Examining Natural Ecosystems and Other Ecosystems

Learning Objectives

SE2 Examine biodiversity within local ecosystems

1. Observe and document a range of organisms to illustrate the biodiversity within a local ecosystem.

3. Identify biotic and abiotic components of an ecosystem.

4. Explain how the biodiversity of an ecosystem contributes to its sustainability.

Learning Event

Set: Either through discussion or through notes and readings, expose students to the following concepts:

- Abiotic elements of an ecosystem are parts of the ecosystem that are not alive. Example: rocks, dirt, buildings, etc.
- Biotic elements of an ecosystem are parts of the ecosystem that are living.
- Biodiversity: All of the different types of plants and animals in an ecosystem
- Natural Ecosystem: An ecosystem that has been untouched by humans. It has been left to grow as natural as possible.
- Conventional Farm: The most common farming operations. These farms use fertilizer and other chemical controls to produce crops.
- Organic Farm: A farm that follows the standards for the organic industry. It uses crop rotations, green pest control, natural fertilizers and has strict regulations on the use of chemicals. Follow the links under Certification at http://foodmiles.saskorganic.com/content/producers
- Sustainability: The ability for an ecosystem to survive over time. Factors such as healthy water, air and soil are indicators of an ecosystem's sustainability

Development:

Now that students have an understanding of what makes up an ecosystem and what it means for an ecosystem to be sustainable, students will evaluate three different types of ecosystems in Saskatchewan: a natural ecosystem, an organic farm, and a conventional farm. The end product of this activity is a debate on which ecosystem is the most sustainable.

Give students information about indicators of sustainability. An excerpt from wikipedia.com follows the instructions. Have them read or teach them about the different ways to evaluate the health and success of any particular ecosystem. (Environmental and Economical).

Break the students into three teams. Have them explore the three different types of ecosystems as they relate to the indicators of sustainability. Each group must evaluate how their type of ecosystem measure up in each indicator. Student work can be evaluated using the following rubric:

http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=2147186

Student research can be evaluated using the following:

http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=2147187&

Students will engage in a debate that explores the benefits and disadvantages of each ecosystem. Review the rules of formal debate with the class and have them create a written preparation for the debate based on their research.

Debates can be evaluated by the following rubric:

http://rubistar.4teachers.org/index.php?screen=ShowRubric&rubric_id=2147188&

Educators can choose to provide the students with the case studies or, if time and student ability allows, students can research on their own the types of organic life found in any given ecosystem. The students will evaluate the biodiversity of each ecosystem as it relates to the sustainability of that ecosystem.

An example of natural ecosystem can be found locally. This is an area that has not been touched by human development or management. Various habitat reserves or preservation areas provide information and are a great resource.

An example of an organic farm can be found through http://www.saskorganic.com/page/what-organic-farming . If you should want to talk to an organic farmer for further reference you will find a directory of producers from all areas of Saskatchewan at the following site http://www.organicfarmdirectory.ca/

An example of conventional farming are any area farms that do not fall under the organic farming umbrella.

Have students research one of these ecosystems and present them to the class. Have the students keep notes and compare the ecosystems as a group. They should examine the biodiversity and the sustainability of each of the ecosystems.

Indicators of Sustainability

www.wikipedia.com

Atmosphere

In March 2009 at a meeting of the Copenhagen Climate Council, 2,500 climate experts from 80 countries issued a keynote statement that there is now "no excuse" for failing to act on global warming and that without strong carbon reduction "abrupt or irreversible" shifts in climate may occur that "will be very difficult for contemporary societies to cope with".[66][67] Management of the global atmosphere now involves assessment of all aspects of the carbon cycle to identify opportunities to address human-induced climate change and this has become a major focus of scientific research because of the potential catastrophic effects on biodiversity and human communities (see Energy below).

Other human impacts on the atmosphere include the air pollution in cities, the pollutants including toxic chemicals like nitrogen oxides, sulphur oxides, volatile organic compounds and particulate matter that produce photochemical smog and acid rain, and the chlorofluorocarbons that degrade the ozone layer. Anthropogenic particulates such as sulfate aerosols in the atmosphere reduce the direct irradiance and reflectance (albedo) of the Earth's surface. Known as global dimming, the decrease is estimated to have been about 4% between 1960 and 1990 although the trend has subsequently reversed. Global dimming may have disturbed the global water cycle by reducing evaporation and rainfall in some areas. It also creates a cooling effect and this may have partially masked the effect of greenhouse gases on global warming.[68]

