Lecture Notes

Sustainable Development and National Strategies

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These Lecture Notes are only for use in the

“Sustainable Development and National Strategies” course at Sofia University "St Kliment Ohridski",
Faculty of Economics and BA, 2014.

Table of Contents

General Information about the workshop:

This workshop is divided into two parts: the first part is from 4th to 7th of March 2014, and the second is from 14th to 17th of April 2014.

Time of teaching for the first part is from 9.00 am to 10.30 am and from 10.45 am to 11.30 am (Tuesday to Friday).

Time of project presentation for the second part is from 9.00 am to 10.30 am and from 10.45 am to 12.15 am (Monday to Thursday).

Course material consists of the Lecture Notes provided to the students some weeks before the workshop starts, as well as a detailed list of the structure and the contents for the project presentation.

Location:

Sofia University "St Kliment Ohridski", Faculty of Economics and BA

Description:

In part one of this workshop students learn some theoretical aspects about the science of sustainable development and about recent researches on national strategies for sustainable development. The starting point is the history and the most often-quoted definition: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" by the Brundtland Commission with the report “Our Common Future” (1987). The term “Sustainable Development” has become worldwide popular after the UN Conference on Environment and Development held in Rio de Janeiro in 1992. With the Agenda 21 they outlined an important action plan for nations. It was adopted by more than 178 nations.

Our world is a complex and dynamic system; some natural processes and cycles are difficult to understand. Therefore in this workshop students will work with a reduced world model consisting of only five natural elements that are necessary to sustain life on earth: air, water, soil, the ozone layer and sun.

The concept of sustainable development (with the descriptors “anthropocentrism”, “nature conservation”, “justice and equity”, “comprehensiveness” and “long-term durability”) can contribute to finding strategies, principles and policies for a national sustainable development. Ecological and social objectives are as important as economic objectives.

Helping impoverished countries and combating against environmental degradation are the biggest challenges in our world. The main limit of our ecosystem is the carrying capacity for human influences controlled by the world population and satisfaction of needs. Suitable sustainable development strategies for nations can’t be implemented immediately. It takes time, maybe long time. But ultimately humans are responsible for a sustainable development and the implementation of strategies for world nations.

Second Part - Project Presentation:

For the presentation the student should work on a case study which consists of an analysis of a country in consideration of the concept of Sustainable Development described and explained in the first part of the workshop. The student can choose a favorite country and try to find out some feasible strategies for a sustainable development in this country.

The student's output is an oral presentation (appr. 20-30 minutes) and a short written summary (maximum 10 pages, Arial 11pt) delivered latest by 17th of April 2014.

Grading:

The assessment consists of two parts: oral presentation (counting 50 %) and written paper (counting 50 %).

Prerequisites:

Students should have a basic understanding of economics and natural sciences.

I. Introduction

The term “Sustainable Development” has become popular since the UN Conference on Environment and Development held in Rio de Janeiro in 1992. The Brundtland Commission Report (World Commission on Environment and Development, 1987) has made a great contribution by emphasizing the importance of sustainable development and by giving the most often quoted definition.

The starting point of theory formation is the ethical idea of sustainability. It is based on obligations toward future generations and presupposes intergenerational equity. Concerning specific resources and services (e.g. fresh water, the atmosphere as a carbon sink, the wide variety of ecosystems), it is evident that continuing growth at these utilization rates is unsustainable.

Problems on earth are diverse: underdevelopment, poverty, drought and famine, environmental depletion, wastage, waste of resources etc. The aim of Sustainable Development is to solve these problems and create a situation that is of long-term durability for all present and future generations, known as intra- and intergenerational equity.

Sustainable Development is of concern to everybody and it affects every country in the world, all firms, all regions, all towns and all households. Sustainable development is an anthropocentric concept, because humans are at the center of interest. It is also a normative concept.

The concept has three main pillars: social, economic and ecological aspects.

A simple world model is the base for developing strategies to implement sustainability on the earth. The main limits are the carrying capacity of the earth and the capacity for human impact on resource removal and waste insertion. Both limits are influenced by population growth and the satisfaction of needs. The development of natural means of livelihood depends on the carrying capacity of the earth. The earth can regenerate if limits are adhered to. The limits of ecosystems have an impact on our economic system if sustainability is implemented.

How should mankind deal with natural resources especially with non-renewables?

How should mankind solve problems like poverty and wastage?

What are the consequences for world nations?

Whether a sustainable world is possible or not, will be discussed at the end of the lecture.

II. Sustainable Development – Definition and History

1. What is Sustainability?

After the United Nations Conference on Environment and Development in Rio (1992) the term “SD” (Sustainable Development) became a keyword. Not only economists, but also physicists, engineers, social and political scientists and theologians are showing their interest.

Sustainable development has been defined in many ways, but the most frequently quoted definition is from *Our Common Future* in 1987, also known as the Brundtland Report (WCED, 1987, p. 43):

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

The starting point of theory formation is the ethical idea of sustainability. It is based on obligations toward future generations and presupposes intergenerational equity.

It contains within it two key concepts:

- the concept of **needs**, in particular the essential needs of the world's poor, to which overriding priority should be given; and
- the idea of **limitations** imposed by the state of technology and social organization on the ability of the environment to meet present and future needs.

2. History

The idea of sustainability dates back more than 40 years.

It was a key theme of the United Nations Conference on the Human Environment in Stockholm in **1972**. The concept was coined explicitly to suggest that it was possible to achieve economic growth and industrialization without environmental damage.

In the ensuing decades, mainstream sustainable development thinking was progressively developed through the World Conservation Strategy (**1980**) and with the publication by the World Commission on Environment and Development (WCED) of its report "*Our Common Future*" (more commonly known as the "Brundtland Report” (**1987**)).

In **1992**, the UN Conference on Environment and Development (UNCED), or the "Earth Summit", in Rio de Janeiro, agreed on a Declaration setting out 27 principles supporting sustainable development. The Summit also agreed a plan of action called Agenda 21, and recommended that all countries produce national sustainable development strategies. A special UN Commission on Sustainable Development was created.

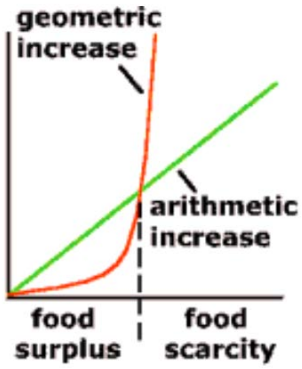
In **2002**, the Johannesburg Summit reviewed the progress made on global sustainable development since the Rio Summit. The World Summit on Sustainable Development (WSSD, 2002) confirmed that the first decade of the new century, at least, would be one of reflection about the demands placed by mankind on the biosphere.

2.1 Meadows et al. (1972, 1992 and 2004)

“The Limits to Growth” is a 1972 book modeling the consequences of a rapidly growing world population and finite resource supplies, commissioned by the Club of Rome. Its authors were Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens. The book used a computer simulation model (system dynamics) and called it the “World3 model” (Forrester, 1971) to simulate the consequence of interactions between the Earth's system and the human system.

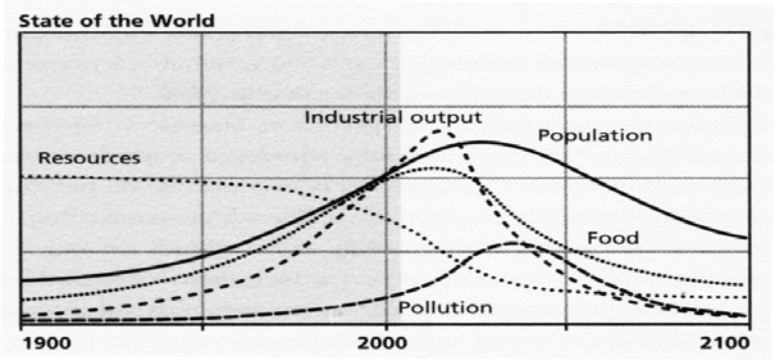
As result they indicated that economic growth at current rates could not continue in the long term. The book was widely understood to claim that environmental limits would cause the collapse of the world economic system by the middle of the twenty-first century.

The book echoes some of the concerns and predictions of the Reverend Thomas Robert Malthus in An Essay on the Principle of Population (1798).



In his essay, Malthus argued that the geometrical power of increase in human numbers (world population), and an arithmetical growth in agricultural production, would regularly combine to produce famine, increased mortality, and longer hours of work. According to Malthus, population growth would reach such a level that the land would no longer be able to support it, and widespread starvation would occur.

Five variables were examined in the original model of Meadows et al. (1972), on the assumptions that exponential growth accurately described their patterns of increase, and that the ability of technology to increase the availability of resources grows only linearly. These variables are: world population, industrialization, pollution, food production and resource depletion:



Many prominent economists, scientists and political figures criticized the *Limits to Growth*. They attacked the methodology, the computer, the conclusions, the rhetoric and the people behind the project.

However, it played an important role in bringing concerns about the over-use of natural resources into the political debate.

Three of the four authors of the 1972 book are the authors of the sequel with the title "Beyond the limits". It uses the same World 3 model as the original. Only some modifications were made, some of the relationships were modified, and some of the numerical values for parameters were changed.

The conclusions:

The three conclusions from the original "The limits to growth" (1972) are still valid:

As far as we can tell from the global data, from the World 3 model, and from all we have learned in the past twenty years, the three conclusions we drew in *The limits to growth* are still valid, but they need to be strengthened. Now we would write them this way;

1. Human use of many essential resources and generation of many kinds of pollutants have already surpassed the rates that are physically sustainable. Without significant reductions in material and energy flows, there will be in the coming decades an uncontrolled decline in per capita food output, energy use, and industrial production.
2. The decline is not inevitable. To avoid it two changes are necessary. The first is a comprehensive revision of policies and practices that perpetuate growth in material consumption and population. The second is a rapid, drastic increase in the efficiency with which materials and energy are used.
3. A sustainable society is still technically and economically possible. It could be much more desirable than a society that tries to solve its problems by constant expansion. The transition to a sustainable society requires a careful balance between long-term and short-term goals and an emphasis on sufficiency, equity and quality of life rather than on quantity of output. It requires more than productivity and more than technology; it also requires maturity, compassion, and wisdom.

(Meadows *et al.*, 1992, p. xvi)

Meadows et. al (2004): In 2004 the three authors Meadows, Meadows and Randers have teamed up again to update and expand their original findings. In many ways, the message contained in "**Limits to Growth: The 30-Year Update**" is a warning. Overshoot cannot be sustained without collapse. After explaining overshoot, the book discusses population and industrial growth, the limits on available resources, pollution, technology and, importantly, ways to avoid overshoot. There is reason to believe that humanity can still reverse some of its damage to Earth if it takes appropriate measures to reduce inefficiency and waste.

2.2 Jørgen Randers (2012)

The book "2052 - A Global Forecast for the Next Forty Years" written by J. Randers is a Report to the Club of Rome Commemorating the 40th Anniversary of "The Limits to Growth".

Forty years ago, The Limits to Growth study addressed the grand question of how humans would adapt to the physical limitations of planet Earth. It predicted that during the first half of the 21st century the ongoing growth in the human ecological footprint would stop – either through catastrophic "overshoot and collapse" – or through well-managed "peak and decline."

In the book, Jørgen Randers, one of the co-authors of "Limits to Growth", issues a progress report and makes a forecast for the next forty years. To do this, he asked dozens of experts to weigh in with their best predictions on how our economies, energy supplies, natural resources, climate, food, fisheries, militaries, political divisions, cities, psyches, and more will take shape in the coming decades. He then synthesized those scenarios into a global forecast of life as we will most likely know it in the years ahead.

The good news: we will see impressive advances in resource efficiency, and an increasing focus on human well-being rather than on per capita income growth. But this change might not come as we expect. Future growth in population and GDP, for instance, will be constrained in surprising ways – by rapid fertility decline as result of increased urbanization, productivity decline as a result of social unrest, and continuing poverty among the poorest 2 billion world citizens. Runaway global warming, too, is likely.

Randers guides in his book along a realistic path into the future and discusses what readers can do to ensure a better life for themselves and their children during the increasing turmoil of the next forty years.

2.3 WCED – Our Common Future (1987)

Ms Gro Harlem Brundtland, who chaired the WCED (World Commission on Environment and Development) in 1987, was the former Prime Minister of Norway. The report "Our Common Future" (edited by WCED) described both the extent of

poverty and the various threats to sustainability. What was needed was a new kind of economic growth that had much less environmental impact and which increased the capacity of the environment to deliver human satisfaction.

The Brundtland Report may be considered to be a political document, not based on rigorous scientific analysis. The report comprised three objectives:

1. To re-examine the critical environment and development issues and to formulate realistic proposals for dealing with them;
2. To propose new forms of international cooperation on these issues that will influence policies and events in the direction of needed changes;
3. To raise the levels of understanding and commitment to action of individuals, voluntary organizations, businesses, institutes and governments.

The WCED focused on the issues of: population growth, food security, biodiversity loss, energy, resource depletion, and pollution and urbanization. (Common and Stagl, 2005, p. 363)

2.4 United Nations Conference on the Human Environment (1972)

The United Nations Conference on the Human Environment, held in Stockholm, Sweden, in 1972, was a ‘first’ in many respects: it was the first meeting that brought the nations of the world (113 countries participated) together to discuss the environmental future of the planet; it was the first United Nations conference on a single global issue; it was the first global meeting that saw a large presence and influence of non-state actors, including non-governmental organizations and scholars; and it was the first meeting to seek global policy consensus on issues related to the environment.

The major institutional legacy of the conference was the creation of the United Nations Environmental Programme (UNEP). This was accompanied by two declaratory documents – The Stockholm Declaration and the Stockholm Action Plan – ideas from which have been carried forth by subsequent summits.

2.5 United Nations Conference on Environment and Development (1992)

The **United Nations Conference on Environment and Development** (UNCED), also known as the **Rio Summit**, **Rio Conference**, **Earth Summit** was a major United Nations conference held in Rio de Janeiro in 1992. 172 governments participated, with 108 sending their head of State or Government. Some 2,400 representatives of non-governmental organizations (NGOs) attended, with 17,000 people at the parallel NGO "Global Forum", who had Consultative Status.

The issues addressed included:

- systematic scrutiny of patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste including radioactive chemicals
- alternative sources of energy to replace the use of fossil fuels which are linked to global climate change
- new reliance on public transportation systems in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog
- the growing scarcity of water

An important achievement was an agreement on the Climate Change Convention which in turn led to the Kyoto Protocol. Another agreement was to "not carry out any activities on the lands of indigenous peoples that would cause environmental degradation or that would be culturally inappropriate".

The Convention on Biological Diversity was opened for signature at the Earth Summit, and made a start towards redefinition of measures that did not inherently encourage destruction of natural ecoregions and so-called uneconomic growth.

