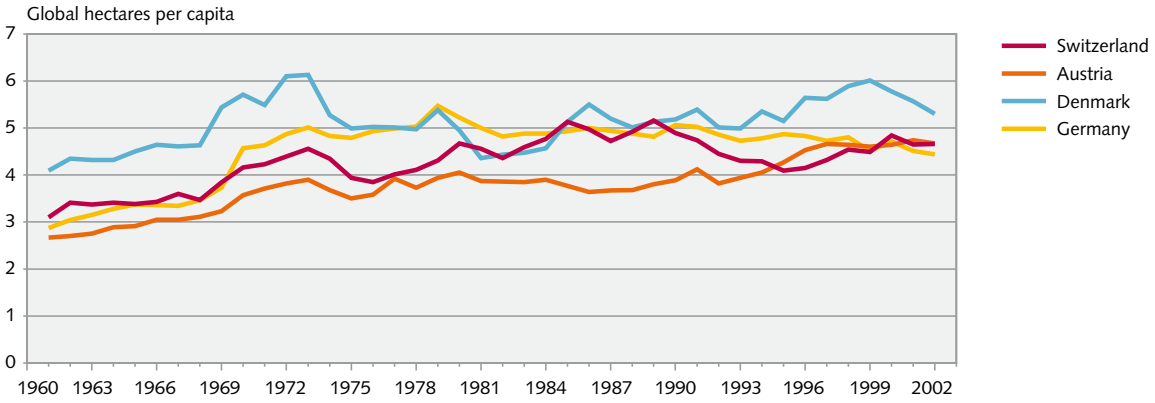
2.3 Switzerland in relation to europe

At 4.7 gha in 2002, Switzerland's per-capita footprint is almost exactly equal to the average for all EU countries. The range within the EU goes from 3.3 gha in Poland to 6.9 gha in Finland[10].

[9] Federal Statistical Office, 2005

[10] Global Footprint Network / European Environmental Agency, 2005

Development of footprint **G 10**



Development of the per-capita footprint in Switzerland, Austria, Denmark and Germany between 1961 and 2002. The per-capita footprint has grown larger in all four countries, albeit at different speeds.

Source: Global Footprint Network

As a comparison with Germany, Austria and Denmark demonstrates, in many areas Switzerland's footprint has developed similarly to other western European countries. In all four nations, the per-capita footprint has grown since the 1960s. Since the early 1980s, the trends have been diverging somewhat. The per-capita ecological footprint has decreased a little in Germany and at times also in Switzerland, while the footprint in Austria and Denmark has continued to grow. The differences are attributable primarily to energy trends.

Denmark has the greatest footprint of these countries, with 5.3 gha per capita. The footprints of Switzerland and Austria are almost exactly equal, at about 4.7 gha per capita. Germany has the smallest ecological footprint, largely as a result of its export surplus in embodied energy in trade.

A comparison of biocapacity with the footprints in individual areas exhibits a similar pattern in all four countries. The greatest deficit is in energy. With the exception of Denmark, which also has surpluses in cropland and fisheries, an environmental reserve is found only in forestry. Switzerland, Austria and Germany can meet their own consumption only in wood products. In all other areas they depend on imports from other countries.

Energy

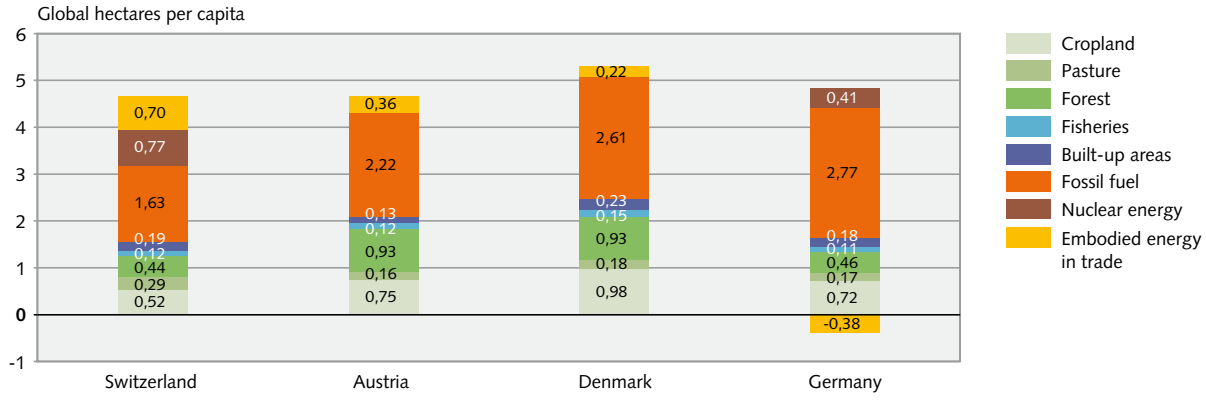
In all four nations, per-capita energy consumption has grown a great deal since 1961. With shares between 53 percent (Denmark) and 67 percent (Switzerland), energy consumption is the most significant component of the entire ecological footprint in every country. Since production alone, and not the import and export of nuclear energy, is taken into consideration in the footprint[11], country comparisons are somewhat distorted. Nuclear energy is produced only in Switzerland and Germany. Austria and Denmark do not have their own nuclear power plants and mostly meet their energy needs with fossil fuel sources.

Austria has the smallest energy footprint. It meets much of its electricity needs with hydropower and does not produce any nuclear energy itself. In Switzerland the footprint for fossil fuels and nuclear energy is also relatively small, which can be attributed to the significant proportion of hydropower in the energy mix. Denmark generates about half of its electricity needs in coal-fired power stations, which results in a large fossil fuel footprint. In Germany the footprint from fossil fuels and nuclear energy is comparatively high, but Germany is one of the few countries to have succeeded in continuously lowering its carbon dioxide emissions[12].

[11] Determining the actual footprint from the consumption of nuclear energy would require taking the international electricity trading into account. Currently this is not being done. This means that nuclear energy is charged to the country where it is produced, even if that country does not consume all of the power itself. According to the Global Footprint Network, electricity trading will be taken into consideration in the next revision of the method.

[12] European Environmental Agency, 2006

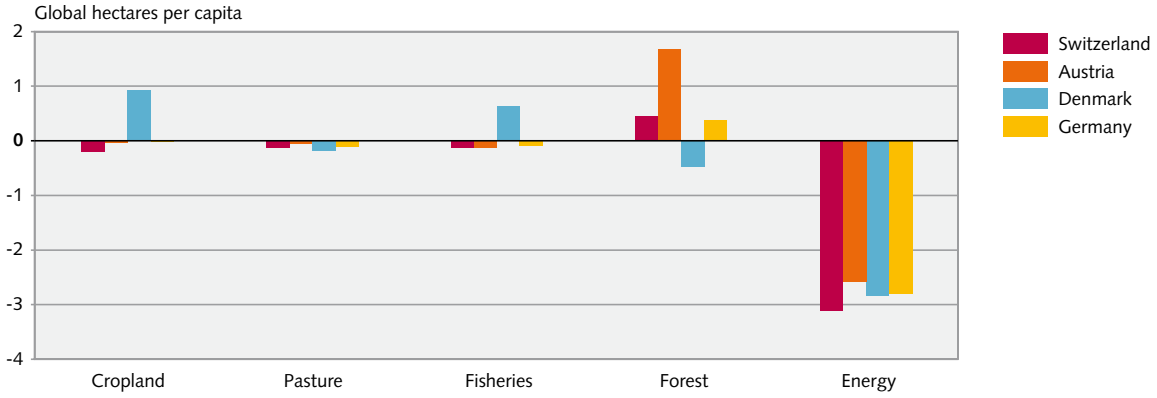
Composition of footprint (2002) G 11



Composition of the per-capita footprint in Switzerland, Austria, Denmark and Germany in 2002. The Swiss footprint is comparable to that of Austria. Denmark's is larger than Switzerland's while Germany's is smaller.

Source: Global Footprint Network

Deficit and reserves (2002) G 12



The ecological deficit per-capita in Switzerland, Austria, Denmark and Germany in 2002. Ecological deficit = biocapacity minus footprint. In all countries, the greatest deficit is in energy.

Source: Global Footprint Network

Denmark and Germany have an export surplus of embodied energy in trade. The goods that they export required more energy to produce than those that they import. In Germany the export of machines and vehicles, in particular, is a factor here, as are chemical products. By contrast, Denmark has a massive export surplus in foodstuffs and animals, which can be attributed to intensive livestock raising and to fisheries.

Switzerland imports more energy than it exports in almost all categories, in particular processed goods like plastics and metals and manufactured goods such as cars and furniture. Austria imports a great deal of embodied energy in the form of chemical and pharmaceutical products, while showing an export surplus for wood products.

