

# Chapter 17 Lecture – Climate Change

## Econ 275 – Environmental Economics

### Chapter 17 Lecture - Climate Change



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## The Science of Climate Change

- Greenhouse gases absorb infrared radiation, trapping heat that would otherwise radiate into space.

- Carbon dioxide: most abundant
- Emissions of these gases increasing over time

- Intergovernmental Panel on Climate change (IPCC) reported in 2007 that most warming over last 250 years can be attributed to human activity.

[https://www.un.org/en/climatechange/reports?gad\\_source=1&gclid=EAlaIqobChMIqlyW4OHVlQMvjmZHR2GAhISEAAYASAAEgIENFD\\_BwE](https://www.un.org/en/climatechange/reports?gad_source=1&gclid=EAlaIqobChMIqlyW4OHVlQMvjmZHR2GAhISEAAYASAAEgIENFD_BwE)

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## The Science of Climate Change

With respect to projected climatic changes, the report found the following:

- CO<sub>2</sub> increases due to use of fossil fuels and land-use change, methane/NO<sub>2</sub> due to agriculture.
- The global increases in carbon dioxide concentration are due primarily to fossil-fuel use and land-use change, while those of methane and nitrous oxide are due primarily to agriculture.
- Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

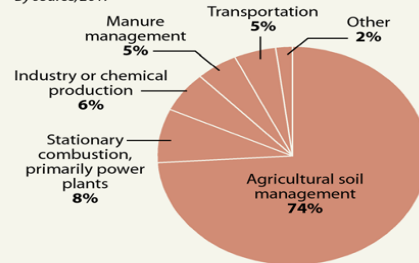
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## Where Does N<sub>2</sub>O Come From?

Agriculture, particularly fertilized soil and animal waste, accounts for about three quarters of U.S. nitrous oxide emissions.

### U.S. NITROUS OXIDE EMISSIONS

By source, 2017



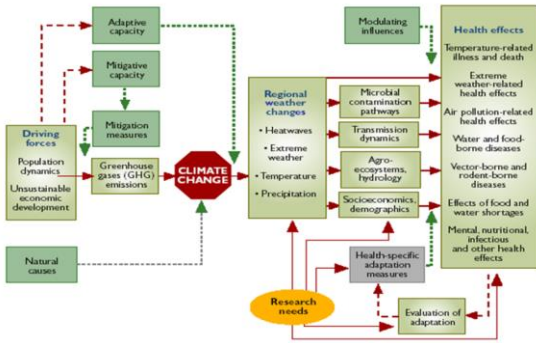
SOURCE: EPA

PAUL HORN / InsideClimate News

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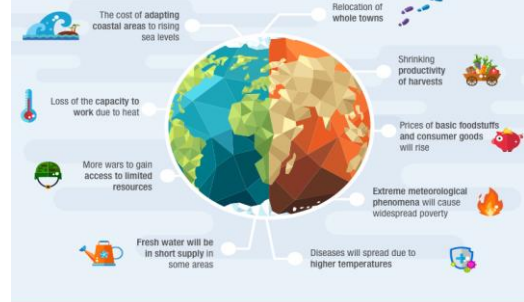
## Climate Change and Health



<https://www.who.int/globalchange/climate/summary/en/index12.html>

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## SOCIAL AND ECONOMIC IMPACT OF CLIMATE CHANGE



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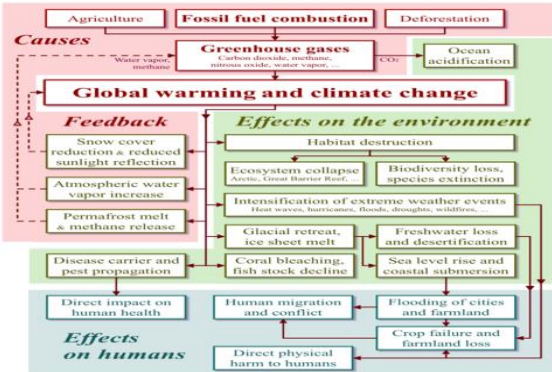
## The Science of Climate Change

- Human-induced warming and sea-level rise would continue for centuries due to the timescales associated with the climate processes and feedbacks, even if greenhouse gases were to be stabilized.
- Projected impacts of the warming include contracting snow cover, shrinking sea ice in the Arctic and Antarctic regions, and increasing weather events such as extreme heat, heavy precipitation and intense storms.



