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АНГЛИЙСКИЙ ЯЗЫК. СБОРНИК ТЕКСТОВ ДЛЯ СТУДЕНТОВ ЭКОЛОГИЧЕСКИХ СПЕЦИАЛЬНОСТЕЙ

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М66 **Митина Ю.В., Чернышева С.Н.** Английский язык: сборник текстов для студентов экологических специальностей. – СПб.: РГГМУ, 2018. – 60 с.

Сборник текстов предназначен для студентов дневного отделения экологического факультета РГГМУ. Применение в учебном процессе материалов, представленных в сборнике, ориентировано на развитие навыков перевода, подробного и краткого пересказа текстов профессиональной направленности. Тематика подобранного текстового материала охватывает широкий круг экологических дисциплин.

Mitina J., Chernysheva S. English texts for the students of Ecology – St. Petersburg: RSHU Publishers, 2018. – 60 pp.

The textbook is designed for full-time students of the faculty of Ecology at Russian State Hydrometeorological University. It focuses on developing reading comprehension and translation skills, as well as skills of rendering and detailed representation of ecological texts into Russian. The topics of the texts cover the broad areas of ecological sciences. The materials are adopted from the original English-language sources – books, articles, and the Internet.

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Предисловие

Данный сборник представляет собой набор научных текстов на английском языке. Тематика подобранного текстового материала охватывает широкий круг экологических дисциплин. Материалы заимствованы из оригинальных англоязычных источников – научных статей и монографий, поэтому пособие может представлять интерес и для широкого круга читателей, имеющих дело с научной литературой на английском языкев данной профессиональной области.

Тексты рассчитаны на средний уровень владения английским языком.

Сборник логически разделен на три раздела, которые содержат тексты, ориентированные на развитие умений перевода, подробного и краткого пересказа.

Introduction

The collection of texts in English is designed for full-time students of Ecology and Physics of Nature at Russian State Hydrometeorological University. The topics of the texts cover the broad areas of Ecological sciences. The materials presented are built on the authentic books and articles, therefore it could be useful for all those who are interested in Ecological sciences.

The texts are meant for intermediate level students of English.

The collection is logically divided into five sections containing the texts focused on developing translation skills, detailed and brief retelling.

Welcome to Ecology

1. Ecology

Ecology is the study of environmental systems, or as it is sometimes called, the economy of nature. «Environmental» usually means relating to the natural, versus human-made world; the «systems» means that ecology is, by its very nature, not interested in just the components of nature individually but especially in how the parts interact. Ecology is technically an academic discipline, such as mathematics or physics, although in public or media use, it is often used to connote some sort of normative or evaluative issue as in something is «ecologically bad» or is or is not «good for the ecology». More properly ecology is used only in the sense that it is an academic discipline, no more evaluative than mathematics or physics. When a normative or evaluative term is needed then it is more proper to use the term «environmental», i. e. environmental quality or «environmentally degrading». Most professional ecologists are not terribly unhappy when ecology is used in the normative sense, preferring the wider public awareness of environmental issues today compared to the widespread ignorance of three decades ago.

The subject matter of ecology is normally divided onto four broad categories: physiological ecology, having to do with the response of single species to environmental conditions such as temperature or light; population ecology, usually focusing on the abundance and distribution of individual species and the factors that cause such distribution; community ecology, having to do with the number of species found at given location and their interactions; and ecosystems ecology, having to do with the structure and function of the entire suite of microbes, plants, and animals, and their abiotic environment, and how the parts interact to generate the whole. This branch of ecology often focuses on the energy and nutrient flows of ecosystems, and when this approach is combined with computer analysis and simulation we often call it systems ecology. Evolutionary ecology, which may operate at any of these levels but most commonly at the physiological or population level, is a rich and dynamic area of ecology focusing on attempting to understand how natural selection developed the structure and function of the organisms and ecosystems at any of these levels. Ecology is usually considered from the perspective of the specific geographic environment that is being studied at the moment: tropical rain forest, temperate grassland, arctic tundra, benthic marine, the entire biosphere, and so on. Thus you might study the population ecology of lions in an African savanna, an ecosystems study of a marine benthic environment, global nutrient budgets, and so on. The subject matter of ecology is the entire natural world, including both the living and the non-living parts. Biogeography focuses on the observed distribution of plants and animals and the reasons behind it. More recently ecology has included increasingly the human-dominated world of agriculture, grazing lands for domestic animals, cities, and even industrial parks. Industrial ecology is a discipline that has recently been developed, especially in Europe, where the objective is to follow the energy and material use throughout the process of, e. g., making an automobile with the objective of attempting to improve the material and energy efficiency of manufacturing. For any of these levels or approaches there are some scientists that focus on theoretical ecology, which attempts to derive or apply theoretical or sometimes mathematical reasons and generalities for what is observed in nature, and empirical ecology, which is concerned principally with measurement. Applied ecology takes what is found from one or both of these approaches and uses it to protect or manage nature in some way. Related to this discipline is conservation biology. Plant ecology, animal ecology, and microbial ecology have obvious foci.

There are usually four basic reasons given to study and as to why we might want to understand ecology: first, since all of us live to some degree in a natural or at least partly natural ecosystem, then considerable pleasure can be derived by studying the environment around us. Just as one might learn to appreciate art better through an art history course so too might one appreciate more the nature around us with a better understanding of ecology. Second, human economies are in large part based on the exploitation and management of nature. Applied ecology is used every day in forestry, fisheries, range management, agriculture, and so on to provide us with the food and fiber we need. For example, in Argentina in many circles there is no difference between ecology and agriculture, which is essentially the ecology of crops and pastures. Third, human societies can often be understood very clearly from ecological perspectives as we study, for example, the population dynamics (demography) of our own species, the food and fossil energy flowing through our society. Fourth, humans appear to be changing aspects of the global environment in many ways. Ecology can be very useful to help us understand what these changes are, what the implications might be for various ecosystems, and how we might intervene in either human economies or in nature to try to mitigate or otherwise alter these changes. There are many professional ecologists, who believe that these apparent changes from human activities have the potential to generate enormous harm to both natural ecosystems and human economies. Understanding, predicting and adapting to these issues could be the most important of all possible issue for humans to deal with. In this case ecology and environmentalism can be the same.

Since ecology by its very nature is an integrative discipline, science students preparing themselves professionally in the field are encouraged to take a broad suite of courses, mostly in the natural sciences and including physics, chemistry, and biology of many sorts but certainly including evolution, meteorology, hydrology, geography, and so on. Ecologists interested in human ecology are encouraged to take courses and undertake readings in agronomy, demography, human geography, sociology, economics, and so on. Since ecology is so broad there are many things that an ecologist might wish to do and to train for. Today many ecology courses are taught in biology departments, where the focus is often on population or community ecology and also individual species.

There are a number of classical areas of interest in ecology, and they revolve around questions similar to the following: how much is the photosynthesis of a hectare of land? How many animals of what types might that photosynthesis be able to support as a base for their food resources? How many species might «divide up» the land or food resources available? How do the species present change as the physical conditions change, for example as one ascends a mountain? What is the proportion of food that is passed on from each food or «trophic» level to the next? What are the mechanisms that control the populations, communities and ecosystems in some area? How are human activities impacting these natural systems?

Ecology should be more than just a set of ideas and principles that one might learn in a classroom or book but rather more a way of looking at the world which emphasizes the assessment and understanding of how the pieces fit together, how each influences and is influenced by the other pieces and how the whole operates in ways not really predictable from the pieces. When we are lucky we are able to capture these relations in conceptual, mathematical or, increasingly, computer models that allow us some sense of truly understanding the great complexity of nature, including as it is impacted by human activity. This is the goal of most ecologists.

Questions

1. How is the subject matter of ecology normally divided?
2. What are four basic reasons to study and understand ecology?
3. What is the goal of most ecologists?

2. Biodiversity

Biodiversity is the degree of variation of life. This can refer to genetic variation, species variation, or ecosystem variation within an area, biome, or planet. Terrestrial biodiversity tends to be highest near the equator, which seems to be the result of the warm climate and high primary productivity. Marine biodiversity tends to be highest along coasts in the Western Pacific, where sea surface temperature is highest and in mid-latitudinal band in all oceans. Biodiversity generally tends to cluster in hotspots, and has been increasing through time but will be likely to slow in the future.

Rapid environmental changes typically cause mass extinctions. One estimate is that < 1–3 % of the species that have existed on Earth are extant.

The earliest evidences for life on Earth are graphite found to be biogenic in 3.7 billion-year-old metasedimentary rocks discovered in Western Greenland and microbial mat fossils found in 3.48 billion-year-old sandstone discovered in Western Australia. Since life began on Earth, five major mass extinctions and several minor events have led to large and sudden drops in biodiversity. The Phanerozoic eon (the last 540 million years) marked a rapid growth in biodiversity via the Cambrian explosion – a period during which the majority of multicellular phyla first appeared. The next 400 million years included repeated, massive biodiversity losses classified as mass extinction events. In the Carboniferous, rainforest collapse led to a great loss of plant and animal life. The Permian–Triassic extinction event, 251 million years ago, was the worst; vertebrate recovery took 30 million years. The most recent, the Cretaceous–Paleogene extinction event, occurred 65 million years ago and has often attracted more attention than others because it resulted in the extinction of the dinosaurs.

The period since the emergence of humans has displayed an ongoing biodiversity reduction and an accompanying loss of genetic diversity. Named the Holocene extinction, the reduction is caused primarily by human impacts, particularly habitat destruction. Conversely, biodiversity impacts human health in a number of ways, both positively and negatively.

«Biodiversity» is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists most often define biodiversity as the «totality of genes, species, and ecosystems of a region». An advantage of this definition is that it seems to describe most circumstances and presents a unified view of the traditional three levels at which biological variety has been identified: species diversity, ecosystem diversity, genetic diversity.

In 2003 Professor Anthony Campbell at Cardiff University, UK and the Darwin Centre, Pembrokeshire, defined a fourth level: Molecular Diversity.

This multilevel construct is consistent with Dasmann and Lovejoy. An explicit definition consistent with this interpretation was first given in a paper by Bruce A. Wilcox commissioned by the International Union for the Conservation of Nature and Natural Resources (IUCN) for the 1982 World National Parks Conference. Wilcox's definition was «Biological diversity is the variety of life forms...at all levels of biological systems (i. e., molecular, organismic, population, species and ecosystem)...» The 1992 United Nations Earth Summit defined «biological diversity» as «the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems».This definition is used in the United Nations Convention on Biological Diversity.

One textbook's definition is «variation of life at all levels of biological organization».

Genetically biodiversity can be defined as the diversity of alleles, genes, and organisms. They study processes such as mutation and gene transfer that drive evolution.

Measuring diversity at one level in a group of organisms may not precisely correspond to diversity at other levels. However, tetrapod (terrestrial vertebrates) taxonomic and ecological diversity shows a very close correlation.

Biodiversity is not evenly distributed, rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. The study of the spatial distribution of organisms, species, and ecosystems, is the science of biogeography.

Diversity consistently measures higher in the tropics and in other localized regions such as the Cape Floristic Region and lower in polar regions generally. Rain forests that have had wet climates for a long time, such as Yasuni National Park in Ecuador, have particularly high biodiversity.

Terrestrial biodiversity is up to 25 times greater than ocean biodiversity. Although a recent discovered method put the total number of species on Earth at 8.7 million of which 2.1 million were estimated to live in the ocean, however this estimate seems to under-represent diversity of microorganisms.

Generally, there is an increase in biodiversity from the poles to the tropics. Thus localities at lower latitudes have more species than localities at higher latitudes. This is often referred to as the latitudinal gradient in species diversity. Several ecological mechanisms may contribute to the gradient, but the ultimate factor behind many of them is the greater mean temperature at the equator compared to that of the poles.

Even though terrestrial biodiversity declines from the equator to the poles, some studies claim that this characteristic is unverified in aquatic ecosystems, especially in marine ecosystems. The latitudinal distribution of parasites does not follow this rule.

Biodiversity is the result of 3.5 billion years of evolution. The origin of life has not been definitely established by science, however some evidence suggests that life may already have been well-established only a few hundred million years after the formation of the Earth. Until approximately 600 million years ago, all life consisted of archaea, bacteria, protozoans and similar single-celled organisms.

The history of biodiversity during the Phanerozoic (the last 540 million years), starts with rapid growth during the Cambrian explosion – a period during which nearly every phylum of multicellular organisms first appeared. Over the next 400 million years or so, invertebrate diversity showed little overall trend, and vertebrate diversity shows an overall exponential trend [32]. This dramatic rise in diversity was marked by periodic, massive losses of diversity classified as mass extinction events. A significant loss occurred when rainforests collapsed in the carboniferous [17]. The worst was the Permo-Triassic extinction, 251 million years ago. Vertebrates took 30 million years to recover from this event.

