Introduction to environmental economics

Lecture notes

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Introduction

The aim of the present document is to support students in acquiring knowledge and skills necessary to successfully accomplish the subject "Introduction to environmental economics", in accordance with the intended learning outcomes based on academic performance determined by the Intended Learning Outcome Regulations of the English language Business Administration and Management bachelor programme of the Faculty of Economics and Business Administration at the University of Szeged.

In order to fulfil this goal, the present document aims to provide a brief overview of some major problems and topics dealt with by environmental and ecological economics. Although the "Introduction to environmental economics" course does not have any strict prerequisites, during certain lectures we will build on students' most basic knowledge acquired in micro- and macroeconomic courses.

The present document and the subject of "Introduction to environmental economics" in general contributes to the following professional competencies to be mastered.

Regarding knowledge, students

- will have a firm grasp on the essential concepts, facts and theories of economics and will be familiar with the relationships of national and international economies, relevant economic actors, functions and processes;
- will be familiar with the basic principles of other professional fields connected to his/her own field (engineering, law, environmental protection, quality control, etc.);
- will master the professional and effective usage of written and oral communication along with the presentation of data using charts and graphs; and
- will have a good command of the basic linguistic terms used in economics both in his/her mother tongue and at least one foreign language.

Regarding competencies, students

- will be able to follow and understands business processes on the level of international and world economy along with the changes in the relevant economic policies and laws and their effect. The student will be able to consider the above when conducting analyses, making suggestions and proposing decisions;
- will be capable of calculating the complex consequences of economic processes and organisational events;
- will be able to present conceptually and theoretically professional suggestions and opinions well both in written and oral form in Hungarian or in a foreign language according to the rules of professional communication; and
- will be intermediate users of

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professional vocabulary in a foreign language.

Regarding attitude, students

- will be open to new information, new professional knowledge and new methodologies, and to take on task demanding responsibility in connection with both solitary and cooperative tasks.
- will be sensitive to the changes occurring to the wider economic and social circumstances of his/her job, workplace or enterprise, and tries to follow and understand these changes; and
- will be accepting of the opinions of others and the values of the given sector, the region, the nation and Europe (including social, ecological and sustainability aspects).

Regarding autonomy and responsibility, students

- will be able to conducts the tasks defined in his/her job description independently under general professional supervision;
- will be able to takes responsibility for his/her analyses, conclusions and decisions; and
- will be able to take responsibility for his/her work and behaviour from all professional, legal and ethical aspects in connection with keeping the accepted norms and rules;

Below you will find 6 chapter descriptions that together constitute the major study material of the "Introduction to environmental economics" course. Each chapter begins with the clarification of the given part's aim and ends with questions and tasks for self-audit concerning the content of the chapter.

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1. A brief history of environmental thinking in economics based on a subjective selection (of authors, organizations and their works)

The **aim of the present chapter** is to provide a brief overview of the most influential environmental thinkers and works which influence the way environmental and ecological economists (and society in general) think about socio-environmental problems and related solutions nowadays.

Thinking about the relationship of economy, society and nature from an environmental point of view has a long past. Numerous ancient (e.g. Aristotle) and modern philosophers (e.g. John Stuart Mill, Aldous Huxley or Mahatma Gandhi) had interesting and relevant thoughts about the aforementioned relationship. During the 20th century even more thinkers, including economists, placed the relationship of economy and environment in the focus of their attention. Within the present topic we introduce some of the works of some of these people. Picking several authors and their works while neglecting others is necessarily an arbitrary process. Our selection is based on the literature of environmental history (Guha 2000, Taylor 2000) and the history of environmental thought in economics (Spash 1999, Röpke 2004) on one hand and on the personal preferences of the lecturer on the other.

One of the most important books in the history of environmental thinking and movements is Rachel Carson's (1962) Silent Spring. Carson gathered and synthesized our scientific knowledge about the effects of pesticides (most well-known is DDT) on the biosphere and human health. She published her findings in a relatively plain manner making her book extremely popular among the general public very quickly. Carson showed that:

- Development is a contradictory issue since new technologies (in this case pesticides) might cause enormous harm to the biosphere and human health.
- Because of inevitable human ignorance there is a necessary uncertainty regarding the unknown and unintended "side effects" of modern technologies.
- The biosphere is an interdependent system of ecosystems. Effects (pressure by humanity) on certain parts of the system affects the whole system, thus
- the strategy of "separation" (humanity separating itself from the effects it causes in nature) does not seem to work well.

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Carson's book generated social debates about the nature of 20th century "development" processes. It had such a great social impact that it basically gave the first push to the "modern" mass environmental movements in developed countries.

Another important work is Garreth Hardin's (1968) article about "The Tragedy of the Commons". This article shows how the open access (unregulated) use of natural resources leads to the overuse (unsustainable use) and degradation of said resources. Hardin's work has been extremely influential since then in many disciplines from sociology to political science including economics. (We will discuss the environmental economic relevance of the topic of open access in Part 6 entitled *"The problem of common goods in environmental economics"*.)
The next influential book is Paul Ehrlich's (1968) "The Population Bomb". This book showed extreme population growth tendencies of the 19th and 20th century and the effects of "overpopulation" on the use of nature (natural resources/biosphere). Since then environmental economists often use the so called IPAT formula (Impact = Population * Affluence * Technology) to examine the effect of different anthropogenic factors on the natural environment (the extent of human transformation on the biosphere).

An important stream in the history (and presence) of environmental-economic thinking is related to the long-term sustainability of economic growth. Probably the first economist addressing this problem was Kenneth Boulding (1966) in his article about "The Economics of the Coming Spaceship Earth". Boulding distinguishes between "cowboy-economy" (or economics) and "spaceship economy" (or economics). The former does not consider the material limits to the growth of societies and handles natural resources as infinite (the same way cowboys used to think of the prairie), the latter on the other hand realizes the finiteness of natural resources and emphasizes the need for careful resource use, recycling etc. (just like the need for spacemen to use limited resources within a spaceship).

Another important work emphasizing the limits to growth approach is Nicholas Georgescu-Roegen's (1971) book: "The Entropy Law and the Economic Process". Georgescu-Roegen wrote about "biophysical economics" emphasizing that economists should not forget about the biological and physical basis of the economic process (as it often happens in mainstream/neoclassical economics). Georgescu-Roegen applied the entropy law to the economic process according to which the recycling of energy is impossible – as a result economies sooner or later will have to rely solely on renewable energy sources. He also formulated *"the minimum program of biophysical economy"*, according to which:

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- the production of weapons should be stopped immediately;
- there is a need for an immediate help of poor countries to be able to fight extreme poverty;
- human population should be reduced to a level which can be fed (supported) with organic agriculture;
- each and every form of energy waste should be stopped;
- our dependency on extravagant goods has to be eliminated;
- we have to get rid of fashion;
- durable and fixable goods have to be produced; and
- we have to get rid of workaholism and reach work-life balance.

The most well-known work in the area of questioning the sustainability of economic growth is that of Dennis and Donella Meadows (1972) and their co-authors called "Limits to Growth". In their book the authors introduce the results of their world system computer models created to analyse the long-term sustainability of economic growth. Their conclusion is that regardless of what we think of future technological development, if economic growth is to continue in the long run it leads to "overshoot" and a catastrophic collapse of well-being (production and consumption opportunities) of modern societies. The only way to overcome this problem is to stop economic growth: stabilization (non-growth) of human population and production is needed to avoid future catastrophe.

The last book which is important from a historical perspective regarding the questioning and critique of the sustainability of economic growth is Herman Daly's (1977) Steady-State Economics. Daly, a student of Georgescu-Roegen, provides an environmental economic critique of economic growth and creates an alternative economic model of an economy with a non-growing material and energy "throughput", which he calls "steady-state economy".

The sustainability of continuous economic growth (whether sustainable economic growth is a real option or not) has been a debated topic ever since in environmental and ecological economics – there are new approaches emphasizing the need for a transition to non-growing economies. The most popular and influential of these nowadays is probably the concept of "degrowth".[1] We discuss this topic later in detail within the environmental policy course in the topic of *"Economic growth and environment"*.

The work of Barnett and Morse (1963) entitled "Scarcity and Growth" introduced the problem of non-renewable and renewable resources into economic thinking. They examined the

[1] See www.degrowth.org

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optimal use of renewable and non-renewable natural resources, e.g. through the concept of maximum sustainable yield (MSY). Krutilla (1967) in his article entitled "Conservation Reconsidered" addresses the "hedonic value" of nature and the loss of this "hedonic value" in case nature is destroyed/degraded. He gives an economic argument for the protection of nature. Monetary valuation of nature (natural resources) is a debated issue even since then, "environmental valuation" has become a separate field of research in environmental and ecological economics.[2]

Another important work is Kneese et al.'s (1970) "Economics and the Environment". A Materials Balance Approach" which applies Pigou's external cost concept to the analysis of environmental pollution. The external cost approach to environmental problems is extremely influential within environmental economics, we learn more about its theoretical background and practical applications during the environmental policy course in the *"Externalities, Pigouvian taxies and the Coase theorem"*.

Another well-known book which has been influencing public thinking about the economy-environment relationship is Ernst Schumacher's (1973) "Small Is Beautiful: Economics As If People Mattered". This book is basically a collection of Schumacher's "papers" and it is probably most known because of two trails of thoughts:

1. The environmental and social critique of large-scale technologies (Schumacher argues that such technologies are necessarily out of control for local communities and are environmentally destructive) and Schumacher's „appropriate" technology/"people-centred" technology concept which emphasizes the need for smaller-scale, better controllable and more human technologies.
2. Schumacher's essay on „Buddhist" economics – how economics would look like if it were rooted in the Buddhist religious/philosophical tradition.[3]

The report of the UN Committee for Environment and Development led by Gro Harlem Bruntland (1987) called "Our Common Future" is a vital document because it defined "sustainable development" and put the notion on the international political agenda. While analysing development processes the document observes that global development trends are unsustainable because they are extremely (1) environmentally destructive and (2) socially unjust. Thus, humanity is on an unsustainable development path which has to be replaced with a "sustainable development" one: a "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* It is important to emphasize that the document did get a lot of critique because it identified

[2] We will not be able this topic within present course. For the basic dilemmas regarding environmental valuation see e.g. http://www.macaulay.ac.uk/economics/research/eve/index.htm.

[3] Nowadays Buddhist economics is a separate field of heterodox economics, see e.g. http://en.wikipedia.org/wiki/Buddhist_economics

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sustainable development with green economic growth, although the sustainability of economic growth is in itself questioned by many scholars and different disciplines (see previous paragraphs).

An important event in the history of environmental thinking is the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988.[4] The organization is working on estimating the state and impacts of global climate change[5] based on current high quality scientific knowledge about the topic. Experts from universities from more than 100 countries, research centres/agencies, business organizations, environmental non-governmental organizations (NGO-s) and other organizations (altogether several hundred experts) take part in the work of the IPCC. The IPCC releases so called *"Synthesis reports"* in every 7 years in which it summarizes our current scientific knowledge about climate change. These reports are written by IPPC and reviewed by lead researchers of the field and are accepted by the plenary of the IPCC based on consensus. In 2007 the IPCC won Nobel Peace Prize for its 4th Synthesis Report. Its 5th Synthesis Report was released in 2014. The main messages of the last reports are that there is a very high probability (>90%) that:

- global climate change is caused most of all by human activities, and
- in case we do not take serious measures for mitigation it might have catastrophic consequences for humanity.[6]

By the 1990s there has been extreme interest in sustainability-related issues, therefore there are many scientists, research projects, publications and journals addressing the economy-society-nature relations – the problems of sustainability/sustainable development. Therefore, selecting only several authors and works for introduction is necessarily an extremely arbitrary process. However, I would still like to emphasize the importance of several recent works/organizations.

An important and interesting book is Jared Diamond's (2004) Collapse. In this book Diamond tries to answer the following question: Why have certain civilizations collapsed while others survived? He examines several past civilizations – his most well-known example is Easter Island – and creates a model examining the collapse and/or survival of civilizations based on 5 variables:

- climate change;
- society's effect on the natural environment (causing/not causing environmental problems);
- political, social and religious relations of societies (being/not

[4] The organization has a quite informative homepage: www.ipcc.ch
[5] We learn about global climate change within the *"Global environmental problems"* topic, based on e.g. the documents of the IPCC.
[6] Based on the success of the IPCC a new organization has been formed in the past years with the same functions in the area of biodiversity and ecosystem services – this is the Intergovernmental Platform on Biodiversity and Ecosystem services (www.ipbes.net).

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being able to adapt to environmental changes);
- trade relationships with friendly neighbours (presence/lack (collapse) of trading partners); and
- attacks of hostile neighbours (lack/presence of hostile neighbours).

A project of great importance for environmental and ecological economics is United Nations' Millennium Ecosystem Assessment[7] project which published its final Synthesis Reports by 2005. This project assessed the consequences of ecosystem change for human well-being and aimed to provide a scientific basis for action needed to enhance the conservation and sustainable use of ecosystems. The project also contributed to the understanding and mainstreaming of the concept of ecosystem services (defined simply as *"the way people and communities benefit from ecosystems"*) which has been a central and debated concept within the environmental and economic literature even since then. On the one hand the concept is the basis of modern economic-based environmental policy instruments, e.g. within the projects of "*The Economics of Ecosystems and Biodiversity"*[8] and *"Payment for Ecosystem Services"*[9]. On the other hand its use as a ground for market-based environmental policy is heavily criticized for several reasons (Gómez-Baghettún–Pérez 2011). We further elaborate the concept of ecosystem services within the topic of *"Global environmental problems"*.

The so called Stern Review (2006) on climate change was carried out by a research team lead by economist Nicolas Stern. The Report's aim was to estimate the effect of global climate change on global GDP. The report is extremely important in environmental and ecological economics because by applying a GDP-centred approach to the problem of global climate change it created significant debate within top mainstream economic journals and among leading scholars regarding the future welfare effects of global climate change. (The fact that mainstream economics has only started to deal with the issue of global climate change at this point of time shows its GDP-centred focus. The report is of the same nature: its title is *„The Economics of Climate Change"* and this way it identifies economics with GDP-centred thinking and analysis.)

The main messages of the report are that:
- mitigation regarding climate change is clearly cheaper than „non-mitigating", and
- if global economy continues to develop on a „business as usual" path, global climate change will have catastrophic effects on human welfare (measured in GDP).

Another important research report is the report of the Commission on the Measurement of Economic Performance and Social Progress lead by Nobel Prize winner Economist Joseph

[7] http://www.millenniumassessment.org/en/index.html
[8] www.teebweb.org
[9] http://www.unep.org/pdf/PaymentsForEcosystemServices_en.pdf

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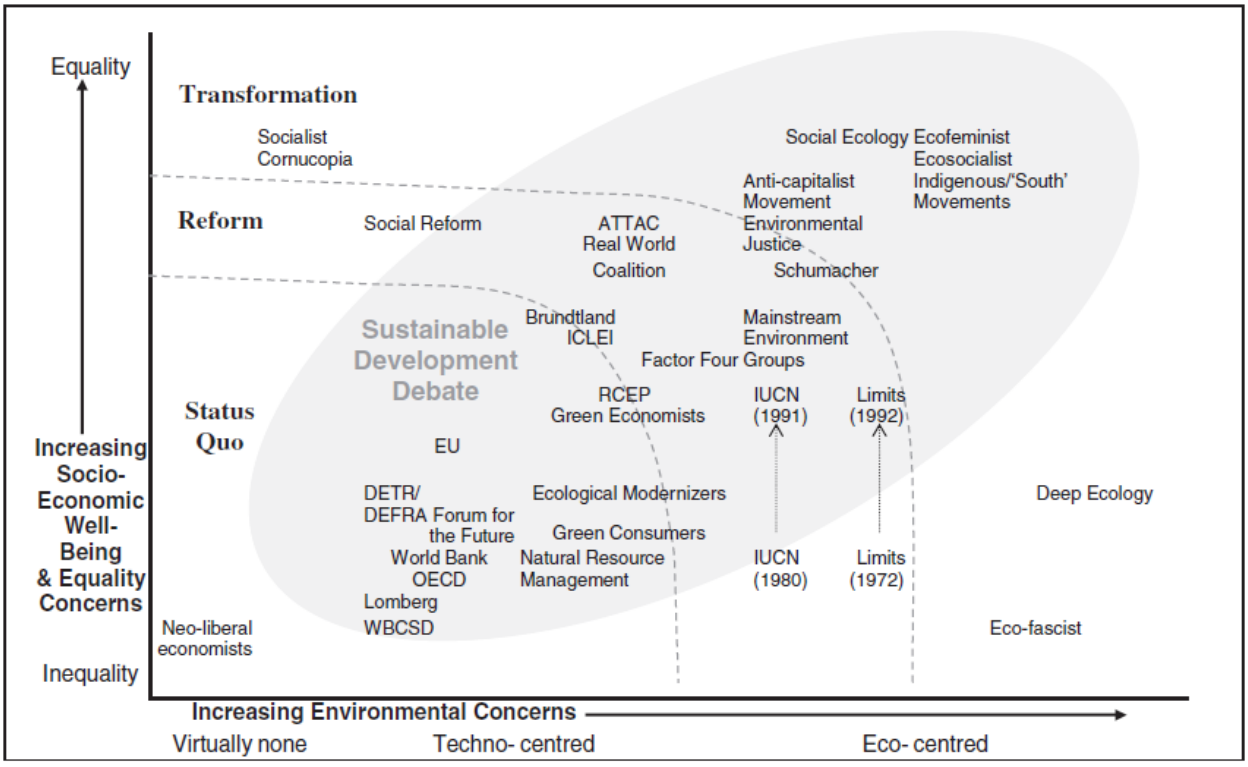
Stiglitz and Amartya Sen. The Stiglitz-Sen-Fitoussi Report (2009) gives an extensive critique of the System of National Accounts (SNA) and its central economic measure of Gross Domestic Product (GDP) as an indicator of social progress. Beside analysing the limits of SNA and GDP from the perspective of the measurement of social progress the report also synthetizes current knowledge about social progress and sustainability measurement. The report is important because although the critique of SNA- and GDP-centred economic thinking has a long tradition in environmental and ecological economics it has not become the part of mainstream economic thinking until the publication of the Report.

Nowadays, there are many different social and scientific approaches focusing on the economy-social-environmental relations – focusing on the issue of sustainability/sustainable development. The diversity of approaches is shown by *figure 1*.

Figure 1. Mapping of views on sustainable development



Source: Hopwood et al. (2005).

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Within economics, there are two paradigms that have the economy-environment relationship in the primary focus of analysis: environmental economics and ecological economics. There are a number of articles dealing with the detailed analysis of the differences between these, see e.g. Gowdy–Erickson (2005), Röpke (2005) and Venkatachalam (2007). Probably the most important (influential) difference is that while environmental economics applies the rules, methods and tools of neoclassical economics to environmental (sustainability) problems, ecological economics considers neoclassical economics inappropriate for approaching sustainability problems meaningfully and applies a problem-centred (transdisciplinary) approach to sustainability problems involving knowledge from many different disciplines from biology and ecology through psychology and political science to sociology and economics.

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Gowdy, J.–Erickson, J. D. (2005): The Approach of Ecological Economics. *Cambridge Journal of Economics*, 29, 2, 207–222.

Guha (2000): *Environmentalism. A Global History.* New York, Longman.

Gómez-Baggethun, E. – Pérez, M.E (2011): Economic valuation and the commodification of ecosystem services. *Progress in Physical Geography*, 35, 613-628.

Hopwood, B. – Mellor, M. – O'Brien, G. (2005): Sustainable Development: Mapping Different Approaches. *Sustainable Development*, 13, 38-52.

http://en.wikipedia.org/wiki/Buddhist_economics

http://www.macaulay.ac.uk/economics/research/eve/index.htm

http://www.millenniumassessment.org/en/index.html

http://www.unep.org/pdf/PaymentsForEcosystemServices_en.pdf

Röpke, I. (2004): The Early History of Modern Ecological Economics. *Ecological Economics*, 50, 3–4, 293–314.

Röpke, I. (2005): Trends in the Development of Ecological Economics from the Late 1980s to the Early 2000s. *Ecological Economics*, 55, 2, 262–290.

Spash, C. L. [1999]: The Development of Environmental Thinking in Economics. *Environmental Values*, 8, 4,413–435.

Taylor, D. A. (2000): The Rise of the Environmental Justice Paradigm: Injustice Framing and

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the Social Constriction of Environmental Discourses; *American Behavioral Scientist*, 43, 508–580.

Venkatachalan, L. [2007]: Environmental Economics and Ecological Economics: Where they can converge? *Ecological Economics*, 61, 2–3, 550–558.

Works introduced within present chapter

www.degrowth.org

www.ipbes.net

www.ipcc.ch

www.teebweb.org

Questions/exercises for self-audit

List 5 authors and their works which had enormous influence on thinking in terms of the economy-environment!

What are the main messages of Elinor Ostrom's "Slient Spring"?

What are the main messages of the Stern Review on Climate Change?

What is the difference between environmental economics and ecological economics?

What do we mean by ecosystem services?

What is the IPPC? Why is it relevant to environmental economics?

What does "sustainable development" mean?

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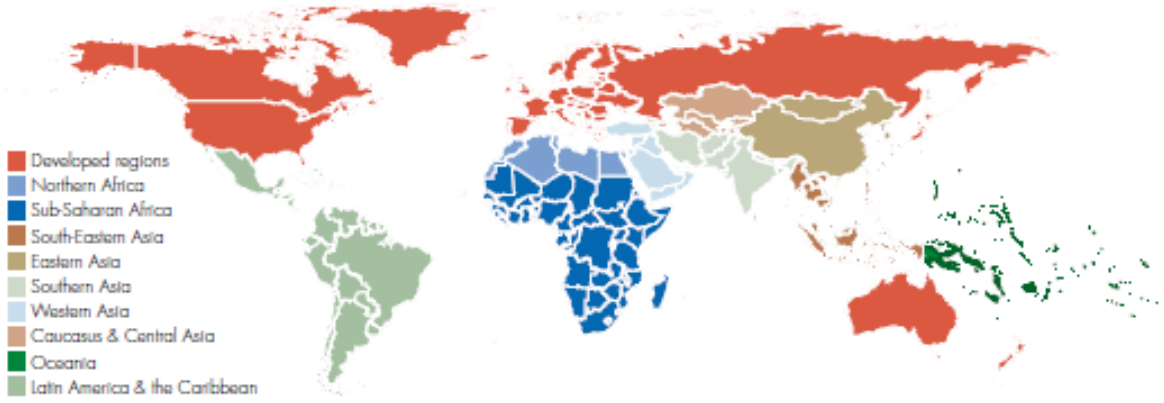
2. Global social problems

The **aim of the present chapter** is to give a brief overview of certain global social problems, belonging to the "social pillar" of sustainability thinking.

