Further Reading: Detailed Notes Posted on Class Web Sites

Outline

- impacts
- adaptations
- mitigation
Introduction

• Human activities are increasing the atmospheric concentrations of greenhouse gases - which tend to warm the atmosphere - and, in some regions, aerosols - which tend to cool the atmosphere.

• Potentially serious changes have been identified, including an increase in some regions in the incidence of extreme high-temperature events, floods, and droughts, with resultant consequences for fires, pest outbreaks, and ecosystem composition, structure, and functioning, including primary productivity.

• Policy makers are faced with responding to the risks posed by anthropogenic emissions of greenhouse gases in the face of significant scientific uncertainties.

• Within this context, we shall look at the impacts of climate change and options for adaptation and mitigation polices.
Water Resources

- **Flood magnitude and frequency** are likely to increase in most regions as a consequence of increase in the frequency of heavy precipitation events.

- Climate change **challenges existing water resources management** by adding uncertainty. One-third of the world's population (1.7 billion people) presently live in countries that are water-stressed. This number is projected to increase to about 5 billion by 2025.

Agriculture & Food Security

- Most studies indicate that mean annual temperature increases of 2.5 degrees C or greater would prompt **food prices to increase** as a result of slowing in the expansion of global food capacity relative to demand.

- The impacts of climate change on agriculture are estimated to result in small percentage changes in global income, with **positive changes** in more **developed regions** and smaller or **negative changes** in **developing regions**.
Ecosystems

- Increasing CO2 concentration would increase net primary productivity whereas increasing temperatures may have positive or negative effects.

- Climate change will lead to pole-ward movement of the southern and northern boundaries of fish distributions, loss of habitat for cold and cool-water fish and gain in habitat for warm-water fish.

- If warm events (El Nino) increase in frequency, plankton biomass and fish larvae abundance would decline and adversely impact fish, marine mammals, seabirds, etc.

- Coastal ecosystems such as coral reefs, salt marshes, mangrove forests, etc. will be impacted by sea-level rise, warming SSTs and any changes in storm frequency and intensity.
Humans

- Population may be affected through extreme weather, changes in health status, or migration. The most widespread serious potential impacts are flooding, landslides, mudslides and avalanches, driven by projected increases in rainfall intensity and sea level rise.

- Weather and climate related losses can stress insurance companies to the point of impaired profitability, consumer price increases, with drawl of coverage etc.

- There is evidence of human health sensitivity to climate, particularly for mosquito-borne diseases (malaria).

- If heat waves increase in frequency and intensity, the risk of death and serious illness would increase, principally in older age groups and the urban poor.

- Climate change will decrease air quality in urban areas with air pollution problems.
Industry

- Energy use in 1990 was estimated to be 98 to 117 EJ (Exa Joules or 10^{18} Joules), and is projected to grow to 140 to 242 EJ in 2025 without new measures.

- Industrial sector energy-related greenhouse gas emissions in most industrialized countries are expected to be stable or decreasing as a result of industrial restructuring and technological innovation, whereas industrial emissions in developing countries are projected to increase mainly as a result of industrial growth.

- Technologies and measures for reducing energy-related emissions from this sector include improving efficiency (e.g., energy and materials savings, cogeneration, energy cascading, steam recovery, and use of more efficient motors and other electrical devices); recycling materials and switching to those with lower greenhouse gas emissions; and developing processes that use less energy and materials.
Transportation

- Energy use in 1990 was estimated to be $61-65 \text{ EJ}$, and is projected to grow to $90-140 \text{ EJ}$ in 2025 without new measures.

- Projected energy use in 2025 could be reduced by about a third to $60-100 \text{ EJ}$ through vehicles using very efficient drive-trains, lightweight construction, and low air-resistance design, without compromising comfort and performance.

- Further energy use reductions are possible through the use of smaller vehicles; altered land use patterns, transport systems, mobility patterns, and lifestyles; and shifting to less energy-intensive transport modes.
Commercial/Residential

- Energy use in 1990 was estimated to be about 100 EJ, and is projected to grow to 165-205 EJ in 2025 without new measures.

- Projected energy use could be reduced by about a quarter to 126-170 EJ by 2025 without diminishing services through the use of energy efficient technology.

- Technical changes might include reduced heat transfers through building structures and more efficient space-conditioning and water supply systems, lighting, and appliances.

- Ambient temperatures in urban areas can be reduced through increased vegetation and greater reflectivity of building surfaces, reducing the energy required for space conditioning.
GHG Reductions in Use of Fossil Fuels

- **More Efficient Conversion of Fossil Fuels**: The efficiency of power production can be increased from the present world average of about 30% to more than 60% in the longer term.

- **Switching to Low-Carbon Fossil Fuels and Suppressing Emissions**: Switching from coal to oil or natural gas, and from oil to natural gas, can reduce emissions. The lower carbon containing fuels can, in general, be converted with higher efficiency than coal. Large resources of natural gas exist in many areas.

- **De-carbonization of Flue Gases and Fuels, and CO2 Storage**: The removal and storage of CO2 from fossil fuel power-station stack gases is feasible, but reduces the conversion efficiency and significantly increases the production cost of electricity. For some longer term CO2 storage options, the costs, environmental effects, and efficacy of such options remain largely unknown.
Switching to Non-Fossil-Fuel Sources of Energy

• **Switching to Nuclear Energy**: Nuclear energy could replace base load fuel electricity generation in many parts of the world if generally acceptable responses can be found to concerns such as reactor safety, radioactive-waste transport and disposal, and nuclear proliferation.

• **Switching to Renewable Sources of Energy**: Solar, biomass, wind, hydro, and geothermal technologies already are widely used. In 1990, renewable sources of energy contributed about 20% of the world's primary energy consumption, most of it fuel wood and hydropower.
Agriculture, Rangelands & Forestry

- A number of measures could conserve and sequester substantial amounts of carbon (approximately 60-90 Gt in the forestry sector alone) over the next 50 years.

- **Land use and management** measures include –
  - Sustaining existing forest cover
  - Slowing deforestation
  - Regenerating natural forests
  - Establishing tree populations
  - Promoting agro-forestry
  - Altering management of agricultural soils and rangelands
  - Restoring degraded agricultural lands and rangelands
Policy Instruments

- Mitigation depends on reducing barriers to the diffusion and transfer of technology, mobilizing financial resources, supporting capacity building in developing countries, and other approaches to assist in the implementation of behavioral changes and technological opportunities in all regions of the globe.

- Energy pricing strategies (e.g., carbon or energy taxes, and reduced energy subsidies)
- Reducing or removing other subsidies (e.g., agriculture and transport subsidies) that increase greenhouse gas emissions
- Tradable emission permits
- Voluntary programs and negotiated agreements with industry
- Regulatory programs, including minimum energy efficiency standards (e.g., for appliances and fuel economy)
- Stimulating RD&D to make new technologies available
- Renewable energy incentives during market build-up
- Incentives such as provisions for accelerated depreciation and reduced costs for consumers
- Education and training; information and advisory measures