The fossil record suggests that the last few million years featured the greatest biodiversity in history. However, not all scientists support this view, since there is uncertainty as to how strongly the fossil record is biased by the greater availability and preservation of recent geologic sections. Some scientists believe that corrected for sampling artifacts, modern biodiversity may not be much different from biodiversity 300 million years ago, whereas others consider the fossil record reasonably reflective of the diversification of life. Estimates of the present global macroscopic species diversity vary from 2 million to 100 million, with a best estimate of somewhere near 9 million, the vast majority arthropods. Diversity appears to increase continually in the absence of natural selection.

1. **Biodiversity** is often defined as the variety of all forms of life, from genes to species, through to the broad scale of ecosystems. «Biodiversity» was coined as a contraction of «biological diversity» in 1985, but the new term arguably has taken on a meaning and import all its own. A symposium in 1986, and the follow-up book BioDiversity (Wilson 1988), edited by biologist E.O. Wilson, heralded the popularity of this concept.

2. **Extinction** – the end of an organism or of a group of organisms (taxon), normally a species. The moment of extinction is generally considered to be the death of the last individual of the species, although the capacity to breed and recover may have been lost before this point.

3. **Biota** – the total collection of organisms of a geographic region or a time period, from local geographic scales and instantaneous temporal scales all the way up to whole-planet and whole-timescale spatiotemporal scales. The biota, or biotic component of the Earth makes up the biosphere.

Questions

1. Where is terrestrial biodiversity highest? Where is marine biodiversity highest?
2. How didthe United Nations Earth Summit define «biological diversity» in 1992?
3. Which period is considered to feature the greatest biodiversity in history?

3. Future of the Earth

The biological and geological future of the Earth can be extrapolated based upon the estimated effects of several long-term influences. These include the chemistry at the Earth's surface, the rate of cooling of the planet's interior, the gravitational interactions with other objects in the Solar System, and a steady increase in the Sun's luminosity. An uncertain factor in this extrapolation is the ongoing influence of technology introduced by humans, such as geoengineering, which could cause significant changes to the planet. The current biotic crisis is being caused by technology and the effects may last for up to five million years. In turn, technology may result in the extinction of humanity, leaving the planet to gradually return to a slower evolutionary pace resulting solely from long-term natural processes.

Over time intervals of hundreds of millions of years, random celestial events pose a global risk to the biosphere, which can result in mass extinctions. These include impacts by comets or asteroids with diameters of 5–10 km (3.1–6.2 mi) or more, and the possibility of a massive stellar explosion, called a supernova, within a 100-light-year radius from the Sun, called a Near-Earth supernova. Other large-scale geological events are more predictable. If the long-term effects of global warming are disregarded, Milankovitch theory predicts that the planet will continue to undergo glacial periods at least until the quaternary glaciation comes to an end. These periods are caused by eccentricity, axial tilt, and precession of the Earth's orbit. As part of the ongoing supercontinent cycle, plate tectonics will probably result in a supercontinent in 250–350 million years. Some time in the next 1.5–4.5 billion years, the axial tilt of the Earth may begin to undergo chaotic variations, with changes in the axial tilt of up to 90°.

During the next 4 billion years, the luminosity of the Sun will steadily increase, resulting in a rise in the solar radiation reaching the Earth. This will cause a higher rate of weathering of silicate minerals, which will cause a decrease in the level of carbon dioxide in the atmosphere. In about 600 million years, the level of CO_2 will fall below the level needed to sustain C3 carbon fixation photosynthesis used by trees. Some plants use the C4 carbon fixation method, allowing them to persist at CO_2 concentrations as low as 10 parts per million. However, the long-term trend is for plant life to die off altogether. The die off of plants will be the demise of almost all animal life, since plants are the base of the food chain on Earth.

In about 1.1 billion years, the solar luminosity will be 10 % higher than at present. This will cause the atmosphere to become a «moist greenhouse», resulting in a runaway evaporation of the oceans. As a likely consequence, plate tectonics will come to an end. Following this event, the planet's magnetic dynamo may come to an end, causing the magnetosphere to decay and leading to an accelerated loss of volatiles from the outer atmosphere. 4 billion years from now, the increase in the Earth's surface temperature will cause a runaway greenhouse effect. By that point, most if not all the life on the surface will be extinct. The most probable fate of the planet is absorption by the Sun in about 7.5 billion years, after the star has entered the red giant phase and expanded to cross the planet's current orbit.

Humans now play a key role in the biosphere, with the large human population dominating many of Earth's ecosystems. This has resulted in a widespread, ongoing extinction of other species during the present geological epoch, now known as the Holocene extinction. The large-scale loss of species caused by human influence since the 1950s has been called a biotic crisis, with an estimated 10 % of the total species lost as of 2007. At current rates, about 30 % of species are at risk of extinction in the next hundred years. The Holocene extinction event is the result of habitat destruction, the widespread distribution of invasive species, hunting, and climate change. In the present day, human activity has had a significant impact on the surface of the planet. More than a third of the land surface has been modified by human actions, and humans use about 20 % of global primary production. The concentration of carbon dioxide in the atmosphere has increased by close to 30 % since the start of the Industrial Revolution.

The consequences of a persistent biotic crisis have been predicted to last for at least five million years. It could result in a decline in biodiversity and homogenization of biotas, accompanied by a proliferation of species that are opportunistic, such as pests and weeds. Novel species may also emerge; in particular taxa that prosper in human-dominated ecosystems may rapidly diversify into many new species. Microbes are likely to benefit from the increase in nutrient-enriched environmental niches. However, no new species of existing large vertebrates are likely to arise and food chains will probably be shortened.

There are multiple scenarios for known risks that can have a global impact on the planet. From the perspective of humanity, these can be subdivided into survivable risks and terminal risks. Risks that humanity pose to itself include the misuse of nanotechnology, a nuclear holocaust, warfare with a programmed superintelligence, a genetically engineered disease, or perhaps a disaster caused by a physics experiment. Similarly, several natural events may pose a doomsday threat, including a highly virulent disease, the impact of an asteroid or comet, runaway greenhouse effect, and resource depletion. There may also be the possibility of an infestation by an extraterrestrial lifeform. The actual odds of these scenarios are difficult if not impossible to deduce.

Should the human race become extinct, then the various features assembled by humanity will begin to decay. The largest structures have an estimated decay half-life of about 1000 years. The last surviving structures would most likely be open pit mines, large landfills, major highways, wide canal cuts, and earth-fill flank dams. A few massive stone monuments like the pyramids at the Giza Necropolis or the sculptures at Mount Rushmore may still survive in some form after a million years.

Questions

1. How can biological and geological future of the Earth be extrapolated?
2. How has the large-scale loss of species caused by human influence since the 1950s been called?
3. What are the multiple scenarios for known risks that can have a global impact on the planet?

Environmental threats

4. Eco problems

The Earth is the only planet in the solar system where there is life. If you look down at the Earth from a plane you will see how wonderful our planet is. You will see blue seas and oceans, rivers and lakes, high snow-capped mountains, green forests and fields. For centuries man lived in harmony with nature until industrialization brought human society into conflict with the natural environment. Today, the contradictions between man and nature have acquired a dramatic character. With the development of civilization man's interference in nature has increased. Every year the world's industry pollutes the atmosphere with millions of tons of dust and other harmful substances. The seas and rivers are poisoned with industrial waste, chemical and sewage discharge. People who live in big cities are badly affected by harmful discharge from plants and city transport and by the increasing noise level which is as bad for human health as lack of fresh air and clean water.

Among the most urgent problems are the ozone layer, acid rains, global warming, toxic pollution of atmosphere, disappearance of forests, contamination of underground waters by chemical elements, destruction of soil in some areas, threat to some flora and fauna representatives, etc.

One of the most important pollution problems is the oceans. Many ships sail in the ocean water- fishing ships, some ships carrying people, some carrying oil. If a ship loses some of the oil in the water, or waste from the ships in put into the ocean, the water becomes dirty. Many sea birds die because of the polluted water. Many fish are dying in the sea, others are getting contaminated. Fishermen catch contaminated fish which may be sold in markets, and people may get sick from eating them. Lakes and rivers are becoming polluted, too. Some beaches are dangerous for swimming.

Another important problem is air pollution. Cars and factories pollute the air we use. Their fume also destroys the ozone layer which protects the Earth from the dangerous light of the Sun. Aerosols create large «holes» in the ozone layer round the Earth. Burning coal and oil leads to global warming which may bring about a change in the world's climate.

The other problem is that our forests are dying from acid rains. Deforestation, especially destruction of tropical forests, affects the balance of nature in many ways. It kills animals, changes the climate and ecosystem in the world.

A person can do some damage to the environment but the greater part of pollution certainly comes from industry. Modern industry production is the main threat to nature.

Few words should be said about animals in danger of extinction. The blue whale is the largest animal that has ever lived. Once there were over 200 000 of these creatures living in the Atlantic and Pacific oceans. Since the seventeenth century they have been hunted for their oil and meat. In fact, so many of them were killed that by 1963 their population had been reduced to just 1000. Today it is even less than that. The African elephant is the world's largest land animal. Today there are fewer than one million of these animals left. Even though they are now protected, they are still being hunted because of their tusks, which are used to make ornaments and jewellery. There is only one way to save wild animals and wild habitats –conservation. That means protecting animals in danger by law, opening more national parks, building fewer new roads, planting more new forests, cutting pollution. If this doesn't happen, many wild animals will soon have just one habitat – the Zoo.

Ecological problems have no borders. European states solve these problems together: the necessary measures are taken, congresses and conferences on these questions are organized, and these questions have already the reflection in the legislation of many countries.

The activity of many public organizations is directed to protect environment. One of the most known organizations is «Greenpeace», whose purpose is prevention of environment degradation. This organization was founded in 1971 by the activists from the USA and Canada and it has representations in 25 countries of the world. «Greenpeace» acts against nuclear tests, radiating threat, pollution of the environment by waste industrial products, to protect the animal world, etc. This organization influences public opinion through mass media, under its aegis manifestations and protest actions are carried solutions for concrete ecological problems.

For example, the «Greenpeace» sent its boats to protect whales, and today commercial whaling is banned. In the North Sea Greenpeace swimmers turned back dump ships carrying chemical waste, and a new laws to protect the North Sea have been considered.

What can be done to protect nature? I believe that environment disasters can be avoided if people broaden ecological education and every person understands that the beauty of nature is extremely fragile and people must obey the unwritten laws of nature. Governments must be prepared to take action against pollution. Air pollution could be reduced if plants and factories were made to fit effective filters on chimneys and car exhausts. Green zones around big cities must be protected and extended. Natural resources should be used economically because their stocks are not unlimited.

1. **Acid rains** – a rain or any other form of precipitation that is unusually acidic, meaning that it possesses elevated levels of hydrogen ions (low pH). It can have harmful effects on plants, aquatic animals and infrastructure. Acid rain is caused by emissions of sulfur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids.

2. **Discharges of sewage** into our water bodies can come from many sources, including wastewater treatment facilities, runoff from livestock operations, and vessels. Nutrients, metals, solids, toxics, endocrine disrupters, and pathogens are among the types of pollutants present in sewage discharges, and, as such, these discharges have the potential to impair water quality, adversely affect aquatic environments, and increase risks to human health. While sewage discharges have potentially wide-ranging impacts on all aquatic environments, the impacts may be especially problematic in marinas, slow moving rivers, lakes, and other bodies of water with low flushing rates.

3. **Deforestation (**clearance or clearing) – the removal of a forest or stand of trees where the land is thereafter converted to a non-forest use. Examples of deforestation include conversion of forestland to farms, ranches, or urban use.

Questions

1. What are the most urgent problems of the environment?
2. When was «Greenpeace» founded and what does it act against?
3. What can be done to protect nature?

5. Climate change

Climate change is the biggest and most controversial environmental issue of our times.

The fact that the Earth's climate has changed over its history – sometimes with cataclysmic consequences, called mass extinctions, for many of the planet's inhabitants – is not disputed. However, what has been the cause of fierce debate is whether or not human activity is currently causing a warming of the world.

What climate change, man-made or not, is not - is short-term weather. These trends are much bigger and much longer term than a hot summer or a cold winter, we're thinking more of ice ages than cold snaps when we talk about climate change.

There is a number of reasons why the Earth's climate has changed historically. As the continents have moved through the process of plate tectonics they see changes in their climate, both as a result of the influence of the changing oceans and the size of landmass.

The Sun also plays a role: as the main source of heat and light for the planet, its activity is a major player in our climate and it is not a constant; fluctuating both cyclically and as it goes through its lifespan as a star.

The Earth's position relative to the sun is also not as constant as you might like to think, we're not in a circular orbit and the tilt of the planet also changes, causing changes in how all that heat and light from the Sun hits the planet's surface. Volcanic activity too can change climate by putting large amounts of material into the Earth's atmosphere and thus reflecting heat away from the surface.

Such large eruptions are however rare, in fact, the phrase "once in a blue moon" probably comes from the change in the atmosphere caused by ash plumes from the eruption of Krakatoa in 1883. It's also been theorized that asteroid strikes on the planet have a similar effect, throwing material into the sky, and some scientists believe that the end of the age of the dinosaurs may have been caused by a giant asteroid hit.

The final reason why climates change – and this is where the controversy comes in – relates to human activity, or anthropogenic global warming, which is what is meant when you read a news story about climate change.

