8a- Human Impacts of Climate Change

Vulnerability to climate change

- consequences of anthropogenic climate change
    - warmer days and nights
    - fewer cold days
    - more heat waves
    - more areas exposed to droughts
    - increased frequency of extreme storms
    - continued rise of sea levels
- Vulnerability = Potential for harm or loss
    - ∝the nature of physical changes a population is exposed to
    - ∝the sensitivity of that population to climatic variability & change
    - ∝the adaptive capacity of that population
    - ➡ V = f (E, S, A)
        - E=exposure, S=sensitivity, A=adaptive capacity
    - E&S similar for Holland and Bangladesh
        - A is very different

Public & scientific debate

- Climategate
    - 2009, hackers posted on internet using email accounts of scientists at U of East anglia, UK
    - giving impression that they conspired to refute critics of climate science, manipulated data to achieve results
    - UEA= important centre for climate research
        - story emerged just before the Copenhagen climate change in 2009
    - Net effects
        - popular media: always portrayed climate science as if there were great debates about the basic scientific understanding➔ there wasn't
        - ↑media coverage to those opposed to controlling GHG emissions
        - polling = less public enthusiasm for taking actions to reduce GHG emissions, especially with economy struggling
    - Opposing parties:
        - oil & gas industry
        - countries, states & provinces receiving large revenues from them
        - politician beholden to oil industry
        - right-wing CAVE people (Citizens Against Virtually Everything)

> It is difficult to get a man to understand something when his job depends on not understanding it.
>
> --- Upton Sinclair

- less vocal, more thoughtful critics: geologists & quantitative modeling specialists

• Scholarly debates
  - What will GHG emissions be like in the future?
  - What will impacts be in the future?
  - What steps should be taken to mitigate GHG emissions?

• Responding to climate change: 3 ways
  1. Mitigation
     1. UN Framework Convention on Climate Change (UNFCC)
     2. Kyoto Protocol
  2. Adaptation
  3. (Intervention)

<u>UNFCC</u>

• 1994, 189 countries signed
• broad international framework for responding to climate change
• Agreed to
  - keep track of GHG emissions
  - try to prevent dangerous accumulation of GHGs
  - assist vulnerable countries in adapting to the impacts of climate change
  - meet each year, discuss how to implement the convention = COPs

<u>Kyoto Protocol</u>

• Agreement at COP-3 in Kyoto, 1997
• "Annex I countries" agreed to reduce emissions to 5% below1990 levels by 2008-2012
• Canada signed
  - 1990=~600 vs. 2008=~734 ➔ 24.1% above
  - withdraws from Kyoto Protocol in 2012
• Rationale

Montreal (CFCs)	Kyoto (GHGs)
All nations have mandatory targets - Industrialized countries required to act first	Industrialized nations have mandatory targets
Readily-available substitutes for CFCs	Presently NO alternatives to fossil fuels that produce similar amounts of energy
Changes in ozone layer are measurable	Changes in CO2 & other GHG concentrations are measurable
Certain public health impacts of failure to act	Hard to forecast climate changes of failure to act
All countries would suffer	Impacts not equally felt by all countries
High level of compliance	Poor level of compliance
CFC emissions are falling globally	GHG emissions continue to rise globally
Stratospheric ozone levels appear stable	Impacts of climate change begin to emerge

8b- Arctic Climate Change

Arctic region and climate over the years

- Traditional definitions of the arctic:
    - The arctic circle 60° 33'' N latitude
    - The 10°C July Isotherm (red line)
- Now under the most rapid and severe climate change on earth
    - Temperature ↑twice the rate as the rest of planet in the past decades
    - GHG emission not originated here yet brings wide-ranging changes to the Arctic
    - Arctic changes in turn ➔ impacts on the planet
- Reasons the Arctic is warming at a faster rate:
    1. Circulation of temperate ocean waters and transport of long-lived GHGs to the arctic
        - aerosols in temperate latitudes (industry, transport, combustion) travel north
        - due to arctic oscillation, transport of gases strongest in the winter = with Black Carbon
    2. Strong local feedbacks caused by melting sea ice and ground ice➔ release of GHGs stored in arctic frozen soils
        1.Surface reflectivity = Albedo
            - earlier springs and later winters→ ↑ absorption of solar radiation
            - Freshwater lakes and rivers also contribute to albedo
                - warming→early snow melt→↓winter albedo
                - warming→↑thermokarst activity ↑lakes absorb more solar radiation
        2.Preserved GHGs released from permafrost
            - Permafrost= naturally frozen Carbon trapped in organic matter
            - warming→↑permafrost thaw→decomposition→release of methane and CO2→further warming

Increased Ice Melt	Implications
↓Sea ice glacier/ice shelf retreat permafrost degradation ground ice thaw	Sea level rise, ↓ocean salinity, introduction of pollutants, alteration of natural water chemistry, changed habitat ecology, vegetation alterations, watercycle/ hydrological shifts, wildlife population change, aboriginal traditional livelihoods change, infrastructure issue, political and economical repercussions

