

REM 100

Global Change

A Course Overview

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Questions to Think About

- Global:
 - What is global change, or what makes a problem global?
 - Is there a global environmental crisis and if so, how serious is it?
 - What are problems we face when we tackle global environmental issues?
 - Does awareness of global change mean that we are experiencing a paradigm shift?
 - Does responding to global change require a paradigm shift?
- Environment:
 - What is sustainable development?
 - Why do we create environmental problems? What can we do to abate/prevent them?
 - How much of today's change is due to human activity rather than natural variability?
 - Is the pace of our response to environmental degradation fast enough to solve our problems before we have compromised the ability of the environment to support a reasonable standard of living for humans?
- Economics:
 - Has economic growth become the goal instead of the means to approach the goal?
 - Can the earth support extending to all people the high consumption lifestyle of the current richest 20%?
 - Do rising incomes lead to more or less environmental impact?
 - Is poverty a cause of environmental degradation?
 - How much should companies be punished for damage to the environment?
- Humanity:
 - Can technological changes be a force for positive environmental change?
 - How can we, as a species, consider ourselves 'rational self interested' creatures when we engage in this type of irrational behaviour?
 - Ecofeminism:
 - Is the oppression of nature related to the oppression of women?
 - Does environmental degradation affect women more than men?
 - Should feminists and environmentalists separate?
 - War:
 - Hupy (2003) notes that there is very little research conducted about the ecological effects of war. Why do you think this is the case?
 - Given that just testing nuclear weapons creates such 'wicked', complex ecological problems, why do we persist in producing, testing, and storing nuclear weapons?

Introduction to Sustainable Development

- Concepts of sustainability:
 - Utility/welfare does not decline over time
 - Resources managed for the future
 - Renewable resources/services managed for sustainable yield
 - Natural capital does not decline over time
 - Ecosystem resilience and stability maintained
 - Sustainable development builds capacity and consensus
- **Sustainable development:** Development which meets the needs of the present without compromising the ability of future generations to meet their needs
 - Definition coined in *Our Common Future* written by the Brundtland Commission
 - Mebratu, 1998: Conceptual definition of sustainable development includes:
 - Concept of essential needs
 - Limitations of technology and social organization currently mean that the environment cannot meet present and future needs
 - Approaches:
 - Economic: Maximization of income; maintaining stock of capital
 - Ecological: Resilience/strength of ecosystems
 - Socio-cultural: Stability of socio-cultural systems
 - Central factors:
 - Poverty (Lack of essential human capabilities)
 - Population
 - Pollution
 - Participation
 - Policy/market futures
 - *Omission*: Not acting when action is necessary
 - *Commission*: Acting when action is not necessary
 - Prevention and management of disasters
 - Human determinants: Production, distribution, consumption
 - Critiques:
 - People should not have to make sacrifices for future generations
 - Income and technology increase will alleviate problems
 - Resources would better benefit the poor

History

Introduction

- **Malthusianism:** School of thought which believes that unchecked consumption will create problems
 - **Thomas Malthus:** English economist and country pastor
 - Wrote *An Essay on the Principle of Population*
 - Believed population was limited by misery, vice, moral restraint
 - Believed that when not limited, population increased in a geometric ratio and subsistence increased in an arithmetic ratio
- **Cornucopians:** School of thought which links increase in population with increase in benefits from the planet
 - Believe that increase in population is an incentive to develop better technology to produce more food
 - Believe that future is limited only by human ingenuity or inability to correct the economic field (i.e. Social and political adaptability)
- **Global change:** Human-induced transformation of the global environment
- **Global problems:**
 - Persistent
 - Challenge the world status quo
 - Challenge global institutions
 - Capture worldwide attention
 - Large-scale regional effects
 - Cannot be solved by one country acting alone; requires inter-dependence between countries/regions
 - Linked to other global issues

The Great Transformation

- 1800 - Present
- Unprecedented changes in society, economics, and the environment
- Transformation of the biosphere from its natural state by human action
- Massive change in the social and economical organization of Western societies
 - Profound effect on the global environment
 - Examples of transformations:
 - Religion to science
 - Feudal system to democracies
 - Rural societies to urban societies
 - Agriculture to industry
- Mode of adaptation: Cultural way of living which determines the population size that can be supported by a given environment
 - **Hunter-gatherer societies:**
 - Substantially altered their environment to increase its utility
 - Low and ecologically sustainable population densities
 - **Agrarian societies:**
 - Higher human population densities than hunter-gatherers
 - Allowed for specialization, political organization, developments of urban elites
 - Generally ecologically sustainable
 - Farming methods evolved to limit environmental degradation (e.g. crop rotation)
 - Relatively low population densities
 - Feasible for populations to move around
 - Industrialized societies
- Industrial revolution:
 - Replacement of labour-based industries with machine-based factories
 - Water power, then steam engines fuelled by coal
 - Pressures to reform from serious social health and environmental problems
 - Improvements in diet, sanitation, health care
 - Agriculture production boosted by mechanization, fertilizers, irrigation, agro-chemicals
 - Consumerism funded by easy access to credit is promoted to sustain economic growth
- Population growth:
 - Created an unsustainable drive for welfare
 - Resources must now be found from outside national boundaries
 - More affluent population has an impact on the less affluent population