Primarily, this has referred to the misleadingly named greenhouse effect. While a greenhouse warms the air by allowing in and retaining heat and not allowing in cooling air, greenhouse gases warm the planet by absorbing the Sun's heat and then reemitting it into the atmosphere.

The main greenhouse gases are: water vapour, carbon dioxide (CO_2), methane, water vapour, ozone, nitrous oxide and CFC-12, a chlorofluorocarbon the use of which in many countries as an aerosol propellant and refrigerant has been banned. With the exception of CFC-12, which is man-made, these gases have historically existed in the atmosphere and there have been natural fluctuations (for example volcanoes emit CO_2) in their levels.

The most common of these gases and thought to be the most significant greenhouse gas is water vapour but it's one on which human activity has little effect. As air warms it can hold more water, the increase in water vapour is said to be responsible for a possible amplification of global warming as the temperature warms.

Plants, which rely on CO_2 to survive and which use and store it as they photosynthesise are said to be natural carbon sinks and over history natural variations in the levels of CO_2 in the atmosphere are thought to have been balanced by their action.

However, since around the middle of the 18th Century, human activity affecting the levels of carbon dioxide in the atmosphere has rapidly increased. Since the industrial revolution took hold we not only burned more CO_2-emitting fuels, from wood to coal to oil, but we have also massively reduced the amount of vegetation on the planet.

In July 2010 the British Government's Meteorological Office and the United States National Oceanic and Atmospheric Administration issued findings that they said showed unequivocally the world was warming. Using 10 indicators, seven temperature measures and three ice or snow cover measures, they said that each of the last three decades has been warmer than the last and successively broken temperature records.

The roots of world-wide action on climate change date back to the 1988 foundation of the Intergovernmental Panel on Climate Change (IPCC) by the World Meteorological Organisation, a department of the United Nations in 1988.

Since its foundation it has reported regularly on the state of climate change, with its 1990 report inspiring the United Nations Framework Convention on Climate Change (UNFCCC), the first international treaty that aimed to reduce global warming, which was signed at the so-called Earth Summit in Rio de Janeiro in 1992.

One of the key moments in the growth of concern about global warming was the release in 2006 of the film, An Inconvenient Truth. The documentary followed former US Vice President Al Gore as he tried to convince audiences about the seriousness of climate change. Gore won a Nobel peace prize as a result, but, like everything else to do with climate change the film has been the subject of much debate, particularly when schools have tried to show it to pupils.

The countries that signed the treaty have met since, with much fanfare, but often to little effect. The most recent major meeting was at Copenhagen in 2009 and was widely criticised by environmentalists.

Much of what has been agreed is also controversial, particularly so-called carbon trading arrangements which aim to set a marketplace for carbon credits sold by those who live with a small carbon footprint or contribute to carbon reduction by, for example, planting trees, to those who pollute.

Most countries have set targets for the reduction in carbon emissions. For example, the British Government's Climate Change Act of 2008 set legally-binding targets of a 34 % reduction by 2020 and at least 80 % by 2050.

1. **Greenhouse gases** – gases in an atmosphere that absorb and emit radiation within the thermal infrared range. This process is the fundamental cause of the greenhouse effect. The main greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone. In our solar system, the atmospheres of Venus, Mars and Titan also contain gases that cause greenhouse effects. Greenhouse gases greatly affect the temperature of the Earth; without them, Earth's surface would be on average about 33 °C (59 °F) colder than at present.

2. **Eruption** – the sudden occurrence of a violent discharge of steam and volcanic material

3. **Ash plumes** – an airborne column of volcanic ash, dust, and gas ejected during an explosive eruption of a volcano. Ash plumes are popularly associated with eruptions by stratovolcanoes, however, they also occur with shield volcanoes. Not all eruptions of volcanoes produce ash plumes, and the eruption column of a volcano may contain rock in addition to gases, ash, and dust.

Questions

1. What are the reasons why the Earth's climate has changed historically?
2. What are the main greenhouse gases?
3. When and where was the first international treaty that aimed to reduce global warming signed?

6. Acid rains

Acid rain is a serious environmental problem that affects large parts of the United States and Canada. Acid rain is particularly damaging to lakes, streams, and forests and the plants and animals that live in these ecosystems. «Acid rain» is a broad term referring to a mixture of wet and dry deposition (deposited material) from the atmosphere containing higher than normal amounts of nitric and sulfuric acids. The precursors, or chemical forerunners, of acid rain formation result from both natural sources, such as volcanoes and decaying vegetation, and man-made sources, primarily emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) resulting from fossil fuel combustion. In the United States, roughly 2/3 of all SO_2 and 1/4 of all NOx come from electric power generation that relies on burning fossil fuels, like coal. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. The result is a mild solution of sulfuric acid and nitric acid. When sulfur dioxide and nitrogen oxides are released from power plants and other sources, prevailing winds blow these compounds across state and national borders, sometimes over hundreds of miles. Wet deposition refers to acidic rain, fog, and snow. If the acid chemicals in the air are blown into areas where the weather is wet, the acids can fall to the ground in the form of rain, snow, fog, or mist. As this acidic water flows over and through the ground, it affects a variety of plants and animals. The strength of the effects depends on several factors, including how acidic the water is; the chemistry and buffering capacity of the soils involved; and the types of fish, trees, and other living things that rely on the water. In areas where the weather is dry, the acid chemicals may become incorporated into dust or smoke and fall to the ground through dry deposition, sticking to the ground, buildings, homes, cars, and trees. Dry deposited gases and particles can be washed from these surfaces by rainstorms, leading to increased runoff. This runoff water makes the resulting mixture more acidic. About half of the acidity in the atmosphere falls back to earth through dry deposition.

Acid rain causes acidification of lakes and streams and contributes to the damage of trees at high elevations (for example, red spruce trees above 2000 feet) and many sensitive forest soils. In addition, acid rain accelerates the decay of building materials and paints, including irreplaceable buildings, statues, and sculptures that are part of our nation's cultural heritage. Prior to falling to the earth, sulfur dioxide (SO_2) and nitrogen oxide (NOx) gases and their particulate matter derivatives – sulfates and nitrates – contribute to visibility degradation and harm public health.

Acid rain is measured using a scale called «pH.» The lower a substance's pH, the more acidic it is. Pure water has a pH of 7.0. However, normal rain is slightly acidic because carbon dioxide (CO_2) dissolves into it forming weak carbonic acid, giving the resulting mixture a pH of approximately 5.6 at typical atmospheric concentrations of CO_2. As of 2000, the most acidic rain falling in the U.S. has a pH of about 4.3.

There are several ways to reduce acid rain – more properly called acid deposition – ranging from societal changes to individual action. It is critical that acid deposition be reduced, not only in the United States and Canada, but also throughout the world to preserve the integrity of natural habitats, as well as to reduce damage to man-made structures. To solve the acid rain problem, people need to understand how acid rain damages the environment. They also need to understand what changes could be made to the air pollution sources that cause the problem. The answers to these questions help leaders make better decisions about how to control air pollution and therefore, how to reduce – or even eliminate – acid rain. Because there are many solutions to the acid rain problem, leaders have a choice of which options or combination of options are best.

Almost all of the electricity that powers modern life comes from burning fossil fuels such as coal, natural gas, and oil. Acid deposition is caused by two pollutants that are released into the atmosphere when fossil fuels are burned: sulfur dioxide (SO_2) and nitrogen oxides (NOx). Coal accounts for most U.S. SO_2 emissions and a large portion of NOx emissions. Sulfur is present in coal as an impurity, and it reacts with air when the coal is burned to form SO_2. In contrast, NOx is formed when any fossil fuel is burned.

There are several options for reducing SO_2 emissions, including using coal containing less sulfur, washing the coal, and using devices called «scrubbers» to chemically remove the SO_2 from the gases leaving the smokestack. Power plants can also switch fuels – for example, burning natural gas creates much less SO_2 than burning coal. Certain approaches will also have the additional benefit of reducing other pollutants such as mercury and carbon dioxide (CO_2). Understanding these «co-benefits» has become important in seeking cost-effective air pollution reduction strategies. Finally, power plants can use technologies that do not burn fossil fuels. Each of these options, however, has its own costs and benefits; there is no single universal solution. There are other sources of electricity besides fossil fuels. They include nuclear power, hydropower, wind energy, geothermal energy, and solar energy. Nuclear and hydropower are used most widely in the United States, while wind, solar, and geothermal energy have not yet been harnessed on a large enough scale to make them economically-feasible alternatives. There are also alternative energies, such as natural gas, batteries, and fuel cells, available to power automobiles. All sources of energy have environmental costs as well as benefits. Some types of energy are more expensive to produce than others, which means that not all Americans can afford all of them. Nuclear power, hydropower, and coal are the cheapest forms of energy today, but advancements in technologies and regulatory developments may change this in the future. All of these factors must be weighed when deciding which energy source to use today and which to invest in for tomorrow.

Acid deposition penetrates deeply into the fabric of an ecosystem, changing the chemistry of the soil and streams and narrowing – sometimes to nothing – the space where certain plants and animals can survive. Because there are so many changes, it takes many years for ecosystems to recover from acid deposition, even after emissions are reduced and the rain pH is restored to normal. For example, while visibility might improve within days, and small or episodic chemical changes in streams improve within months, chronically acidified lakes, streams, forests, and soils can take years to decades, or even centuries (in the case of soils) to heal.

1. **Acid deposition** – a general name for a number of phenomena, namely acid rain, acid fog and acid mist.

2. **Emission** – a substance, fluid, etc, that is emitted; discharge

3. **Prevailing winds** – the predominant wind direction; prevailing winds are the trends in speed and direction of wind over a particular point on the earth's surface.

Questions

1. What is acid rain?
2. How is acid rain measured?
3. How can acid rain be reduced?

7. An endangered species

An endangered species is a group of organisms which is at risk of becoming extinct for one or more of three reasons:

- destruction or interruption of environment, in other words habitat loss;
- an alteration in the ecological balance resulting in an increase in predators;
- too few remaining members for sustainable breeding.

A study in Nature suggested that without some form of radical change 25 % of the world's land animals will become extinct within the next 50 years.

When considering the reasons why so many species are becoming endangered it is important to realise that this is very closely linked to the need to conserve the biodiversity of the planet.

Habitat loss is by far the most widespread cause of species endangerment. Usually this is due to some form of human activity. Forests are cut down to create more land for agriculture or building and coastal marshlands are drained for the same reason. Agricultural activity such as removal of hedgerows and pesticide spraying have removed both habitat and food supply for many species.

It was only after a noticeable decline in numbers of the bald eagle and the peregrine falcon that the use of DDT and other persistent pesticides began to be questioned. When the ecosystem of a species is not maintained, such as the removal of food supply, the species is forced to adapt to new surroundings or perish.

Pollution is a major disrupter and destroyer of ecosystems and this was graphically illustrated following the April 2010 Deepwater Horizon oil disaster in the Gulf of Mexico. This devastated many marine ecosystems and caused the death of countless seabirds and marine creatures.

Overexploitation, such as deepwater trawling has put a number of species of fish at serious risk. This can also have a knock-on effect of removing the food supply of other marine creatures, putting them at risk as a consequence.

Climate change can alter the delicate balance of an ecosystem. Relatively minor changes in temperature can allow some species to thrive, while others perish. More dramatic climate changes can lead to the melting of ice caps and glaciers, with the consequent disruption to the local ecosystems. On a worldwide basis, the resulting rise in sea levels can disrupt the ecosystems of many species, including humans.

Habitat loss can also occur when alien species are introduced into ecosystems, either by chance or by design. In 1918 a ship ran aground on a Pacific island. While the ship was being repaired a number of Black Rats escaped and set up a thriving colony on the island. Within a short time they had wiped out several of the island's native birds and other fauna. The islanders introduced masked owls in an effort to control the rats, but this simple led to the loss of many of the remaining sea birds.

As habitat loss combines with other ecological disruptions, many species find it increasingly difficult to breed. This leads to a gradual decline in numbers until the point is reached where the species is no longer sustainable.

The International Union for Conservation of Nature (IUCN) maintains a Red List of Threatened Species. This is the most comprehensive inventory of the global status of plant and animal species. IUCN calculates that around 40 % of the world's organisms are endangered.

The IUCN has a classification system to enable criteria to be set with respect to rate of decline, population size, area of geographic distribution and the degree of population and distribution fragmentation.

- EX – extinct with no individuals remaining; examples include Javan Tiger, Dodo and Woolly Mammoth;
- EW – extinct in the wild; only surviving in captivity or in locations outside its historic range; examples include Hawaiian Crow, Socorro Dove and Scimitar Oryx;
- CR – critically endangered; extremely high risk of extinction in the wild; examples include Mountain Gorilla, Bactrian Camel, California Condor and White Rhinoceros;
- EN – endangered; high risk of extinction in the wild; Blue Whale, Giant Panda, Snow Leopard and Tiger;
- VU – vulnerable; high risk of endangerment in the wild; examples include African Elephant, Cheetah, Polar Bear and Hippopotamus;
- NT – near threatened; likely to become endangered in the near future; examples include American Bison, Jaguar, Okapi and Tiger Shark;
- LC – least concern; lowest risk; no immediate threat to survival; many examples including Giraffe, Brown Bear, Grey Wolf, House Mouse, Emperor Penguin and Human.