The Earth Summit resulted in the following documents:

- *Rio Declaration on Environment and Development*
- *Agenda 21*
- *Convention on Biological Diversity*
- *Forest Principles*
- *Framework Convention on Climate Change (UNFCCC)*.

Both *Convention on Biological Diversity* and *Framework Convention on Climate Change* were set as legally binding agreements.

Critics, however, point out that many of the agreements made in Rio have not been realized regarding such fundamental issues as fighting poverty and cleaning up the environment.

2.6 The World Summit on Sustainable Development (2002)

The **World Summit on Sustainable Development** (WSSD) or **Earth Summit 2002** took place in Johannesburg, South Africa, in 2002. It was convened to discuss sustainable development by the United Nations. WSSD gathered a number of leaders from business and non-governmental organizations, 10 years after the first Earth Summit in Rio de Janeiro. (It was therefore also informally nicknamed "Rio+10".)

The Johannesburg Declaration was the main outcome of the Summit; however, there were several other international agreements. It laid out the Johannesburg Plan of Implementation as an action plan.

The absence of the United States rendered the summit partially impotent. George W. Bush boycotted the summit and did not attend; the US government did not send a delegation.

2.7 United Nations Conference on Sustainable Development (2012)

The **United Nations Conference on Sustainable Development** took place in Rio de Janeiro, Brazil, on 20-22 June 2012 (nickname: Rio+20) to mark the 20th anniversary of the 1992 United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro, and the 10th anniversary of the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg.

The conference was organized by the United Nations Department of Economic and Social Affairs. The decision to hold the conference in 2012 in Rio de Janeiro was made by the UN General Assembly Resolution on 24 December 2009.

<u>The conference had three objectives:</u>

1. Securing renewed political commitment for sustainable development.
2. Assessing the progress and implementation gaps in meeting previous commitments.
3. Addressing new and emerging challenges.

<u>The conference has two themes agreed upon by the member states.</u>

1. Green economy within the context of sustainable development and poverty eradication.
2. Institutional framework for sustainable development.

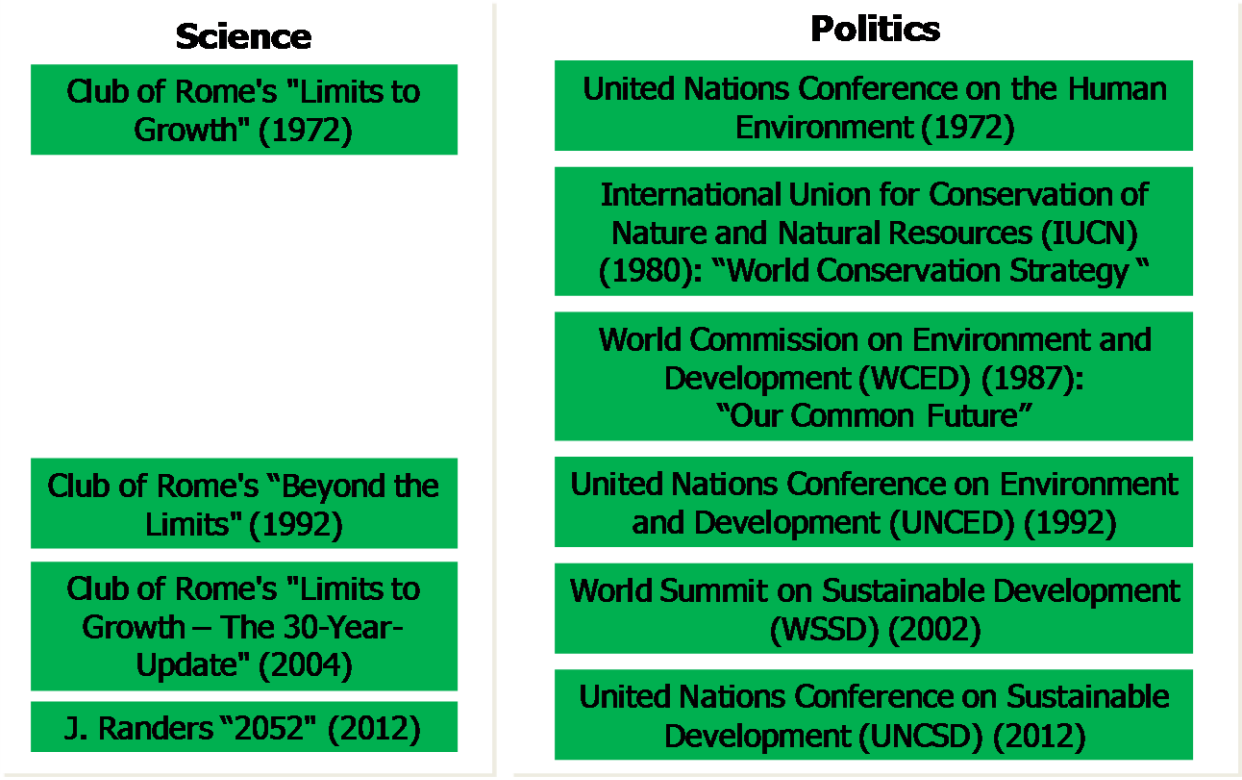
<u>7 Critical Issues at Rio+20:</u>

The preparations for Rio+20 have highlighted seven areas which need priority attention; these include

1. decent jobs,
2. energy,
3. sustainable cities,
4. food security and sustainable agriculture,
5. water,
6. oceans and
7. disaster readiness.

(see http://www.uncsd2012.org/)

2.8 Summary

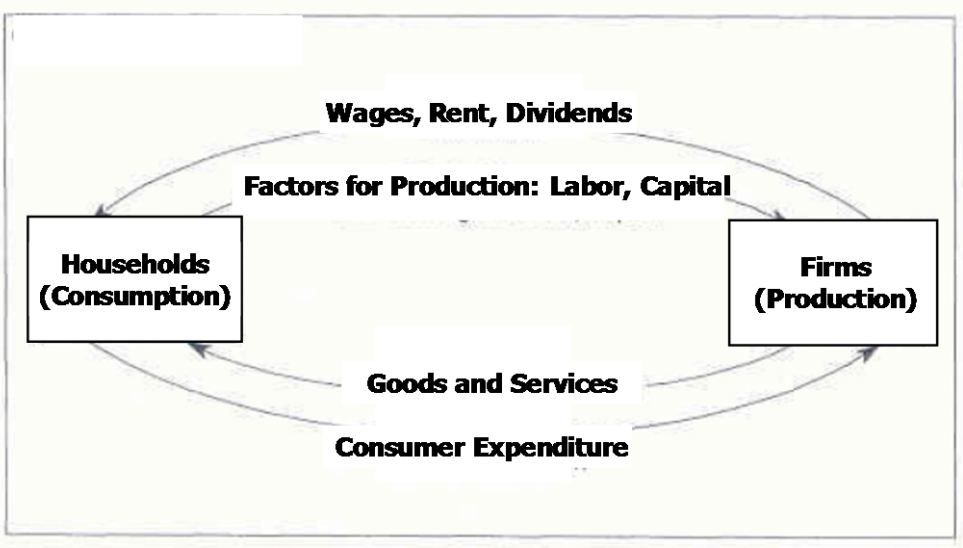

Science
Club of Rome's "Limits to Growth" (1972)
Club of Rome's "Beyond the Limits" (1992)
Club of Rome's "Limits to Growth – The 30-Year-Update" (2004)
J. Randers "2052" (2012)
Politics
United Nations Conference on the Human Environment (1972)
International Union for Conservation of Nature and Natural Resources (IUCN) (1980): "World Conservation Strategy"
World Commission on Environment and Development (WCED) (1987): "Our Common Future"
United Nations Conference on Environment and Development (UNCED) (1992)
World Summit on Sustainable Development (WSSD) (2002)
United Nations Conference on Sustainable Development (UNCSD) (2012)

III. Sustainable Development – Governance

1. Sustainable Development and Economic Growth

1.1 Basics

The circular flow model



The circular flow model consists of seven assumptions:

1. The economy consists of two sectors: households and firms.
2. Households spend all of their income (Y) on goods and services or consumption (C). There is no saving (S).
3. All output (O) produced by firms is purchased by households through their expenditure (E).
4. There is no financial sector.
5. There is no government sector.
6. There is no overseas sector.
7. It is a closed economy with no exports or imports.

In the simple **two sector circular flow of income model** the state of equilibrium is defined as a situation in which there is no tendency for the levels of income (Y), expenditure (E) and output (O) to change, that is:

$Y = E = O$

The circular flow describes how a market economy works. A market economy is one in which individuals influence directly what is produced, marketed, and consumed. Individuals do this by spending money on what they want. This then directs producers to produce goods and services that individuals will consume. The amount

of goods and services that are made available is related to the laws of supply and demand.

The circular flow of goods and services is a simplified illustration of basically two flows: the flow of incomes to households from businesses, and the flow of resources to businesses from households. This model excludes the more complex influences of microeconomic factors. In the macroeconomic perspective, resources flow from households to businesses, which change the resources into goods and services for consumption in the product markets. Households are rewarded for the resources they provide in the form of money. It is a circular process that flows in both directions.

1.2 The Economic System and Thermodynamics

A major contribution to economics by Georgescu-Roegen (Nicholas Georgescu-Roegen, with his well-known book “The Entropy Law and the Economic Process” from 1971) was the concept of entropy from thermodynamics. His work contributed significantly to bio-economics and to ecological economics.

> *“The almost fabulous comfort … of many past and present societies made us forget the most elementary reality of economic life, the fact that, among all the things that are required for our living, only the purely biological ones are indispensable for our survival.” (*Nicholas Georgescu-Roegen, 1971)

Basics

First Law (Law of Conservation of Matter): Energy/Matter can neither be created nor destroyed.

Second Law (Law of Increased Entropy): In all energy transformations, energy/matter quality will be consumed.

First Law of Thermodynamics

The first law of thermodynamics is one of the absolute physical laws of the universe.

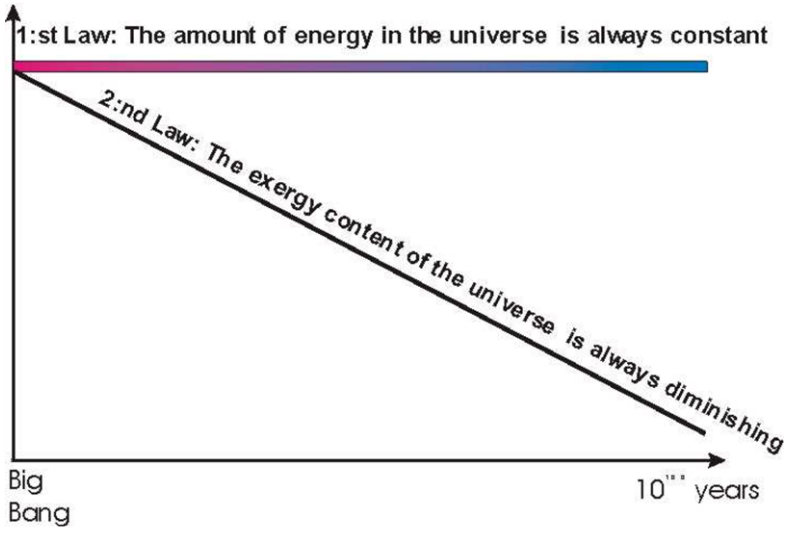
The amount of energy in the universe is constant – energy can be changed, moved, controlled, stored, or dissipated. This energy can be in work, heat, potential or kinetic form.

Second Law of Thermodynamics

The second law of thermodynamics shows that all of the energy in the universe is moving towards a less “useable” form. The quality deteriorates gradually over time. Usable energy is converted into unusable energy.

"Entropy" is defined as a measure of unusable energy within a closed or isolated system: as usable energy decreases and unusable energy increases, "entropy" increases.

Summary:



Source: http://www.holon.se/folke/kurs/Distans/Ekofys/fysbas/exergy/exergybasics.shtml

Contribution to Economics

Applying the thermodynamic theory to the economic system there is a transformation from low entropy (resources) to high entropy (wastes). As a by-product you obtain goods for satisfying human needs. The economic system is absolutely dependent on the low entropy from the ecological system. In the context of sustainable development it is essential that the economic system produces goods and services without consuming too much low entropy.

Thermodynamics and Recycling

According to the second law of thermodynamics, in all energy transformations, energy or matter quality will be consumed, and entropy increases.

With Recycling, the high entropy wastes of production, which are unusable energy or matter, are processed and then reused as inputs to production. So Recycling helps to decrease entropy.

Recycling has two consequences:

- The amount of waste inserted into the environment is reduced.
- To the extent that recycled material is used, the amount of the corresponding resource extracted from the environment is reduced, too.

Applying the thermodynamic theory to the economic system causes a transformation from low entropy (resources) to high entropy (wastes). As a by-product you obtain goods for satisfying human needs. The economic system is thoroughly dependent on the low entropy from the ecological system. Without low entropy the economic system couldn't function, e.g. produce goods and services. In the context of aiming for sustainable development it is essential that the economic system produces goods and services without consuming too much low entropy.

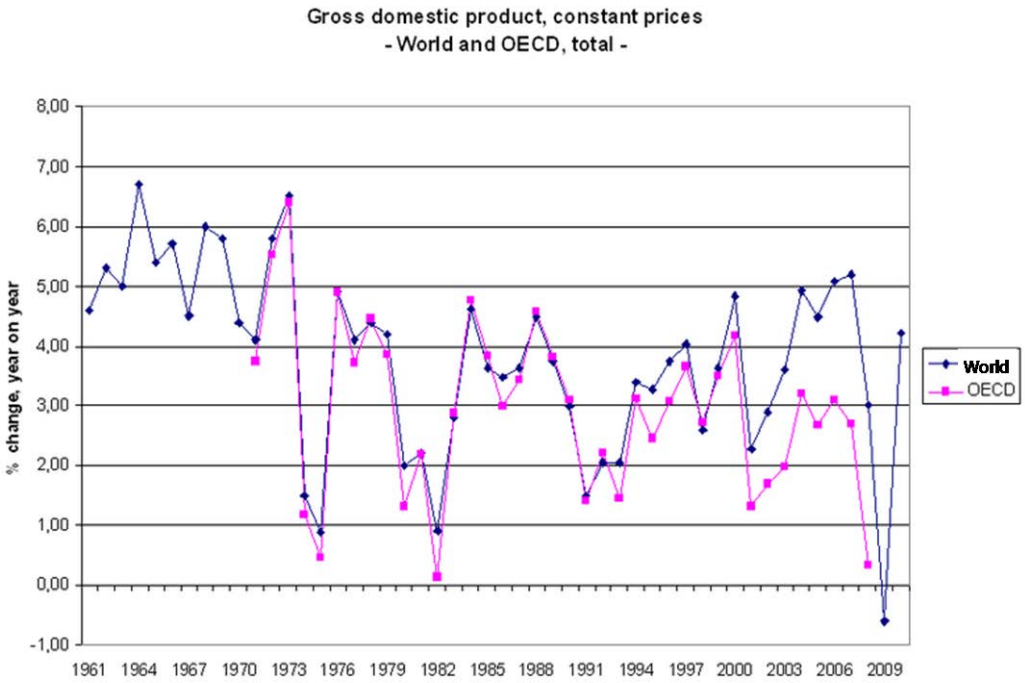
1.3 Economic Growth, GDP, Life Quality and Welfare

The Brundtland Report outlines: What is needed now is a new era of economic growth – growth that is forceful and at the same time socially and environmentally sustainable.

