www.e-co-foot.eu

Teacher material on Ecological Footprint

0 BACKGROUND INFORMATION on the Footprint concept

This material is part of a course on the Ecological Footprint for students. The course consists of the following modules for two age groups:

Age group 1 10-13 years	Age group 2 14-18 years
General Introduction	General Introduction
Mini Hectare Workshop	Mini Hectare Workshop
Food	Food
Housing	Housing core Housing additional
Mobility	Mobility
Other Consumption	Other Consumption core
Background information	

You are here

calculator.e-co-foot.eu is an online tool, where students can log their daily activities and trace the ecological footprint of their habits. **elearning.e-co-foot.eu** is an e-learning with similar content as these lectures.

All the material can be downloaded for free at **www.e-co-foot.eu** in different languages.

IMPRINT

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The global framework - world out of balance:

For the first time in modern times, the current generation of children could have worse future prospects than their parents. It must be recognized that climate-, financial-, economic-, hunger- and other crises, are symptoms of the same phenomenon: planet Earth has become too small - at least for the claims of the "Global Consumer Class".

Calculations of the Ecological Footprint (Footprint) for the year 2019[2] show that humanity as a whole already makes demand on 1.7 planets, so that it lives ecologically only "on credit". Despite the planet's unsustainable overuse, millions of people are starving and billions live in abject poverty. The underprivileged three-quarters of people would have every right to consume more energy and more goods. Around a quarter of the world's population consumes three quarters of all energy and resources. If all people wanted to live as the wealthy quarter, we would require more than three planets of the quality of the Earth. These extra planets cannot and will not exist!
Like no other scientific measure the Ecological Footprint allows to combine ecological and social necessities. Since the earth will not grow, any area taken that exceeds the fair measure is withheld from another person. At the moment (2016), for each citizen of the earth, there are approximately 1.6 global hectares (gha), given the mathematical distribution of the earth's usable area (area, which is fruitful or productive). Of this area, at least a share of 15% must be reserved for all other living beings (nature), leaving about 1.4 gha for each human being. This is the share of the biocapacity of the earth, which means, those parts of the earth´s surface, which produce plants and animals which we need to live. That is fair for everyone to cover all needs.

At around 5 gha, Europeans actually live far above target.
It would take nearly 3.5 planets of the quality of the earth, if all humans would want to live like we in Europe, about 6 planets, if the average American lifestyle should be the model. We in the wealthy countries live at the expense of others, at the expense of nature and the future.

The idea of "good housekeeping", which is important in "ecology" and "economy", can merge into a new "global common sense" through the concept of the Ecological Footprint. This global Golden Rule should become the self-evident model for a sustainable world:
A good life with a fair Footprint, with a fair share of planet Earth, in peace with each other and with nature.

This is all the more urgent as humanity as a whole already lives in the "Overshoot". Although the majority of people still live in poverty, due to the over-consumption of the wealthy quarter humanity is already consuming more resources (biocapacity) than planet Earth can provide in the long run.

As the world population will continue to grow, by the middle of the century about 1 gha per citizen of the world will be available.[1] Living within these ecological boundaries is a given and absolutely essential prerequisite for a peaceful and ecologically stable world.

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[1] That is why the “Hectare Workshop” refers to 1 gha and not the current fair share of about 1.4 gha for man and nature! (Respecting the needs of animals and need to have biodiversity which are up to discussion); If humans get all, the fair share would be 1,6 gha as in other documents mentioned.

The central question of the future of the 21st century therefore is:
"How can we all live a good life, within the fair share of the world?"
The challenge in those countries that consume far above the global target is particularly great. The currently existing wasteful economic and social models and their associated lifestyles have to be adapted to enable a good life within the fair Footprint for all.
This transition will require political as well as economic and individual changes. The faster it starts, the sooner the transition can be mastered without economic and social disasters.

What such a sustainable society could look like, where the most effective measures can be taken, and what that will mean for the changes in individual lifestyles and their improvement, can be experienced in a playful and impressive manner with the "hectare workshop" and other provided Footprint learning materials which will help underline the importance of “global common sense”.

Benefits of sustainable lifestyles

Need makes you inventive, abundance makes you stupid!

For a long time, the environmental movement thought that by describing the upcoming environmental catastrophes in detail, the concern created would lead to the necessary changes.

