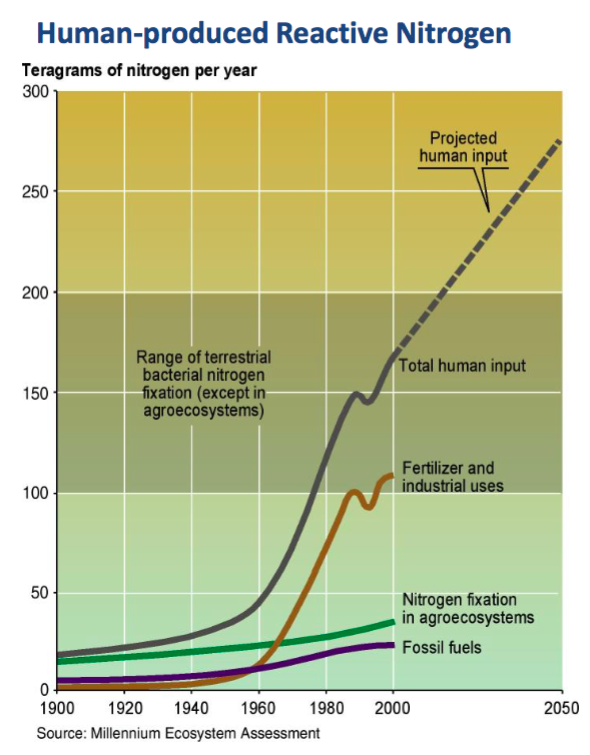
**MODULE 1 – ENVIRONMENT & RESOURCES**

**Unit 1: Change In Natural Systems: Timescales Involved, Types of Changes, & Examples**

* Humans have constantly experienced changes
  + i.e. The Little Ice Age from Medieval Times to end of the 19th century
    - People in Europe experienced cold conditions
* Variation is constant in natural systems
  + i.e. Oscillations between cold glacial periods, and warm interglacial periods, over the past several hundreds of thousands of years
* Changes in natural systems seemingly are now more abrupt or are happening faster
* Earth’s climate is changing (global warming), and so is our environment
  + Since the 19th century, global average surface temperature has been increasing
* There is strong evidence that human activities are a key driving force behind environmental change
* These changes are due in part to how humans are interacting with natural systems, in their activities
  + i.e. Atmospheric pollution, deforestation, mining, etc.

**Unit 2: The Millennium Ecosystem Assessment, Its Findings, & Development Goals**

* The Millennium Ecosystem Assessment was called for by the UN Secretary – General Kofi Annan in 2000
  + It was carried out between 2001 and 2005 to assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well-being
  + Involved the work of more than 1,300 experts from 95 countries
* Findings provide a scientific appraisal of the condition and trends in the world’s ecosystems; and options to restore, conserve or enhance the sustainable use of ecosystems
  + The experts concluded that many of the changes are non-linear and once they start, the processes of degradation will increase rapidly
* The Millennium Development Goals were adopted by the United Nations, in 2000
* This is an attempt to adopt at global scale goals for reaching a sustainable society by 2015, and to improve human well-being by:
  + Reducing poverty, hunger, child/maternal mortality
  + Ensuring education for all
  + Controlling and managing diseases
  + Tackling gender disparity
  + Ensuring environmental sustainability
  + Pursuing global partnerships
* Here are some highlights of the findings made by the Millennium Ecosystem Assessment
  + There’s a change in the structure and function of ecosystems
    - i.e. More land was converted to cropland in the 30 years after 1950 than between 1700 and 1850
  + Cultivated Systems in 2000 cover 25% of Earth’s terrestrial surface
    - Defined as areas where at least 30% of the landscape is in croplands, shifting cultivation, confined livestock production, or freshwater aquaculture
  + The amount of water in reservoirs has quadrupled since 1960
    - In terms of intercepted Continental Runoff, it means that there is 3 – 6 times as much water in reservoirs as in natural rivers
  + Water withdrawn from rivers and lakes has doubled since 1960
  + 70% of water use worldwide is for agriculture.
  + It is estimated, with low to medium certainty, that for 5 to possibly 25% of global freshwater, the use exceeds long-term accessible supplies
  + 15 - 35% of water withdrawn for irrigation exceed supply rates and are therefore unsustainable
  + Since 1960, the Flows of biologically available nitrogen in terrestrial ecosystems have doubled
  + Over 50% of all the synthetic nitrogen fertilizer ever used has been used since 1985
    - The Flows of phosphorus have tripled during the same period
  + The amount of biologically available nitrogen may grow a further 65% by 2050
  + The following graph shows the changes that have occurred since the start of the 20th century and the projections for 2050



* + In parallel, 60% of the increase in the atmospheric concentration of CO2 that has occurred since 1750, has taken place since 1959
  + The distribution of species on Earth is becoming more homogenous
    - This means that the set of species in any one region of the world are becoming more similar to other regions.
    - This is largely as a result of the massive movement of species associated with increased travel and shipping.
      * i.e. Growth in Number of Marine Species Introductions in North America and Europe
    - In addition, the population size or range (or both) of the majority of species across a range of taxonomic groups is declining

**Unit 3: The Different Perspectives On What Constitutes A Resource**

* Resources are specific components of the environment, such as forests, oceans, rivers, lakes, minerals, petroleum, and wildlife
* There are different perspectives on what constitutes a resource
* Anthropocentric view says that value is defined relative to human interests, wants, and needs
  + Elements in the environment, such as minerals, or animals, do not become resources until they have value for humans
    - i.e. Coal and copper were not considered resources until humans understood how they could be used, and had the technology to access and utilize them
* Ecocentric and Biocentric says that resources exist independently from human desires
  + They ecological and existence value in their own right
  + They do not necessarily have an immediate value to humans
  + Their value reside in that they contribute to Earth as a global ecosystem
    - i.e. Grizzly bears have intrinsic value regardless of their value to people
* The difference between the Biocentric and Ecocentric views is that non-living components are part of an Ecocentric perspective, not just living beings
  + The physical integrity of ecosystems is also important according to this Ecocentric view
    - i.e. Water quality, air quality, etc.

**Unit 4: The Different Approaches To Understanding The Environment, And Our Relation To It**

* Disciplinary Approach is organized around the concepts, theories, assumptions, and methods associated with one academic discipline – may limit understanding of complex systems
  + This approach breaks down environmental problems in different parts, that may be easier to grasp
    - For instance, we can consider a problem from the perspective of the field of biology, from the perspective of environmental chemistry
  + This however, represents a reductionist view of the environment
* In a Multidisciplinary Approach, specialists examine an issue from each of their disciplinary perspectives, and their findings and insights are synthesized, increasing understanding
  + A drawback is that combining results after the research has been conducted may result in a lack of connecting research
* In Cross-Disciplinary Approach, a disciplinary specialist borrows concepts, theories, and methods from other disciplines to enhance their perspective.
  + i.e. A soil specialist using concepts and methods from plant science
  + It can increase understanding of a problem, or can also lead to misunderstanding
  + The researcher may also overlook material with which he or she is unfamiliar
* In Interdisciplinary Approach, various specialists work together from the beginning of a project, leading to synthesis and integration of understanding
  + This approach is time-consuming, requiring trust, patience and openness
  + This approach incorporates the benefits of all disciplines right from the start – therefore connective research needs can be identified
    - A drawback is that it takes extra money and time or communication
* Transdisciplinary Approach extends the interdisciplinary perspective by seeking a holistic understanding that transcends disciplinary boundaries, not viewing them in the context of any one discipline and weighing each area equally
  + This can enhance understanding or lead to confusion or information overload.
  + An example is sustainable development, which brings together concepts and methods from the environmental science, engineering, and economics
  + It includes equally important research from environmental, social and other areas of research
  + When managing resources and environmental problems, from a science perspective, all the relevant information and interpretation must be considered

**Unit 5: Sustainable Development And Livelihoods**

* Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs
  + It has 3 strategic aspects

1. It presents a vision regarding the nature of future societies, for example a notion of human stewardship of nature
2. It emphasizes a system of governance and management characterized by openness, transparency, decentralization, and accessibility
3. It seeks to ensure that economic, environmental, and social aspects are considered together, and that trade-offs are visible and transparent to those affected
   * Some believe that it provides a compelling vision for the 21st century and acknowledges longer-term development implications and the need to balance social, economic and environmental considerations
   * Others believe that the term is so vague that it can be used in different ways to suit varying and often conflicting interests, such as justifying economic growth so that future generations have same standard of living