In a limited world, unlimited growth is not possible. We need a new growth, a growth that consists of economic, ecological and social components.

Gross domestic product (**GDP**) refers to the market value of all final goods and services produced within a country in a given period. It is often considered an indicator of a country's standard of living.

GDP measures both a nation's total output of goods and services and its total income.



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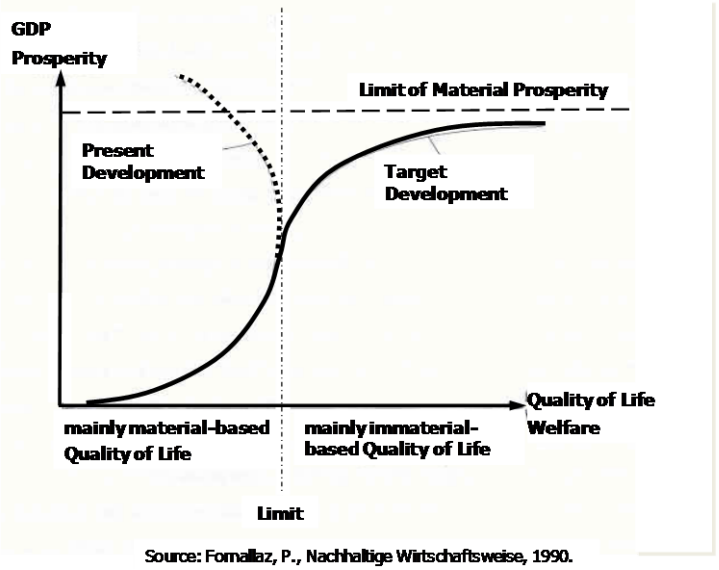
Relationship between GDP, Life Quality and Welfare (see Fornallaz, 1990, p. 33)



Quality of Life:

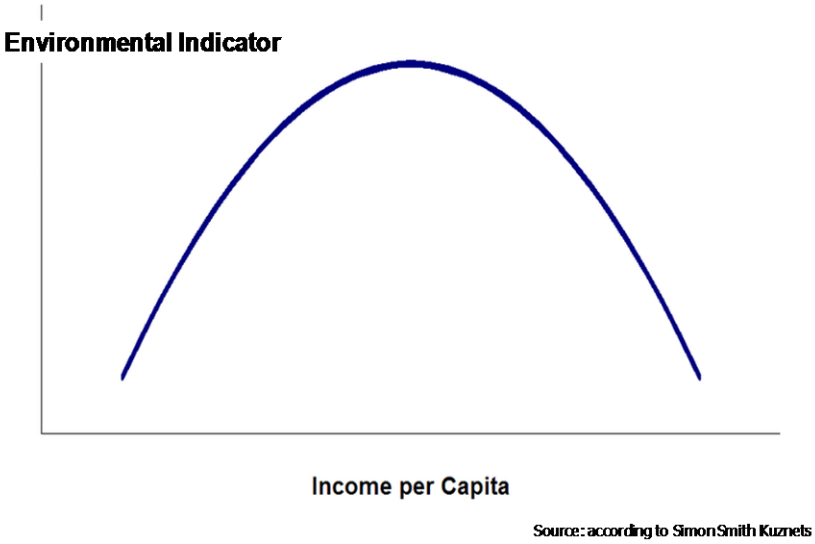
Material-based:
Income, Property and Goods

Immaterial-based:
Housing, Working Conditions, Social Integration, Living in a Safe Area, Medical Insurance , Job Security

The curve starts at a point, where a small increase in GDP contributes to a big increase in Life Quality. This development has a Limit. It proceeds until an increase in GDP can only be realized by a decrease of Life Quality (see Present Development). The result can be an increasing resource depletion and environmental degradation. At this point, when achieving a sufficient material supply, it should be of interest to expand the immaterial supply in order to obtain more Life Quality (Target Development).

This development should be possible in developed countries where a sufficient material supply is guaranteed. A minimum of material supply is necessary to sustain human life, such as in developing countries. As a consequence, only developed countries have the possibility of conserving the environment adequately. This circumstance leads to a paradox, formulated by some scientist: “As long as the satisfaction of needs has not already reached a minimum amount, people have to exploit their environment in order to reach a situation when minimum life quality is reached and environmental protection is possible. So satisfaction of needs is a prerequisite of environmental conservation.”

The Environmental Kuznets Curve (EKC) comes to the same conclusion:



Source: according to Simon Smith Kuznets

The relationship between Environmental Degradation and Income per Capita is shown in the figure. Countries with a low per Capita Income has an increasing environmental influence, countries with a high per Capita Income reach a situation with decreasing environmental impact. The consequence is that only countries with a high per Capita Income can implement environmental precautions effectively.

World countries have to realize a minimum Life Standard for environmental conservation strategies. At the same time it is also necessary when reaching a high standard of Life Quality to limit the environmental impact. A maximum Life Quality is dependent on the environmental Carrying Capacity.

1.4 Qualitative Economic Growth

Environmental assets play a role in the concept of qualitative growth. “Qualitative Growth” is often defined as a growth, in which the per Capita Income results in an increasing satisfaction of needs by sustaining the present environmental quality or by increasing it.

How can we transform the global economy from a system striving for unlimited quantitative growth, which is manifestly unsustainable, to one that is ecologically sound without generating human hardship through more unemployment?

From the ecological point of view, the distinction between ‘good’ and ‘bad’ economic growth is obvious. Bad growth is growth of production processes and services which externalize social and environmental costs that are based on fossil fuels, involve toxic substances, deplete our natural resources, and degrade the Earth’s ecosystems. Good growth is growth of more efficient production processes and services which fully internalize costs that involve renewable energies, zero emissions, continual recycling of natural resources, and restoration of the Earth’s ecosystems.

A few steps toward Qualitative Growth (according to Fritjof Capra, 2009):

1. Need to be formulated by multi-disciplinary teams
2. Tax systems need to be restructured
3. Companies need to reassess their production processes
4. Reforming international finance and monetary systems

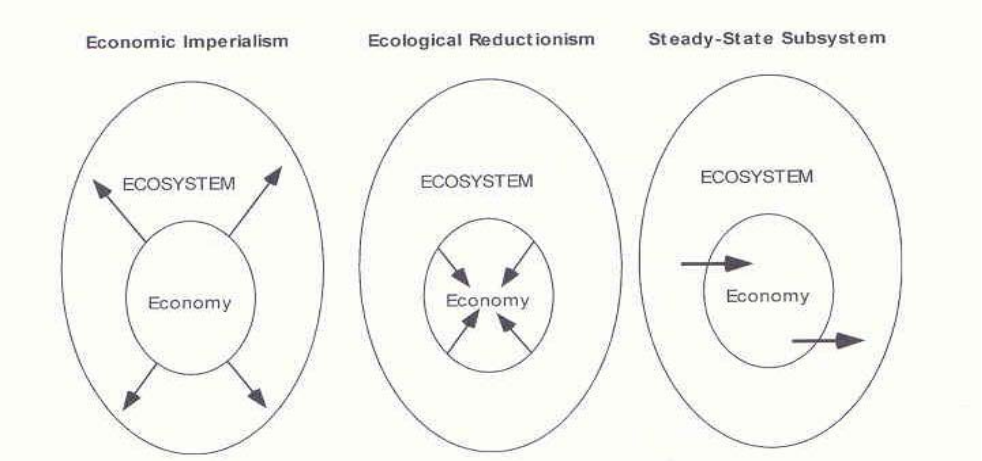
1.5 "Growth" and "Development"

Leading American economist Herman Daly illustrates the fundamental difference between growth and development by these definitions:

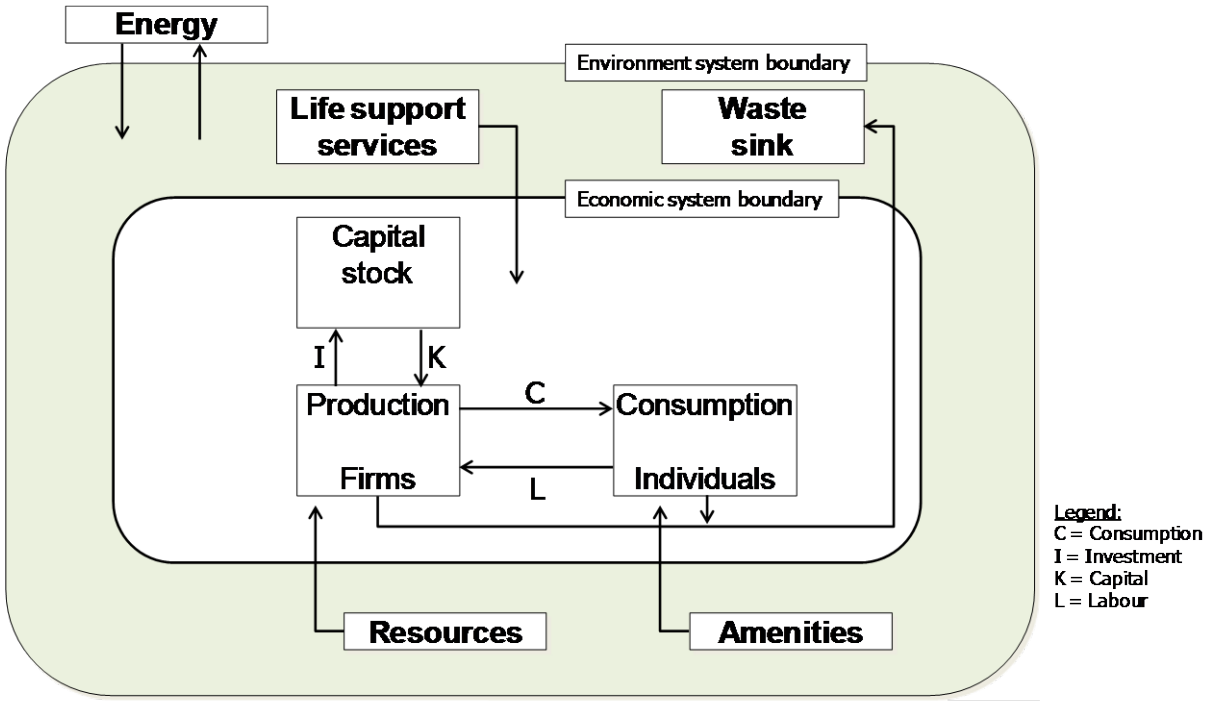
- Growth – the *quantitative* increase in size or throughput of biophysical matter. Daly has argued that economic growth is based on the "limitless transformation of natural capital into man-made capital".
- Development – the *qualitative* improvement in economic welfare from increased quality of goods and services as defined by their ability to increase human well-being. This infers promoting increased economic activity only insofar as it does not exceed the capacity of the ecosystem to sustain it.

2. Sustainable Development and the Ecology

Three Strategies for Integrating Ecology and Economics (by Daly, H.E. and Farley, J., Ecological Economics, 2011, p.51.):



In this course the circular model is defined as the economic system. The economic system is a subsystem of the ecological system:



Source: Common/Stagl (2005), Ecological Economics, p. 87

IV. Sustainable Development – A New Approach?

1. Description

Sustainability aims a development that is sustainable. The focus is human life, so man is at the center of interest. Man is a major part of the Economic System and absolutely dependent on an Environmental System. When searching for a new approach it is necessary to examine the role of the environmental system. Future generations should be considered thus intergenerational equity is essential. All generations, present and future should have the same access to environmental resources and same possibilities to satisfy their needs. So principles of equality are to be considered. Development applies to humans as a whole, so a holistic concept is needed. How long should a Sustainable Development last?

2. Principles and Concept

2.1 Anthropocentrism

From Rio Declaration:

Principle 1 of the Rio declaration: Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Sustainability points out an anthropocentric point of view. Anthropocentrism means that the humans are in the center of the debate. Sustainability focuses on humans. Humans are absolutely dependent on natural resources and on a healthy ecological system.

2.2 Nature Conservation

Conservation of Species is the reason why humans care first for their own life and then for Nature. But man is only “complete” if he protects Nature adequately. So it is necessary that the Ecological System plays an important role when finding principles for sustainability.

2.3 Justice and Equality

Justice can only exist within the coordinates of equality. This basic view can be elaborated in many different ways, according to what goods are to be distributed and how they are to be distributed equally between individuals, families, nations, races, and species. It affirms that freedom and justice without equality are hollow and that equality itself is the highest justice.

Pearce (1988) differentiates between three sorts of justice:
- Intragenerational Justice
- Intergenerational Justice
- Justice to Nature

Sustainability focuses on humans of all generations, present and future. All generations should have access to the same possibility of satisfying needs.

Problem: How can we allocate resources between the present and future generations? Future generations are not represented in the process of making decisions today.

Problems of equity:

- All use of natural resources, especially of the non-renewables, benefits the present generations but not future generations.
- Degradation in the quality of environmental resources
- Loss of environmental services performed by natural resources
- Lack of effective access to natural resources
- Irreversible actions such as nuclear accidents harm all generations
- Depletion of resources
- Degradation in environmental quality

Positive:

Improvement in technology

The theory of intergenerational equity according to Edith Brown Weiss (1989):

“At any given time, each generation is both a custodian and trustee of the planet for future generations and a beneficiary of its fruits. This imposes obligations upon us to care for the planet and gives us certain rights to use it.”

Intragenerational equity is justice in the present generation: How can we expect impoverished countries to care about future generations, if they cannot even care for their own people today?

Poverty is a primary cause of ecological degradation. Intergenerational equity requires wealthy countries, which can afford to protect natural resources without overexploitation, to assist impoverished ones in realizing access to natural resources without destruction.

We have a responsibility towards future generations. Each generation is responsible for the next generation, its own children and grand-children.

The theory is that each generation receives a natural and cultural legacy in trust from previous generations and holds it in trust for future generations. Obligations: to conserve natural and cultural resources for future generations, to benefit from the resources of their ancestors.

2.4 Comprehensiveness

Sustainability affects all countries and all mankind. In most cases environmental problems (e.g. enhanced greenhouse effect, depletion in the ozone layer) are world problems. An interdisciplinary approach should be given, because economic theory alone can't solve the existing problems.

Sustainable development embodies integration, and understanding and acting on the complex interconnections that exist between the environment, the economy, and society. This is not a balancing act or a playing of one issue off against the other, but recognition of the interdependent nature of these three pillars.