NatureServe is a conservation organisation that has its headquarters in the United States, but operates throughout North America, Latin America and the Caribbean. Its prime aim is to make biodiversity a mainstream consideration in all significant conservation and natural resource management decisions. NatureServe is actively engaged with a number of leading international initiatives that promote the development, distribution, and sharing of biodiversity information.

It uses a slightly different scale to define risk of endangerment.

- 1 = critically imperiled
- 2 = imperiled
- 3 = vulnerable
- 4 = apparently secure
- 5 = secure

A prefix letter, G, N or S is inserted to indicate whether the risk is global, national or more localised within a particular country. For instance, G3 would indicate that a species was globally vulnerable, but N3 would indicate that it was vulnerable within a particular country, although more secure elsewhere.

It has been claimed in some quarters that maintaining biodiversity in today's world is both costly and time consuming and in short is a waste of time and money. The counter argument is that not only should species be saved for aesthetic and moral reasons, but wild species are also important as providers of products and services essential to human welfare. Many scientific breakthroughs have come from the study of wild organisms.

The natural world and the species that inhabit it are vital to us all. Either directly or indirectly our world provides us with clean air, food, water, shelter, energy, soil, medicines, protection from natural disasters, as well as recreation, inspiration, diversity and beauty.

But this is a fragile world. Many its diverse species are in danger of being lost of ever; basically the choice is ours.

Questions

1. What is the most widespread cause of species endangerment?
2. How many of the world's organisms are endangered by IUCN estimates?
3. How do Nature Serve and IUCN classify the risk of endangerment?

8. Food and water security

How easy it is to take things for granted. From the comfort of the developed world it is hard to imagine what it must be like to be constantly hungry, with an ever-present fear of starvation and to live in a world where a plentiful supply of fresh water is just a dream.

Nobody knows the exact number of malnourished people in the world. Latest estimates by the UN Food and Agriculture Organisation (FAO), released in October 2010, put the number at 925 million, which is 13.6 % of the estimated world population. Other sources maintain that by 2007 there were already a billion malnourished people in the world and the number has been rising by 10 million a year ever since. Whatever source you care to rely on for information, these are mind boggling numbers. In round figures at least 1 in 7 people are hungry.

As long ago as 1996 the World Food Summit said that food security would only exist "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life." Taking 824 million as the starting point, which was the number in 1990–92, a target was set to halve this number of undernourished people by 2015. Although there has been progress in Asia, Latin America and the Caribbean, it is clear that the world is not making much overall progress towards this goal.

Understandably, nearly all of the undernourished people come from developing countries, with 62 % coming from Asia and the Pacific Region and 26 % coming from Sub-Saharan Africa. Somewhat surprisingly according to FAO 19 million malnourished people live in developed countries.

Children are the most vulnerable and poor nutrition plays a part in at least half of the 10.9 million child deaths each year. Children born to a malnourished mother have a higher proportion of learning disabilities, mental problems, general poor health, blindness and premature death.

Poverty is the underlying cause of hunger and the political situation in a given area can also be an important factor. In many cases the resources and income of an area are based on military, political and economic power. Typically this will end up in the hands of a minority who live well, while those at the bottom barely survive.

Clearly there must be political will to improve the local situation, but often the question is "where on earth do we start?" In countries that are already desperately poor, it is necessary to prioritise scarce resources. Unfortunately it often boils down to who can shout the loudest.

Charities can make a significant contribution, but it is important if possible to avoid 'food aid' projects where food is simply handed out. This in effect is no more than ''dumping' food and will simply undermine the local economy by undercutting local producers, who will then stop producing.

Sometimes in the case of extreme famine, immediate support is necessary and food aid is the only answer, but initiatives to support local producers by providing tools, seeds and expertise have proved to be significantly more successful in the longer term. Often a combination of both is an appropriate solution.

Poverty and political turmoil are the usual reasons for hungry people to stay hungry, but it is important to look at the reasons why they are hungry in the first place. Almost invariably the answer will point to climatic conditions.

Many of the poorer people of the world live by subsistence farming and their crops are dependent on the weather. Extreme weather can prove fatal. Crops can fail if the weather is too hot or too cold; or too dry or too wet, or simply because rain does not fall at the right time.

The Intergovernmental Panel on Climate Change believes that: "climate change alone is estimated to increase the number of people at risk of hunger to between 40 million and 170 million." It is considered to be very likely that climate change and variability will lead to extreme weather events such as more intense and longer droughts. This coupled with water scarcity reduces dietary diversity and overall food consumption, which in turn can lead to under nutrition.

The frequency of rainfall has increased over most land areas and the risk of flooding may increase, both from sea level rise and increased rainfall in coastal areas. As a result it is likely that more people will become exposed to diarrhoeal and other infectious diseases, which will lower their capacity to utilise their food effectively.

The projection is that by 2020 climate change will increase the burden of diarrhoeal diseases in low income regions by 2 % to 5 %. In Africa it is estimated that by 2100 climate change will have increased the number of person-months of exposure to malaria by 16 % to 28 %. This will affect food availability, access an utilisation and contribute to increased rates of anaemia in pregnancy.

Changes in vegetation on a large scale will affect surface temperatures and alter regional rainfall patterns. Diminishing and melting mountain glaciers could lead to water shortages and further food insecurity. It has been estimated that a 2°C rise in world temperature would lead to 220 million people being put at risk of under nutrition due to reduced agricultural output.

Water security in many ways goes hand in hand with food security. At present, almost 900 million people worldwide do not have access to clean water and more than 2.6 billion people do not have access to basic sanitation. Studies indicate that around 1.5 million children under the age of five die each year as a result of water and sanitation-related diseases.

In October 2010 the UN Human Rights Council affirmed that the right to safe, clean drinking water and sanitation is contained in existing human rights treaties and that States have a primary responsibility to ensure the full realisation of this and all other basic human rights. This is legally binding.

Food and water security are complex sustainable development issues, linked to heath through malnutrition, but also to sustainable economic development environment and trade.

We live in a world of extremes. Many of us have so much food that the World Health Organisation estimates that more than 1.5 billion adults, aged 20 and older, are overweight. Of these over 200 million men and nearly 300 million women are obese. Yet at the same time, in other parts of the world, millions are starving.

Food and water security are an aspiration for all and their absence is an affront to human dignity. Regrettably it must be said that universal food and water security are still a long way off but this should not stop everyone from doing everything in their power to bring it closer.

A major contributor to this lack of security is obviously climate change and although it is impossible to halt its relentless progress, by becoming more environmentally aware at least we can help to slow it down. From the comfort of the developed world it is easy to forget that we have a global responsibility for all mankind.

Questions

1. Where do most all of the undernourished people come from?
2. What are themain causes of hunger?
3. How does climate change affect the number of people at risk of hunger?

9. Nuclear

Until recently nuclear power has largely been presented as providing a net benefit to the environment. This is in complete contrast to power produced by fossil fuels.

Specifically the benefits of nuclear power have been that:

- it emits no carbon dioxide, so it does not contribute to global warming;
- it produces no notable sulphur oxides, nitrous oxides or particulates;
- nothing is burned so there is no ash;
- heat is produced through nuclear fission and not oxidation;
- unlike fossil fuels no gas is emitted into the local environment and solid wastes are contained within the plant throughout the generation process.

This all seems wonderful until we come to consider the problem of dealing with the waste. Most waste from nuclear plants will be solid waste, such as spent fuel, plus some process chemicals, steam and heated cooling water. Although the amount of waste is small relative to the amount of electricity that is produced, where it differs from other forms of waste is that this waste is highly radioactive and must be disposed of in a highly specialised way.

Spent nuclear fuel that has recently been removed from a nuclear reactor will continue to generate large amounts of heat as it decays and water will need to be continually pumped over it for at least a year to cool it and prevent it from overheating.

Added to this, neutron radiation is present in nuclear reactors and material that has been exposed to this may become radioactive in its own right, or be contaminated with nuclear waste. Toxic or dangerous chemicals that have been used in the plant's operation will also need to be properly handled and appropriately disposed of.

The safe disposal of spent fuel is the greatest environmental concern of the nuclear power industry. Spent fuel will remain radioactive for many years and its disposal can be very expensive. Much of the spent fuel is buried and this is the favoured option in the US.

Other countries prefer to reprocess spent fuel, but this can only be done at a number of specialized centres. The transport of spent material to these centres must be done with utmost security since a terrorist group could use this waste fuel to make a 'dirty bomb'.

Over the years there have been a string of assurances from the nuclear power industry that safety has a high priority. Safety and performance of reactors has improved and new supposedly safer reactor designs have been proposed, but these are generally untested.

Important things can get overlooked during the design process. When the Japanese power plant at Fukushima was designed, backup systems were built in that would stabilise the plant in the event of an earthquake. Unfortunately nobody considered the possibility that a tsunami would follow the earthquake and wipe out the backup systems.

Nuclear power plants are among the most sophisticated and complex energy systems ever designed and any complex system, no matter how well it is designed or engineered, cannot be deemed failure-proof. When things go wrong the results can be catastrophic.

An operating nuclear reactor contains large amounts of radioactive fission products and in the event of some catastrophe the result can be serious radioactive contamination of soil and vegetation. Humans and animals can ingest it and human exposure at high enough levels can cause illness and death in the short-term, or cancer and other diseases in the longer term.

The French Commissariat al'Energie Atomique (CEA) conducted an assessment and concluded that no amount of technical innovation can eliminate the risk of human errors associated with the operation of nuclear power plants. The two most common mistakes that can lead to accidents are errors made during maintenance and testing, and small accidents coinciding with human errors that cascade into complete failure.

The big safety fear is that a combination of human error and mechanical failure will lead to some malfunction going unnoticed, causing a delay in remedial action being taken, resulting in a catastrophic event.

Reactors can fail in a variety of ways. Instability of the nuclear material can generate unexpected behaviour and this can result in an uncontrolled power excursion. The cooling system in the reactor is designed to be able to handle the excess heat that is generated, but should the reactor experience a loss-of-coolant at the same time, everything can overheat and melt. This is known as a meltdown.

In the Chernobyl disaster of 1986, a meltdown generated so much pressure inside the reactor vessel that there was a steam explosion, resulting in vast amounts of radioactive ash being blown into the atmosphere.

In the last 50 years there have been a number of other accidents of various levels of seriousness, but in spite of universal concern, studies have shown that during this period nuclear energy has generated far fewer deaths than the high pollution levels that result from the use of conventional fossil fuels.

Advocates of nuclear power are keen to point out its advantages, and of course there are many. It is also suggested that building more nuclear power stations would reduce their unit cost. However, the big problem would then be, how do you dispose of all that extra waste?

Questions

1. What are the benefits of nuclear power?
2. What is the greatest environmental concern of the nuclear power industry?
3. What is a meltdown?

10. Ocean Acidification

If majority rule applied to all things natural, then the oceans would win the bid for status and recognition hands down, making up 71 % of the planet, providing a habitat for 50 % of all species, providing large volumes of oxygen and being the conveyor belt for climate. It was the production of oxygen in the oceans in prehistoric Earth that created the atmosphere and enabled diverse life.

The ocean is integral to life on earth, sustaining the atmosphere with moisture, keeping the planet cool enough, acting as a carbon sequester, ensuring the hydrologic/water cycle is constant and providing an invaluable protein supply to humans. It has taken humans just two hundred years to destroy the natural equilibrium that nature has established to keep the cycles going, the crisis disequilibrium we are facing is that of climate change, the human-induced radical changes to our climate system globally.

The Earth is a closed system, nothing exists in a vacuum, pollution emitted from a land-locked site, kilometres from the oceans will inevitably reach the oceans through the various interdependent cycles from the atmospheric cycle to the hydrologic cycle to biochemical cycle. Pollution released in one medium, e.g. air emissions, moves to other mediums such as soil and water and spreads across the globe.

Carbon dioxide (CO_2) reaches the oceans through various industrial and agricultural sources; and is a top toxic green house gas (GHG). The main source being the fossil-fuel industry. The oceans CO_2 levels were balanced prior to reckless human industrialisation without consequence, wreaking ecological havoc. It would seem that much of the polluting industrial technological choices and processes continue unabated.

«Over the past 200 years the oceans have taken up 500 Gt CO_2 from the atmosphere out of 1300 Gt CO_2 total anthropogenic emissions (IGOC, Unesco, 2007).» The pH of water in the ocean has been altered by a decrease of 0.1 pH indicates the level of acidity or alkalinity of liquid as represented on the scale of 0–14 (pH 0–6 = acid; pH = neutral; pH 8–14 = alkaline). Scientists during the early days of climate change impacts recognised the invaluable role of the oceans as sinks for CO_2 but over time studies revealed how the oceanic environment is suffering due to this overload of CO_2, altering the biochemistry and ecosystem functioning of the oceans. It is estimated that the oceans absorb about a quarter of CO_2 emissions.