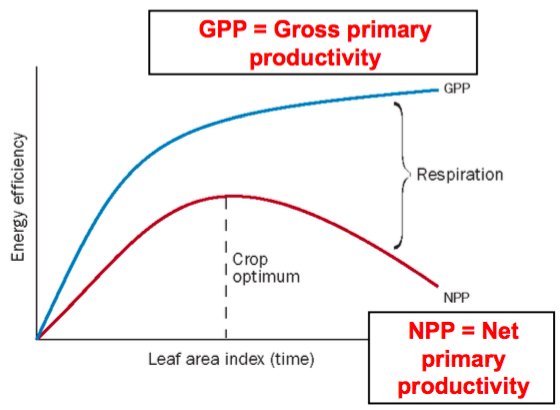
* Sustainable livelihoods emphasize the conditions necessary to ensure that basic human needs are satisfied
  + It is a human-centered approach to broad environmental management
  + Directed towards ways for local people to meet their basic needs as well as other needs related to security and dignity through meaningful work
  + Aims to minimize environmental degradation, rehabilitate damaged environments, and address concerns about social justice

**MODULE 2 – ECOSYSTEMS & BIODIVERSITY**

**Unit 1: High-/Low-Quality Energy**

* Low-quality energy is diffuse, dispersed, and difficult to gather (i.e. Ocean Tides)
  + Majority of energy in the ecosphere is low-quality
* High quality energy, such as a hot fire or coal is easy to use, easy to harness, provides intense energy, but the energy disperses quickly (i.e. Non-renewables)
  + High-quality energy has low entropy
    - As it is transformed, entropy increases
* The energy type should be matched to use to maximize efficiency
  + i.e. House heating systems usually only need low-quality energy to be satisfactory
  + However, this is not what we see in reality, in most developed countries
    - Instead high-quality energy is dominantly used
      * i.e. High-powered lines
  + Generation from powerful source such as nuclear energy
  + The use of fossil fuel is another example: only about 10% of the chemical energy of the gas is actually converted into mechanical energy
    - Rest is dispersed into the environment as low-quality energy (i.e. Heat)
      * This results in increase in entropy and energy that cannot be recycled (at least not easily)
        + i.e. Coal takes a long time to create, while its energy is quickly used

**Unit 2: Differences In Productivity Between Ecosystems**

* Gross primary productivity (GPP) is the overall rate of biomass production
* Cellular respiration (R), is the metabolic cost and must be subtracted from the GPP to reveal the net primary productivity (NPP)
  + NPP: Amount of energy available to heterotrophs by producers
* The diagram below shows productivity of a forest as it grows over time
* Forestry aims to target the crop optimum (where the maximum NPP is attained)
  + Humans use 40% of all terrestrial NPP for their own use
* The most productive ecosystems are wetlands and tropical rainforests
  + The least are deserts, the Arctic and open ocean
* Measurements can also be made of net community productivity (NCP), including heterotrophic and autotrophic respiration
  + Over time, natural systems mature towards maximization of NCP
* Auxiliary energy flows allow some ecosystems and sites to be very productive
  + i.e. Tidal energy in an estuary brings in nutrients and helps dissipate wastes

**Unit 3: Ecological Succession**

* Ecosystems and communities change over time
  + Change is driven by many factors including abiotic conditions and species’ tolerances
  + Change can be rapid or slow
  + Species will have to respond to climate change
* Ecological succession is the gradual replacement of one assemblage of species by another as conditions change over time
  + Succession is not always linear
    - Cyclic succession may occur if a community was hit again by a disturbance
  + There are two basic types of succession: primary succession and secondary succession
* Primary succession is the colonization of a previously un-vegetated surface, where little or no soil exists
  + i.e. When a glacier retreats or a landslide removes all traces of the vegetation of the previous ecosystem
* Primary colonizers are the first species to occupy the area, and must be able to withstand harsh conditions
  + i.e. Lichens (and later, mosses) (grasses in dune systems)
* Secondary succession is the sequential development of biotic communities on previously vegetated surfaces that have soil cover, and that have been disturbed
  + i.e. Abandoned farm fields, a forest after a wildfire
  + It develops faster than primary succession, and is initiated by invading species such as annual ‘weeds’
* The next stage in successional advance is usually invasion by herbaceous plants such as grasses and ‘weed’ species
  + The seeds that lie ‘in wait’ in the soil are considered to be part of the soil seed bank
* The next stage is hardy shrubs and light tolerant trees, with trees dominating the final stage
* Each stage along the way is known as a seral stage
  + Seral stages may blend into one another, rather than being discrete
    - Blended areas have high species diversity and are known as ecotones
* It was long believed that vegetation would reach a well-defined, stable stage called the climax community
* This final successional stage was believed to be in equilibrium with the environment
  + It has now become clear that equilibrium conditions are rare
* Disturbances are so common that most systems never reach a dynamically stable climax stage: fires, insect infestations, flooding, ice storms
  + Communities do not always reach a stable climax community, and a climax should be seen as constantly evolving

**Unit 4: Keystone Species And Hyperabundance**

* Species with a strong influence on the whole community are known as keystone species
  + i.e. Beaver which modifies the hydrological regime at given locations
  + It is very significant when a keystone species is removed from an area, or extirpated, by human activity; a cascade of affects typically ensues
* Hyperabundance: In very great abundance (abundance = plenty)

**Unit 5: R & K Strategists**

* Different species have different reproductive strategies
* R-Strategists produce large numbers of young early in life and over a short time period, but invest little parental energy in their upbringing
  + i.e. Insects, rodents, algae, annual plants, fish, etc.
  + Such species are usually small and short-lived; they are opportunists; and tend to dominate the early seral stages of the successional process
  + They focus on the quantity of their offspring
* K-Strategists focus on quality; they produce few offspring but devote time and effort to ensuring these offspring reach maturity; they tend to live longer and are larger
  + i.e. Larger mammals, including humans
  + Many endangered species are K-strategists

**MODULE 3 – ECOSYSTEMS & MATTER CYCLING**

**Unit 1: What Are Biogeochemical Cycles, How They Work, Their Different Types, And The Different Types Of Nutrients**

* Biogeochemical cycles are the biological, chemical, and geological processes and components by which materials cycle through ecosystems
  + Generalized models of these cycles help us represent the complexity of Earth’s processes
  + Nutrients are stored in compartments; there is often a large, slow-moving abiotic pool
  + Nutrients move between compartments; rapidly interacting biotic-abiotic exchange pool
* Matter cycles among components of the ecosphere
  + These cycles are essential to life
* Nutrients are elements necessary for life
  + Macronutrients are needed in fairly large amounts by all organisms
  + Micronutrients are required in smaller amounts by most species
* Ecosystems vary substantially in terms of the speed of cycling and the relative proportion of nutrients in each compartment (i.e. Temperate Vs. Tropical forest soils)
  + Speed of cycling may also change within a cycle, depending on season and type of nutrient
    - i.e. It may take up to 300 years for an atom of carbon to pass through the entire carbon cycle
* Residence time: the typical length of time something stays in one compartment
  + i.e. CO2 in the atmosphere (5 – 7 years)
* Detritus food chains are the main means by which nutrients in the biotic component of the ecosphere are recycled to the abiotic component for future reuse
  + They are Earth’s major mediator in nutrient recycling
* Decomposer organisms include fungi, earthworms, slugs, snails, beetles, ants, termites, and heterotrophic bacteria. Each plays its own role in nutrient recycling
* Under natural conditions, recycling rates between components achieve a balance over time in which inputs and outputs are equal
* Human activities speed up the transfer between the components of cycles
  + Many pollution problems result from human-induced accumulation in one or more components of a cycle that is too great for natural processes to dissipate
* Cycles can be classified according to the main source of their matter
  + Gaseous cycles have most of their matter in the atmosphere
    - i.e. The Nitrogen Cycle
* Sedimentary cycles hold most of their matter in the lithosphere (i.e. Phosphorus and Sulfur)
  + Elements in sedimentary cycles tend to cycle more slowly than those in gaseous cycles
    - Because elements may be locked in geological formations for millions of years
  + These cycles mobilize materials from the lithosphere to the hydrosphere and back to the lithosphere
* Carbon is most abundant in rocks and sediments on Earth
  + Also, it is the most relevant to biological activity that is in the atmosphere

**Unit 2: The Importance Of Phosphorus; The Major Features Of Its Biogeochemical Cycle, And The Associated Environmental Impacts**