There is extensive literature (including textbooks, homepages, statements etc.) on global social problems. Different authors list different global social problems and group them in different ways. Furthermore, introduction and analysis is difficult because global social problems are interrelated and related data might be unreliable.

Furthermore, these problems affect different regions in different ways and to different extents. Therefore, it is important to distinguish between different regions when discussing global social problems. Within the present topic we use the usual *"North-South", "developed-developing"* and *"rich-poor"* dichotomies, however, the situation is much more complex than that when classifying relatively homogenous regions from the perspective of global social problems (*figures 1 and 2*).

Figure 2. Regional groupings of countries for analysing millennium development goals - world



Source: UN 2014

Figure 3. Regional groupings of countries for analysing millennium development goals - Africa

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Source: UN 2014

Probably the most important initiative dealing with global social problems is the UN's Millennium Development Goals project.[10] This identifies the following problem areas:

- Extreme poverty and hunger (and inequalities)
- Lack of primary education
- Gender inequality
- Child mortality
- Maternal health
- HIV/AIDS, Malaria and other diseases
- Environmental unsustainability
- Lack of global partnership for development

Besides, other global social problems might be identified, such as

- Global debt crisis
- Wars, military expenses, weapons of mass destruction
- Overpopulation/Population growth
- Energy crisis

In the present course we do not have the opportunity to discuss all of these in detail – this would require (at least) a separate thematic course for global social problems. Here we only introduce the following main problem groups:

- Poverty/inequalities
- Food crisis
- Overpopulation and population growth

[10] http://www.un.org/millenniumgoals/2014%20MDG%20report/MDG%202014%20English%20web.pdf

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- Energy crisis.

2.1. Poverty/inequalities

Inequalities take many forms and have many different dimensions. Also, different studies dealing with social inequalities come to different conclusions about their extent, change etc. (based on e.g. the methodology they use). For this reason it is difficult to make general statements regarding poverty and inequalities.

However, we can talk about a global 80-20 rule (which has become a 85-15 rule lately). According to this rule a few years ago approximately 80% of global goods used to be consumed by the richest 20% of global population. However, global inequalities have grown further in the last decade: the richest 15 percent of the global population consumes 85% of goods produced annually. Differences are even higher if we look at inequalities in the distribution of wealth globally[11].

Inequalities appear both on an international level and within nations. Internationally, we distinguish "Northern" (rich, developed) and "Southern" (poor, developing) countries. The former (including most of Europe, Northern America, Japan, Australia and New Zealand) are a lot richer on average than the latter. Within nations inequalities are found everywhere in the world, although to different extent.

The extent of global poverty is extremely high, its rate is probably decreasing, but absolute numbers are increasing. For statistics on social inequalities and poverty see the related slides of *"Global social problems"* ppt.

Although we usually emphasize the division between Northern and Southern countries regarding global social problems, extreme poverty and inequalities can be found also within developed nations.

2.2. Food crisis

One example for extreme inequalities is the distribution of food globally. While in Southern countries the main reason of mortality is undernourishment, in Northern countries it is overweight. This means that while the population of developed nations consume too much food on average, many people living in developing counties do not have enough food for healthy nutrition.
The number of undernourished people is extremely high, approximately 1 billion people

[11] See slide 4 of "Global social problems" ppt at coospace.

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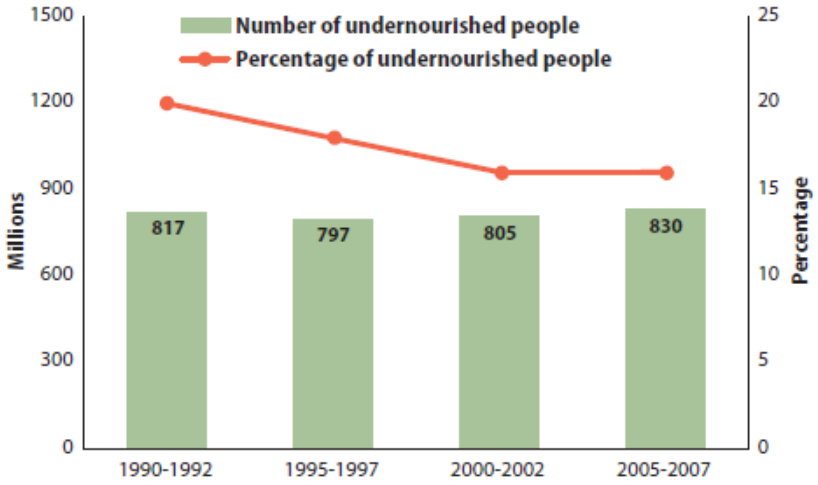
belong here (*figure 3*). (For further statistics see related slides of *"Global social problems"* ppt.)

Figure 4. The number and percentage of undernourished children



Source: UN (2010)

Research shows that there is no global food shortage at present. It means that humanity produces enough food to provide healthy nourishment for every people on a global level. However, food is extremely unevenly distributed – thus we can say that the food crisis is most of all a distributional problem. It is influenced by many factors, e.g. the uneven distribution of wealth and income, but also land. In many societies – most of all in developing countries – agricultural land is extremely unevenly distributed. Its distribution follows a so called 95%-5% rule which means that 5% of the large landowners own 95% of agricultural land so only 5% of the land serves 95% of small farmers – this trend might be reinforced by land grabbing[12]. It means that on the one hand we have huge agro-industrial complexes producing agricultural produce for global markets, while on the other hand extremely small parcels of land for poor households are not big enough to cover household consumption.

As Amarty Sen shows, undernourishment is the result of the lack of positive freedom regarding having access to food. Positive freedom means that people are actually capable of committing certain deeds, e.g. access to food in our case. Thus, they have the tools – be it money or land – to secure access. Unfortunately in present societies many people lack such basic positive freedoms, even if there is significant food production at the place. Amartya Sen showed that many food exporting countries face undernourishment – which means that they are able to produce enough food to feed their population, but among present global market

[12] http://vimeo.com/29316428

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circumstances food is distributed based on the global market mechanism, which results in many people lacking the necessary resources to access it.

Although there is no global food shortage at the present (see above), future trends regarding food supply are not promising. On the one hand, the demand is to grow: the (1) fact that enormous economic growth in certain huge developing countries like India and China results in a new consumer class in Southern countries consuming more, (2) global population growth, and (3) the need for biomass energy (especially biofuels) all contribute to the growth in global food demand. On the other hand, it is questionable that supply is able to follow the growth in demand because: (1) agricultural yields of important cereals seems to be peaking (might not be further extended), (2) most fish stocks are overharvested and declining, (3) agricultural land is overused (not managed in a sustainable way) in many areas because of industrial agriculture, (4) the extent of land suitable for agricultural production cannot be extended and (5) environmental problems (e.g. climate change, extinction of bees, invasive species) might result in a reduction in agricultural yields.

2.3. Population growth

Human population on Earth has reached 7 billion (Figure 4) and it is still growing (by approximately 75 million people/year), although in a reduced extent. There are different forecasts, but global population might peak about 9 billion people around 2050.

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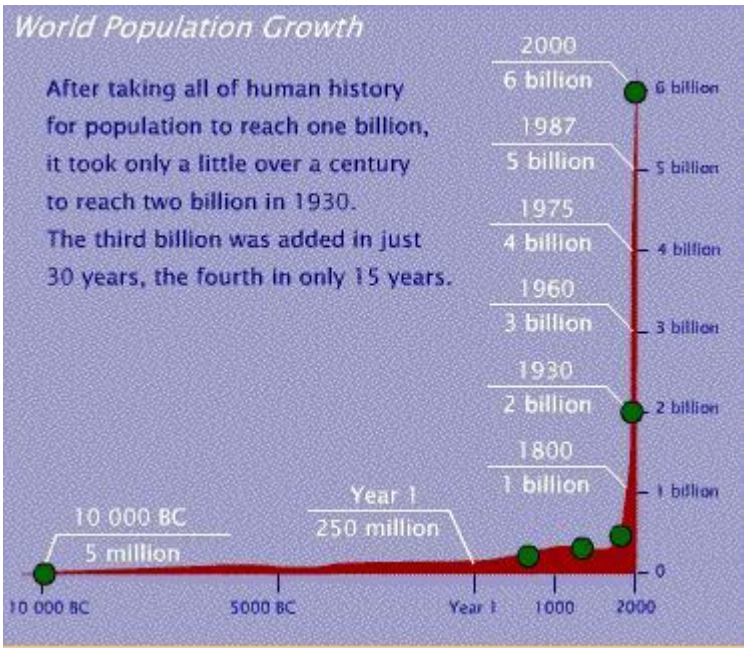
Figure 5. Human population growth since 10000 BC to 2000 AC.



Source: http://www.sustainablescale.org/areasofconcern/population/populationandscale/quickfacts.aspx

Population growth is globally uneven (*figure 5*). As long as many developed regions face a decline in population, many developing countries still face high levels of population growth.

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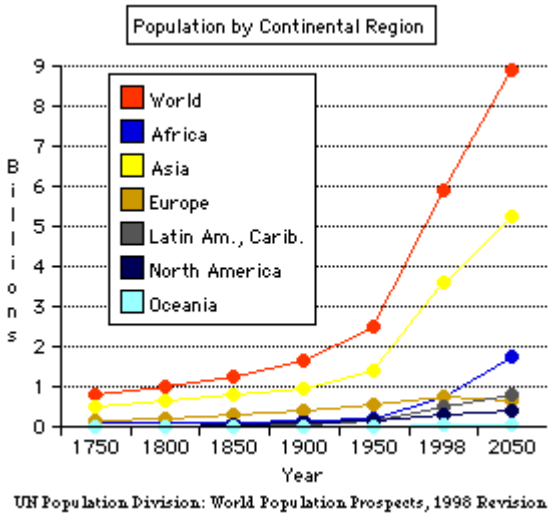
Figure 6. Population growth by regions



Source: http://www.worldpopulationbalance.org/global_population

High level of population growth causes many problems in developing countries. It is extremely difficult to provide basic public services (e.g. education, health care) to many children and young adults. Also, the job market of developing countries is not able to absorb the high amount of young people entering it each year. Population growth also results in growing cities, megacities, where people living in slums (constituting 33% of all urban population in developing regions) live among extremely poor circumstances[13]. Population growth is also problematic from an environmental perspective – it results (together with growth in consumption and even more effective technology) in an increased pressure on natural resources and increased pollution[14].

There are several solutions for speeding up population transition (slowing down and stopping population growth). Such solutions are (1) family planning, (2) contraception, (3) changing the social status of women, (4) investments in education and (5) social security. However, these are extremely expensive (especially for developing countries) and many are hindered by cultural (religious) norms.

2.4. Energy crisis

Energy crises are not new in the 20th century history of human societies. According to experts modern societies have been facing an energy crisis in the past several years. It is related to the following:

[13] For documentaries about the topic visit www.thecultureunplugged.com.
[14] For further statistics see the slides of *"Global social problems"* ppt at coospace.

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- Modern societies' strong dependence on fossil fuels (figure 6 and 7)[15]
- Extreme differences in energy consumption levels (Figure 8)
- Scarcity of fossil fuels and peak oil (discussed later within this topic)
- Fossil fuels and environmental pollution
    - Direct negative environmental effects of fossil fuels are CO2 and methane emissions which are the main sources of greenhouse gas effect and global climate change (see *"Global environmental problems"* topic), but non-conventional oil production has also other significant environmental effects[16].
    - Indirect negative environmental effects of fossil fuels are related to the ever growing energy inputs of the economy which allows for population and economic growth and serve as positive feedback loops causing even higher fossil fuel use. This self-reinforcing growth in population, consumption and energy use is the reason for enhanced transformation of the biosphere in many ways.
- „Lack of" safe and clean alternatives (discussed later within this topic)

[15] https://www.youtube.com/watch?v=cJ-J91SwP8w
[16] https://www.youtube.com/watch?v=YkwoRivP17A

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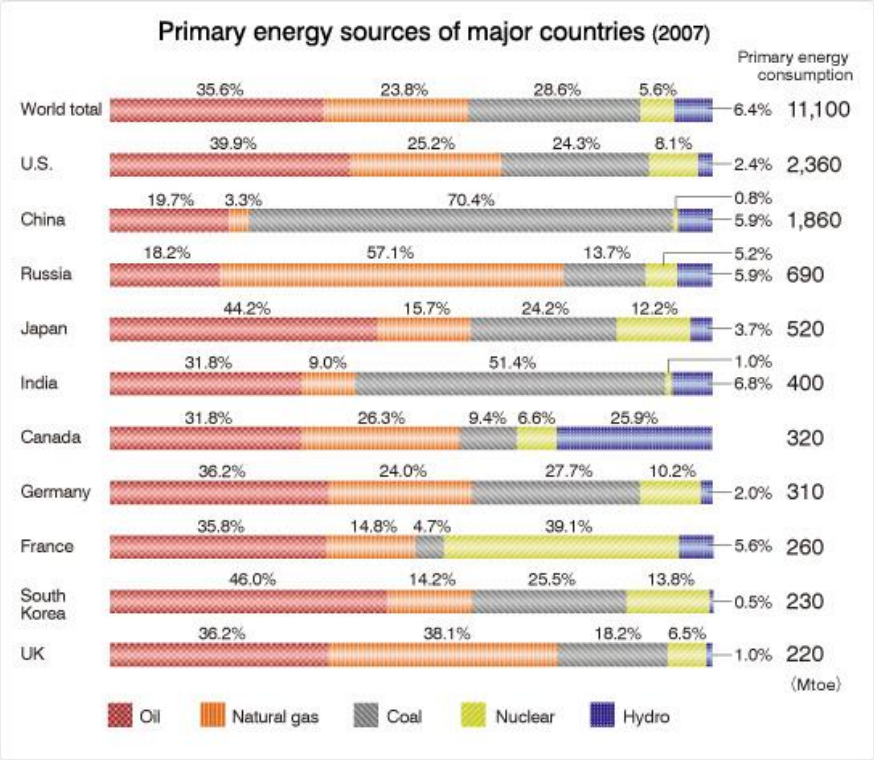
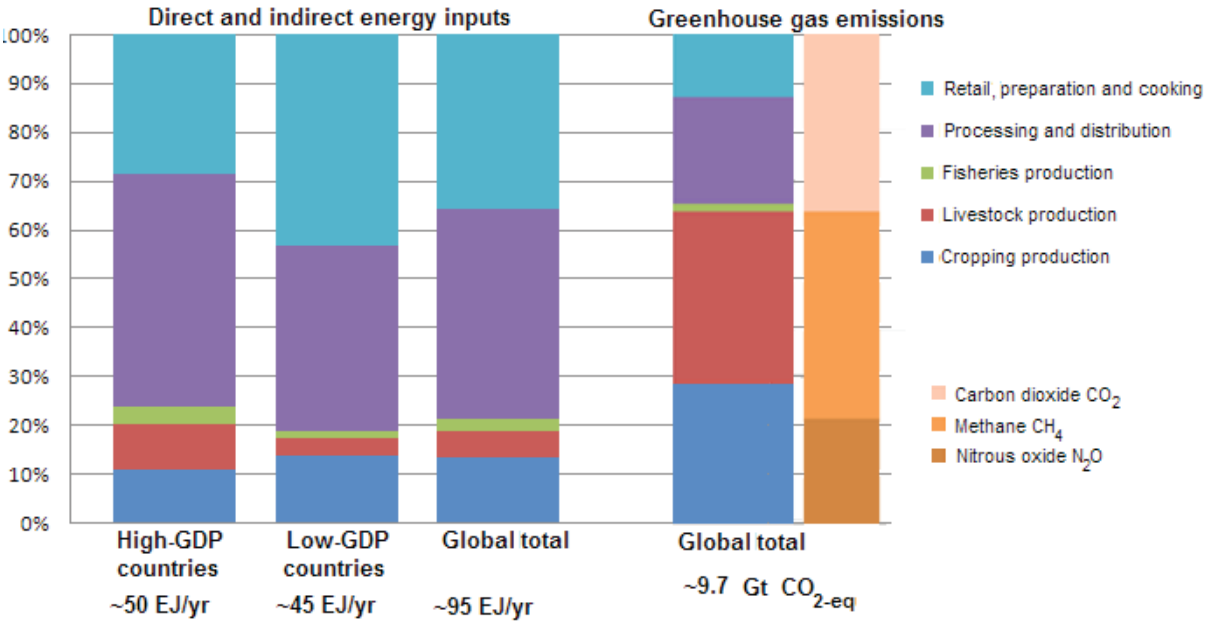
Figure 7. Primer energy sources of major countries



Source: https://www.mhi-global.com/discover/earth/issue/history/history.html

Figure 8. Agriculture's share in fossil energy use



Source: FAO (2011)

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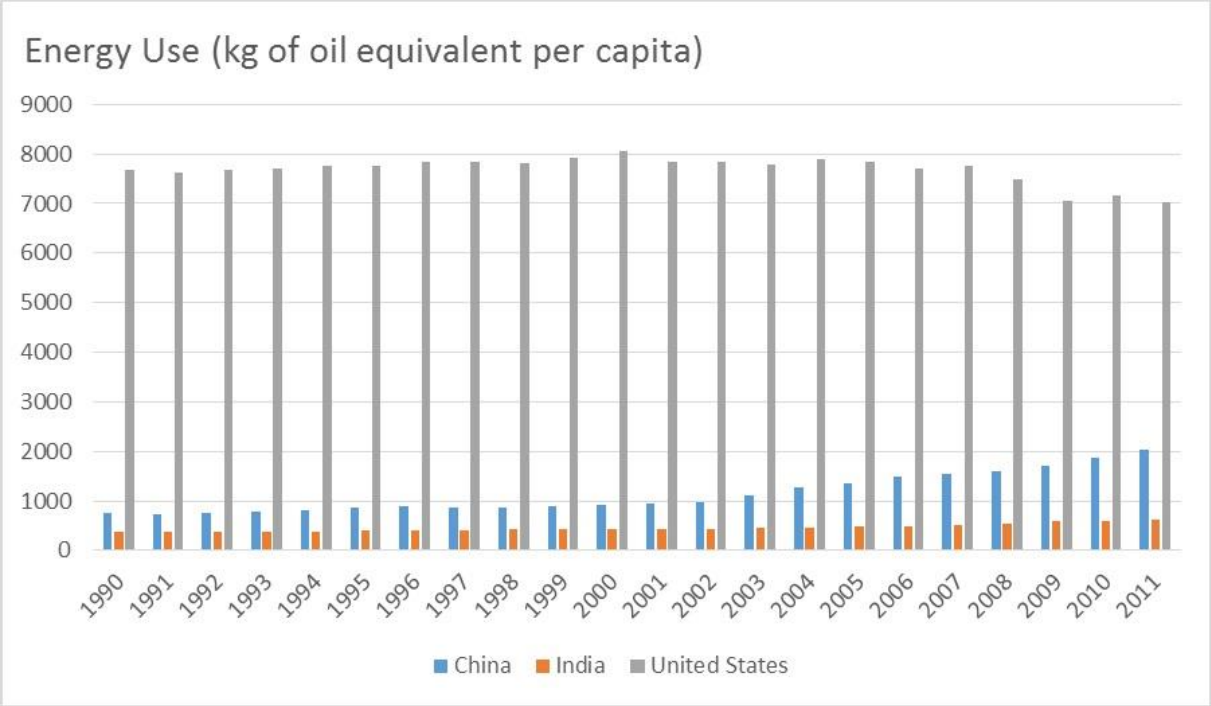
Although energy (including fossil energy) use among human societies is extremely uneven (*figure 8*), our high dependence on fossil energy can be easily shown – we basically use fossil energy-based technologies for fulfilling each and every of our (basic) needs: from food through sheltering and communication to mobility.

Figure 9. Examples for uneven energy use on Earth



2.4.1. Scarcity of fossil fuels and peak oil

Fossil fuels are non-renewable, thus scarce. The exact extent of scarcity is difficult to guess because of several reasons. There is uncertainty regarding

- the amount of fossil fuel reserves on Earth,
- the future of technology affecting the harvesting opportunities of fossil fuel reserves,
- the future of alternative (renewable, substitute) technologies and the amount of renewable energy human societies will be able to use in the future, and
- societal preferences regarding energy use in the future.

In spite of these uncertainties many experts think that the scarcity of fossil fuels might mean a problem for industrial civilizations in the near future. The reason for that is the so called peak oil theory/phenomena.
Researchers examining the process of oil production realized that oil production of

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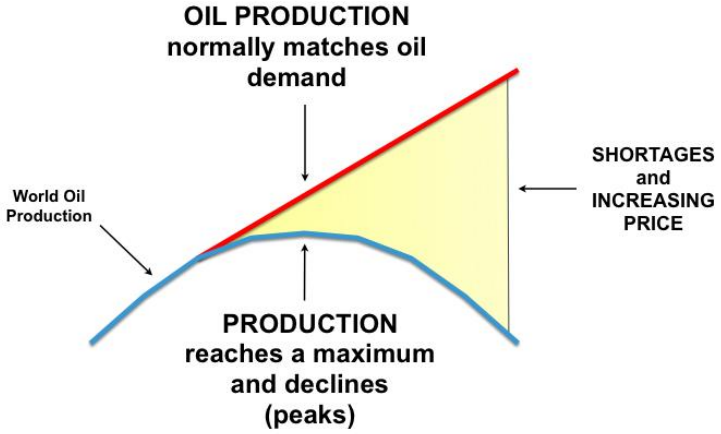
oil fields can be characterized by an inverse "U" shaped curve (*figure10*). It means that after a while the amount of oil harvested from an oil field will decline no matter how harvesting efforts are extended. And what is true for single oil fields seems to be also true for larger entities: nations, regions and even globally. It means that global oil production also has a peak.

Figure 10. The "Hubbert curve" and the long-term supply and demand for oil



Source: http://www.postpeakliving.com/peak-oil-primer

Peak oil is a problem because it means a peak for long term global oil supply, while in our heavily fossil fuel dependent societies demand is continuing to increase. Limited supply and increasing demand will result in significant price increase which result in the price increase of each and every goods and services we produce and consume. It drastically reduces real income (amount of goods and services we are able to buy) which potentially means a new form of civilization with extremely reduced production and consumption levels (material well-being).