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## Global warming and climate change Causes and effects

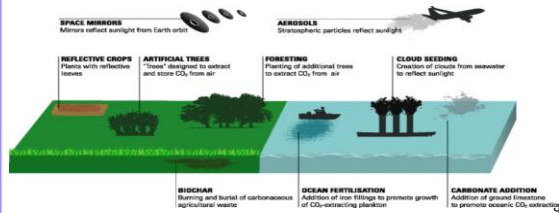


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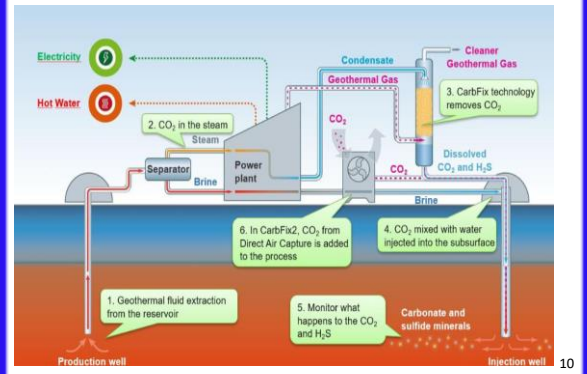
## Negotiations over Climate Change Policy

- Characterizing the Broad Strategies
  - Climate engineering (geoengineering): two categories
    - Carbon dioxide removal—air capture, ocean fertilization
    - Solar-radiation management—injecting stratospheric aerosols
  - Adaptation: modify natural or human systems to minimize harm
  - Mitigation: attempts to moderate the temperature rise by reducing emissions, increase planet's capacity to absorb greenhouse gases



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## Carbon Capture



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## Negotiations over Climate Change Policy

- Game Theory as a Window on Climate Negotiations
  - Game theory has been used to study participation in agreements with public good problems.
  - “Issue linkage” is a strategy where countries simultaneously negotiate a climate change agreement and another economic agreement on a linked issue, e.g. trade.
  - A final strategy involves transfers from gainers to losers or a redistribution of net benefits.
  - Choosing cost-effective policies can positively affect the level of participation.

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## Game Theory Example

The decision at the negotiations table for both Rich and Poor countries is whether they act now (before climate change) or act later (wait for climate change to happen and then act).

The 4-box matrix on the next slide shows the four potential scenarios that could have come out of the mid-1990s climate change negotiations:

1. Green growth – all countries act now, no change in global distribution of wealth.
2. Green equity – rich act first, poor act later, most of climate change is avoided (since rich countries have the majority of emissions) but poor countries are able to catch-up on global development
3. Carbon colonialism – poor countries act now, rich act later. Much of climate change still occurs and rich get richer.
4. Carbon wasteland – no countries act until later. Catastrophic climate change occurs, world economy suffers, no change in distribution of wealth.

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# Chapter 17 Lecture – Climate Change

2050 payoffs for rich and poor countries in mid-1990s climate change negotiations

|                          |           | Poor Countries (non-Annex I)                                     |                                                               |
|--------------------------|-----------|------------------------------------------------------------------|---------------------------------------------------------------|
|                          |           | Act now                                                          | Act later                                                     |
| Rich Countries (Annex I) | Act now   | <b>Green growth</b><br>Rich: 100<br>Poor: 50<br>Global: 150      | <b>Green equity</b><br>Rich: 70<br>Poor: 65<br>Global: 135    |
|                          | Act later | <b>Carbon colonialism</b><br>Rich: 85<br>Poor: 35<br>Global: 115 | <b>Carbon wasteland</b><br>Rich: 50<br>Poor: 25<br>Global: 75 |

<http://essaydocs.org/game-theory-and-international-climate-change-negotiations.html>

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**Dominant strategy for rich countries: act now**

**Poor countries will push for green equity**

Equilibrium is for Green Equity scenario: rich act now, poor act later

|                          |           | Poor Countries (non-Annex I)                                     |                                                               |
|--------------------------|-----------|------------------------------------------------------------------|---------------------------------------------------------------|
|                          |           | Act now                                                          | Act later                                                     |
| Rich Countries (Annex I) | Act now   | <b>Green growth</b><br>Rich: 100<br>Poor: 50<br>Global: 150      | <b>Green equity</b><br>Rich: 70<br>Poor: 65<br>Global: 135    |
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<http://essaydocs.org/game-theory-and-international-climate-change-negotiations.html>

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## The Clean Development Mechanism