* Phosphorus is a macronutrient incorporated into many organic molecules
  + It is essential for metabolic energy use
  + It is relatively rare on the Earth’s surface in relation to biological demand; it is critical that phosphorus cycles efficiently between components
  + It is not well-replenished via weathering or soil availability
    - The amount retained by biomass is critical
* Phosphorus is often the dominant limiting factor in freshwater aquatic ecosystems and for plant growth in terrestrial soil
  + Hence the need for use of fertilizers; they are rich in phosphorus
* Nitrogen and carbon cycles in the ocean, which are key in a response to global warming, are ultimately controlled by phosphorus thus it will be a main determinant of global futures
* The availability of phosphorus in the soil is influenced by soil acidity
  + It gets bound into insoluble compounds under very acidic, and very basic conditions
    - Therefore, acid precipitation limits phosphorus availability
* Rocks in the Earth’s crust are the main reservoir of phosphorus
* Animal wastes are also a large source of phosphorus (to soils)
* Decomposition also provides phosphorus to soils
* Bacteria mineralize phosphorus in soil, back into inorganic phosphate, making it available to plants
* Phosphorus in soil is taken up by plants or removed by water transport
* Transport of phosphorus and other nutrients by streams into lakes and oceans enhance the productivity of estuaries and other coastal ecosystems, and enter the oceanic food chain via uptake by phytoplankton
* Guano are marine bird droppings which return phosphorus from marine food chain back to land
  + They are a main source of phosphorus for fertilizer
* Humans interfere in the phosphorus cycle by:
  + Mining phosphorus-rich rock for fertilizers and detergents, leading to excess phosphorus in runoff
  + Removing biomass, leading to erosion and phosphorus in runoff
  + Concentrating organisms that produce phosphorus in waste, such as cows, pigs, and ourselves, leading to waste and phosphorus in runoff
  + Removing phosphorus from oceanic ecosystems through fishing, leading to more inputs of phosphorus to freshwater (and ultimately to marine system again)
* The result is eutrophication from excessive phosphorus accumulation on freshwater systems

**Unit 3: The Importance Of Nitrogen; The Major Features Of Its Biogeochemical Cycles**

* Nitrogen is a colorless, tasteless, odorless gas required by all organisms for life
  + It is an essential component of chlorophyll, proteins, and amino acids
  + The atmosphere is over 78% nitrogen gas (N2), and contains other forms of Nitrogen such as ammonia (NH4), nitrogen dioxide (NO2), nitrous oxide (N2O) and nitric acid (NO)
* The atmosphere-lithosphere interface is where most important nitrogen cycling occurs through biological activity
* The main way in which the atmospheric reservoir is linked to the biotic components of the food chain is through nitrogen fixation and denitrification, both mediated through microbial activity
* Mineralization, nitrification and denitrification are also important processes in the nitrogen cycle.
* Nitrogen is often a limiting factor in terrestrial soils
* Nitrogen fixation occurs as bacteria transforms atmospheric nitrogen into various forms that are available to plants, such as nitrate and ammonium
  + The most important nitrogen fixers are bacteria of the Rhizobium family that grow on root nodules of plants
    - In the pea or legume family
      * An example of mutualism
  + Chemotrophic bacteria fix N2 into NH3 and NH4
  + Other bacteria and algae that fix nitrogen are not attached to specific plants. These free-living nitrogen fixers are important in the Arctic and the ocean.
* 5% of nitrogen occurs in the atmosphere via lightning
* Nitrogen is tightly circulated in most ecosystems between dead and living biomass.
* Most physical nitrogen in soil (nitrates and ammonium salts) comes from the breakdown of existing biomass by decomposer food chains
* Mineralization is the process by which decomposing biomass (i.e. Dead plants) is converted back to ammonia (NH3) and ammonium salts (NH4) by bacterial action and returned to the soil
* Nitrification is when chemotrophic bacteria convert NH3 and NH4 into nitrates (NO3-) and nitrites (NO2-)
* Denitrification is when anaerobic bacteria convert nitrates (NO3-) into nitrogen gas (N2), returning it to the atmosphere
* Nitrates are highly soluble in water; it is easily lost to the ecosystem via surface runoff
* Ammonia tends to adhere to soil particles; it is susceptible to loss by soil erosion
* Like phosphorus, nitrogen is often a limiting factor for growth. When excessive concentrations occur in water, it is a major contributor to the process of eutrophication
* Unlike phosphorus, however, nitrogen is not immobilized in deep-ocean sediments but has an effective feedback mechanism to the atmosphere from the ocean through microbial denitrification
* Humans interfere in the nitrogen cycle by chemical fixation to supply nitrates and ammonia as fertilizer, leading to runoff of excess fertilizer (contributing to eutrophication) and denitrification
  + This contributes to climatic change
  + Humans also interfere in the nitrogen cycle by the removal of nitrate and ammonium ions from agricultural soils through the harvesting of nitrogen-rich crops.
    - And high-temperature combustion, which produces nitric oxides (NO) that combine with oxygen to produce nitrogen dioxide (NO2), which reacts with water vapor to form nitric acid (HNO3), a main component of acid deposition.

**Unit 4: The Importance Of Carbon; The Major Features Of Its Biogeochemical Cycle, And**

**The Associated Environmental Impacts**

* Carbon dioxide makes up only 0.03% of atmospheric gases, but it is the main reservoir for the carbon that is the building block for all necessary fats, proteins, and carbohydrates that constitute life
* Plants take up carbon dioxide directly from the atmosphere through the process of photosynthesis and at the same time emit oxygen
* Carbon is incorporated in biomass and passed along the food chain
* Respiration by organisms transforms some carbon in biomass back into CO2 which enters atmosphere
* Cellular respiration by decomposers helps to return carbon from dead organisms into the atmosphere as CO2 and in anaerobic conditions as methane (CH4)
* The cycling of carbon and the flow of energy through food chains are closely related
* Carbon can be stored in the lithosphere for extended periods of time as organisms become buried before they decompose
  + This is particularly true under relatively inefficient anaerobic decay conditions such as in peat bogs
* Over millions of years, past forest, marine, and freshwater ecosystems have been transformed into fossil fuels through heat and compression
* Carbon dioxide can be dissolved in shallow ocean waters for up to 6 years, or deeper ocean waters for up to 350 years
  + The oceans’ capacity to store CO2 may be decreasing under increased atmospheric CO2
  + Large amounts of carbon are stored for much longer periods in the ocean through the death of marine organisms with calcium carbonate (CaCO3) shells, which eventually form rocks
* Humans are interfering in the carbon cycle by replacing natural ecosystems with land uses such as urban and agricultural systems, that have reduced capacity to uptake and store carbon
* Human activity, particularly industrial activity, has mobilized large amounts of fossil fuels from the lithospheric component of the cycle to the atmospheric component
  + We release the equivalent of one million years of photosynthetic activity annually
* Atmospheric carbon dioxide now exceeds 390 ppm; more than 90 ppm above the maximum values of the past 740,000 years. This value has surpassed 400 ppm.

**Unit 5: The Importance Of The Hydrological Cycle; Its Major Features, And The Associated Environmental Impacts**

* Humans interfere in the hydrological cycle by:
  + The storage and redistribution of runoff to augment water supplies for domestic, agricultural, and industrial uses
  + The building of storage structures to control floods
  + The drainage of wetlands
  + The pumping of groundwater
  + Cloud seeding
    - Changing the amount or type of precipitation that falls from clouds, by dispersing substances into the air that serve as cloud condensation or ice nuclei
      * This alters the microphysical processes within the cloud
  + Land-use changes
    - i.e. Deforestation (cutting trees to make urban centers)
  + Urbanization
    - The process of making an area more urban (i.e. Building skyscrapers & homes)
  + Agriculture that affects runoff and evapotranspiration patterns
    - Evapotranspiration is the sum of evaporation and plant transpiration from the Earth's land and ocean surface to the atmosphere
  + Climatic change caused by interference with biogeochemical cycles
    - Biogeochemical cycles are the biological, chemical, and geological processes and components by which materials cycle through ecosystems

**MODULE 4 – ENVIRONMENTAL PLANNING & MANAGEMENT**

**Unit 1: Social Learning; Single-Loop Learning; Double-Loop Learning**

* Social learning is learning applied not only to individuals but also to social collectives, such as organizations and communities
  + Resource and environmental management processes should be designed so that both individuals and organizations are able to learn from their experience and become more knowledgeable and effective in the future (“theory of action”)
  + Both single and double-loop learning should be used
* The emphasis in single-loop learning is to ensure a match between intent and outcome
  + It leads in a change to conditions as a result of monitoring
  + It asks what is the right way to get something done
    - i.e. A thermostat receives information and takes corrective action to ensure an outcome consistent with intent
* Double-loop learning addresses a condition, when there is a mismatch between intention and outcome
  + Challenges underlying values and behavior
    - i.e. Why do we want to regulate temperature in the first place?
  + This encourages ‘out of the box’ thinking
    - It asks: What is the right thing to do?