- Magnitude of the transformation:
 - E.g. Europe in the 17th century:
 - Most were poor
 - Low life expectancies
 - Widespread malnutrition
 - Population and welfare:
 - World population grew from 1 billion to 7 billion from 1800 to 2011
 - Life expectancy and per capita income began increasing in the 1800s
 - Working people struggled to improve their lives
 - Improved human welfare
 - Increase in wealth and consumption (and therefore, pollution)
 - Inequitably shared wealth
 - Land changed from common ownership to private ownership
 - Experimentation with new methods of production
 - More food available
 - People pushed off their land, becoming employed
 - New transportation systems allowed distant farmers to access growing city markets
 - Increased population, improved nutrition
 - Shortage of wood-derived charcoal in the iron industry caused industries to use coal
 - Economic growth became paramount

Ecological Effects of War

- General ecological effects (Hupy (2003)):
 - 3 main effects:
 - Environmental disturbance/destruction from weaponry/munitions
 - Direct consumption of resources such as timber, water, food
 - Indirect consumption of resources by military industrial complexes which supply the war effort
 - Environmental disturbance has increased in scale due to contemporary war and the industrial revolution

- Causes:
 - Munitions explosions (*bombturbation*)
 - Heavy vehicle traffic
 - Chemical defoliants (e.g. Agent Orange)
 - Pollution of the environment (unintentionally and intentionally)
- Before advancements in warfare:
 - Artillery relied on visual contact with enemies (i.e. direct fire)
 - Small-scale battlefields
 - Battles lasted hours and rarely went into the night
- Changes in warfare:
 - American Civil War increased the temporal nature of war
 - Smokeless gunpowder blasting caps and TNT developed
 - Created a new form of warfare capable of destroying landscapes
- After advancements in warfare:
 - Artillery is fired at enemies' general location or coordinates (i.e. indirect fire)
 - Large-scale battlefields
 - Battles last years
- WWI:
 - Objectives were to destroy defenses and shatter morale
 - Indirect fire based on calls of forward observers
 - E.g. Rolling barrage: Artillery fired continuously ahead of an advancing line; used by the Canadians in WWI to take Vimy Ridge
 - Devastating environmental impact; left landscape cratered and stunted
- WWII:
 - 100+ million acres of forests destroyed directly
 - Pacific War: Naval & aerial bombardments of islands
- Nuclear war:
 - On the WWII nuclear bombing, a committee and scientific panel concluded that:
 - The bomb should be used against Japan as soon as possible
 - The bomb should make a strong psychological impression by affecting civilians
 - The bomb should be used without warning
 - Post-WWII: World dominated by USA and Soviet Union; it was believed that a stalemate between these two would prevent nuclear destruction
 - US executed 23 bomb tests at Bikini Atoll
 - Sent islanders into a permanent exile
 - Buried the irradiated waste; currently may be leaking

- Second Indochina War (Vietnam War):
 - 1954 – 1975
 - Key components of physical environments deliberately destroyed
 - Defoliants used to:
 - Eliminate enemy troops' cover
 - Provide bases for operation
 - Carpet bombing on areas of enemy soldiers by B-52 bombers
 - Created 26 million craters
- Millions of bombs dropped in WWII, Korean War, Second Indochina War, etc.
- 1.5 million hectares of forests destroyed
- 4% of forests embedded with shrapnel (loses its value and ability to be used)
- Soil undergoes laterisation (increased concentration of iron) after it loses its protective cover
- Warring over resources:
 - Conflicts over critical/valuable materials
 - E.g. Water, timber, minerals
 - E.g. In 1991, Iraqi forces spilt oil at Kuwait into the Gulf as an attack
 - Tensions between US and Soviet Union over control of fuel and minerals
 - USA-led invasion of Iraq brought the issue of resource wars to the public
 - US targeted regimes which were both opposed to the US and were reluctant to open their oil/gas fields
 - Some believe that the war on terror was really an imperialist war for oil
 - Humans have access to a limited amount of land; definite environmental limits exist
 - Population and economic growth leads to increased demand, which may mean greater tendencies to fight over resources in the future
 - E.g. Asia has a growing energy demand
 - Basis for peace may lie in solving the ecological breakdown and creating fair/distributed access to resources
 - On the other hand, abundance of resource wealth appears to increase the probability of civil war
 - Absolute/Malthusian scarcity created when there is not enough supply to fully meet demand

Ecological Thought and Philosophies

- Two main sides of ecological thought:
 - Utilization of nature by humanity
 - Land is soil providing for commodity production
 - Animals are commodities for sport and food
 - Focuses on allowable annual kills and artificial propagation
 - Use of conventional agriculture
 - Intrinsic value of nature
 - Land is a biota providing services from nature
 - Threatened species should be protected
 - Use of organic agriculture
- Three possible human perspectives on nature: Domination, stewardship, deep ecology
- Attitudes towards nature and natural resources:
 - **Anthropocentrism:** Nature exists as resources for humans' use
 - Environment is seen in terms of benefit to humans
 - Based on utility/value to us
 - Means to an end
 - Subject to human appraisal/valuation
 - Natural materials only have value as commodities
 - Little to no ecological limits
 - Human ingenuity will solve all problems
 - **Ecocentrism/Biocentrism/Deep ecology:** Living beings have intrinsic value independent of humans
 - Natural materials are fixed and limited; limited resource use
 - Resources primarily defined by nature as what the ecosystem provides
 - Neo-Malthusian ecological framework
- Ecological philosophies:
 - Comparison from anthropocentric to ecocentric:
Domination, stewardship, conservation, eco-feminism, deep ecology
 - **Stewardship:** Responsible use of natural resources through sustainable practices
 - Includes a social-distributional dimension as well as one of environmental management