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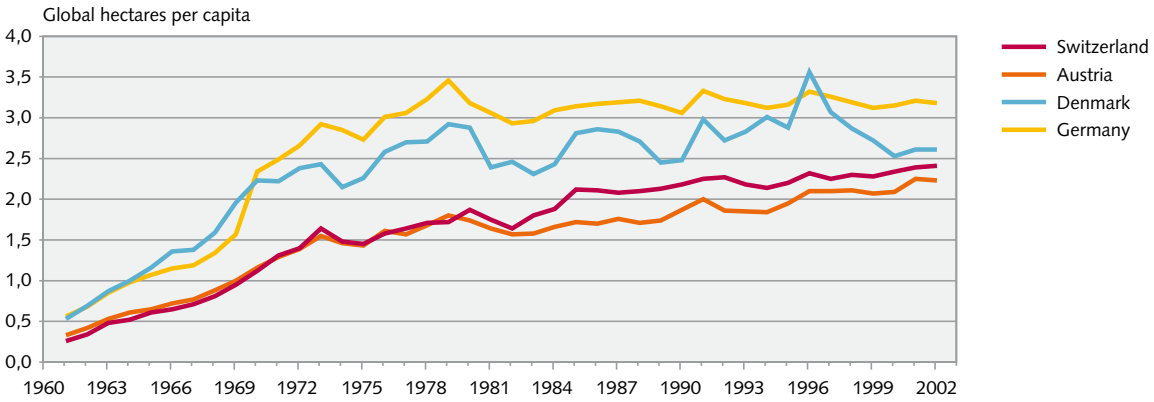
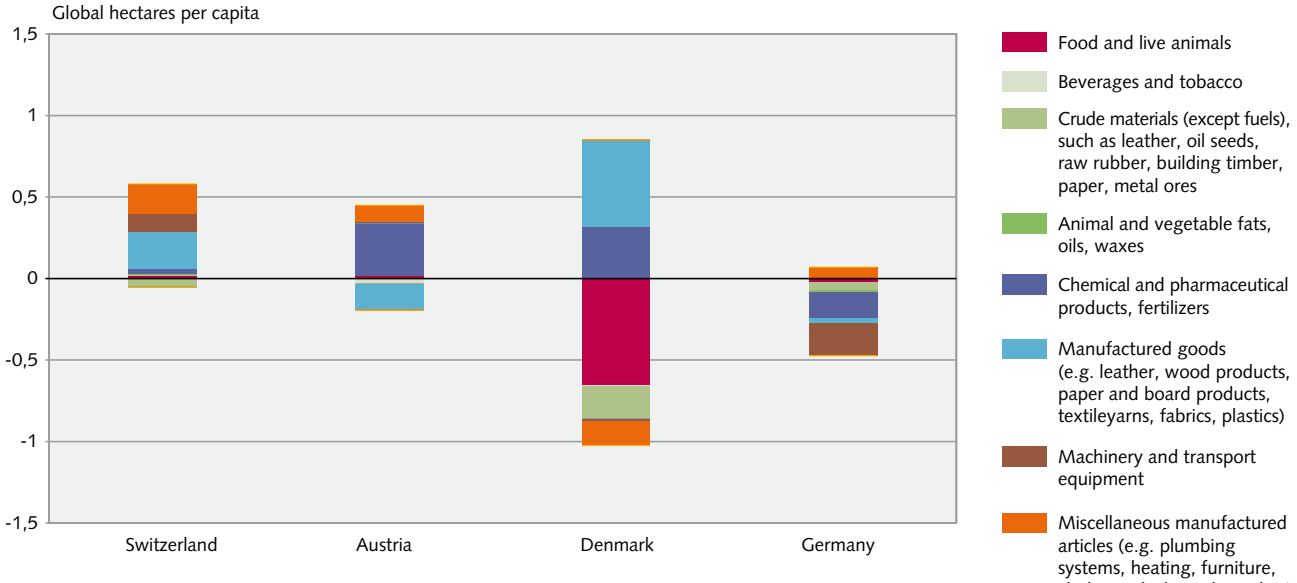
Development of footprint from fossil fuels and nuclear energy G 13



Development of the footprint from fossil fuels and nuclear energy in Switzerland, Austria, Denmark and Germany between 1961 and 2002. In all four nations, per-capita energy usage has grown a great deal since 1961.

Source: Global Footprint Network

Composition of footprint for embodied energy in trade (2002) G 14



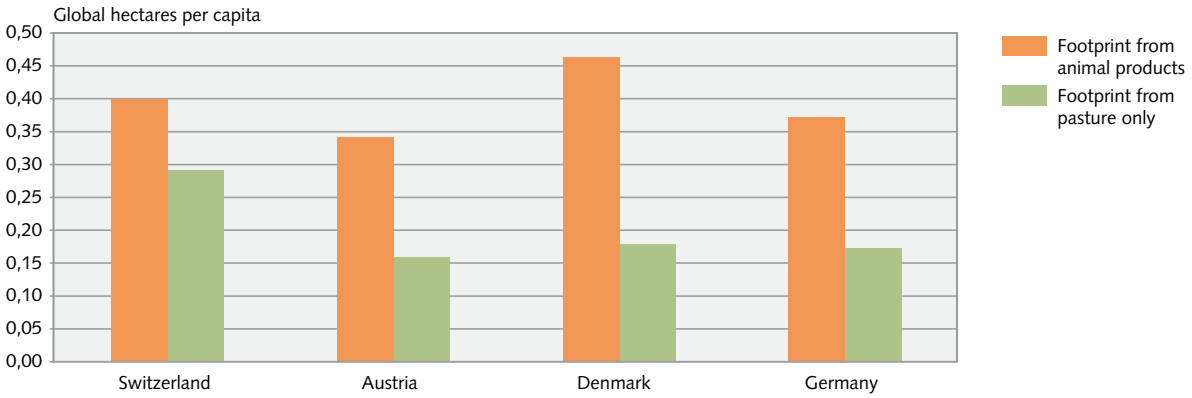
Composition of the footprint from embodied energy in trade per capita in Switzerland, Austria, Denmark and Germany in 2002. Example: Denmark exports significantly more food and animals than it imports. Therefore, the footprint from embodied energy in trade is negative in this area. Conversely Denmark imports large volumes of chemical and pharmaceutical products and fertilizers, which is expressed in a positive value.

Source: Global Footprint Network

Cropland

In cropland the trend in all four countries is toward a decreasing footprint, although on different levels. In this area, Switzerland has the smallest footprint, at 0.5 global hectares per capita, and Denmark has the largest, at almost 1.0 global hectares. The differences can be attributed primarily to the different levels of grain required for animal feed. For example, Denmark has a per-capita demand for grain about six times higher than Switzerland's (measured in terms of the footprint), because more meat is eaten in Denmark. Furthermore, this meat is increasingly produced using feed concentrates (see Livestock). Use of feed is also significantly higher in Germany and Austria than in Switzerland.

Footprint from animal products and pasture (2002) **G 15**



Footprint from animal products in Switzerland, Austria, Denmark and Germany in 2002. The footprint from animal products (orange column) includes animals fed on animal feeds, grass, hay and pasture. The footprint from pasture (green column) includes only those animals fed on hay and grass or pastured.

Source: Global Footprint Network

Livestock

The footprint for animal products makes up seven to nine percent of the entire footprint in all four countries. There are big differences in the way livestock is fed. In contrast to the other three countries, Swiss farmers feed their animals much more hay and grass. While in Switzerland animal feed accounts for only about 27 percent of the footprint for animal husbandry, the share for feed in the other three countries is more than 50 percent. Differences can also be seen in the significance of individual animal products for the four countries. Here in Switzerland the consumption of milk products, veal and beef is above average, while in the three other countries pork products predominate.

Fisheries

In all four countries the footprint from fisheries is growing smaller because yields have increased. With the exception of Denmark, the biocapacity of the countries in question is negligible because they are landlocked or have only a comparatively short coastline.

Forestry

The footprint from wood and wood products as well as their share of the entire ecological footprint is about twice as big in Denmark and Austria as it is in Switzerland and Germany. The comparatively large footprint from forest products in Austria is due to the high value placed on wood energy there. Traditionally there are many wood-burning stoves in Austria, and the country promotes the use of wood energy very actively. No reduction can be seen in fossil fuel use as a result, however.

This increasing importance of forest products in Austria is reflected in the development of the footprint over approximately the last 40 years. While the Swiss footprint from forest products has grown smaller during this time, it has nearly doubled in Austria. Since the biocapacity of Switzerland's forests exceeds demand for wood products, potential still exists – as in Austria – to use wood increasingly to generate energy or in construction.

Built-up areas

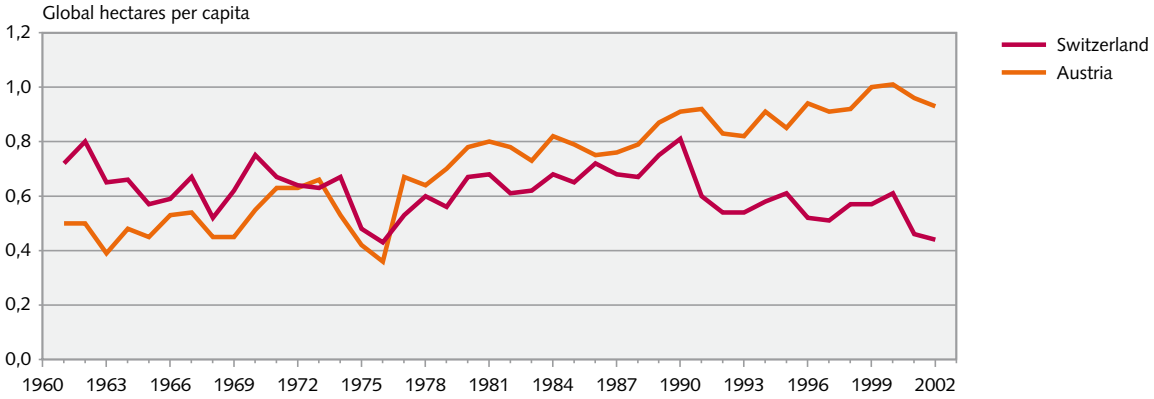
The ecological footprint for built-up area in all four countries is equal to three to four percent of the entire footprint, and is therefore not particularly significant.

Footprint from forest products (2002) G 16

Ecological footprint from forest products (wood, paper, cardboard and pulp) in Switzerland, Austria, Denmark and Germany. The footprint is about twice as big in Denmark and Austria as in Switzerland and Germany.

Source: Global Footprint Network

Development of footprint from forest products G 17



Development of the footprint from forest products per capita in Switzerland and Austria between 1961 and 2002. While Switzerland's footprint has grown smaller during this time, it has nearly doubled in Austria.

