Ecology and Sustainable Development, Examples for Examination:

Duration of the test: 1 hour

1. Provide some examples:

Each correct entry is 1 point. Each wrong entry is minus 1 point. Maximum number of entries equal to the number of lines. 3 such examples will be given. Maximum 15 points. = 3 x 5

- Very important chemical substances in relation to pollution of the environment are:
  - CO_2 CH_4 N_2O O_3
  - PM_{10} NO_2 SO_2 SO_3
  - .....
  - .....

2. Choose the correct figure:

Each correct choice is 1 point. 10 such examples will be given. Maximum 10 points.

- 1 %, 3%, 5 %, or 10 % of the water volume is fresh water.
- Use of nitrogen fertilizers has increased 5, 8, 10, 25-fold in EU during last 50 years.
- Heating: responsible for 1, 8, 12, 20 % of emissions

3. Select the correct components by underlining:

Each correct choice is 1 point. Each wrong choice is minus 1 point. 2 such examples will be given. Max 10 points.

- The main factors influencing average global temperatures on earth and consequently climate are the concentrations of carbon dioxide, methane, nitrous oxides, sulphuric acid, particulates in the atmosphere, the direction of the ocean currents, magnetic field of the earth, the tectonic movements, changes in the Earth's orbit around the Sun known as Milankovitch cycles, the continuous expansion of the galaxy, regional/local changes in the atmospheric water content.

4. Complete the following sentences:

Each correct entry is 1 point. 5 examples will be given. Maximum 5 points.

- Phytoplankton ....were the first oxygen-producing species.
- Acid rain is mostly caused by human emissions of NOx ....and SO_2 .... compounds which react in the atmosphere to produce acids.

5. Chemical reactions or definition of an indicator using a mathematical formula:

Correct entry is 5 points. Maximum 5 points.

Photosynthesis, aerobic respiration, ozon formation in stratosphere.

$6CO_2 + 6H_2O + h\nu \rightarrow C_6H_{12}O_6 + 6O_2$

$+ 2880 \frac{kJ}{mol}$

6. Assign figures to countries:

Each correct assignment is 1 point. Max 5 points.

- E.g. World population by region, Green House Gas emissions to different countries etc.

Grading scheme:

45 – 50 points = S1

39 – 44 points = U2

33 – 38 points = B3

26 – 32 points = G4

0 – 25 points = N5

Name: ……..

Ecology and Sustainable Development, Examination Group A 23 March 2012:

1. Provide some examples:

Each correct entry is 1 point. Each wrong entry is minus 1 points. Maximum number of entries equal to the number of lines. Maximum 15 points.

- Threats to biodiversity:

➢ ……

➢ ……

➢ ……

➢ ……

- Very important chemical substances in relation to pollution of the environment are:

➢ ……

➢ ……

➢ ……

➢ ……

- Likely Impacts of Climate Change in 21st Century:

➢ ……....

➢ ……....

➢ ……....

➢ ……....

➢ ……....

- Two examples of present <u>global</u> ecological crises are:

  ➢ ……

  ➢ ……

2. Chose the correct figure:

Each correct choice is 1 point. Maximum 10 points.

- This biosphere is postulated to have evolved, beginning through a process of biogenesis some 5, 3.5, 3 or 2 billion years ago.
- The IUCN Red List contains now more than 100, 500, 1000, 16.000 threatened species. IUCN is the International Union for the Conservation of Nature and Natural Resources.
- The most recent withdrawal of the ice sheets occurred 20.000, 10,000, 5000 0r 2000 years ago leading to an interglacial period known as the Holocene.
- Use of nitrogen fertilizers has increased 2, 4, 10, 20-fold in EU during last 50 years.
- Within the ecosystem, species are connected by food chains or food webs: Energy from the sun, captured by primary producers via photosynthesis, flows upward through the chain. On average, only 2, 10, 20, 50 % of the organism's energy is passed on to the next trophic level.
- The concentrations of Green House Gases CO2, N2O and CH4 increased due to fossil fuel consumption, agriculture and land use changes from 280 to 320, 350, 430, 550 ppm CO2e (weighted sum of all GHGs).
- From 1975 to 2000 Africa lost 2, 10, 16, 26 % of its forests.
- The European Union also regulates maximum concentrations of pesticides in water. The Maximum Residue Limit (MRL) for ground and drinking water is typically 0,1; 1; 5; or 10 microgram per liter.
- Presently about 1.000, 10.000, 100.000, 1.000.000 different chemical compounds are regularly produced by industry and enter the environmental system.
- Under the "Business-as-usual" scenario for Climate Change the average global temperature will rise by 2, 3, 4, 6 degrees by 2100 (compared to pre-industrial times).

3. Select the correct components by underlining:

Each correct choice is 1 point. Each wrong choice is minus 1 point. Max 10 points.

- General Problems of water resources in Europe: surface water bodies threatened by pollution with nitrate, pollution with pesticides, acidification of lakes in Spain, water scarcity in Northern Europe, stress on coastal waters due to aquaculture, occasionally poor bathing water quality, elevated surface water temperatures in Central European rivers, oil discharges on open seas.

- The main factors influencing average global temperatures on earth and consequently climate are the concentrations of carbon dioxide, methane, nitrous oxides, sulphuric acid, particulates in the atmosphere, the magnetic field of the earth, the structure of the lithosphere, changes in the Earth's orbit around the Sun known as Milankovitch cycles, the continuous expansion of our solar system, regional/local changes in the atmospheric pressure.

4. Complete the following sentences:

Each correct entry is 1 point. Maximum 5 points.

- The energy required for the process of photosynthesis comes from ……
- The …….. layer is important to protect many living species from ultraviolet radiation since it absorbs UV radiation.
- Public awareness of environmental pollution was first raised massively in 1962 by …… through her battle against the uncontrolled use of pesticides in agricultural production in the USA for which she coined the term „biocides".
- The ……is an international non-governmental organization for the conservation, research and restoration of the natural environment.
- Enhancement of energy efficiency required in the EU Climate Change Programme: consumption – ……% by 2020 compared to projections.

5. Chemical reactions or definition of an indicator using a mathematical formula:

Correct entry is 5 points. Maximum 5 points.

- The reaction for aerobic respiration is essentially the reverse of photosynthesis and is simplified as:

……..

6. Assign figures to regions:

Each correct assignment is 1 point. Max 5 points.

- World population by region: 60 %, 12 %, 6
  - ➢ North America
  - ➢ Europe
  - ➢ Asia
- Primary energy supply per capita and year: 8.000, 3.500, kg of oil equivalent
  - ➢ Europe
  - ➢ North America

- Phytoplankton .....were the first oxygen-producing species.
- Acid rain is mostly caused by human emissions of ...NOx.....and .....SO2..... compounds which react in the atmosphere to produce acids.

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Photosynthesis, aerobic respiration, ozon formation in stratosphere.

$6CO_2 + 6H_2O + h\nu \rightarrow C_6H_{12}O_6 + 6O_2$

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

6. Assign figures to countries:

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- Very important chemical substances in relation to pollution of the environment are:
  - SO_2
  - NO_x
  - PM10, Dust
  - Ozon

2. Choose the correct figure:

Each correct choice is 1 point. 10 such examples will be given. Maximum 10 points.

- 1 %, 3% , 5 %, or 10 % of the water volume is fresh water.
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- The main factors influencing average global temperatures on earth and consequently climate are the concentrations of carbon dioxide, methane, nitrous oxides, sulphuric acid, particulates in the atmosphere, the direction of the ocean currents, magnetic field of the earth, the tectonic movements, changes in the Earth's orbit around the Sun known as Milankovitch cycles, the continuous expansion of the galaxy, regional/local changes in the atmospheric water content.