The three pillars of sustainable development, from left to right, the theory, the reality and the change needed to better balance the model

Source: IUCN (2004)

2.5 Long-term Durability

How long is long-term? Costanza and Patten (1995) have discussed this question and came to the conclusion that it does not mean “maintenance forever”, because “nothing lasts forever, not even the universe”. According to them a “sustainable system … is thus one that attains its full expected life span within the nested hierarchy of systems within which it is embedded”. This means that a shortening of the normal natural lifecycle of systems has to be avoided.

Humans have to take care of future generations, so there is need to protect all natural resources, especially the non-renewables.

Different developments in countries give the people different chances to secure their survival and the survival of their children and grand-children. The question about intergenerational equity and fairness must be discussed. Currently, one quarter of the world population is using three quarters of the world’s resources.

3. Sustainable Growth?

The Brundtland Report points out that Sustainable Development is a Development, that respects the limits of nature. Therefore we need a new growth.

Does a Sustainable Growth exist?

Only a few scientists have discussed this question. The most famous is Daly: “Sustainable Growth: An Impossibility Theorem”:

“Impossibility statements are the very foundation of science. It is impossible to: travel faster than the speed of light; create or destroy matter-energy; build a perpetual motion machine, etc. By respecting impossibility theorems we avoid wasting resources on projects that are bound to fail. Therefore economists should be very interested in impossibility theorems, especially the one to be demonstrated here, namely that it is impossible for the world economy to grow its way out of poverty and environmental degradation. In other words, sustainable growth is impossible.

In its physical dimensions the economy is an open subsystem of the earth ecosystem, which is finite, nongrowing, and materially closed. As the economic subsystem grows it incorporates an ever greater proportion of the total ecosystem into itself and must reach a limit at 100 percent, if not before. Therefore its growth is not sustainable. The term "sustainable growth" when applied to the economy is a bad oxymoron—self-contradictory as prose, and unevocative as poetry.

Economists will complain that growth in GNP is a mixture of quantitative and qualitative increase and therefore not strictly subject to physical laws. They have a point. Precisely because quantitative and qualitative change are very different it is

best to keep them separate and call them by the different names already provided in the dictionary. To grow means "to increase naturally in size by the addition of material through assimilation or accretion." To develop means "to expand or realize the potentialities of; to bring gradually to a fuller, greater, or better state."
When something grows it gets bigger. When something develops it changes. The earth ecosystem develops (evolves), but does not grow. Its subsystem, the economy, must eventually stop growing, but can continue to develop. The term "sustainable development" therefore makes sense for the economy, but only if it is understood as "development without growth" - i.e., qualitative improvement of a physical economic base that is maintained in a steady state by a throughput of matter-energy that is within the regenerative and assimilative capacities of the ecosystem. Currently the term "sustainable development" is used as a synonym for the oxymoronic "sustainable growth." It must be saved from this perdition.

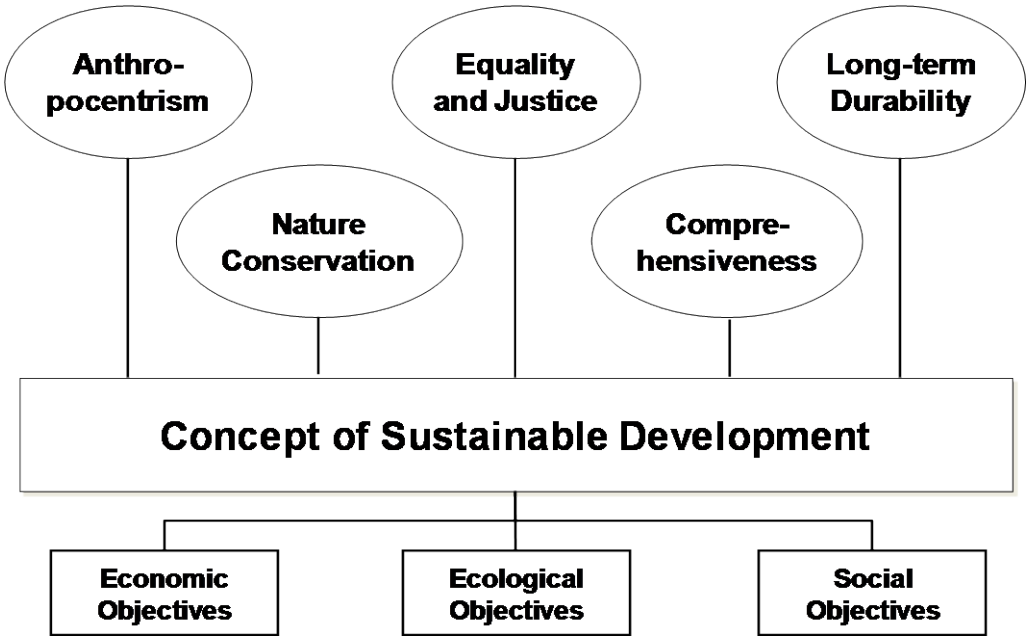
Politically it is very difficult to admit that growth, with its almost religious connotations of ultimate goodness, must be limited. But it is precisely the nonsustainability of growth that gives urgency to the concept of sustainable development. The earth will not tolerate the doubling of even one grain of wheat 64 times, yet in the past two centuries we have developed a culture dependent on exponential growth for its economic stability. Sustainable development is a cultural adaptation made by society as it becomes aware of the emerging necessity of nongrowth. Even "green growth" is not sustainable. There is a limit to the population of trees the earth can support, just as there is a limit to the population of humans and of automobiles. To delude ourselves into believing that growth is still possible and desirable if only we label it "sustainable" or color it "green" will just delay the inevitable transition and make it more painful.”

From European Commission (see http://ec.europa.eu/europe2020/priorities/sustainable-growth/index_en.htm):

Sustainable growth means:

- building a **more competitive low-carbon economy** that makes efficient, sustainable use of resources
- **protecting the environment**, reducing emissions and preventing biodiversity loss
- capitalizing on Europe's leadership in developing **new green technologies** and production methods
- introducing **efficient smart electricity grids**
- **harnessing EU-scale networks** to give our businesses (especially small manufacturing firms) an additional competitive advantage
- **improving the business environment,** in particular for SMEs
- **helping consumers** make well-informed choices.

4. Summary


Anthro-pocentrism
Equality and Justice
Long-term Durability
Nature Conservation
Compre-hensiveness
Concept of Sustainable Development
Economic Objectives
Ecological Objectives
Social Objectives

V. Why Sustainable Development?

1. Main Problems: Overpopulation and Environmental Degradation

1.1 Industrialized and Developing Countries

The world can be divided into industrialized and developing countries. Each country has more or less their own unsustainable growth path due to their specific problems, e.g. overpopulation or satisfying of needs, depletion of resources and waste accumulation etc.

It is necessary to achieve a situation in which people satisfy their needs without destroying the environment.

To achieve sustainable development is the work of mankind, especially in industrialized countries, because they have money and technical know-how, but they also waste the most resources and are the main polluters of global environmental devastation.

Differences between industrialized and developing countries are shown in a gradient of extreme consumption and production. About 20% of the world population lives in industrialized countries, their consumption of goods is about 80% of world goods. The consequences are a high accumulation of waste; they cause nearly 90% of the waste in the world.

Differences can be noticed in the rate of population growth, life expectancy, health care etc. Underdeveloped countries have a high population growth rate (about 45% are under 15 years) and an average life expectancy of 66 years (see World Bank, 2010, http://data.worldbank.org/indicator/SP.DYN.LE00.FE.IN/countries/1W?display=map).

Life expectancy is a fundamental indicator of both well-being and poverty.

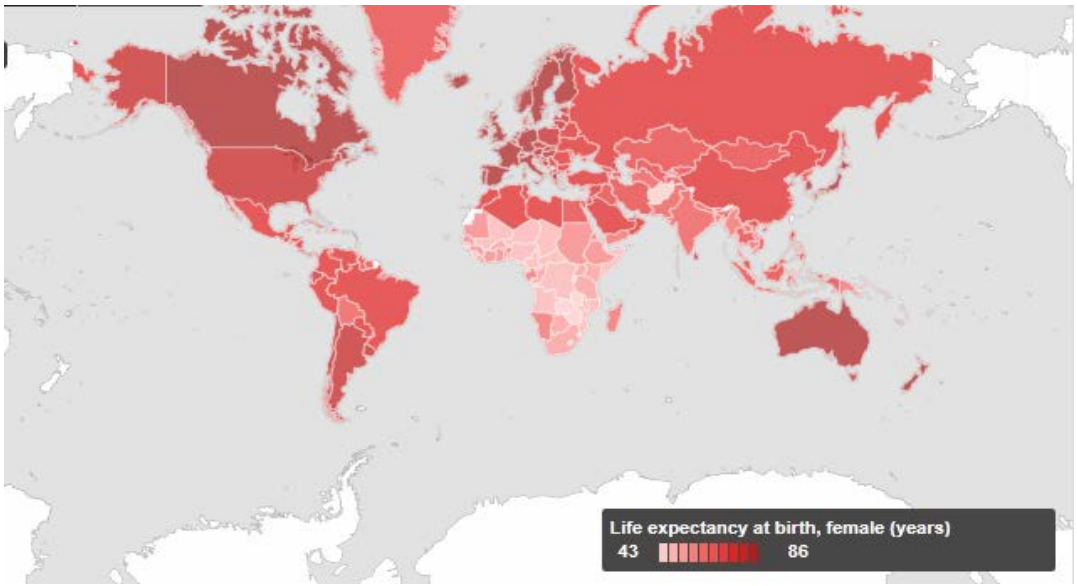
Life expectancy is projected to increase in developed and developing countries in future years, according to the United Nations. For the world as a whole, life expectancy at birth rose from 47 years in 1950-1955 to 69 years in 2005-2010. Over the next 40 years, life expectancy at birth is expected to continue on a similar path. At the global level, it is projected to reach 76 years in 2045-2050 and 82 years in 2095-2100. By the end of the century, people in developed countries could live on average around 89 years, compared to about 81 years in developing regions.

Life expectancy is projected to increase in the world’s least developed countries (LDCs), which include many countries highly affected by HIV/AIDS. Life expectancy at birth in the LDCs was estimated to be 58 years in 2005-2010 but is expected to

increase to about 70 years in 2045-2050, and 78 years by 2095-2100 (United Nations, 2013).

Infant mortality is about 7 to 10 times higher than in industrialized countries.

There are still 1.4 billion people living in poverty, although this represents a decline from the 1.9 billion in 1981 (UN, Poverty Report 2010). Poverty is the principal cause of hunger and undernourishment. According to the most recent estimates of the Food and Agriculture Organization of the United Nations (FAO, 2009), the number of hungry people worldwide is 963 million, or about 14.6 per cent of the estimated world population of 6.6 billion. Most of the undernourished live in developing countries.

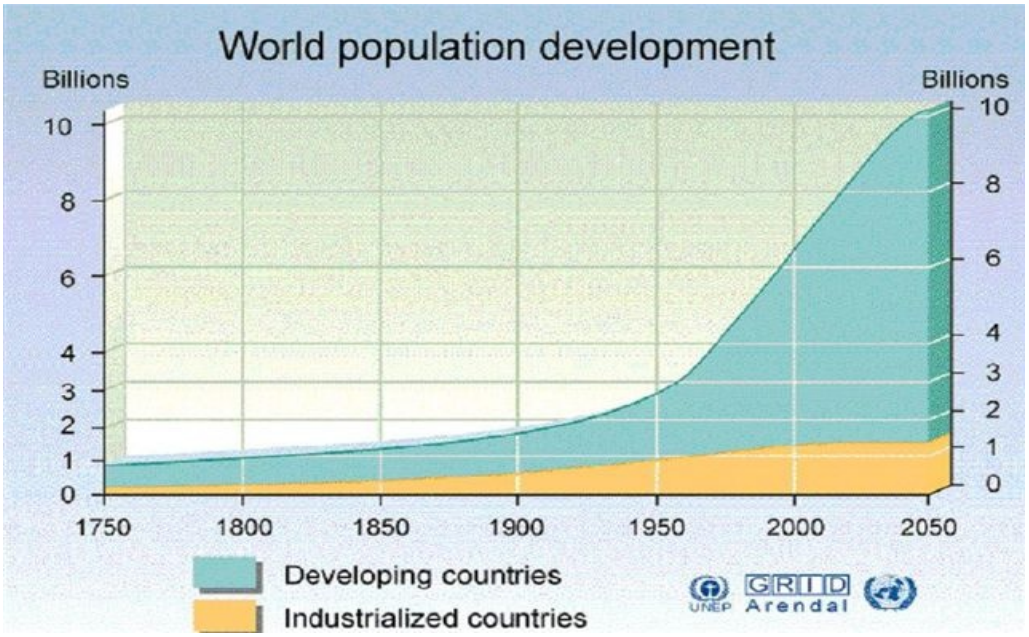


The poorest 40 % of the world's population account for only 5 % of global income. On the other hand, the richest 20 % account for 75 % of world income (United Nations Development Programme, 2007).

Overpopulation combined with human consumption rates and patterns in recent history are rapidly depleting the Earth's natural resources. The UNEP Global Environmental Outlook 2007 Report declares that while the human ecological footprint demands 21.9 hectares of land per person, the planet has a biological capacity for only 15.7 hectares per person. By 2025, 1.6 billion people will live in countries with absolute water scarcity, while decreasing land productivity and biodiversity will threaten billions of people. The UNDP's annual Human Development Report depicts a decline in social capital in the developing world and an alarming growth in economic disparity.

The world population has grown tremendously over the past two thousand years. In 1999, the world population passed the six billion mark.

According to the United Nations, ("2010 Revision of the World Population Prospects") world population has reached 7 Billion on October 31, 2011. World population for 2015 is estimated at **7,324,782,000**.



The chart shows past world population data back to the year 1750 and future world population projections through the year 2050.

World Population Growth

Year	Population
1	200 million
1000	275 million
1500	450 million
1650	500 million
1750	700 million
1804	1 billion
1850	1.2 billion
1900	1.6 billion
1927	2 billion
1950	2.55 billion
1955	2.8 billion
1960	3 billion
1965	3.3 billion
1970	3.7 billion
1975	4 billion
1980	4.5 billion
1985	4.85 billion
1990	5.3 billion
1995	5.7 billion
1999	6 billion
2006	6.5 billion
2009	6.8 billion
2011	7 billion
2025	8 billion
2043	9 billion
2083	10 billion

United Nations, Department of Economic and Social Affairs, Population Division (2013): *World Population Prospects: The 2012 Revision, Press Release*: "World Population to reach 9.6 billion by 2050 with most growth in developing regions, especially Africa".