Source: Global Footprint Network

Conclusion

Overall, Germany, Denmark, Austria and Switzerland are facing the same basic problem: The ecological footprint remains stubbornly large everywhere, although it has decreased markedly where cropland is concerned. With the exception of Germany, however, this decrease is neutralized by increasing energy use. Larger differences within the individual domains can mostly be explained by different environmental conditions or economic structures. Differences in dealing with natural resources or even underlying political strategies can be read from the countries' ecological footprint only in isolated cases. With such similar economies, it seems that the methodology is not sensitive enough to measure fine deviations.

3 The global footprint

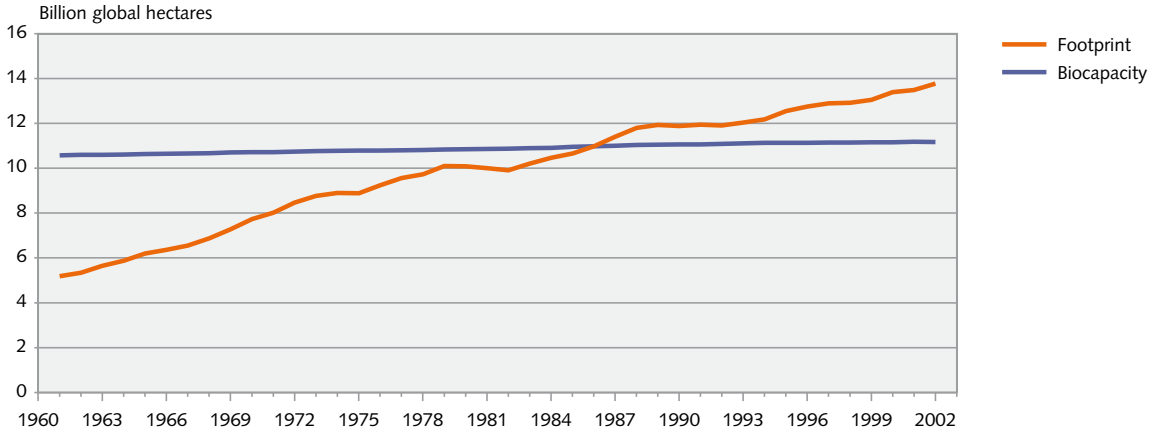
3.1 Development and composition

The ecological footprint for the world as a whole in 2002 was 13.8 billion global hectares (gha) or about 2.2 gha per capita. Biocapacity was a total of 11.2 billion global hectares. The global footprint has been greater than worldwide biocapacity since the mid-1980s, which means that natural capital is being used faster than it can regenerate itself.

The energy footprint has grown enormously in the past forty years, increasing by more than a factor of ten since 1961. The pastureland and fisheries footprints have doubled or trebled, which can be explained largely by the increased demand for animal and fish products. The footprint from built-up areas and transportation infrastructures has more than doubled as well. While the footprint for forest products has increased around the world, it has not outpaced the growth of the world's population during the same period. Finally, the footprint from cropland has grown very little worldwide, although the world population has more than doubled since 1961. The reason for this is a massive increase in yields. The intensification of agriculture is partly responsible, however, for the enormous growth in energy consumption.

The global footprint from foodstuffs (cropland, pastureland, fisheries) is much higher than the Swiss one. Foodstuffs account for about 35 percent of the total footprint, compared with about 20 percent in Switzerland. In contrast, the energy share of the entire footprint is 51 percent, compared with 67 percent in Switzerland.

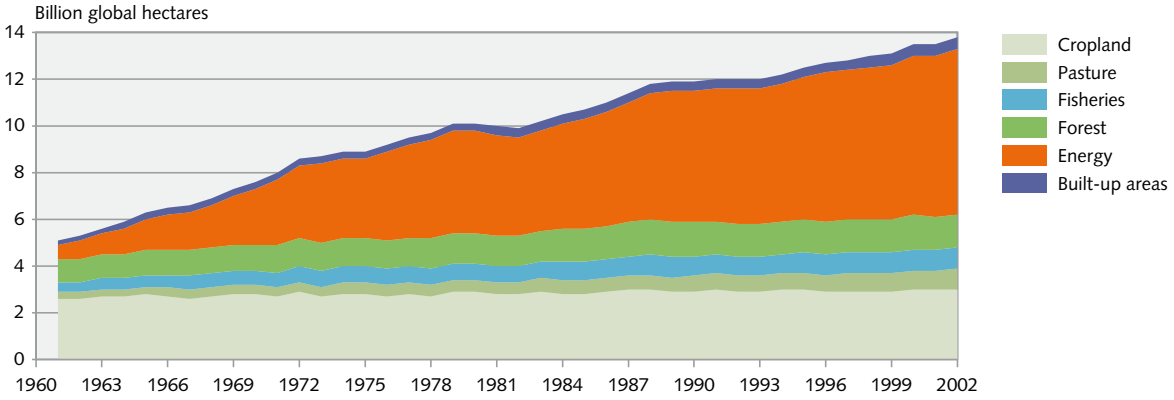
Global development of footprint and biocapacity **G 18**



The global development of the footprint and biocapacity from 1961 to 2002 (in billions of global hectares). Since the mid-1980s, the footprint has exceeded the world's biocapacity

Source: Global Footprint Network

Development of global footprint **G 19**



Development of the global footprint by categories between 1961 and 2002. The energy footprint has grown enormously, increasing by more than a factor of ten since 1961.

Source: Global Footprint Network

3.2 The footprint in different countries and regions

Global biocapacity averages 1.8 global hectares per capita. At 2.2 global hectares per capita, the average footprint is significantly larger. In addition, demands on natural capital are distributed very unevenly across regions. The United Arab Emirates' ecological footprint of 10.5 global hectares per capita is the world's largest, followed by the United States with 9.7 global hectares. The countries with the smallest footprint are Afghanistan with 0.1 and Somalia with 0.2 global hectares per capita – making their footprint about 100 times smaller!

Northern countries consume up to three times more resources per capita than they are entitled to according to the global average. At 9.5 global hectares per capita, North America's ecological footprint is much greater than that of all other regions – for example nine times greater than Africa's. The footprint of Western Europe is also substantially greater than the global average. In contrast, southern countries – especially those in Africa and Southeast Asia – use much less biocapacity per capita than the global average[13].

In addition to size, the composition of the footprint differs substantially from region to region. The varying significance of the footprints for food and energy for the individual continents is especially noteworthy. In Africa, the footprint from food and wood amounts to about 0.7 global hectares, while in North America it totals almost 3 global hectares per capita – making it four times larger. Nevertheless, as part of the entire footprint for North America, the share of the footprint for food and wood is only about half as large, because the entire footprint is much bigger. The greatest difference between North and South is found in the energy footprint, however. Average energy consumption in North America is more than 23 times higher than in Africa. Built-up areas are of little consequence around the world. Only in North America is the demand for built-up area substantial – more than 0.4 global hectares per capita.

The size of the ecological footprint depends greatly on national income: The higher the income, the greater the footprint and the higher the share of energy footprint. Rich economies have high energy demands. Countries with low incomes are less developed economically, are largely agriculture-based and use much less energy.

Since the early 1990s, however, the line between industrialized and developing nations has begun to blur. Numerous developing nations have become emerging markets with double-digit growth rates – for example, countries that are emerging as energy suppliers (Saudi Arabia, Venezuela), hardware and software suppliers (Thailand, China, India) and significant buyer markets (Brazil, China). With economic success, demand for resources and therefore the ecological footprint is growing markedly in these countries. In particular, energy demands have risen sharply in recent years in the emerging countries while climbing rather slowly in the low-level developing countries.

[13] In Africa, available biocapacity is also below the global average.