(Although in the present writing we cannot go into detail regarding the effects the huge price increase of oil prices would cause to our civilization, imagine e.g. the change large cities should undergo in order to be able to solve their food supply. Presently food supply is solved from outside, food (produced with the help of fossil fuel technology) is often transported from thousands of kilometres (with the help of fossil fuels…)).

Although we are now about peak oil, it is debated when global oil production is (going) to peak – there is significant scientific debate on this topic (*figure 11*). According to some it already happened (several years ago, appr. in 2010) or is just happening, while others state that it is only going to happen in 20-30 years from now. Whatever we think of the exact time of the global oil peak, it is clear that humanity needs to look for energy sources other than non-renewable fossil ones. Present alternatives

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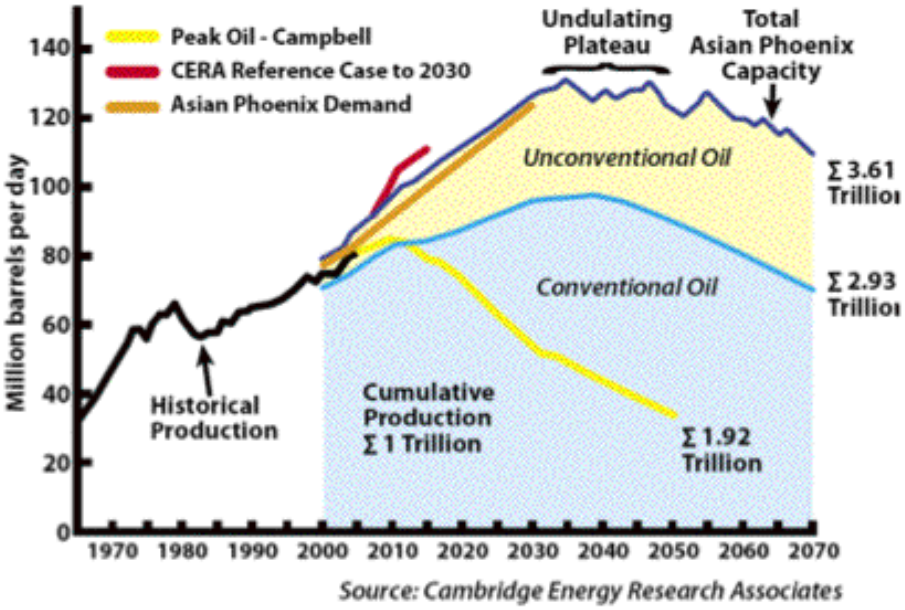
can be grouped into (1) nuclear and (2) renewable energy sources.

Figure 11. Global oil invention and production in the past and future



Source: http://www.feasta.org/documents/energy/oil_peak_opinions.htm

2.4.2. Lack of safe and clean alternatives

When discussing present alternatives to fossil fuels we usually discuss the potential role of nuclear energy and renewable energy sources.

Nuclear energy

One of the alternatives of fossil fuels is nuclear energy. Different nations have different attitudes to this form of energy production. As long as many European states (Germany, many Nordic countries, Italy) and Japan etc. consider nuclear energy too risky and try to solve their energy supply without it, others (USA, Russia, China, CEE countries including Hungary) consider it as an important source of energy in the coming decades.

Regarding nuclear energy it is important to emphasize the following:

- Risks – it generates risk because of potential power plant accidents and nuclear waste production.
- Radioactive waste – radioactive waste is extremely hazardous and should be stored for thousands of years without any contact with (emissions to) the environment. At the moment there is no real safe solutions for that – there exist no waste disposal site on Earth for final high-level radioactive waste disposal.

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- Non-renewable – it is based on non-renewable minerals (uranium).
- Social opposition – because of the associated risks there is often strong social opposition against power plants and waste disposal sites.

Renewable energy

According to most scholars, investing in renewable energy technologies is potentially the best way for future (post-carbon) energy production. However, the potential of renewable energy is limited at the present, which means that at the moment it is not possible to replace fossil energy with renewables. (The topic of renewables is also a huge one and unfortunately here we do not have the opportunity to discuss it in detail.)

Last but not least it is important to emphasize that according to many researchers an ever growing energy supply means ever growing use of each forms of energy (fossils, nuclear, renewables) and this way necessarily generates more and more future risks. Thus human societies should address the question of sufficiency (the question of *"How much is enough?"*) beside the efforts for increasing energy efficiency.

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http://www.un.org/millenniumgoals/2014%20MDG%20report/MDG%202014%20English%20web.pdf

www.thecultureunplugged.com

Questions/exercises for self-audit

What do you know about global poverty/inequalities?

What do you know about the food crises?

What do you know about global population growth tendencies?

What do you know about the energy crises?

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3. Global environmental problems. Ecosystem services.

The **aim of the present chapter** is to provide an introduction to some major global environmental problems – problems which primarily contributed to the urgent need for environmental action and the emergence of environmental and ecological economic thinking within economics.

Global environmental problems are those problems which "forced" economists to deal with environmental issues. Within the topic we touch upon several of these:

- Problems related to the atmosphere (global climate change, ozone layer depletion),
- problems related to water (oceans, fresh water), and
- problems related to biodiversity loss.

We neglect numerous global environmental problems (e.g. soil, deforestation, waste) from the investigation – the reason for that is the lack of time to deal with them. We also examine these problems from an (anthropocentric) economic point of view – we do it by examining the concept of ecosystem services.

3.1. Global environmental problems – a thematic overview

3.1.1. Global climate change

If a social scientist (e.g. economist) wants to gain reliable knowledge about climate change, the quickest and most reliable way to do it is probably to follow the work of the IPCC[17]. The IPCC publishes *"Synthesis Reports"* every 6-7 years. Within these current scientific knowledge about climate change is summarized. According to their latest (2014) report:

- global climate change (global warming) is in process, and
- humanity plays an essential role in it.

Humanity contributes to the greenhouse effects by emitting greenhouse gases to the atmosphere (*figure 1*). These greenhouse gases contribute to climate change to different extents – they have different global warming potentials, e.g. methane's GWP is 21 times more compared to CO2's - see *figure 1*.

[17] www.ipcc.ch

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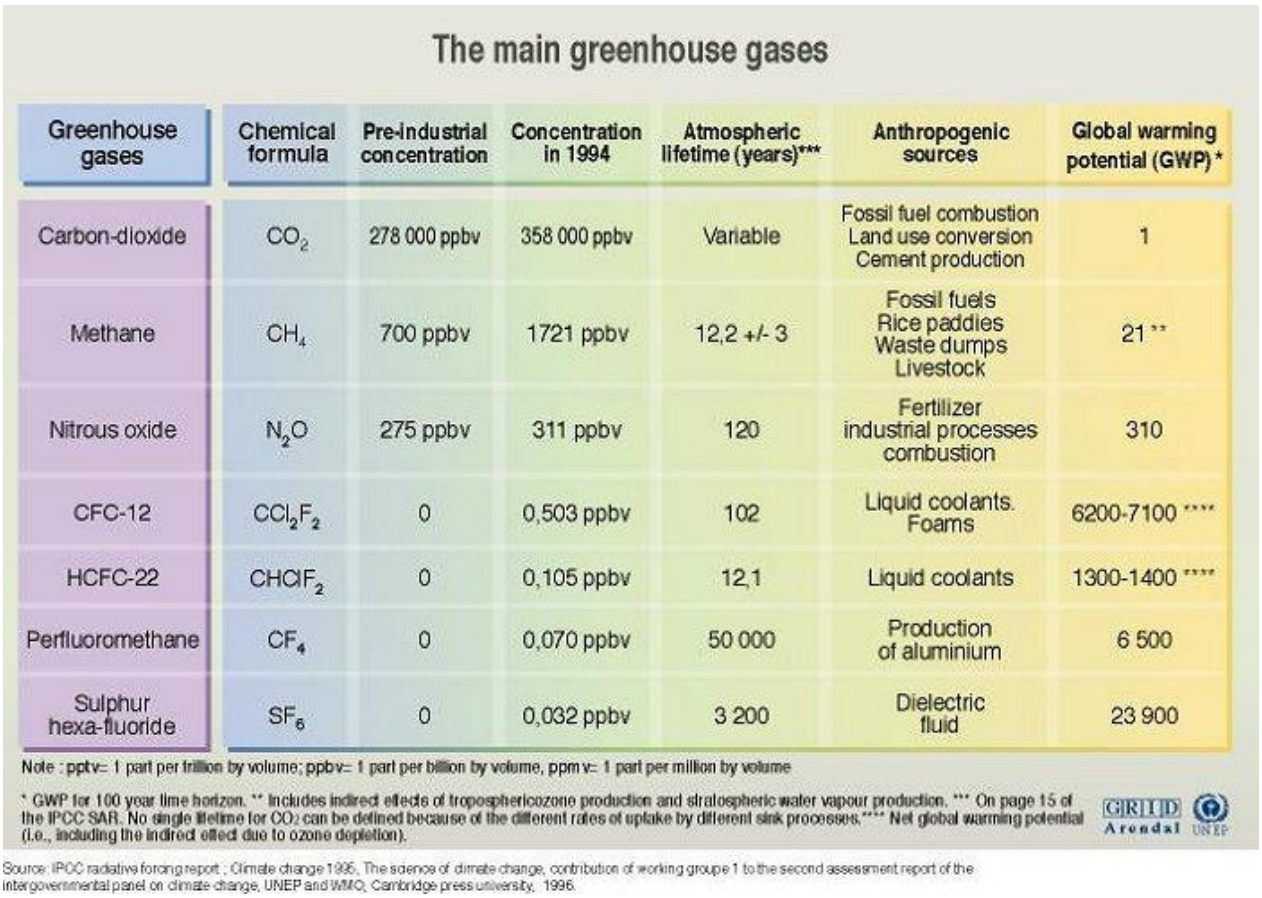
Figure 12. The main greenhouse gases



The main greenhouse gases

Greenhouse gases	Chemical formula	Pre-industrial concentration	Concentration in 1994	Atmospheric lifetime (years)***	Anthropogenic sources	Global warming potential (GWP) *
Carbon-dioxide	CO_2	278 000 ppbv	358 000 ppbv	Variable	Fossil fuel combustion Land use conversion Cement production	1
Methane	CH_4	700 ppbv	1721 ppbv	12,2 +/- 3	Fossil fuels Rice paddies Waste dumps Livestock	21 **
Nitrous oxide	N_2O	275 ppbv	311 ppbv	120	Fertilizer industrial processes combustion	310
CFC-12	CCl_2F_2	0	0,503 ppbv	102	Liquid coolants. Foams	6200-7100 ****
HCFC-22	$CHClF_2$	0	0,105 ppbv	12,1	Liquid coolants	1300-1400 ****
Perfluoromethane	CF_4	0	0,070 ppbv	50 000	Production of aluminium	6 500
Sulphur hexa-fluoride	SF_6	0	0,032 ppbv	3 200	Dielectric fluid	23 900

Note : pptv= 1 part per trillion by volume; ppbv= 1 part per billion by volume, ppmv= 1 part per million by volume

* GWP for 100 year time horizon. ** Includes indirect effects of tropospheric ozone production and stratospheric water vapour production. *** On page 15 of the IPCC SAR. No single lifetime for CO_2 can be defined because of the different rates of uptake by different sink processes.**** Net global warming potential (i.e., including the indirect effect due to ozone depletion).

GRID Arendal UNEP

Source: IPCC radiative forcing report ; Climate change 1995, The science of climate change, contribution of working groupe 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge press university, 1996.

Soure: IPCC 2007

The most well-known greenhouse gas is CO2, it contributes to more than 75% of anthropogenic GHG emissions (*Figure 2*). The sources of GHG emissions by sectors is shown at *Figure 3.* (More detailed data about GHGs and GCC is shown in the ppt *"Global environmental problems. Ecosystem services."*

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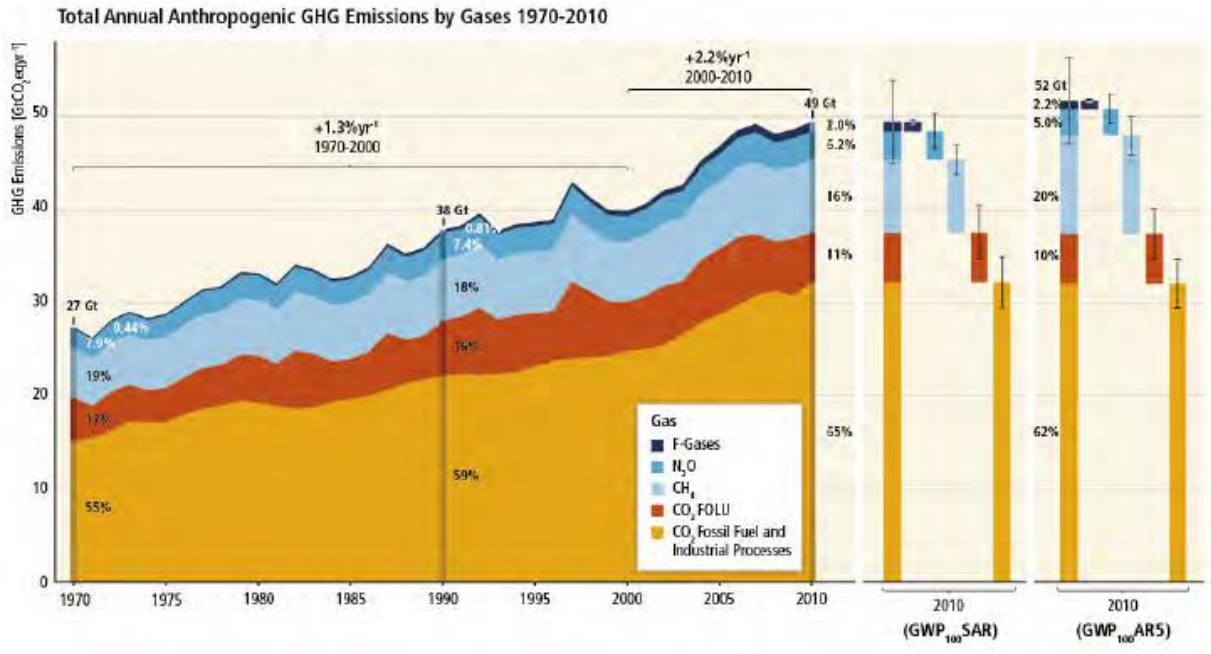
Figure 13. Total Annual Anthropogenic GHG emissions by Gases 1970-2010



Source: IPCC 2014

Figure 14. GHG emissions by sectors (2004)

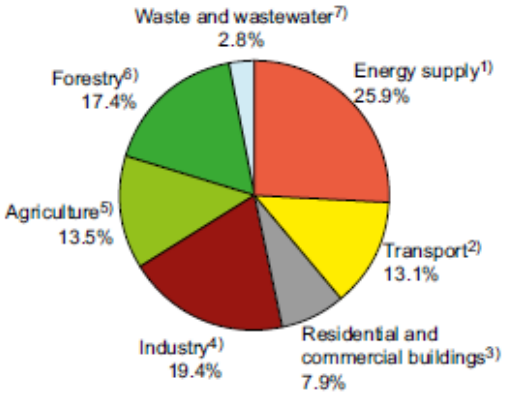


Figure TS.2b: *GHG emissions by sector in 2004 [Figure 1.3b].*

Source: IPCC 2007

Climate change is a long-run process. Its future effects are characterized by a high level of uncertainty and might differ in different regions (*figure 4*). Still, scientists assume that these effects can effect human well-being quite negatively

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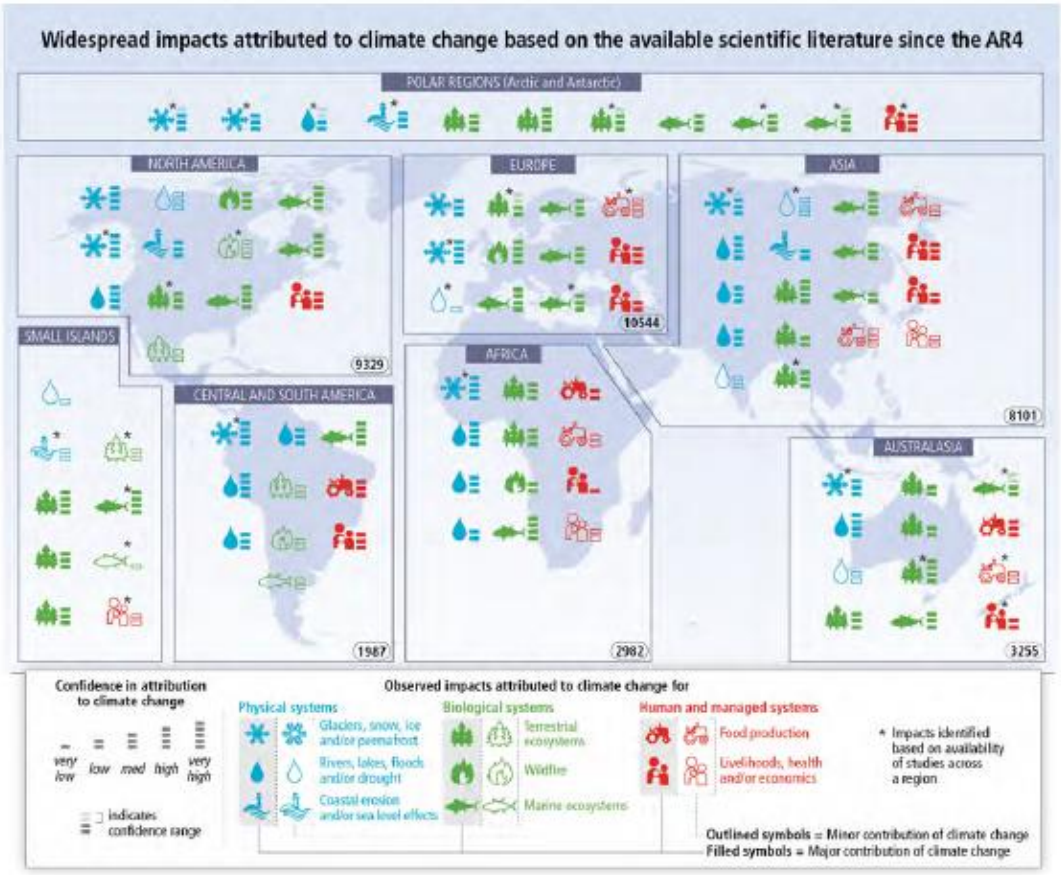
on the long run if climate change reaches high levels[18].

Figure 15. Widespread impacts attributed to climate change based on the available scientific literature since AR4



Source: IPCC 2014

The process of global climate change is characterized by:

- A high degree of inertia and irreversibility. Even if humanity stopped all GHG emissions today, the process would go on for hundreds of years.
- Thresholds (non-linear changes). Climate change is not a linear process. One unit of stress (e.g. GHG emission) does not result in one unit of effect (e.g. one unit of predictable change in the ecosystem). It means that anthropogenic stress (GHG emissions) might not have any effect on ecosystems (or climate) for long, but after reaching a critical threshold, radical changes in the environment (climate) may occur. Researchers cannot predict

[18] Remember the "Six Degrees Can Change the World" movie: http://www.youtube.com/watch?v=R_pb1G2wIoA.

the amount of stress which results in thresholds – all we know is that growing anthropogenic stress (GHG emissions) increases the probability of reaching such thresholds.[19]

- Climate change may result in positive feedback loops – it may create processes which are reinforcing climate change – i.e. it has a self-reinforcing nature. Such a process is e.g. the melting of permafrost[20]. Without climate change, permafrost is frozen, and methane within the permafrost stays under the Earth's surface. However, with global warming permafrost is melting and methane is being released into the atmosphere. Methane being a GHG, this means that it contributes to GCC – thus we have a self-reinforcing positive feedback loop: GCC → melting permafrost → methane released in the atmosphere → more GCC.

The social impacts of GCC are manifold. It affects the whole biosphere, each and every society (although in different ways and to different extent):

- Freshwater basins. E.g. the melting of glaciers (e.g. in the Himalaya) endangering freshwater access of hundreds of millions of people[21].
- Ecological systems are also affected in many ways.
- Changes in the ecological systems also affect the availability of food and forest products. According to some researchers the largest threat of GCC is that agricultural yields are to decrease because of the changed environmental conditions (*Figure 5*).
- Rising sea levels have an impact on coastal areas. Although the precise extent of sea level rise is difficult to predict, hundreds of millions of people might be affected in case their livelihoods are flooded, increasing the level of climate refugees[22].
- Climate change, heat waves also have a potential negative effect on human health.

[19] An example of a probable threshold and radical (catastrophic) change can be seen at: https://www.youtube.com/watch?v=SnvqsWVluCE
[20] https://www.youtube.com/watch?v=2w4UQfJHD-A
[21] https://www.youtube.com/watch?v=ypiwKi-H5JM
[22] https://www.youtube.com/watch?v=RaD3ax2j3Ks

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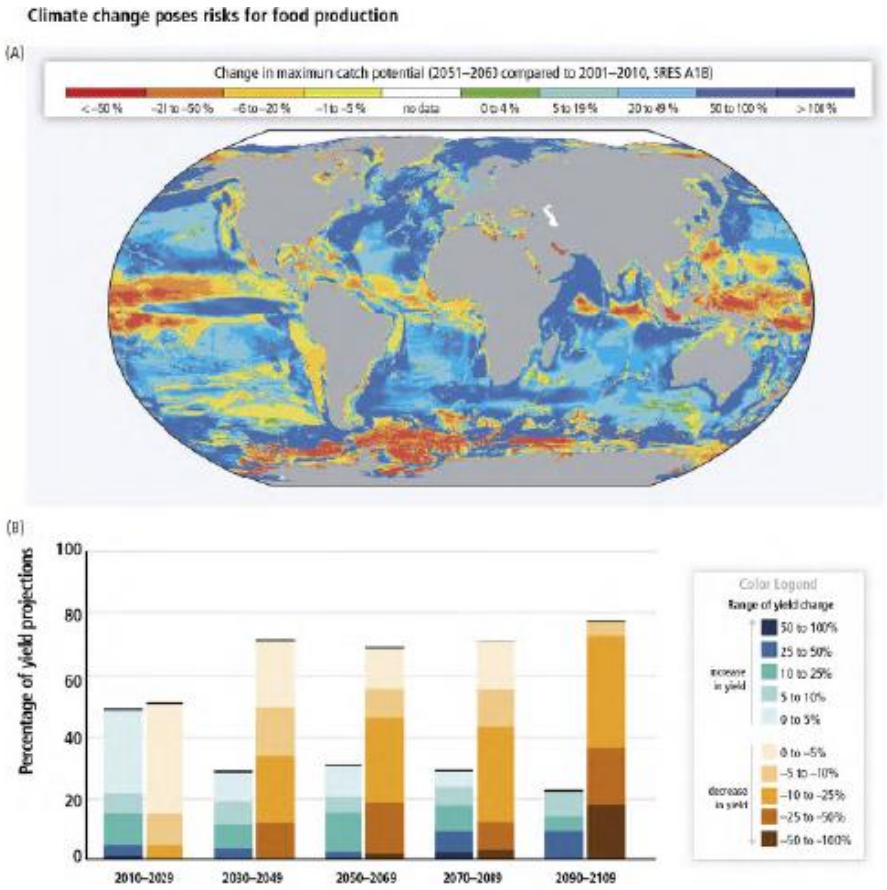
Figure 16. Climate change poses risks for food production



Source: IPCC 2014

The aforementioned effects are different in different scenarios – see IPCC (2014) for a detailed description – and regions. But as aforementioned, the probability of large scale (catastrophic) shifts increase with increasing stress, and the higher the extent of global change is, the higher are the costs of adaptation.