But the implementation of preventive measures is very difficult where the necessary steps cause too many efforts and costs in the present. It is not necessarily part of the human "nature" to be abstinent today in order to prevent a misfortune tomorrow. People do not easily change their lifestyles, especially when this means less comfort for them. So, accompanying and reinforcing the "warnings," the vision of a positive future must be a central element for the effort of change to be accepted. Only such a strong vision of a liveable and fair world can encourage the necessary steps before emergency and scarcity really force us to take these steps.

It is therefore sensible and wise to communicate the boundaries, not only to emphasize the environmental needs, but also the enjoyable benefits that come with sustainable lifestyles.

In fact, almost everything that is important to people's wellbeing can continue to grow. Satisfaction, education, happiness, and above all the time available to us to enjoy life, should and may increase! More fairness, worldwide and within societies, also means less fear of the disadvantaged, fair sharing of resources means less conflicts and wars.
What we gain is time to be human, time for family, friends, hobbies - and not least for ourselves.

A better life - not at the expense of others and not at the expense of nature.

Introduction

1. Good life by stepping lightly on Earth - The Ecological Footprint

The Ecological Footprint (Footprint) is an easy-to-understand tool to illustrate the excessive use of natural resources and different lifestyles.
The Ecological Footprint is a measure of the limits of the earth; it is based on a strong metaphor as well as on a scientific method. The idea of "good housekeeping", which is important for both "ecology" and "economy", can be illustrated by the Footprint concept. Based on complex calculations the measuring instrument makes it possible to translate resource consumption into a measure of area and thus make it well imaginable.
“Everything” we need to live comes from nature and needs area; e.g. the cotton for our clothes, our food, materials for our furniture and other utensils, roads and tracks that help us get around, or our waste that needs to be reused, recycled or deposited. The Ecological Footprint represents the sum of productive natural areas consumed in one year, regardless of where in the world these areas were claimed. It is possible to calculate the Ecological Footprint at different levels: for the entire world population, for countries, regions, products and also for people. For the latter, easy-to-use, personal Footprint calculators were developed (see, for example http://www.footprintcalculator.org/).

The strengths of the Footprint concept lie in its easy communicability and clarity. The understanding of sustainability is supported by the method and possibilities for action are shown. The data used are internationally comparable and are updated annually.

2. The scientific concept

The concept of the Ecological Footprint was developed in the early 1990s by scientists William Rees and Mathis Wackernagel. Their research question was: How much space do we claim for living and how much space is available to us? To answer this question, they compared the available productive natural surface with the natural surface which is consumed by humanity annually. Thus, the resulting Footprint concept can be considered as a tool to determine the extent of available nature and of resource consumption. It is like a balance sheet for nature. The area data are given in "global hectares" (gha) and are based on the calculations of the Global Footprint Network (GFN). The Footprint method is a young and dynamic science. Due to annual updates, methodological improvements and new insights, as well as by correcting errors, the data and actual numbers are constantly changing (e.g., the global productive area size or the Footprint of a nation).