- **Conservation:** Maintaining the health of nature
 - Thoreau
 - John Muir:
 - Periodic nature writer
 - Helped to establish national parks in the US
 - George Perkins Marsh:
 - Published *Physical Geography as Modified by Human Action*
 - Was labeled the 'fountainhead of the conservationist movement'
 - **Aldo Leopold:**
 - Ecocentric Western scholar
 - Established an ecological conscience
 - Assertions:
 - Basic lack of human regard for the land causes most resource and agricultural problems
 - Economics should not determine land use
 - **Land ethic:** The biotic community should have its own rights and values
"A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."
 - Beliefs:
 - *Land pyramid:* Diagram to illustrate how everything relies on everything else and that humans should not disturb this structure
 - Evolution of land ethic is both objective and subjective
 - 1907 – Division into:
 - **Preservationist conservationists:** Seek to maintain natural areas in their natural state
 - **Utilitarian conservationists:** Seek to manage the sustainable harvesting of natural resources for human benefit

- **Ecofeminism:**
 - Awareness of interrelatedness
 - Draws a link between oppression/exploitation of nature/women
 - Vandava Shiva:
 - Cartesian/dualistic view: Views nature as resources to be used by man
 - Nature is seen as:
 - Passive
 - Mechanistic
 - Separable
 - Separate from humanity
 - Inferior
 - Exploitable/usable
 - Destroys nature and women simultaneously
 - Ecologically sustainable way of living can be similar to the world-views of ancient civilizations and cultures
 - Violation of nature linked to violation/marginalization of women
 - Argues that not all women play this role
 - Revolutionary potential
 - Women in developing countries have not been involved in our mal-development and therefore can view nature as interconnected and valuable for life
- **Shallow ecology:** Treatment of environmental problems without treating the underlying causes and without confronting current ways of thinking
 - E.g. Reduction of pollution (viewed as damage to human health) through allowable amounts of pollutants, technology to purify the ecosystem, moving industries to developing countries with less regulations
- **Deep ecology:** Belief that human societies need to be restructured and that living things have their own inherent value
 - Coined by Arne Naess
 - E.g. Reduction of pollution (viewed as damage to the ecosystem rather than to humans) through its deeper causes, banning of the exporting of industries
 - Guidelines:
 - All life has intrinsic value
 - Richness and diversity contribute to life's well-being and have value

- Humans have no right to reduce the richness and diversity of nature except for needs, responsibly
 - Human impact on the ecosystem is excessive and worsening
 - Human lifestyles and population cause this impact
 - Diversity of life can only flourish with less human impact
 - Basic structures (institutions) of humanities must change
 - Anybody who believes in these has a responsibility to act
- Attitudes towards capital:
 - **Natural capital:** Stock of available natural elements giving a flow of resources for people's livelihoods
 - Extension of the economic notion of *capital* (manufactured means of production) to natural goods and services
 - **Man-made capital:** Capital generated through economic activity through human ingenuity and technological change
 - E.g. Physical infrastructures used to produce goods and services
 - Requires natural capital
 - **Weak sustainability:** Belief that human capital can be substituted by natural capital
 - Related to anthropocentrism
 - **Strong sustainability:** Belief that human capital and natural capital are not interchangeable
 - Related to ecocentrism
 - Conservation of natural capital preserves:
 - Inter-generational equity
 - Increased resilience to environmental stress and shock
 - Intrinsic value
 - Unknown/undiscovered value
- Attitudes towards technology solving the global food crisis:
 - **Techno-optimism:** Resource constraints can be nullified through development and creation of technology
 - **Techno-pessimism:** Resource constraints cannot be nullified through development and creation of technology

- Paradigm: Beliefs, values, ideals, and structures of thinking during a time period
 - **Paradigm shift:** A change in one or more of society's institutions
 - Involves a change in views and/or thinking
 - Examples:
 - Abolition of slavery
 - Acceptance of divorce
 - Equal rights for women
 - Malthus was one of the first economists to foresee the limits to growth caused by scarcity of resources
 - Society's institutions depend on a sufficient consensus that its values, norms, and roles are valid; society finds a problem when it sees that it departs from the values and beliefs embodied in its institutions
 - Cognitive dissonance (mental rationalization of two conflicting ideas) builds up to push over the institution and create an 'improved' version
 - Substantial change usually requires a generational time scale; contemporary societies adapt slowly to changing circumstances
 - **Dominant Social Paradigm:** Main paradigm of an era
 - Society's dominant institutions and belief structure which organize the way people perceive and interpret the functioning of the world around them
 - Current: Democracy, acceptance of regulated capitalism, individualism, economic growth, notion of progress, faith in science and technology
 - (Economic) Growth Paradigm: Belief in the importance of growth of the economy
 - Growth dilemma: Unlimited economic growth vs. biophysical limits
 - Control dilemma: Free markets vs. government intervention
 - Distribution dilemma: Free trade vs. protectionism
 - Protectionism: Barriers such as tariffs to promote domestic growth
 - *Easterlin Paradox*: Higher levels of material consumption have not increased people's perception of their happiness