<http://essaydocs.org/game-theory-and-international-climate-change-negotiations.html>

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Hoped that CDM would change payoffs to create new equilibrium of green & equitable growth

|                          |           | Poor Countries (non-Annex I)                                           |                                                               |
|--------------------------|-----------|------------------------------------------------------------------------|---------------------------------------------------------------|
|                          |           | Act now                                                                | Act later                                                     |
| Rich Countries (Annex I) | Act now   | <b>Fair green growth</b><br>Rich: 100.80<br>Poor: 50.70<br>Global: 150 | <b>Green equity</b><br>Rich: 70<br>Poor: 65<br>Global: 135    |
|                          | Act later | <b>Carbon colonialism</b><br>Rich: 85<br>Poor: 35<br>Global: 115       | <b>Carbon wasteland</b><br>Rich: 50<br>Poor: 25<br>Global: 75 |

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## Some Things to Consider

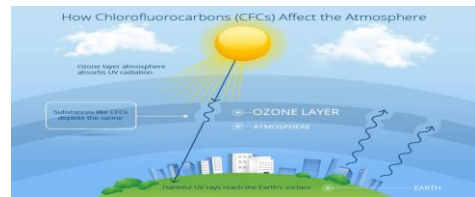
- A main difficulty in constructing self-enforcing agreements is the free-rider effect.
- Climate change involves a global pollutant and the effects of emissions reductions are a public good. All nations receive the benefits of emissions reductions whether those nations contributed to those reductions or not.
- Individual nations therefore bear all of the costs of their reductions, but gain only a portion of the resulting benefits.
- This means the private marginal benefit for any nation's reduction effort is lower than the social marginal benefit, which is the sum of the marginal benefits received by all nations.
- Therefore when an individual nation reduces emissions until its private marginal cost of reduction is equal to its private marginal benefit, this private optimum results in too little reduction.

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## The Precedent: Reducing Ozone-Depleting Gases

- Stratospheric ozone shields earth from harmful radiation and factors in determining climate.
- The use of chlorofluorocarbons (CFCs) for aerosol propellants, packing materials, and refrigeration has been a large factor in the depletion of the stratospheric ozone shield.
- Major known effect of ozone depletion: increase in nonmelanoma skin cancer.



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## Economics and the Mitigation Policy Choice

- **Providing Context: A Brief Look at Three Illustrative Carbon Pricing Programs**
  - The British Columbia Carbon Tax
  - The European Union's Emissions Trading System
  - The Australian Hybrid System

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## Economics and the Mitigation Policy Choice

### British Columbia Carbon Tax Program

- British Columbia has imposed a carbon tax on each metric ton of carbon dioxide equivalent (CO<sub>2</sub>-e) emissions from the combustion of fuel.
- The carbon tax is applied and collected at the wholesale level, using the administrative channels established earlier for collecting motor fuel taxes.
- The cost of the tax is ultimately passed forward to consumers via higher prices.
- The carbon tax is revenue neutral.
  - With a revenue-neutral tax, the government keeps none of the money collected from the levy. Instead, it redistributes all of it back to taxpayers in the form of tax cuts.

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### Economics and the Mitigation Policy Choice

#### European Union Emissions Trading System (E.U. ETS)

- The program establishes a cap on the total amount of certain GHGs.
- Under this cap, companies receive emission allowances (EUAs), which they can sell to, or buy from, one another as needed. At the end of the year each company must surrender enough allowances to cover all its emissions or pay penalties on any excess.
- Companies can bank any spare allowances for future sale or for covering their future needs.

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### Economics and the Mitigation Policy Choice

#### Australian Hybrid System

- In the first stage emitters face a fixed price for each metric ton of carbon emitted. The price started at \$A23 (US\$23.8) per metric ton and rises at 2.5 percent per annum in real terms.
- In the second stage, which began in 2014, the fixed carbon price regime transitions to a fully flexible price regime, with the price determined by an emissions trading market.

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### Economics and the Mitigation Policy Choice

#### Three Carbon Pricing Program Design Issues: Using the Revenue, Offsets, and Price Volatility

- **Revenue**
  - Revenues could be used to reduce the financial burden of the policy on low-income populations, to boost the economy, to increase the magnitude of the emissions reductions, to aid workers displaced by the policy, and even to increase the likelihood that a carbon-pricing policy might be enacted in the first place.