Atmospheric CO_2 reaches the ocean through precipitation, fallout, wind-blown particulate matter, in the ocean CO_2 forms a chemical reaction with salt water, forming bicarbonate ions and carbonic acid. This creates irreparable damage to the ocean's pH balance, making it more acidic and thereby having a direct impact on pH dependent processes such as calcification. Calcium carbonate minerals, necessary for the formation of shells and skeletal structures of marine organisms are depleted, thus decimating species and having consequences for the entire marine food chain. This food chain extends to the terrestrial and ocean-land interface food chains where humans and bird life depend on the oceans as a direct food source.

Increased acidity in the ocean changes the ability of species to build the necessary physiological material needed to survive, shellfish need shells, marine animals require their skeletons, as do the land animals. Can you imagine having your skeleton eroded with acid? Well that's exactly the painful reality been forced upon by humans on existing marine life-forms, let alone the reproductive and birth defects being suffered by new offspring due to the hindered calcification process arising from high content acid in the oceans.

What will be wiped out eventually? Corals – shallow and deep corals, the coral reefs. Coral reefs are a haven habitat for biodiversity, we have already destroyed them with marine development, ocean acidification will corrode and erode the reefs.

Shellfish – oysters, clams, mussels, snails. Snail species such as the vital pteropod, a winged snail species providing a food source for many commercial fish, has shown shell dissolution. Phytoplankton and Zooplankton – from single-celled to multi-celled organisms, these calcifying organisms will dwindle. Fish and Invertebrates species – may suffer from a impeding health impact called acidosis, which increases carbonic acid content in body fluid and blood, affecting immunity, altering physiological and reproductive health.

Similarly, as with human-induced climate change impacts, increased oceanic CO_2 levels and acidification, are happening at such a rapid pace, that unlike prehistoric changes over million-year timelines whereby nature can evolve and adapt, human destruction is happening in the blink of evolutionary time.

Overfishing and environmentally destructive fishing methods have not only wiped out target fish species but also non-target species. Fishing methods such as trawling have caused untold damage to the diversity of the ocean floor habitats. The once undisturbed oceanic carbon sinks have come undone a while ago with interference to the ocean bed with drilling, dragging and mining extractions.

Like it isn't enough that we release tons of pollutants into the air, water and soil. We now want to 'inject CO_2' into the ocean as a solution to the high-level atmospheric CO_2. Manual injection of CO_2 into the oceans is being proposed by industry and government as one of the bright plans to resolve the carbon crisis.

Do the environmental impacts of this further damage need to be spelt out? So, redirect our emissions and store them in the ocean floors at varying depths and what happens when a natural disaster or another intelligent human process like offshore drilling, releases all this concentrated CO_2 back into the atmosphere?

What of the other high probability of the slow release injected-CO_2 from those human created sinks into the ocean that is already acidic? How is redirecting pollution from one medium to another solving the crisis?

The crisis lies with the dirty polluting technologies that we still use and our hard-headed refusal to radically transform our societies into dominant clean technology proponents with the urgency that this crisis warrants.

According to the US National Oceanographic and Atmospheric Administration (2011), estimates of future carbon dioxide levels, based on business as usual emission scenarios, indicate that by the end of this century the surface waters of the ocean could be nearly 150 percent more acidic, resulting in a pH that the oceans haven't experienced for more than 20 million years.

The impact of the altered natural chemistry of the ocean is dire for us, dire for marine ecosystems and the survival of marine animals. Once the link or several links of the chain are compromised, broken, destroyed, altered or minimised, the entire chain weakens and suffers. Nothing we do is without consequence and the sooner we realise this the better for all life-forms on the planet.

Questions

1. What created the atmosphere and enabled diverse life in prehistoric Earth?
2. How much of CO_2 emissions do the oceans absorb?
3. What is theimpact of the altered natural chemistry of the ocean?

11. The greenhouse effect

The greenhouse effect is a process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases, and is re-radiated in all directions. Since part of this re-radiation is back towards the surface and the lower atmosphere, it results in an elevation of the average surface temperature above what it would be in the absence of the gases.

Solar radiation at the frequencies of visible light largely passes through the atmosphere to warm the planetary surface, which then emits this energy at the lower frequencies of infrared thermal radiation. Infrared radiation is absorbed by greenhouse gases, which in turn re-radiate much of the energy to the surface and lower atmosphere. The mechanism is named after the effect of solar radiation passing through glass and warming a greenhouse, but the way it retains heat is fundamentally different as a greenhouse works by reducing airflow, isolating the warm air inside the structure so that heat is not lost by convection.

If an ideal thermally conductive blackbody was the same distance from the Sun as the Earth is, it would have a temperature of about 5.3 °C. However, since the Earth reflects about 30% of the incoming sunlight, this idealized planet›s effective temperature (the temperature of a blackbody that would emit the same amount of radiation) would be about −18 °C. The surface temperature of this hypothetical planet is 33 °C below Earth›s actual surface temperature of approximately 14 °C. The mechanism that produces this difference between the actual surface temperature and the effective temperature is due to the atmosphere and is known as the greenhouse effect.

Earth's natural greenhouse effect makes life as we know it possible. However, human activities, primarily the burning of fossil fuels and clearing of forests, have intensified the natural greenhouse effect, causing global warming.

The existence of the greenhouse effect was argued for by Joseph Fourier in 1824. The argument and the evidence was further strengthened by Claude Pouillet in 1827 and 1838, and reasoned from experimental observations by John Tyndall in 1859, and more fully quantified by Svante Arrhenius in 1896.

In 1917 Alexander Graham Bell wrote «[The unchecked burning of fossil fuels] would have a sort of greenhouse effect», and «The net result is the greenhouse becomes a sort of hot-house.» Bell went on to also advocate for the use of alternate energy sources, such as solar energy.

The Earth receives energy from the Sun in the form UV, visible, and near IR radiation, most of which passes through the atmosphere without being absorbed. Of the total amount of energy available at the top of the atmosphere (TOA), about 50 % is absorbed at the Earth's surface. Because it is warm, the surface radiates far IR thermal radiation that consists of wavelengths that are predominantly much longer than the wavelengths that were absorbed (the overlap between the incident solar spectrum and the terrestrial thermal spectrum is small enough to be neglected for most purposes). Most of this thermal radiation is absorbed by the atmosphere and re-radiated both upwards and downwards; that radiated downwards is absorbed by the Earth's surface. This trapping of long-wavelength thermal radiation leads to a higher equilibrium temperature than if the atmosphere were absent.

This highly simplified picture of the basic mechanism needs to be qualified in a number of ways, none of which affect the fundamental process. The incoming radiation from the Sun is mostly in the form of visible light and nearby wavelengths, largely in the range 0.2–4 μm, corresponding to the Sun's radiative temperature of 6,000 K. Almost half the radiation is in the form of «visible» light, which our eyes are adapted to use. About 50 % of the Sun's energy is absorbed at the Earth's surface and the rest is reflected or absorbed by the atmosphere. The reflection of light back into space – largely by clouds –does not much affect the basic mechanism; this light, effectively, is lost to the system.

The absorbed energy warms the surface. Simple presentations of the greenhouse effect, such as the idealized greenhouse model, show this heat being lost as thermal radiation. The reality is more complex: the atmosphere near the surface is largely opaque to thermal radiation (with important exceptions for «window» bands), and most heat loss from the surface is by sensible heat and latent heat transport. Radiative energy losses become increasingly important higher in the atmosphere largely because of the decreasing concentration of water vapor, an important greenhouse gas. It is more realistic to think of the greenhouse effect as applying to a «surface» in the mid-troposphere, which is effectively coupled to the surface by a lapse rate.

The simple picture assumes a steady state. In the real world there is the diurnal cycle as well as seasonal cycles and weather. Solar heating only applies during daytime. During the night, the atmosphere cools somewhat, but not greatly, because its emissivity is low, and during the day the atmosphere warms. Diurnal temperature changes decrease with height in the atmosphere.

Within the region where radiative effects are important the description given by the idealized greenhouse model becomes realistic: The surface of the Earth, warmed to a temperature around 255 K, radiates long-wavelength, infrared heat in the range 4–100 μm. At these wavelengths, greenhouse gases that were largely transparent to incoming solar radiation are more absorbent. Each layer of atmosphere with greenhouses gases absorbs some of the heat being radiated upwards from lower layers. It re-radiates in all directions, both upwards and downwards; in equilibrium (by definition) the same amount as it has absorbed. This results in more warmth below. Increasing the concentration of the gases increases the amount of absorption and re-radiation, and thereby further warms the layers and ultimately the surface below.

Greenhouse gases – including most diatomic gases with two different atoms (such as carbon monoxide, CO) and all gases with three or more atoms – are able to absorb and emit infrared radiation. Though more than 99 % of the dry atmosphere is IR transparent (because the main constituents – N2, O2, and Ar – are not able to directly absorb or emit infrared radiation), intermolecular collisions cause the energy absorbed and emitted by the greenhouse gases to be shared with the other, non-IR-active, gases.

Questions

1. What process is called the greenhouse effect?
2. How much of the total amount of energy available at the top of the atmosphere is absorbed at the Earth's surface?
3. Which radiation are greenhouses gases able to absorb and emit?

12. Deforestation

Since the human expansion began, we have always cleared some forest for our needs. Biodiversity remained. With agriculture, larger areas were cleared for our domestic plants and then we found we needed industry. With the recent advent of opencast and cities with dormitory cities, the woods with which we might have grown up are finally lost. Whereas developed countries have recreational forest, none of this is ancient in many countries. Biodiversity has been lost. Only well-wooded regions such as Sweden boast some original species mixtures, while the lucky Americans of both hemispheres have only been destroying their habitats for a few hundred years. For thousands of years, only forests that could be used for hunting or some royal pastime or other were preserved in any rational way. The «New Forest» of William the Conqueror is now the oldest forest in England, while true ancient forest, such as the Americans have, is restricted to truly tiny areas in the far north of several countries.

Mountains unfortunately don't support large trees, otherwise we could count on high areas for some protection from us. Europeans tended to live originally on hills to avoid the lowland forest, so we decimated even those few high places that could have been conserved in modern times. Later, in the 15th century, the tree was the basis of all of that magnificent colonisation and warring on every continent, by virtue of naval power (6000 oaks per ship were required by Nelson's navy). There is no point in blaming our ancestors. Whether we can rebuild forest in a natural state is doubtful in many regions where so many species of fauna and flora have been lost.

By far the most serious aspect of deforestation is the destruction of tropical rain forest, where crops can quickly provide profit. The trees can also be profitable of course, as in Indonesia where toilet paper is being made from trees, removing the last refuge of Sumatran tigers there. Really valuable trees such as teak have been replanted in some countries. Thailand has many new golden teak plantations. This hardly compensates for the sites that can be seen as you fly over the remnants of rainforest.

Everywhere, oil palm and industrial farming is taking the pristine plants and their attendant rare animals. The Amazon is the largest example of sheer exploitation. With the murders of Mendes and, recently, Ribeiro, apparently by ranchers, in nature reserves in Brazil, the takeover by large-scale farming, loggers mining corporations and ranchers is inevitable unless the powerless government changes.

It seems that deforestation is more about politics than any other conservation issue. When first brought to notice, the response to deforestation was to reforest areas, not always in the same place. The afforestation was often unsuitable, with Sitka spruce where Scots pine had been taken and varieties that local organisms could not adapt to. Very few animals live in some of the dark, dense forestry projects in some European countries. Habitat has been lost forever.

Ancient forests and the huge trees that dominate them still remain. Unfortunately their only role seems to be in a small national Park, preserved rather than conserved as a large ecosystem. Scotland still has stands of ancient pine that are nostalgic to view. All the native species that survive there remind you of a tropical forest. But these few stands are being enlarged slowly so we may gain back the forest that wild areas deserve. The Countess of Sutherland long ago condemned her crofters to poverty and emigration (to America), but she also condemned her own trees, with the introduction of the industrial farming of the 19th century – sheep!

Elsewhere, these lessons have to be learnt. The few remaining large trees in South East Asia can be seen standing, lonely, in mountain areas, with National Parks attempting to protect them. But if you build a golf course nearby, will you attract more Japanese tourists? Perhaps the worldwide regulation of natural areas is the only imaginable, but draconian solution. Loss of trees to desertification (and heavy soil erosion as a result) is a problem not confined to the usual African Sahel examples.

Water shortages on every continent are building up, and Africa cannot expect to regain desert, once lost. Trees of course make for a much damper climate, the water being essential both for us and the rest of the environment. The loss of rights for people is an alternative to this loss of this planet's resources on such a gigantic scale. With the intrinsic global warming implied by such destruction of carbon, international action is already forcing replanting as carbon offset programmes. More trees and their forest soils especially, absorb more carbon and store it long-term. This is termed biosequestration, as described in the landmark Kyoto Protocol.

We also need to study how each tree, in each habitat influences other species and the whole environment. Mangrove species are a unique but salutary example, where such worldwide losses have occurred, that, in Senegal, 6 million have been planted. This preserves coastal villages that have long been protected by the maritime mangrove.