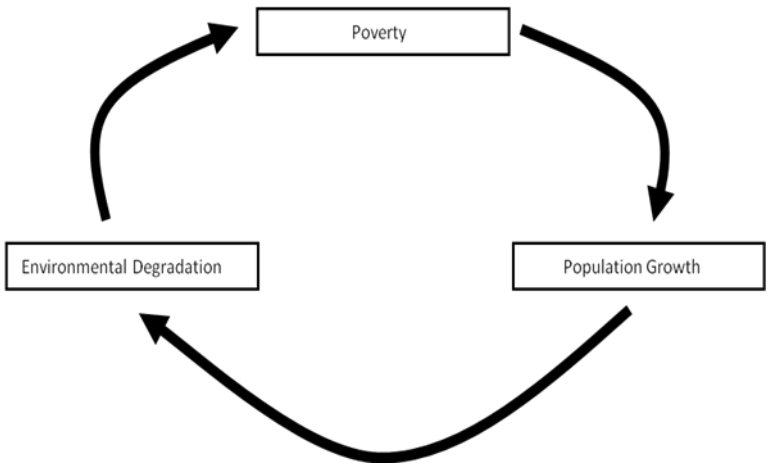
Effects of human overpopulation (from Wikipedia, http://en.wikipedia.org/wiki/Overpopulation#cite_note-202):

- **Inadequate fresh water** for drinking as well as sewage treatment and effluent discharge. Some countries, like Saudi Arabia, use energy-expensive desalination to solve the problem of water shortages.
- **Depletion of natural resources**, especially fossil fuels
- Increased levels of **air pollution, water pollution, soil contamination and noise pollution**. Once a country has industrialized and become wealthy, a combination of government regulation and technological innovation causes pollution to decline substantially, even as the population continues to grow.
- **Deforestation and loss of ecosystems** that sustain global atmospheric oxygen and carbon dioxide balance; about eight million hectares of forest are lost each year.
- **Changes in atmospheric composition and consequent** global warming
- Irreversible **loss of arable land** and increases in **desertification** Deforestation and desertification can be reversed by adopting property rights, and this policy is successful even while the human population continues to grow.
- **Mass species extinctions** from reduced habitat in tropical forests due to slash-and-burn techniques that sometimes are practiced by shifting cultivators, especially in countries with rapidly expanding rural populations; present extinction rates may be as high as 140,000 species lost per year. As of 2008, the IUCN Red List lists a total of 717 animal species having become extinct during recorded human history.
- High **infant and child mortality**. High rates of infant mortality are caused by poverty. Rich countries with high population densities have low rates of infant mortality.
- **Intensive factory farming** to support large populations. It results in human threats including the evolution and spread of antibiotic resistant bacterial diseases, excessive air and water pollution, and new viruses that infect humans.
- Increased chance of the emergence of **new epidemics and pandemics.** For many environmental and social reasons, including overcrowded living conditions, malnutrition and inadequate, inaccessible, or non-existent health care; the poor are more likely to be exposed to infectious diseases.
- **Starvation, malnutrition** or poor diet with ill health and diet-deficiency diseases (e.g. rickets). However, rich countries with high population densities do not have famine.
- Poverty coupled with **inflation** in some regions and a resulting low level of capital formation. Poverty and inflation are aggravated by bad government and bad economic policies. Many countries with high population densities have eliminated absolute poverty and keep their inflation rates very low.
- **Low life expectancy** in countries with fastest growing populations

- **Unhygienic living conditions** for many based upon water resource depletion, discharge of raw sewage and solid waste disposal. However, this problem can be reduced with the adoption of sewers. For example, after Karachi, Pakistan installed sewers, its infant mortality rate fell substantially.
- **Elevated crime rate** due to drug cartels and increased theft by people stealing resources in order to survive
- Conflict over scarce resources and crowding, leading to **increased levels of warfare**
- **Less Personal Freedom / More Restrictive Laws.** Laws regulate interaction between humans. Law "serves as a primary social mediator of relations between people." The higher the population density, the more frequent such interactions become, and thus a need for more laws and/or more restrictive laws to regulate these interactions develops. It is even speculated that democracy is threatened due to overpopulation, and could give rise to totalitarian style governments.

1.2 Threats to Sustainability: Environmental Degradation

Poverty leads to Population Growth and is a primary cause of ecological degradation. People are forced to overexploit the resources in order to satisfy their own basic needs.



More threats to sustainability:

1. Resource depletion
2. Waste accumulation
3. Loss of resilience
4. Biodiversity loss (see http://www.iucn.org/)

VI. Major Objective: A Sustainable World

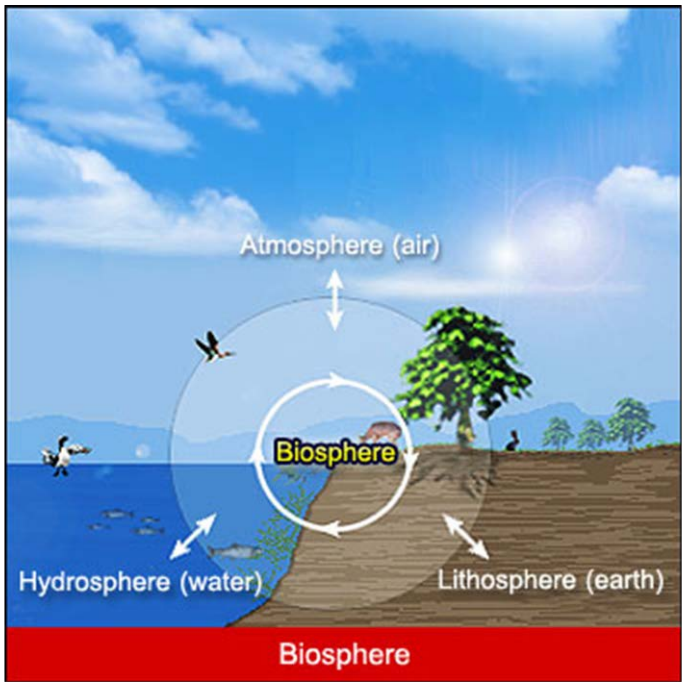
1. Our World and our Limits

1.1 Basics

The human species inhabits a unique planet – planet earth. The earth has existed for about 4.6 billion years. Humans have inhabited this planet for perhaps only 3 million years. With our technology we are able to destroy the environment, but we also have the capability to improve the conditions for future generations. For about 200 years now, man has been aware that he is overexploiting nature and its resources.

The development of life and vegetation is a dynamic process, in which several animals and plants came into existence by adapting to changes and some have become extinct.

The ecosystem Earth has several spheres:



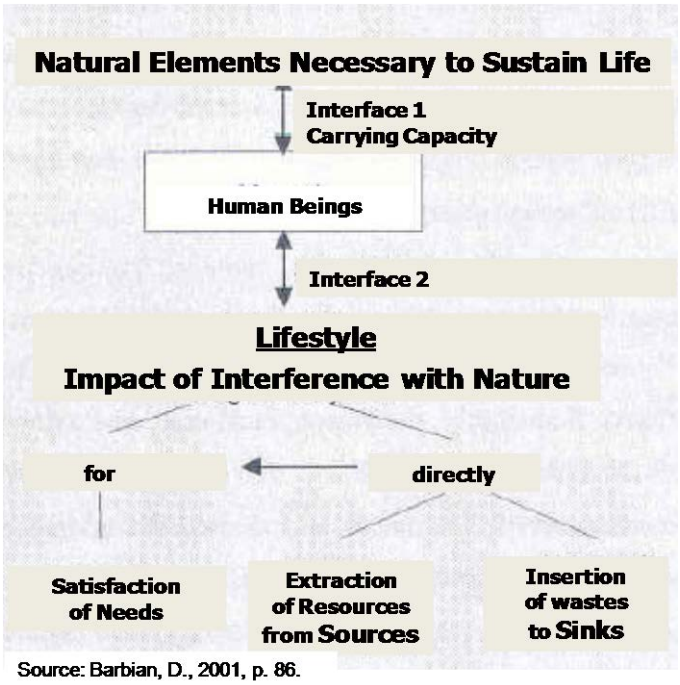
Source: http://library.thinkquest.org/09jan-oracle-n-001/02242/page_490783175.html

Planet earth can be seen “as comprising four main spheres:

1. Lithosphere: the solid outer shell of the earth;
2. Hydrosphere: the water on or near the surface of the earth;
3. Atmosphere: the gases surrounding the earth’s surface;

4. Biosphere: living organisms and their environment." (Common and Stagl, 2005, p. 22)

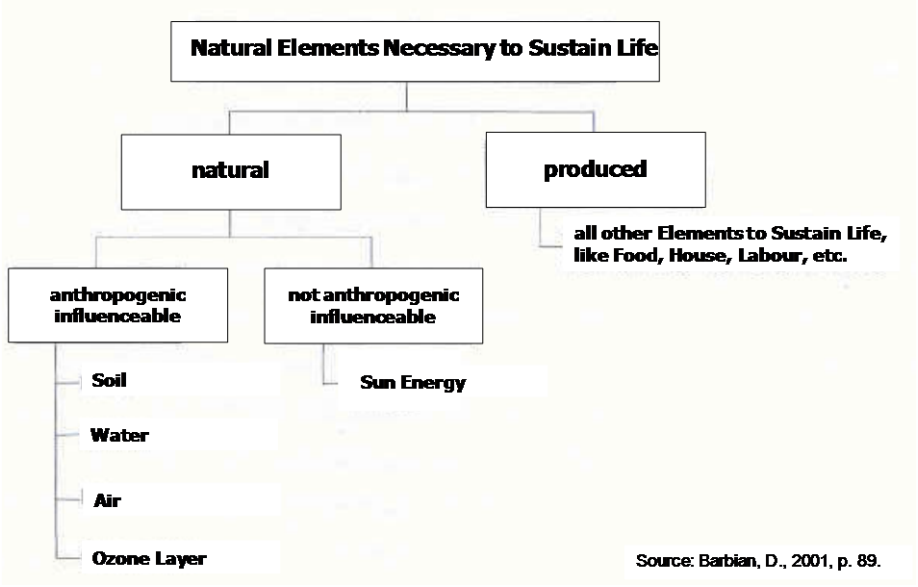
Interfaces between environment and human beings:



Source: Barbian, D., 2001, p. 86.

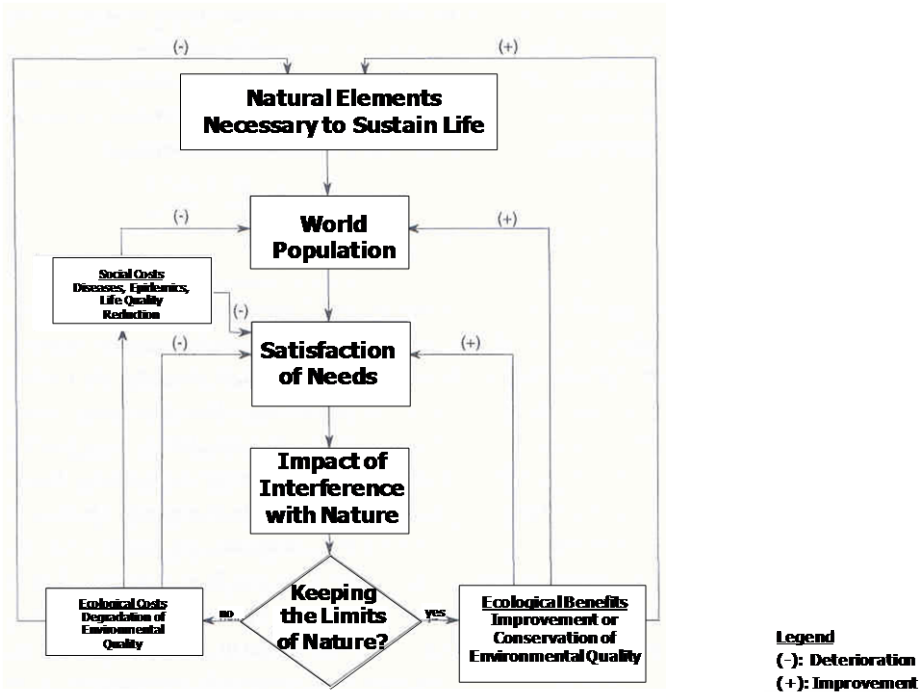
1.2 Natural Elements Necessary to Sustain Life and Carrying Capacity

1.2.1 Specification of the Natural Elements



Source: Barbian, D., 2001, p. 89.

Influencing Factors to the Natural Elements (Soil, Water, Air and Ozone Layer):



Source: Barbian, D., 2001, p. 91.

1.2.2 Carrying Capacity

Carrying capacity refers to the maximum abundance of a **species** that can be sustained within a given area of **habitat**. When an ideal population is at equilibrium with the carrying capacity of its environment, the **birth** and death rates are equal, and size of the population does not change. Carrying capacity is never static.

Supporters of the concept argue that humans, like every species, have a finite carrying capacity. Animal population size, living standards, and resource depletion vary, but the concept of carrying capacity still applies. The carrying capacity of Earth has been studied by computer simulation models like World3 (see Forrester, 1971).

Carrying capacity, at its most basic level, is about organisms and food supply, where "X" amount of humans need "Y" amount of food to survive. If the humans neither gain nor lose weight in the long run, the calculation is fairly accurate. If the quantity of food is invariably equal to the "Y" amount, carrying capacity has been reached. Humans, with the need to enhance their reproductive success, understand that food supply can vary and also that other factors in the environment can alter humans' need for food.

Technology is an important factor in the dynamics of carrying capacity. Currently, the use of fossil fuels has artificially increased the carrying capacity of the world by the use of stored sunlight, albeit at the expense of many others.

Agricultural capability on Earth expanded in the last quarter of the 20th century. But now there are many projections of a continuation of the decline in world agricultural capability (and hence carrying capacity) which began in the 1990s.

Development of the Carrying Capacity for Humans:

10,000 B.C.	Hunters and Gatherers	6 million Humans
1 A.D.	Hunter and Gather, simple Agriculture	300 million Humans
appr. 1780 A.D.	Pre-industrial agrarian society	750 million Humans
appr. 1830 A.D.	Early industrial societies	1 billion Humans
appr. 2000 A.D.	Modern industrial societies	> 6 billion Humans

One way to estimate human demand compared to the ecosystem's carrying capacity is "Ecological Footprint" accounting (see http://en.wikipedia.org/wiki/Ecological_Footprint).