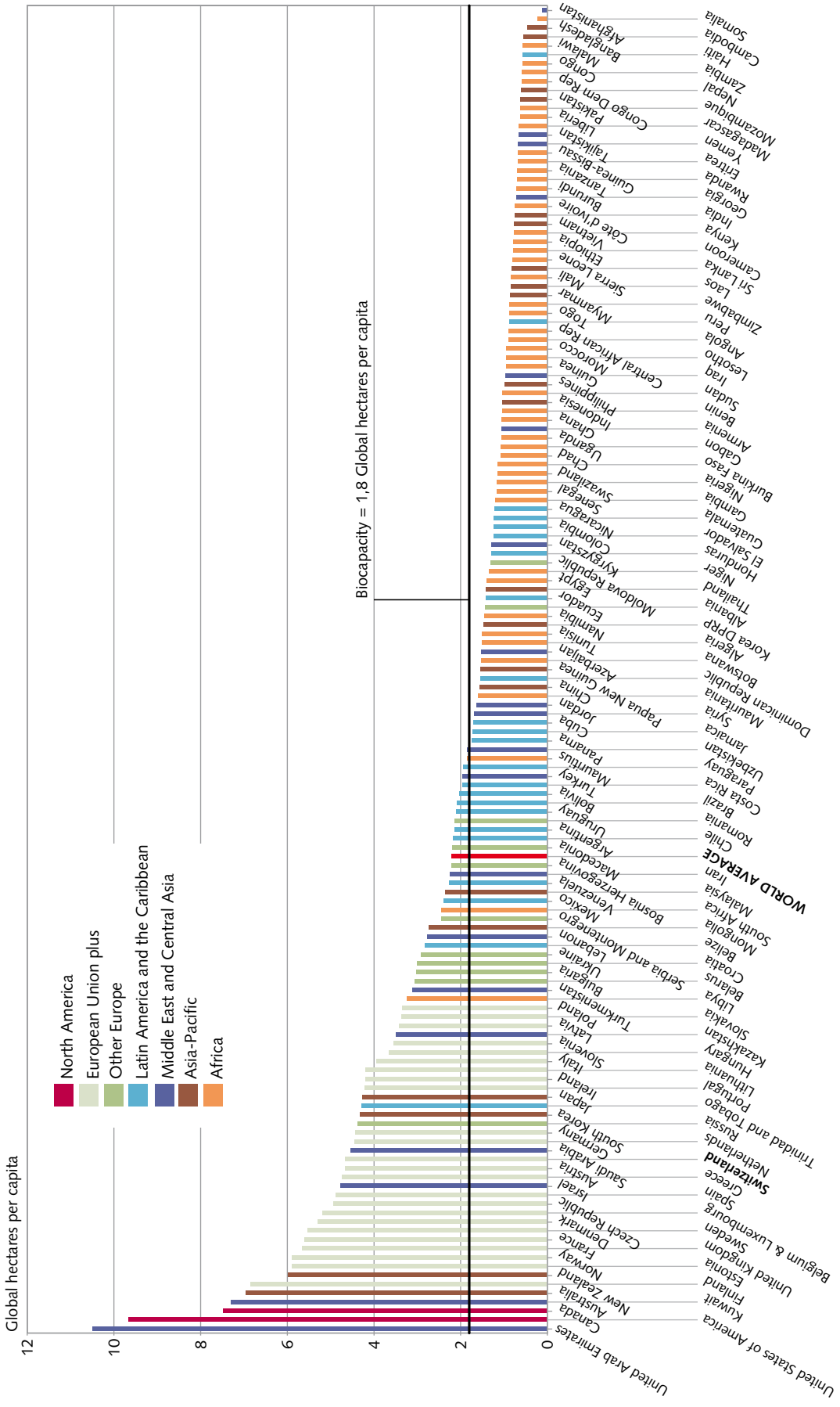
The populous nations of India and China are examples of emerging countries that use increasing amounts of fossil fuels. The energy footprint in China and India (0.7 gha and 0.3 gha per capita, respectively) is still much smaller than the global average of 1.1 gha, but growth rates are high. Since 1961 the energy footprint in both countries has increased by a factor or 10 or even 12. Since India and China together account for about two-fifths of the world population, a demand for other resources is emerging along with the huge demand for energy, which increases the global footprint considerably.

Today, the ecological footprint in the Asia-Pacific region, at 1.3 global hectares per capita, is much lower than the global biocapacity of 1.8 gha. However, since the region is home to more than half of the global population, a slight rise in the regional per-capita footprint leads to a ballooning global footprint. If every person in that area were to use the average available global biocapacity of 1.8 global hectares, the global footprint would grow by more than 12 percent. If the per-capita footprint in the Asia-Pacific region were as big as in Western Europe, the global footprint would double. If it were as large as in North America, the global footprint would treble from what it is today.

This example shows the huge momentum that emerges from economic development in emerging countries with large populations. Serious effort is required around the world to at least hold the ecological deficit on our planet steady in view of the extraordinary growth in the emerging countries.

Per capita footprint in individual countries (2002)

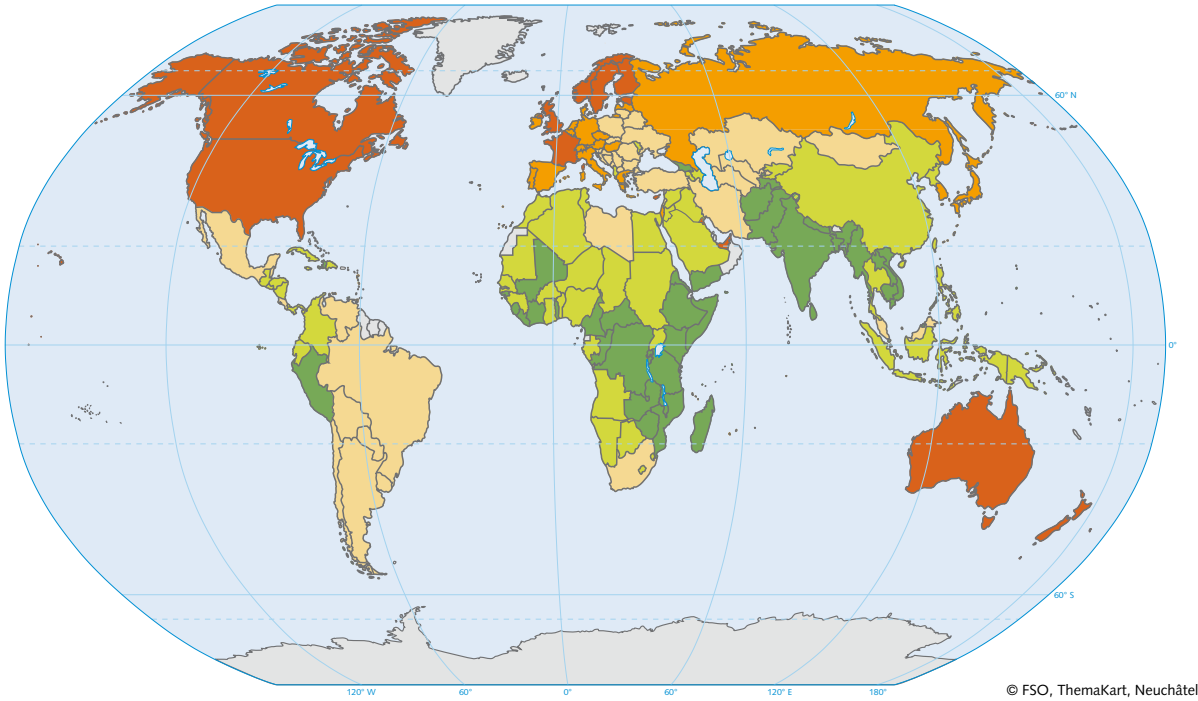
G 20



The ecological footprint of individual countries. Demands on natural capital are distributed very unevenly across regions.

Source: Global Footprint Network

Global distribution of the ecological footprint, 2002 M 1



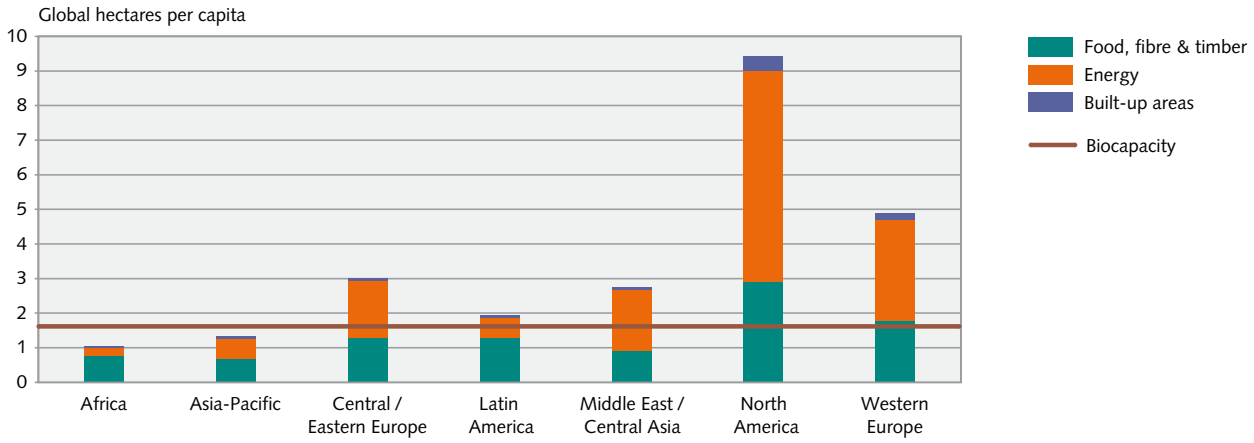
Ecological footprint in proportion to the average available worldwide biocapacity per person, in %

< 50 | 50 – 99 | 100 – 199 | 200 – 299 | ≥ 300 | no data available

Source: Global Footprint Network, 2005

Global distribution of the footprint per capita. Countries that consume more than the worldwide average available biocapacity per person are shown in red. Countries that consume less than the worldwide average available biocapacity per person are shown in green. The world map reveals a clear North-South gap. Northern countries use up to three times more resources per capita than they are entitled to according to the global average.

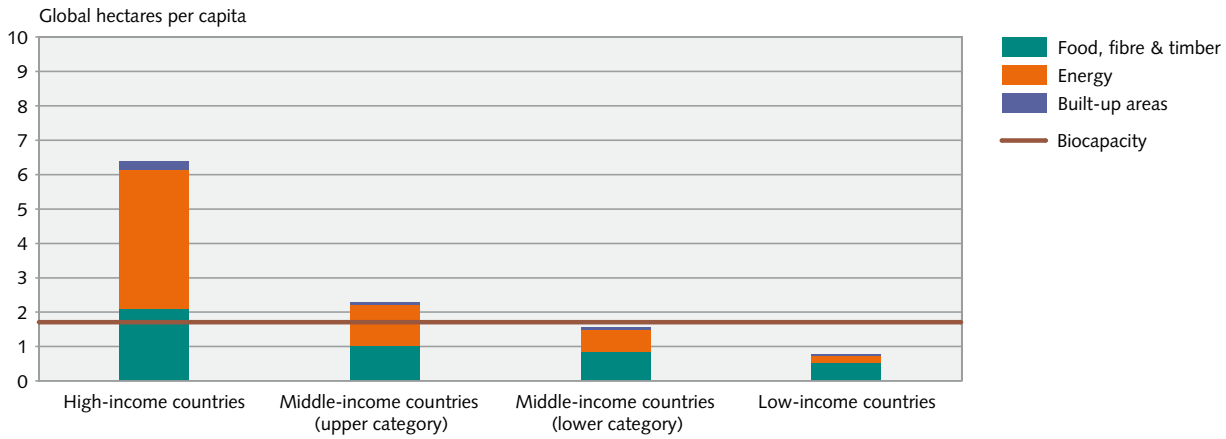
Footprint by world region (2002) G 22



The footprint's composition by world region in 2002. The greatest difference between North and South is found in the energy footprint. The category food, fibre and timber includes vegetable products (cropland), animal products (livestock), fish and seafood, and wood (forest products). The biocapacity available per person, 1.8 gha, is shown with an brown line.