3.1.2. The Ozone hole

The ozone layer is part of Earth's stratosphere. It absorbs most of the Sun's UV radiation arriving at Earth because it contains high concentrations of ozone (O_3). The ozone layer is vital for life on Earth. If it is depleted, enhanced UV radiation affects every forms of life on Earth. Without the ozone layer there would be almost no life on Earth.

The ozone layer has been depleted in the 20th Century due to anthropogenic activities – due to the release of ozone depleting substances (ODSs) like chlorofluorocarbons (CFCs) and bromofluorocarbons. These compounds are extremely stable in the atmosphere.

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They are capable of breaking down over 100,000 ozone molecules. These molecules used to be used for heating (e.g. in refrigerators and air conditioning machines) and in aerosol sprays. These substances have been emitted in high quantities in the whole 20th century until 1987, when an international treaty (Montreal Protocol) limited their emission.

Some ODSs, including CFCs, have atmospheric lifetimes ranging from 50 to over 100 years. It means that the ozone layer is to recover to 1980 levels approximately by mid-21st Century. The story of the ozone hole is also a story of human ignorance (Epstein et al. 2014). As long as CFCs were invented and have been used from the 1940's, their effect on ozone layer was only discovered approximately 40 years later, in 1978 (*table 1*). It means that their unintended side effect, being extremely dangerous for humanity, remained hidden for more than half a century.

Table 1. Milestones in the story of ozone depletion

Snapshot	Date	Event
	1939	CFCs are invented.
	1973	R. Stolarsky and R. Cicerone indicate that chlorine released into the stratosphere could unleash a complicated chemical process that would continually destroy ozone for several decades (published in 1974).
	1974	M. Molina and S. Rowland discover that, unlike most other gases, CFCs are not chemically broken down or rained out quickly in the lower atmosphere but rather, because of their exceptionally stable chemical structure, persist and migrate slowly up to the stratosphere. They conclude that CFCs are eventually broken down by solar radiation and, in the process, release large quantities of chlorine into the stratosphere.
	1970s	Start of international scientific efforts to begin cooperation on research with an eye toward building a regulatory regime. They begin under conditions of great uncertainty.
Snapshot 1: Open access 1977–1988	1977	International cooperation starts with a conference of experts from 32 countries, convened by the United Nations Environment Programme (UNEP), adoption of the World Plan of Action, and establishing a Coordinating Committee.
	1981	The UNEP Governing Council authorizes negotiations to attempt to create a binding treaty on measures to protect the ozone layer.
	1985	Vienna Convention for the Protection of the Ozone Layer.
	1986	Ozone hole is clearly observed.
	1987	Montreal Protocol on Substances that Deplete the Ozone Layer successfully negotiated and opened for signatures.
	1988	NASA-sponsored Ozone Trends Panel reports that ozone depletion was occurring and that it has human-induced causes.
Snapshot 2: International cooperation 1989–2012	1989	The Montreal Protocol enters into force.
	1990	Second meeting of parties to Montreal Protocol at London. London amendments to the Montreal Protocol.
	1992	Copenhagen amendments to the Montreal Protocol permanently establish the Multilateral Fund.
	1997	Montreal amendments to the Montreal Protocol.
	1999	Beijing amendments to the Montreal Protocol.
	2007	Montreal Declaration.
	2012	25th Anniversary of the Montreal Protocol.

Source: Epstein et al. (2014)

3.1.3. Water

Problems regarding oceans (rising sea levels and the loss of biodiversity at coral reefs because of higher ocean

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temperatures) have already been mentioned earlier. Beside these problems the pollution of the oceans can be considered as a serious global problem. Polluted fish stocks result in polluted food for many. Nitrogen pollution causes oxygenless areas within the deep layers the ocean without basically any forms of life being present. Waste causes huge garbage islands at Oceans – so called ocean garbage patches[23]. Overfishing results in declining fish stocks and reduced food production resources (Rakonczai 2008).

Only 1 to 2,5% of world water reserves is fresh water. Regarding fresh water, humanity faces two problems. The first one is absolute scarcity – the lack of water for approximately 1,1 billion people who do not have access to enough water to fulfil their basic water related needs. Besides, there is also problem with quality: 2,3 billions of people lack access to safe, healthy water – these people risk their health on a daily basis when they drink water.

Just like in many other dimensions, access to water is extremely unequal on Earth.

3.1.4. Loss of biodiversity

By biodiversity we refer to the diversity of life on Earth – the diversity of genes, populations, species and ecosystems[24]. Biodiversity on Earth is getting reduced in an ever increasing pace (*figure 6*).

[23] https://www.youtube.com/watch?v=J-gqJAsXiKQ
[24] For an explanation of the notion of biodiversity watch https://www.youtube.com/watch?v=0-PE3ve3w2w.

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Figure 17. Extinctions per thousand species per millennium

Source: MEA 2005

Human pressure on the natural environment has been continuously increasing in the past decades (see pressure indicators at *figures 7 and 8*). The level of social responses has also been increased, but is by far not enough to reach conservation goals (Butchart et al. 2010).

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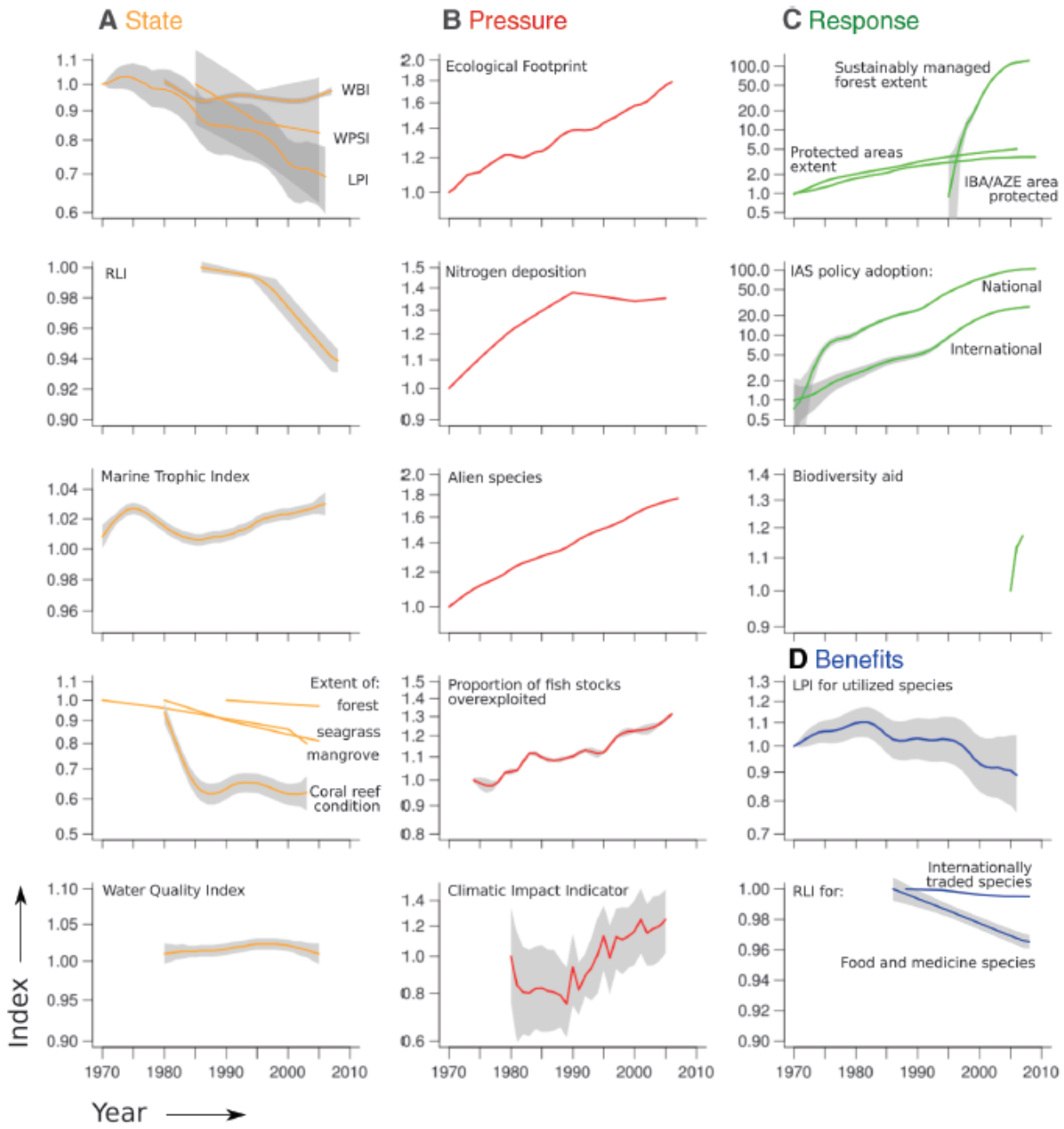
18. Figure: State, pressure, response and benefit indicators of biodiversity



Source: Butchart et al. (2010)

19. Figure. Aggregated state, pressure and response indicators of biodiversity

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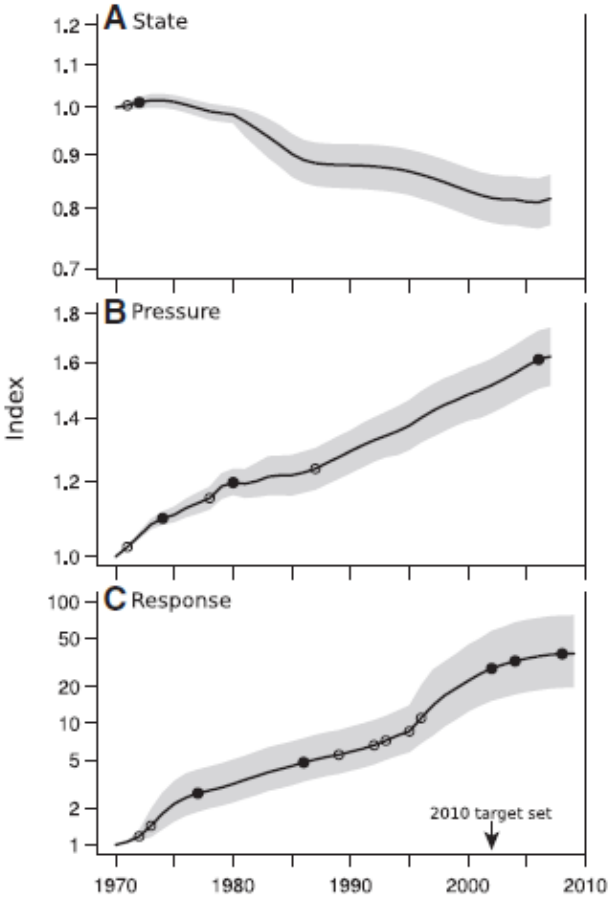

Source: Butchart et al. (2010)

Loss of biodiversity has several main anthropogenic drivers, such as:

- habitat destruction (segregation),
- pollution/nutrient loading (first of all nitrogen and phosphor),
- overexploitation/overhunting,
- alien species (invasive species)[25] and
- climate change.

These drivers have influenced and will influence biodiversity in different ecosystems to different extents (*figure 9*).

[25] https://www.youtube.com/watch?v=TmYld25z-JU, https://www.youtube.com/watch?v=6WS7naoEH5o

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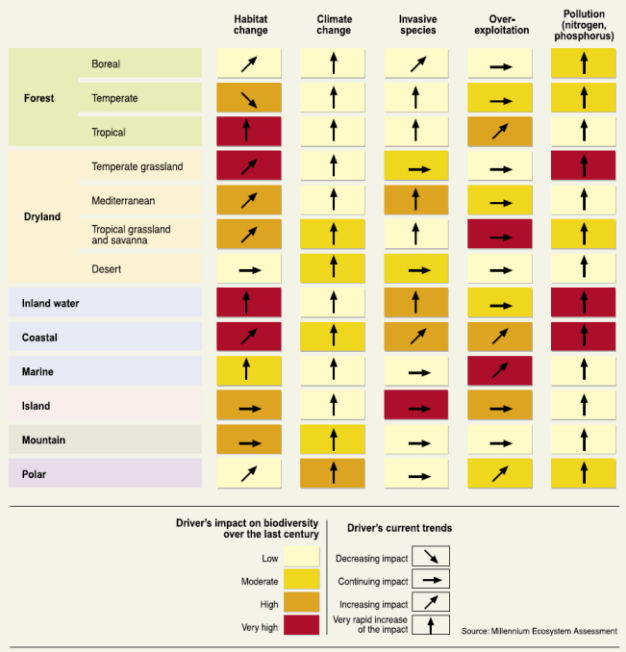
20. Figure: Different drivers effects on biodiversity in different ecosystems



Source: MEA (2005)

3.2. Ecosystem services

Conventional economics is an anthropocentric science. It means that economic, social and environmental changes are evaluated from the perspective of human well-being. If these changes affect human well-being, they have an economic relevance. Otherwise they are not significant for conventional economics.

Regarding global environmental problems (GEPs) it means that these are only problems from an economic perspective if they reduce human/social well-being. Thus, economic analysis of GEPs needs to consider the well-being effects of GEPs.

Probably the best framework for such an evaluation is provided by the approach of ecosystem services – which refers to the multitude ways humankind benefits from ecosystems (MEA 2005). If ecosystems are to be changed (radically) by humans, these ecosystems might be lost. This is why resource extraction and environmental pollution and the resulting GEPs have economic relevance.

There are several typologies for ecosystem services, the most well-known being the one of MEA's (2005) (*figure 10*).

- Provisioning Services – products obtained from ecosystems.

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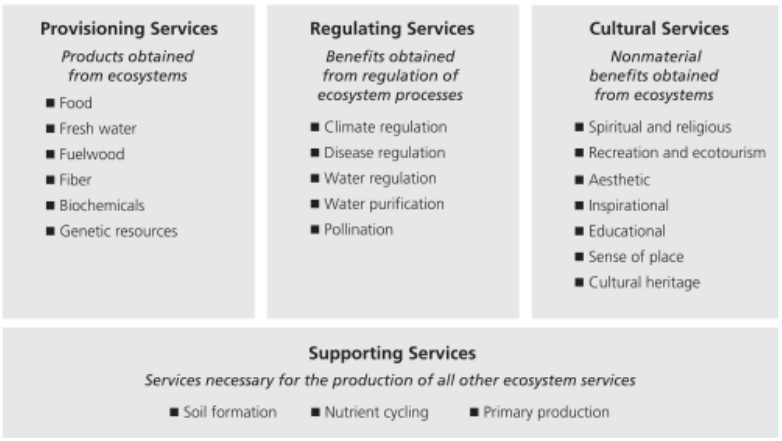
- Regulating Services –benefits obtained from the regulation of ecosystem processes
- Cultural Services –nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experiences
- Supporting Services - are necessary for the production of all other ecosystem services. They differ from provisioning, regulating, and cultural services in that their impacts on people are either indirect or occur over a very long time, whereas changes in the other categories have relatively direct and short-term impacts on people

21. Figure. MEA's typology for ecosystem services.



Source: MEA (2003)

As we see, nature contributes to human well-being many ways – indeed nature's processes are the source of human life on Earth (*figure 11*).

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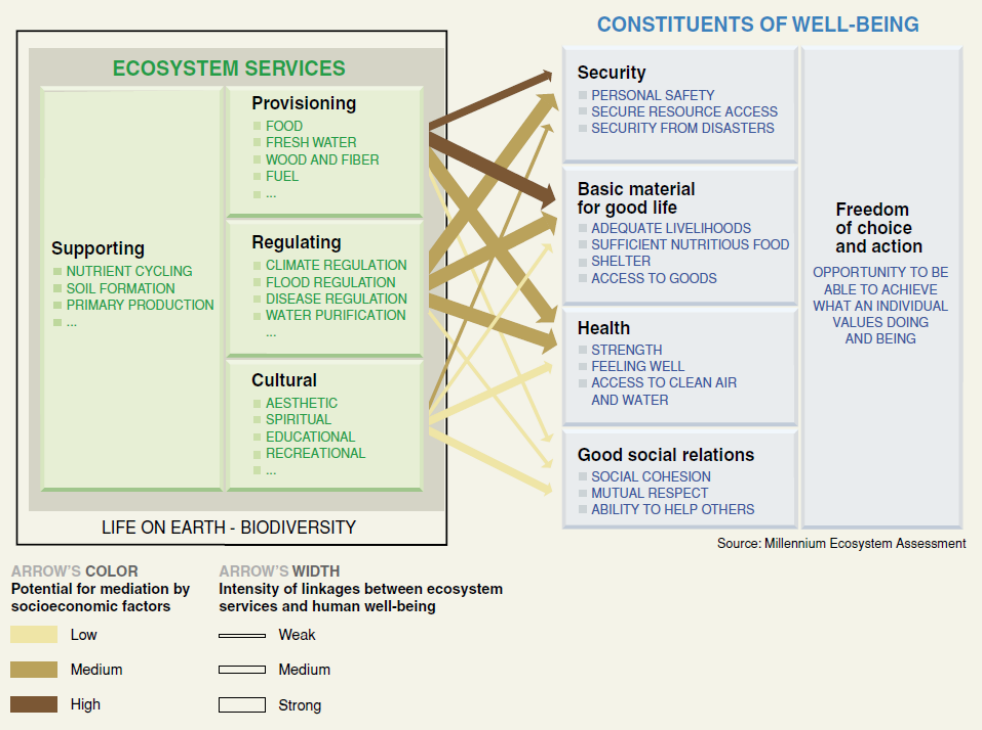
22. Figure: Ecosystem services and human well-being



Source: MEA 2005

Although it is not in the core of attention in conventional economics, losing certain ecosystem services might reduce well-being to a radical extent. Such process is e.g. the mass distinction of bees which may result in reduced pollination levels and drastically reduced agricultural yields[26].

Conclusions

As we see it, humankind faces many different global environmental problems, which might have serious and continuously growing negative effect on human well-being. These well-being effects are extremely difficult to estimate precisely. These are characterised by many uncertainties – e.g. regarding the effect of anthropogenic stress on ecosystems, the effect of ecosystem change on ecosystem services, the effect of ecosystem service change on human welfare or the extent of the adaptation capabilities of human communities (*figure 12*).

[26] https://www.youtube.com/watch?v=St8nnQ6PqBQ

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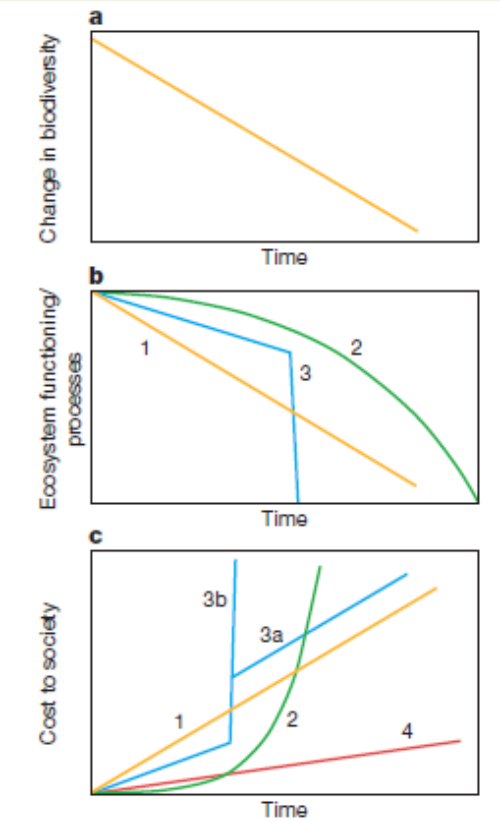
Figure 23. Ecosystem and societal consequences of changes in biodiversity



Source: Chapin et al. 2000

However, according to our current scientific knowledge growing anthropogenic stress on ecosystems (growing transformation of the biosphere) will probably lead to even more unknown and dangerous processes in the future because of the enhanced probability of reaching critical thresholds leading to large-scale and sudden environmental changes (or catastrophic shifts) and reduced level of human well-being (*figure 13*).

Figure 24. Value responses to stress under 'marginal' (well-behaved

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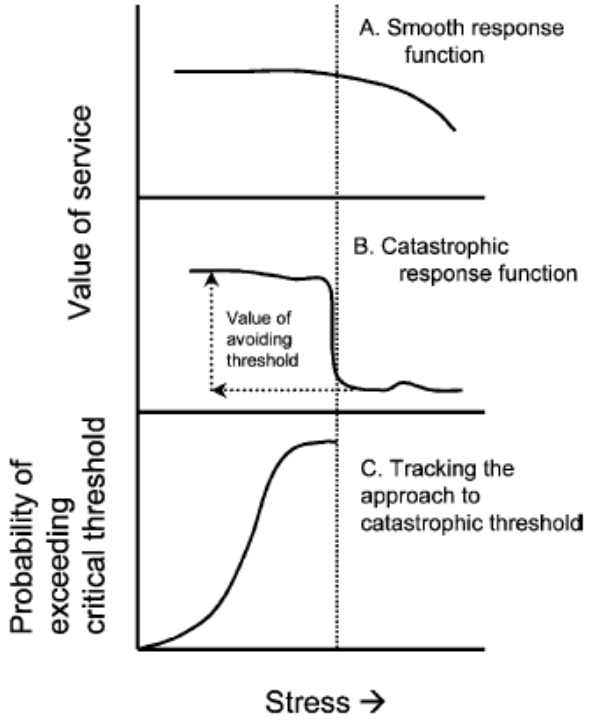
dynamics) and 'non-marginal' (nonlinear, threshold dynamics) system behaviours



Source: Limburg et al. 2002

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Questions/exercises for self-audit

What do you know about global climate change?
What do you know about the ozone hole?