Questions

1. Which country can still boast some original species mixtures?
2. What is the most serious aspect of deforestation?
3. What is biosequestration?

13. Water Pollution

Water pollution occurs mostly, when people overload the water environment such as streams, lakes, underground water, bays or seas with wastes or substances harmful to living beings.

Water is necessary for life. All organisms contain it, some drink it and some live in it. Plants and animals require water that is moderately pure, and they cannot survive, if water contains toxic chemicals or harmful microorganisms. Water pollution kills large quantity of fish, birds, and other animals, in some cases killing everything in an affected area.

Pollution makes streams, lakes, and coastal waters unpleasant to swim in or to have a rest. Fish and shellfish harvested from polluted waters may be unsafe to eat. People who polluted water can become ill, if they drink polluted water for a long time, it may develop cancer or hurt their future children.

The major water pollutants are chemical, biological, and physical materials that lessen the water quality. Pollutants can be separated into several different classes.

The first class is petroleum products: oil, fuel, lubrication, plastics. The petroleum products get into water by accidental spills from ships, tanker trucks and when there are leaks from underground storage tanks. Many petroleum products are poisonous for animals. Spilled oil damages the feathers of birds and the fur of animals, often it causes death.

The second class is pesticides and herbicides. There are chemicals used to kill harmful animals and plants. If they penetrate into streams, rivers, lakes, these chemicals can be very dangerous. The chemicals can remain dangerous for a long time. When an animal eats a plant that's been treated with it, the poisons are absorbed into the tissues and organs of the animals.

When other animals feed on a contaminated animal, the chemicals are passed up to them. As it goes up through the food chain, the chemical becomes more harmful, so animals at the top of the food chains may suffer cancers, reproductive problems, and death. Nitrates can cause a lethal form of anemia in infants.

The third class are heavy metals, such as, mercury, selenium, uranium, radium, cesium, etc. They get into the water from industries, automobile exhausts, mines, and natural soil. Heavy metals also become more harmful as they follow the food chain. They accumulate in living being's cells and when they reach high levels of concentration in the organism, they can be extremely poisonous, or can result in long-term health problems. They can sometimes cause liver and kidney damage.

The fourth class is fertilizers and other nutrients used to promote plant growth on farms and in gardens.

The fifth class is infectious organisms and pathogens. They enter water through sewage, storm drains, runoff from farms, etc.

The last one is thermal pollution. Water is often taken from rivers, lakes or seas to be used in factories and power plants. The water is usually returned to the source warmer than when it was taken. Even a small temperature change in a body of water can drive away the fish and other species that were originally there, and attract other species in place of them. It breaks a balance and can cause serious circumstances in future.

Questions

1. When does water pollution occur mostly?
2. What are he major water pollutants?
3. What is thermal pollution?

14. Thermal pollution

Thermal pollution is the act of altering the temperature of a natural water body, which may be a river, lake or ocean environment. This condition chiefly arises from the waste heat generated by an industrial process such as certain power generation plants. The concept is most frequently discussed in the context of elevating natural water temperature, but may also be caused by the release of cooler water from the base of reservoirs into warmer rivers. Elevated river temperatures can also arise from deforestation or urbanization that can reduce stream shading. Thermal pollution is one parameter of the broader subject of water pollution. There can be significant environmental consequences of thermal pollution with respect to surface receiving waters such as rivers and lakes; in particular, decrease in biodiversity and creation of an environment hospitable to alien aquatic species may occur. Regulation of thermal pollution has been more elusive than for other forms of water pollution, although straightforward mitigation measures are available, especially in the case of elevated temperature discharges.

Early work on mathematical modeling of thermal pollution took place in the 1960s with works by Edinger, Geyer and Tichenor; the first hydrological treatments addressed the equilibrium geometry of a thermal plume, or iso-contour of elevated temperature within the receiving waters. These models considered the mixing of a stream of admixed differing temperature water into a natural water body. Slightly later more advanced models arose which allowed the analysis of thermal plumes across an extensive data base of historical meteorological statistics, so that the full impacts of thermal pollution could be considered in relation to diurnal, seasonal and climate change fluctuations. In any case the technology exists to forecast thermal contours in receiving waters for a proposed or hypothetical thermal source. Given the demand for cooling in power generation and other industrial processes, the extent of thermal pollution worldwide is considerable, particularly in the industrialized countries of Europe, North America, Asia and Australia. For example in the United Kingdom, it is estimated that one half of all river flow is used for cooling purposes and hence leads to some elevated discharge of higher temperature water. As early as the 1980s in the USA thermal discharges amounted to one sixth of the total national river flow. In Australia, there are many instances of warm water discharge subsequent to cooling uses; however, cold water release downstream of reservoirs is at least as great a problem; for example, in New South Wales it is thought that up to 3000 river kilometres may be adversely affected by such cold water releases.

The adverse affects of thermal pollution are often conjoined with other forms of water pollution such as chemical contamination or biological contamination, such that the combined effects of two or more pollution types can create severe stresses on aquatic ecosystems.

Waste heat discharged to natural waters typically depresses the dissolved oxygen content, affecting aquatic species such as fish, amphibians and copepods. The resulting higher water temperature typically raises the metabolic rate of aquatic organisms; for example, increasing enzyme activity occurs, that causes plants and animals to take in greater quantities of nutrients and either carbon dioxide or oxygen. These metabolic changes can alter the balance of species composition, and may also lead to faunal migration, as species attempt to adapt to changed thermal conditions. As a result, original species may migrate away, and alien species may enter a local aquatic system. In some cases significant loss of biodiversity can arise, and in some instances total bio-productivity can increase at the expense of species declines. The most readily observable phenomenon is that of mass fish kills in a surface water body; in this case, there are often large numbers of dead fish seen floating in the water or washed up on the water banks. Juveniles or fish fry are particularly vulnerable to small changes in water temperature.

Many aquatic organisms are very sensitive to small temperature changes of as little as one degree Celsius; not only can the temperature change alter metabolic rates, but adverse changes in other cellular biological may arise, including reduction of cell wall permeability, harming osmotic processes; in addition, alteration of enzyme metabolism can be effected as well as coagulation of cell proteins. In many cases these cellular level impacts can affect reproductive success and even impact organism mortality. A large increase in temperature can lead to the denaturing of life-supporting enzymes by breaking down hydrogen and disulphide bonds within the quaternary structure of the enzymes. Decreased enzyme activity in aquatic organisms can cause problems such as the inability to break down lipids, which leads to malnutrition.

Primary producers are affected by thermal pollution since elevated water temperature increases aquatic plant growth rates, potentially resulting in a shorter lifespan and species overpopulation. This can cause an algae bloom that reduces the water's oxygen content in the water. The higher aquatic vegetative density leads to an increased plant respiration rate and also to a reduced underwater light intensity. The outcome is similar to the eutrophication that occurs when watercourses are polluted with leached agricultural inorganic fertilizers.

In the case of injection of cooler water from a reservoir into a warmer stream or river below, there can also be significant impacts upon fish, especially in the egg and larval stage; upon macro invertebrates and upon total aquatic productivity in the receiving river. These cold-water forms of thermal pollution can also create a modified aquatic environment such that certain alien species may have a competitive advantage over native species.

There are several means of reducing impacts of warm water thermal discharges, including use of cooling ponds, cooling towers and also productive use of the heated water for a secondary industrial process or space heating. In the case of cold-water discharge from reservoir bottoms, the mitigation is not as straightforward, and can often be very expensive. Since there are seasonal variations in the degree of vertical thermal stratification, the timing of water releases can sometimes be conducted to minimize cold-water differences in the discharge, provided these releases are consistent with needs for flood control or power generation. In the summer, for example, there may be extremes in formation of cold-water layers at the reservoir bottom; such times would be adverse for cold-water release impacts downstream.

Some countries and even individual states and provinces require limits on discharges that lead to thermal pollution of receiving waters, although this aspect of water pollution has proven to be more elusive than conventional chemical discharge. In many cases regulation has come about through judicial application of the United States Clean Water Act and other statutes. For example, in a state statute challenge the court found that anticipated thermal pollution impacts were sufficient grounds to reverse approval of construction of two nuclear power plants. Regulation may take very different approaches; in some laws, the best practice is required, such as the use of cooling ponds or cooling towers for waste heat discharge. In other cases, a numerical limit on acceptable temperature increase in the receiving waters is applied. For example, the World Bank standard provides a maximum increase of three degrees Celsius at the margin of the mixing zone.

Questions

1. What are the causes and consequences of thermal pollution?
2. What are several means of reducing impacts of warm water thermal discharges?
3. What approachesmay the regulation of thermal pollution take?

15. Herbicides

A herbicide is any of a number of chemical substances intended to kill vegetation. Since the vast majority of herbicides are non-selective in their lethal action, there may be widespread adverse ecological consequences from their use. These outcomes include not only organism death, but may involve mutagenic, developmental and carcinogenic effects to animals and plants.

Herbicides are in broad use for agriculture, golf courses, utility corridors, residential and other land uses. The earliest herbicides were inorganic chemical substances, although modern herbicides are dominated by organic compounds. Presently, there is massive application of chemical herbicides; in the USA alone 480 million kilograms are applied annually.

Widespread herbicide use beginning in the 1940s is responsible for numerous species extinctions, including birds, amphibians, fish and arthropods. In many cases, herbicide use is a contributory cause along with habitat destruction to species endangerment. Many herbicides have persistent effects in the environment, retaining their toxicity as they remain in soils for decades in some cases; furthermore, some herbicides are highly soluble, so that they may enter aquatic systems, where non-selective lethal effects can occur. Often the herbicides undergo chemical change after release into the environment; in some cases, the altered chemicals may have different toxicity effects upon plants and animals. Herbicide use has been linked to certain human diseases and mortality, as well as some types of reproductive and endocrine system impacts.

Even though herbicides are intended for certain plant organisms, the net result of their use is accumulation in large amounts in the environment (for example, the soil, aquatic, biotic and atmospheric systems). These effects are amplified by the following phenomena: (a) high solubility of many classes of herbicides; (b) magnification of concentrations of herbicides upon entry into the food chain and successive concentration in lipids for higher species in that chain; and (c) persistence of many herbicides and transformation to other harmful metabolites upon residence in soil, water and biota.

In surface waters of the world atrazine and 2,4 D are ubiquitous, even in western countries that have generally stringent water quality criteria. Atrazine is generally toxic to most fish species at concentrations on the order of one part per billion in water. To understand the magnitude of the ocean accumulation, note that in one month of peak discharge 650 metric tons of herbicide are discharged to the Gulf of Mexico.

Herbicides are taken up not only by plant, but also animal and bacterial organisms. The process often results in toxicity to the uptake organism, and may engender a chemical transformation in the herbicide itself. These chemical changes are important not only to understand the toxicity within the affected organism, but also to analyze the persistence of each herbicide in the environment and the generation of metabolites that may have different ecological effects from the original herbicide.

Very few herbicides are stable within living organisms. Only the chlorinated aliphatic molecules and glyphosate evince strong stability. For the rest, linkages of alkyl, hydroxyl, carboxyl, amino, amido, nitrile, or halogenated groups are subject to enzymatic or chemical attack via hydrolysis or redox reactions; subsequently, these reactive sites may enable conjugation with sugars, amino acids and thiol-peptides. Generally plants cannot break down aromatic rings, although bacteria are often quite adept at such biotransformation.

Bioaccumulative effects in plants and higher animals are well known, whereby plants can typically concentrate an herbicide or heavy metal by a factor of 1000 from its environmental concentration in soil or water; correspondingly, higher animals can concentrate a given herbicide by a factor of 2000. Many classes of herbicides act across a wide variety of species. Organo-chlorine compounds, for example, act broadly to inhibit cellular adenosine triphosphatase activity that broadly underlies animal metabolism, and these substances also interfere with fundamental renal and liver function.

Dicamba is toxic to mammals by ingestion or inhalation; it is also toxic to coldwater fishes when present in water bodies. Glyphosate was originally thought to have low ecological impacts, but is now known to have significant adverse impacts upon amphibians, fish, beneficial insects and nitrogen fixing bacteria. Many aliphatics such as acrolein are strongly toxic to fish and wildlife.

While the preponderance of ecological impacts are strictly deleterious, there are a number of lower organisms whose growth is actually stimulated by herbicide treatment. In particular some bacteria, fungi, mites, nematodes and springtails evince initial growth flourishes upon treatment by a minority of herbicides. It is unclear, however, whether longer-term deleterious mutations and fitness reductions are masked by initial growth spurts that are in response to initial stimulation.

One of the most widely used herbicides is 2,4-D, which has been classified as a human carcinogen by the International Agency for Research on Cancer. One Southeast Asian study with over 3000 subjects showed the rated of birth defects quadrupled with exposure to one parent of the herbicide 2,4,5-T. Paraquat is a well-established human toxin, whose lethal ingestion dose may be as low as 1.5 grams; death usually occurs from respiratory or renal failure.