Source: Global Footprint Network

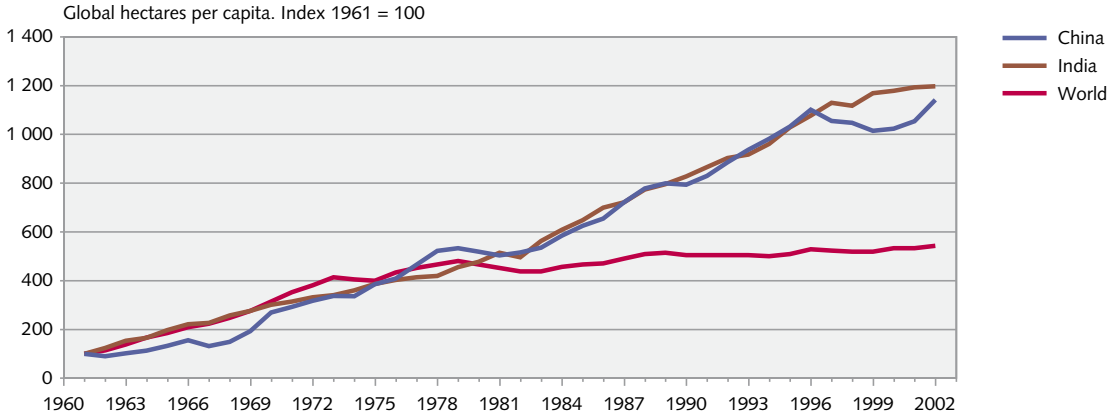
Footprint by country category (2002) G 23



The footprint's composition per capita in accordance with the 2002 World Bank country classifications. The higher the income, the greater the footprint and the higher the share of energy footprint. High-income countries: Gross national product of more than USD10,066 per capita. Middle-income countries (upper category): USD3,256 to USD10,066 per capita. Middle-income countries (lower category): USD826 to USD3,256 per capita. Low-income countries: Less than USD826 per capita. See http://web.worldbank.org.

Source: Global Footprint Network

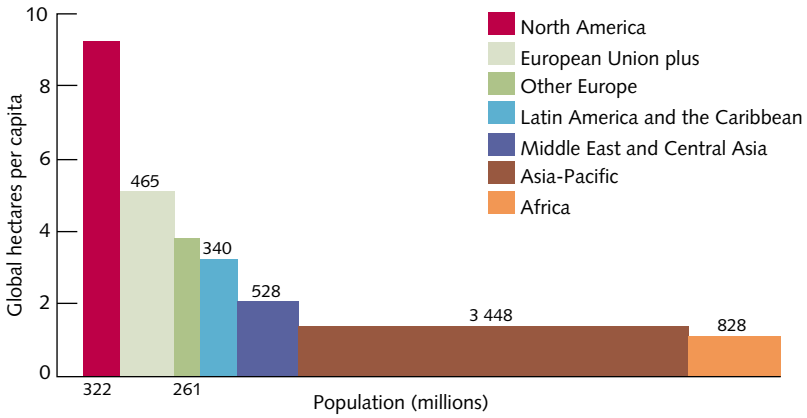
Development of energy footprint in India and China (indexed) G 24



Development of the per-capita energy footprint in India and China between 1961 and 2002. Compared with the global energy footprint, the corresponding footprints of India and China have exhibited much stronger growth. The curves are indexed on the figure from 1961 and illustrate the momentum of the growth, but not the absolute size, of the individual footprints.

Source: Global Footprint Network

Ecological footprint and population figures by region (2002) G 25



Footprint and population figures by region in 2002. The height of the bars corresponds to the per-capita footprint, and the width of the bars to the population figures for the regions concerned.

For example, the per-capita footprint is relatively small in the Asia-Pacific region, at 1.3 global hectares, but the population of 3.4 billion is very high.

Source: Global Footprint Network

4 Outlook

4.1 Global challenges

How are these global problems currently manifesting themselves? A look at the pressing topics that significantly influence the earth's ecological footprint.

Rising greenhouse gas emissions

Human activities are changing the atmosphere and, in all probability, have been largely responsible for global warming over the last fifty years. As the global energy footprint shows (graphic 19), carbon dioxide emissions far exceed nature's ability to absorb them. In addition, forested areas, which could absorb some of the greenhouse gases, are dwindling worldwide. Industrialized nations are currently responsible for most greenhouse gases, but up-and-coming economies like China, India and Brazil are contributing more and more. Without significant technological advances in energy and the environment, not to mention changes in the pattern of consumption, greenhouse gas emissions will increase even further. Climate models show that greenhouse gas emissions would have to be halved, approximately, to keep global warming at an acceptable level. However, most northern countries are already having trouble with the modest reduction requirements of the Kyoto Protocol, which calls for an average of only five percent over a period of 20 years. To protect the climate effectively, emerging countries will have to take responsibility as well in the medium term. This is realistic, however, only if the northern countries lead the way and institute effective measures to reduce emissions permanently.

Even if the forecasts are tainted with uncertainty, it can be anticipated that the environmental – and ultimately the economic – disadvantages of climate change will be unevenly distributed throughout the world. According to current calculations, the areas that are particularly negatively effected by climate change are the ones that release the least greenhouse gases, in particular poor southern countries. In contrast to the industrialized world, poor countries lack the means to adapt their agriculture and infrastructures to the changing climate.

Resorting to coal

The economic upswing in the emerging countries is reflected in a growing demand for fossil fuels and the accompanying increase in the price of oil. Energy experts believe that the price of oil will shoot up even higher if peak oil production is reached in one or two decades and outputs then begin to fall. A central problem is that not all countries have the same conditions for implementing more efficient technology. Since poorer economies cannot afford the new technology, it is feared that higher energy prices will not curtail the use of fossil fuels everywhere, leading in turn to greater consumption of renewable energy sources. It is more likely that poorer countries will fall back increasingly on coal and firewood – with far-reaching environmental consequences. Coal, which is still available in large quantities, pollutes the air and the climate more than petroleum products do, and increased use of firewood puts more pressure on environmentally valuable forests. The world is already experiencing a revival in the use of nuclear energy, which is not renewable and is associated with a risk of hazardous incidents.

Biodiversity under threat

Humans today impact on a large proportion of the Earth's land area. Almost all productive land or water is used intensively, especially for agriculture. Even areas that had previously been left largely untouched, such as tropical rain forests, are increasingly coming under serious pressure. The growing demand for land for human use can lead to the loss of natural areas and habitats for many species. The earth's biological diversity will thus continue to decrease, and terrestrial and marine ecosystems are already losing a great many species[14]. Once biodiversity is lost, it cannot be regained, and that means future generations will have far fewer opportunities open to them.

[14] The WWF's Living Planet Index, which measures the development of vertebrate populations, sank between 1970 and 2000 by about 40% (WWF 2004).

Overfishing

According to the international Food and Agriculture Organization (FAO) more than 25 percent of all fishing stocks are exhausted or nearly exhausted. An additional 50 percent are being fished to their biological limit. The world's fishing stocks nearly halved between 1970 and 2000[15]. Although the decline of the stocks is being compensated by new catch methods and the expansion of fishing areas, biocapacity has fallen again since the 1990s because of sinking yields. Overfishing not only puts pressure on yields, but it also threatens the oceans' environmental balance.

World population growth

Even as falling population is becoming more and more of a problem in Switzerland and Europe in general, the global population continues to increase. Although the rate has fallen, the world's population continues to swell by about 70 million people[16] annually. With little likelihood of the world's biocapacity increasing, this growing population means an even greater ecological overshoot is on the cards. World population growth is not distributed evenly and further aggravates the North/South divide. The population is growing primarily in the South, with a corresponding increase in pressure on ecosystems there.

Unequal results of globalization

Although global trade may be expected to become more important as barriers are removed, it continues to be based on unequal economic structures. The exchange of manufactured products takes place primarily between northern countries, while agricultural and mining products with less added value, and other raw materials, largely move from southern to northern countries. This means that the North meets its environmental area requirements with biocapacity from the South. For example, northern countries use cropland in southern countries in the form of coffee and cocoa plantations. Moreover, the environmental stresses at lower levels of processing are generally especially high – for example, waste products from mining, bycatch in fishing, soil erosion on account of unsustainable agriculture and heavy industry emissions. Thus the North not only claims southern land to satisfy its own needs, but it also shifts some very damaging activities to the environment there[17].

[15] www.fao.org/fi/default

[16] United Nations, 2005

[17] Wuppertal Institut, 2005

The environment and development

The development of the global footprint reveals that the world is not on a course toward environmental sustainability. Quite the reverse, in fact – the earth's environmental deficit is growing steadily. A comparison between the ecological footprint and the United Nations' Human Development Index (HDI)[18], as an indicator of economic and social development, shows a clear line between poorer states with a low HDI and a small footprint and richer states with a high HDI and a big footprint (graphic 26). Hardly any countries have a high HDI and a small footprint, which could be described as sustainable. Anyone looking at trends over the last 20 to 30 years will see that the richer countries are even moving further away from sustainability on account of their growing footprint.