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What do you know about water-related environmental problems?
What do you know about the loss of biodiversity?
What do you know about ecosystem services?

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4. Basic theories of sustainability/sustainable development and their implications for sustainable development paths and tools

After analysing global environmental and social problems it is clear why so many people (including activists, politicians and scientists) and communities consider the present global development path unsustainable and emphasizes the need to change it to a sustainable one. The **aim of the present chapter** is to introduce the basic distinction within sustainability thinking in economics – the division between the more techno-optimistic view of weak sustainability and the more techno-sceptic view of strong sustainability.

In order to be able to think about sustainability transitions, we have to answer two questions:

1. What kind of development is sustainable?

As we already introduced in our firs topic ("*History of environmental thinking in economics"*), there are many different approaches to sustainability and sustainable development. Within the present topic we do not have the opportunity to examine all of these but only to introduce economic theories to sustainability.

2. How to achieve sustainable development?

Different economic theories of sustainable development offer/suggest different tools for sustainability transitions. At the end of the present topic we list these tools and introduce how they appear in our environmental courses *("Introduction to environmental economics"* and *"Environmental policy"*).

4.1. From economic theories to sustainability

The most well-known definition of sustainable development comes from Bruntland (1987): Sustainable development is *„Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*

However, this definition is an uncertain and general one, e.g. we do not have any knowledge about the needs of future generations or about technologies human societies are going to have in the future to fulfil any kinds of needs. Therefore, in order to think of sustainable development transition paths and tools, this notion has to be further concretized (operationalized).

Within economics there are two different theories to sustainability: these are the theories of weak- and strong sustainability (Gutés 1996, Neumayer 1999).[27] This debate is related to the difference of judgment regarding the relationship of natural and man-made capital:

[27] These theories are strongly connected to other influential sustainability concepts. As long as the theory of weak sustainability is closely connected to techno-optimism and eco-modernization)(Mol 2010), the theory of strong sustainability is closely related to techno-scepticism and the theory of treadmill of production (Schnaiberg et al. 2002).

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Q= f(K,L,N), where

- K = man-made capital
- L = human capital (labour)
- N = natural capital

As long as in the theory of weak sustainability K (man-made capital) is a substitute for N, according to the theory of strong sustainability K and N are complementary. This difference in the judgement regarding the relationship between K and N results in contradictory suggestions regarding sustainability pathways and tools.

4.1.1. The theory of weak sustainability

According to the theory of weak sustainability there exist direct and indirect substitution between K and N. Direct substitution is when K directly substitutes N in any production processes. An example for that is the substitution of biodiversity with pesticides in agriculture for pest control.

However, it is indirect substitution which is important in the long run. This is a dynamic process: when (1) N is getting scarce, than (2) its price rises, which (3) induces innovation activities for substitutes, this way (4) (formerly not even known) substitutes emerge. The result is that N is substituted by K. This is what economists call the theory of induced innovation. An example for that is the shift in energy technologies: when (1) oil (fossil energy) gets scarce, (2) it becomes more and more expensive, (3) innovation activities regarding renewable energy sources emerge and (4) renewables substitute oil in energy production.

In case this theory works in practice the reduction of N (use of natural resources and increasing environmental pollution) is not a problem as long as we invest enough in K (K is produced faster than the decline of N).

4.1.2. The theory of strong sustainability

According to the theory of strong sustainability K and N are not substitutes, but complements – both are needed for production (producing well-being). The proponents of this approach are not that optimistic regarding future substitution of N by K because according to them:

- many ecosystem services cannot be substituted by capital/technological fixes at the moment and there is no guarantee at the present for future substitution opportunities;
- many ecosystem services and natural resources (e.g. stable climate, forests, oceans, inland water) are not subject of (private) property rights, thus price

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mechanism does not even exist in their case;

- but even if they are subject to (private) property rights, the extensive presence of external costs means that their price does not reflect their scarcity, and
- the theory of induced innovation is of limited validity in explaining technological change because technological change is a complex phenomenon characterized by e.g. path dependency and technology regimes[28] which mean limits regarding the role of technological change regarding the substitution of N with K.

Because the aforementioned, K and N are not substitutes but complements and both needed for production (well-being) and for shifting to a sustainable development path. This means that N should not decline below a critical level (which might be referred to as „critical natural capital"). Even though this critical natural capital level is probably impossible to determine exactly – remember e.g. thresholds, uncertainty regarding anthropogenic stress on the biosphere etc. which were discussed within the global environmental problems topic.

Debate – technological change

Let us consider three technological shifts which might serve the goal of sustainability:

Shift 1: Cars running on fossil fuels → cars running with electricity

Shift 2. Nuclear power-based electricity generation → renewable energy sources

Shift 3. Industrial food complex → ecological food complex

Form three groups and discuss the following (for 10 minutes):

In order for these shifts to happen:

1. How related infrastructure has to change?
2. How consumer habits have to change?
3. Who have interested and conflict of interest regarding these changes?

[28] Technology regime or socio-technical regime (Geels 2002) includes a web of inter-linking actors across different social groups and communities following a set of rules: the established practices of a given system. Its dimensions are

- Technology
- User practices and application
- The symbolic meaning of technology
- Infrastructure
- Policy
- Techno-scientific knowledge.

Path dependency refers to the phenomena that the set of decisions one faces for any given circumstance is limited by the decisions one has made in the past, even though past circumstances may no longer be relevant.

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4.1.3. Who is right in the weak vs. strong sustainability debate?

Because the weak vs. strong sustainability debate is a debate about the future it is impossible to judge who is right. However, policy decisions influencing future development pathways either in the weak or in the strong sustainability direction have to be met in the present. In such an uncertain situation the related matrix of Costanza (1989) might be of help for policymakers.

Figure 25. Payoff matrix for technological optimism vs. pessimism

Current Policy	Real State of the World: Optimists Right	Real State of the World: Pessimists Right
Technological Optimist Policy	High	Disaster
Technological Pessimist Policy	Moderate	Tolerable

Source: Costanza 1989

Figure 1 shows that a policy serving weak sustainability (technological optimistic policy) is a risky one since such a policy choice might lead to a disaster in case proponents of the theory of strong sustainability (pessimists) are right and the future state of the world is characterized by processes which they emphasize (lacking/limited substitution opportunities of N by K).

4.2. Tools for overcoming environmental problems (tools for sustainability transitions)

Economic theories of sustainability offer different tools for sustainability transitions. The proponents of weak sustainability believe in "reformist" environmental policy tools – tools which aim reform existing economic and political structures and are mostly aimed at enhancing eco-efficiency. Such tools are[29]:

- Environmental norms and taxes (Environmental policy)
- Environmental/ecological tax reform (Environmental policy)
- Tradable permits (e.g. carbon market) (Environmental policy)
- Corporate social responsibility (CSR)
- Voluntary agreements (e.g. GRI, GC, FCS etc.)

[29] Tools which are introduced within the environmental bloc of the education are marked with bold and the course within which they are discussed is written in brackets behind the given tools.

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- Environmental management systems
- Environmental accounting – micro and macro level (Introduction to environmental economics)
- „Governing the commons" → Global Sustainable Development Governance Regime (international organizations, e.g. the UN) (Introduction to environmental economics)
- Maximum sustainably yield (MSY)
- Payment for ecosystem services (PES)) (Environmental policy)
- Eco-efficiency
- …

According to the proponents of strong sustainability applying the aforementioned reformist tools is not enough for sustainability transition. Instead, radical shifts (radical environmental policy choices) are needed, aimed at new economic and social structures and sufficiency instead of eco-efficiency. Such changes are:

- The localization of production and consumption instead of globalization (environmental policy)
- Overcoming capitalism as an economic order (environmental policy)
- Questioning economic growth as an ultimate social goal (e.g. transformation towards degrowth (environmental policy)
- Transforming the global monetary system
- Leave the oil in the soil
- …

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Questions/exercises for self-audit

What do you know about weak sustainability?

What do you know about strong sustainability?

What is the role of technological change in sustainability transitions according to the main economic theories to sustainability?

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5. Economic development, quality of life (QoL) and the environment

Environmental and ecological economics have been long expressing their concerns concerning the suitability of System of National Accounts (SNA) and its major indicators – most of all gross domestic product (GDP) – to measure environmentally sustainable social progress. The **aim of the present chapter** is to provide an overview of some main measures of social development and environmental sustainability and show how these relate to GDP centred thinking on development.

Within the present topic we examine the relationship of economic development as understood in mainstream (textbook) economics to the broader concept of well-being (quality of life – QoL) and sustainability. Within this topic we:

1. define economic development as understood in mainstream (textbook) economics;
2. examine the concept of well-being or quality of life (QoL) (including examining QoL theories and related composite indices);
3. examine the relationship economic development and sustainability (and natural environment) (including sustainability composite indices established based on different sustainability theories); and
4. examine the relationship between economic development, QoL and sustainability.

5.1. Economic development in (textbook) economics

Within textbook economics (but the same is more or less true for conventional economic thinking), development is directly or indirectly identified with growth in material welfare, meaning growing consumption measured by GDP/capita. (GDP refers to the market value of all officially recognized final goods and services produced within a country in a year, or other given period of time. It is often recognized as a measure for "standard of living" of countries. It basically aims to measure aggregate consumption opportunities of societies in a given period of time.)

This way economic development in economics is identified with growth in GDP/capita.

5.2. Development as well-being or quality of life (QoL)

The tendency that GDP/capita is often referred to as a measure of development and well-being (quality of life) in economics is problematized by numerous scholars, including economists (see e.g. Stiglitz et al. 2009). It means a problem because *"what we measure shapes what we collectively strive to pursue – and what we pursue determines what we*

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measure (Stiglitz et al. 2009). This means that if GDP/capita is a wrong measure for development (well-being/quality of life) than economic policies are not going to be aimed at development (well-being/quality of life) but something else: aggregate consumption opportunities, which is indeed reflected in the GDP/capita measure. The same is true for sustainability: in case GDP/capita does not include relevant sustainability information, economic policies will not be sensibly open to the aspects of sustainability. Therefore many raise concerns regarding identifying GDP growth with development and well-being/quality of life.

Exercise
Individual work

- List and rate the five most important things which influence your quality of life. Rating: 5: very important → 1: not at all important (5 minutes)

Group work

- Form 3 groups! Discuss and try to agree on the five most important things which influence your quality of life! Discuss how these relate to material welfare! (10 minutes)

5.2.1. The theory of subjective well-being (Stiglitz et al. 2009)

One of the most influential well-being theories identifies QoL with subjective well-being. According to this theory QoL increases if subjective well-being increases. Here subjective well-being is measured with questionnaires, aimed at:

- life satisfaction, *i.e.* a person's overall judgment about their life at a particular point in time
- the presence of positive feelings or affect, *i.e.* the flow of positive emotions (such as feeling happiness and joy, or a sense of vitality and energy) from moment to moment;
- the absence of negative feelings or affect, *i.e.* the flow of negative emotions (such as feeling angry, sad or depressed) from moment to moment.

One of the most interesting results in this respect is the diminishing marginal utility of money. Research results show that after a certain level material welfare (GDP/capita) adds less and less to subjective well-being (*figure 1 and 2*).

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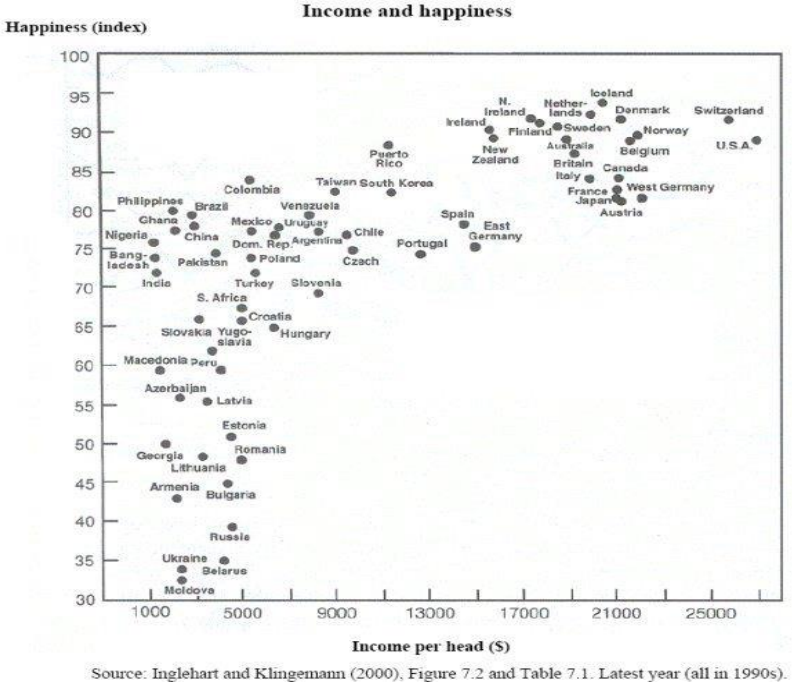
Figure 26. Income and happiness – a cross-country comparison



Source: Inglehart and Klingemann (2000), Figure 7.2 and Table 7.1. Latest year (all in 1990s).

Source: https://irishliberty.wordpress.com/2009/03/23/happiness-economics-butchers-marginal-utility-theory/

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Figure 27. Average income and happiness in the United States, 1957-2002

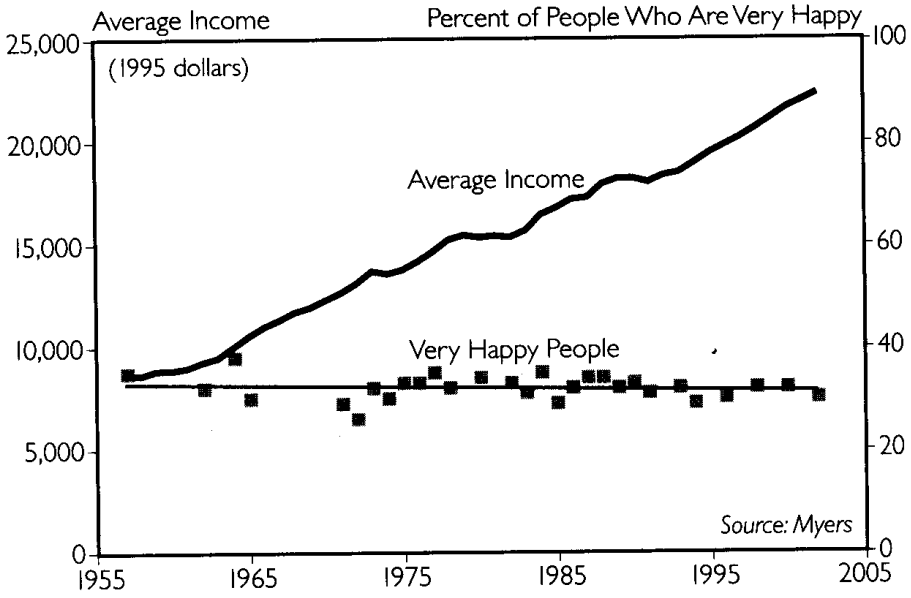

Figure 8–1. Average Income and Happiness in the United States, 1957–2002

Source: http://geraldguild.com/blog/2012/05/23/happiness-as-measured-by-gdp-really/comment-page-1/

There are several reasons for the diminishing marginal utility of money:

- peer effects and relative comparisons;
- adaptation; and
- sources of happiness other than material welfare (see e.g. *figure 3*).

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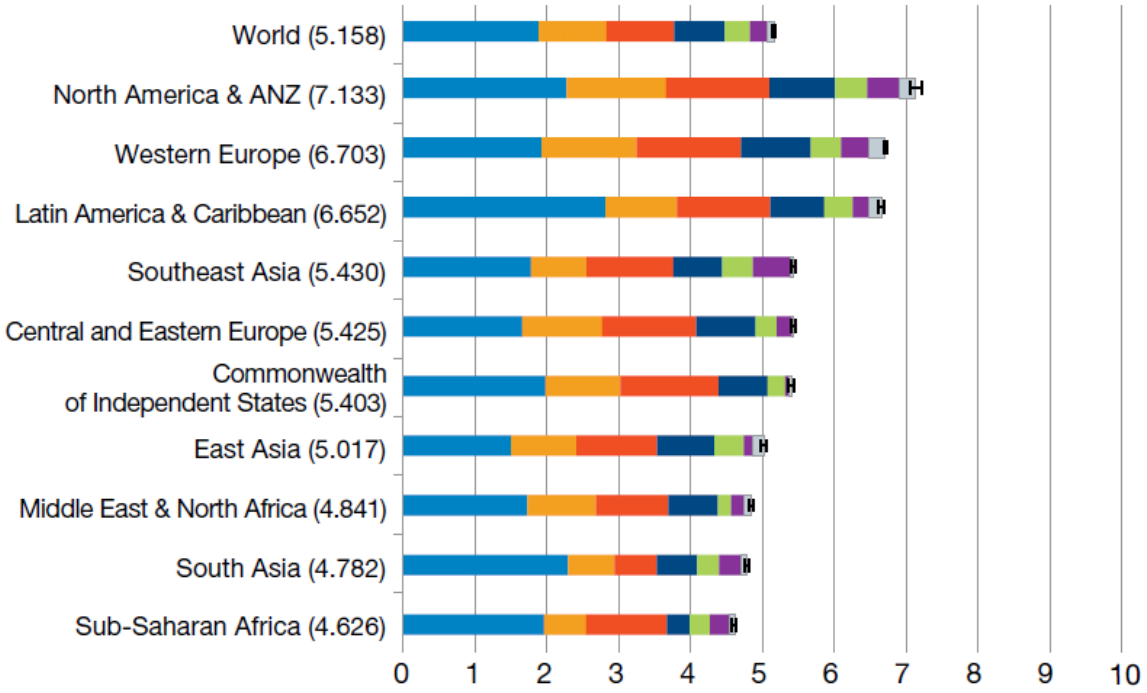
Figure 28. Level and decomposition of Happiness by Regions, 2010-12



Source: Helliwell et al. (2013)

5.2.2. QoL as capabilities (Amartya Sen's "Capability approach") (Stiglitz et al. 2009)

The second influential well-being theory in economics is Amartya Sen's Capability approach. Sen defines capabilities as *"conceives a person's life as a combination of various "doings and beings" (functionings), and assesses QoL in terms of a person's freedom to choose among the various combinations of these functionings (capabilities)."* (Stiglitz et al. 2009) Functionings *"refer to the activities and situations that people spontaneously recognize to be important"* (Stiglitz et al. 2009), e.g. health, knowledge or having a meaningful job etc. Functioning range from basic (e.g. being safe and well-nourished) to complex ones (e.g. to express oneself in public without shame). Freedom *"requires expanding the range of information relevant for assessing people's lives beyond their observed achievements, to the full range of opportunities open to them."* (Stiglitz et al. 2009).

In this approach material goods are tools possibly serving the realization of valuable functionings – this way material consumption is and not goal in itself. In order to transform tools to functionings "conversion factors" are also needed (Figure 4). Two possible examples are:

- having a bicycle: in order to use a bicycle (tool) for cycling or mobility (functioning) one need

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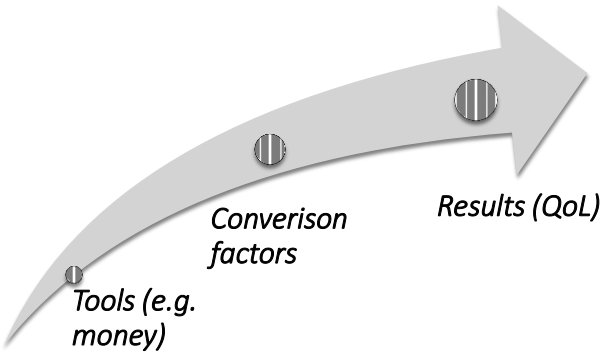
to be able to ride a bike (conversion factor).

- having money: in order to use money (tool) to live a happy life (functioning) one has to be able to use the money properly (e.g. do not spend it on maniac consumption) (conversion factor).