4. Complete the following sentences:

Each correct entry is 1 point. 5 examples will be given. Maximum 5 points.

01 March 2012

Important facts and data presented in lecture course "Ecology and Sustainable Development" providing the knowledge base for the examination

Chapter 1.1:

- Protein production is directed by the nucleic acids deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).
- The DNA contains all the hereditary information.
- Regions of the DNA which perform the particular coding functions are called „genes".
- The genome is the whole set of genes of an organism and is divided into chromosomes.
- Cells are the smallest unit of life that can function independently.
- Prokaryotes are single cell organisms like bacteria.
- The first living things on Earth were prokaryotes. The oldest ancient fossil microbe-like objects are dated to be 3.5 billion years old.
- Animals, plants, fungi have eukariotic cells.
- Eukariotes generally have many different cells.
- Different cells perform different functions. Cells of the same function form tissues and tissues make up organs.
- The potential energy of chemical substances is the energy the held in the bonds between the atoms. Breaking down larger molecules through a chemical reaction releases this potential energy as heat or kinetic energy.
- An **ecozone** is the largest scale biogeographic division of the earth's surface based on the historic and evolutionary distribution patterns of plants and animals. List a few ecozones.
- A **biome** is a climatically and geographically defined area of ecologically similar communities of plants, animals, and soil organisms. There are terrestrial and aquatic biomes. List a few biomes.
- Ecosystem services are "fundamental life-support services upon which human civilization depends," and can be direct or indirect. List a few ecosystem services.

Chapter 1.2

- The biosphere is postulated to have evolved at least some 3.5 billion years ago.
- The **lithosphere** is the solid outermost shell of a rocky planet and is fragmented into tectonic plates, which move independently relative to one another. This movement of lithospheric plates is described as plate tectonics and can lead to earthquakes, tsunamis….
- The maximum density of **water** is at 4C:
  - Cold water sinks to the bottom of water bodies and creates circulation and supply of nutrients and oxygen for living species.
  - Ice floats on water protecting lower layers from freezing.
- Chemical compounds dissolved in water determine the acidity of water.
- Acidity is expressed as a pH value. pH = - log [H+]. The pH scale comprises 14 orders of magnitude. Some substances make water acidic (pH<7), others basic (pH>7).

- The **Earth's hydrosphere** consists of water in all forms: the oceans, inland seas, lakes, and rivers; rain; underground water; ice (as in glaciers and snow); and atmospheric water vapor (as in clouds).
- The abundance of water on Earth is a unique feature that distinguishes our "Blue Planet" from others in the solar system. Approximately 70.8 percent (97% of it being sea water and 3% fresh water) of the Earth is covered by water and only 29.2 percent is landmass.
- The most recent withdrawal of the ice sheets occurred only 10,000 years ago leading to an interglacial period known as the Holocene.
- The water cycle describes the methods of transport for water in the hydrosphere.
- Oceans comprise 97% of the planet's water. Source of the vast majority of water vapor that condenses and falls as rain or snow.
- The tremendous heat capacity of the oceans moderates the planet's climate, and its absorption of gases affects the composition of the atmosphere.
- Oceans show strong movements of water masses which are vital for regional climate.
- Top 10 m surface zone of oceans absorbs 80 % of solar energy. In this „photic zone" practically all of the oceans primary production of biomass by phytoplankton takes place. Phytoplankton is the first step in the food chain and source of all life in the oceans.
- Ocean water contains on the average ca 3,5 % salt. The salt content arises from permanent transport of salts from land masses through rivers and atmospheric deposition. The salt content increases the density of water and influences the ocean currents, like the gulf stream.
- Sea water contains dissolved gases, like oxygen produced by photosynthetic processes of plants, and carbon dioxide, mainly from exchange processes with the atmosphere.
- The earth's ocean is composed of huge river-like flows driven by density differences, heating and cooling, gravity and wind.
- Gulf Stream: Largely driven by the global thermohaline Circulation. Powerful, warm, and swift Atlantic ocean current that originates in the Gulf of Mexico, exits through the Strait of Florida, and follows the eastern coastlines of the United States and Newfoundland before crossing the Atlantic Ocean. At about 30°W, 40°N, it splits in two, with the northern stream crossing to northern Europe and the southern stream recirculating off West Africa.
- **The atmosphere** protects life on Earth by absorbing ultraviolet solar radiation and reducing temperature extremes between day and night.
- Atmospheric pressure is a direct result of the total weight of the air above the point at which the pressure is measured. Atmospheric pressure decreases with height.
- Approximately 3.3 billion years ago the formation of the earth's present atmosphere started. The cyanobacteria were the first oxygen-producing species through photosynthesis based on the consumption of carbon dioxide leading to the formation of organic molecules. Photosynthesising plants would later evolve and continue releasing oxygen and sequestering carbon dioxide. The increase in oxygen in the atmosphere enabled the evolution of species using cellular respiration consuming O_2 and building materials of living matter, like proteins.
- Atmospheric circulation refers to large scale movement of air, and the means (together with the smaller ocean circulation) by which heat is distributed on the surface of the Earth.
- The major driving force of atmospheric circulation is solar heating, which on average is largest near the equator and smallest at the poles.
- The atmospheric circulation transports energy polewards, thus reducing the resulting equator-to-pole temperature contrast.

- The Hadley cell is a circulation pattern that dominates the tropical atmosphere, with rising motion near the equator, poleward flow 10-15 kilometers above the surface, descending motion in the subtropics, and equatorward flow near the surface. In the tropical zone the hot air picks up lots of moisture from the surface, cools when rising and releases much of the moisture in form of rain in the tropical zone. As the air flows towards the pole it is exposed to further cooling and therefore sinks to the ground as dry air, warms during sinking due to compression leading to a warm arid climate in these zones. The air then flows back to the tropical zone due to pressure differences.
- Near the tropopause, as the air moves polewards in the Hadley cell, it is turned eastward by the Coriolis force creating the subtropical jet streams that flow from west to east „Westerlies"). Analogously, near the surface, the equatorward return flow is rotated to the west. These surface winds, with both an equatorward and a westward component, are referred to as the trade winds.
- The large-scale structure of the atmospheric circulation varies from year to year, but the basic structure remains fairly constant.
- However, individual weather systems - midlatitude depressions, or tropical convective cells - occur "randomly", and it is accepted that weather cannot be predicted beyond a fairly short limit: about ten days in practice.
- Nonetheless, the average of these systems, the climate, is quite stable.
- **The most important biogeochemical cycles are:** The carbon cycle. The nitrogen cycle. The phosphorus cycle. The oxygen cycle
- The **carbon cycle** is the biogeochemical cycle by which carbon is exchanged between the biosphere, geosphere, hydrosphere, and atmosphere of the Earth. The cycle is usually thought of as four major reservoirs of carbon interconnected by pathways of exchange.
- The major carbon reservoirs are:
  - the atmosphere,
  - the terrestrial biosphere (which usually includes freshwater systems and non-living organic material, such as soil carbon),
  - the oceans (which includes dissolved inorganic carbon and living and non-living marine biota),
  - the sediments (which includes fossil fuels).
- The ocean contains the largest active pool of carbon near the surface of the Earth (38.000 Gto).
- Carbon exists in the Earth's atmosphere primarily as the gas carbon dioxide (CO_2). Although it is a very small part of the atmosphere overall (approximately 0.04% on a molar basis, though rising), it plays an important role in supporting life.
- Carbon exists in the biosphere as living species (plants, animals) largely consisting of organic carbon compounds (carbohydrates, celluloses, proteins…..) and of inorganic carbonates (e.g. shells of animals).
- Carbon exists in the lithosphere as inorganic carbonate rocks and as carbon rich deposits of dead organic matter (coal, oil, natural gas).
- Carbon exists in the hydrosphere as dissolved carbon dioxide, suspended carbonates, dead organic matter.
- Carbon is an essential part of life on Earth. It plays an important role in the structure, biochemistry, and nutrition of all living cells.
- Organic compounds are produced from CO_2 by autotroph organisms through the process of photosynthesis. The energy required for this process comes from solar radiation.
- The most important autotrophs for the carbon cycle are trees in forests on land and phytoplankton in the Earth's oceans.