3. The Ecological Footprint in detail

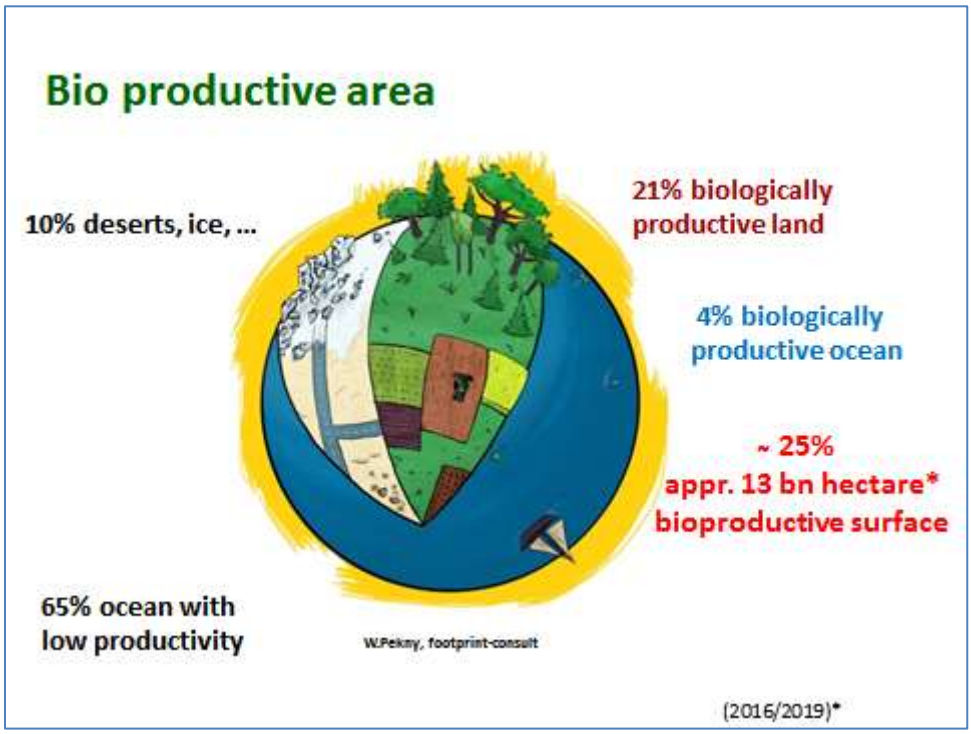

Figure 1: Representation of the biologically productive areas of the earth

The total fertile (bio productive) area of the earth divided by the number of the current population gives the share that would be due to fair distribution available for every citizen of the world. In 2019[2] it was around 1.6 global hectares per capita. The unit of measure for the Ecological Footprint is the global hectare (gha).

1 gha = 10,000 m² with the average global biological productivity

The productivity of the earth's surface varies greatly from location to location. On arable land, more can be produced than on an area of the same size in the tundra. The global hectare is a uniform measure that compensates for the different fertility of soils and makes country comparisons possible. The biocapacity of one global hectare therefore corresponds to the "capability" of 10,000 m² surface with the average global productivity to build biomass and / or decompose pollutants in one year.
The Footprint of a country consists of land areas at different locations on the planet as a result of global trade. The calculations are based on existing technologies and procedures for resource management. The bigger the Footprint, the more the environment is stressed.
An average EU citizen has an area consumption of around 5 gha. In contrast, the average human Footprint in India is around 1.2 gha. The Footprint makes it clear: we live beyond our means, at the expense of other people. However, within our society, the proportion of the Footprint is very different and can be between about 2.8 gha to well over 10 gha.

[2] with the latest data according to GFN from the year 2016

The Footprint can be categorized in four areas:

- Nutrition (Food)
- Housing
- Mobility
- Goods & Services (Other consumption)

E.g. the biggest part of the average Austrian Footprint consists of nutrition. 75% of the nutritional Footprint is attributed to the consumption of meat and other animal products. Furthermore, in addition to the mentioned areas, the so-called **Grey Footprint** has been defined. This share of the Footprint is divided among the four sectors and includes those public services in which each citizen participates (infrastructure, hospitals, city lighting, police ...)

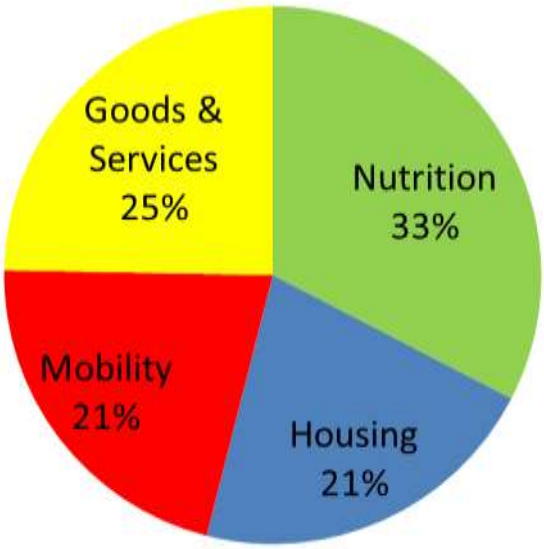

Fig.2: The different areas of our Footprint; food is the biggest part

4. Biocapacity and overshoot

Biocapacity is defined as the ability of nature to generate raw materials and absorb pollutants and wastes. The Footprint of our lifestyle (per year, measured in gha) can be compared to this biocapacity; if the Footprint is larger than the existing biocapacity, it is called “overshoot”. Already since the 1980s, humanity has been living in overshoot respectively in ecological deficit. Our consumption of resources per year is therefore greater than what the earth can reproduce in one year. In 2019[2], the world population as a whole consumed about 70% more than was sustainably available this year. The earth took about 1 year and 8 months to regenerate all resources and sinks. Such overuse is not sustainable in the long run (see the already visible consequences of overuse of forests, seas, atmosphere and soil).