Figure 29. The basic logic of the capability approach



Source: Juhász (2015)

5.2.3. Development as well-being (QoL)

As we saw above there are different theories regarding well-being and Qol with different messages. However, there is consensus that QoL is more than GDP/material welfare, thus development is more than enhancing opportunities for growing material consumption. Dimensions of QoL include (see also *figure 5*):

- Health
- Education
- Personal activities, including
  - Paid work
  - Unpaid domestic work
  - Commuting
  - Leisure time
- Housing
- Political voice and governance
- Social connections
- Environmental conditions
- Insecurity

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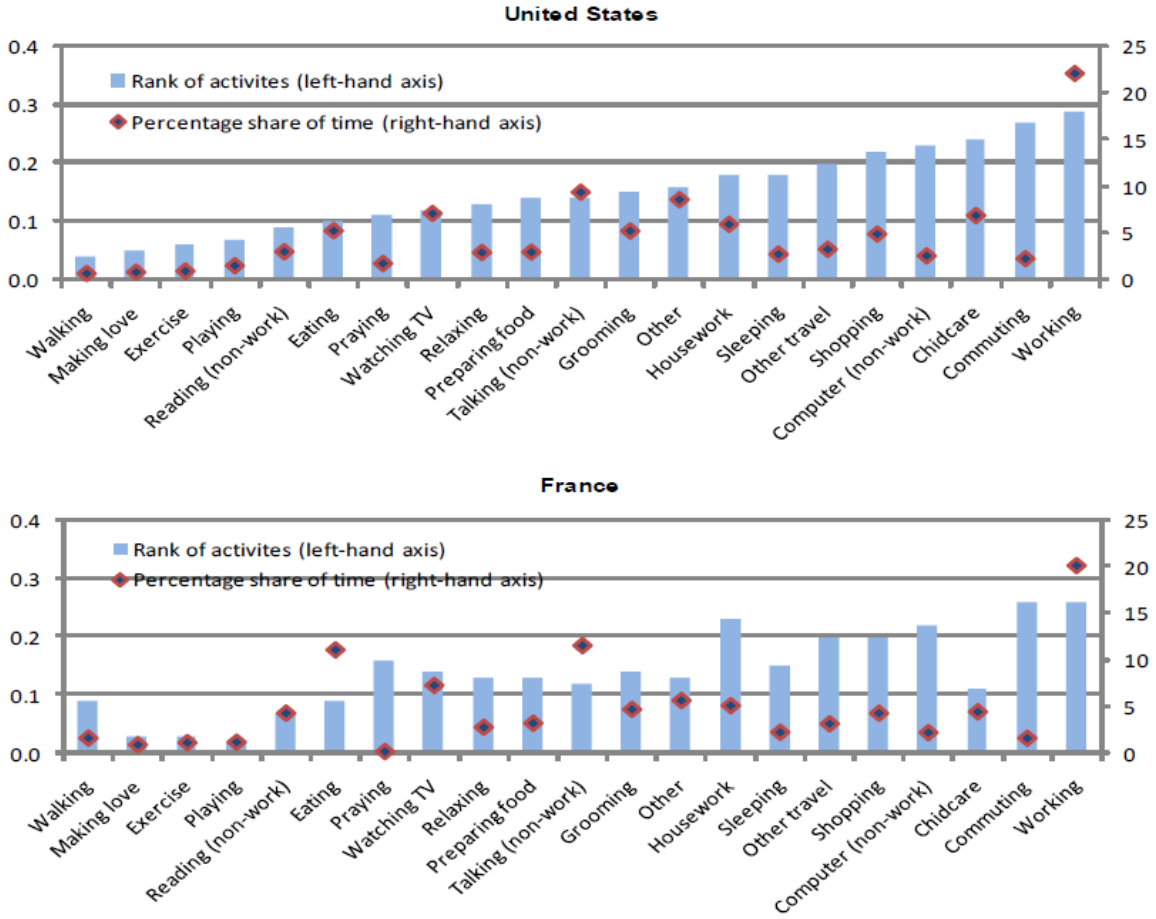
Figure 30. Ranking of different personal activities based on women's hedonic experiences and share of time devoted to them, in selected cities in the United States and France



Note: The ranking of activities is based on information on the proportion of 15-minute intervals in which the hedonic experience of "stress", "sadness" or "pain" exceeded that of "happiness". Data refer to a sample of women interviewed in Columbus (Ohio, United States) and Rennes (France), interviewed in 2006 with the *Princeton Affect and Time Survey*.

Source: Stiglitz et al. (2009)

5.2.4. Composite indices for development

Many composite indices have been developed in the last decades to measure well-being/Qol. *"A composite indicator is formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multi-dimensional concept that is being measured."*[30] There are many composite indices for development/well-being/QoL. Within the present course we do not have the opportunity to examine these in detail.[31] We only have the opportunity to

[30] https://stats.oecd.org/glossary/detail.asp?ID=6278

[31] An example for the great amount of alternatives is that many nations and communities created their own composite indices, see e.g. https://www.youtube.com/watch?v=AC1KE66sldA for Canada.

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show how certain indices aim to operationalize the aforementioned well-being theories. Thus we briefly examine two indices:

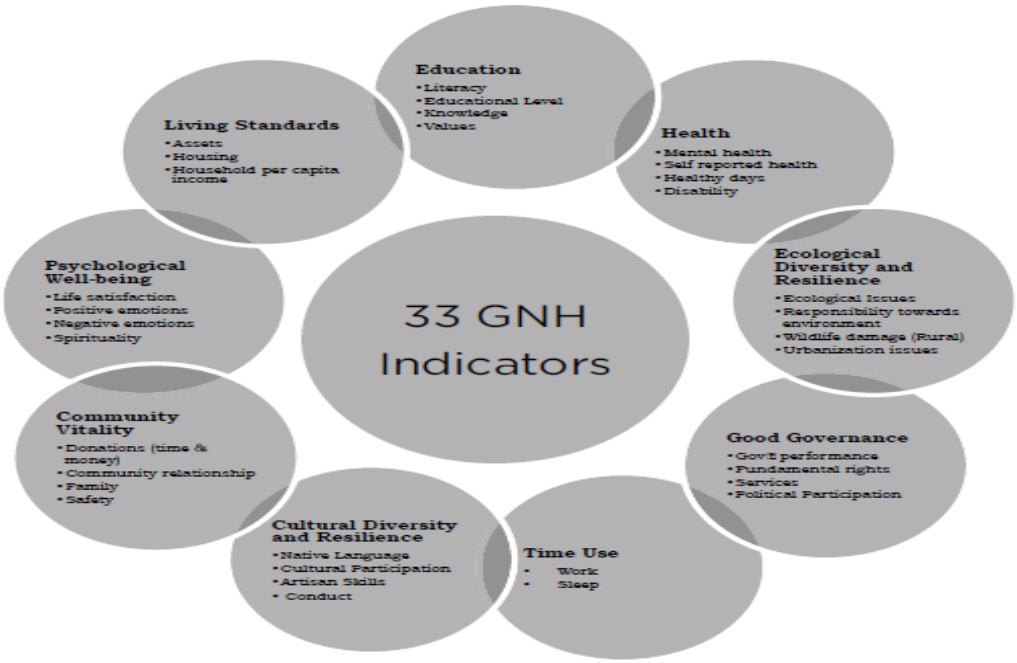
- Gross National Happiness Index (GNHI), which tries to measure QoL based on the theory of subjective well-being
- Human Development Index (HDI), which tries to operationalize the capability approach

5.2.4.1. Gross National Happiness Index (GNHI) (Ura et al. 2012, Schroeder 2014)

GNHI is a composite index for subjective well-being. *„GNHI measures the quality of a country in a more holistic way (than GDP) and believes that the beneficial development of human society takes place when material and spiritual development occurs side by side to complement and reinforce each other."* (Ura et al. 2012)

GNHI consists of nine domains, which are based on 33 clustered and weighted indicators created from 124 variables (*figure 6*).

Figure 31. The nine domains and 33 indicators of GNH



Source: Ura et al. 2012.

Indicators are constructed based on variables. Indicators are then aggregated into the nine domain level indicators (*figure 6.*) which are further combined through equal weighting into a single societal GNH measure. For each variable and indicator a "sufficiency threshold" is

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determined at the individual level. In case the value of the variably/indicator reaches this value, it implies the presence of happiness, while otherwise indicates lack of happiness.

Let us take the domain of psychological well-being as an example. It is built up based on four indicators:

(1) Life satisfaction. This indicator is made up based on the following variables (variable in this case is an individual's subjective assessment regarding a certain aspect of life): (1) health, (2) occupation, (3) family, (4) standard of living and (5) work-life-balance.
   a. Individuals rate these variables from 1 (very dissatisfied) to 5 (very satisfied).
   b. This way possible indicator values for life satisfaction are between 5 and 25.
   c. The sufficiency threshold is 19.

(2) and (3) Emotional balance (2- positive emotions, 3- negative emotions): The indicator is made up of 10 self-reported positive and negative (disturbing) emotional items (variables).
   a. Individuals report on the frequency of these feelings in their life in the past few weeks.
   b. Individuals rate these frequencies from 1 (never) to 5 (very much)
   c. Possible indicator values are between 5 and 25 for both positive and negative emotions
   d. Sufficiency thresholds are 15 for positive, and 12 for negative emotions.

(3) Spirituality: The indicator is made up of 4 questions (variables): (1) self-reported spirituality level, (2) karma, (3) praying, (4) meditation
   a. Individuals rate these from 1 (not at all) to 4 (regularly)
   b. Possible indicator values for spirituality are between 4 and16.
   c. The sufficiency threshold is 12.

After calculating indicators these are aggregated to domains by weighting (*table 1*). (A detailed review of indicators and measurement can be found in Ura et al. (2012).)

Table 2. Weights on the 33 Indicators of GNH

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Domain	Indicators	Weight	Domain	Indicators	Weight
Psychological wellbeing	Life satisfaction	33%	Good Governance	Political participation	40%
	Positive emotions	17%		Services	40%
	Negative emotions	17%		Governance performance	10%
	Spirituality	33%		Fundamental rights	10%
Health	Self reported health	10%	Community vitality	Donation (time & money)	30%
	Healthy days	30%		Safety	30%
	Disability	30%		Community relationship	20%
	Mental health	30%		Family	20%
Time use	Work	50%	Ecological diversity & resilience	Wildlife damage	40%
	Sleep	50%		Urban issues	40%
Education	Literacy	30%		Responsibility towards er	10%
	Schooling	30%		Ecological issues	10%
	Knowledge	20%	Living Standard	Per capita income	33%
	Value	20%		Assets	33%
Cultural diversity & resilience	Zorig chusum skills (	30%		Housing	33%
	Cultural participatio	30%			
	Speak native langua	20%			
	Driglam Namzha (Eti	20%			

Source: Ura et al. (2012)

A "happiness threshold" shows the number of domains or percentage of indicators within which sufficiency must be achieved in order to define an individual as happy (*table 2*, *figure 7*).

Table 3. Overview of GNH domains and breakdown of indicators

	Definition of groups ~ Sufficiency in:	Percent of population who are:	Average sufficiency of each person across domains
HAPPY	66%-100%	40.9%	72.9%
Deeply Happy	77%-100%	8.3%	81.5%
Extensively Happy	66%-76%	32.6%	70.7%
NOT-YET-HAPPY	0-65%	59.1%	56.6%
Narrowly Happy	50%-65%	48.7%	59.1%
Unhappy	0-49%	10.4%	44.7%

Source: Ura et al. (2012)

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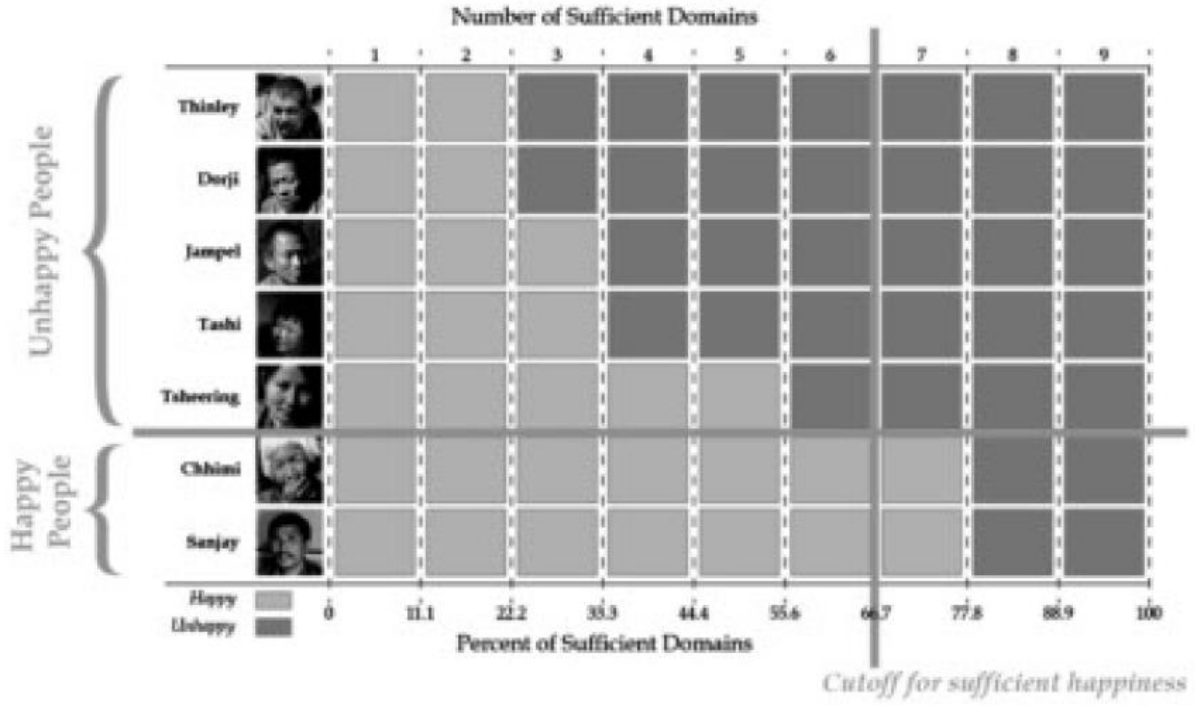
Figure 32. Identifying who is happy according to the GNH



Source: Ura et al. (2012)

The final aggregate GNH measure is decomposable to enable comparisons of GNH across geographic districts, time, demographic categories and the nine domains – e.g. allows for comparison with income levels (*figure 8*).

Figure 33. GNH compared with per capita income

Source: Ura et al. (2012)

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5.2.4.2. Human Development Index (HDI)

HDI is a composite index for the measurement of well-being and development based on Sen's capability approach. It has been developed by the United Nations (UN) and the UN publishes it each year since 1990 – thus it has a standardized methodology.[32]
Until 2010 HDI consisted of three components (*figure 9*):

- Health (H) index aiming to measure "life opportunity"
- Education (E) index aiming to measure "knowledge opportunity"
- Material welfare (Y-index) aiming to measure „basic-commodity opportunity"

Figure 34. Calculation of HDI until 2010

$$(1)\ \text{H-Index}_i = \frac{\text{LE}_i - 25\ \text{years}}{85\ \text{years} - 25\ \text{years}}$$

$$(2)\ \text{LIT-Index}_i = \frac{\text{LIT}_i - 0\%}{100\% - 0\%}$$

$$(3)\ \text{ENR-Index}_i = \frac{\text{ENR}_i - 0\%}{100\% - 0\%}$$

$$(4)\ \text{E-Index}_i = 2/3(\text{LIT-Index}_i) + 1/3(\text{ENR-Index}_i)$$

$$(5)\ \text{Y-Index}_i = \frac{\ln(\text{Y}_i) - \ln(\$100)}{\ln(\$40{,}000) - \ln(\$100)}$$

Source: http://hdr.undp.org/en/content/human-development-index-hdi

The calculation of the index value of HDI is the simple arithmetic average of the three sub-indices. The final value of HDI is between 0 and 1 and three development categories are defined for countries based on their HDI score:

- High level of human development: HDI>0,8
- Medium level of human development: 0,8>HDI>0,5
- Low level of human development: 05>HDI

There was a change in the calculation of the Index in 2011. At the present it is calculated based on the following three components (see also *table 3*):

- Health is measured with life expectancy at birth ("*life opportunity*")
- Education is measured by the geometrical average of mean years of schooling and expected

[32] The index is published yearly as part of the Human Development Report (http://hdr.undp.org/en)

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years of schooling ("*knowledge opportunity*")

- Material welfare (standard of living) is measured with GNI/capita (log, PPP) ("*basic-commodity opportunity*")

Table 4. Calculation of HDI since 2011 (with "goalposts" or observed maximum and minimum values regarding indicators in the 2010 HDR)

Dimension	Observed maximum	Minimum
Life expectancy	83.2 (Japan, 2010)	20.0
Mean years of schooling	13.2 (United States, 2000)	0
Expected years of schooling	20.6 (Australia, 2002)	0
Combined education index	0.951 (New Zealand, 2010)	0
Per capita income (PPP $)	108,211 (United Arab Emirates, 1980)	163 (Zimbabwe, 2008)

1. Life Expectancy Index (LEI) $= \frac{\text{LE} - 20}{83.2 - 20}$

2. Education Index (EI) $= \frac{\sqrt{\text{MYSI} \cdot \text{EYSI}} - 0}{0.951 - 0}$

2.1 Mean Years of Schooling Index (MYSI) $= \frac{\text{MYS} - 0}{13.2 - 0}$

2.2 Expected Years of Schooling Index (EYSI) $= \frac{\text{EYS} - 0}{20.6 - 0}$

3. Income Index (II) $= \frac{\ln(\text{GNIpc}) - \ln(163)}{\ln(108,211) - \ln(163)}$

Source: http://www.discoveringsaopaulo.com/2011/06/human-development-index-of-sao-paulos.html, UNDP (2010)

The aggregation methodology has also been changed: instead of the former arithmetic average method sub-indices are aggregated to a final index by applying geometric average.[33] The final HDI score is still between 0 and 1 and the same three development categories are defined:

- High level of human development: HDI>0,8
- Medium level of human development: 0,8>HDI>0,5
- Low level of human development: 05>HDI

5.3. Economic development and sustainability (natural environment)

GDP growth affects the natural environment in many ways (see e.g. the *„Global environmental problems, ecosystem services"* topic). However, environmental change (problems) is reflected in the measure of GDP only to a very limited extent – to the extent it implies market processes. However, because most ecosystem services and natural resources do not have any price and are not subject to private property, most environmental changes (problems) are not reflected in market processes and do not influence GDP values to a significant extent. Thus, GDP hardly has any sustainability/environmental predictability strength. It means that GDP, or its growth from year to year does not say anything about its sustainability – whether GDP growth is sustainable or not.

[33] This change was important to handle one of the former criticisms of HDI. According to this applying an arithmetic average aggregation method resulted that improvement in one sub-index (dimension) compensated for the decrease in another which was in contradiction with the original intention of Sen's approach, namely, that all three dimensions are equally important for human development. Applying a geometric average aggregation method is an indirect weighting: the weight of the sub-index (dimension) with the worst performance (lowest value) is higher than those of better performance. This way compensation between sub-indices (dimensions) becomes more limited.

Therefore, we find many sustainability composite indices in the special literature. Within the present course we do not have the opportunity to address the complexity of sustainability measurement in detail. Here we only have the opportunity to briefly introduce two indices based on the sustainability theories in economics mentioned in the *"Basic theories of sustainable development"* topic:

- Genuine savings (GS) aims to operationalize weak sustainability; while
- Ecological Footprint (EF) does the same with strong sustainability.

5.3.1. Genuine savings (GS)

GS is based on the theory of weak sustainability. It is calculated and published yearly by the World Bank, thus it has a standard methodology. According to its logic the basic requirement for maintaining (sustaining) future well-being (consumption) opportunities (sustainability) is non-declining aggregate capital stock – it applies a capital-based approach to sustainability. Its calculation is the following (Nourry 2008):

- Q = f(K, L, N, S)
- GS = brut national savings – depreciation of man-made capital + educational expenditures –depreciation of natural resources – damages caused by pollutants

In case GS>0, the economy is on a sustainable development path. In case GS<0, the economy is on an unsustainable development path.
It is important to emphasize that the index gets many critiques from many perspectives (Neumayer 2000, 2004), e.g.

- for being a weak sustainability measure of sustainability (K and N are substitutes: the growth in K compensates for the loss of N) which means that sustainability policy choices carried out based on the sustainability requirements of GS might be risky (see the matrix of Costanza at the *"Basic theories of sustainable development"* topic).
- for the monetary valuation of natural capital, which is an extremely debated issue in environmental and ecological economics (because of the lack of market prices for natural resources change in natural capital has to be calculated in monetary terms – which is an extremely uncertain and fuzzy area of monetary valuation).
- for what is valued within GS and what stays out of the index (valued natural resources are oil, gas, brown and black coal, bauxite, copper, iron, lead, nickel, zinc, phosphate, tin, gold, silver and forests, and valued environmental damages are CO2 and particulate matter, while all other natural resources and environmental damages – e.g. degradation of groundwater, decline of fish stocks, ground degradation, decline in biodiversity etc. – stay out of the indicator).
- for certain prices which are used for valuing N – e.g, the price of CO2 which is 20 USD/tonne and

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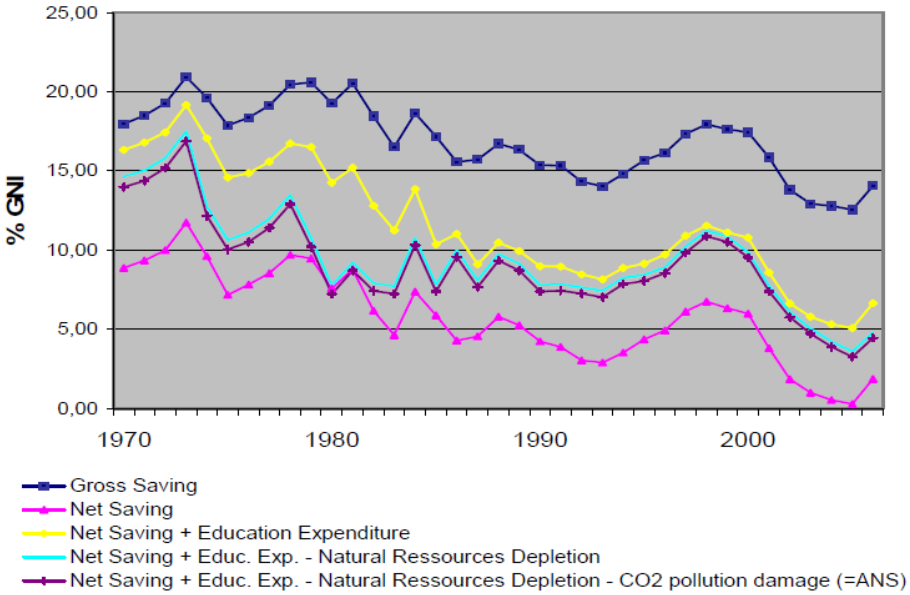
this way hardly influences the final value of GS (*figure 10*).