4.2. Possible courses of action

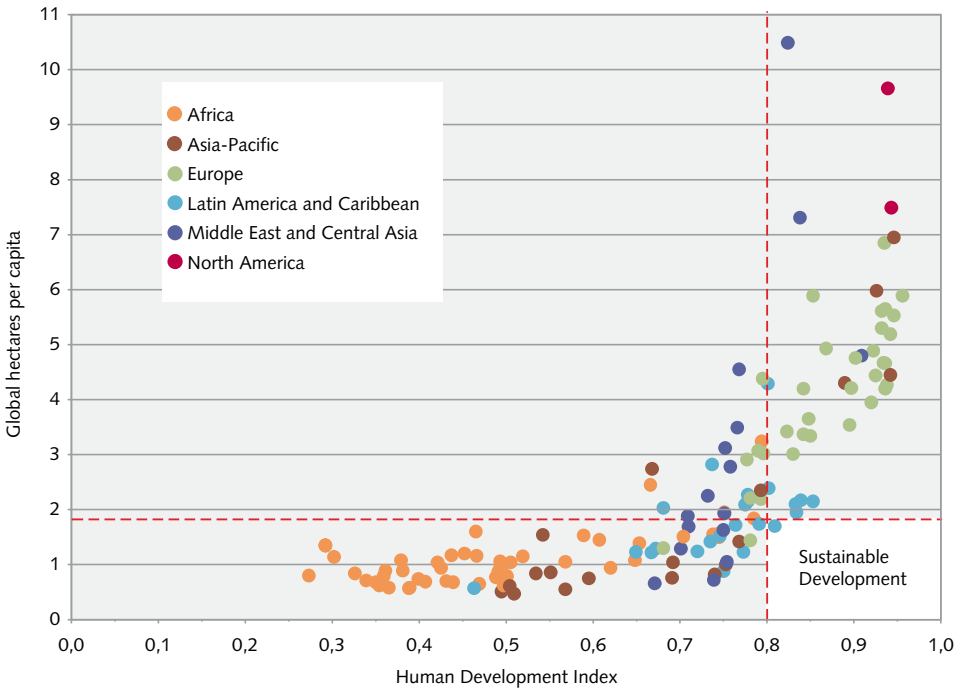
The results of the ecological footprint study show that our planet's ecosystems have been overused and polluted over the last 20 years to the point that they can no longer renew themselves properly. With the economic upswing taking place in such highly populated emerging markets as India, China and Brazil, who are adopting the energy and resource-guzzling economic model of the North, pressure on natural resources will grow enormously in the coming years.

The North must take the lead

The industrialized nations must be the first to take action. The primary duty significantly to reduce consumption of energy and natural resources is theirs. They are largely responsible for the oversized global ecological footprint in the first place. In addition, they have the expertise and the economic power to place production and consumption of resources on a more conservation-orientated footing. Finally, northern countries already have a high standard of living.

[18] The HDI is composed of the following elements: Life expectancy at birth, literacy rate of those over 15, education (primary, secondary, tertiary) and gross domestic product per capita. See http://hdr.undp.org.

Footprint and HDI for individual countries (2002) **G 26**



Footprint and the Human Development Index (HDI) in individual countries in 2002.

Hardly any countries have a high HDI and a small footprint, which could be described as sustainable.

Source: Global Footprint Network

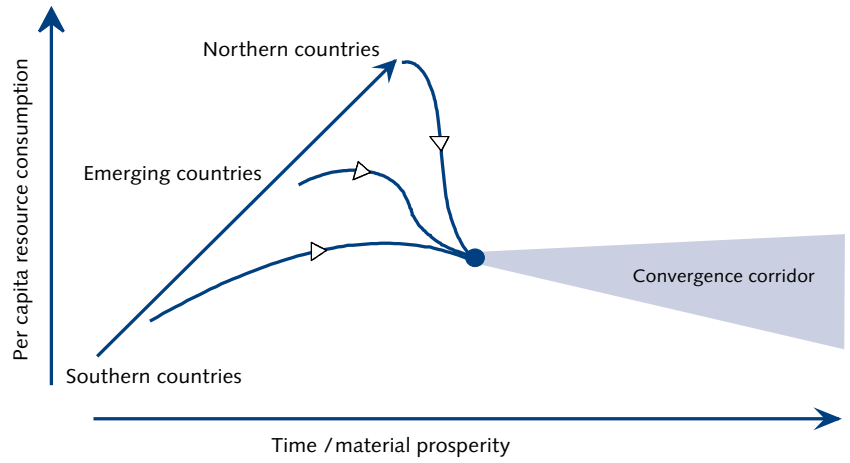
Southern countries, however, are still entitled to augment their consumption of energy and natural resources for the time being. By rights, no one can keep them from making the same use of the environment as the North has done for decades now. Per-capita usage in the North and South should meet at an environmentally acceptable rate before developing and emerging countries attain northern-style high levels, which would be ruinous for the global environment. In the climate conservation debate, the term "convergence" has come to stand for this process of meeting halfway. Over the long term, the greenhouse gas emissions should level off at a similar per capita rate for each country, in what is known as a convergence corridor (graphic 27).

The sooner industrialized nations institute effective measures to reduce the ecological footprint, the better. Not only do such measures ease pressure on their own environments and that of the world as whole, but they also provide emerging countries with the necessary tools to reach the convergence corridor from their end. In so doing, it is important to consider that production and consumption patterns are partly influenced by stable structures like built-up areas and transportation infrastructures, which can be changed only in the long term. The earlier the course is set for a sustainable, resource-conserving lifestyle, the better the change can be managed economically and the more opportunities for development present themselves – for both North and South.

Where to begin?

How can the global ecological footprint be reduced without taking away the southern countries' right to develop further? The first step is to use resources more efficiently and to replace non-renewable resources with renewable ones. Today many resources, especially fossil fuels, are too cheap, economically speaking. Therefore there is not enough incentive to use resources efficiently or to use renewable resources. In many areas, however, technologies that would significantly reduce the consumption of non-renewable resources are already known and being tested. Many different actors are needed to help them make a breakthrough. Some promising approaches are familiar. At a political level, free-market tools must play a central role. Taxes and certificate systems can give the market the right price signals to inspire manufacturers and consumers to consume resources more efficiently and to use renewable energies. As a result, researchers' interest in developing more efficient technologies and in renewable resources also grows.

Convergence corridor **G 27**



Over the long term, resource consumption should level off at a similar per-capita rate for each country, in what is known as a convergence corridor.

Source: INFRAS and al. 1996

For the first time, environmental issues will be covered in trade liberalisation talks at the World Trade Organization (WTO). The purpose of adding environmental issues to trade liberalisation talks at the WTO is to ensure that WTO regulations on international trade in goods and services include provisions for the efficient protection and rational use of natural resources worldwide.

Population growth also influences the ecological footprint. This influence is still relatively small when seen on a global scale, because population growth is generally highest in the poorest regions, and therefore in areas where the per-capita footprint is the smallest. As poor countries develop economically, however, their footprint will grow. Consequently, population growth is becoming an increasingly significant factor. As a result, it is important to give poor regions material security and opportunities to develop, not only for reasons of global fairness, but also from an environmental perspective. This would halt population growth and therefore help to prevent the overexploitation of local ecosystems.

Appendix

Appendix 1: Definitions/reliability of the ecological footprint

Ecological footprint

The ecological footprint is a measurement that expresses the consumption of all types of natural resources such as fossil fuel, wood and cropland in units of land area (global hectares, see below). The footprint shows clearly how much land and water area a region, country or the entire human race would really need to meet the demand for resources renewably and to absorb the waste it generates. The ecological footprint can be divided by population figures and used as a per-capita measurement, allowing different regions to be compared more effectively.

Global hectares

The ecological footprint and biocapacity are both measured using the same units, global hectares (gha). A global hectare is a hectare of productive area with a productivity level corresponding to the global average.

Equivalence factors to compare different types of land area

The different kinds of land areas (land for producing vegetable products, wood, etc.) are converted into global hectares using equivalence factors. One hectare with an average biological productivity has a equivalence factor of one.

Average global yields

Average global yields per hectare are determined for every kind of land. These average yields are necessary to determine the footprint from the use of a certain space. The higher the average yield, the smaller the footprint.

Yield factors

Yield factors describe the productivity of a specific type of land (for example, cropland or forests) in comparison to global average productivity for that type of land. The higher the yield factor, the higher the productivity of the land and the higher the corresponding biocapacity. Yield factors differ for every country, every year and every kind of land.

Biocapacity

Biocapacity is a measure of an area's biological productivity. A country's biocapacity encompasses all of its land, even that which is not used – whether for reasons of geography, economics, or conservation. The footprint of a region, country, or the world as a whole falls if population figures or per-capita consumption fall, or if resource efficiency rises. Biocapacity increases if productivity per unit of area or the productive areas increase.

Ecological deficit

An ecological deficit exists when the ecological footprint of a certain area (such as a country) is bigger than the corresponding biocapacity, that is, when more is consumed than the area naturally produces. A country's ecological deficit can be made up for by importing products, and thus biocapacity, from other countries. Every part of the deficit that cannot be compensated for, however, leads to the erosion of a country's natural capital (ecological overshoot). It is not possible to compensate for a global ecological deficit.

Ecological overshoot

That proportion of the ecological deficit that cannot be compensated for by importing biocapacity is called ecological overshoot. Resources are being consumed faster than they can regenerate naturally and natural capital is used up to cover the ecological deficit.

What information is the ecological footprint unable to assess?