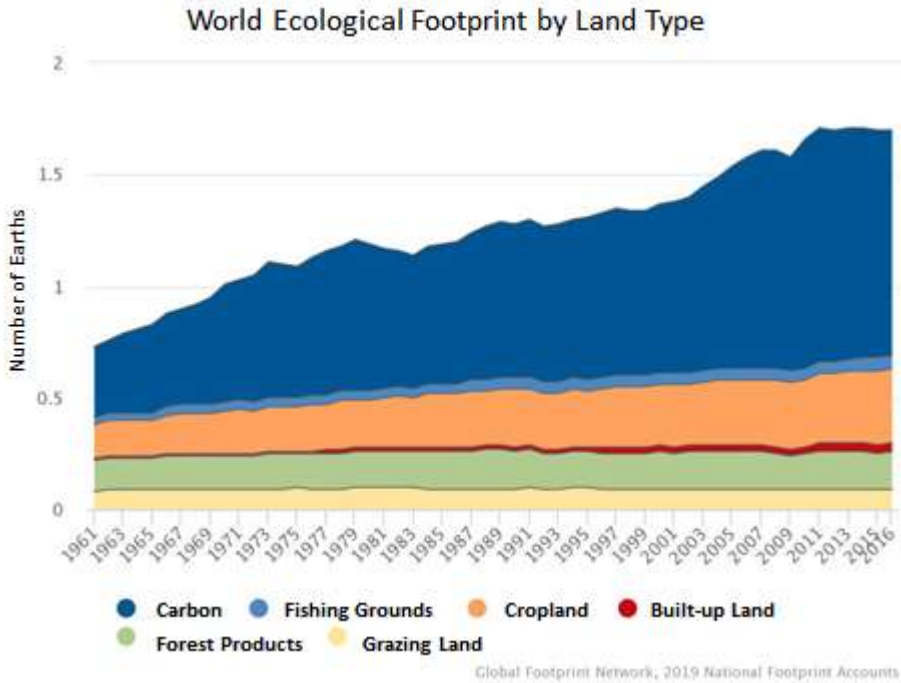

Fig 3: Since the 1980s, humanity has used up more resources than the Earth replicates in a year - this phenomenon is called Overshoot [GFN 2016]

The actual use of biocapacity is very different worldwide. For country data, see the Global Footprint Network website. The following figure shows this unequal resource consumption of the different regions of the world. The Ecological Footprint makes it clear which countries of the world live far beyond their means.