- Carbon is transferred within the biosphere as heterotrophs feed on other organisms or their parts (e.g. fruits).
- **Phytoplankton** are the autotrophic component of plankton. Size usually less than 0,1 mm. Through photosynthesis, phytoplankton are responsible for about half of the oxygen produced in the Earth's atmosphere.
- **Carbon uptake from the atmosphere;**
  - **Photosynthesis:** When the sun is shining, plants perform photosynthesis to convert carbon dioxide into carbohydrates, releasing oxygen in the process. Chlorophyll is vital for photosynthesis, which allows plants to obtain energy from light. Chlorophyll molecules absorb light and transfer that light energy to the cells. Photosynthesis follows the reaction $6CO_2 + 6H_2O + h\nu \rightarrow C_6H_{12}O_6$ (glucose) + $6O_2$.
  - **Inorganic processes:** At the surface of the oceans carbon dioxide is readily exchanged with the atmosphere and dissolved in the water. This carbon exchange becomes important in controlling pH in the ocean and can also vary as a source or sink for carbon.
- **Carbon release back into the atmosphere:**
  - **Respiration performed by animals** involving the breaking down of glucose (or other organic molecules) into carbon dioxide and water.
  - **Decay of animal and plant matter.** Fungi and bacteria break down the carbon compounds in dead animals and plants and convert the carbon to carbon dioxide if oxygen is present, or methane if not.
  - **Combustion of organic material:** produces carbon dioxide (and other compounds, like water vapor). Burning fossil fuels such as coal, petroleum products, natural gas or biomass releases carbon that has been stored in the geosphere for millions of years.
  - **Outgasing from oceans:** At the surface of the oceans where the water becomes warmer, dissolved carbon dioxide is released back into the atmosphere.
  - **Volcanic eruptions:** release primarily water vapor, carbon dioxide and sulfu dioxide.
- The **nitrogen cycle** is the biogeochemical cycle that describes the transformations of nitrogen and nitrogen-containing compounds in nature. Earth's atmosphere is about 78% nitrogen, making it the largest pool of nitrogen. Nitrogen is essential for many biological processes; and is crucial for any life here on Earth. It is in all amino acids, is incorporated into proteins, and is present in the bases that make up nucleic acids, such as DNA and RNA.
- **Uptake of gaseous nitrogen from atmosphere:**
  - **Nitrogen fixation:** conversion of gaseous nitrogen into forms usable by living organisms is done by bacteria.
  - **Assimilation:** Most plants can absorb nitrate or ammonium ions from the soil via their root hairs.
- **Fertilizers:** Compounds given to plants to promote growth; they are usually applied through the soil for uptake by plant roots. Fertilizers can be organic (composed of organic matter), or inorganic (made of simple, inorganic chemicals or minerals). They can be naturally occurring compounds such as peat or mineral deposits, or manufactured through natural processes (such as composting) or chemical processes (such as the Haber-Bosch process). Fertilizers typically provide the plant nutrients (the major ones being nitrogen, phosphorus, and potassium).
- In the Haber-Bosch Process developed 1910 ammonia (NH_3) is produced through a high temperature/high pressure reaction between hydrogen (from natural gas) and

atmospheric nitrogen. NH_3 is used to produce nitrogen fertilizer, mostly in the form ammonium nitrate and urea. The Haber-Bosch process now produces 100 million tons of nitrogen fertilisers per year. That fertilizer is responsible for sustaining one-third of the Earth's population, but overfertilisation is considered a severe environmental problem.

- **Release of nitrogen into the atmosphere:**
  - **NOx:** Fossil fuel combustion has contributed to a 6 or 7 fold increase in NOx flux to the atmosphere. NOx actively alters atmospheric chemistry, and is a precursor of tropospheric (lower atmosphere) ozone production, which contributes to smog, acid rain, and increases nitrogen inputs to ecosystems.
  - **N_2O:** The use of fertilizers on a global scale emits significant quantities of this green house gas into the atmosphere.
  - **NH_3:** Concentration in the atmosphere has tripled mainly as the result of increased use of fertilisers. It reacts in the atmosphere with NOx and SO_2/SO_3 forming ammonium nitrate and sulfate as an aerosol. These are components of acid precitation.
- **Significance of phosphorus:** Key component of all living matter (cell membranes) and molecules vital for life, like DNA, RNA. Primary uptake in food chain of water soluble phosphorus by plants, then transfer upwards.
- **Supply of phosphorus to waters and soil:**
  - Excretion of waste and decomposition of the compounds. Waste water is a major source of phosphorus (also due to detergents).
  - Input through fertilisation in agriculture. Oversupply of waters with phosphorus contributes to eutrophication.
- **Oxygen** constitutes 20.9% of the volume of air.
- Free oxygen also occurs in solution in the world's water bodies. The increased solubility of O_2 at lower temperatures has important implications for ocean life, as polar oceans support a much higher density of life due to their higher oxygen content. Polluted water may have reduced amounts of O_2 in it, depleted by decaying algae and other biomaterials (eutrophication).
- **Sources of oxygen:**
- The main source of oxygen within the biosphere and atmosphere is photosynthesis.
- Photosynthesizing organisms include the plant life of the land areas as well as the phytoplankton of the oceans.
- Green algae and cyanobacteria in marine environments provide about 70% of the free oxygen produced on earth and the rest is produced by terrestrial plants.
- **Oxygen consumption from the atmosphere:** The main way oxygen is lost from the atmosphere is via respiration, mechanisms in which animal life and bacteria consume oxygen and release carbon dioxide. The reaction for aerobic respiration is essentially the reverse of photosynthesis and is simplified as: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O +$ 2880 kJ·mol-1. In vertebrates, O_2 is diffused through membranes in the lungs and into red blood cells (erythrocytes).Erythrocytes consist mainly of hemoglobin.

Chapter 1.3

- Within the ecosystem, species are connected by food chains or food webs: Energy from the sun, captured by primary producers via photosynthesis, flows upward through the chain to primary consumers (herbivores), and then to and secondary consumers (carnivores and omnivores), before ultimately being lost to the system as waste heat. On average, only 10% of the organism's energy is passed on to its

predator. The other 90% is used for the organisms life processes or is lost as heat to the environment.