- *Environmentalism*: Belief in the protection and improvement of the natural environment
 - Arose in Western societies in 1960s
 - Increasing concern about the state of the environment because of:
 - Visible pollution of the atmosphere and of waterways
 - Devastation of bird populations by pesticides
 - Threatened extinction of the whales
 - Includes the Gaia Hypothesis, ecofeminism, etc.
 - Acknowledgement of the need to protect the environment is high
 - Not a novel idea – e.g. hunter-gatherer societies saw biotic and physical processes as having spiritual significance beyond their utility
- 3 views of the human-environment relationship:
 - Primitivism:
 - Rousseau and the 'noble savage', conservation, and Arne Naess & deep ecology
 - Unspoiled nature; interspecies equity
 - Ideally reduce the human population
 - Believe that environmental/social goodness declined greatly in the agrarian and industrial societies
 - Agrarianism:
 - Going back to work on the land
 - 'Appropriate' technology; no industrialism or consumerism
 - Believe that environmental/social goodness rose greatly during agrarian societies and declined sharply in the industrial society
 - Scientific industrialism:
 - Conservation and wise use based on scientific knowledge
 - Efficiency; sustained production
 - Believe that environmental/social goodness rose sporadically during the industrial age
- *New environmental paradigm*: Nature and natural resources should be preserved for:
 - Their intrinsic value, or
 - Utilitarian use by humans
- *Humanistic economic paradigm*: Emphasizes a hierarchy of needs rather than a collection of substitutable wants
 - Based on Maslow's hierarchy of needs in behavioural psychology
 - Assumes that preferences are interdependent and change over time

Ecological Sustainability

- The term 'sustainability' came from forestry/fisheries/groundwater industries describing how much can be harvested while still having a functioning, undamaged ecosystem

The Earth

- **Biosphere/Ecosphere:** The part of the Earth consisting of all living organisms and their collective environments
 - Includes incident energy, land, water, atmosphere, biota (primary and secondary producers, aquatic and terrestrial)
 - Biocapacity: Resources the world can regenerate/reset in a year
- **Environment/Ecology:** Complete range of external conditions (physical and biotic) in which an organism lives
 - E.g. Soil, water, climate, food supply
 - Includes social, cultural, economic, and political considerations
- **Gaia Hypothesis:** Earth is its own self-regulating biosphere/organism
 - E.g. Carbon cycle
 - Earth regenerates lost resources and fixes damaged areas
 - Organisms co-evolve with their environment
 - Proposed by Lovelock

Climate Change

- Attributed to the effects of human activity
 - Climate change happens naturally, but not as drastically as from past human activity
- Causes of climate change:
 - Greenhouse gas emissions in the atmosphere
 - Aerosols that affect the heat budget of the earth's surface and atmosphere
 - Industrial activity
 - **Atmospheric heat budget:** Net flow of heat energy coming into the Earth
 - Tied to the natural carbon cycle
 - Anthropogenic CO₂ emissions are increasing exponentially
 - CO₂ emissions could possibly be limited by a set carbon quota

- Effects of climate change:
 - Global temperature, methane, nitrous oxide, CFC, and CO₂ concentrations have been steadily increasing over the last 150 years
 - Increase in average global temperature
 - Retreat of glaciers and sea ice
 - Rise of sea levels
 - Changes in precipitation patterns
 - Extreme weather events (i.e. natural disasters)
 - Damage to biodiversity and agriculture
- Adapting to and solving climate change:
 - Political action:
 - Rio Declaration of Environment and Development
 - UNFCCC
 - Kyoto Protocol
 - Mitigation and adaptation
 - Improvements in energy efficiency; incentives for adoption of efficient technologies
 - Carbon taxes to reduce fuel usage
 - Removal of perverse subsidies
 - Removal of CO₂ from the atmosphere
 - Emissions trading system: Countries buy 'carbon credits' from countries with low emissions to be able to emit more of their own emissions
 - An example of this is in the Kyoto Protocol
 - Involves uncertainty and disagreement
 - E.g. Emphasis on mitigation or adaptation