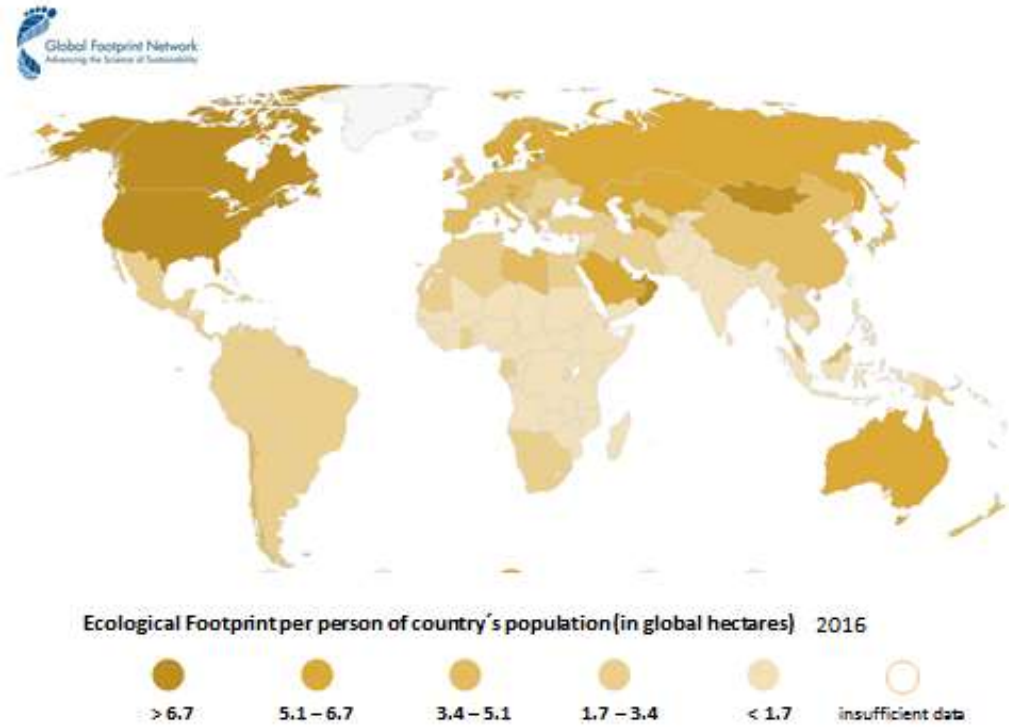

Fig.4: The Ecological Footprint of industrialized nations exceeds global biocapacity. Some African and Asian countries, on the other hand, use less than they would be entitled to.

To raise awareness of this unsustainable consumption of resources, the annual "World Overshoot Day" is announced. According to calculations by the Global Footprint Network, the “World Overshoot Day” for the year 2019 was as early as 31 July 2019. It's as if we were spending our annual income as early as the beginning of August, and from that point on we would only live on the savings of our donors that inevitably come to an end.
The Ecological Footprint is so far the only indicator that can show the overshoot.

5. CO_2-Footprint

The Ecological Footprint concept makes it possible to convert CO_2 emissions that are released when fossil fuels are burned into a measure of area. Specifically, it takes into account the size of the forest areas needed to absorb all CO_2 emissions (minus emissions that have been absorbed by the oceans). However, the supply of appropriate biocapacity (CO_2 absorption area) is too small to accommodate the total amount of CO_2 produced by humans. The result is increasing CO_2 concentrations in the atmosphere. Part of the comprehensive CO_2-Footprint is the Carbon Footprint (CF). This refers to the weighted sum of the most important greenhouse gases that arise during the manufacture, use and disposal of a product or service. It does not specify an area but the weight (in tonnes or kilograms of CO_2-equivalents). In industrialised countries, the Carbon Footprint accounts for well over half of the total Ecological Footprint.
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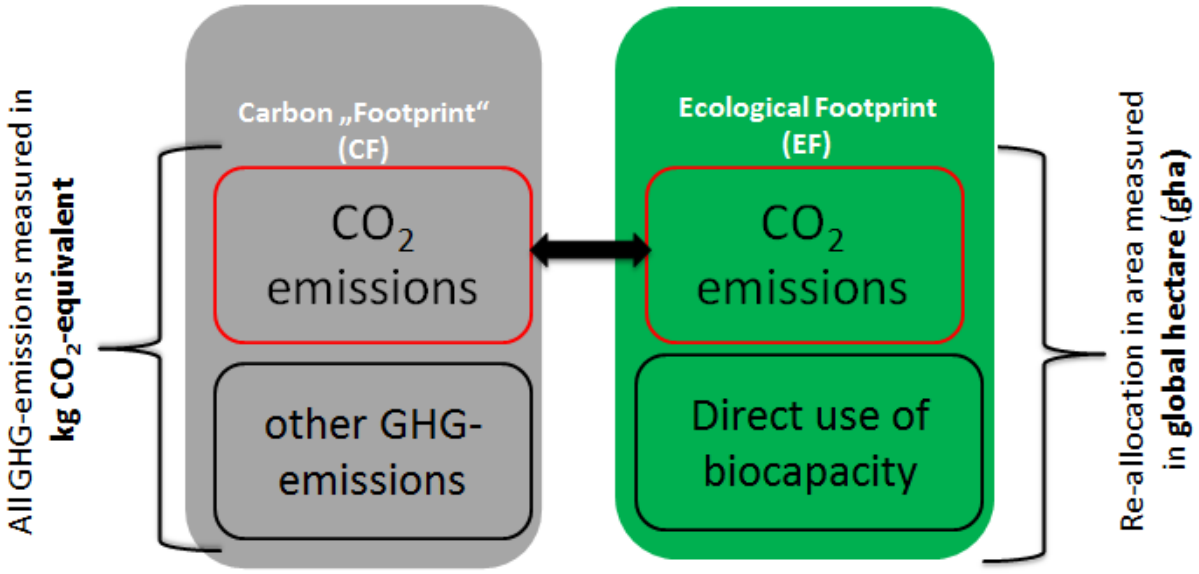