- Non-environmental aspects of sustainability: The footprint is not a complete sustainability indicator. It includes only the environmental aspects of sustainability and not the social and economic ones. Social and economic aspects would also have to be incorporated to make a comprehensive statement on sustainability.
- The size of the ecological footprint tends to be too small, as it does not take into account qualitative and poorly quantifiable aspects (for example, non-biodegradable materials, the damage done by waste, loss of biodiversity, freshwater consumption). See explanations in the separate sections.
- Reduction of non-renewable resources: With the exception of fossil fuels, the footprint measures the consumption of non-renewable resources only indirectly. Although the method takes into consideration how much of a given renewable resource is needed to make the non-renewable resources available, the footprint does not illustrate the limits of these resources.
- Fundamentally unsustainable activities: Activities and events that fundamentally cannot be sustainable, such as environmental pollution caused by heavy metals or persistent pollutants (PCB, PVC, dioxins), are not included in the calculation of the ecological footprint. Since these materials degrade very little or over a very long period of time, it is not possible to determine an area that would be needed to for the materials to degrade.
- Environmental damage: Environmental damage such as deforestation, overfishing and depleted soil is not incorporated directly into the calculation of the footprint. The ecological footprint cannot estimate future losses of biocapacity caused by current overuse. That is, long-term damage through overuse of resources is not expressed as long as yields do not decrease. Biocapacity does not diminish until environmental damage causes a reduction in biological productivity. Thus the global footprint from fisheries grew smaller and smaller for some time, because more and more fish were caught per ocean surface area thanks to modern catch methods. The footprint has increased only since global catch volumes have begun to fall owing to overfishing.
- Loss of biological diversity: The loss of biodiversity that accompanies deforestation and more intensive farming, for example, is not incorporated into the ecological footprint.
- Natural capital: In calculating biocapacity, no land or water areas are excluded from use, as would be the case with nature reserves, for example. Even if there is no ecological deficit according to the footprint method, a multitude of plants and animals will hardly be able to survive if humans fully use all areas. To maintain biodiversity, humans would have to forego the full exploitation of biocapacity.
- Tourism: Resources used by tourists are charged to the country that tourists are visiting, rather than to their home country. Of course this has no influence on the ecological footprint at the global level

What does the ecological footprint represent insufficiently?

- Since the damage done to the environment by waste and pollutants, such as sulphur dioxide produced by the combustion of fossil fuel sources, (still) cannot be quantified, they are currently not included in the footprint's calculation.
- Freshwater consumption is expressed indirectly, because no globally comparable data is available. The method shows a change only when a lack of fresh water for irrigation causes a decrease in biological productivity from cropland.
- The ecological footprint method is based on global averages. It calculates the global average amount of surface area needed to maintain resource consumption. In some cases this may give rise to minor inaccuracies. If, for example, Switzerland imports products from countries whose productivity is higher than the world average, this is not taken into consideration. Information about local biocapacities and footprints is generally available, however.

Transparency

Taking a number of components into account requires different steps and decisions. The underlying data sources, assumptions and calculations, as well as the handling of missing data are not explained clearly. Thus far no actual method manual summarizing these methodological fundamentals has been produced. Since the ecological footprint is a commercial product, additional information is not available to the public.

Appendix 2: Results from data comparison

A comparison of the data used by the Global Footprint Network with the Swiss statistics for 2002 shows that it generally corresponds well. Larger deviations in individual areas are attributable mainly to different conversions and units. The differences in the overall footprint are negligible, however. The most significant differences are listed by areas below, and additional details are given in the technical report.

Energy

A comparison of the data from the International Energy Agency (IEA) which is used by the Global Footprint Network, the Swiss data regarding general energy statistics, and the Swiss greenhouse gas inventory shows that the data for 2002 is comparable and the results are reliable. The differences range between one percent for nuclear energy and two percent for fossil fuels and are due to different system classifications. Embodied energy in trade was not compared, because Switzerland does not have any statistics on this subject.

Comparison of data revealed that the current method used to calculate traded grey energy is based on a restrictive data filter intended to remove implausible data. This filter corrects any amount entries for goods priced five times over or less than world market prices. However, for countries that import or export goods at high prices, the filter produces major data distortions. In Switzerland, the filter produces a major overestimation of exports of pharmaceuticals, which leads to an underestimation of net imports of grey energy. The Global Footprint Network has therefore decided to apply a much weaker data filter in the future. With this change in method, the 2006 edition will contain the revised figure of 5.1 instead of 4.7 global hectares for year 2002. The share of traded grey energy will increase from 15% to 21%.

Cropland

A review of the data quality for key products shows methodological differences between the international data from the United Nations Food and Agriculture Organization (FAO) and the Swiss data in terms of declared units and how secondary products are treated. As they apply to the footprint, however, the differences in this area are relatively small.

Livestock

A review of the data shows that the production figures from the international FAO statistics used and the Swiss statistics correspond well. Import and export figures are not directly comparable, because different units are used. Overall, however, the international data is clear to Switzerland and therefore can be used reliably.

Fisheries

International data from the FAO is not comparable with Swiss data from foreign trade statistics, because different fish categories and different units are reported. The Global Footprint Network's data does seem plausible, however.

Forestry

The comparison between international FAO statistics and Swiss statistics shows only small differences with primary products like roundwood and sawnwood. However, only rough estimates are available for secondary products such as planks. They are based on different units and their conversions are unclear.

Built-up areas

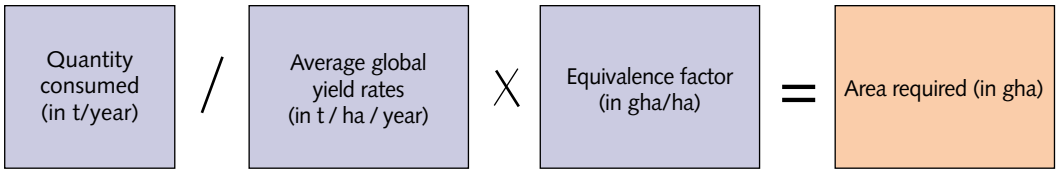
A comparison between the data used by the Global Footprint Network and the Swiss statistics for 2002 demonstrates good correspondence overall, because Switzerland uses figures from earlier years and extrapolates them for 2002. By contrast, the Global Footprint Network's time series are not very meaningful, because too few data points are known and the figures reflect only population growth. The Swiss national study therefore also takes into consideration the data from the Swiss area statistics in calculating the footprint.

Appendix 3: Calculating the ecological footprint

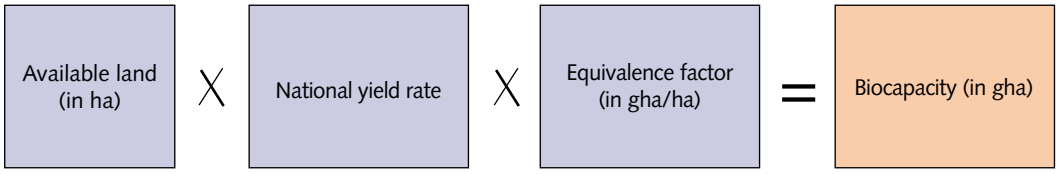
The ecological footprint and biocapacity are calculated in the individual components roughly according to the following formula:

Diagram of the calculation formula for the footprint and biocapacity **G 28**

Footprint



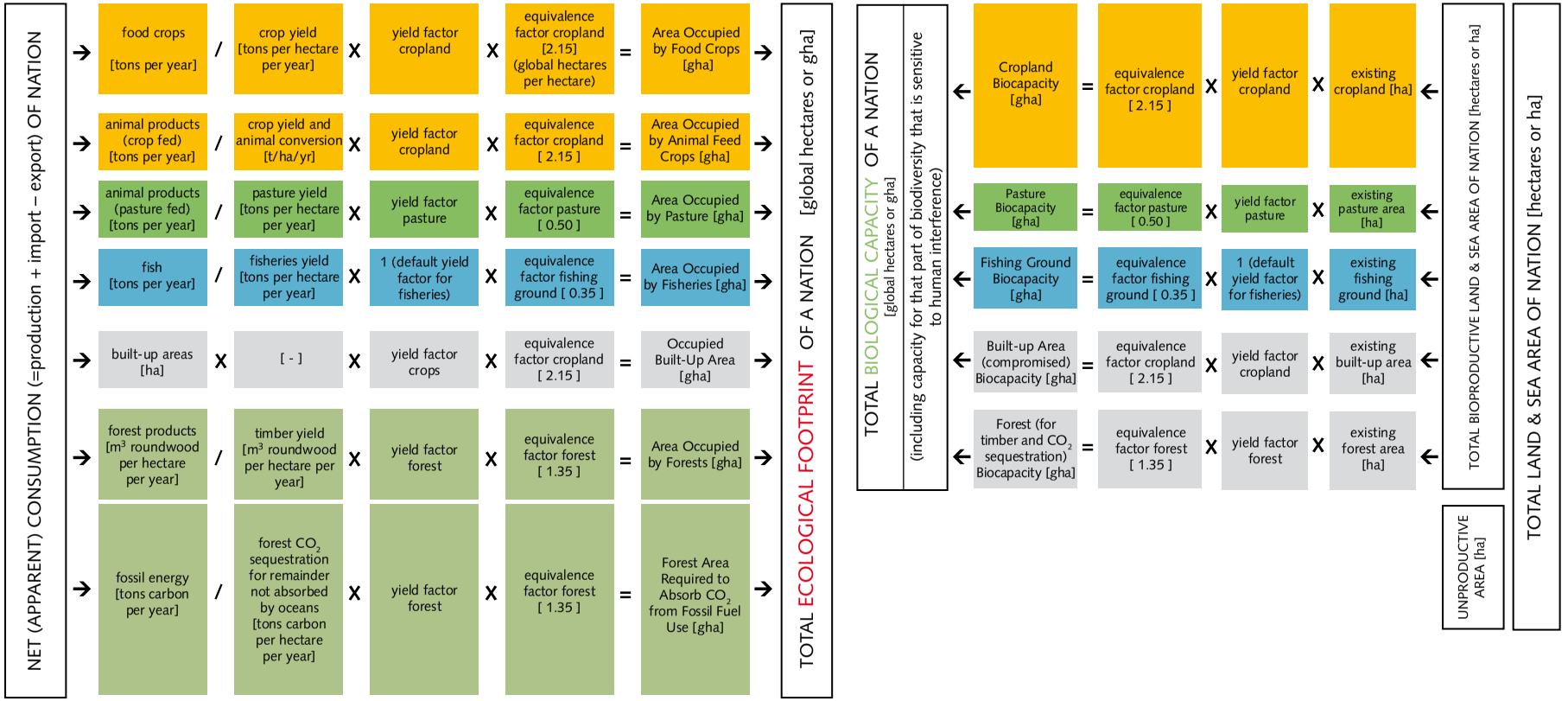
Biocapacity



The complete calculation formula for all components is shown in graphic 29. The components of built-up area and energy follow another, slightly modified calculation formula. The calculations for the individual components are explained in more detail afterwards.