Figure 35. From GNS to ANS. What really counts (USA)



Source: Stiglitz et al. (2009)

5.3.2. Ecological footprint (EF)

EF aims to quantify strong sustainability. It is a measure of human demand on the Earth's ecosystems. It represents the amount of biologically productive land and sea area necessary to supply the resources a human population consumes, and to assimilate associated waste. Its main categories are ecological demand (the amount of biologically productive land and sea area necessary to maintain current lifestyles beside current level of technology expressed in global hectares - gha) and ecological supply (the amount of biologically productive land and

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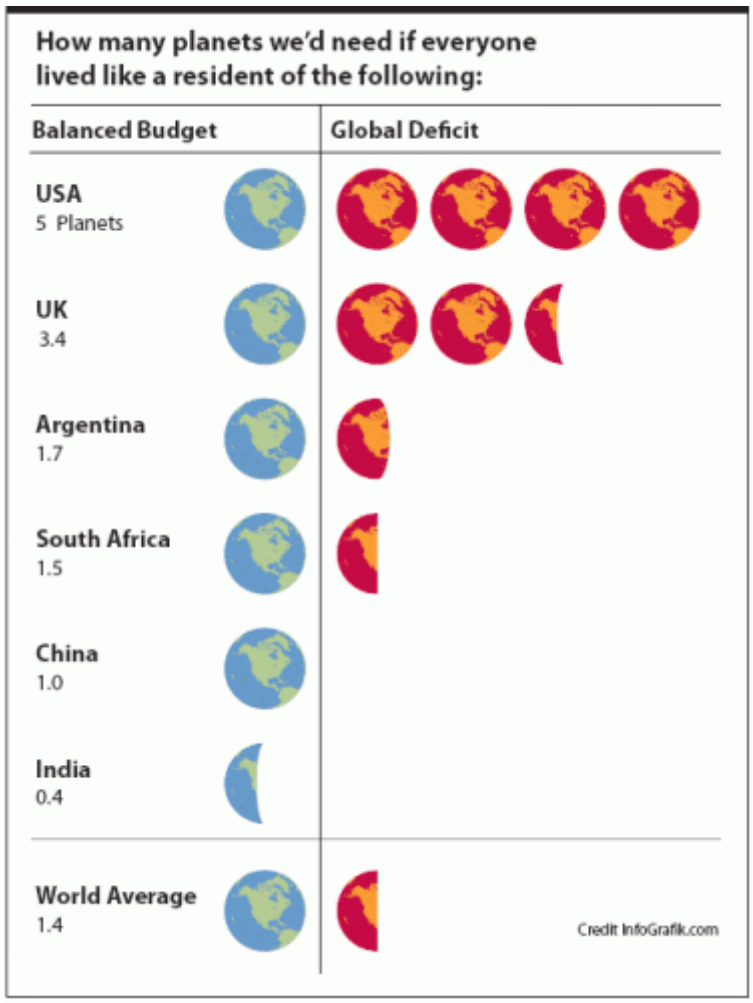
sea area societies have to fulfil ecological demand, also expressed in gha). In case ecological demand exceeds ecological supply we can talk about ecological deficit (and the unsustainability of lifestyles). In case ecological supply exceeds ecological demand we talk about ecological surplus (and the sustainability of lifestyles).[34]

EF is an important measurement because it tries to express the (un)sustainability of lifestyles based on the theory of strong sustainability. This way it clearly shows that rich countries – although being more technologically developed, eco-efficient and environmentally conscious regarding compared to poor countries – have lot less sustainable consumption patterns compared to poor countries (*figure 11*).[35]

Figure 36. Ecological footprint of selected nations



[34] A good introduction can be found at https://www.youtube.com/watch?v=g_aguo7V0Q4
[35] For detailed EF data visit e.g. http://awsassets.panda.org/downloads/1_lpr_2012_online_full_size_single_pages_final_120516.pdf

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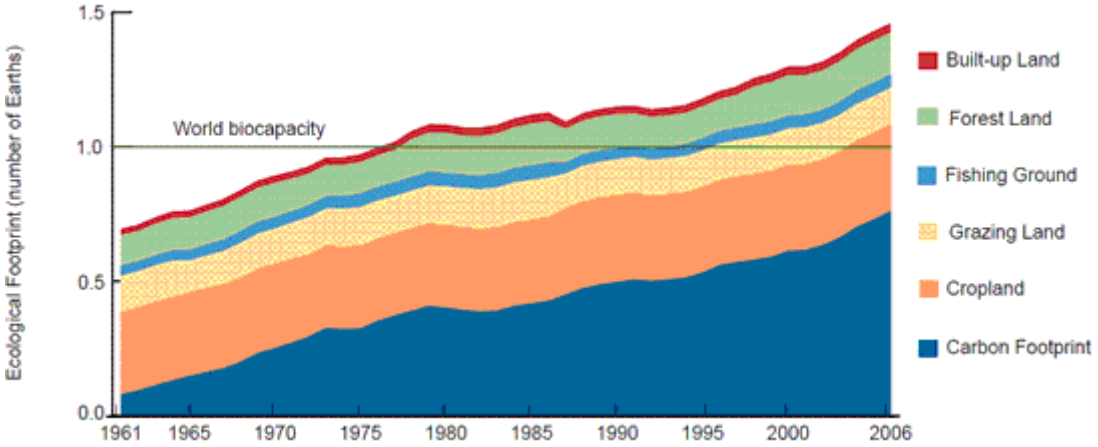
Source:
http://www.footprintnetwork.org/de/index.php/newsletter/bv/humanity_now_demanding_1.4_earths

Just like any other composite indices, EF also gets a lot of critique for not being a precise measurement of strong sustainability. E.g. if we analyse its components we clearly see that the growth in EF is a result of greenhouse gas emissions – which means that EF in its present form more or less "only" quantifies the (un)sustainability effects of global climate change (*figure 12*):

Figure 37. Ecological footprint by component



Source:
http://www.footprintnetwork.org/de/index.php/newsletter/bv/humanity_now_demanding_1.4_earths

Exercise

Calculate your EF: http://footprint.wwf.org.uk/

How could we reduce it? (10 minutes)

Form groups of 5 people. Think about community-level solutions for reducing EF!

5.4. Development, QoL and the environment

Last but not least let us take a quick look at the relationship of economic development, QoL and the environment (sustainability) based on the aforementioned measures. First, the diminishing return of money (or economic development as measured by per capita GDP growth) seems to be

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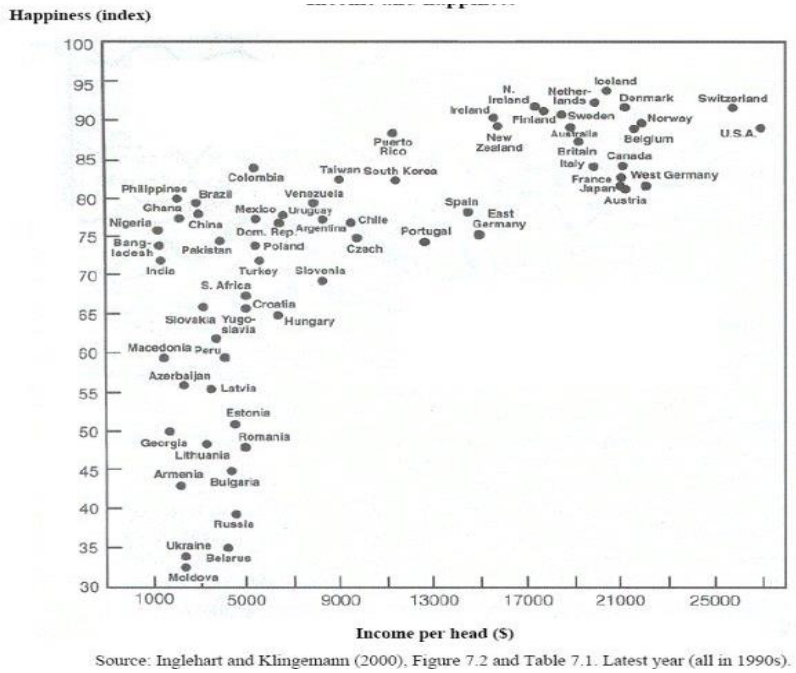
reinforced by the relationship of the aforementioned well-being/QoL indicators and GDP/capita (*Figures 13-16*).

Figure 38. Income and happiness – an international comparison



Source: Inglehart and Klingemann (2000), Figure 7.2 and Table 7.1. Latest year (all in 1990s).

Source: https://irishliberty.wordpress.com/2009/03/23/happiness-economics-butchers-marginal-utility-theory/

Figure 39. Average income and happiness in the United States, 1957-2002

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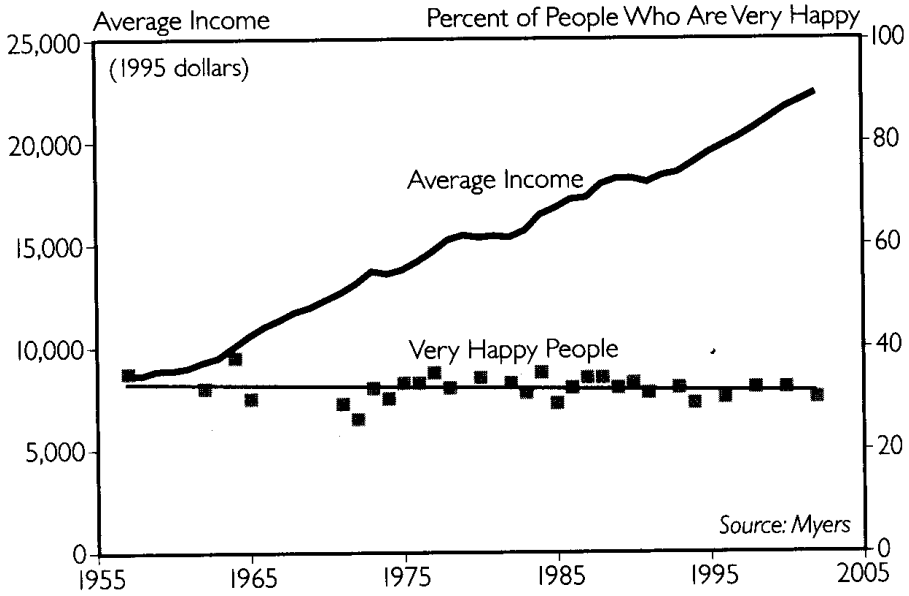
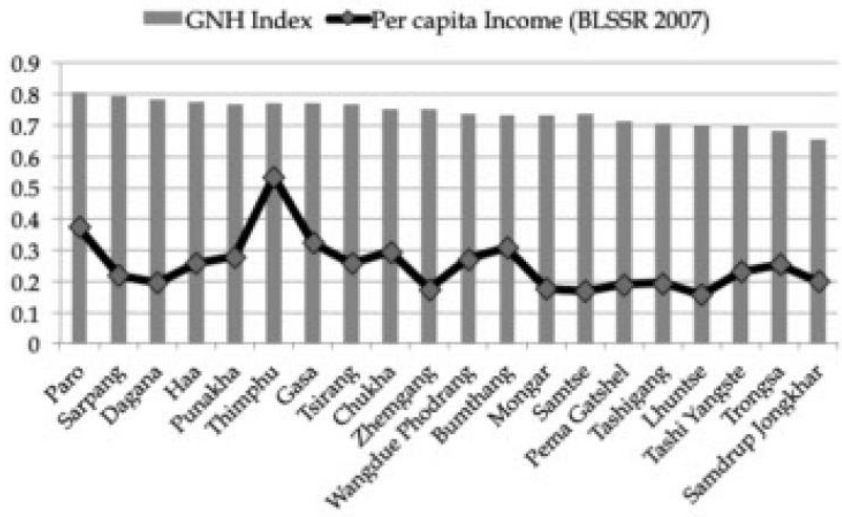


Source: http://geraldguild.com/blog/2012/05/23/happiness-as-measured-by-gdp-really/comment-page-1/

Figure 40. GNH compared with per capita income



Source: Ura et al. (2012)

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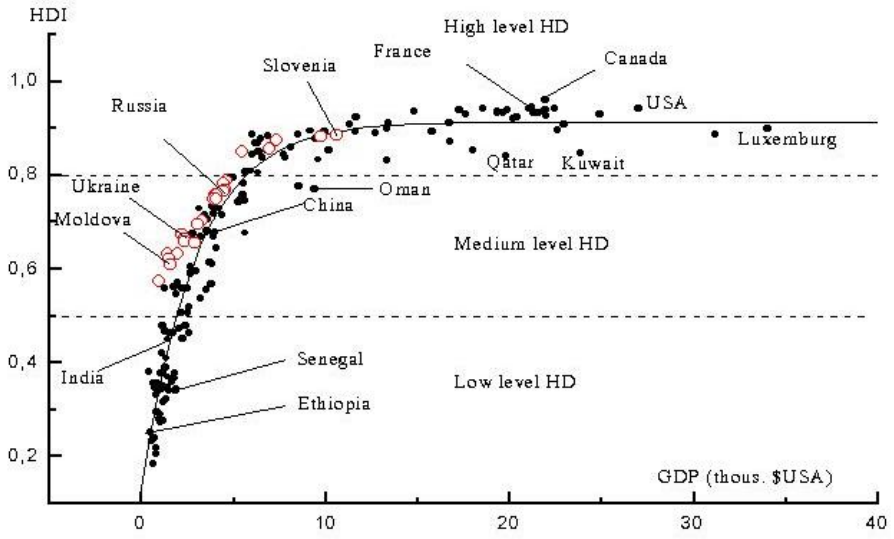
Figure 41. The relationship between GDP/capita and HDI



Source: http://www.ois.4pla.net/science/Center/Simash_berl.html

Second, the effect of economic development measured in GDP/capita on sustainable development depends on the sustainability theory and composite index we analyse. It seems that growth in GDP results in less sustainability if we define sustainability based on the theory of strong sustainability (and measure it with EF) while it results in more sustainability in case sustainability is defined based on weak sustainability (as measured by GS) (*figures 17-20*).

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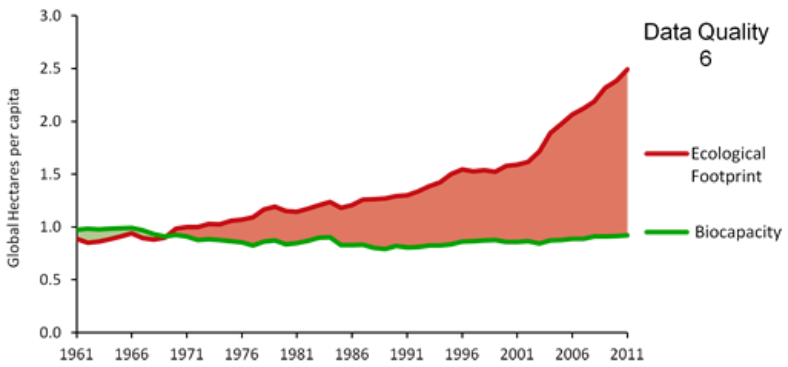
Figure 42. Development and EF in China, 1961-2001



Source: http://www.footprintnetwork.org/en/index.php/GFN/page/trends/

Figure 43. Development and EF in the USA, 1961-2001

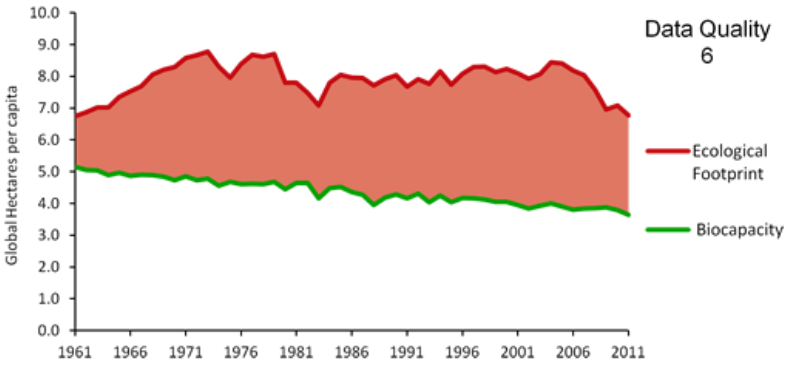


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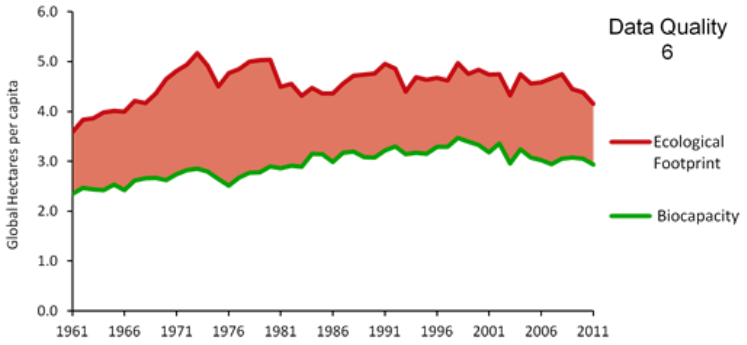
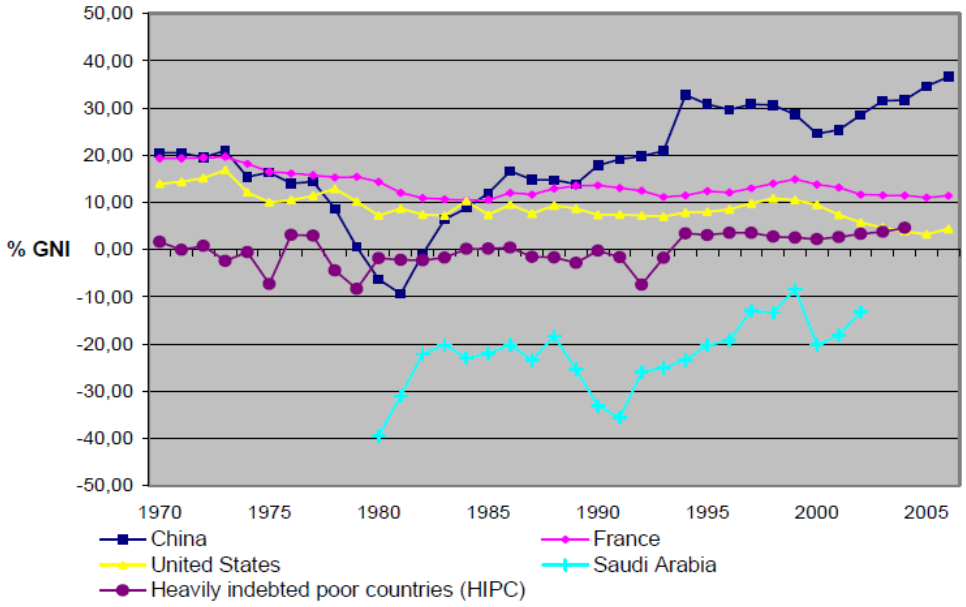
Figure 44. Development and EF in France, 1961-2001



Source: http://www.footprintnetwork.org/en/index.php/GFN/page/trends/

Figure 45. ANS (GS) for selected countries, 1970-2006



Source: Stiglitz et al. (2009)

Third, if we compare development as operationalized based on the capability approach (measured by HDI) and strong sustainability (measured by EF) there is only one country, which can be considered of high human development and of sustainable consumption patterns: Cuba (*figure 21*).

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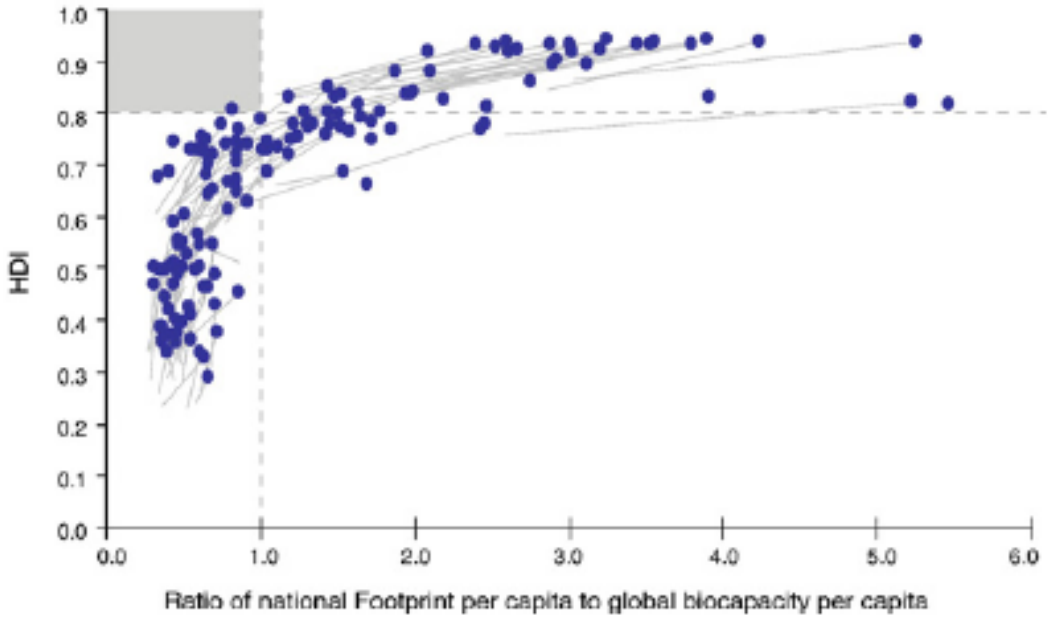
Figure 46. Well-being (HDI) and strong sustainability (EF) – an international comparison



Source: Moran et al. (2008)

Conclusions - economic growth, quality of life and sustainability

Although mainstream economics and economists measure development by growing GDP/capita, development understood as well-being/quality of life is a far more complex phenomenon. A GDP-centred development approach is also heavily criticized for not considering sustainability (environmental) aspects.

Both well-being/QoL and sustainability are debated concepts with different approaches, paradigms, theories:

- e.g. regarding QoL we find the theories of subjective well-being and the capability approach; and
- regarding sustainability the theories of weak and strong sustainability.

Composite indices measuring well-being/QoL and sustainability are manifold, often have antagonistic results/messages and are subject of extensive criticism regarding their usefulness, precision etc.

Although the relationship between GDP/capita and QoL is debated, there is a consensus among researchers that QoL is a lot wider concept than GDP (material welfare), and most research show that GDP growth adds less to QoL after a certain level of material welfare (there is a diminishing marginal utility of income).

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Economic development (as measured in GDP growth) results in even higher environmental burden. According to the theory of weak sustainability (and the indicator of GS) it is not necessarily a problem if enough man-made capital (K) is produced, while according to the theory of strong sustainability (and the measure of EF) it clearly indicates unsustainability. This way even if economic growth adds to Qol, there is a good reason to think that it is not sustainable in the long run, except if we believe in weak sustainability and techno-optimism.

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Questions/exercises for self-audit

What do you know about the theory of subjective well-being?

What do you know about the capability approach?

What do you know about GNHI?

What do you know about HDI?

What do you know about genuine savings?

What do you know about ecological footprint?

How do economic development, quality of life and environmental sustainability relate to each other to our present knowledge?

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6. The problem of common goods in environmental economics

The problem of common goods or common-pool resources (CPRs) is a huge topic within environmental and ecological economics since it has significant explanatory power related to numerous natural resources (from the deforestation and degradation of tropical forests to the changing of the global climate).[36] Discussions have begun in 1968 with Gareth Hardin's article entitled *"The tragedy of the commons"*. Since then, related research is of many streams influencing many different disciplines from sociology through political science to economics. In economics, Elinor Ostrom was awarded a Nobel-prize for her work in this area. For a few years the topic has also had its own thematic journal[37]. Therefore, **the aim of the present chapter** is to provide an introduction to the topic based on Hardin's original work and some more recent research results related most of all to Ostrom's and her colleagues' works.