Simplified description of the relation of EF and CF

© SERI, Plattform Footprint, 2009

Fig.5: Ecological Footprint and Carbon “Footprint” overview. Carbon "Footprint" is put under quotation marks because it is not a square measure as a footprint implies to be.

6. Limits of the Ecological Footprint

Undoubtedly, the reduction of the Footprint of many nations to a globally acceptable level is the necessary precondition for a sustainable world. The Ecological Footprint is a helpful "balance sheet for nature"-tool. However, other aspects that are important for sustainability cannot (yet) be measured or mapped with the Footprint model for methodological reasons. These include, for example, social justice or biodiversity, which forms the basis of our livelihoods. Nor can the negative environmental impacts of nuclear energy and its risks, of particulate matter emissions or of pesticides, be captured by this instrument. Improvements of the methodology regarding these aspects are currently in this area pursued. However, it can be assumed that a mathematical inclusion of all these disregarded aspects would increase the overall Footprint. Their exclusion thus contributes to a systematic *underestimation* of the Footprint and does not change the basic statement, that is: We live on a much too big Ecological Footprint today.

7. What can we do?

As we saw, currently (2019[2]), 1,6 gha is the fair share of the biocapacity of the earth, with which we should get along to meet our needs, so that the coming generations can find the same opportunities and can live a liveable life.
A reduction of the personal Footprint often is possible by taking small but conscious decisions in everyday life. By adhering to the following five points a big step towards a sustainable lifestyle can be made:

+ avoid air travel
+ consume less meat and animal products
+ drive less by car and if possible, never alone
+ good insulation and energy efficiency of housing
+ enjoy your frugal, sustainable lifestyle

Changing your own lifestyle does not mean forgetting everything that is important to you. Rather, it is about conscious actions in everyday life and contentment.

It is never too little, what is enough. (Seneca)

When you think about your own consumer behaviour, prefer quality rather than quantity and become aware of your responsibilities and the consequences of your consumption both in social and in environmental terms and talk to family and friends about it, you have already made a big difference.

The other name of freedom is responsibility. (Thomas Mann)

Glossary

gha ..... Global hectare (gha) is a measure that describes the yields of biologically productive land and water. With the Global hectare, both the biological capacity (biocapacity) of the planet and the demand of humans (Ecological Footprint) can be quantified with a globally comparable measure. The biocapacity of one global hectare corresponds to the "ability" of 10,000 m² surface with the world average productivity, to build biomass in one year and / or to reduce pollutants.

kWh ..... Kilowatt-hour is a unit of measurement of work or energy. In this unit, especially electricity, but also heating energy are billed and recorded with measuring equipment such as the electricity meter or heat meter.

Overshoot ..... If the Ecological Footprint is greater than the existing biocapacity in a certain period of time, this is called overshoot.

The Paris Agreement ..... is an agreement within the United Nations Framework Convention on Climate Change (UNFCCC), dealing with greenhouse-gas-emissions mitigation, adaptation, and finance, starting in the year 2020. The agreement's language was negotiated by representatives of 196 state parties at the 21st Conference of the Parties of the UNFCCC near Paris, France, and adopted by consensus on 12 December 2015. As of February 2019, 195 UNFCCC members have signed the agreement, and 185 have become party to it. The Paris Agreement's long-term goal is to keep the increase in global average temperature to well below 2 °C above pre-industrial levels; and to limit the increase to 1.5 °C, since this would substantially reduce the risks and effects of climate change. Each country must determine, plan, and regularly report on the contribution that it undertakes to mitigate global warming.[3]