Freshwater and Oceans

Water covers 71% of the Earth's surface. Of this, 97.5% is the salty water of the oceans and only 2.5% freshwater, most of which is locked up in the Antarctic ice sheet. The remaining freshwater is found in glaciers, lakes, rivers, wetlands, the soil, aquifers and atmosphere. Due to the water cycle, fresh water supply is continually replenished by precipitation, however there is still a limited amount necessitating management of this resource. Awareness of the global importance of preserving water for ecosystem services has only recently emerged as, during the 20th century, more than half the world's wetlands have been lost along with their valuable environmental services. Increasing urbanization pollutes clean water supplies and much of the world still does not have access to clean, safe water.[69] Greater emphasis is now being placed on the improved management of blue (harvestable) and green (soil water available for plant use) water, and this applies at all scales of water management.[70]

Ocean circulation patterns have a strong influence on climate and weather and, in turn, the food supply of both humans and other organisms. Scientists have warned of the possibility, under the influence of climate change, of a sudden alteration in circulation patterns of ocean currents that could drastically alter the climate in some regions of the globe.[71] Ten per cent of the world's population – about 600 million people – live in low-lying areas vulnerable to sea level rise.

Land use

Loss of biodiversity stems largely from the habitat loss and fragmentation produced by the human appropriation of land for development, forestry and agriculture as natural capital is progressively converted to man-made capital. Land use change is fundamental to the operations of the biosphere because alterations in the relative proportions of land dedicated to urbanisation, agriculture, forest, woodland, grassland and pasture have a marked effect on the global water, carbon and nitrogen biogeochemical cycles and this can impact negatively on both natural and human systems.[72] At the local human scale, major sustainability benefits accrue from sustainable parks and gardens and green cities.[73][74]

Since the Neolithic Revolution about 47% of the world's forests have been lost to human use.

Present-day forests occupy about a quarter of the world's ice-free land with about half of these occurring in the tropics.[75] In temperate and boreal regions forest area is gradually increasing (with the exception of Siberia), but deforestation in the tropics is of major concern.[76]

Food is essential to life. Feeding more than six billion human bodies takes a heavy toll on the Earth's resources. This begins with the appropriation of about 38% of the Earth's land surface[77] and about 20% of its net primary productivity.[78] Added to this are the resource-hungry activities of industrial agribusiness – everything from the crop need for irrigation water, synthetic fertilizers and pesticides to the resource costs of food packaging, transport (now a major part of global trade) and retail. Environmental problems associated with industrial agriculture and agribusiness are now being addressed through such movements as sustainable agriculture, organic farming and more sustainable business practices.[79]

Management of Human Consumption

Further information: Consumption (economics)

The underlying driver of direct human impacts on the environment is human consumption.[80] This impact is reduced by not only consuming less but by also making the full cycle of production, use and disposal more sustainable. Consumption of goods and services can be analysed and managed at all scales through the chain of consumption, starting with the effects of individual lifestyle choices and spending patterns, through to the resource demands of specific goods and services, the impacts of economic sectors, through national economies to the global economy.[81] Analysis of consumption patterns relates resource use to the environmental, social and economic impacts at the scale or context under investigation. The ideas of embodied resource use (the total resources needed to produce a product or service), resource intensity, and resource productivity are important tools for understanding the impacts of consumption. Key resource categories relating to human needs are food, energy, materials and water.

In 2010, the International Resource Panel, hosted by the United Nations Environment Programme (UNEP), published the first global scientific assessment on the impacts of consumption and production [82] and identified priority actions for developed and developing countries. The study found that the most critical impacts are related to ecosystem health, human health and resource depletion. From a production perspective, it found that fossil-fuel combusting processes, agriculture and fisheries have the most important impacts. Meanwhile, from a final consumption perspective, it found that household consumption related to mobility, shelter, food and energy-using products cause the majority of life-cycle impacts of consumption.

Energy

Main articles: Sustainable energy, Renewable energy, and Efficient energy use

The Sun's energy, stored by plants (primary producers) during photosynthesis, passes through the food chain to other organisms to ultimately power all living processes. Since the industrial revolution the concentrated energy of the Sun stored in fossilized plants as fossil fuels has been a major driver of technology which, in turn, has been the source of both economic and political power. In 2007 climate scientists of the IPCC concluded that there was at least a 90% probability that atmospheric increase in CO_2 was human-induced, mostly as a result of fossil fuel emissions but, to a lesser extent from changes in land use. Stabilizing the world's climate will require high-income countries to reduce their emissions by 60–90% over 2006 levels by 2050 which should hold CO_2 levels at 450–650 ppm from current levels of about 380 ppm. Above this level, temperatures could rise by more than 2°C to produce "catastrophic" climate change.[83][84] Reduction of current CO_2 levels must be achieved against a background of global population increase and developing countries aspiring to energy-intensive high consumption Western lifestyles.[85]

Reducing greenhouse emissions, is being tackled at all scales, ranging from tracking the passage of carbon through the carbon cycle[86] to the commercialization of renewable energy, developing less carbon-hungry technology and transport systems and attempts by individuals to lead carbon neutral lifestyles by monitoring the fossil fuel use embodied in all the goods and services they use.[87]