- Directly linked to this are pyramids of numbers, which show that as the chain is travelled along, the number of consumers at each level drops very significantly, so that a single top consumer (e.g. a Polar Bear) will be supported by literally millions of separate producers (e.g. Phytoplankton).
- A **food web** extends the *food chain* concept from a simple linear pathway to a complex network of interactions. Food sources of most species in an ecosystem are very diverse, resulting in a complex *web* of relationships.
- An ecosystem(s) is unstable when the load capacity is overrun and is especially unstable when a population has overconsumers.
- The productivity of ecosystems is estimated by comparing three types of land-based ecosystems and the total of aquatic ecosystems: The forests (1/3 of the Earth's land area) contain dense biomasses and are very productive. The total production of the world's forests corresponds to half of the primary production. Savannas, meadows, and marshes (1/3 of the Earth's land area) contain less dense biomasses, but are productive. Represent the major part of what humans depend on for food. Extreme ecosystems in the areas with more extreme climates -- deserts and semi-deserts, tundra, alpine meadows, and steppes -- (1/3 of the Earth's land area) have very sparse biomasses and low productivity. Finally, the marine and fresh water ecosystems (3/4 of Earth's surface) contain very sparse biomasses (except coastal zones).
- **Major abiotic factors** affecting the species in a given ecosystem are:
  - Water, which is an essential element to life and a milieu.
  - Air, which provides mainly oxygen and carbon dioxide to living species and allows the dissemination of pollen and spores.
  - Soil, at the same time source of nutriment and physical support.
  - Temperature, which should not exceed certain extremes, even if tolerance to heat is significant for some species.
  - Light, which provides energy to the ecosystem through photosynthesis.
- **Biotic factors** affecting the species in a given ecosystem are: Relations within a population: co-operation or competition.
- Some examples of global ecological crises are:
  - Permian-Triassic extinction event 250 million of years ago.
  - Cretaceous–Tertiary extinction event 65 million years ago.
- Some examples of an ecological crises with local and regional impact are:
  - The Exxon Valdez oil spill off the coast of Alaska in 1989.
  - The nuclear meltdown at Chernobyl.
  - The overconsumption of natural resources under conditions of abundance as happened at the Easter Island.

Chapter 2.1:

- When people lived on hunting and gathering 1000 ha of land were needed to support 1 person
- Carrying capacity of land increased due to introduction of agricultural practices: 100 ha needed to support 1 person
- Advanced agricultural practices based on production of crops for feeding animals in winter, widespread use of manure on fields for crop production, 10 ha needed to support 1 person.
- Present day industrialised agriculture based on large scale landscape, heavy use of fertilisers - << 1 ha needed to support 1 person.

- **General changes introduced by human evolution on land:**
  - **Deforestation:** forest area decreased substantially over the centuries, natural forest replaced by "industrial forests" in many areas (low resistance to pests and diseases, storms…), impact on water storage capacity of land, biodiversity….
  - **Draining of wetlands:** wetland areas strongly reduced and their functions diminished (water reservoirs, productive biotopes, filtering and de-nitrification, landscape value).
  - **Expansion of infrastructures:** cities, communication infrastructure (transport), industries and industrial infrastructure

Chapter 2.2:

- **Biodiversity** is the variation of life forms within a given ecosystem, biome or for the entire Earth. It is richer in the tropics. As one approaches polar regions one generally finds fewer species. Flora and fauna diversity depends on climate, altitude, soils and the presence of other species.
- The IUCN Red List contains now more than 16.000 threatened species. IUCN is the International Union for the Conservation of Nature and Natural Resources.
- **Benefits of Biodiversity:** There are a multitude of benefits of biodiversity such as:
  - resistance to diseases and catastrophes,
  - provision of food and drink, medicines, industrial products,
  - ecosystem services,
  - technology models, leisure,
  - cultural and aesthetic value.

Threats to Biodiversity (4)

- **Recent reductions of biodiversity:**
  - Extinction of many bird species on remote islands after discovery and introduction of foreign species by man starting 500 years ago.
  - Industrialisation and change of land use beginning in the 19th century.
  - Habitat fragmentation as a consequence of land use changes, like converting forests into agricultural land.
- **Numbers of species:**
  - 300.000 plants,
  - 1,2 million animals (including ca 1 million insects)
- The conservation of biological diversity has become a global concern and is addressed in the **Convention on Biological Diversity,** which is an international treaty of 1992 (Rio) with main goals: conservation of biodiversity, sustainable use of its components and fair sharing of such resources.

Chapter 2.3:

- **Acid rain** is rain or any other form of precipitation (snow, fog, dew) that is unusually acidic (pH<5).
- Acid rain is mostly caused by human emissions of gaseous sulfur and nitrogen compounds (NO_x, SO_2) which react in the atmosphere to produce acids: mainly HNO_3, H_2SO_4
- Main sources:
- burning of fossil fuels (coal, oil, gas) in power plants
- waste incineration and industrial production plants
- diesel and gasoline vehicles and ships
- Acid rain has harmful effects on aquatic animals, plants and buildings.

important chemicals in relation to pollution of the environment (4)

- Industrial acid rain is a substantial problem in China, Eastern Europe, Russia and areas down-wind from them. These areas all burn sulfur-containing coal to generate heat and electricity.
- **Adverse effects of acid rain in surface waters:** damage to fish and other aquatic animals.
- **Adverse effects of acid rain on forests and other vegetation:** Acid rain can slow the growth of vulnerable forests and cause leaves and needles to turn brown and fall off.
- **Technical solutions to reduce emission of acid gases:**
  - Coal-burning power plants use flue gas desulphurisation (FGD) to remove sulphur-containing gases from their stack gases.
  - Automobile emissions control with catalytic converters reduce emissions of nitrogen oxides from motor vehicles.

Chapter 2.4:

- **Water pollution** is a large set of adverse effects upon water bodies such as lakes, rivers, oceans, and groundwater caused by human activities.
- Water pollution has many causes, the most important being:
- Industrial waste water discharges: heavy metals, organic toxins and oils. Now largely eliminated in EU, USA, Japan. Still a major problem in emerging economies and developing countries.
- Agricultural effluents: pesticides, herbicides leading to ground water pollution, nutrients from fertilisation leading to eutrophication, manure leading to bacterial contamination.
- Human waste water discharge, unprocessed or processed in sewage plants: nitrates and phosphates leading to eutrophication and bacterial contamination.
- Oil discharges: oil spills due to accidents with tankers or in drilling or release of hydrocarbons due to intentional cleaning of oil tanks at the open sea.
- Excessive warming of surface waters due to discharges of heated cooling water of thermal and nuclear power stations leading to a depletion of oxygen.
- **Eutrophication:** high primary productivity due to a high nutrient input (particularly phosphorus and nitrogen) into water. A eutrophic lake is subject to excessive alga blooms, resulting in murky water and poor water quality. The bottom waters of such lakes are commonly deficient in oxygen; thus, such lakes commonly lack those fish species.
- A widely-used measure of eutrophication is the determination algal and cyanobacterial biomass from the chlorophyll concentration.
- An **oligotrophic lake** is a lake with low primary productivity, the result of low nutrient content. These lakes normally have very clear waters, some even with drinking-water quality. The bottom waters of such lakes typically have ample oxygen; thus, such lakes often support many fish species.
- **Major sources for eutrophication:** waste water and agriculture.
- **Pathogens** can produce waterborne diseases in either human or animal hosts: Contaminated drinking water, used in the preparation of food, can be the source of foodborne disease through consumption of the same microorganisms. According to the World Health Organization, diarrheal disease is responsible for the 4% of the total daily global burden of disease largely attributable to unsafe water supply, sanitation and hygiene, and mostly concentrated in children in developing countries.
- **Chemical water pollution:**
  - Heavy metals including acid mine drainage,

