

ENVIRONMENTAL LAW AND POLICY

#### Lecture 2. GLOBAL AIR POLLUTION

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# OZONE DEPLETION



- 1. The science of ozone depletion
- 2. International control
- 3. Developing countries
- 4. Lessons learnt



### 1. The science of ozone depletion

CFCs

### Ozone (O<sub>3</sub>)

- A simple molecule of three oxygen as a trace element in the atmosphere.
- The highest concentration of O<sub>3</sub> occur in the middle of stratosphere, from 6 – 30 miles above the Earth surface.
- O<sub>3</sub> performs a critical function when absorbing harmful ultraviolet (UV-B) radiation from the sun.
- A series of chemical reactions create ozone as a counterbalance to the ozone destroyed through absorption of UV-B.

- CFCs was developed in the 1920s by General Motors' chief chemist, Thomas Midgely, as a safe substitute for the amonia and sulfur dioxide refregerants then commonly in use.
- CFCs release highly reactive chlorine (CI) and chlorine oxide (CIO) in the atmosphere with the presence of UV-B.
- These molecules would then set off a chain-reaction, in which just one chlorine atom could destroy thousands of stratospheric ozone molecules.





### 1. The science of ozone depletion

### Impacts of UV-B

- On human health:
  - Greater incidence of skin cancers, cataracts and sunburns.
  - Supressing the immune systems in human with respect to some diseases.
- On agricultural crops:
  - Growth and photosynthesis of certain plants are reduced by relatively low increases in ultraviolet radiation.
- On aquatic life:
  - Increases in UV-B radiation can reduce the growth of marine phytoplankton – the base of the ocean food chain and produces at least as much biomass as all terrestrial ecosystemscombined.
  - Uv-B damages midge larvae the base of many fresh water ecosystems.



 Attended by 43 nations (of which 16 were developing countries) and three industry groups, negotiation in Vienna produced the first international agreement to address CFCs in 1981.

- The result of these initial negotiations, the Vienna Convention for the Protection of the Ozone Layer, was signed by 20 countries.
- Rather than impose controls on CFC consumption or production, the Convention called for countries to take "appropriate measures" to protect ozone layer and established an international mechanism for research, monitoring, and exchange of information.



 In 1985, British scientists announced an "ozone hole" in the Antartic, triggering enormous public interest in ozone depletion.

- The scientists' data showed a 50% springtime reduction in the ozone layer compared to levels in the 1960s.
- There was no proof of CFCs' role in creating "ozone hole" at that time, however, media attention linked the ozone hole in the public's mind to CFCs.
- In the Vienna Convention, no chemicals had been identified or regulated as ODS.





#### • In sum:

- The Vienna Convention for the Protection of the Ozone Layer served as a **framework** for efforts to protect the globe's ozone layer.
- The Vienna Convention was adopted in 1985 and entered into force on 22 Sep 1988.
- The objectives of the Convention were for Parties to promote cooperation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures against activities likely to have adverse effects on the ozone layer.
- The Vienna Convention did not require countries to take concrete actions to control ozone depleting substances. Instead, in accordance with the provisions of the Convention, the countries of the world agreed the Montreal Protocol on Substances that Deplete the Ozone Layer under the Convention to advance that goal.
- The Parties to the Vienna Convention meet once every three years, back to back with the Parties to the Montreal Protocol, in order to take decisions designed to administer the Convention.

In 1987 in Montreal, with representatives from over 60 countries participating, many industrial and environmental groups, and wide media coverage, the world's attention focused on Ozone Depleting Substances (ODS).

In response to the public pressure, the Montreal protocol on Substances that Deplete the Ozone Layer was adopted by consensus.

http://www.nasa.gov/top ics/earth/features/ozonehistory.html



### The world with and without Montreal Protocol



- The Montreal Protocol on Substances that deplete the Ozone Layer is an international treaty designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion.
- The treaty was opened for signature on September 16, 1987, and entered into force on January 1, 1989, followed by a first meeting in Helsinki, May 1989.
  Following that time, it was officially adjusted and amended in 1990 London, 1992
  Copenhagen, 1995 Vienna, 1997 Montreal, 1999 Beijing, and 2007 Montreal.
- It is believed that if the international agreement is adhered to, the ozone layer is expected to recover by 2050.
- Developed and developing countries have different phase out schedules.