Climate change..... = Global warming: Change of the Earth's climate, regardless of whether the causes are based on natural or human (anthropogenic) influences. The current, human-induced global warming is mainly caused by the burning of fossil resources and the emission of carbon dioxide (CO_2) and other greenhouse gases, such as methane (CH_4) or nitrous oxide (N_2O). Since 1880 the average temperature on earth has increased by 1° Celsius. Warming is accelerating and will reach about + 4° to 5°C by 2100 if current CO_2 emissions are not drastically reduced. "The point of no return for mankind is in sight and hurtling towards us." (UN Secretary-General Antonio Guterres, 2019)

Climate Heating..... Since about 2019, the term "climate change" has been perceived as too "gentle" and trivialized and replaced by the term "climate heating". Since the 1960s, environmental disasters have more than tripled, with numerous fatalities and extreme damage.[4] Floods and landslides have increased the most. High temperatures in summer cause heat-related deaths (in summer

[3] https://en.wikipedia.org/wiki/Paris_Agreement

[4] https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health

2003, the number of heat-related deaths in Europe was about 70,000). Species extinction, drought and hunger are further consequences of climate heating.

CO_2-e ..... CO_2 equivalent: CO_2 equivalents (CO_2e) is a unit of mass measurement for standardising the climate impact of the various greenhouse gases. It indicates how much a given mass of a greenhouse gas contributes to global warming compared to the corresponding amount of CO_2.

Green electricity ..... The term “green electricity" usually refers to the electrical energy that comes from environmentally friendly renewable energy sources, such as geothermal energy, wind energy, biomass energy, solar energy and hydro-electric power. In contrast to green energy, conventionally generated electricity derives from nuclear energy and fossil fuels (coal, oil and natural gas). Look for a possibility to switch to green electricity and do something to reduce your Ecological Footprint. There is no other measure that reduces the Footprint at such low additional costs and effort! In some countries ecolabels and green energy guides help to get electricity that is generated exclusively from renewable energy such as hydropower, wind power, biomass or solar energy. If there are no providers of green electricity, then seek and support (or create) an initiative that is committed to the generation of green electricity.

Greenhouse gas..... A greenhouse gas is a gas that absorbs and emits thermal radiation from the sun (infrared rays). Water vapor is the most common and therefore most influential greenhouse gas. It is followed by the gases CO_2, O_3, CH_4, N_2O and the CFCs, which occur only in trace amounts. However, the climate impact of a greenhouse gas is not only determined by its quantity, but also by its residence time and its greenhouse potential. For example, methane is 21 times more climate-effective than carbon dioxide.

CLIMATE IMPACT OF SELECTED GREENHOUSE GASES[5]

Greenhouse gas	Climate impact	Retention time in the atmosphere
Carbon dioxide (CO_2)	1	variable
Methane (CH_4)	21	9 - 15 years
Nitrous oxide (N_2O)	310	120 years
Hydrofluorocarbons (HFC)	140 - 11.700	1,5 - 264 years

The excess CO_2 in the atmosphere that causes anthropogenic global heating comes from the burning of coal, oil, natural gas and forests.
For nitrous oxide and methane agricultural cultivation of the soil, nitrogen fertilizers and animal husbandry are decisive emission sources.[6]
HFC were used as refrigerant. They have been banned since 1995.

[5] https://www.greenpeace.de/themen/klimawandel/welche-treibhausgase-verursachen-die-erderw%C3%A4rmung
[6] https://www.umweltbundesamt.de/themen/boden-landwirtschaft/umweltbelastungen-der-landwirtschaft/lachgas-methan

CFC..... is the abbreviation for chlorofluorocarbons. Since the 1930s, CFCs have been produced in various compounds. They were used as propellants, for example in spray cans or in the production of insulating material, as refrigerants, which were used in refrigerators, freezers and air conditioning systems. Many fire extinguishers also contain substances containing CFCs. In 1989, the EU decided to ban the climate-damaging gas CFCs by the end of the 20th century because they destroy the ozone layer.

EI ..... energy index: indicates the measured specific energy consumption in kilowatt hours per year and m² living space (abbr. KWh / (a m²)) of a building and evaluates the building energetically. The EI is indicated in the energy certificate of a house. While the old building stock (before the 1970s) can still have 150 to 250 kWh / m²a, the new buildings by the year 2000 are usually under 100 kWh / m²a and from the year 2000 in average new construction standard are about 50 to 70 kWh / m²a. The EI can already be much better today or even zero (see low energy house, passive house, zero-energy house and plus-energy house).