Postel (1994)

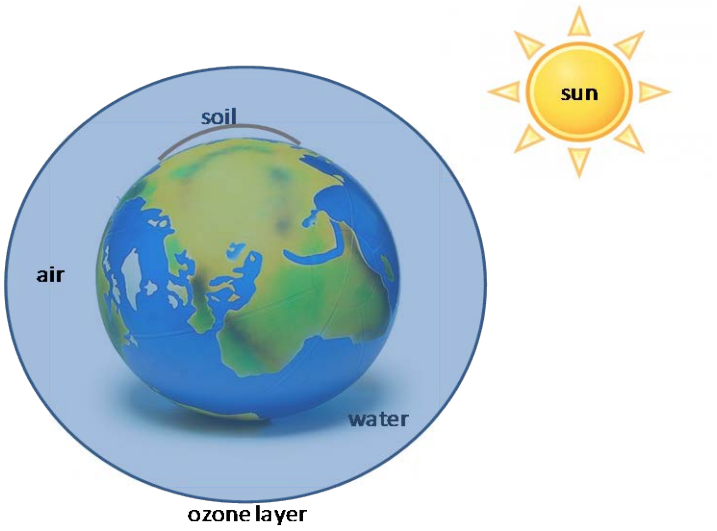
> "The earth's capacity to support humans is determined not just by our most basic food requirements but also by our levels of consumption of a whole range of resources, by the amount of waste we generate, by the technologies we choose for our varied activities, and by our success at mobilizing to deal with major threats."

One of the most important books in this field is from Wackernagel and Rees (1996). They estimated the footprint for the global economy for each year from 1961 to 1999. They found out that the ratio of the footprint size to the land actually available increased from appr. 0.7 (in 1961) to appr. 1.2 (in 1999). This means that the world needs 1.2 earths to run their global economy. There are differences in the use between the countries. The USA uses more than e.g. Togo. If all of the world's people were to consume at the US level, it would require a few earths to support them.

In 2050 it is estimated that we will need 3 earths.

1.2.3 The Natural Elements Necessary to Sustain Life and a Simple World Model

In this workshop we use a simple model of the world in order to find feasible strategies for Sustainable Development.



The simple world model consists of 5 basic natural resources: These are the sun, the soil, the air, the water and the ozone layer. I will call them the five natural elements necessary to sustain life. All our lives are controlled by one or more of these resources.

Man can influence only 4 of these resources. So he is responsible for them. He has influence on the soil quality, water quality, air quality and the ozone layer.

But what are the main influences on air, water, soil and the ozone layer? The way we are satisfying our needs has a major influence on these resources.

Soil:

Our world has a limited surface. There is only limited land for agriculture and cultivation. Our earth can produce only a limited amount of food for humans and animals.

What are the main negative influences that cause soil degradation?

Examples: desertification, erosion, wastage

Water:

99.5 % of our biosphere and 72 % of the earth's surface consists of water. Humans need water for several usages. Only 2 ‰ of the water on the earth is potable. We have enough water for all; the problem is only the availability.

A big problem is the increase in water pollution. Water is an important natural resource that covers 71% of the Earth's surface.

Air:

There is enough air for all human beings. Pollution is the main reason for diminishing air quality. What are the consequences? Regions with a high air pollution cause harm and discomfort to humans and other living organisms.

The air is able to regenerate.

Ozone layer:

The ozone layer is a layer of the Earth's atmosphere which contains relatively high concentrations of ozone. This layer absorbs 97-99 % of the sun's high frequency ultraviolet light, which can damage life on Earth. So the ozone layer makes life possible.

The ozone layer can be depleted by various kinds of free radicals. Over approximately 5 % of the Earth's surface, around the north and south poles, much larger (but seasonal) declines have been seen; these are the ozone holes.

In order to sustain human life on earth it is essential to protect the ozone layer.

Sun:

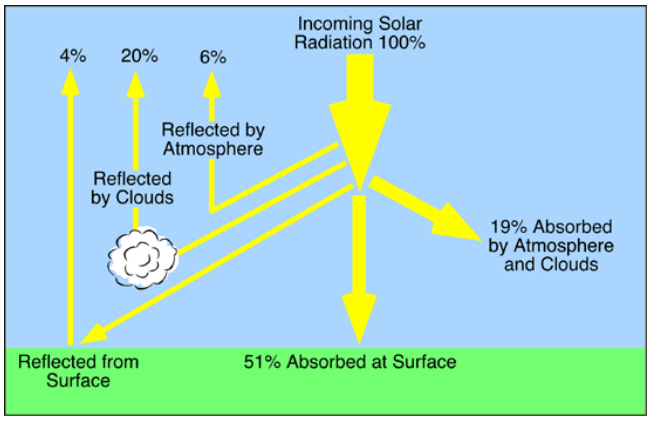
The Sun is the star at the center of the Solar System. The energy of this sunlight supports almost all life on Earth and drives Earth's climate and weather. Humans have long recognized the Sun's role in supporting life on Earth.

The way in which we satisfy our needs has a major influence on our resources. To satisfy our needs we have to use nature's resources and in the same way we produce waste.

Satisfying the needs of a growing world population is a big challenge.

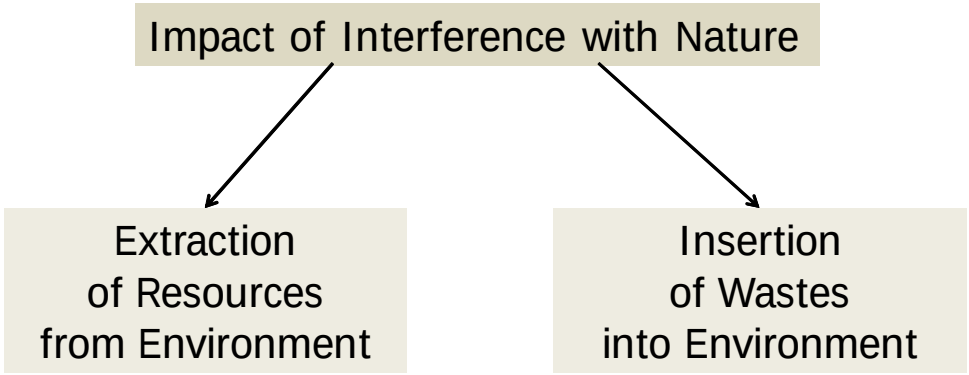
Population exceeding the carrying capacity of an area of environment is called overpopulation. Spikes in human population can cause problems such as pollution and traffic congestion. A growing world population needs more food and so on.

Solar Radiation:

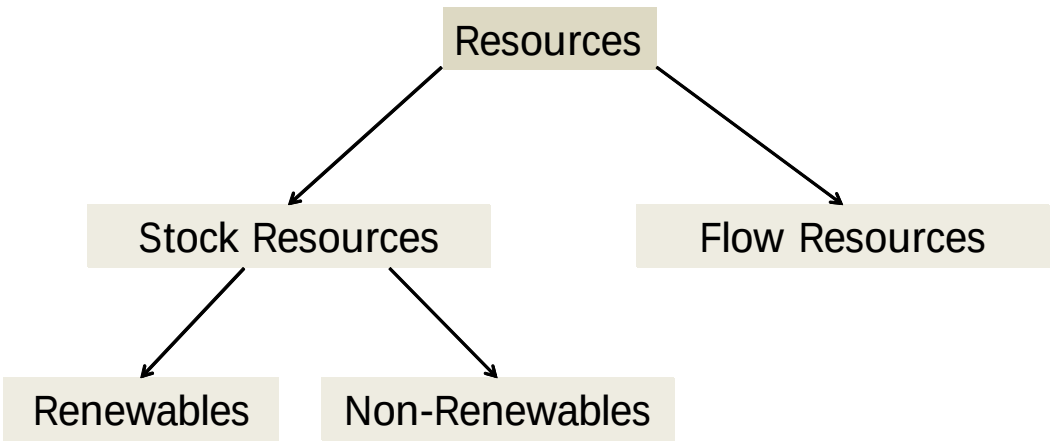


(source: http://www.physicalgeography.net/fundamentals/7f.html)

1.3 Impact of Interference with Nature



1.3.1 Extraction of Resources from Environment



Resources can be distinguished into stock (renewable and non-renewable) and flow resources. Explanation according to Common and Stagl (2005, p.94): “With flow resources, the amount used today has no implications for the amount that could be used in the future. With stock resources, the amount used today does have implications for future availability. In the case of a non-renewable resource, there is no rate of use that can be sustained forever. In the case of a renewable resource, there are rates of use that can be indefinitely maintained.”

Examples for flow resources: solar radiation, wave power, wind power, hydro power, tidal power.

Examples for stock resources:
Renewable resources: are biotic populations which can reproduce
Non-renewable resources: natural growth is zero; minerals and fossil fuels

The Management of Renewable Resources

(according to Pearce, D.W. and Turner, R.K., 1990, p. 241 ff.; and Barbian, D., 2001, p.112 ff.)

Basics

- renewable resources are biotic populations which can reproduce
- stock (X) is not fixed; can be increased as well as decreased
- stock (X) will increase if it is allowed to regenerate
- if regeneration capability is kept, there is a never ending possibility to use renewables for all generations, present and future

Stock of Renewables

- all renewables follow a logistic function
- there is a maximum stock (Xmax), also called “carrying capacity”: no renewable can regenerate to levels above the carrying capacity of the ecosystem in which it exists
- there is a minimum stock (Xmin), also called “safe minimum standard” or “critical level”: a minimum stock level of Xmin should be guaranteed, otherwise the resource is threatened with extinction
- when stock is lower than Xmin, then the resource dies out

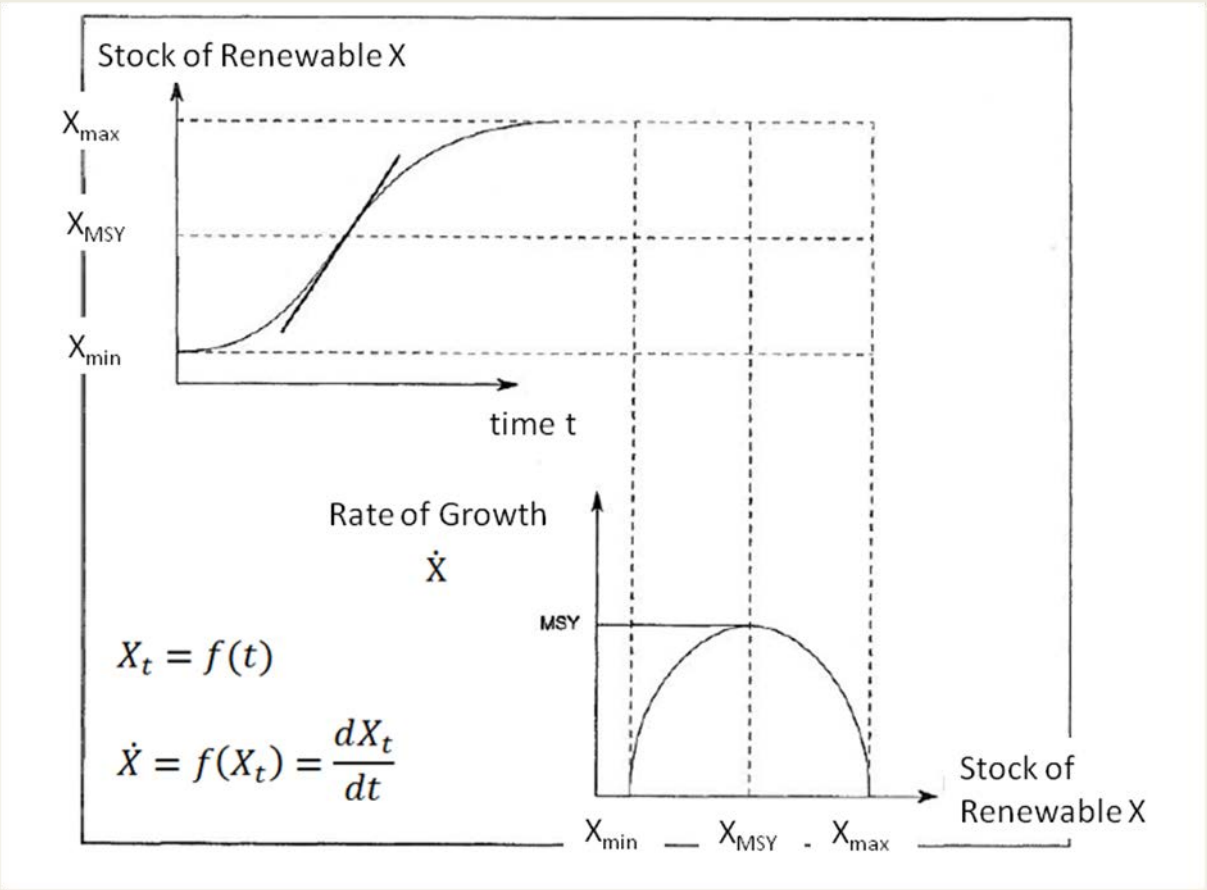
- if stock size is maintained at X_{MSY}, the rate of growth is the fastest possible, and the sustainable yield is greatest

Rate of Growth

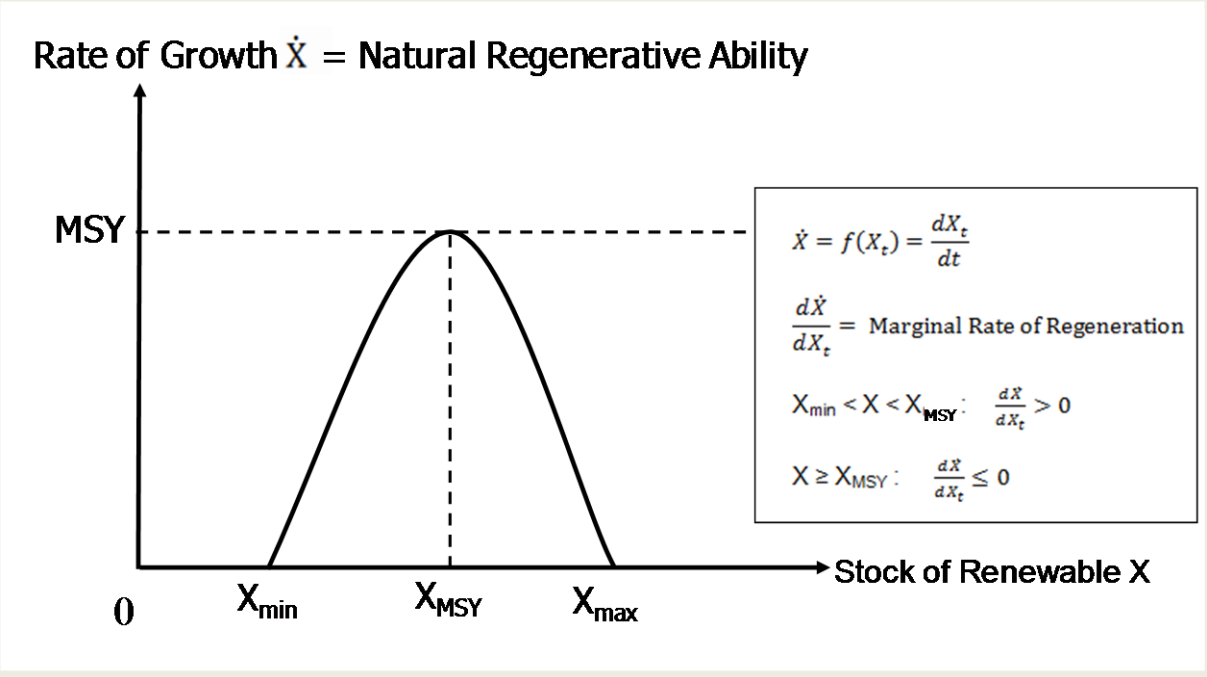
- rate of growth ($\dot{X}$) means “the rate of change in X with respect to time”
- first the rate of growth increases, reaching a maximum (at MSY) and then declines as the stock increases until it reaches the carrying capacity of its environment at Xmax
- rate of growth at Xmin and Xmax of this resource is zero
- rate of growth at X_{MSY} is at its highest level, also called the “maximum sustainable yield (MSY)”
- MSY is the most we can take from the resource on a sustainable basis, without reducing its long-term stock (MSY-Definition: “The MSY is defined as the maximal possible catch such that the population biomass can continue to regenerate.” (Bousquet, Duchesne and Rivest, 2008))