  - chemical waste as industrial by products,
  - fertilizers, in runoff from agriculture including nitrates and phosphates.
- Some important **organic** water pollutants are:
  - insecticides and herbicides (a huge range of organohalide and other chemicals),
  - VOCs (volatile organic compounds), such as industrial solvents, from improper storage, petroleum hydrocarbons including fuels (gasoline, diesel, jet fuels, and fuel oils) and lubricants (motor oil),
  - detergents,
  - various chemical compounds found in personal hygiene and cosmetic products,
  - agropharmaceuticals,
  - human medicines…..
- **Bioaccumulation:** Each successive step up the food chain causes a stepwise concentration of pollutants such as heavy metals (e.g. mercury) and persistent organi pollutants such as DDT.
- **Soil contamination** arises from the rupture of underground storage tanks, application of pesticides, leaching of wastes from landfills or direct discharge of industrial wastes to the soil….. The most common chemicals involved are petroleum hydrocarbons, solvents, pesticides, lead and other heavy metals.
- Waste deposition is one of the largest impacts on soil.
- A number of adverse effects can occur from landfill operations:
- contamination of groundwater and/or aquifers by leakage
- outgassing of methane (green house gas) from decaying organic wastes
- harbouring of disease vectors such as rats and flies
- simple nuisance problems (e.g. dust, odour).
- Mitigation:
- waste reduction and recycling
- incineration and pyrolysis
- composting and mechanical biological treatment
- banning of disposal of untreated waste in landfills (AT, DE, CH)

Chapter 2.5:

- A **chemical substance** is a material with a definite chemical composition. Presently 52 million chemical compounds are known and registered by Chemical Abstracts Services (USA). More than 100.000 different chemical compounds are regularly produced by industry and enter the environmental system.
- The most important chemical substances in relation to pollution of the environment are:
  - fertilisers,
  - plant protection chemicals (pesticides, herbicides…..),
  - detergents,
  - waste materials from human consumption and industrial processes,
  - pharmaceuticals.
- All chemical compounds in actual use have been tested for toxicity, registered at a proper authority (e.g. the US Food and Drug Administration – FDA, EU National Competent Authorities, or the European Chemicals Agency).
- The US registry of the FDA contains 150.000 entries with some 5.000 classified as somehow toxic.

- **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)** covers the production and use of chemical substances in the EU with the aim to achieve an enhanced protection of human health and the environment.
- The most important classes of **pesticides** are:
  - bactericides for the control of bacteria,
  - fungicides for the control of fungi,
  - herbicides for the control of weeds,
  - insecticides for the control of insects.
- United Nations Food and Agriculture Organization (FAO) adopted an International Code of Conduct on the Distribution and Use of Pesticides in 1985 to create voluntary standards of pesticide regulation for different countries. The United Nations Codex Alimentarius Commission seeks to create uniform standards for maximum levels of pesticide residues among participating countries.
- In the European Union an extensive legislative framework is in place controlling the use of pesticides in food and feed.
- **Environmental effects:** Use of pesticides can have unintended effects on the environment. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species. Many of the chemicals used in pesticides are persistent soil contaminants and eventually enter the water systems resp. food chain.
- The European Union also regulates maximum concentrations of pesticides in water: The Maximum Residue Limit (MRL) for ground and drinking water is typically 0,1 microgram per liter.
- **Persistent organic pollutants:** compounds that resist degradation and thus remain in the environment for years. POPs are frequently halogenated, usually with chlorine. Their lipid solubility results in the ability to bioaccumulate in the fatty tissues of living organisms.
- Bioaccumulation of fat soluble persistent organic pollutants in the food chain can lead to a concentration enrichment of factor 10.000.000.
- Some POPs have been banned like Polychlorinated biphenyls (PCBs), DDT, polycyclic aromatic hydrocarbons (PAHs), like Benzo-A-Pyrene while others continue to be used.
- Chlorofluorocarbons reduce concentration of stratospheric ozone, create the „ozone hole" and are therefore responsible that the more UVB-radiation (270 – 315 nm) reaches the surface of the earth which significantly enhances the risk for skin cancer.
- Montreal Protocols of 1987 and 1990 completely phasing out CFC production by 2000.
- Ozone layer seems to remain stable now.

Chapter 3:

- Public awareness of environmental pollution was first raised massively in 1962 by **Rachel Carson** through her battle against the uncontrolled use of pesticides in agricultural production in the USA for which she coined the term „biocides".
- **Dennis Meadows "The Limits to Growth - A Report of the Club of Rome's Project on the Predicament of Mankind" 1972:** "If the world's consumption patterns and population growth continue at the same high rates of the time, the earth will strike its limits within a century."
- **"Decoupling":** A Key Element of Sustainable Development, means decoupling of resource use from economic growth and decoupling of environmental impact from resource use.

WWFs int. non-governmental org. for conservation, research & restoration of natural environment

- **Establishment of the United Nations Environment Programme (UNEP) in 1972:** to coordinate the United Nations environmental activities, to assist developing countries in implementing environmentally sound policies and to encourage sustainable development through sound environmental practices.
- UN-WCED commissioned report **"Our Common Future"** in 1983, published in 1987 ("Brundtland Report") it provided for a definition of Sustainable Development: *„Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."*
- **1988:** The World Meteorological Organization and the UNEP established the **Intergovernmental Panel on Climate Change (IPCC).** IPCC is the scientific body tasked to evaluate the risk of climate change caused by human activity. Main activity of the IPCC is publishing special reports on topics relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC), which is an international treaty to combat global warming.
- **1992: United Nations Conference on Environment and Development** ("Earth Summit") 5 important documents produced:
  - The Rio Declaration on Environment ad Development.
  - Agenda 21: a document of 40 chapters outlining the main tasks to be carried out for the achievement of sustainable development.
  - The Forest Principles on the sustainable management of Forests.
  - The Framework Convention on Climate Change (UNFCCC).
  - The Convention of Biological Diversity (UNCBD).
  - The Convention to Combat Desertification (UNCCD).
  - List a few of the documents produced at the Rio Conference.
- **2000: Establishment of the Millennium Development Goals** at the Millennium Summit held at the UN Headquarters in New York. The **Millennium Development Goals** are eight goals that 189 United Nations member states have agreed to try to achieve by the year 2015:
  - Eradicate extreme poverty and hunger.
  - Achieve universal primary education.
  - Promote gender equality and empower women.
  - Reduce child mortality. Improve maternal health.
  - Combat HIV/AIDS, malaria, and other diseases.
  - Ensure environmental sustainability.
  - Develop a global partnership for development.
  - List a few of the Millenium Goals.
- **Milestones of Environmental and Sustainability Policies in theEuropean Union:**
- 1973: First Environmental Action Programme of EC.
- 1997: Single European Act (Amsterdam) placed environmental protection on equal footing with economic growth and free trade.
- 2001 Gothenburg European Council Decision establishing EU Sustainable Development Policy: *Integration of environmental considerations into all Community policies.*
- 2002 Communication of European Commission "Towards a Global Partnership for Sustainable Development" COM(2002)82: *Commitment of the EU to promoting sustainable development on a global level.*
- *2008: The Climate and Energy Package: A series of Directives to combat climate change.*
- Since 1970 ca 250 pieces of EU legislation have been produced and 6 Environmental Action Programmes established: Basis for the current policy guidelines of the European Union.

- **The Lisbon Agenda of 2005:** Economic Growth, Social Equilibrium, Environmental Quality are the 3 pillars of Sustainable Development which is the Guiding Principle for the European Union.