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### Economics and the Mitigation Policy Choice

#### Various strategies include:

- (1) giving the revenue back to households in the form of a lump-sum rebate on a per capita basis,
- (2) lowering various taxes such as the corporate tax, the income tax, the capital gains tax, the payroll tax, etc.,
- (3) using the revenue to subsidize further emissions reductions, or
- (4) helping workers who are displaced by the shift to a lower carbon energy supply.

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## Chapter 17 Lecture – Climate Change

### Mitigation Policy: Timing

- There are enormous uncertainties associated with climate changes.
- Benefits from control are received in the distant future, while costs occur now.
- Uncertainties about the costs and benefits are also problematic. Governments must make decisions without complete information.

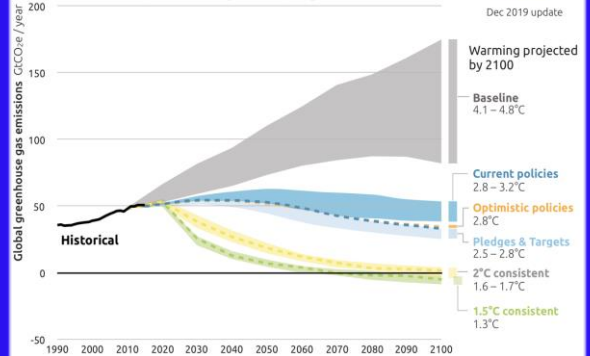
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### 2100 WARMING PROJECTIONS

Emissions and expected warming based on pledges and current policies

Climate Action Tracker  
Dec 2019 update



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### The Role of Adaptation Policy

- Whereas mitigation strategies try to limit damage by limiting the emissions that cause the impacts, adaptation tends to limit damage by reducing the damage caused by the impacts that do occur.
- The two strategies are complements in the sense that the optimal policy response contains both adaptation and mitigation.
- Since the marginal cost function for each strategy is upward-sloping, this normally means that an optimal strategy would employ both mitigation and adaptation.
- Deviating from this optimum necessarily means that costs would be higher than necessary.

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### The Role of Adaptation Policy

- Property rights matter. Because they would incur the losses caused by property damages, renters also have lower incentives than owners to invest in adaptation. In general ambiguous or compromised property rights can be a barrier to effective private action.
- Effective private action depends on good information on both the nature of risks and options for adapting to them.
- Much of this information about future risks is a public good, which means that it will be undersupplied unless the government supplies it or participates in its supply.

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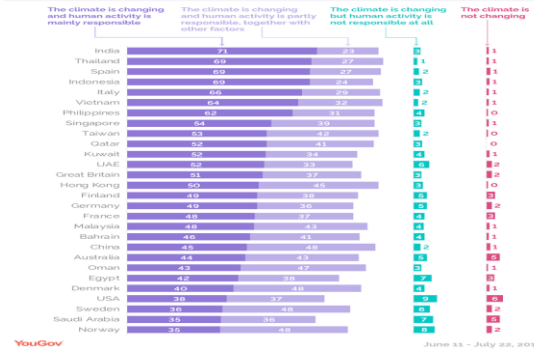
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## The Role of Adaptation Policy

- Adaptation choices can also be limited by affordability, including how a low income diminishes the ability to borrow.
- Much of the adaptation would involve public capital like roads, or public transportation systems and the desirability of many private adaptation responses would be affected by those public adaptation responses.

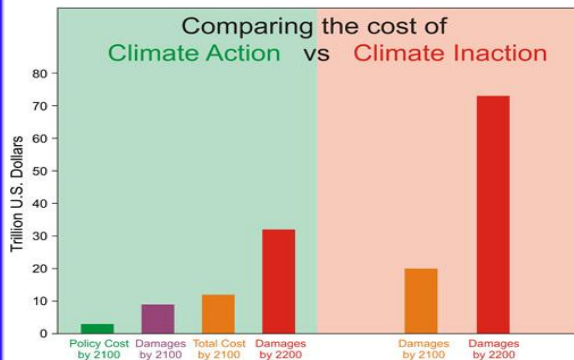
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That climate change is happening and that humanity is at least partly responsible is a view held by the majority across the world. Thinking about the global environment... In general, which of the following statements, if any, best describes your view? (%)



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Comparing the cost of Climate Action vs Climate Inaction



<https://www.globalissues.org/article/233/climate-change-and-global-warming-introduction>

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## THE CLIMATE CHANGE DENIER'S PLAYBOOK



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