Rate of Harvesting

- harvesting within regeneration rate is possible
- if the rate of harvest exceeds the rate of natural growth of the resource, the renewable disappears; this can also happen if the resource population falls below some critical level (Xmin) (e.g. by over-harvesting)
- maximum rate of harvest is MSY; if it is higher the population dies out
- X_{MSY} is in the context of economics the optimal stock; at this level the highest benefit could be achieved



Function of Regeneration for Renewables:



MSY = Maximum Sustainable Yield

Harvest of Renewables:

Harvest Rate = MSY is the highest feasible harvest

Case A $(X = X_{MSY})$

- no stock reduction
- rate of harvest at rate of natural regeneration
- stock of renewables is available for future generations

Case B $(X_{\min} < X < X_{MSY})$

- partial stock reduction
- consumption is higher than natural regeneration
- reduced stock of renewable with reduced natural regenerative ability

Case C $(X = X_{\min})$

- stock is heavily reduced
- natural regenerative ability is just zero
- no availability for future generations

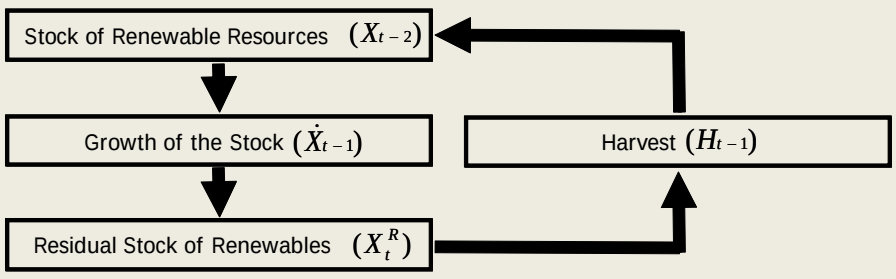
Case D $(X_{MSY} < X < X_{\max})$

- partial stock reduction
- consumption is higher than natural regeneration
- reduced stock of renewable, but with remaining natural regenerative ability

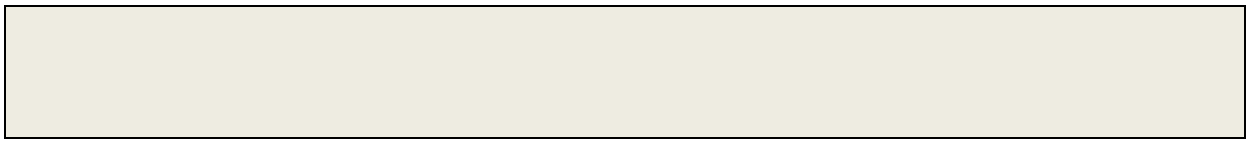
Case E $(X = X_{\max})$

- stock is at saturation level
- natural regenerative ability is just zero
- remaining availability for future generations

Harvest of Renewable Resources according to time t

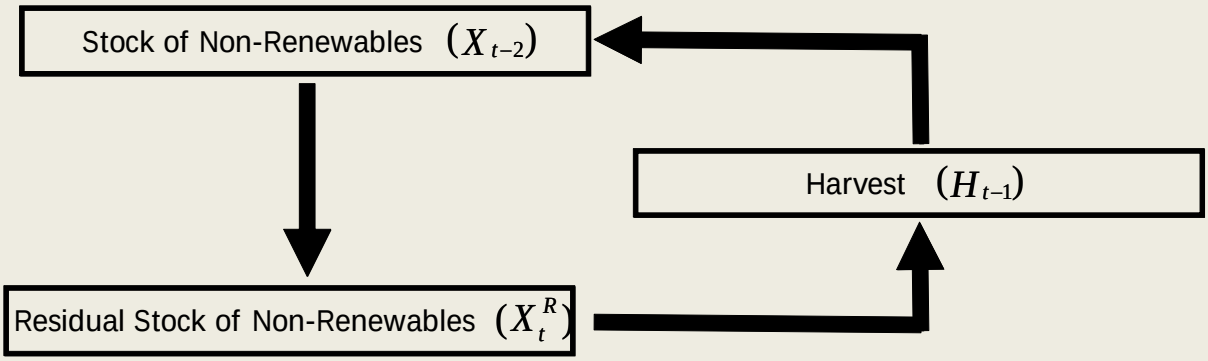


Formula: $X_t^R = X_{t-2} + \dot{X}_{t-1} - H_{t-1}$



The Management of Non-Renewable Resources

Harvest of Non-Renewables according to time t:



Formula: $X_t^R = X_{t-2} - H_{t-1}$

Consequence

- every consumption by actual generation reduces the availability of future generations
- the higher actual consumption rate, the lower future availability

Further problems

- no secure information about existing stocks
- uncertainty about future preferences, demands, technical substitution

Intergenerational Use of Non-Renewables

$$\lim_{g \to \infty} \frac{X}{g} = 0$$

with

X = Stock of Non-Renewable

g = Number of Generations

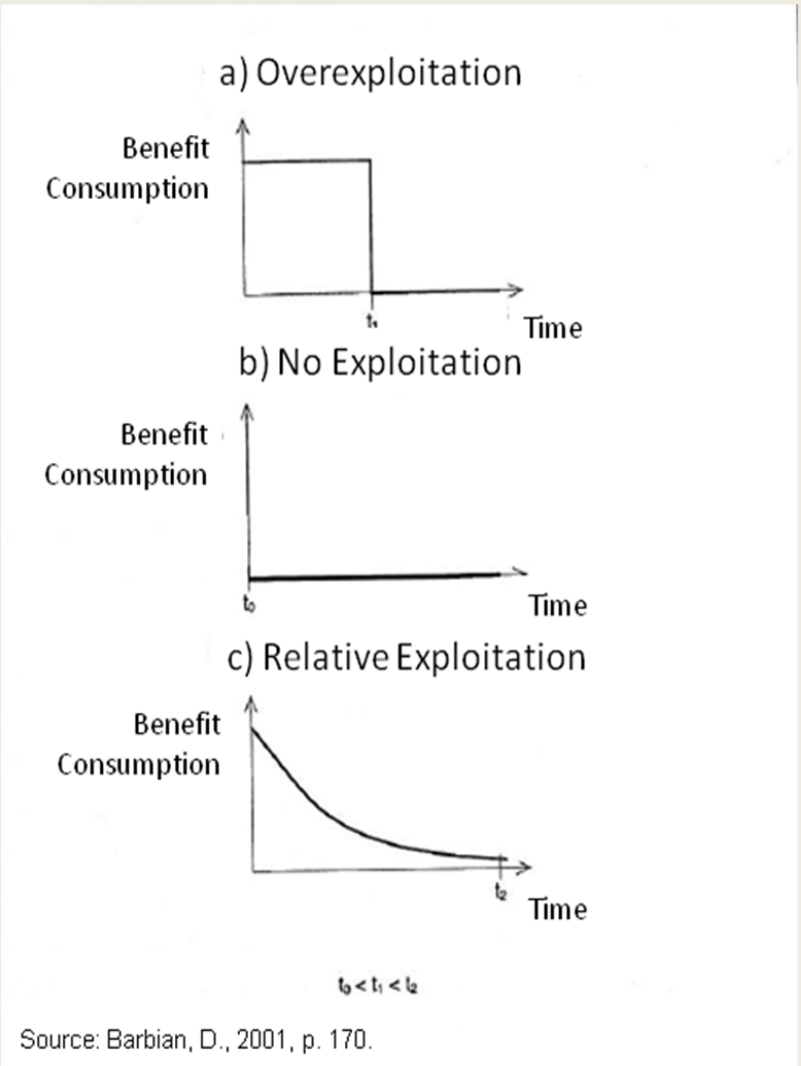
Consequence: use by no generation; no benefits for any generation

Better: Regulations on use

Consequence: Dilemma Situation: every consumption today inhibits future use and vice versa; in each case there is a given preference for one generation which should be avoided when implementing sustainability

Possible Solutions:

- Substitution of Non-Renewables by Renewables
- Increase in ecological efficiency



$t_0 < t_1 < t_2$

Source: Barbian, D., 2001, p. 170.

1.3.2 Insertion of Wastes into Environment

Common and Stagl (2005, p. 337):
Waste: solid, fluid, gaseous

Common and Stagl (2005, p. 98):

Waste: unwanted by-product of economic activity

Emission: flow of wastes into environment

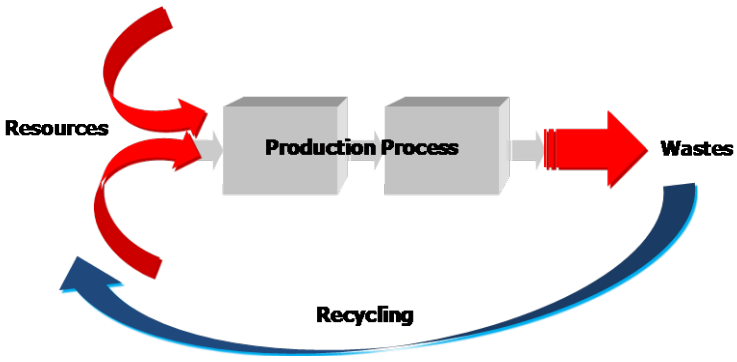
Pollution: wastes can lead to pollution, when the emission is harmful to any living organism

Examples: acid rain, ozone depletion, widespread desertification, species loss, depletion of ocean resources, wastage, waste accumulation

Management of Wastes:

waste treatment: the modification of waste before its discharge into the environment so as to reduce the damage arising (Common and Stagl, 2005, p. 106)

Recycling

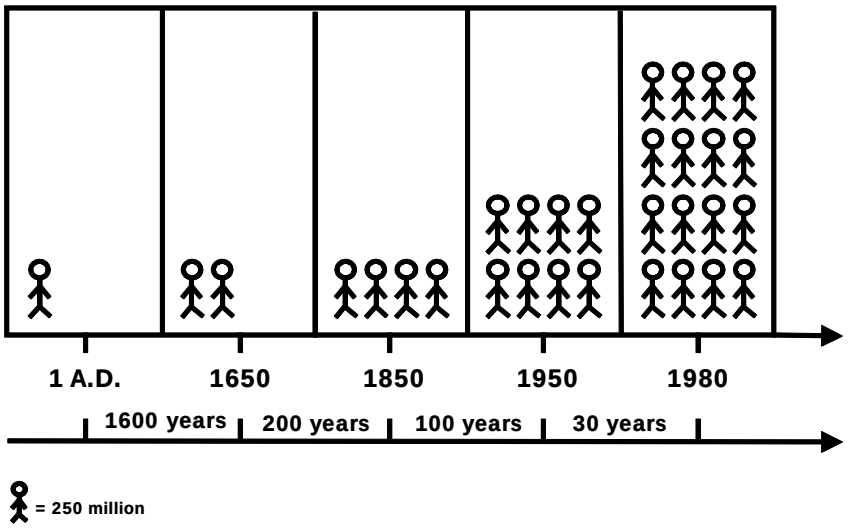


Recycling has two consequences:

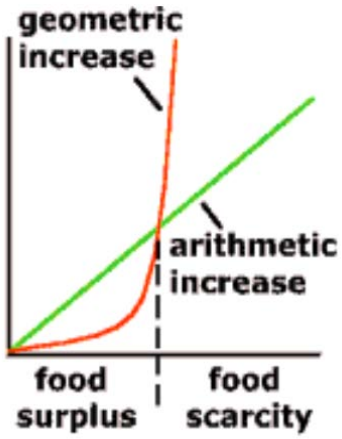
1. Amount of waste inserted into the environment is reduced.
2. Amount of corresponding resource extracted from the environment is reduced.

1.4 Influencing Factors on the Ecological System

1.4.1 Population



Malthus (see Chapter II.2.1):



According to Malthus, population growth would reach such a level that the land would no longer be able to support it, and widespread starvation would occur. When Malthus lived, the earth population was 1 billion. Malthus proposed an adaption of population increase to food supply.

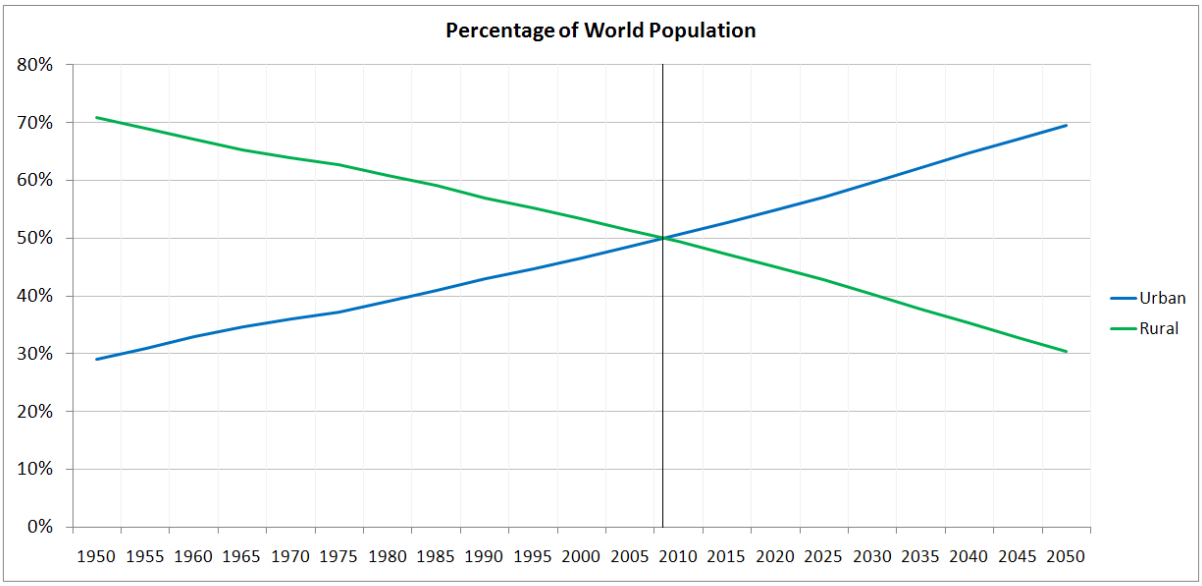
When talking about world population and satisfaction of needs, urbanization should also be mentioned (see http://en.wikipedia.org/wiki/Urbanization):

Urbanization is the physical growth of urban areas as a result of global change. Urbanization is also defined by the United Nations as movement of people from rural to urban areas with population growth equating to urban migration. The United

Nations projected that half of the world's population would live in urban areas at the end of 2008.