**Unit 2: Ingenuity Gap**

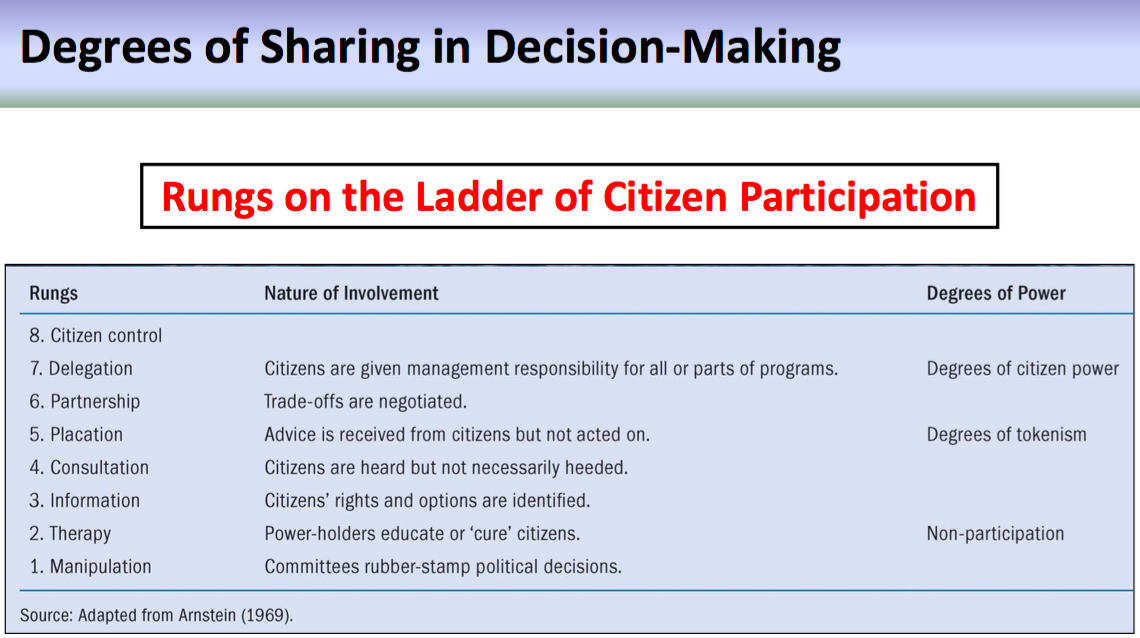
* The ingenuity gap refers to the mismatch between the supply of ideas needed to fix environmental problems and the availability of such ideas
  + Four other contextual aspects are important for understanding lack of progress relating to managing resources and the environment:
    - The preoccupation of many national governments with debt and deficit reduction, leading to reduced funding to environmental infrastructure and services
    - Many national and state governments have been downloading responsibilities for environmental services to lower levels of government (subsidiarity / efficiency)
    - Commercializing of such services
    - Privatizing these services
    - Ideology influences environmental management
  + The preceding four characteristics are often associated with the neo-liberalism; a political theory based on the belief that humans’ well-being is best achieved by encouraging and facilitating individual freedom and minimizing the role of government.
* The defining features of neo-liberalism are:
  + Strong private property rights
  + Free markets
  + Free trade
* Neo-liberalism has been shown to impact resource and environmental management by:
  + Limiting environmental legislation and regulations
  + Reducing key management agencies
  + Scaling back public participation opportunities
  + Rearranging responsibilities amongst agencies
  + Increasing scope of voluntary compliance and self- monitoring within the private sector

**Unit 3: What Is The Ecosystem Approach And Its Characteristics**

* Ecosystems consist of communities of biotic and abiotic elements interacting with each other.
* Their management requires a systems or holistic perspective
* The concept of ‘ecosystem’ was formulated in the 1930s (Tansley, 1935)
* People have been aware of the value of an ecosystem approach to planning and management for some time, and have been using it for decades
* Slocombe suggested that the ecosystem approach has a set of core characteristics like:
  + Systems concepts and analysis
  + Ethical perspectives
  + Stakeholder and public participation
  + A bioregional place-based focus
  + Efforts to identify and develop common goals
  + Gaining a systematic understanding of the ecosystem of interest
* Slocombe developed ecosystem to address common environmental management problems such as:
  + Viewing people and their activities as separate from nature
  + Fragmentation of knowledge or disciplines, ecosystems, jurisdictions, and management responsibilities
  + Emphasizing single resource uses or economic sectors while ignoring conflicts over possible alternative uses
* The ecosystem approach was developed to address common environmental management problems such as:
  + Not recognizing the many ways in which ecological and socio-economic systems are interconnected
  + Ignoring the propensity of biophysical and socio- economic systems to change, sometimes rapidly and unexpectedly
  + Being reactive and attempting to eliminate uncertainty by controlling complex, dynamic systems instead of anticipating change and problems and adapting to them
* The ecosystem approach challenges the dominant anthropocentric / techno-centric perspective, which is prevalent in North America
* It reminds us to consider management problems and solutions in the context of linked ‘systems’
  + i.e. Relation between land use practices and flooding
  + i.e. The removal of vegetation
* It demands that the links between natural and economic or social systems be considered (exceeding thresholds lead to environmental degradation)
  + i.e. Increased agricultural production with pesticides Vs. Health impacts
* It reminds us that decisions made (or actions taken) at one place or scale can have implications for other places or scales
* It raises questions regarding what is the most appropriate areal or spatial unit for planning and management (not political boundaries)
* It highlights that systems are dynamic or continuously changing (in short and long terms)
* Overall, the ecosystem approach incorporates the key ideas that:
  + Humans are part of nature rather than separate from it • interrelationships must be emphasized
  + Critical thresholds exist
  + Implementing an ecosystem approach requires adjustments to governance and management

**MODULE 5 – PLANNING & MANAGEMENT PROCESS**

**Unit 1: The Rungs On The Ladder Of Citizen Participation**

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* During the 1980s, dissatisfaction with the process, methods, and products associated with many resource and environmental management decisions began to rise
  + Out of this situation came the idea that ‘stakeholders’ had a right to participate in decisions
    - This is illustrated by the rungs on the ladder of citizen participation
* Tokenism refers to a policy or practice of limited inclusion of members of a minority group, usually creating a false appearance of inclusive practices, intentional or not

**Unit 2: The Issues Around The Communication Of Environmental Science Issues To The**

**Public**

* To overcome communication challenges, we must recognize that a range of target audiences exist, such as scientists, planners and managers, elected decision-makers, and the general public
* We should ensure that messages are created with regard to who the target audience will be and what their level of understanding is
  + Much of general public does not understand science or how it is conducted
    - i.e. Can be seen with polls of public opinion on global warming in US
  + Except for gambling, general public does not understand the concept of probability
    - Therefore risks, causation, association, all mean the same thing in the public’s mind
* While it is important to achieve understanding of natural and human systems and their interactions, it is also important to determine how this knowledge and insight can be shared with others
  + We must recognize that media does not convey well in general how science evolves, which creates confusion

**Unit 3: Precautionary Principle**

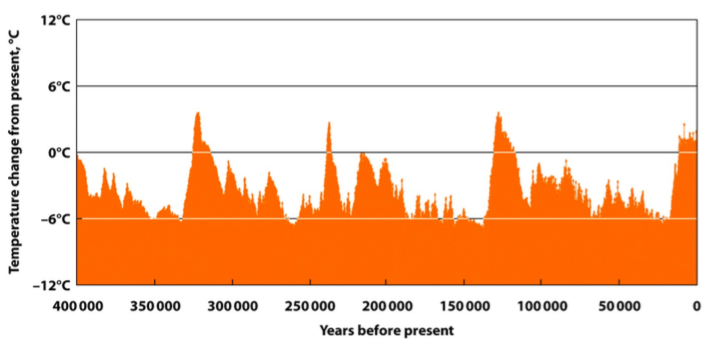
* The precautionary principle is a guideline stating that when there is a possibility of serious or irreversible environmental damage resulting from a course of action, lack of scientific certainty is not an acceptable reason for postponing a measure to prevent environmental degradation or for assuming that damage in the future can be rectified by some kind of technological fix

**Unit 4: Public Consultation, Negotiation, Mediation, Arbitration**

* Specific types of Alternative Dispute Resolution include public consultation, negotiation, mediation, and arbitration
* Negotiation is one of the two main types of Alternative Dispute Resolution
* Negotiation occurs when two or more parties involved in a dispute join in a voluntary, joint exploration of issues with the goal of reaching a mutually acceptable agreement
  + Participants can withdraw at any time
* Mediation is the second main type of Alternative Dispute Resolution
  + A negotiation process is guided by a facilitator / Mediator
  + The Mediator’s task is to help parties overcome their differences & reach an agreement
  + The Mediator has no power to impose any outcome
  + The Mediator has to be acceptable to all parties
  + Stakeholders are responsible to accept or reject any solutions to the dispute
* Arbitration differs quite a bit from negotiation and mediation because it usually involves stakeholders accepting a third party with the responsibility to make a decision on the issue(s) in conflict
  + This party develops a solution to be accepted by the participants and the solution is usually binding
  + The Arbitrator is usually chosen by stakeholders, whereas in the judicial system, they cannot choose the judge
* Public consultation involves the concepts of partnership and delegated power

**MODULE 6 – CLIMATE CHANGE**

**Unit 1: What Is Climate Change**

* Climate change is a long-term alteration in the climate of a particular location or region or for the entire planet
* Earth has gone through warm periods (inter-glaciations) and cold periods (glaciations) over the last 400,000 years. See picture below.