Chapter 4.1:

- **Major air pollutants:**
  - Particulate Matter (PM10),
  - Ozone (O_3),
  - Nitrogen dioxide (NO_2),
  - Sulphur dioxide (SO_2)
- **Population exposure:**
- A significant fraction of Europe's population suffers from summer (ozone) or winter smog (PM, SO_2) conditions.
- Ozone concentrations typically 3 - 4 times higher than in pre-industrial era.
- Acidification of lakes and streams remains widespread throughout southern Scandinavia.
- Respiratory diseases very common.
- Transport responsible for emissions of CO_2, Particulate Matter, SO_2 (shipping), NO_x + VOCs (forming ozone).
- Transport accounts for roughly 25 % of the energy consumption and of the GHG emissions. Transport in many regions now the major source for air pollution.
- Energy efficiency in transport very low, only 20 %, and for transporting a single person of 80 kg in a vehicle of 1 ton, as is the normal situation in urban traffic, only 1–2 %. *-In comparison: the energy which is consumed by a human being during a full day would move a car only a few (perhaps 3) km*
- Large disparities in transport costs: Road: 20 EUR, Rail: 60 EUR (for 1000 ton.km), Ship: < 10 EUR.

Chapter 4.2:

- **General Problems of water pollution in Europe:**
  - 20 % of all European surface water bodies seriously threatened by pollution (nitrate and pesticides).
  - Widespread acidification of lakes in Northern Europe.
  - European seas threatened by eutrophication.
  - Coastal zones under heavy pressure.
  - Occasionally poor bathing water quality.
  - Frequent oil discharges on open seas.
  - List a few of these problems.
- **Wide-spread over-consumption of water, particularly in the South of Europe.**
- **Water Framework Directive (WFD) 2000/60/EC:** Integrated impact-based river basin management. Ecosystem approach: Holistic assessment of surface water status. Major objective: "good surface water status" by 2015.
- **Waste Water Treatment:**
  - Primary: removal of solid materials.
  - Secondary: biological treatment.
  - Tertiary: chemical treatment
- Concentrations of phosphorus in European rivers and lakes decreased during the 1990s, reflecting the improvement in waste water treatment. The decrease was not sufficient to halt eutrophication. Nitrate concentrations in Europe's groundwaters have

Glückwünsche Effizienz

remained constant and are high in some regions, threatening drinking water abstractions. Main reason is the increased use of fertilisers in agriculture.

- Overall for Europe there is limited information available and a lack of reliable data on pesticides in groundwater. However, from national reports and EEA (2000) it appears that there is a danger of pesticide pollution in many countries.
- Agriculture is the main source of nutrients (and other chemicals) to surface waters leading to eutrophication and groundwater pollution. Use of nitrogen fertilisers has increased 10-fold in EU during last 50 years!
- The quality of water at designated bathing beaches in Europe (coastal and inland) has improved throughout the 1990s and early 2000s. In 2003, 97% of coastal bathing waters and 92% of inland bathing waters complied with the mandatory standards.
- **Coastal Zones** are subject to strong anthropogenic pressures:
  - freshwater inputs rich in pollutants,
  - population growth in coastal areas,
  - fish and shellfish farming (500.000 tons of molluscs annually),
  - tourism
- Ecosystem functioning disruptions in coastal zones: anoxic crises, algal blooms, etc.
- **Water Scarcity:** Agriculture consumes 70 % of the water in Southern Europe.
- **Tourism areas:** Each year 200 million people move from the North to the South of Europe. Water consumption: local 200 lt/day, tourist 500 lt/day, Price of water: 1 EUR for 1.000 lt.

Chapter 4.3:

- **Soil performs a number of key environmental, social and economic functions that are vital for life:**
  - Plants and crops depend on soil for the supply of water, nutrients and as a medium for growing.
  - Soil stores, filters, buffers and transforms substances that are introduced into the environment, crucial in protecting water supplies and regulating greenhouse gases.
  - Soil is a provider of raw materials.
  - Soil is a fundamental component of our landscape and cultural heritage.
  - List a few soil functions.
- **Land use in the EU:** 36 % forest, 47 % agricultural area, 17 % other use
- **Soil problems:**
  - Soil erosion by water and by wind.
  - Southern Europe soils often have a reduced organic carbon content.
  - Forests severely damaged by forest fires.
  - Major land use changes.
- The Boreal region has the biggest carbon stocks on earth. Threat of loss of methane by global warming.
- The **European forests** are listed in the European Forest Monitoring and Information System..
- Carbon uptake in EU forests = 10% of EU emissions
- Forest fires destroy every year several hundred thousand hectares of forests in the South of Europe.

Chapter 4.4:

- The concentrations of **Green House Gases** CO_2, N_2O and CH_4 increased due to fossil fuel consumption, agriculture and land use changes from 280 to 430 ppm CO_2eq (weighted sum of all GHGs).
- Green House Gas emissions have strongly enhanced the natural warming having led to an overall increase of the global mean temperature by 0,8C and a sea level rise by 15 cm.
- The IPCC is publishing reports on topics relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC) based on the assessment of scientific information relevant to human-induced climate change, its impacts and options for adaptation and mitigation.
- CO_2 changes during last 400.000 years: Changes in the Earth's orbit around the sun, known as Milankovitch cycles , are believed to be main reason for the large oscillations, but the industrial revolution has caused a fast and dramatic rise in CO_2 concentrations of the atmosphere.
- The main factors influencing average global temperatures on earth and consequently climate are:
  - changes in the Earth's orbit around the Sun known as Milankovitch cycles, and
  - the concentrations of the green house gases (carbon dioxide, methane, nitrous oxides) and of particulates in the atmosphere,
- CO_2 amounts to 72 % of all GHG emissions, CH_4 to 18 % and N_2O to 9 %.
- 75 % of GHG emissions result from burning fossil fuel or biomass.
- Total GHG emissions: global 50 Gto/yr CO_2eq, EU 5,5 Gto/yr CO_2eq
- Per capita GHG-emissions: USA ca 25 tons CO_{2eq}, EU ca 10 tons CO_{2eq}, Latin America ca 10 tons CO_{2eq}, China ca 6 tons CO_{2eq} , India ca 3 tons CO_{2eq} ,Africa ca 4 tons CO_{2eq}
- Under baseline scenarios (IPCC A2 scenario) CO_2 emissions will increase till 2050 by 70 % in industrialized countries and by 250 % by countries in development. In such a case average global temperature will rise by 2 degrees by 2050 (compared to pre-industrial times) and 4 degrees by 2100.
- **Visible effects of Global Warming:**
  - Strong retreat of Alpine glaciers.
  - Warming of Mediterranean Sea by 2 – 3 ° during the last 25 years.
  - Increased seasonal melting of the Greenland ice cover.
  - Reduction of Arctic ice shield by 40 % since 1970.
- **Likely Impacts of Climate Change in 21st Century:**
  - Increased probability for extreme weather events (droughts, heavy precipitation and floods).
  - High likelihood for heat waves with significant health impact.
  - Further melting of ice shields reducing reflection of sun-light leading to enhanced warming: sea-level rise of perhaps up to 0,2-0,5m (?).
- **Low probability, but high impact events:**
  - Melting of all Greenland ice and parts of Antarctic ice shield leading to sea level rise of 5 m or more.
  - Melting of permafrost releasing huge amounts of methane (forcing factor 23 x of CO_2) leading to a non-linear accelerated warming.
  - Strong reduction of thermohaline circulation (gulf stream) with severe impact on coastal temperatures in North America and Western Europe.
  - Disturbance of monsoon cycles.