Studies in 2008 found atrazine to increase gene activity linked to abnormal human birth weight when over-expressed in the placenta. Atrazine, the second most common herbicide applied in the USA, also targeted a gene that has been amplified in the uterus of women with unexplained infertility. 2,4-D a common herbicide and 2,4,5-T are implicated in human reproductive failure and miscarriage according to reports in the New York Times. In a Minnesota study of 1537 children, parental exposure to glyphosate was correlated with increased birth defects. Pre-natal exposure to the herbicide nitrogen has produced increased mortality of babies, with noted malformations of cardiac tissue.

A number of herbicides exhibit pronounced carcinogenic effects that pose risks for consumers and farmworkers. For example, epidemiological research shows increased risk of cancer, notably soft-tissue sarcomas and non-Hodgkin's lymphomas, in people occupationally exposed to chlorophenoxy herbicides. Triazine herbicide exposure has evinced strong correlation with increases in breast cancer incidence.

The herbicide glyphosate is most often applied under the formulation and trade name of Roundup, a substance which produces symptoms of sore throat, abdominal pain and vomiting; however, it is thought that some of these effects are due to the presence of the surfactant polyoxyethyleneamine.

For the herbicide alachlor the EPA has recognized skin and eye irritation; renal, spleen and liver damage risk; and cancer of the lining of nasal cavity and eyelids. The use of alachlor as a herbicide has been banned by the European Union.

Herbicides are widely used worldwide, with the earliest uses arising in developed countries; application methods typically involve aerial spraying or truck-borne spray rigs. The earliest uses involved many chemicals that are persistent in the environment. In western countries the use of many persistent herbicides toxic to animals have been banned, but many of these substances such as DDT remain in widespread use in China, Brazil, India and many underdeveloped countries.

Herbicides were a cornerstone feature of the so-called green revolution, which promised the increase of crop production in the 1970s. Unfortunately the green revolution resulted in unintended consequences of massive ecological damage, extensive herbicide and pesticide soil residues and prodigious loss of topsoils concomitant with the tillage practices associated with these intensive chemical practices. In many world locations, such as the North China Plain, the green revolution actually produced unsustainable peaks in production, such that crop yields have been systematically declining for the last two decades.

In Europe, over 64 000 tones of herbicide per annum are applied to agricultural uses, with France and Germany the principal users of herbicides; however, on a land intensity basis, both Belgium and the Netherlands exceed the French and German per hectare application. Triazines are the most common type of herbicides used in Europe, although some European countries began a ban on certain triazines starting in the 1990s.

In North America, triazines are the most commonly used class of herbicide for the USA. However, glyphosate is extremely widely used in the USA as well, with an estimated application of over 100 million pounds per annum.

In Asia, triazines are highly widespread, being the most applied herbicide in China.

In the past several decades there is emerging interest in reducing the widespread ecological impacts of chemicals of historic herbicide usage. Thus some research has focused upon formulations that avoid acute toxicity to organisms, especially non-target species. An example of such a herbicide is corn meal gluten, which has virtually no toxicity, but acts by inhibiting seed germination in certain plant species.

Habitat fragmentation

Habitat fragmentation involves alteration of habitat resulting in spatial separation of habitat units from a previous state of greater continuity.

This phenomenon occurs naturally on a geologic time-scale or in unusual and catastrophic events: however, since the Holocene era, humans have produced dramatic and swift transformation of landscapes throughout the world, resulting in a level of habitat fragmentation that has induced worldwide reduction in biodiversity and interruption of sustainable yields of natural resources.

Humans produce habitat fragmentation chiefly from agricultural land conversion, urbanization, pollution, deforestation and introduction of alien species; ironically, both human caused wildfires as well as the systematic practice of fire suppression can also create habitat fragmentation. Prior to the dominance of mankind, long-term changes engendered by geologic processes or climate oscillations contributed to habitat fragmentation.

Habitat fragmentation can manifest in an endless array of geometries, depending on the shape and extent of the separation zone.

It is important to note that the separation distance required for effecting fragmentation may vary considerably depending upon the dynamics of reproduction of key species involved. These factors include such spatially related parameters as distance typically traveled for faunal mating, seed dispersal radii, seasonal migration patterns and diurnal faunal foraging. In general, the smallest of these characteristic distances must be regarded as the controlling factor in order to respect the integrity of the ecosystem.

There is a sizeable suite of geometric measures that can be useful in describing the patch geometry of a fragmented habitat; some of these major factors are patch area, number of patches, ratio of patch size distribution and the patch edge length to area ratio. Fundamentally, the risk of extinction from habitat fragmentation generally increases with terrestrial animal size, since home range and migration needs are largest; however, small terrestrial fauna and plants with compact seed dispersal patterns are vulnerable to very small separations of habitat patches.

The chief natural phenomena that have driven fragmentation are glacial advances, volcanic activity, geologic faulting, tectonic movement, mass land slumping, serpentinization, major sea level rise and climate oscillation. Each of these actions has the potential to create irreversible effective isolation of previously connected habitat units; note that, for example, climate oscillations or minor glacial advances lasting only a few centuries have a reasonable probability that the landscape will revert, since mass extinctions are not necessarily produced from natural oscillatory functions having an effective time scale this small, especially since regional refugia can mitigate losses of such scale.

Major glacial advances may have taken tens or hundreds of thousands of years, such that the resulting habitat fragmentation is likely to have translated into new speciation as well as extinction of populations that were driven below minimum viable population size. One notable example of long timescale fragmentation on a large scale is the Andean uplift in the Amazon Basin. In this pre-Pleistocene epoch topographic change occurred so slowly that the uplift engendered further speciation and actually enhanced biodiversity.

Habitat fragmentation is a significant cause of biodiversity destruction. Research has demonstrated that fragmentation characteristically reduces species richness and taxon diversity, and may reduce the efficacy of ecosystem functioning. Fragmentation not only reduces the amount of functional habitat, but it may isolate a species population into subpopulations, that may be sufficiently near the minimum viable population size to risk local extinction from successive demographic processes or catastrophic events. The mechanics of these impacts often relate to the alteration of relationships among species. In some cases the population of certain species may actually increase within the fragmented habitat complex; however, these few increases are typically already dominant or keystone species, and such increases are usually at the expense of reducing populations of (if not elimination of) other species. With an original habitat becoming fragmented, some species have insufficient dispersal robustness to travel among the fragmented patches. In these cases such taxa may suffer from genetic drift or inbreeding due to restricted gene flow, and may have difficulty in re-colonizing or rescuing a subpopulation from local extirpation. Even if a given species has dispersal strength, it may suffer from insufficient dispersal and survival of taxa with which it interacts.

Considerable research has been conducted on species impacts to vertebrates, being macroscopically observable in the landscape, and on flora, since they are somewhat stationary whilst being analyzed. Notably there is a lack of data on arthropods, which comprise most of the extant biomass of our planet. Furthermore, the position of arthropods within an ecosystem places them in a role of considerable influence on the entirety of ecosystem services. Conservation biologists have developed the concept of habitat corridors as partial mitigation for the adverse impacts of habitat fragmentation.

The adverse biodiversity impacts can be extended in time consequence. For example Lovejoy and Hannah note that the massive pre-1850 New Zealand and Australian deforestation by aborigines and Europeans continues to express and magnify its adverse manifestation on the landscape. The same authors make the interesting conjecture that the presently extant species which have successfully survived the dramatic climate fluctuations of the Quaternary (with attendant large swings in species populations) may be somewhat immunized to future climate oscillations.

One of the most widely studied examples of habitat fragmentation is in the Central Amazon Conservation Complex of Brazil, where a number of controlled studies were conducted in the 1980s. Due to pressures of an expanding human population and associated economic pressures, the Brazilian government embarked on a permissive policy of systematic and large-scale forest destruction. In one study north of Manaus these residual patches were variously created in one, ten and 100 hectare sizes. Resident bird species, both frugivores and insectivores, were studied over a seven year period post-clearing. Results showed that bird densities declined in residual patches, with the smaller patches suffering the greatest species loss, even though initial response of small patches showed fewer initial losses as measured by bird density. An even larger long time scale loss of species richness was evident from the century long trend of deforestation in the area, since many of the plots cleared from 100 years ago were enjoying no economic use, but did not effectively rebound with complete forest cover; in a certain number of cases reasonable regrowth of secondary forest occurred. The conclusion drawn is that the ecological damage from long-term deforestation and resulting habitat fragmentation has been disproportionately related to the actual economic taking of forest.

The Three Gorges Dam on China's Yangtze River represents the largest scale anthropomorphic intrusion into freshwater habitat in history. This aquatic barrier is a threat to the survival of numerous fish species and other aquatic biota. Besides the obvious impact to migratory species that utilize river reaches above and below the dam, there are extensive impacts to turbidity and hydrological characteristics that alter the natural habitat of hundreds of species. There were 162 endemic fish species recorded prior to dam development, 44 of which are endemic to the Yangtze Basin. Severing the upstream and downstream portions of the river by dam construction is expected to threaten the survival of 20 fish species, with 6 of them having a high probability of extinction. In addition to severing the aquatic habitat, the dam construction also severs the riparian zone on both sides of the river with dam anchorages and other industrial infrastructure, leading to fragmentation of that terrestrial habitat.

Questions

1. Where are the herbicides used?
2. What does habitat fragmentation cause?
3. What is the concept of habitat corridors?

Environmental opportunities

16. The Concept of Sustainable Development

In 1987, the Bruntland Commission published its report, Our Common Future, in an effort to link the issues of economic development and environmental stability, defining sustainable development as «development that meets the needs of the present without compromising the ability of future generations to meet their own needs» (United Nations General Assembly, 1987, p. 43). The concept of sustainable development aims tomaintain economic advancement and progresswhile protecting the long-term value of theenvironment; it «provides a framework for theintegration of environment policies anddevelopment strategies» (United Nations GeneralAssembly, 1987). However, long before the late20th century, scholars arguedthat there need notbe a trade-off between environmentalsustainability and economic development.

Economics of Sustainability

By utilizing economic tools, early theoristsoffered that policies to protect the environmentcould also promote innovation and turn a profit. In 1920, Arthur Pigou noted that the presence ofincidental, uncharged services act as a barrier toachieving equilibrium in the market. In his work»The Economics of Welfare», Pigou noted that the divergence between marginal private costs andbenefits and marginal social costs and benefitscreate what we now call «externalities» (Pigou, 1920). These externalities are conceived as transaction spillovers, or costs and benefitsunaccounted for in the given price of a good orservice. In order to correct the market failure, Pigou proposed a tax on those activities thatproduce negative externalities at a rate equal tothose external costs. By levying this charge, called a Pigouvian tax, the market price will moreaccurately reflect the comprehensive costs andbenefits of the activity.

From this, Michael Porter and Claas vander Linde theorized that pollution is a sign ofinefficient resource use. Therefore, win – win opportunities for the environment and economy can be captured through improvements which reduce pollution in production processes (Porter & van der Linde, 1999). These authors argue that competitive advantages rely on the capacity for innovation; thus, «by stimulating innovation, strict environmental regulations can actually enhance competitiveness» (Porter & van der Linde, 1995, p. 98). As the Porter Hypothesis states, properlydesigned environmental policies that make use ofmarket incentives can encourage the introductionof new technologies and reduce productionwaste. The tests of this theory have yieldedmixed results, but scholars generally agree thatpolicy design and public support are crucialelements to the success of these incentives.Nonetheless, market-based environmental toolsare generally perceived as more «businessfriendly» than traditional command and controlpolicies (Cooper & Vargas, 2004).

The appreciation of our natural resourceconstraints is also in our best interest. Trulyrational and «effective governance requires anation to consider and protect the environmentand natural resources on which its current and future development depend. Any other approachis self-defeating. The connections between theenvironment and development thus provide apowerful rationale for environmental protection: enlightened self-interest» (Dernbach J.C., 1998, p. 220). This inherent interdependence between thelong-term stability of the environment and theeconomy is the foundation of the field ofsustainable development.

Similar to Porter's win-win hypothesis that a trade-off isn't necessary, sustainable development policies look to tackle the sources of environmental degradation, not just the symptoms, while still providing opportunities and creating incentives for economic advancement (Porter & van der Linde,1995).Components of a healthy environment,such as clean air and water, are considered publicgoods in that they are non-rivalrous and nonexcludable. Thus, it is up to the public sector tomaintain the provision of these goods andservices. More recently, nations have movedtowards the implementation of these market basedmechanisms to internalize the completecosts of pollution and ensure long-term stabilityof the environment; in other words, to ensuresustainable development.

Sustainable Development: Definition andPrinciples

Although many definitions abound, themost often used definition of sustainabledevelopment is that proposed by the Brundtl and Commission (Cerin, 2006; Dernbach J.C., 1998; Dernbach J.C., 2003; Stoddart, 2011). This broaddefinition does not limit the scope of sustainability. Theexplanation does, however, touch on theimportance of intergenerational equity. Thisconcept of conserving resources for futuregenerations is one of the major features thatdistinguish sustainable development policy fromtraditional environmental policy, which also seeksto internalize the externalities of environmentaldegradation.