Low energy house ..... A house that needs to be heated little in winter. It has an Energy Index of about 20 to 40 kWh / m²a; If the Energy Index is very low in the range of 20 to 30 kWh / m²a, the house is also called "ultra-low-energy house".

Passive House ..... is a house that rarely needs to be heated in winter. It has an EI of less than 15 kWh / m²a. In addition to very good insulation, passive houses have a ventilation system. In a passive house, you must not open the windows to ventilate, otherwise too much heat would be lost to outside in winter and vice versa, too much heat would flow into the rooms in summer. In winter the heat is recovered from the exhaust air: the outgoing air warms up the incoming air

Zero-energy house..... has an EI of less than 15 kWh / m²a, whereby this energy standard for buildings is achieved when the external energy consumption of the building is balanced by its own energy production (e.g. by solar plants, etc.). Therefor with its own energy production, the house reaches an EI of around zero kWh / m²a. Technically, the zero energy houses are often improved passive houses, which in addition to the passive heat recovery are also equipped with solar energy systems for hot water and electricity production to compensate the external energy supplies during the year. At first glance, a zero-energy house appears to be identical to the passive house. But there is a significant difference. In theory, every zero-energy house is a passive house. But not every passive house has to be a zero-energy house. This is only the case if the energy consumption and energy production in a Passive House are in balance.[7]

Plus-energy house ..... If more energy is generated than consumed by the house itself, this is called a plus energy house. The period under consideration is usually an annual

[7] https://www.immobilienscout24.de/wissen/bauen/nullenergiehaus.html

balance, therefore a plus-energy house does not have an energy surplus at all times.

Golden Rule ..... "One should treat others as one would like others to treat oneself"[8]

Grey Footprint ..... refers to the parts of the total Ecological Footprint that cannot be attributed to individuals, but more meaningfully to all of us. These include for example the Footprint of roads, hospitals, schools, fire brigades, courts, police and all buildings. These are things or services that are important to all people, even when they are not using them, e.g. hospitals, roads, fire department.

GFN ..... Global Footprint Network, an international non-profit organization, was founded in 2003 to enable a sustainable future where all people have the opportunity to thrive within the means of one planet. See Homepage: www.footprintnetwork.org.

Sustainability..... The word stands for a substantial and far-reaching action. It means that the natural resources available to mankind today are treated with care so that they can still be used by future generations.[9]

[8] https://en.wikipedia.org/wiki/Golden_Rule

[9] https://www.helpster.de/was-bedeutet-nachhaltigkeit-eine-erklaerung_144546

Literature

Erb, K-H; Wiesinger. M; Gaube, V; Haberl, H; Adensam, H; Gingrich, S. (2008): Ecological Footprint Calculator Austria, Update 2007, Institut für Soziale Ökologie (Wien), Fakultät für interdisziplinäre Forschung und Fortbildung (iff) Universität Klagenfurt. Erstellt im Auftrag des Österreichischen Lebensministeriums

Pekny, W. und Schwingshackl, M. (2010): Globalverstand - Vom Guten Leben mit kleinem Fußabdruck - Anleitung für zukunftsfähige Lebensstile; Handbuch zum 1-ha Workshop, November 2010, Version 1.0. www.gutlebenvoneinemhektar.org

GFN 2016: National Footprint Accounts (NFA) from Global Footprint Network; Statistical data till 2012; http://www.Footprintnetwork.org/en

GFN 2018: National Footprint Accounts (NFA) from Global Footprint Network; Statistical data till 2014; http://www.Footprintnetwork.org/en

GFN 2019: National Footprint Accounts (NFA) from Global Footprint Network; Statistical data till 2016; http://data.footprintnetwork.org -> Country Trends

Data for e-co-foot project:

Detailed calculations for the country specific data have been made using the GFN 2018 data set available at the start of the project, which is based on data up to 2014.
At the end of the project the data from 2019 were available and were used for the average Footprints of the countries (without recalculation of the Consumption-Landuse-Matrix (CLUM) and scaling of all country data).
This practical approach to the great variety of materials already produced and a data set that changes annually anyway, has so far no influence to any message or interpretation of the data, because all data show sadly but clearly: we are far away from a one planet living!