- In order to give countries flexibility in their reduction schedules, the Protocol developed a "basket" strategy. Each chemical's ozone-depleting potential (ODP) was compared to that of CFC11.
  - Since CFC113 is less destructive of the ozone layer than CFC11, its ODP is 0.8.
  - Using the "basket" strategy, a country would achieve the same reduction in consumption levels by using either 8 tons less of CFC11 or 10 tons less of CFC113 (8 tons \* ODP of 1 = 10 tons \* ODP of 0.8).
  - This arithmetic was important because CFC113 was widely used as a solvent in the electronics industry.
- To avoid the free rider behavior and as an incentive for countries to join, the Protocol provided tough trade measures.
  - Regarding imports, parties to the Protocol are prohibited from importing from non-parties either controlled substances or certain products containing controlled substances (domestic, commercial, and vehicle air conditioners, refrigerators, and portable fire extinguishers).
  - Regarding exports, parties must similarly ban the export of controlled substances to nonparties unless the country of destination can demonstrate full compliance with the Protocol's reduction schedules.



- Article 5 of the Protocol addressed aid to developing countries.
  - While developing countries' per capita consumption of CFC in 1987 was much lower than in the developed world, their domestic requirements were steadily growing.
  - In part to accept the responsibility for having created most of the ODS, and in part to encourage broad international participation, developed countries supported a ten-year grace period following ratification for developing countries before the control measures would apply.
  - During this period, developing countries were permitted to increase their consumption to 0.3 kg per capita in order to meet their basic needs. Then, they would have ten more years to reduce their consumption by 50%.
- With 24 nations signing in Montreal, the Protocol was universally hailed as a diplomatic triumph. Starting from low or no expectations in Vienna, within 18 months strict international controls had been negotiated that would be refined and changed over time with the benefit of more knowledge.



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- On 16<sup>th</sup> September 2009, the Vienna Convention and the Montreal Protocol became the first treaties in the history of the United Nations to achieve universal ratification.
  - Vienna Convention:
  - Montreal Protocol:
  - London Amendment:
  - Copenhagen Amendment:
  - Montreal Amendment:
  - Beijing Amendment:

- ratified by 197 countries



## 3. Developing countries

- While Article 5 provided a grace period for developing countries coming into compliance, Montreal had glossed over the terms of financial assistance to developing countries.
- Ozone depletion could not be solved without the full cooperation of all countries, particularly developing countries.
  - China and India, representing approximately 37% of the global population, were not Parties to the Protocol.
  - These countries' large and growing domestic markest made the Protocol's trade restrictions moot.
- Products containing CFCs (refrigerators and air conditioners) were viewed as necessary to improve the standard of living in those countries, and essential in a number of application.

 $\rightarrow$  These facts gave developing countries additional power in the negotiations, requiring innovative compromises to meet their demands.



### 3. Developing countries

- Developing countries showed a keen interest in the emerging global scientific consensus over ozone layer depletion but rejected the options of either going without these products or paying more for the expensive substitutes and retrofitting existing equipment.
  - Developing countries sought assurance that if aid proved insufficient they would be relieved from meeting their treaty obligations. They wanted to avoid writing their own check.
  - Developed countries wanted to avoid writing a blank check providing financial and technical aid with the amounts determined by the recipient country.
- As a compromise, the parties approved an interim funding source that, in 1992, was permanently established as the Multilateral Fund.



## 3. Developing countries

- Multilateral Fund.
  - By April 2013, constributions made to this Fund by some 45 countries totaled over US\$ 3.09 billion.
  - Multilateral Fund pays for so-called "incremental costs" the additional costs incurred in a project by not using ODS technologies.
  - For example, if it costs more to build a meat-packing plant in India with refrigeration technology that doea not use CFCs than if traditional refrigeration technologies had been used, the Fund could pay for this additional, incremental cost of using an "ozone-friendly" technology.
- Assuming that all countries meet the Protocol's broad reductions, scientist predict the ozone layer will stabilize by around 2050.