Ecological Economics

- Based on three integrated goals:
 - Sustainable scale
 - Social fairness
 - Economic efficiency
- *Econometric view*: Belief that everything can be assigned a value
- **Ehrlich Identity (IPAT) (1991)**: $\text{Impact} = \text{Population} \times \text{Affluence} \times \text{Technology}$
 - Population: Number of people
Affluence: Consumption per person
Technology: Throughput per unit of consumption
 - Helps to relate the effects created by population and affluence increase, and development of technology
 - Relies on economic throughput
 - *Jevon's Paradox*: The greater the efficiency possible, the more the technology is used, which eventually balances the efficiency gained
 - Technology improvements do not necessarily mean an increase in ecological impact
 - E.g. Improved energy efficiency
 - Applied by the IPCC to studies of CO₂ levels
- **Gross Domestic Product (GDP)**: Market value of all the goods and services produced within the country in a given year
 - *Gross National Product (GNP)*: Market value of all the goods and services by the citizens of a country
 - GDP plus net exports and imports
 - Does not consider:
 - Distribution of wealth
 - State of the environment (e.g. Money spent on oil spill cleanup increases GDP)
 - External costs (e.g. Pollution, disasters, disease)
 - Social factors (e.g. Quality of education, equality, governmental system, crime)
- **Sustenance economy**:
 - Organic nature
 - Involves local knowledge
 - Local consumption for local needs

- **Steady-state economy:** Little or no economic growth
 - Aims for an economy which respects ecological limits
 - Evidence found that growth in developed countries does not increase happiness
- *Commodity/cash economy:*
 - Destruction of natural cycles
 - Uses nature as raw materials and resources
 - Need for centralized purchase and sale
 - Specialization and exportation
 - Surplus is a myth
- **Rational economic person:** Person seeking to maximize their own welfare and self-interests
 - Rationality indicated by efficiency and consistency
 - Ethical/moral obligations ignored
 - Wants are substitutable
 - In theory, a society consisting only of rational economic people will create an optimal state where collective welfare is maximized
 - If a collective society's welfare is not maximized by the operation of free markets, a market failure occurs
- **Ecosystem services:** Benefits obtained from ecosystems for humans
 - Goods and services
 - Considered 'free'
 - E.g. Pollination, nutrient cycling
 - **Market failure:** Economic explanation for depletion of ecosystem services
 - *(Negative) externality:* Market failure where the price does not take production and consumption benefits, or social costs, into account
 - *Transboundary externality:* Externality where an area across a boundary is affected adversely
 - Common pool resources - difficulty in excluding users from resources
 - E.g. Fisheries can drain natural stocks of marine life
 - Imperfect information and definition
 - Assigning monetary value to ecosystem services and resources:
 - Controversial
 - Creates an economic incentive to exploit resources
 - May not account for costs of environmental degradation

- *Subsidy*: Payment to businesses by a government to increase public welfare
 - **Perverse subsidy**: Subsidy which has an overall effect of reducing public welfare
- Pareto Optimality: State of economy where any increase in the well-being of any group will decrease the well-being of another group
 - Not being Pareto efficient creates market failures

Sustainability & Humanity

Political Aspects

- **Rio Declaration on Environment and Development (1992):**
 - United Nations conference
 - Based on 27 principles:
 - 1. Development is human-centred
 - 3. Developmental equity between present/future generations
 - 6. Priority to the least developed and most environmentally vulnerable countries
 - 14. Discouragement of relocation of materials/activities damaging to the environment or to human health
 - 15. Application of the precautionary principle
- **Multilateral Environmental Agreements:** Legally binding agreement between 3+ countries relating to the environment
 - *Bilateral Environmental Agreement:* Legally binding agreement between 2 countries relating to the environment
 - **UN Framework Convention on Climate Change (UNFCCC):** Agreement to stabilize atmospheric greenhouse gas concentrations to prevent dangerous levels of human interference with the climate
 - Signed and ratified by many countries
 - Created at the Rio Earth Summit
 - Led to the Kyoto Protocol
 - **Intergovernmental Panel on Climate Change (IPCC):** Scientific organization which produces reports to support the UNFCCC
 - **Kyoto Protocol:** Treaty committing countries to reduce greenhouse gas emissions
 - Implementation of the UNFCCC
 - Came into force in 2005
 - Calls for developed countries to reduce emissions and to remain within an assigned emissions quota
 - Overall emissions: 5% below 1990 levels by 2012

- Canada's position:
 - 17% over 1990 levels (Environment Canada)
 - Committed to reduce emissions from 2005 levels
 - Left the agreement in 2011, before the fines were to be enacted
 - Likely not meeting planned cuts from the 2005 levels; projections suggest we are 20% over our 2005 levels
- Problems:
 - Difficult to govern and enforce
 - Time and effort necessary to ratify and implement
 - Trade barriers
- **Millennium Development Goals (UN):**
 - 8 goals:
 - Eradicate poverty
 - Achieve universal education
 - Promote gender equality
 - Reduce child mortality
 - Improve maternal health
 - Combat diseases
 - Ensure environmental sustainability
 - Global partnership for development
 - Non-binding
 - Lack analysis and justification for prioritization of goals

Agrobiodiversity

- **Agrobiodiversity:** Variety and variability of organisms used for food/agriculture
 - Includes:
 - Soil organisms
 - Crops
 - Biocontrol agents
 - Wild species
 - Cultural and local knowledge of diversity
 - Shaped by human agricultural practices
 - Land managers manage the systems which foster Agrobiodiversity
 - Conservation of agrobiodiversity in production systems is linked to sustainable use