- **Kyoto Protocol (1997, in force since 2005):** 136 countries responsible for 85 % of GHG emissions have ratified protocol. USA is a signatory but did not ratify protocol. Commitment to reduce GHG emissions by 5% below 1990 levels till 2012
- **Preparation of a post-2012 climate change policy:** Goal: Limitation of further global temperature increase to 2 °C compared to pre-industrial times.
- **EU GHG emission reduction targets:** 20 (30) % in EU till 2020 below 1990 levels
- **Energy targets for 2020:**
  - Biofuels: 10 % share of fuel consumed for transport by 2020;
  - Energy Efficiency: consumption – 20 % by 2020 compared to projections;
  - Renewable Energies: 20 % of consumed energy from renewable sources by 2020
- **UN Climate Change Conference Bali 2007:** 192 Signatories of UNFCCC agreed to start FORMAL negotiations on a climate regime for the post-Kyoto (2012) period. **Goal:** Significant reduction of ***global*** GHG emissions: 20 – 40 % by 2020.
- **Huge differences in GHG emissions between different countries:**
  - USA 25 tons CO_{2eq} /per capita annually
  - EU 10 tons CO_{2eq} /per capita annually (Austria 12)
  - East Asia 6 tons CO_{2eq} /per capita annually – rapidly growing
  - South Asia 3 tons CO_{2eq} /per capita annually – rapidly growing
- **Global mitigation scenario:** To stabilise the GHG concentrations at 450 ppm CO_2e a global emission reduction of 50 % by 2050 is required (rel. 1990). Industrialised countries must start reduction immediately with goals -30 % by 2020 and -85 % till 2050. Developing countries are allowed + 30 % till 2020, but must decrease to 1990 emission levels till 2050.
- **UN Conference Copenhagen 2009:**
  - Commitment of 82 countries which together are responsible for 80 % of the green house gas emissions to implement national action plans for mitigation.
  - These countries will communicate individual 2020 reduction targets to the UNFCCC: USA – 17%, China – 45%, EU – 20 (30)%
  - Agreement of 50 % global reduction by 2050 and consensus that industrialised countries would reduce by 80% till 2050.
  - No legally binding international treaty, only "declarations of intent".
- **UN Conference Cancun 2010:**
  - Confirmation of 2 degree target, but not of concentration limit of 450 ppm CO_{2eq}
  - Agreement on halting deforestation, a.o. with financing by industrialised states.
  - Agreement to enhance technology transfer to developing countries.
- **UN Conference Durban 2011:**
  - Prolongation of Kyoto protocol till 2015 and agreement to work for a binding international treaty involving all countries by 2015.
  - Agreement to provide by 2020 annually 100 billion $ for adaptation in least developed countries ("Green Climate Fund").

Chapter 4.5:

- World population by region: Asia (ca 60 %), Europe (ca 12 %), North America (ca 6 %), Sub-Saharan Africa (ca 12 %), Latin America (ca 10 %)
- Evolution of population till 2050: Africa + 100 %, Latin America + 50 %, Asia + 30 %, North America + 30 %, Europe – 5 - 10 %.
- Population ageing is most advanced in the most highly developed countries.
- **Competitive Strengths of EU:**

  - High education level.
  - High employment rate due to integration of females in work force.
  - High level social system (pensions, health insurance, unemployment services…)
  - European Union has become the largest economic region of the world (measured as sum of GDP of all member states with the „current currency exchange rate" as a basis for comparing with other countries).
  - European Union expansion to CEE led to a dynamic large region due to substantial growth in new Member States of the European Union.
  - The Euro has become a major currency (25% of global currency volume).
  - Evolution to „soft global power" based on economic strength and the principles of sustainable development.
  - Positive development with neighboring regions (Russia, Mid-Asia, Near East).
  - Polical agenda of the European Union serves as a model for evolution of major regions in the world.
  - List a few of these.
- **Competitive Weaknesses of the EU:**
  - European Union has a complex structure with an often tedious decision making process.
  - National interests of the member states often dominate over common interests.
  - Consequently up to now no common economic, social or foreign policy.
  - Military expenses very high, but low efficiency of defense systems.
  - Extremely high dependence on energy and raw materials delivered from outside.
  - EU much slower in innovation than USA, Japan.
  - Not enough R&D investments in future technologies.
  - Technology leadership in key areas not with Europe.
  - Still low mobility of work force.
  - Not attractive for highly skilled immigrants.
  - High taxes and labor costs.
  - High costs of state owned social security and health insurance systems.
  - Fairly large deficits of individual countries.
  - Lack of dynamism compared to some other regions („Wellness Society").
  - Ongoing de-industrialisation, but growth of service industries.

Chapter 5.1:

- **Evolution of Global Population:** 0,7 billion in 1750, 7 billion in 2012, 10 billion in 2050
- Evironmental Quality of Megacities: extremely high air pollution, frequent water pollution, non-sustainable waste disposal
- GDP per capita of major regions (2004):
  - Africa 2.500 $,
  - Asia 5.000 $,
  - Europe 18.000 $,
  - North America 35.000 $.
- Life expectancy: 50 years in Africa, 75 years in Europe
- To supply the 10 billion people with food in 2050 a doubling of global food production is necessary, *but* available agricultural land per inhabitant now 0,25 ha, and only 0,15 ha in 2050.

1. Wald Europa

+°C 2100

Chapter 5.2:

- 36 percent of the world's workers are employed in agriculture, but agricultural production accounts for less than five percent of the gross world product.
- Modernisation of agriculture has allowed the world population to double over the last 50 years.
- Globally only 12 % of land surface usable for agriculture and only 2,5 % high value farmland.
- Over-extraction of water already now a very severe problem for dry regions in Africa and Asia! By 2030 2 billion people will be affected by severe water shortage.
- Fish catches of certain species and in specific regions have dramatically decreased due to reduction of the fish stocks: e.g. North Atlantic cod, salmon, tuna
- The "United Nations Convention on the Law of the Sea" treaty deals with aspects of **overfishing** and grants coastal states exclusive fishing rights for a 200 mile zone. All coastal states to ensure that the maintenance of living resources in their exclusive economic zones is not endangered by over-exploitation
- **Aquaculture production:** 60 million tons (in comparison: fish catches are 90 million tons).

Chapter 5.3:

- Nowadays about 30 % of the earth's surface are covered by forests.
- Human-caused deforestation and the degradation of forest habitat is continuing primarily due to:
  - expansion of agriculture (with often slash and burn practices),
  - urban sprawl,
  - illegal logging,
  - over harvest of fuel wood,
  - mining, and petroleum exploration.
- In the world's tropical rainforests destruction is most pronounced at the current time: One fifth of the world's tropical rainforest was destroyed between 1960 and 1990
- Rainforests account for around 5 % of the Earth's land surface and are home to above 50 % of the estimated number of vegetal and animal species. They regulate climate at local and global levels and provide resources to some 1.4 billion people who are among the poorest.
- Loss of forests and woodlands in Africa was 16% between 1975 and 2000
- **Impact of deforestation on the environment:**
  - Reduction of biodiversity.
  - Reduction of the landscape's capacity to intercept, retain and transport precipitation.
  - Reduction of amount of water in the soil and groundwater.
  - Deforested areas become sources of surface water runoff which can lead to flash flooding.
  - Enhancement of green house gas emissions due to burning of forests and release of organic carbon from soil.
  - Land degradation, drying of the soil layers, eventually desertification.
- The primary reasons for desertification are:
  - overgrazing,
  - overcultivation,

  - incorrect irrigation methods,
  - deforestation,
  - overdrafting of groundwater,
  - increased soil salinity,
  - global climate change.
- The transition zones between deserts and the normal vegetation zones (desert fringes) have fragile, delicately balanced ecosystems. In these marginal areas human activity may stress the ecosystem beyond its tolerance limit, resulting in degradation of the land.
- Lake Chad has shrunk to 10% of its original size since the 1960s.
- Globally 10 – 20 % of the drylands are deserted.