* In contrast, global warming addresses changes only in average surface temperatures
  + Warming does not mean warming throughout the world
  + These changes are associated with corresponding changes in global circulation
* Over the past 100 years or so, the world’s climate has changed noticeably

**Unit 2: The Different Lines Of Evidence, Of Ongoing Climate Change**

* Since 19th century, average global temperature has increased by: 0.6 °C ± 0.2°C
* Solid scientific evidence supports the following points
  + The world has been warming, with an average global temperature at the Earth’s surface having increased by about 0.6°C, with an error range of plus or minus 0.2°C, since the late 19th century
  + The years since 1995 have been among the warmest since 1850
  + The increase in the average temperature of the northern hemisphere during the 20th century was the largest of any century in the past 1,000 years
    - This can be traced in paleoclimate indicators
      * i.e. Past climate indicators which are based largely on ice core, tree ring, and coral reef data
  + Greenhouse gas concentrations have been rising for several decades
  + CO2 and CH4 concentrations are higher now than at any point over the past 420,000 years
    - The same is observed for nitrous oxide, another greenhouse gas
  + In many areas of the world, reduced snow cover has been documented, particularly since 1996, as well as earlier spring melting of ice on rivers and lakes
  + Measurements show that permafrost is warming in many regions
  + In most parts of the world since 1980, glaciers have lost more mass than they have gained
  + Losses of glacier mass are all consistent with increases in global temperature
    - i.e. Moving Glacier in Strathcona Provincial Park, on Vancouver Island can be seen from differences in photographs taken in 1931 and 1981
* The findings mentioned previously related to temperature, greenhouse gas concentrations, glaciers, snow cover, river and lake ice break-up, permafrost, and traditional environmental knowledge all indicate that climate change is occurring

**Unit 3: Implications Of Climate Change For Ecosystems**

* It is possible that within your lifetime, many terrestrial systems, along with the associated fauna and flora, will change significantly
* Climate change may result in a northward shift of tree-lines (i.e. Boreal forest may move north)
  + This will lead in a greater exposure to forest fires, insect infestations, and diseases
  + The consequences of this change to terrestrial systems could be dramatic
* National and provincial parks, which were created to protect representative ecosystems, may disappear or greatly change as the distinctive ecosystems currently protected by such parks evolve into something completely different
* The habitats of some species would be compromised
  + i.e. The habitat of polar bears would be impacted
    - This could lead to a reduced breeding capacity

**Unit 4: The Relation Between Climate Change, Lifestyles And Policy Options**

* To resolve climate change, a mix of strategies will be required, including both mitigation and adaptation
  + Mitigation involves reducing emissions of GHGs, which in turn will limit future temperature changes. This can be done by:
    - Levying a carbon tax on countries based on their generation of GHG
    - Finding alternatives to fossil-fuels, such as:
      * Hydro-generated electricity
      * Ethanol fuels
      * Wind-based energy
      * Carbon sequestration
  + Adaptation involves adjusting to changing conditions
    - In Developing countries, this means preparing for upcoming changes / disasters
      * i.e. Shifting away from crops that are water-intensive
    - This will also require creations of incentives by local governments
    - Adaptation involves as well adjustment to different or changing circumstances, such as when insurance companies modify their claims forecasting and setting of premiums with regard to future climate change conditions

**MODULE 7 – OCEANS & FISHERIES**

**Unit 1: The Link Between Oceanic Ecosystem Productivity And Currents**

* The highest productivity on continental shelves exists at depths less than 200 meters, where most fisheries occur
  + Some of the most productive marine areas in the world are near the coasts of Canada
* Upwelling occurs as winds blow parallel to the coasts, cool water resurfaces from below and brings nutrients that trigger algal blooms
  + Upwelling of nutrients triggers algal blooms (i.e. In the Arctic Ocean)
* An interesting difference between terrestrial and marine ecosystems is in the shape of the biomass pyramids
  + In terrestrial ecosystems, greater biomass generally exists at the level of primary consumers, with the least total biomass at the highest trophic levels
  + In marine ecosystems, the reverse is true, and the pyramid is inverted because there is a high turnover of biomass at the lowest level
    - Most biomass is therefore contained in the long term closer the top
      * i.e. Blue Whales

**Unit 2: Canada’s Oceanic Eco Zones**

* Canada’s oceans can be divided in ecozones
  + The pacific ocean is the wintering ground for important populations of seabirds and marine mammals
    - Pollution is a concern because there are major paper mills discharges nearby
      * As a result, areas have been closed to shellfish harvesting
    - Oil spills have resulted in deaths of seabirds
    - Populations of sea lions, seals, have yet to recover from hunting and the sea otter has been extirpated
    - There are also invasive species such as the green crab, which impacts shellfish populations
* The arctic basin is largely covered by a permanent ice pack
  + Marine species live at the margins of ice pack (i.e. Beluga Whale)
  + Ringed seals constitute the most abundant species, as they are able to claw their way through the ice
    - 40% of their body is blubber for insulation
    - They are well-adapted to arctic conditions (i.e. They can mate under the ice)
    - Their main food source is the krill, a crustacean
* The Arctic Archipelago is characterized by the presence of polynyas, which are areas of permanent open water
  + They remain ice-free through a combination of currents, tides, ocean-bottom upwellings, and winds
  + The polynyas are biologically productive areas
    - They provide breathing holes for whales and seals and hunting ground for polar bears
    - The largest polynya is offshore of Ellesmere Island. It is an important hunting and fishing zone for Inuits, but there are potential conflicts over exploitation of fossil fuels looming on the horizon
* The Northwest Atlantic is covered in ice during winter
  + The temperature is higher than the Arctic because of warm currents.
  + The ecozone extends from the Hudson Strait to the St Lawrence River and it is known for being the ground of the seal hunt
    - There has been a lot of controversy over the seal hunt
      * It has been practiced since the mid-18th century
        + Over 687,000 pelts were recovered by 10,000 sealers
      * Outcry in 1980s led to a ban in Europe on seal fur, and the seal hunt has collapsed since then
* The Atlantic ecozone is generally ice-free
  + At one time, the most abundant fisheries on Earth were off these coasts
  + An abundant population of seabirds is supported as well
  + The ecozone hosts an abundant population of cold adapted Coral reefs, which have been damaged by fishing activities
  + The Gorgonia coral doesn’t depend on synergistic relation with algae to feed
    - Therefore, bleaching is not a problem
  + Reefs of Gorgonia are nursery grounds for many fish
    - However; they are very sensitive to temperature and chemical conditions
    - They are expected to be the first corals to disappear with the acidification of the ocean
* The Atlantic ecozone is also a major ground for oil exploration
  + i.e. Hibernia Oil Field

**Unit 3: Different Types And Approaches To Fisheries And Their Impacts On The Oceans**

* Over the past 50 years, Artisanal fishery (small scale) has gradually been replaced by industrial, factory fishing (large scale)
  + One of the practices used is longline fishing
    - Unnecessarily catches millions of sharks along with seabirds
* With bottom trawling, heavy nets are dragged along the bottom to catch benthic or supra-benthic species
  + This practice destroys benthic habitats
  + Bottom trawling has caused damage to more than half of the seabed in certain areas
    - i.e. Sponge Reefs off the coast of BC
    - The damage is so extensive that the federal government has closed some areas to trawling after voluntary restrictions failed
  + This method is used for shrimp fishing, the net drags against the sea floor and scoops up everything
* This has an indirect impact on species that feed on the targets of commercial fisheries
  + i.e. Steller sea lions are forced to feed on less energy efficient preys, as Cod is no longer available