- Benefits:
 - Ecologically:
 - Reduce dependency on external inputs
 - Conserve soil and increase natural soil fertility/health
 - Conserve ecosystem
 - Humanistically:
 - Increase productivity, food security, and economic returns
 - Improve nutrition and provide sources of medicine/vitamins
 - Reduce risks to individuals/nations
 - Diversify products and income opportunities
- Issues affecting agriculture:
 - Genetically modified organisms and biotechnology:
 - Novel techniques for modifying organisms and their physiological processes for applied purposes
 - Joining the DNA of multiple organisms to produce a recombinant DNA
 - Little research done on its effects
 - Chemistry measurements show signs of toxicity (Séralini, 2007)
 - May have unforeseen effects in nature or our bodies
 - Religious people may see it as tampering with the building blocks which God gave humans
 - Climate change
 - Urban sprawl
 - Increase in animal-based diets
- **Conventional (Agro-chemical based) agricultural systems:** Large-scale, mechanized production of food with the use of synthetic chemicals to maintain plants and animals
 - Use of:
 - Genetically modified organisms
 - Chemical pesticides/herbicides/fertilizers
 - Mechanical processes
 - Benefits:
 - Makes food more affordable (when not taking externalities into account)
 - Produces more food while requiring less land

- Drawbacks:
 - Pesticides reduce beneficial species
 - Pests become resistant or spread to a new crop, requiring more pesticide
 - Waterlogging and salinity caused by cheap, impure water
 - Loss of soil nutrients/fertility caused by overfarming and erosion
 - Compacting and crusting caused by use of heavy machines
 - Tilling allows exposed soil to be eroded
 - Acidification and toxic pollution caused by chemicals from the environment
 - Developed countries' production of great amounts of food lowers the cost of food (globally if the food is sold internationally) and local farmers cannot keep up with the monopolies held by the large businesses from overseas selling food at much lower prices
- Solutions to land degradation:
 - Encourage natural processes
 - Reduce use of external inputs
 - Reduce machinery usage (e.g. tilling)
 - Increase use of self-knowledge
 - Increase use of mulch for soil structure and weed killing
 - Increase crop rotation
 - Emphasis on production systems which include conservation
- **Organic farming**; Labour-intensive production of food without synthetic inputs
 - Involves natural nutrient cycling (crop rotation) and biological pest control
 - Less environmental impact
 - More humane to animals
 - Drawbacks:
 - More expensive
 - Less yield
 - Badgley & Perfecto (2007) found that organic yield can contribute substantially to feeding current and future generations on the agricultural land base
 - **Certified Organic Associations of British Columbia (COABC)**: Organization representing provincial organic certifying agencies

Resource/Energy Use

- **Absolute/Malthusian scarcity:** There is more demand for a resource than the amount of resource which is available to be used
- Resources:
 - **Renewable resources:** Resources replaceable through natural processes
 - E.g. Oxygen, animals, natural gas
 - Tends to recover towards its carrying capacity
 - **Sustainable yield:** Rate of harvest is less than or equal to the rate of recovery so no lasting damage is done
 - Depletion of the resource over the sustainable yield is called 'mining'
 - **Non-renewable (exhaustible) resources:** Resources not replaced by natural processes on a human-relevant time scale
 - E.g. Copper, natural gas
 - Cannot all be recovered after use and eventually becomes dispersed into the environment
 - Energy is dissipated as low-grade heat which is lost in space
 - **Throughput resources:** Resources effectively in constant supply
 - E.g. Energy from the sun, water (e.g. rain, geyser steam, hydroelectricity), oxygen
 - Cannot be depleted or enhanced
- **Assimilative capacity:** Amount of residue/damage the environment can absorb without lasting damage or inhibition
 - Akin to a renewable resource:
 - If the rate of discharge is low, then little environmental harm is caused.
 - If the rate of discharge is high, then the assimilative capacity will be exceeded and lasting harm will be done.
 - **Critical threshold:** Point beyond which environmental harm is irreversible
- Recycling:
 - Matter can be recycled; energy cannot be recycled
 - Waste heat can be used in another process which requires heat
 - Requires further energy to recover some energy from the recycled product (Less energy required than to make the object from raw materials)

- Water:
 - Running out of fresh water due to unsustainable use:
 - Water consumption is increasing
 - Increasing amount of people facing a scarcity of clean water
 - Some usable water is too difficult to reach for use
 - Often made up for by tapping ground water
 - When rate of extraction exceeds rate of renewal, the well dries up
 - Major problem in India, China, Australia, Middle East, etc.
 - Many wells expected to dry up and be uneconomic to pump by 2050
 - Countries use more than their produced clean water
 - Ogallala Aquifer: Large body of groundwater lying under multiple US states
 - Formed 20 million years ago
 - Irrigates 20% of all US cropland
 - Negligible recharge; immense drawdown (falling 2m per year)
 - Common property resource
 - Consequences of overuse:
 - Local climate change
 - Windblown salt/dust
 - Loss of fisheries
 - Increased risk of respiratory diseases
 - Runoff and groundwater contaminated with pesticides and fertilizer
 - Solutions:
 - Careful irrigation
 - Speeding up water renewal systems (e.g. in cities)
 - Limit countries from using more than their annual production
 - Global freshwater conflicts (Key issue: International rivers):
 - Trans-boundary
 - 1831 water-related disputes in the last 50 years; disputes expected to increase
 - 3000 water-related treaties negotiated in the last 50 years
 - E.g. Colorado Basin (US & Mexico), Ganges-Brahmaputra (India/Bangladesh)
 - Aral Sea (Central Asia):
 - Once the world's 4th largest lake
 - Fed by 2 rivers which were diverted to grow cotton and rice
 - Input fell to 0; lake shrunk to a fraction of what it once was