Chapter 5.4:

- By 2050, water availability is projected to decrease by 10-30% over some dry regions at mid-latitudes and in the dry tropics.
- At 5 m sea level rise cities like *New Orleans, Miami, Jacksonville, Bangkok, Ho Chi Minh City, Rangoon* would disappear.

Chapter 5.5:

- **Global income distribution:**
- The „upper" 20% of the global population posess 82,7% of the means of this world.
- The „bottom" 20% own only 6% of the global wealth.
- The income of the wealthiest 20% is in average 80 times higher than the income of the poorest 20%.
- **Indicators for global poverty:**
  - 1 billion people live on less than 1 Euro per day.
  - 2,6 billion people without proper sanitation services.
  - 1 billion people are without access to safe drinking water. This number will increase to 2 billion by 2030.
  - 400 million people undernourished
  - 2 billion people without energy services, like access to electricity.
- **Basis of EU policies for shaping a global partnership for sustainable development:**
  - Johannesburg Declaration of 2002 and its Implementation Plan.
  - Doha Development Agenda (Trade) of 2001.
  - Monterrey consensus (Financing for Development) of 2002.
  - Cotonou Partnership Agreement for Africa's Development, the Caribbean and Pacific (ACP) of 2000 involving 77 developing contries.
  - *Commitment of the EU to promoting sustainable development on a global level.*
- Africa: 3 billion Euro annually development aid from European Union.

Chapter 6.1:

- The global economic growth is accompagnied by a dramatically increased demand for energy and natural resources.
- In addition, global warming – which largely caused by the consumption of fossil fuel - has been recognised as a global threat.
- Both evolutions require the development of energy and resource efficient technologies.

- The ecological footprint is a measure of human demand on the Earth's ecosystems.
- **Primary energy supply per capita and year in kg of oil equivalent:**
  - North America 8.000,
  - Europe 3.500,
  - Latin America 1.200,
  - Asia 1.200,
  - Africa 600
- Global energy consumption will more than double till 2050 and energy related CO2 emissions will rise from 28 Gto/yr to 62 Gto/year by 2050 according to OECD/IEA analysis unless a technology change occurs.
- **Shares in global total energy production:**
  - oil 35 %,
  - coal 26 %,
  - gas 21 %,
  - biomass 10 %,
  - nuclear 6 %,
  - hydropower 2 %,
  - geothermal, wind, solar 0,5 %
- Total energy production and consumption rate now 15 TW and > 30 TW in 2050.
- 81 % of the present global energy production is from fossil fuels.
- Only 13 % of energy comes from renewable sources
- Future technologies must support the reduction in consumption of natural resources, be climate relevant, be affordable for different regions of the world.
- **Key development areas in the Third Industrial Revolution:**
  - Resource efficient technologies in materials processing:
    - recycling of materials
    - lighter and smaller products
  - Energy efficient technologies:
    - new efficient transport systems
    - energy efficient houses and offices
    - energy efficient consumer devices
  - Low carbon electricity generation:
    - renewable energies
    - carbon sequestration and storage
    - new energy storage and distribution systems
  - New information and communication technology systems:

new global monitoring techniques to achieve a more efficient and effective governance

- Estimated costs of energy shift: perhaps 1% of global GDP = ca 500 billion EUR annually (Stern Report).
- Global subsidies for fossil fuel production 250 billion EUR
- Total global annual military spending: > 1.000 billion EUR

Chapter 6.2:

- **Enhancement of energy efficiency:** consumption – 20 % by 2020 compared to projections
- **Industrial production:** responsible for 20 % of GHG emissions, partially old and energy inefficient technologies used; *Approaches:* emission limits for industrial production sectors, promotion of Best Available Technologies (BAT).

- **Electricity generation:** responsible for 25 % of GHG emissions, thermal power plant: 50 % efficiency for electricity generation; *Approaches:* enhancement of efficiency for primary energy consumption by use of heat generated (cogeneration technology)
- **Transport:** responsible for 20 % of EU GHG emissions; *Approach:* low weight electrical cars based on fuel cells or high power batteries for urban transport (80 % of Europeans live in urban regions)

- **Biofuels: 10 % share of fuel consumed for transport by 2020** *(from "sustainable production")*
  - ambitious target: present biofuel share only 2,5 %
  - contentious decision, raises many questions:
  - Europe will only be able to achieve target through imports, e.g. from Brazil: impact on Amazonian rain forest ?
  - Will there be a competition between food production and energy production ?
  - 1 liter of bioethanol corresponds in terms of available energy to the necessary daily food uptake of a mid-size family.
  - Global Population Growth: 7 billion in 2012 - 10 billion in 2050. Doubling of global food production deemed necessary.
  - **First generation of biofuels:** methanol from sugars and cereals, diesel from plant oils.
  - **Second generation biofuels:**syngas (carbon monoxide and hydrogen) production by thermochemical gasification from biomass or production of fermentable sugars from cellulosic, fibre or wood based waste biomass by hydrolysis based on enzymatic degradation.
  - **Third generation biofuels:** algae fuel
- **Heating and personal electricity use:** responsible for 12 % of EU GHG emissions
  - *Policy measures:* requirement of "energy consumption pass for housing", forbidding sales of incandescent lamps, regulation on stand-by loads
  - *Approaches:* enhancement of efficiency of energy use by improving insulation of houses and installation of energy-efficient illumination devices; new technologies: fluorescence lamps, LEDs, intelligent electronic devices, energy efficient motors, tv sets and refrigerators; passive and surplus houses, new architectural concepts like energy autonomous villages.
  - conventional light bulbs have a yield of 4 % and are phased out in the EU.

- **Chapter 6.3:**

- **Shares in global electricity production:** coal 40 %, gas 20 %, hydropower 16 %, nuclear 15 %, biomass 10 %, oil 7 %, wind, solar, biomass 2 %.
- Electricity consumption is expected to at least double till 2050.
- Nearly 70 % of electricity produced is from burning of fossil fuel or biomass.
- **Principal approaches for low carbon electricity production:**
  - Capture of emitted CO_2 in power plants burning fossil fuel and safe storage underground or under sea (CCS).
  - Use of low carbon emission production technologies, nuclear power generation, renewable energies (hydropower, wind energy, solar energy production, biomass utilisation, geothermal energy, tidal energy).
- **CCS.:** Theoretically reduction of CO_2 80-90% possible, but increased fuel needs of a coal-fired plant with CCS by 25%-40%. Recycling of captured CO_2 for production of methanol by reaction with H_2 („methanol economy").
  -

- **Renewable Energies:** EU goal is 20 % of consumed energy from renewable sources by 2020

Chapter 6.4:

- **GMES operational dimension**: Land Monitoring; Marine Services; Atmospheric services; Crisis Management
- **GEOSS**: Building a Comprehensive Global Earth Observation System (USA, EU, Japan……).
- **SEIS** is based in *in-situ* monitoring and earth observation data to produce policy relevant information