**MODULE 8 – WATER**

**Unit 1: Contamination Of The Water Supply In Walkerton**

* Most Canadians have access to treated, municipal water; others depend on private wells
* Canadians in rural areas use groundwater
* The relative abundance of water in Canada, the high levels of water use, and the myth of superabundance make most Canadians complacent about the adequacy and safety of their water supplies
  + This changed in 2000, when the small town of Walkerton, Ontario experienced contamination of its water supply system by Escherichia coli
    - Community of 5,000 expose to water contaminated with a pathogenic strain
    - 7 people died; 2 300 ill from E. coli bacteria
  + A public inquiry by Justice O’Connor established that:
    - A well had been contaminated by manure, despite proper manure-spreading methods
    - Chlorination equipment was being repaired and would have prevented contamination if it were operating
    - Provincial government approval and monitoring programs were inadequate
    - Well operators were not trained and there was a history of improper operating practices
    - The water manager withheld adverse water quality information, delaying a boil-water advisory
    - Government water-testing labs had been shut down due to budget cuts, and private labs weren’t required to submit results
  + O’Connor recommended a multi-barrier approach to drinking water safety with:
    - A comprehensive watershed management approach
    - A watershed-based source-protection plan framework
    - Planning at the local watershed level by those most affected, to ensure goodwill and acceptance
* Since this report, this approach has been adopted by other federal and provincial governments, Walkerton residents have been compensated financially, the Walkerton Clean Water Centre opened, and training has been provided across Ontario

**Unit 2: The Red River Flood, 1997**

* The Red River is 880 km long, and the watershed has an area of 290,000 km2
  + The river originates in North Dakota/Minnesota & drains into Lake Winnipeg
  + The river has a long history of flooding because of the low capacity of the river to accommodate extreme flows
  + It has a low gradient, and is shallow
  + Water flows slowly, and has extensive floodplain as a result
* The Red River caused a catastrophic flood in late April-early May 1997
  + The magnitude surpassed any previous flood
  + Grand Forks was flooded
  + Damage in the US was $4 billion
  + Per capita, it is the most costly flood for a metropolitan area
  + 85% of all structures were damaged in Grand Forks
  + Roughly 60,000 people were forced from their homes and downtown Grand Forks was left in flames.
* Factors leading to the 1997 Flood were:
  + High precipitation in 1996 resulting in saturated soil during winter freeze-up
  + Near-record levels of precipitation during winter
  + A long winter leading to high-water content in snowpack into the spring
  + A blizzard in the spring brought in more snow, leading to more water
* Winnipeg was protected by a floodway
  + The floodway kept damage in Winnipeg to a minimum
* The floodway was completed in 1968

**Unit 3: Proposed Water Diversions Schemes To The United States**

* The North American Water and Power Alliance (NAWAPA), proposed by the Ralph M. Parsons Co. of California, has been the most publicized major project
  + Water from the headwaters of the Yukon, Skeena, Peace, Fraser and Columbia rivers would be stored in the Rocky Mountain trench in eastern BC, and diverted by pipeline to the Canadian prairie provinces and western states
    - The Canadian federal and provincial governments strongly opposed the proposal, and the underlying assumption that water is a “continental resource”
* The Grand Recycling and Northern Development (GRAND) Canal was proposed by a Canadian engineer, Thomas Kierans
  + It is a major diversion of water involving a reservoir created by a dyke across James Bay, pumping of water into the Great Lakes basin, and shipping by pipeline to the southwestern states
  + The eight states and two provinces in the Great Lakes basin all opposed this proposal

**Unit 4: Issues And History Of The James Bay Hydroelectric Project**

* The James Bay development was proposed by Quebec Premier Robert Bourassa in 1971 in order to meet future electricity needs in Quebec
  + Rivers on the eastern side of James Bay would be used to channel water into the La Grande River Basin
  + The natural flow doubled and the project produced energy from rivers covering 1.5 of Quebec’s surface area
* In Phase I, three hydroelectric plants were built
  + The area is equivalent to the size of France
  + The estimated cost was $2 billion, however after 15 years the final cost was $14.6 billion
* The last phase LG4 was completed in 1986
* The provincial government and Hydro Quebec justified the project on grounds of job creation, industrial growth, and stability
* Little regard was given to the fact that the area was home to about 10,000 Cree and Inuit whose people had hunted and lived in the region for centuries
  + No social or environmental impact assessment had been completed when the project was announced, and it was fought by the Cree of Northern Quebec
* The James Bay and Northern Quebec Agreement of 1975 is the first ‘modern’ Aboriginal land claims agreement in Canada
  + The agreement provided for land rights and guaranteed a process to deal with future hydroelectric developments; it included provisions for assessments for future developments, monetary compensation, economic and social development, and income security for Cree hunters and trappers
* During the ten-year Phase I construction period from 1974 to 1984, various concerns had emerged, such as:
  + Relocation of the Fort George community
  + Quality of drinking water in the new community
  + Maintaining traditional hunting areas that were now more accessible due to road construction
  + Alteration of ice breakup patterns due to release of warmer water from reservoirs in winter and spring
  + Increased erosion of the banks of La Grande
  + Increased access to other people and values
  + High mercury levels in reservoir fish and therefore leading to concerns about the health of the Cree communities as seen here in this table
  + Elevated mercury levels in fish were known from smaller developments in Manitoba and Labrador, but were dismissed as not significant for La Grande
  + Mercury biomagnifies in aquatic food chains, and top predator fish are a main food source in Northern Quebec
  + Decomposition of organic material stimulated by flooding releases more mercury into the food chain
  + 64% of Cree in their new community had unsafe levels of mercury in their bodies by 1984
    - Fish had six times the normal level of mercury in their tissues
* 15 years later mercury was decreasing, but still high

**Unit 5: The Soft Path To Water Management**

* The Soft path aims to improve water use efficiency by challenging basic patterns of consumption
* While demand management emphasizes the question of “how” to use less water, the soft path asks “why” water is even used for a function
* This promotes consideration of a broader range of methods that use less, or no water
  + i.e. Waterless toilets, recycling water from bathtubs and washing machines, using drought-tolerant vegetation
* The soft path approach is based on four principles:
  + Water is treated as a service rather than an end
  + The quality of delivered water is matched to an end-use requirement
    - i.e. Why use drinking water to water lawn?
  + Ecological sustainability is fundamental
  + Future conditions should be determined and planned back to the present
* Ideally, water quality and quantity should be achieved by a mix of supply and demand management, and soft path approaches in an integrated strategy

**Unit 6: Hydrosolidarity**

* Hydrosolidarity is an approach that recognizes the interconnections among aquatic, terrestrial, and other resource systems, leading to management that is integrated, participative, collaborative, coordinated, and shared, whether at local, provincial, national, or international levels
* Hydrosolidarity contrasts traditional approaches where control over water takes place within political boundaries without consideration for downstream users
* Hydrosolidarity recognizes that there are differing upstream and downstream interests; connections exist between land and water systems; and there are multiple uses for water
* Best practices of Hydrosolidarity include:
  + Using watersheds as the basic management unit
  + Ensuring attention to upstream–downstream issues
  + Recognizing water–land–resource system relationships • Stakeholder engagement
  + Acknowledging biophysical system needs
* Consistent with Hydrosolidarity is the concept of integrated water resource management (IWRM)
  + This approach that promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems

**MODULE 9 – IMPACTS OF AGRICULTURE**

**Unit 1: The Green Revolution And Approaches To Increase Yields**

* The Green Revolution refers to a set of research and the development of technology transfer initiatives occurring between the 1930s and the late 1960s, that increased agricultural production worldwide, particularly in the developing world.
* The initiatives resulted in the adoption of new technologies, including:
  + High-yielding varieties (HYVs) of cereals, especially dwarf wheats and rice
  + Chemical fertilizers and agro-chemicals
  + Controlled water-supply (usually involving irrigation)
  + New methods of cultivation, including mechanization
* The First Green Revolution occurred in the 1950’s, in the developed countries
* The Second Green Revolution started in 1967 and continued onwards, in developing countries.

**Unit 2: The Effects Of Modern, Industrial-Scale Agriculture On Soils, Water, And Human**

**Health**

* The effects of agriculture on biodiversity includes the loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains; the killing of wild predators to protect livestock; the loss & degradation of habitat from clearing grasslands & forest & draining wetlands.
* The effects of agriculture on soils include erosion and loss of fertility; salinization; waterlogging & desertification.
* The effects of agriculture on air quality include greenhouse gas emissions from fossil fuel use; other air pollutants from fossil fuel use.
* The effects of agriculture on water include increased runoff & flooding from land cleared to grow crops; fish kills from pesticide runoff.
* The effects of agriculture on nutrients result in a linear flow leading to sediment pollution from erosion; surface & groundwater pollution from pesticides & fertilizer; eutrophication.
* The effects of agriculture on nutrients include nitrates in drinking water; bacterial contamination of the food supply; contamination of drinking / bathing water from livestock wastes; pesticide residues in drinking water, food & air.