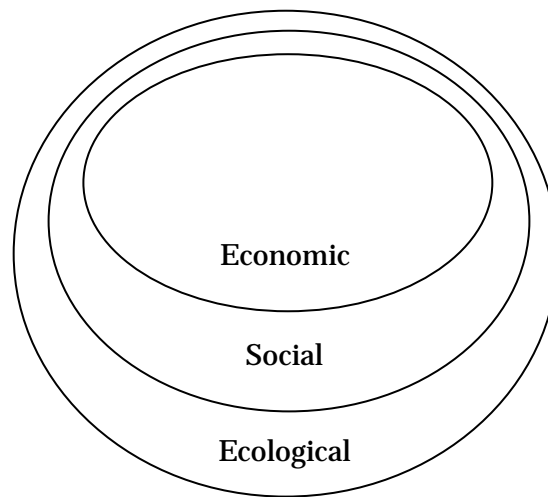
- Supply management:
 - Limited opportunities to build dams
 - Dams and other infrastructure damage the ecosystem by changing the quantity and quality of water flowing downstream
 - Importing water
 - E.g. Via pipeline/canal from the Nile River
 - Wastewater treatment
 - Desalination (reverse osmosis)
- Demand management issues:
 - Inefficiency in irrigation
 - Pricing (e.g. irrigation subsidies vs. shantytowns)
- Energy sources:
 - Fossil fuels: Declining use because of high costs
 - Nuclear power: Great costs (building/maintenance); possibility of serious accidents
 - Solar power: Expensive; requires many panels for little power
 - Tidal power: Expensive and intrusive in the marine environment
 - Utilizes temperature difference between deep water and surface water
 - Wind: Sometimes viewed as an eyesore
 - Safest energy source
 - Expensive and less reliable

Miscellaneous

- Global problems:
 - Created because:
 - Drive towards short-term fulfillment of needs
 - Lack of awareness of how systems are connected
 - Difficulties in solving them:
 - **Tragedy of the Commons:** Theory that open access leads to selfish overuse
 - Concept described by Hardin
 - E.g. Degradation of open access soil/land through too many animals using the land
 - Tension between developed and less developed countries
 - Difficult to bind countries to an agreement
 - Difficult to agree on an issue to be focused on

- Corollary: Everything is connected
 - Fundamental Principle of Ecology: You can never change just one thing
 - Fundamental Principle of Economics: There is no such thing as a free lunch
 - Fundamental Principle for Interpreting Politics: Anyone who says they have the answer has not understood the question
- **Living Planet Index (LPI)**: Reflects changes in the health of ecosystems by tracking population numbers
 - Aggregate of the temperate LPI and the tropical LPI
 - 30% decline between 1970 and 2007
 - Terrestrial Living Planet Index: Populations of birds, mammals, amphibians, and reptiles from forests, grasslands, and drylands
 - Marine Living Planet Index: Populations of fish, seabirds, and marine turtles/mammals from marine ecosystems
 - Freshwater Living Planet Index: Populations of fish, birds, reptiles, amphibians, and mammals from freshwater ecosystems
- **Social Development Indicators (SDI)**: Evaluation and progress monitoring of a critical social development parameter
 - **Social development elasticity (SDE)**: Percentage change in the ratios of income distribution
 - Ratio of income of the richest 20% to the poorest 20% of the population
- 3 spheres of sustainable urban development:
 - Ecological sphere:
 - Efficient and ecologically sensitive land use
 - Reduction in the use of natural resources
 - Reduction/elimination of pollution
 - Social sphere:
 - Within the ecological sphere
 - Equality
 - Community capacity/engagement/involvement
 - Urbanity – Embracing the traditional lure of urban areas
(May not necessarily be the best way)
 - Economic sphere:
 - Within the social and ecological spheres
 - Economic security
 - Local self-reliance (greater use of local resources and industries)
 - Ecologically sound economic activity (e.g. sending waste paper to China for recycling is not ecologically sound)

- Example of the hierarchy: Without the social structure, the economic structure would be worthless and collapse