Climate change effects in arctic Canada and associated impacts

Arctic Peoples: The Vuntut Gwitchin First NAtion of Old Crow Flats, YT

"People of the lakes"

- Old Crow, population = 300
- Livelihood: trapping, hunting, fishing, wage economy
- Government: progressive self governing community with elected Chief and Council representing citizens
- Dynamic hydrology
- Melting permafrost and riverbank slumping
- Unpredictable river water levels
    - changes in fish and wildlife→ultimately affect food security→health concerns
    - ex. Caribou meats replaced by low nutrition meals and junk food
- Adaptive strategies
    - "Yeendoo Nanh Nakhweenjit K'atr'ahanahtyaa"="Looking after the land for the future"
    - Project Objectives:
        1) reconstruct the history→understand past trends in the ecology
        2) assess the impact changes have on wildlife & vegetation
        3) evaluate the impact of changes traditional food sources
        4)develop a long-term environmental monitoring program (a legacy)
- Scientific efforts mixed with traditional knowledge
- Community Based Projects
    - sharing knowledge to help create a monitoring program
- Youth Conference on Climate Change

What can we do?

- Our actions in the south add to northern atmospheric GHG concentrations
- we must make an effort to ↓ our environmental foot print, encourage governments to set progressive environmental policies that ↓ GHGs

9a- Water Pollution & Environmental Toxins

Water Resources, threats & solutions

- Unequal distribution/consumption between nations
- Unequal distribution within nations
- Five criteria: Resources, Access, Capacity, Use, Environment
    - Strong connection between "water poverty" & "Income poverty"
- Myth of Canadian freshwater abundance
    - very little renewed on an annual basis
    - aggregated data = average annual precipitation and surface runoff→mask important variability in water supplies

- Spatial
- Temporal

- Threats to water
  - Human Stress: overuse, pollution, climate change
- Use of water
  - Consumptive uses
    - irrigation, agriculture
    - industrial
    - residential
  - Non-consumptive uses
    - electric power production
    - some industrial
    - some residential
- Water sources
  - Surface water
    - reliance of surface water vs. ground water
      - highly variable by region/nation
      - reflects environmental and economic circumstances
    - Dams. canals, diversions, channelization
      - harness surface sources for human use
      - benefits and drawbacks of dams
      - Three Gorges Dam- China
        - ✓ Power; flood control; navigation
        - × GHGs; ecosystem; heritage; people
  - Groundwater
    - ~98% of all liquid fresh water
    - recharges via percolation BUT non-renewable in many areas
      - e.g. fossil groundwater
    - overdrawing is growing global problem
      - consequences- falling water tables=depleted resources
      - Saltwater intrusion
      - diminishing surface waters
      - loss of wetland ecosystems
      - land subsidence
    - solutions
      - ↑supply/access
      - ensure existing sources remain secure, clean
        - watershed management- e.g. Oak Ridges Moraine
        - polluter pay policies
        - prohibit bulk export
      - get/store more water
        - dams
        - tapping more groundwater
        - desalinization
        - international development aid: ↓'economic' water scarcity
  - Desalinization

- removal of salt from seawater of other water of marginal quality
- Distilling = hastens evaporation and condenses the vapor
- Reverse Osmosis = forces water through membranes to filter out salts

- Solutions: Reduce consumption/demand
  - agriculture, municipal uses, industry
  - Economic approaches
    - appropriate water pricing/↓subsidies
    - privatization (good???)
    - international aid

<u>Pollution & Treatment</u>

- Ancient Rome: common lead poisoning
  - lead-containing water pipes & glazed pottery wine storage vessels
  - some historians: led to downfall of Rome
- Safe Water
  - clean water = the most basic public health requirement
- Pollution
  - any undesirable thing enters the environment
  - typically human-produced in origin
  - Types: Air, Water, Land, Soil, Noise
- In water
  - Excess nutrients, pathogens & waterborne diseases, toxic chemicals, suspended matter, thermal pollution
- Point-source/ Non-point-source
- In developing world
  - open sewers
  - e.g. India
    - Slums and factories discharge untreated waster into watercourses
    - contaminated groundwater
    - inadequate toilets
    - waterborne disease: ongoing
    - New Delhi: toilet statistics
      - 1990 survey: 440,00 residents poor housing→ 270 toilets = 1600 people per toilet
      - open defecation
- Global environmental challenge: Sanitation
  - Direct linkages to public health: disease
  - links to environmental degradation: toxins in environment
- Social impacts
  - GI illness
  - women's health
  - quality of life
  - loss of productive time
  - harm to children, kept our of school to collect water
- Why persist in India?