**MODULE 10 – AGRICULTURE**

**Unit 1: Soil Salinization**

* Salinization is the deposition of salts in irrigated soils, making them unfit for most crops
  + It is caused by a rising water table due to inadequate drainage of irrigated soils
  + Irrigated croplands worldwide are less productive as a result
  + This is a major problem in areas where irrigation is common
    - As water evaporates, it leaves behind dissolved salts
    - Salts accumulate over time and may render the soil unusable
  + It can be made worse by cropping practices in which natural vegetation is removed
  + Surface evaporation increases, and concentrates salts at the surface
* Summer fallow is a practice common on the Prairies in which land is ploughed and kept bare to minimize moisture losses through evapotranspiration but which leads to increased salinization
  + As a Result, crop yields are reduced by as much as 75%
* Salinization in some areas is increasing every year
  + However the practice of summer fallow is on the decline because of new, better management practices

**Unit 2: The Economic Geography Of Agriculture In Canada**

* Seven percent of Canada’s total land area is agricultural land, a number that has remained pretty much the same for the past 50 years
* The agricultural and agri-food sector is an $86-billion industry, exporting more than $28 billion in products annually
  + Wheat is still the dominant crop in Canada
* The Prairie provinces account for 81% of the agricultural land base

**Unit 3: Issues Related To The Non-Selectivity Of Biocides**

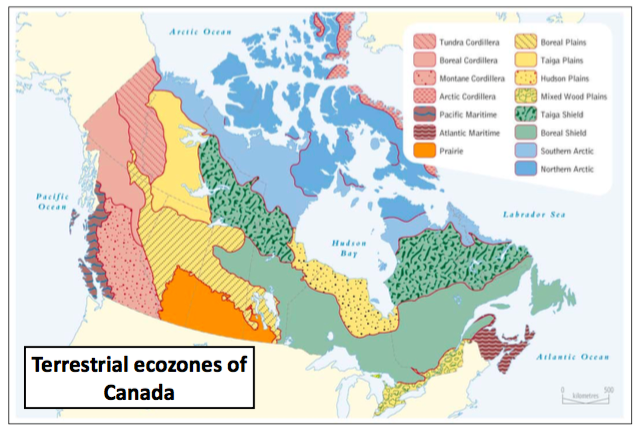
* There is a constant need to develop new biocide products to keep one step ahead of biological adaptation
  + This leads to an increased difficulty in controlling pests through spraying
* Constant spraying leads to the selection of resistant pests because it will leave behind pests that are naturally resistant to the biocide
  + The “Biocide treadmill” is used to describe this phenomenon
* It is estimated that in Canada and US, 900 major agricultural pests are now immune to various types of biocides, the majority of which are insects
* Many biocides are popular because they are broad-spectrum poisons; there is no need to identify the specific pest, because a broad-spectrum poison will kill most insects
* Therefore they tend to eliminate not only the target species but also valuable species, including some that may control pests
  + i.e. Endrin is used to control the brown rat, but also affects the minnow
  + i.e. Heptachlor is used to control termites, but its use has led to reduced breeding of sparrows
  + i.e. Carbofuran is sprayed against the grasshopper, but also affects birds
    - It is available in liquid or granular forms; birds use them as grit to grind seeds

**Unit 4: No-Till/Conservation Agriculture**

* No-till/Conservation agriculture refers to zero, minimum, or low tillage to protect and stimulate the biological functioning of the soil while maintaining and improving crop yields, which includes direct sowing or drilling of seeds instead of ploughing, maintenance of permanent cover of plant material on the soil, and crop rotation
* Crop rotation is alternating crops in fields to help restore soil fertility and also control pests
* Cover crops protect the soil when main crops aren’t planted
* Strip cropping is a technique similar to contour cultivation in which different crops are planted in strips parallel to the slope
  + Strip cropping involves planting row crops in strips across the slope, with alternate strips of grain and/or forage crops.
  + Strip cropping combines the soil and moisture conservation properties of cross slope farming with the soil building advantages of a crop rotation and is more effective in reducing soil losses.
* Contour cultivation is the cultivation and seeding of fields parallel to the contour of the slope, which serves to reduce the speed of runoff by catching soil particles in the plough furrows
* No-till farming disturbs the soil even less
  + No till essentially involves eliminating all tillage operations, and placing seed, fertilizer or manure with minimal soil disturbance.
* While conventional techniques still dominate worldwide, no-till/conservation agriculture is on the rise in Canada

**MODULE 11 – FORESTS**

**Unit 1: The Geographic Distribution Of Canada’s Terrestrial Eco Zones**

* Although all the provinces are dominated by forest land, forest types differ significantly
* Canada has eight major ecozones: Boreal Cordillera, Pacific Maritime, Montane Cordillera, Boreal Plains, Taiga Plains, Boreal Shield, Mixed Wood Plains and Atlantic Maritime
* They are mixtures of forests, woodlands, wetlands, lakes, glaciers, and rock
* Each has its own climate, geology, genetic diversity, and types of human development
* Of 140 000 species found in Canada, 66% are found in forests
  + However many of them occupy a fraction of their former range

**Unit 2: The Importance Of Canada’s Forests To Its Landscape And Economy**

* Canada has 1/3 of the world’s boreal forest, and more than ½ consists of tracks that are more than 50 000 hectares that have yet to be disturbed
* Canada’s Boreal Shield contains about one quarter of the world’s remaining original forests
* The Boreal Shield is Canada’s largest ecozone, covering almost 58 per cent of the country’s land mass and stretching through all provinces except PEI, Nova Scotia, and New Brunswick
  + The forests are home to a wide diversity of terrestrial and aquatic wildlife
  + The boreal forests also support commercial activities such as logging, wood fiber, and saw-log production, pulp and paper mills, and fiber board production
  + Almost 50 per cent of the boreal forest is currently allocated to industry
  + Large areas of the Boreal are now experiencing a number of serious environmental stresses

**Unit 3: Intensive Forestry And How It Is Practiced, And The Parameters Guiding It**

* Intensive forestry leads to a simplification of forest ecology at various levels: genetic, structural, successional
  + It emphasizes short-term economic maximization
* The rate of conversion of natural to managed forests is one of the most controversial issues in Canadian forestry
* Each province establishes an annual allowable cut (AAC), the amount of timber that is allowed to be cut annually from a specified area
  + The Annual Allowable Cut should reflect the long-run sustained yield (LRSY) of a given unit of land, or what that land should yield in perpetuity
* Old-growth forests have very high timber volumes, while second growth on these sites will have much lower volumes
  + This is known as the fall down effect and results in Annual Allowable Cuts that are up to 30 per cent lower as old-growth forests are eliminated
* To calculate Annual Allowable Cuts, it is also necessary to know the rotation period for each forest type, which is called the culmination age
* The Annual Allowable Cuts will also vary substantially depending on the proportion of old-growth to second- growth timber included in the proposed cutting unit

**Unit 4: Differences Between Managed Forest Ecosystems And Unmanaged Ones**

* A managed forest is a reduction of genetic and species diversity
  + The reduction of diversity is a result of having most plantations selected for desirable characteristics
* Because of the transition from natural and complex systems to (mono)cultural and simple ones, forests are more susceptible to pests, Because they are less able to adapt
* The spread of the mountain pine beetle in BC since 1990s is tied to the establishment of uniform mature stands of pine trees

**Unit 5: Strategies And Initiatives To Manage Forests Sustainably, And Trends**

* In the 1980s, it became clear that forestry in Canada could not continue as it had in the past and that new ways had to be found to develop more sustainable management practices
* The Canadian Council of Forest Ministers (CCFM) created the National Forest Strategy (NFS)
  + It was established for 1998–2003; and updated in 2003 for 5 more years
  + It includes all forest ministers, at the provincial, territorial, and federal levels
  + It is committed to sustainable development
  + And its priorities are the transformation of the forest sector, addressing climate change, it includes all stakeholders
  + Canada was the first country in the world to develop such a strategy
* One commitment from Canada’s National Forest Strategy which had success was the development of a system of model forests in the major forest regions
  + Model forests demonstrate sustainable forest management and have a deliberate strategy of intra-site and inter-site demonstration and networking
* Also there are growing concerns from customers about how wood products are derived
  + There is a growing trend to buy products from forests managed sustainably
  + And a Growing trend of certification by the Forest Stewardship council, The Canadian Standard Association, And the Sustainable forestry initiative
    - This has even been adopted by some large companies
* The next decade will be crucial in determining whether Canada is still considered a forest nation 50 years from now
  + Forestry will continue to play a role in many economies, but it will no longer be the main industry in many communities as mills continue to close