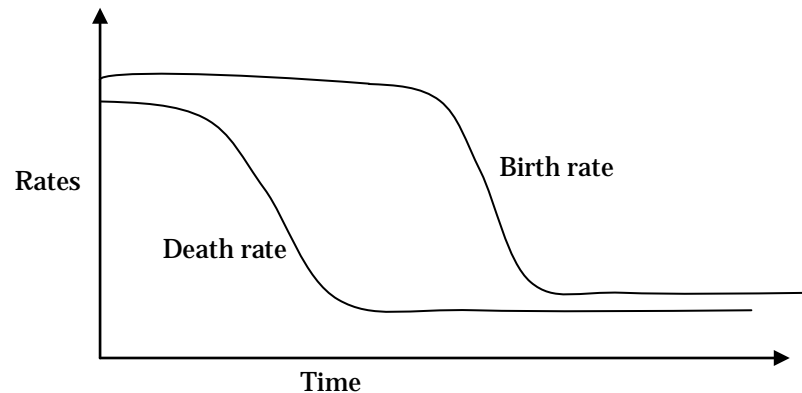


- Case study: Southeast False Creek – The Olympic Village
 - **Communicative participation:** Participation in which all participants arrive at a mutual understanding regarding substantive (things definable through numbers) and normative (things which should happen) issues they are addressing in the planning process
 - Concerns:
 - Ecologically sound
 - Intersection of transit lines
 - Walking distance to downtown
 - In 1990s, groups were established and events held to kickstart activity, planning, and development
 - 2010 Olympics was the catalyst to allow further sustainable projects to happen
 - Drawing conclusions:
 - Inclusiveness: Failed to address cultural background issues (e.g. Aboriginals)
 - Equality of opportunity: relative level of equality
 - Mutual understanding: Participants came to mutual understandings
 - Transparency: Reasonably open process, but not as transparent as it should have or could have been
 - Power impartiality: Power played a significant role
 - Weak sustainability achieved

- Ecological aspects:
 - **Carrying capacity:** Maximum population size that the environment can sustain indefinitely
 - Not necessarily a desirable level of population or living
 - **Ecological footprint:** Amount of productive land and water required to produce all the resources a given population consumes and absorb the waste produced
 - Measured in hectares
 - Resource accounting tool; non-monetary way to measure environmental impact
 - *Ecological overshoot:* Consuming renewable resources faster than they can be regenerated
- Food and food production:
 - Genetic modification and engineering exponentially increases our ability to produce food
 - Greater amounts of consumption creates diminishing yields, and health concerns create objections to genetic modification
 - Soil depletion due to over farming
 - Fertilizers and added soil nutrients can help growth, but can also be expensive and leach chemicals into the environment/water sources
 - Malnourishment and malnutrition in developing countries due to not enough money to buy the food (though there is a surplus of food)
 - Fish harvests are declining due to overfishing
 - Bird populations are declining
- Life cycle of a specific item must be analyzed completely to determine its overall impact on the environment
- Urban ecosystems:
 - 7 different natural categories:
 - Street trees
 - Lawns & parks
 - Urban forests
 - Cultivated land
 - Wetlands
 - Lakes/sea
 - Streams

- Urban vegetation:
 - Improves air quality by filtering chemicals from the air
 - Decreases energy usage for heating and cooling of buildings
- Water areas even out temperature deviations
- Flora and fauna create an overall positive effect on the social environment
- Implementations of sustainable development:
 - Green roofs:
 - **Extensive green roofs:** Inaccessible to the public
 - Shallow soil planters
 - Hardy plants requiring little to no irrigation
 - **Intensive green roofs:** Accessible to the public
 - Deep soil planters
 - Park-like plantings requiring irrigation
 - Car-free developments:
 - Require local, easily accessible services and supplies (e.g. transportation, grocery stores)
- Socio-cultural aspects:
 - **Institution:** Elemental structure required for the functioning of a society
 - Embodies values, norms, roles that a society believes to be essential for its continued existence
 - E.g. Politics, governance/law, economy and work, arts and education
 - Demographic transition:
 - Population growth:
 - Locally/regionally:
 - Caused by natural increase (birth rate greater than death rate) and immigration
 - Globally:
 - Caused by natural increase
 - Major differences in population growth in developed countries versus in developing countries
 - Does not necessarily imply increased environmental degradation

- Stages:
 - 1st stage: Birth/death rates fluctuate with a little overall increase
 - 2nd stage: Death rates decline; birth rates stay high
 - Causes: Sanitation, healthcare, etc.
 - 3rd stage: Birth rates decline
 - Causes: Improvements in social power of women, better overall standards of living



- Causes for having higher birth rates:
 - Infant mortality creates a need for 'insurance children' in case some of them die
 - Need for manpower
 - Parents' dependence on their children
- Better to change social costs instead of private costs as incentives for people to make changes in their lives
 - E.g. Manipulating costs, carbon quota
 - Increased income increases consumption
- **Precautionary principle:** Actions are assumed harmful to people and the environment unless scientifically proven otherwise
 - Social responsibility to protect public/environment from harm; duty to prevent harm when it is in our power to do so
 - Shifts burden of proof onto those who might harm the environment

- Ownership of the environment:
 - Implies the right to use the property and to control who may use it
 - Property is an institution
 - Private:
 - Individuals or corporations
 - Established and controlled by cultural and legal systems
 - Access by permission
 - State:
 - Government or government corporation
 - In the public interest
 - May be sold, rented, or given away
 - Open access:
 - May not be owned by anyone
 - Tragedy of the Commons may occur
- Less developed areas (in general):
 - Lack sanitary sewage disposal (e.g. Dubai)
 - Lack an adequate water supply
 - Have greater public health issues
 - Asia is responsible for many major problems in terms of negative aspects of population growth
 - Less expenditure on health care