### 4. Lessons learnt

• The first is the necessity of international cooperation to deal with the international environmental challenges.

- The establishment of the Multilateral Fund to finance the incremental costs of acquiring substitute technologies helped allay developing countries' fears that they might be charged exorbitant prices for new substitute technologies.
- Without the Fund and technical assistance, the Protocol would almost certainly have been a failure because CFC use in developing countries would eventually have eclipsed use in developed countries.



### 4. Lessons learnt

 Second, the participation of non-state actors proved just as important as the participation of developing countries.

- Scientists' study of the ozone layer laid the foundation for all of the negotiations and persuaded governments of the need for haste.
- The Montreal Protocol established clear and certain timetables which gave companies confidence to invest in development of new chemicals.



### 4. Lessons learnt

• Third, a precautionary approach to treaty making can work.

- At the heart of this success is the flexible nature of the Vienna Convention.
- Despite having only minimal substantive standards, the Vienna Convention provided a framework for the international community to respond through an evolving consensus to the urgency of ozone depletion.
- The ozone treaties provide the best examples of international implementation of the Precautionary Principle.



# CLIMATE CHANGE



- 1. The science of climate change
- 2. Impacts of climate change
- 3. International legal responses
- 4. Climate change policies
- 5. Successes and Failures

### 1. The science of climate change



**VIÊN MÔI TRƯỜNG** 

Mars – without atmospheric greenhouse effect, the planet is a frozen block of ice



Venus – there is a runaway greenhouse effect, making surface temperature so hot that liquids vaporize and permanently cover the planet in clouds



### 1. The science of climate change

- Over a century ago, in 1896, the Swedish chemist Arrhenius first advanced the theory that carbon dioxide emissions from combustion of coal would lead to global warming.
- This process is known as the greenhouse effect because, in some respects like a glass green house, greenhouse gases allow sunlight to pass through the atmosphere; they then absorb heat from the earth's surface and re-radiate heat back, leading to additional warming.
- Major man-made greenhouse gases include CO<sub>2</sub>, CH<sub>4</sub>, NO<sub>x</sub>, and CFCs.



Ice core samples taken from the Antartic and Greenland ice caps show that atmospheric concentrations of  $CO_2$ ,  $CH_4$ ,  $NO_x$  have increased by about 37%, 150% and 19% respectively in the industrial era.

The pre-industrial concentration of  $CO_2$  was 280 ppm, today's levels have exceeded 400 ppm and it is estimated to be 450 ppm or higher by 2050.

CO<sub>2</sub> and NO<sub>x</sub> remain in the atmosphere and contribute to greenhouse effect for many decades to centuries.

#### Human CO2 Emissions vs. Atmospheric Concentration



# Anthropogenic emission and atmospheric concentration of CO<sub>2</sub>



### 1. The science of climate change

- Only half of the carbon dioxide emitted over the past 50 years has remained in the atmosphere. The additional carbon has been assimilated, either through plants and the soil or through increased absorption by the oceans.
- Thus, in addition to emissions of greenhouse gases by burning fossil fuels, many land-use and agricultural practices directly influence climate change.



\* Net Emissions (Sources + Sinks) = 6,204 MMT CO2E

\*\* High GWP Gases include: HFCs, PFCs, and SF6

Data expressed in Million Metric Tons of Carbon Dioxide Equivalents (MMT CO<sub>2</sub> E) Source: US EPA Inventory of Greenhouse Gas Emissions and Sinks, 2006. The relationship of forest to the global climate system is complex and not completely understood.

Forest can act as reservoirs (storing carbon), sinks (actively sequestering carbon), or source (emitting carbon), depending on the relative maturity of the forest as well as the human uses of land.

Over time, changes in the forest cover have contributed significantly to the level of carbon in the atmosphere.

Indeed, estimates suggest that roughly 20% of anthropogenic carbon contributions come from deforestation.



### **Deforestation and climate change**



### 1. The science of climate change

- Anticipating the critical role that scientific consensus would play in building the political will to respond to climate change, the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO) created the Intergovernmental Panel on Climate Change (IPPC) in 1988.
- The IPCC was assembled with over 2000 accomplished natural and social scientists from around the globe and initially charged with assessing the scientific, technical and economic basis of climate change policy in preparation for 1992 Earth Summit and the negotiations of the Climate Change Convention.