**MODULE 12 – MINERALS & ENERGY**

**Unit 1: Distinction Between: Occurrence, Transferability, Energy Content, Reliability, Storability, Flexibility, Price, Safety, Cleanliness**

* Transferability == The distance over which an energy source may be transported is a function of its physical form, energy content, and transport technology.
* Energy content == This is the amount of usable energy by weight or volume of a given source.
  + Low-energy-content sources are inadequate when demand is large and spatially concentrated.
* Reliability == Uninterrupted availability gives one source an advantage over a source with intermittent availability
* Storability == To meet interruptions of supply or peaks of demand, a source that can be stored has an advantage over one that cannot.
* Flexibility == The greater the variety of end uses to which a given source or form may be put, the more desirable it is.
* Price == A less expensive source or form will be preferred over the more expensive.
* Safety and impact == Sources that may be produced or used with low risk to human health and the environment will be preferred over less benign sources.
  + i.e. Nuclear power: major accidents have lead to catastrophic health and environmental impacts
  + i.e. The fire at the Chernobyl nuclear plant in 1986
    - Deaths of many workers of the cleanup crew occurred in years afterwards
    - There are ongoing health issues in Ukraine
* A cloud of radioactivity spread all over Europe at the time and contamination persists
* Cleanliness and convenience == A cleaner and more convenient source will be preferred over a dirty and the cumbersome source.

**Unit 2: Distinction Between Flow And Stock Resources**

* Renewable (flow) resources are renewed naturally within a relatively short period of time
  + i.e. Air, water, animals, and plants
  + Critical zone resources can renew themselves as long as humans use allow their reproduction or regeneration
  + They can be harvested or exploited to exhaustion
    - i.e. Overfishing, clear-cutting, etc.
* Stock resources are non-renewable (i.e. Fossil Fuels)
  + They are often consumed through use and only changed to another form
  + They are often polluting, but some can be recycled

**Unit 3: Major Non-Renewable Resources In Canada: Potash, Coal, Uranium And Nuclear Power**

* Potash was discovered in Canada in the 1940s during exploratory drilling for petroleum
  + Canada is now the largest producer and exporter of potash globally
    - Saskatchewan’s potash industry is the most productive worldwide
  + Potash is a generic term that includes various salts of potassium
    - Most important is potassium chloride
* Potassium is a necessary nutrient for plant growth and 95% of potassium produced is used in fertilizers
  + Saskatchewan’s potassium is located in flat beds at depths of more than 1,000 meters, and is very high in quality, making extraction very efficient
  + Estimated reserves of potassium in Saskatchewan will meet global demand for several hundred years, assuming current levels of use
* This industry is sufficiently lucrative to have attracted several international takeover bids for Potash Corp., all have which have been rejected by the Canadian government as not being of ‘net benefit’ to Canada
  + As Canada has allowed foreign takeover of many other natural resources companies, many observers believe the decision to reject such bids in this case reflect partisan politics, not any clear policy
* Fertilizer will become even more important in the future as nations struggle to feed growing populations
* Coal and uranium are the basis for 1/3 of energy production in Canada
  + Alberta produces nearly 50% of coal mined in Canada
    - It also depends on it for almost 50% of its electricity power
* By end of 2006, 21 coal-fired power generation plants were operating in Canada accounting for 90% of coal consumption in Canada

**MODULE 13 – ENERGY**

**Unit 1: Impacts And Challenges In Using Coal And Natural Gas**

* Impacts & Challenges In Using Coal:
  + The environmental impacts include abandoned mines, acid mine drainage, oxidation products are washed into streams and lakes
  + Acid deposition and mountaintop removal
  + 15-25% of the mountaintops in S. West Virginia are affected
    - Valleys are filled with tailings and debris, and there is CO2 released
* Impacts & Challenges In Using Natural Gas
  + Deposits located far from usage points
  + In terms of transport, in the U.S., this means ≈ 100,000 vehicles
  + Deposits are often found by offshore drilling
  + There is also not enough fuel stations equipped with equipment
  + Transporting is difficult, as natural gas can be explosive

**Unit 2: New Renewable Energy Resources: Solar, Wind Power**

* New Renewables have grown at much faster rates than conventional sources
  + It will take time to build them up
    - Advances in technology make it easier and less expensive
    - Government still subsidizes fossil fuel, rather than investing in renewables
* Wind power is the fastest growing renewable energy
* Their use has expanded quickly because of growing concerns over diminishing fossil fuels and the environmental impacts of fossil fuel combustion
* Benefits of the new renewables include that they:
  + Alleviate air pollution and greenhouse gas emissions that can cause climate change
  + They are inexhaustible
  + Help diversify a country’s energy economy
  + May create jobs and may be sources of income and taxes, especially in rural areas

**MODULE 14 – SUSTAINABILITY & CITIES**

**Unit 1: Patterns Of Urbanization At The Global Scale And In North America**

* Suburbs have become a new haven, new “non-rural” environments
* Urban sprawl is characterized by its land-use patterns: extremely low density; discontinuity between residential, industrial and commercial areas
* Large tracts of land remain undeveloped as pockets between developed areas
  + Places that are next to one another are not necessarily related economically, socially or in any other sense
* Urban sprawl requires transportation from one location to the next, based upon car driven transportation
* Other means of transportation in North America not as well developed as road infrastructure

**Unit 2: Green Architecture**

* With Green Architecture, structures are built using environmentally responsible and resource-efficient processes throughout a building's life-cycle
  + i.e. Hearst Tower in NY: the steel & glass triangles uses 2000 tons less steel, ≈ 90% of the steel used is recycled
    - The building makes use of low–vapour paints, low- toxicity sealants, etc.
* Zero energy buildings & landscaping decreases the need for air conditioning during summers

**MODULE 15 – URBAN ENVIRONMENTAL MANAGEMENT**

**Unit 1: Trends And Patterns Of Urban Development**

* Urban form refers to the type and distribution of infrastructure in cities and is a key factor influencing environmental quality
* Transportation configuration impacts energy use, building design affects energy efficiency, and energy use contributes to GHG emissions
* Urban sprawl contributes to the loss, disruption, or degradation of adjacent agricultural land, environmentally sensitive areas, natural habitats, and water and air quality
* Urban sprawl is characterized by areas with low population densities and significant travel costs
* A compact urban form is most environmentally desirable
* The proportion of low-rise, low density homes is increasing

**Unit 2: How The Environmental Problems Caused By Cities Can Be Addressed By Best**

**Practices In Urban Development**

* Individual urban residents can help by walking, cycling, and taking public transit, and also improving household energy efficiency and purchasing locally-produced food and other goods
* If people are to change their behavior, incentives must be provided, and people need to be educated in order to understand why such changes are needed
  + i.e. Drivers should be encouraged to use more fuel-efficient vehicles through incentives such as access to commuter lanes and reduced parking fees
* There are some technical matters to resolve
  + i.e. What are appropriate thresholds for fuel efficiency, or GHG emissions reduction
* For example, is it more energy efficient to have one person travel in a smart car than four people car-pooling in a conventional vehicle?
* Alternative transportation should be encouraged, for example by having fees for car access to city centers, and providing bikes or electric cars for rent

**Unit 3: How To Address Sustainably In Cities Issues Such As Transportation, Energy Use, Waste Management, The Urban Heat Island Effect, And The Hydrological Cycle**

* Achieving urban sustainable development requires attention to at least four key factors:
  + Energy Use
    - Use solar panels to reduce energy use by 30 – 70%
    - Use appropriate and efficient material for buildings
      * i.e. Proper insulation so no heating is required
      * i.e. Smart air filtering to remove air conditioner need
    - Comply with LEED and CBIP requirements
  + Transportation
    - Facilitating teleworking and teleservices to reduce travel time
    - Encouraging carpooling programs
    - Initiating transit pass programs that provide seamless transitions
      * i.e. A single AIO pass to ride the train and transit
    - Facilitating the use of bicycles
  + Waste Management
    - Divert as much waste as possible away from disposal through the 3 R’s
    - Reduction at the source; use less material
  + Urban Heat Island Effect
    - Designing neighbors to balance structures with the shape of areas between them to reduce the amount of energy hitting surfaces
      * North-South street orientations work best
    - Use light-colored surfaces and less thermally absorptive exterior facings on buildings
    - Provide vegetation surfaces in place of, or to shade heat-absorbing surfaces
    - Green roof technology involves creating a new roof with a growing medium allowing plants, shrubs, or trees to grow on it
      * Reduce electricity demand and GHG emissions
      * Improve storm water retention by 40 – 50%
  + Hydrological Cycle
    - Include run-off retention ponds to minimize precipitation run-off