As more and more people leave villages and farms to live in cities, urban growth is increasing. The rapid growth of cities like Chicago in the late 19th century and Mumbai a century later can be attributed largely to rural-urban migration. This kind of growth is especially commonplace in developing countries.

Percentage of World Population: Urban vs. Rural.



Data Source: United Nations, http://esa.un.org/unup/p2k0data.asp

Urbanization rates vary from country to country. The United States and United Kingdom have a far higher urbanization level than China, India, Swaziland or Niger, but a far slower annual urbanization rate, since a lower percentage of the population live in rural areas.

The world is undergoing the largest wave of urban growth in history. In 2008, for the first time in history, more than half of the world's population will be living in towns and cities. By 2030 this number will swell to almost 5 billion, with urban growth concentrated in Africa and Asia. While mega-cities have captured much public attention, most of the new growth will occur in smaller towns and cities, which have fewer resources to respond to the magnitude of the change.

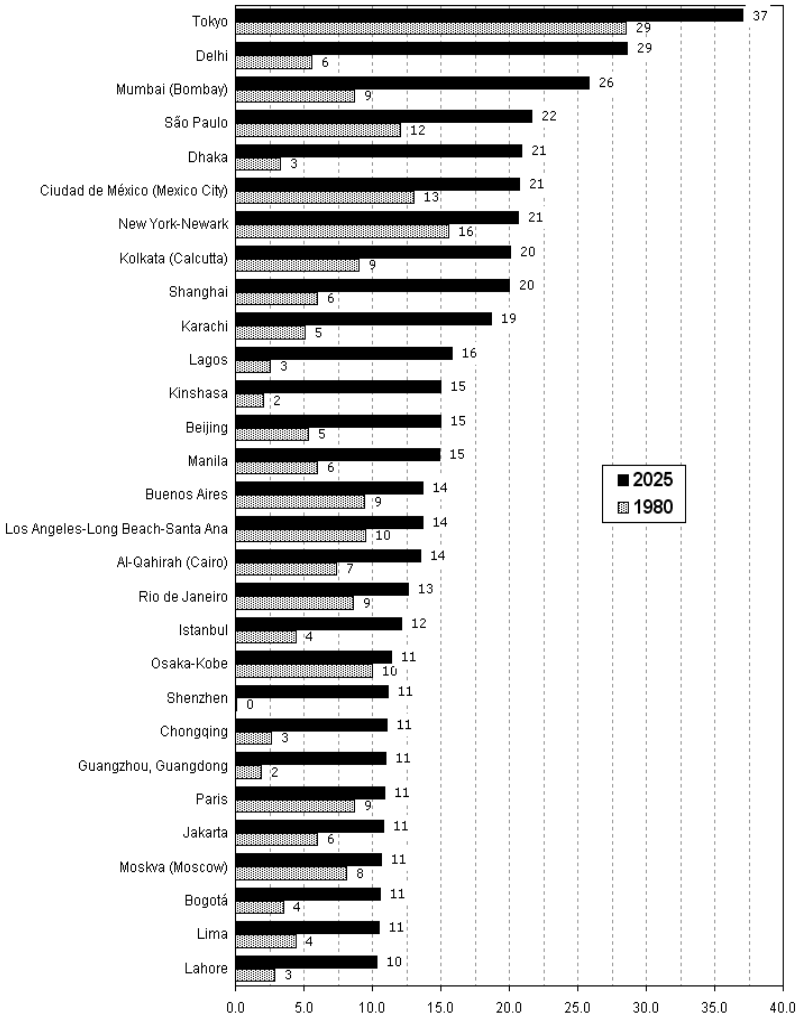
Economic effects of Urbanization

Urbanization is often viewed as a negative trend, but can in fact, be perceived simply as a natural occurrence from individual and corporate efforts to reduce expense in commuting and transportation while improving opportunities for jobs, education, housing, and transportation. Living in cities permits individuals and families to take advantage of the opportunities of proximity, diversity, and marketplace competition.

Environmental effects of Urbanization

The urban heat island has become a growing concern and is increasing over the years. The urban heat island is formed when industrial and urban areas are developed and heat becomes more abundant. In rural areas, a large part of the incoming solar energy is used to evaporate water from vegetation and soil. In cities, where less vegetation and exposed soil exists, the majority of the sun's energy is absorbed by urban structures and asphalt. Hence, during warm daylight hours, less evaporative cooling in cities allows surface temperatures to rise higher than in rural areas. Additional city heat is given off by vehicles and factories, as well as by industrial and domestic heating and cooling units. This effect causes the city to become 2 to 10^{o} F (1 -6^{o} C) warmer than surrounding landscapes.

Population of the 29 urban agglomerations that are expected to become mega-cities in 2025:



Source: United Nations, Department of Economic and Social Affairs, Population Division: *World Urbanization Prospects, the 2009 Revision*. New York, 2010.

1.4.2 Satisfying Needs

Need: something that is necessary for organisms for survival and to live a healthy life

Want: something that a person would like to have

Humans have to use natural resources when satisfying their needs. But what are the limits of satisfaction?

Maslow's hierarchy of needs (from http://www.abraham-maslow.com/m_motivation/Hierarchy_of_Needs.asp**)**

Physiological Needs

Physiological needs are those required to sustain life, such as:

- Air
- Water
- Food
- Sleep

If these fundamental needs are not satisfied then one will surely be motivated to satisfy them. Higher needs such as social needs and esteem are not recognized until one satisfies the needs basic to existence.

Safety Needs

Once physiological needs are met, one's attention turns to safety and security in order to be free from the threat of physical and emotional harm. Such needs might be fulfilled by:

- Living in a safe area
- Medical insurance
- Job security
- Financial reserves

According to the Maslow hierarchy, if a person feels threatened, needs further up the pyramid will not receive attention until that need (threat) has been resolved.

Social Needs

Once a person has met the lower level physiological and safety needs, higher level motivators awaken. The first level of the higher level needs are social needs. Social needs are those related to interaction with others and may include:

- Friendship
- Belonging to a group
- Giving and receiving love

Esteem Needs

After a person feels that they "belong", the urge to attain a degree of importance emerges. Esteem needs can be categorized as external motivators and internal motivators.

Internally motivating esteem needs are those such as self-esteem, accomplishment, and self respect. External esteem needs are those such as reputation and recognition.

Some examples of esteem needs are:

- Recognition (external motivator)
- Attention (external motivator)
- Social Status (external motivator)
- Accomplishment (internal motivator)
- Self-respect (internal motivator)

Maslow later improved his model to add a layer in between self-actualization and esteem needs: the need for aesthetics and knowledge.

Self-actualization

Self-actualization is the summit of Maslow's motivation theory. It is about the quest for reaching one's full potential as a person. Unlike lower level needs, this need is never fully satisfied; as one grows psychologically there are always new opportunities to continue to grow.

Self-actualized people tend to have motivators such as:

- Truth
- Justice
- Wisdom
- Meaning

Self-actualized persons have frequent occurrences of *peak experiences*, which are energized moments of profound happiness and harmony. According to Maslow, only a small percentage of the population reaches the level of self-actualization.

1.4.3 How much is enough? What makes people happy?

The answer is the result of the work of psychologists (and a few economists). They tried to measure how satisfying various human needs contributes to happiness. They have been studying peoples' feelings and investigating what makes them happy.

According to Common and Stagl (2005, p. 200) "happiness is a state of mind, of feeling, and psychologists ask people how they feel".

The results are that people with a high happiness scores are more likely to:

- Be rated as happy individuals by family and friends
- Be more optimistic about the future
- Be less likely to attempt suicide
- Recall more positive than negative life events
- Smile more during social interaction
- Be more healthy

2. Implementing Sustainability

2.1. Protection of Natural Elements Necessary to Sustain Life

If sustainability is to be implemented in the world, some basic conditions are required. First of all existing pollution and devastation should to be reduced.

The main challenge is to protect the controllable natural elements (air, water, soil, ozone layer).

The economic system is absolutely dependent from the ecological system.

- respect regenerative ability of ecological system
- respect assimilative ability of ecological system to absorb wastes
- respect the natural means of livelihood (soil, air, water, ozone layer)

2.2. Reduction of Bad Influences for Ecosystem

Strategies for Reducing Environmental Problems:

1. Complying with limit values
2. Improving environmental efficiency
3. Respecting the natural regenerative ability

The environment is already degraded by many wastes. Environmental degradation is of many types:

Dimension	Environmental Problems
International	Ozon hole, enhanced greenhouse effect, rainforest deforestation, ocean overfishing, plastic waste in oceans
National	Acid rain, soil degradation, air pollution, water degradation
Regional	Waste, waste water, exhaust gases, noise

Proposal for the Intergenerational Use of Non-Renewables:

Each generation can use an amount between 0 (zero) and the maximum stock of the Non-Renewable.

It is better for each generation to use the Non-Renewables than not to use them.

It is necessary to avoid over-exploitation.

A possible solution:

Each generation is allowed to use the same percentage of the Non-Renewables. That would be in accordance with a nearly intergenerational equity of use. The result is a relative intergenerational equity, but not an absolute intergenerational equity.

An appropriate removal rate should be defined. A use under 50 % of the stock is recommended unless the stock would be overexploited.

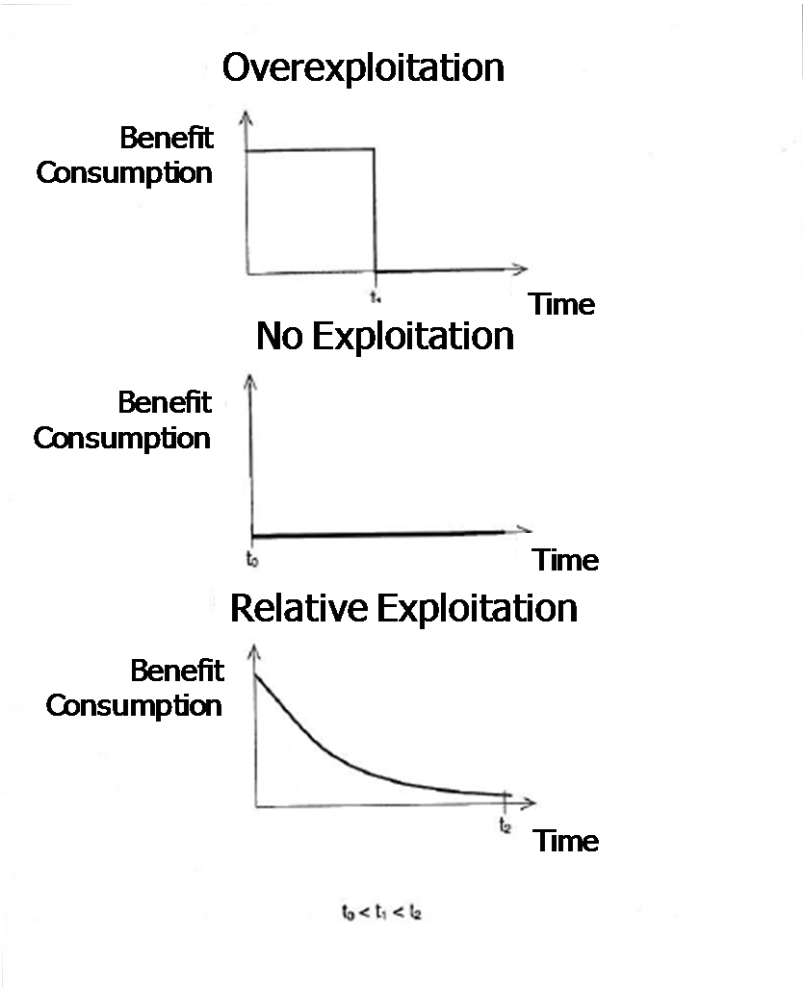
Intergenerational Use of Non-Renewables

$$\lim_{g \to \infty} \frac{X}{g} = 0$$

with

X = Stock of Non-Renewables

g = Number of Generations



Intergenerational Use of Non-Renewables

$$X_t = X_0 \cdot q^t \qquad \text{with } q = 1 - \frac{p}{100}$$

with

X_t = Stock of Non-Renewable at time t (present time)

X_0 = Initial Stock of Non-Renewable

p = Removal per time unit t [in %]

2.3. Consequences for World Countries

The protection of the natural elements to sustain life has the highest importance.

Which are the consequences and affordable changes for
Transportation, Food, Energy?

Developing countries have to use natural resources and produce waste because they have to satisfy their really basic needs. Poverty is the main problem in these countries, so poverty reduction is the first strategy towards sustainability. (A number of impoverished countries have recently received partial or full cancellation of loans from foreign governments and international financial institutions, such as IMF and World Bank.)

Industrialized countries have already reached a high level of satisfaction of needs. An increasing level of consumption doesn't necessary lead to more welfare. There is the need to think about what is really necessary for life.

2.4. A Sustainable World

Is a sustainable world feasible? How high is our carrying capacity?

A Sustainable World cares for all Human Beings in all Countries. Natural Elements Necessary to Sustain Life are to be protected. Impact of Interferences to Nature are allowed within the Regenerative Capacity without Harming Nature or Poeple's Health. A Sustainable World is of Long-term Durability.

5 Parts:
Anthropocentrism, Nature Conservation, Justice and Equality, Holistics, Long-term durability

3 Pillars:
Economy, Ecology, Social Objectives

Protection of Air, Water, Soil and Ozone Layer.

Reduction of Negative Impacts caused by Population Growth and Satisfaction of Needs.

Some strategies for businesses: cradle-to-cradle; design-to-recycle

VII. Summary and Conclusions

The starting point of the theory foundation is the definition of “Sustainable Development” from the World Commission on Environment and Development (1987). By developing some descriptors we will try to find strategies for the implementation of sustainable development in the world.

A sustainable world can’t be reached immediately. It takes time, maybe long time.

But ultimately humans are responsible for a sustainable world and for the implementation of suitable strategies.

Important internet pages:

- World Bank: www.worldbank.org
- International Monetary Fund: www.imf.org
- United Nations Conference on Trade and Development (UNCTAD): www.unctad.org
- United Nations Development Programme (UNDP): www.undp.org
- Food and Agricultural Organization (FAO): www.fao.org
- World Trade Organization (WTO): www.wto.org
- World Health Organization (WHO): www.who.int
- United Nations Industrial Development Organization (UNIDO): www.unido.org
- International Labour Organization (ILO): www.ilo.org

Some important articles:

Articles
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