IPCC

PANEL ON CLIMATE CHANGE



Intergovernmental Panel on Climate Change (IPCC)



### 1. The science of climate change

- Despite variations in weather over the short-term, the long-term climate data suggest that the planet's average surface air temperature has increased by an estimated 1.37°F (0.74°C) since the 1970s, with the most significant warming occurring in Alaska, Siberia, and the Antarctic Peninsula.
- The year 2010 was the warmest year on record for the Northern Hemisphere.
- In 2012, Artic winter ice reached the lowest coverage since records were first kept.
- Glacial melting and thermal expansion of water have also resulted in sea level rise.



Not all greenhouse gases are created equally; different gases have different "global warming potentials" (GWPs).

For example, the GWP of methane is 56 times that of  $CO_2$ .

Most greenhouse gas emissions come from industrial activity and thus, industrialized countries have been the primary contributors to the increase in atmospheric concentration of greenhouse gases over the past century.

### Who's to Blame

Greenhouse gas emissions by country in 2000 (including land-use change)



#### Green House Gases by Country

#### Who's to Blame?

National totals represent only part of the picture, because they depend on both population size and the level of industrial activity.

Per capita emissions provide a measure for comparing an average individual's contribution to emissions in each country.

From this perspective, an American emits four times more  $CO_2$  than a Chinese though China is the largest contributor of  $CO_2$ , a little larger than the USA.

#### Each Country's Share of 2011 Total Carbon Dioxide Emissions from the Consumption of Energy



#### Who's to Blame?



## 2. Impacts of climate change

- Global sea level has risen over 7 inches since the industrial revolution, and this is very likely caused by global warming.
- Sea level rise coupled with changes in storms and storm surges could result in the erosion of shores and associated habitat, increased salinity of estuaries and freshwater aquifers, altered tidal ranges in rivers and bays, and increased coastal flooding.
- Warmer global temperatures introduce more energy into the global weather system and are likely to lead to a more vigorous hydrological cycle; this translates into prospects for more extreme and unpredictable weather events, with more severe droughts, floods, and heat waves in some places.
- Changes in the total amount and frequency of precipitation directly affect the magnitude and timing of floods and droughts.
- The increase in global temperatures may also have significant impacts on public health (the spread of insect-borne diseases, increased illnesses and deaths from heat waves and air pollution and other water-borne diseases, particularly in developing countries.
- Climate change could also cause quite substantial harm to biodiversity, since forests and other ecosystems will not be able to adapt to the rate of change.



## 2. Impacts of climate change

- While the concern over climate change stems from the costs, it should be kept in mind that there will likely be some beneficial impacts as well.
  - Prospects of increased crop yields in some regions at mid-latitudes such as Siberia;
  - An increase in timber supply;
  - Increased water availability in some water-scarce regions (e.g., in parts of southeast Asia);
  - Reduced cold-weather mortality in mid and high-latitudes;
  - Reduced energy demand due to higher winter temperatures.
- The IPCC has firmly concluded that the costs of climate change will clearly and significantly outweigh the benefits.





- Concern about climate change and calls for international action began in the 1970s and continued throughout the 1980s. In 1990, the United Nations authorized an Intergovernmental Negotiating Committee on Climate to begin discussions of a global treaty. These negotiations culminated in the 1992 Framework Convention on Climate Change signed at the Earth Summit.
- Central to the Convention is the objective found in Article 2, requiring that Parties achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".





- The most significant provisions of the Climate Change Convention addressed the specific commitments of the Parties. The Parties are essentially divided into 3 categories:
  - o All Parties;
  - Annex I, which includes all industrialized countries Parties;
  - Annex II, which includes all industrialized countries Parties except those from the former Soviet bloc in a process of economic transition.





- In December 1997, the Parties responded by negotiating the Kyoto Protocol to the Climate Change Convention, which established binding reduction targets for the US and other developing countries.
- The core of Kyoto Protocol was targets and timetables, or "Quantified Emissions
  Limitation and Reduction Objectives" (QELROs), for industrialized Parties (Annex I) to reduce their net emissions of greenhouse gases.
- Most European countries agreed to lower their emissions by 8% or more below 1990 levels, while the US agreed to a 7% reduction.