Water

Further information: Water resources

Water security and food security are inextricably linked. In the decade 1951–60 human water withdrawals were four times greater than the previous decade. This rapid increase resulted from scientific and technological developments impacting through the economy – especially the increase in irrigated land, growth in industrial and power sectors, and intensive dam construction on all continents. This altered the water cycle of rivers and lakes, affected their water quality and had a significant impact on the global water cycle.[88] Currently towards 35% of human water use is unsustainable, drawing on diminishing aquifers and reducing the flows of major rivers: this percentage is likely to increase if climate change impacts become more severe, populations increase, aquifers become progressively depleted and supplies become polluted and unsanitary.[89] From 1961 to 2001 water demand doubled - agricultural use increased by 75%, industrial use by more than 200%, and domestic use more than 400%.[90] In the 1990s it was estimated that humans were using 40–50% of the globally available freshwater in the approximate proportion of 70% for agriculture, 22% for industry, and 8% for domestic purposes with total use progressively increasing.[88]

Food

Further information: Food and Food security

The American Public Health Association (APHA) defines a "sustainable food system"[92][93] as "one that provides healthy food to meet current food needs while maintaining healthy ecosystems that can also provide food for generations to come with minimal negative impact to the environment. A sustainable food system also encourages local production and distribution infrastructures and makes nutritious food available, accessible, and affordable to all. Further, it is humane and just, protecting farmers and other workers, consumers, and communities."[94] Concerns about the environmental impacts of agribusiness and the stark contrast between the obesity problems of the Western world and the poverty and food insecurity of the developing world have generated a strong movement towards healthy, sustainable eating as a major component of overall ethical consumerism.[95] The environmental effects of different dietary patterns depend on many factors, including the proportion of animal and plant foods consumed and the method of food production.[96][97][98][99] The World Health Organization has published a *Global Strategy on Diet, Physical Activity and Health* report which was endorsed by the May 2004 World Health Assembly. It recommends the Mediterranean diet which is associated with health and longevity and is low in meat, rich in fruits and vegetables, low in added sugar and limited salt, and low in saturated fatty acids; the traditional source of fat in the Mediterranean is olive oil, rich in monounsaturated fat. The healthy rice-based Japanese diet is also high in carbohydrates and low in fat. Both diets are low in meat and saturated fats and high in legumes and other vegetables; they are associated with a low incidence of ailments and low environmental impact.[100]

At the global level the environmental impact of agribusiness is being addressed through sustainable agriculture and organic farming. At the local level there are various movements working towards local food production, more productive use of urban wastelands and domestic gardens including permaculture, urban horticulture, local food, slow food, sustainable gardening, and organic gardening.[101][102]

Sustainable seafood is seafood from sources that can maintain or increase production in the future without jeopardizing the ecosystems from which it was acquired. The sustainable seafood movement has gained momentum as more people become aware of both overfishing and environmentally-destructive fishing methods.

Materials, Toxic Substances, Waste

As global population and affluence has increased, so has the use of various materials increased in volume, diversity and distance transported. Included here are raw materials, minerals, synthetic chemicals (including hazardous substances), manufactured products, food, living organisms and waste.[103] By 2050, humanity could devour an estimated 140 billion tons of minerals, ores, fossil fuels and biomass per year three times its current appetite unless the economic growth rate is decoupled from the rate of natural resource consumption. Developed countries citizens consume an average of 16 tons of those four key resources per capita (ranging up to 40 or more tons per person in some developed countries with resource consumption levels far beyond what is likely sustainable.[104]

Sustainable use of materials has targeted the idea of dematerialization, converting the linear path of materials (extraction, use, disposal in landfill) to a circular material flow that reuses materials as much as possible, much like the cycling and reuse of waste in nature.[105] This approach is supported by product stewardship and the increasing use of material flow analysis at all levels, especially individual countries and the global economy.[106]

Synthetic chemical production has escalated following the stimulus it received during the second World War. Chemical production includes everything from herbicides, pesticides and fertilizers to domestic chemicals and hazardous substances.[107] Apart from the build-up of greenhouse gas emissions in the atmosphere, chemicals of particular concern include: heavy metals, nuclear waste, chlorofluorocarbons, persistent organic pollutants and all harmful chemicals capable of bioaccumulation. Although most synthetic chemicals are harmless there needs to be rigorous testing of new chemicals, in all countries, for adverse environmental and health effects. International legislation has been established to deal with the global distribution and management of dangerous goods.[108][109]

Every economic activity produces material that can be classified as waste. To reduce waste industry, business and government are now mimicking nature by turning the waste produced by industrial metabolism into resource. Dematerialization is being encouraged through the ideas of industrial ecology, ecodesign[110] and ecolabelling. In addition to the well-established “reduce, reuse and recycle,” shoppers are using their purchasing power for ethical consumerism.[45]