The chapter is structured as follows: (1) First we discuss the related definitions and how common goods relate to natural resources; (2) after that we show how and why overuse (unsustainable use) is a real opportunity in case of common goods or common-pool resources (CPRs); later (3) we introduce some early debates regarding the problem of overuse and its solutions; and at the end (4) we highlight the role of institutions in the sustainable use of CPRs based on the works of Ostrom and her colleagues.

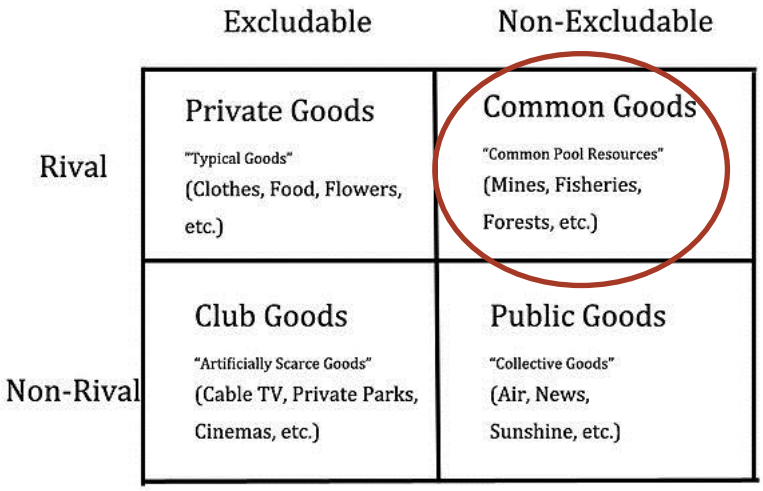
6.1. Definitions – common goods and natural resources

A widespread typology of goods in economics is based on the dimensions of rivalry and excludability (*figure 1*). The definition of these categories:
"an excludable good is a good that one can prevent another from owning and using by owning it themselves. So if person A owns the excludable good, then person B can be prevented from owning it. If anyone could not be prevented from getting benefits from a good or service, then this good or service is called "non-excludable. … a "rival good" is a limited resource to be consumed. In other words, the amount of the good is finite, and therefore if person A were to acquire more of the good, it would mean that person B has less of the good."[38]

Within this typology "typical goods" are "private goods": these are excludable and their consumption is characterized by rivalry. Common goods or common-pool resources (CPRs) are goods which are non-excludable and rival. It means that on the one hand their supply is limited, this way such goods can be overused, and it is difficult to exclude potential users from using them, which causes that the potential for overuse (unsustainable use) is of high probability.

[36] We use the verbs open access resources, common goods and common pool resources (CPRs) as synonyms because they are more ore less used like this in the special literature.
[37] http://www.thecommonsjournal.org
[38] http://en.wikibooks.org/wiki/Strategy_for_Information_Markets/Features_of_Goods#cite_note-Webster-1

Figure 47. Typology of goods based on rivalry and excludability



Source: http://en.wikibooks.org/wiki/Strategy_for_Information_Markets/Features_of_Goods

The original typology (*figure 1*) was modified by Ostrom and her colleagues to be less theoretical (*figure 2*) emphasizing that rivalry and excludability are not absolute categories but work as dimensions with a continuum.

Figure 48. Typology of goods as modified by Ostrom and her colleagues

		Subtractability	
		Low	*High*
Excludability	*Difficult*	Public goods	Common-pool resources
	Easy	Toll goods	Private goods

Source: Acheson (2011)

There are many different kinds of goods within the aforementioned categories. These differ in their size, number of users, measurability etc.

The aforementioned typologies are important for us because many natural resources/environmental goods can be considered as common goods – it is difficult to exclude potential users from their use on one hand and they can be overexploited (overused) because of their limited availability (supply) on the other hand. Just like in the case of common goods in general, these natural resources are quite diverse e.g. regarding their size,

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number of users, measurability etc. Such environmental goods/resources are also strongly interrelated, just like the problems related to them:

- One resource/good is connected to more ecosystems and one ecosystem provides more than one resource/good; and
- anthropogenic stress affects multiple resources/goods and ecosystems at the same time.

Examples for such environmental goods/resources are:

- oceans,
- ocean fish stocks,
- groundwater basins,
- (rain)forests,
- pastures,
- soil,
- global climate,
- biodiversity etc.

6.2. Common goods, common-pool resources (CPRs) and overuse (unsustainable use)

The debate regarding the overuse of CPRs and its potential solutions begun in 1968 with the article of Gareth Hardin. (The intensity of the debate is shown e.g. that in April 2015 there are more than 26.000 quotations to this article according to google scholar.)
Hardin asked the following question: What happens to a pasture of open access (a "common"/common good) in case farmers using it with the goal of short-term profit-maximization?
Hardin's initial scenario is the following:

- The pasture is of finite carrying capacity (in this sense Hardin's example is techno-pessimistic/based on the theory of strong sustainability).
- The goal of the users (farmers) is short-term profit maximization
- There are 10 farmers using the pasture, each of them keeping 1 cow on it.

Hardin shows that in case of the aforementioned circumstances farmers are going to overuse the pasture because it is in their short term interest of profit maximization (see table 1.)

Table 5. The overuse of an open access pasture according to the model of Hardin

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Number of cows	Weight of one cow (kg)	Net benefit of farmers having two cows compared to the baseline scnerio	Net benefit of farmers having two cows compared to the previous scnerio	Wright of all cows (kg)	Loss in weight (loss of te community)
10	1000	-	-	10000	-
11	900	800	800	9900	100
12	800	600	700	9600	400
13	700	400	600	9100	900
14	600	200	500	8400	1600
15	500	0	400	7500	2500
16	400	-200	300	6400	3600
17	300	-400	200	5100	4900
18	200	-600	100	3600	6400
19	100	-800	0	1900	8100
20	0	-1000	-100	0	10000

Table 1 shows that farmers who let one extra cow on the pasture (in addition to the initial one cow/capita they had on the pasture at the beginning) have a positive personal return (profit) compared to the actual scenarios. However, if everyone follows their own self-interest there will be too many cows on the pasture compared to its carrying capacity. This way the pasture is going to be overused and exploited and the community (and every single farmer) loose the ecosystem services (food production) used to be provided by the pasture earlier. This way everyone lose in the long run because the pasture (the CPR) is going to collapse because of overexploitation.

Hardin's example shows that cooperation would be the long-term interest of users but in the short run competing means a higher pay-off for them individually.

Another problem regarding the overuse of CPRs and the lack of investment in maintaining them is the problem of free riding. Here the following question emerges: Should the individual decision-maker buy a bus ticket in case the bus is of open access?

In case the number of service users is high and the effect of individuals is non-significant on the maintenance of the bus service, it is not going to be in the short term economic interest of individuals to pay for it (and other public services) since not paying (free riding) has a higher utility for them (*table 6*). The reason for that is that the maintenance of the public service is independent from the individual since her contribution is insignificant within total maintenance costs. Maintenance depends on the potential contributions of other users because of the high maintenance costs and many users of public services. Since all of us are individual decision-makers, none of us are economically motivated to contribute to maintenance in such cases.

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Table 6. The problem of free riding - payoff matrix for the individual (contributing to public services of open access)

		Society	
		Contributes (+1)	Does not contribute (-1)
Individual	Contributes (-1)	0	-2
	Does not contribute (0)	1	-1

Again, short term private and long term collective (and private) interests are in conflict. In the long run it is in the interest of the community and the individuals to maintain public services, however, in the short run individual decision-makers (all of us) are economically motivated not to pay (to free ride).

The same logic applies e.g. to environmentally significant behaviour (*table 3*). Why should I quit eating meat or using my car in case my effect on the whole food system or carbon emissions is negligible? In case others do not change their habits, my behaviour basically does not have any effect on the system-level.

Table 7. Payoff matrix for the individual for environmentally conscious behaviour

Society / *Individual*	**Eco-friendly**	**Non-eco-friendly**
Eco-friendly	I Gain: 20 Cost: 10 Net profit: 10	III. Gain: 0 Cost: 10 Net profit: -10
Non-eco-friendly	II. Gain: 20 Cost: 0 Net profit: 20	IV. Gain: 0 Cost: 0 Net profit: 0

Source:
http://www.tankonyvtar.hu/hu/tartalom/tamop425/0049_16_economic_models_and_stimulations/3924/index.scorml

6.3. Early debates regarding the problem of overuse

The problem of the overuse of common goods is a social trap:

- Cooperation would be the interest of everyone in the long run but in

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the short run competing means a higher pay-off; and

- (1) diverging personal and community interest (rationalities) in the short run cause (2) competition which (3) leads to overuse and this way (4) reduced community-level (and personal) well-being/benefit.

The first conclusion drawn by Hardin and others recognizing this problem was that users (individuals and the community of users) are not able to cooperate on their own to prevent overuse (unsustainable use), thus there is a need for intervention from the outside for resource conservation. It can be defining either (1) private or (2) state property over the resource.

Although these early suggestions might sound appealing but there are two problems with them.

(1) These suggestions are reductionists: theoretical concerns can be raised if state and/or private property secures sustainable use.
State property theoretically overcomes overuse problems (Feeny et al. 1990) in case the state is

- well-informed regarding sustainable use,
- able to monitor resource use, and
- (1) able and (2) intend to sanction unsustainable use.

However, in practice the state is often:
(1) uninformed regarding sustainable use,
(2) not able to monitor resource use, and
(3) (1) not able to and (2) does not intend to sanction unsustainable use.

Private property is theoretically able to overcome overuse problems (Feeny et al. 1990) if private owners are
(1) able to enforce their rights,
(2) well-informed regarding sustainable use, and
(3) motivated to the sustainable use (preservation) of the resource.

However, in practice private owners are often

- not able to enforce their rights,
- not well-informed regarding sustainable use, and
- not motivated to the sustainable use (preservation) of the resource (e.g. in case interest rates and rates of return for alternative uses are higher than the rate of return of the sustainable use of the resource – the latter being often limited by the pace of regeneration of the given resource).

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(2) The suggestions are also in contradiction with field experiences: in many cases users (the community of users) organized sustainable use on their own while the state and the market (private property) has often led to unsustainable use (Feeny et al. 1990).

Research revealed examples for both successful and unsuccessful use of common-pool resources, however, these cannot be attached to uniform solutions/property forms (e.g. the market/private property or the state). Local communities have been able to organize themselves for sustainable use in numerous cases, while in others they have not been able to do so. Furthermore, in many cases local community solutions were successful in sustaining CPRs and state intervention has worsened the situation. A typical example for that is forest use in developing countries. Communities on their own often use forests in a way that preserves the resource, thus community property manages the resource sustainability. The state taking over the management of forests often results in open access and resource overuse for different reasons – e.g. the state gives permits to large business corporations to (over)use, or locals not respecting the authority of the state.

Furthermore, property forms are usually not uniform in case of a given common-pool resource. Pure state or private property is seldom, CPRs are usually a mix of public- and private-like property institutions – this fact also shows that sustainable management in practice is more difficult than defining a single type of property over the resource.

6.4. Institutions and the sustainable use of CPRs based on the works of Elinor Ostrom

As aforementioned, there has been a massive amount of research from the 70's and 80's on regarding CPR problems and their solutions. A ground-breaking work in this respect is Elinor Ostrom's (1990) book entitled *"Governing the commons: The Evolution of Institutions for Collective Action".* This can be considered the second "classic" work in the field beside Hardin's – with more than 21000 citations as of April 2015 according to google scholar. Research on CPR problems have become complex and far reaching in the past three decades, and here we do not have the opportunity to discuss it in detail or even to provide a proper overview. We are only able to highlight some interesting streams of research and results below.

Within her book Ostrom provided an institutional analysis of common-pool resource (CPR) situations. She defines institutions as rules: *"the prescriptions that humans use to organize all forms of repetitive and structured interactions including those within families, neighborhoods, markets, firms, sports leagues, churches, private associations, and governments at all scales."* (Ostrom 2005)

Her main research questions were the following (Acheson 2011):

(1) Why are natural resources over-exploited?

(2) Under what conditions are resource users and communities able to generate effective rules to

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manage them? (What are the institutions which foster sustainable use?)

The characteristics of a CPR situation in Ostrom's work are the following:

- CPRs are shared by groups of people.
- They are characterized by subtractability: one person's use of the resource subtracts from the amount available to others.
- Users face great difficulties of exclusion in the case of CPRs.

(This way CPR situations are the same as a "common" situation in Hardin's approach or common goods in conventional economics.)

According to Ostrom (1990), the problems regarding CPR situations are the following (Acheson 2011):

- Successful management must involve rules to control entry and to ensure efforts on the resource, thus both the problems of appropriation (and "appropriators") and provision (and „providers").
- Case studies show that there are many different combinations of rules and strategies that can be used to govern common-pool resources in a successive way. Thus, there are no general solutions or institutional arrangements which can be considered a guarantee for success. It rather makes sense to identify *"design principles"* of sustainable use (see below).
- It is difficult to use market solutions to govern common-pool resources, since users can often foist externalities to others.

After analysing many local-scale case studies including both robust, long-lasting resource-management systems (common-pasture management in Switzerland and Japan and irrigation systems in Spain and the Philippines) and systems that have failed (fisheries in Turkey, Sri Lanka, and Nova Scotia; and irrigation systems in Sri Lanka), Ostrom defined the following *"design principles"* for sustainable use of CPRs:

1. well-defined boundaries
2. proportional equivalence between benefits and costs
3. collective-choice arrangements
4. monitoring
5. graduated sanctions
6. conflict-resolution mechanisms
7. minimal recognition by governments of the rights of local people to organize
8. nested enterprises (i.e. common-pool resource management units arranged in a nested hierarchy)

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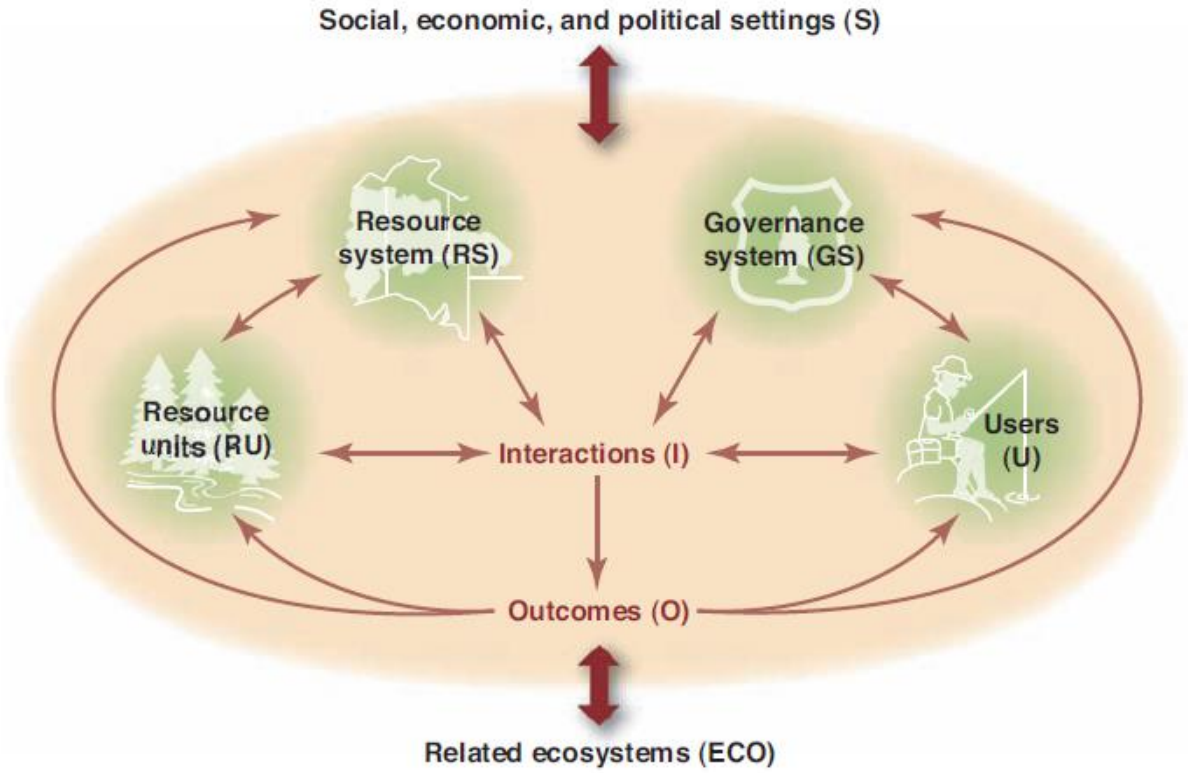
Current research – among other goals – aims to identify and analyse variables influencing cooperative behaviour and sustainable use of CPRs. The model of Ostrom (2009) called *"General Framework for Analyzing Sustainability of Social-Ecological Systems"* lists many of such potential variables (*figures 3 and 4*).

Figure 49. The core subsystems in a framework for analysing social-ecological systems



Source: Ostrom (2009)

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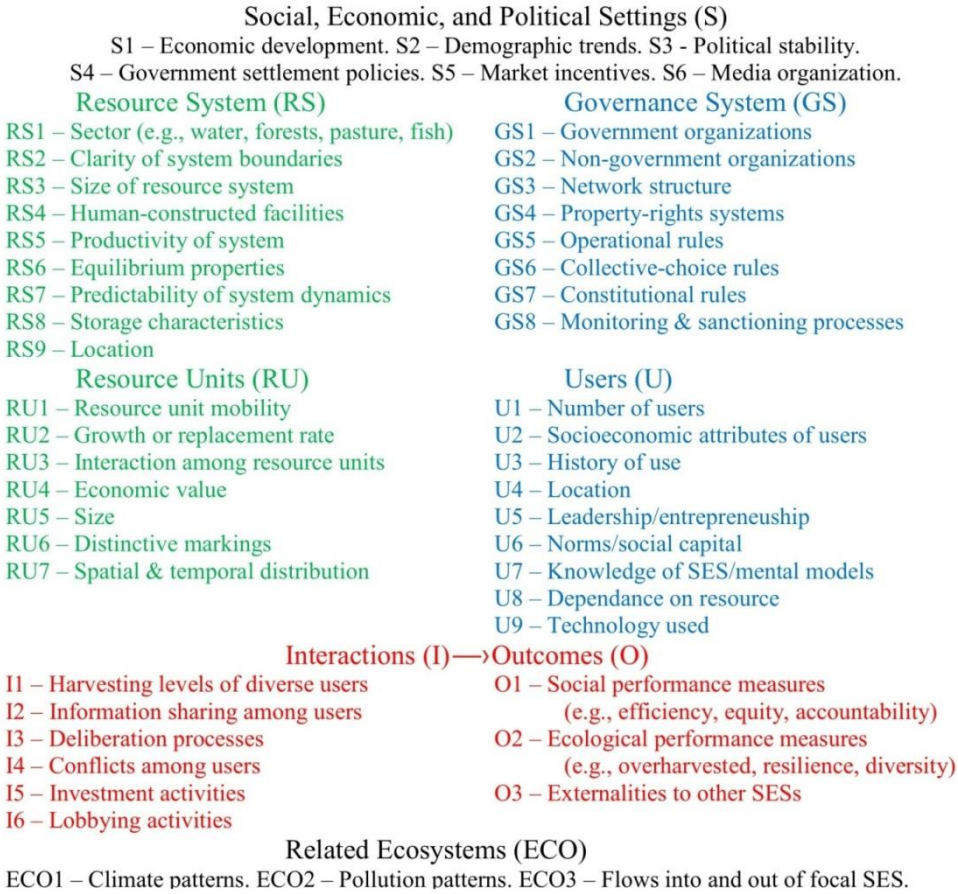
Figure 50. Examples of second-level variables under first-level core subsystems in a framework for analyzing social-ecological systems



Source: Ostrom (2009)

As shown above, research identified many variables potentially influencing the (lack of) emergence of rules in CPR situations. E.g. there is a higher probability of succeeding in getting norms if communities (Acheson 2011):

- are small,
- are homogenous,
- have a lot of social capital,
- have a strong sense of community,
- are characterized by mutual trust,
- can change the rules of use,
- are dependent on the resource,
- have a low discount rate (i.e. willingness to sacrifice current payoffs for higher payoffs in the future), and

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- have leadership/political entrepreneurship.

Last but not least, it is important to mention that we know a lot about the management of small-scale (local) CPRs, but a lot less about global commons. Here we face the problem of scale (consider e.g. that many variables enhancing the probability of the emergence of norms are connected to the small size of the community which uses the resource.) Scale makes an enormous difference here, e.g. because of

- the difference between the number of users in case of small-scale CPRs and global commons (e.g. global climate);
- the spatial distance between users and producers (demand and supply) growing with the growth of scale, the number of users and economic globalization processes (e.g. the spatial distance between resource extraction and the consumption of final products in case of most industries at the present); and
- the problems of rule enforcement in case of CPRs the use of which is connected to more than one political nations (e.g. the lack of a climate regime because cooperation problems and lack of enforcement opportunities).

Because of the aforementioned problems regarding scale, protecting the global commons is a *"struggle"* (Dietz et al. 2003). We lack successful examples. Most global environmental problems are getting more and more sever nowadays which indicates the overuse (unsustainable use) of global commons to an ever growing extent. We cannot yet talk about a successful *„Global environmental governance/global sustainable development governance regime"* (Najam et al. 2006).

Summary

As a short summary regarding the topic we can establish the following:

- There is a large body of research regarding CPR problems from the 60's and 70's on. Research has come a long way: it begun with the reductionist analysis and solutions of Hardin and by today it has been examining the issue of CPRs in its full complexity.
- The success regarding CPR situations (the sustainable use of open-access natural resources) is influenced by very many factors (see e.g, the General Framework for Analyzing Sustainability of Social-Ecological Systems).
- We do know a lot about the factors of successful governance of CPRs but this knowledge is most of all connected to the local scale. Unfortunately we have a very limited knowledge about how to successfully manage and protect the global commons.

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Questions/exercises for self-audit

What do you know about common goods? How do the concept of common goods relate to natural resources?
What are Hardin’s main messages concerning common goods?
What are Ostrom’s main messages concerning common pool resources?

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