Data: http://cdm.unfccc.int/Statistics/Issuance/CERsIssuedByHostPartyPieChart.html



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- Kyoto Protocol vs. Developing countries:
  - The issue if emission targets for developing countries was hotly contested during negotiations.
  - Based on the reasoning that developed countries have been responsible for the lion's share of emissions to date and are better able to pay for reductions, the Kyoto Protocol did not address emission reductions for developing countries.





 In general, the Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets.

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- Recognizing that developed countries are principally responsible for the current high levels of GHG emissions in the atmosphere as a result of more than 150 years of industrial activity, the Protocol places a heavier burden on developed nations under the principle of "common but differentiated responsibilities."
- The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005.





#### **2 BROAD CATEGORIES:**

• Mitigation approach: to lower the atmospheric concentration of greenhouse gases

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- > Long term strategy.
- Through reduced emissions at source or creating new sinks, primarily through land use and forestry management.
- Adaptation strategies: to address the consequences of climate change and focus on near-term measures that adapt to these changes.



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### **No-regrets**

- Improvement in energy efficiency, forest management, and air pollution control that provide economic and environmental benefits additional to any climate benefits that may be achieved.
  - Increased energy efficiency technologies often pay for themselves through lowering energy cost.
  - Reduced air emissions may improve public health conditions more than the cost of the technologies.





#### Trading mechanisms

**1. EMISSIONS TRADING** under Article 17 allows an Annex I party to purchase or transfer part of its "Assigned Amount Unit" to another Annex I party.

- For example, country A has excess reductions to meet its goal under Kyoto. It can sell its remaining emissions to country B. These can be subtracted from country B's total emissions in calculating its emissions under Kyoto.
- > Country-based.

**2. JOINT IMPLEMENTATION** (JI) under Article 6 can take place only between Annex I countries.

- Joint fulfillment of commitments under Article 4 allows an agreement between two or more parties to meet their combined commitments by reducing their aggregated emissions.
- Fully operating market for carbon trades, known as the EU Emission Trading Scheme.
- Project-based.



### Trading mechanisms

#### 3. CLEAN DEVELOPMENT MECHANISM (CDM)

- Allows developing countries to help developed countries to meet their emission reduction commitments.
- Article 12 provides that Annex I parties may fund activities in non Annex I countries that result in emission reductions and, after they are certified, use those reduction to offset their domestic emissions.
- There is an extensive verification process for CDM projects, involving host and investor country agreement, third party assessment, and registration by the CDM Executive Board.
- Once verified, the holder of the credits can sell them to Annex I parties who can then subtract this amount from their total emissions.





#### Successes



- Many nations have followed through on their agreement and cut greenhouse gas emissions, an example is the European Union.
  - This graph shows the carbon emissions from various areas (1800 – 2000) → most concerned with the end of the graph which demonstrates many countries have reduced their emissions.
  - The yellow and red-orange lines represent areas that are part of the European Union and you can see their emission have dropped. The EU has dropped their emissions by 5%.

#### **Failures**

Country	Change in GHG emissions 1992 - 2007
India	+103%
China	+150%
United States	+20%
Russian Federation	-20%
Japan	+11%
Total worldwide	+38%

- Many countries have increased dramatically rather than decrease their emissions since the introduction of the Kyoto Protocols.
- The United States still refuses to ratify the treaty (the largest total emitter and largest emitter per capita in the world).
  - because of the absence of binding targets for developing nations.
  - Both India and China's emissions have increased dramatically.
  - Without binding targets for developing nations, they will only increase their emissions and it will be harder to reduce them in the future.



#### Major accomplishment

- bringing awareness to the fact that we need to reduce our greenhouse gas emissions and protect our environment.
- Even if the goals of the Protocol are not met, it will have been a great starting point.
- The Protocol is helping the world work together to protect our planet, much like the world banded together to remedy the Ozone Hole calamity.
- It shows that many countries are serious about environmental protection and show others that need to be less selfish and focus on what's really important.



# Thanks for your listening



#### ANY QUESTION?