Diagram of the formulas used to calculate the ecological footprint

Structure of National Ecological Footprint Account and National Biocapacity Account



Source: Global Foofprint Network

Energy

The energy consumption footprint encompasses the land which is needed to produce energy from fossil fuels, nuclear energy and hydropower, and to neutralize the waste they create. In addition, the footprint takes into account the embodied energy in trade, or the energy required to produce, transport and dispose of products.

The fossil fuel footprint can be calculated in two different ways:

- CO_2 sequestration: The biologically productive area that would be required to absorb CO_2 emissions resulting from the combustion of fossil fuel sources sustainably, i.e. without an increase in the concentration of this greenhouse gas in the atmosphere. The CO_2 absorption capacity of forests serves as a basis (minus the CO_2 absorbed by the oceans). This method has been used to calculate the data underlying the present publication (Kitzes and Wermer, 2005).
- Biomass substitution: With this type of calculation, the footprint corresponds to the land that would be required to provide an equivalent amount of energy from firewood (not used in this report).

Nuclear energy differs from other components in that it creates waste that never degrades or takes a very long time to do so. Thus the area that would be necessary for radioactive waste to decay cannot be determined. In contrast to other toxic substances that are not included in the footprint at all, however, nuclear energy is taken into consideration to avoid giving the impression that nuclear energy does not cause any environmental damage. By including nuclear energy, we avoid underestimating the energy footprint of countries with nuclear power plants and prevent the drawing of false conclusions about environmental achievements or environmental consumption patterns.

As an interim solution, the current method counts one unit of nuclear energy as one unit of fossil fuel, i.e. fossil fuels and nuclear energy are considered equivalent. This approach is supported by the fact that countries that do not use nuclear energy normally use fossil fuels instead.

Other methodological approaches could be used to take nuclear energy into account, however. For example, the land that would be damaged in case of an accident could be quantified, or the nuclear energy footprint could be quantified only in the case of a nuclear accident in the region in question, because the fundamental idea behind the method involves illustrating the current situation and not possible future threats.

Embodied energy in trade is the amount of energy required to produce, transport and dispose of products. The embodied energy in trade footprint encompasses traded embodied energy, or the energy inherent in imported and exported products. The net import of embodied energy is charged to the importing country's energy consumption. A net export therefore reduces the energy footprint. The embodied energy in trade involved in products is converted into CO_2 emissions.

Cropland

The cropland footprint is the area needed to produce consumed vegetable products.

To calculate the footprint from the consumption of agricultural products, data is included from more than 70 vegetable products (for example, grain for human consumption, cotton and crops for animal consumption) and 15 processed products made from vegetable ingredients (for example, vegetable oils). In so doing a line is drawn between vegetable products that grow on fertile land and those that grow on less fertile land. Fertile land and less fertile land have different equivalence factors. Wheat, maize, barley, rice, coffee and fruit need fertile land. Millet and olive trees are examples of crops that grow on less fertile land.

Livestock

The pasture footprint measures the grassland and pasture needed to produce consumed animal products such as meat, eggs, wool and milk. Animal feed made from grain and fish meal is included in the cropland footprint and fisheries footprints, respectively.

Fisheries

The fisheries footprint corresponds to the water area required to produce the consumed amount of fish. Eight categories of freshwater fish, saltwater fish and seafood, and one category of aquatic plants, are taken into consideration to calculate the fisheries footprint. These nine categories are subdivided into 42 species groups. The calculation takes into consideration the place of each type of fish in the food chain. The consumption of such predatory fish as tuna causes a footprint approximately ten times larger than the consumption of mackerel.

Forestry

The forest footprint is the land needed to produce the consumed wood products. Primary wood products such as roundwood and firewood as well as secondary products like charcoal, sawnwood, planks, paper, cardboard and pulp are taken into account in calculating the footprint.

Built-up areas

The built-up area footprint is the land covered by infrastructure for residential buildings, transportation, industry and services. Since most towns were established in areas with fertile cropland, temperate climates and access to fresh water, the method assumes that built-up areas generally lie on top of fertile cropland. Accordingly, in calculating the footprint, urban sprawl is always at the expense of cropland, reducing the overall biocapacity. This area is tainted by major inaccuracies. Even in high-resolution satellite images, for example, it is very difficult to distinguish between asphalted and open land within the built-up area.

Appendix 4: Tables with background figures

T 2 Equivalence factors in 2002

Energy	Fertile cropland (vegetable products)	Less-fertile cropland (vegetable products)	Pastureland (animal products)	Fisheries	Forest	Built-up area
1.38	2.19	1.80	0.48	0.36	1.38	2.19

Equivalence factors in 2002. The different types of land (land for producing vegetable products, wood, etc.) are converted into global hectares using equivalence factors. One hectare with an average biological productivity has a equivalence factor of one. The equivalence factors differ from year to year, but they are the same for every country.

Source: Global Footprint Network.

T 3 Yield factors in Switzerland in 2002

Energy	Fertile cropland (vegetable products)	Less-fertile cropland (vegetable products)	Pastureland (animal products)	Fisheries	Forest	Built-up area
1	2.13	3.29	2.21	0.11	3.5	2.13

The yield factors describe the degree to which land (e.g. land for producing vegetable products) is more or less productive than the worldwide average. A yield factor of more than 1 means that the productivity of a certain area is greater than the global average, and a value of less 1 means that it is under the global average. Yield factors differ for every country, every year and every kind of land.

Source: Global Footprint Network

Bibliography

Bundesamt für Statistik 2005: Arealstatistik Schweiz: Zahlen – Fakten – Analysen, Neuchâtel.

Commission of the European Communities 2006: Communication from the Commission: Halting the Loss of Biodiversity by 2010 – and beyond: Sustaining ecosystem services for human well-being, 22 May 2006, Brussels.

Eidgenössische Oberzolldirektion 2003: Schweizer Aussenhandel: Statistik nach Waren und Länder, Januar bis Dezember, 4/4, 2002, Bern.

European Environmental Agency 2006: Europe and the Globe: How the Planet and the World's Largest Economy Interact. SR8 in support of EEA's "State of the Environment and Outlook Report 2005", Brussels. Excerpt report to be published in 2006 under title: "Europeans use more than two Europes: The European Footprint. How the planet and the world's largest economy interact. EEA.

Global Footprint Network / European Environmental Agency 2005: The Ecological Footprint: A resource accounting framework for measuring human demand on the biosphere. http://org.eea.europa.eu/news/Ann1132753060

Global Footprint Network 2005: National Footprint and Biocapacity Accounts 2005: The underlying calculation method, Oakland.

INFRAS et al. 1996: Structural Transformation Processes towards Sustainable Development in India and Switzerland, Zurich.

Kitzes J./ Wermer P. 2005: The Carbon Conversion Factor in Ecological Footprint Accounts: Calculations and Sources of Variability. Technical Memorandum, Global Footprint Network.

Meadows D.H., Meadows D.L., Randers J., Behrens W. 1972: The Limits to Growth, New York.

United Nations 2005: World Population Prospects: The 2004 Revision: Highlights, New York. www.un.org/esa/population/publications/WPP2004/2004Highlights_finalrevised.pdf

Wackernagel M., Schulz N., Deumling D., Callejas Linares A., Jenkins M., Kapos V., Monfreda C., Loh J., Myers N., Norgaard R., Randers J. 1990: Tracking the ecological overshoot of the human economy, PNAS, Vol 99, No. 14, p. 9266-9271.

Wackernagel M., Rees W. 1996: Our Ecological Footprint: Reducing Human Impact on the Earth, Gabriola Island/Philadelphia.

Wuppertal Institut 2005: Fair Future: Begrenzte Ressourcen und globale Gerechtigkeit, München.

Web links

European Environment Agency: http://org.eea.europa.eu
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Global Footprint Network: www.footprintnetwork.org
UNDP: www.undp.org
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These publications and further information on the indicators for sustainable development are available on the MONET website: www.monet.admin.ch

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Switzerland has made sustainable development a national goal. It is enshrined in the Swiss Constitution. How does one determine whether Switzerland has actually achieved or is on the road towards sustainable development? One way is to use sustainable development indicators. Another way is to use the ecological footprint approach, a scientific method to graphically depict the environmental impact of human activity. The present study closely examines the ecological footprint approach. The first step the authors took was to align Swiss statistics with data contained in the international ecological footprint database. Once data was made compatible, it was then possible to calculate Switzerland's ecological footprint. This publication contains a multitude of easy to read charts showing how well Switzerland compares with other countries in terms of environmental impact. The publication also includes background information enabling readers to assess the ecological footprint approach.

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