The overall goal of sustainabledevelopment (SD) is the long-term stability of theeconomy and environment; this is only achievablethrough the integration and acknowledgement ofeconomic, environmental, and social concerns throughout the decision making process.

In addition to substitutability, thisdefinition of sustainability is also founded onseveral other important principles. Containedwithin the common definition of sustainabledevelopment, intergenerational equity recognizesthe long-term scale of sustainability in order toaddress the needs of future generations (Dernbach J.C., 1998; Stoddart, 2011). Also, the polluter pays principle states that «governmentsshould require polluting entities to bear the costsof their pollution rather than impose those costson others or on the environment» (Dernbach J.C., 1998, p. 58). Thus, government policy shouldensure that environmental costs are internalizedwherever possible; this also serves to minimize externalities.

The precautionary principle establishesthat «where there are threats of serious orirreversible damage, lack of full scientific certaintyshall not be used as a reason for postponing cost-effective measure to prevent environmental degradation» (United Nations Conference on the Human Environment, 1992). Therefore, the proponent of an activity bears the burden ofproving that this action will not cause significantharm. Explicitly stated in the Rio Declaration, the notion of common but differentiated responsibilities recognizes that each nation mustplay their part on the issue of sustainabledevelopment. This principle also acknowledges the different contributions to environmental degradation by developed and developing nations, while appreciating the future development needs of these less developed countries (Brodhag & Taliere, 2006; Dernbach J.C., 1998; United Nations Conference on the Human Environment, 1992). Developed nations,therefore, bear greater responsibility in light ofthe resources they require and the pressures they exert on the environment.

The key principle of sustainable development underlying all others is the integration of environmental, social, and economic concerns into all aspects of decision-making. All other principles in the SD framework have integrated decision-making at their core (Dernbach J.C., 2003; Stoddart, 2011). It is this deeply fixed concept of integration that distinguishes sustainability from other forms ofpolicy.

Institutionally, government organizations are typically organized into sectoral ministries and departments. This works fairly well until the system encounters something very comprehensive and highly integrated in nature, such as sustainable development. In practice, sustainable development requires the integration of economic, environmental, and social objectives across sectors, territories, and generations.

Therefore, sustainable development requires the elimination of fragmentation; that is, environmental, social, and economic concerns must be integrated throughout decision-making processes in order to move towards development that is truly sustainable.

Questions

1. What is the aim of the concept of sustainable concept?
2. What is the foundation of the field of sustainable development?
3. What are the principles of sustainable development?

17. Environmental Education

The roots of environmental education can be traced back as early as the 18th century when Jean-Jacques Rousseau stressed the importance of an education that focuses on the environment in Emile: or, On Education. Several decades later, Louis Agassiz, a Swiss-born naturalist, echoed Rousseau's philosophy as he encouraged students to «Study nature, not books.» These two influential scholars helped lay the foundation for a concrete environmental education program, known as nature study, which took place in the late 19th century and early 20th century.

The nature study movement used fables and moral lessons to help students develop an appreciation of nature and embrace the natural world. Anna Botsford Comstock, the head of the Department of Nature Study at Cornell University, was a prominent figure in the nature study movement and wrote the Handbook for Nature Study in 1911, which used nature to educate children on cultural values. Comstock and the other leaders of the movement, such as Liberty Hyde Bailey, helped Nature Study garner tremendous amounts of support from community leaders, teachers, and scientists and change the science curriculum for children across the United States.

A new type of environmental education, Conservation Education, emerged as a result of the Great Depression and Dust Bowl during the 1920s and 1930s. Conservation Education dealt with the natural world in a drastically different way from Nature Study because it focused on rigorous scientific training rather than natural history. Conservation Education was a major scientific management and planning tool that helped solve social, economic, and environmental problems during this time period.

The modern environmental education movement, which gained significant momentum in the late 1960s and early 1970s, stems from

Nature Study and Conservation Education. During this time period, many events – such as Civil Rights, the Vietnam War, and the Cold War – placed Americans at odds with one another and the U.S. government. However, as more people began to fear the fallout from radiation, the chemical pesticides mentioned in Rachel Carson's Silent Spring, and the significant amounts of air pollution and waste, the public's concern for their health and the health of their natural environment led to a unifying phenomenon known as environmentalism. Environmental education was born of the realization that solving complex local and global problems cannot be accomplished by politicians and experts alone, but requires «the support and active participation of an informed public in their various roles as consumers, voters, employers, and business and community leaders».

One of the first articles about environmental education as a new movement appeared in the Phi Delta Kappan in 1969, authored by James A. Swan. A definition of «Environmental Education» first appeared in The Journal of Environmental Education in 1969, authored by William B. Stapp. Stapp later went on to become the first Director of Environmental Education for UNESCO, and then the Global Rivers International Network.

Ultimately, the first Earth Day on April 22, 1970 – a national teach-in about environmental problems – paved the way for the modern environmental education movement. Later that same year, President Nixon passed the National Environmental Education Act, which was intended to incorporate environmental education into K-12 schools. Then, in 1971, the National Association for Environmental Education (now known as the North American Association for Environmental Education) was created to improve environmental literacy by providing resources to teachers and promoting environmental education programs.

Internationally, environmental education gained recognition when the UN Conference on the Human Environment held in Stockholm, Sweden, in 1972, declared environmental education must be used as a tool to address global environmental problems. The United Nations Education Scientific and Cultural Organization (UNESCO) and United Nations Environment Program (UNEP) created three major declarations that have guided the course of environmental education.

Stockholm Declaration

June 5–16, 1972 – The Declaration of the United Nations Conference on the Human Environment. The document was made up of 7 proclamations and 26 principles «to inspire and guide the peoples of the world in the preservation and enhancement of the human environment.»

Belgrade Charter

October 13–22, 1975 – The Belgrade Charter was the outcome of the International Workshop on Environmental Education held in Belgrade, Jugoslavia (now Serbia). The Belgrade Charter was built upon the Stockholm Declaration and adds goals, objectives, and guiding principles of environmental education programs. It defines an audience for environmental education, which includes the general public.

Tbilisi Declaration

October 14–26, 1977 – The Tbilisi Declaration «noted the unanimous accord in the important role of environmental education in the preservation and improvement of the world's environment, as well as in the sound and balanced development of the world's communities.» The Tbilisi Declaration updated and clarified The Stockholm Declaration and The Belgrade Charter by including new goals, objectives, characteristics, and guiding principles of environmental education.

Later that decade, in 1977, the Intergovernmental Conference on Environmental Education in Tbilisi, Georgia emphasized the role of Environmental Education in preserving and improving the global environment and sought to provide the framework and guidelines for environmental education. The Conference laid out the role, objectives, and characteristics of environmental education, and provided several goals and principles for environmental education.

The following are the objectives of environmental education.

1. Awareness. To help the social groups and individuals to acquire knowledge of pollution and environmental degradation.

2. Knowledge. To help social groups and individuals to acquire knowledge of the environment beyond the immediate environment including distant environment.

3. Attitudes. To help social groups and individuals to acquire a set of values for environmental protection.

4. Skills and Capacity Building:To help social groups and individuals to develop skills required for making discriminations in form, shape, sound, touch, habits and habitats. Further, to develop ability to draw unbiased inferences and conclusions.

5. Participation. To provide social groups and individuals with an opportunity to be actively involved at all levels in environmental decision making.

Questions

1. What scholars were at the roots of ecological education?
2. What is environmentalism?
3. What are the objectives of environmental education?

18. Recycling

Recycling is the process of taking used material and processing it to make something else, or reconditioning an object to restore it to an «as new» condition. It is stage three of what has become known as the 3R Concept:

- Reduce
- Reuse
- Recycle

This is considered to be a very environmentally friendly process since in addition to avoiding the waste of potentially useful materials, it reduces the consumption of fresh raw materials and energy usage. Pollution levels are limited because waste material is not incinerated or buried.

Many kinds of materials can be recycled, such as glass, paper, metal, plastics, textiles and electronics, but many highly developed countries have a very poor record with respect to recycling.

About 5 % of the world's population lives in the United States and on average every US citizen produces about 730 kg of rubbish each year. This is roughly the weight of a heavy draught horse. In total the annual amount of rubbish produced in the US amounts to 228 million tonnes, which is 40 % of the world's waste.

In the past ten years the amount of US recycling has approximately doubled and 32.5 % of US municipal waste is now recycled, but this still means that approximately 154 million tonnes of rubbish ends up in landfill every year.

In the 27 EU states during 2009 each person generated on average 513 kg of municipal waste, which varied from 316 kg per person in the Czech Republic to 833 kg per person in Denmark. This waste was treated in different ways: 38 % went to landfill, 20 % was incinerated, 24 % was recycled and 18 % was composted.

Again this varied from country to country, but Austria was the most environmentally friendly by recycling or composting more than 70 % of its municipal waste. Bulgaria on the other hand sent all of its municipal waste to landfill. Germany is the country with the most highly organised recycling system, with 48 % of its waste being treated in this way.

The rubbish of today is different to the rubbish of 50 years ago. Today's rubbish contains more materials that don't break down when they are put in the ground, or if they do break down this is likely to take a very long time. An aluminium drink can that is buried in landfill in 2011 will still be a recognisable can in the year 2511.

Packaging material makes up about 25 % of all municipal rubbish and most of this can be recycled. Used aluminium cans, melted down, can make new cans that can be on the supermarket shelf within 60 days. Recycling one aluminium can save enough energy to run a TV for three hours.

Steel is another metal that can be recycled. A 60-watt light bulb can run for over a day on the amount of energy saved by recycling a pound of steel.

On average everyone uses up to two pine trees worth of paper each year and it is estimated that half a million trees must be cut down to produce the paper for each week's Sunday newspapers. If all newspapers were recycled, that would save 250 million trees each year. Producing new paper uses almost 65 % less energy than recycling old and it takes 390 gallons of oil to produce one tonne of paper.

Glass is the classic recyclable material. It is virtually indestructible, taking about 4000 years to decompose if buried; yet it can readily be melted down and reformed, but in the UK five out of every sixglass bottles gets thrown away.

Motor oil if disposed of inappropriately can cause serious pollution. A litre of oil can contaminate 2 000 000 gallons of fresh water, yet motor oil never wears out; it just gets dirty. It can be recycled, re-refined and used again, thus reducing our reliance on imported oil.

It is a simple fact that we are running out of space so we can't keep on burying our rubbish, but in some countries recycling is regarded as being a more costly option. This has led to reluctance to move away from traditional means of waste disposal.

Initially this may be the case, but as experience is gained and efficiency improves, costs tend to fall. Also there are economies of scale; small amounts are more expensive to recycle than larger quantities.

But there are more important issues than money.

The release of carbon dioxide into the Earth's atmosphere is a major contributor to global warming. Manufacturing certain products releases far more carbon dioxide into the atmosphere than recycling them. A good example is aluminium. Manufacturing new aluminium goods produces 95 % more carbon dioxide than recycling scrap aluminium. When you consider that the US alone uses 80 billion cans a year that is an awful lot of aluminium and if all the used cans in the world could be recycled a significant reduction in emissions could be achieved.

Recycling paper can also bring a major environmental benefit. It is estimated that each year every tree in the world absorbs almost 250 pounds (113.5 kg) of carbon dioxide from the Earth's atmosphere, using this to feed itself through a process of photosynthesis. Since it takes about 16 trees to make a tonne of paper, the maths speaks for itself.

Air pollution is a major problem in the world. Huge amounts of toxic gases are released into the air from industries manufacturing items from plastic and metals. As the world population continues to increase, demand for these goods also continues to rise. In the US 2.5 million plastic bottles are thrown away every hour. Without recycling the only option is to build more factories, leading to further pollution.

Recycling could also solve many of the problems associated with landfill. Traditionally rubbish was simply dumped in landfill sites, but in the last 50 years not only has the population increased, but the amount of rubbish generated per person has also increased. We have now reached the situation where many areas are running out of sites suitable for landfill. This is reaching crisis point in some cities and suburbs, where landfills are creeping closer to crowded human settlements, with all the associated risks of disease.

Water is vital to life, but it is very easily contaminated and in many cases this contamination is associated with landfill. When waste is disposed of in landfill it is not treated in any way and contaminants seep down to lower levels of the soil and contaminate the groundwater.

Where landfill areas are scarce, there is often little choice but to dump rubbish into seas and oceans. It is well known that the dumping of industrial and municipal waste in this way has a devastating effect on marine ecology and environmental preservation would be an important benefit of recycling.

It's a simple fact that because we cannot carry on burying or burning rubbish for ever we need to increase the amount of rubbish that is being recycled. Governments can introduce rules and regulations, but the most important issue is to persuade people that recycling is now an essential part of life.

We live in a “throw away society’’ and in spite of all the evidence; many people still need to be convinced of the importance of recycling rubbish. Studies have shown that those with friends and neighbours who recycle are more likely to recycle their own rubbish. Those of us who share this passionate belief have an important task on hand.

Questions

1. What is 3R Concept?
2. How is today’s rubbish different from the rubbish 50 years ago?
3. How long does the glass decompose if buried?

Содержание

Учебное пособие

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