- colonial government never bothered to invest in sanitation (manual collection of waste)
- post-1948 politics dominated by middle-class→does not see self-interest in sanitation for all
    - already has access
    - no threat of organized action by lower classes
    - outbreaks dealt with on crisis basis
    - access to health care, antibiotics; less sever/fatal outbreaks

- Vulnerability
- Dealing with water pollution
    - reduce production
    - collect and treat
- Typical evolution of sewage capture & treatment
    2. no capture, wastewater collects in low-lying areas
    3. storm drains & collection sewers built
    4. interception trunk & treatment centre built
- Sewage treatment in Ottawa
    - 2.125km
    - 40 sewage pumping stations
    - treatment center receives industrial, commercial and domestic waste
    - treatment with multiple stages
    - 40-45 thousand tonnes of solid material (decomposed sludge) removed from wastewater each year
        - 60% composted, 30% fertilizer, 5% for landfill
- The Arcata Marsh and Wildlife Sanctuary, California

9b- Energy: Future changes & challenges
- Energy Alternatives

<u>Global energy situation</u>

- Energy is important
    - #1 climate change contributor (energy emissions)
    - society depends on it
- Uses: Heating/cooling, transport, electricity
    - All based on solar energy
    - typically centralized facilities
    - more than half of the energy→consumed in last 2 decades
    - 1990-2008: average use per person ↑10%, world population ↑27%
    - 32% energy lost from supply to end use
        - large loss (67%,2008) in nuclear power

global energy supply	renewable energy potential
Oil, Coal, Gas, Renewable, Nuclear	Solar (8x), Wind, Geothermal, Biomass, Hydro, Ocean

- Keep below 2°C: ↓ 80% global emissions from 1990 levels
- Rapid shift →↑energy conservation & developing renewable energy sources

• Values
- clean air, clean water, nature for grandchildren, no toxic wasters left behind, energy not just for the rich, democratic decision making

Possible clean energy solutions

Power Source	Advantages	Disadvantages
Hydro electricity - turbines in a dam in a river, captures the energy of water in motion →electricity	- Constant rate for long time, cheap - easy to turn on&off - abundant in Canada - up to 90% efficient (coal=25-40%) - also for irrigation & flood control	- expensive to build - flooding of large areas of land, significant environmental impacts (methane, methyl mercury, habitat destruction) - impact fish spawning - forces people out of homeland - depends on water availability
Tidal Power - from gravity	- like wind turbines under water, more energy than in air - more predictable than wind&solar - great potential	
Wave Power - snake-like structures - energy from constant up&down of waves 5-10 km offshore		
Geothermal/ Groundsource - from the heat of Earth - hot rocks 4-5 km below Earth produce steam - electricity generation in 24 countries - heating in 70 countries	- theoretically inexhaustible - no pollution - often excellent supplement to other renewable sources - non-obvious structure	- conditions for electricity are rare - not much power per vent

Power Source	Advantages	Disadvantages
Wind - turbines capture the kinetic energy→electricity	- wind is free - few pollutants - little land used, land below still usable - tourism - remote areas - range of sizes	- wind is not constant, varies from 0 to storm force - some NIMBYism (Not In My Back Yard) - largest turbine available today = 5MW
Solar Photovoltaic (PV) - amorphous silicon, polycrystalline silicon, monocrystalline silicon, cadium telluride, copper indium seleride	- clean and silent - few pollutants - visually unobtrusive - rooftops of existing buildings - urban areas:↓grid losses&transmission liens - reliable operation for long periods - no maintenance - locally available - peaks during summer loads - any size based on requirement - enlarged or removed	- variable source: production dependent on sun (predictable within 3%) - more expensive to produce: devices manufacturing + conversion efficiencies - some toxic chemicals: controlled via recycling and proper disposal
Solar Thermal - use heat of sun's rays→electricity - Canada: solar thermal hot water panels	- free from sun - store and access - situated in areas with fewer other uses (deserts) - smaller systems in households for hot water and heating	- large scale installations require significant amounts of sunlight and take up space - →few potential sites
Passive Solar - efficient use of Sun's heat - orienting homes towards south, large windows, heat distribution, thermal mass to absorb and dissipate heat	- highly efficient,↓heating and cooling demands - cost 50% - no additional investments - ↓GHGs - attractive and comfortable living space	- construction costs > conventional homes - mistakes in choice of building materials: window glass - room and furniture layouts to be planned carefully to avoid glare & ensure air flow - designed to remain cool in summer

Power Source	Advantages	Disadvantages
Biomass - organic materials be burned as source of fuel - Wood	- ↓fossil fuel need - for combined heat and power - dispatchable=balance variable sources - widely available&renewable - agricultural byproduct add value to crop - carbon neutral - biomass crops grow on land unsuitable for other crops	- forest biomass: sustainability issues→deforestation & carbon source - not efficient if heat not also used - agricultural wastes not available if basic crop no longer grow - crops take up space - combustion →air pollution
Biogas - organic waste anaerobically digested into methane, fertilizer remains - manure, food scraps, farm wasters		

<u>Ontario, Communities, OREC</u>

Green Energy and Green Economy Act
• FIT/microFIT programs
• enables everyone's involvement
• creating green jobs & energy in Ontario with domestic content (50,000 predicted)

Community Power
• importance of energy
• centralized electricity system challenges
    • efficiency, vulnerable, psychological
• distributed generation alternative
• community ownership
    • acceptance, local benefit

OREC
• Objectives
    • enable the growth of renewable energy projects in Ottawa
    • support local renewable energy sector
    • promote public awareness of and involvement in renewable energy
    • provide socially and environmental responsible long term investment option to residents of Ottawa