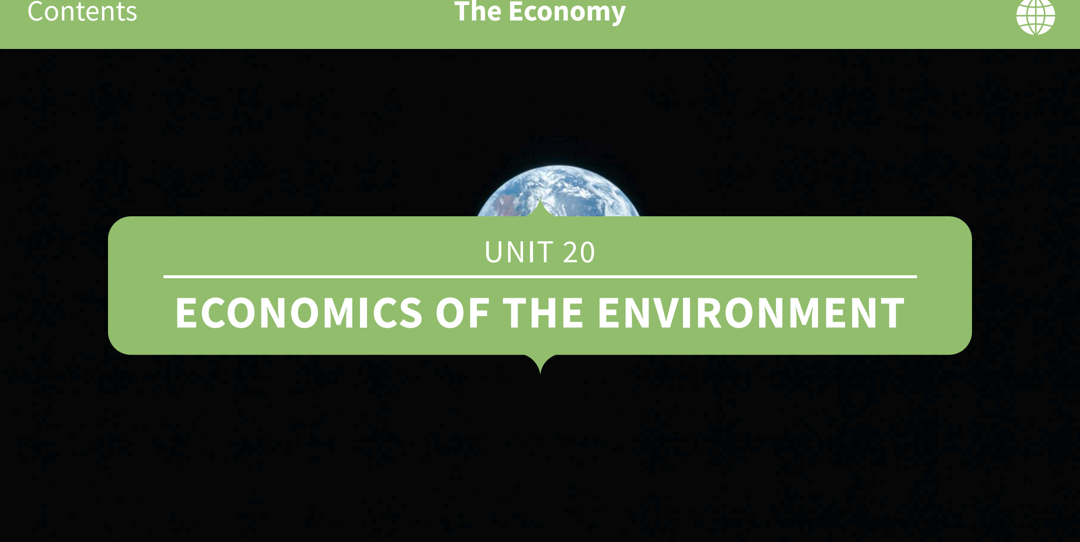

UNIT 20

ECONOMICS OF THE ENVIRONMENT

EXPAND ALL

How economic activity affects the fragile biosphere of our planet, and how the resulting environmental problems can be addressed +

20.1 Recap: External effects, incomplete contracts, and missing markets +

20.2 Climate change –

Many scientists now see climate change as the greatest threat to future human wellbeing. We focus on climate change because of its importance as an environmental problem, and because it illustrates the difficulties of designing and implementing adequate environmental policies. This problem tests our framework of efficiency and fairness to the limit, because of five features that climate change shares with other environmental problems:

Challenges

- *Stabilizing yearly emissions is not sufficient*: Climate is affected by the total amount of **greenhouse gases** in the atmosphere. This is increasing due to the annual flow of emissions. But merely stabilizing emissions at current levels will not be enough, because the stock of greenhouses gases would then continue to increase.
- *Irreversibility of climate change*: Increases in the amount of CO_2 in the atmosphere are partially irreversible, which means that our current actions have long-lasting effects on future generations.
- *The worst-case scenario*: Experts are uncertain about the scale, timing, and global pattern of the effects of climate change, but most agree that climate change could be catastrophic. Therefore, the *most likely* scenario should not be the only guide to policy. We need to take into account a range of possible scenarios, including some very unlikely but disastrous ones.
- *A global problem requiring international cooperation*: The contributions to climate change come from all parts of the world, and its effects will be felt by all of nearly 200 autonomous nations. It will be solved only by a high level of cooperation between the largest and most powerful nations, at a minimum, on a scale without historical precedent.
- *Conflicts of interest*: The impacts of climate change differ among people according to their economic circumstances, both across the globe and within countries. Future generations will experience the effects of today's emissions, but also the actions we take to reduce them. It is unclear how to balance the competing interests of individuals in different economic circumstances, and the interests of current and future generations.

Climate change and economic activity LINK

Figure 20.6 shows the data on the stock of CO_2 (in parts per million) using the right-hand scale, and global temperature (as the deviation from the average over the period 1961–1990) using the left-hand scale, for the period since 1750.

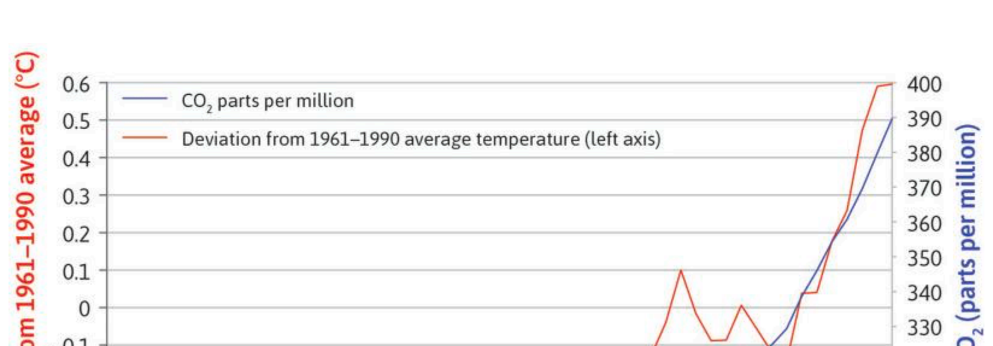

Figure 20.6 Global atmospheric concentration of carbon dioxide and global temperatures (1750–2010).

Years 1010–1975: David M. Etheridge, L. Paul Steele, Roger J. Francey, and Ray L. Langenfelds. 2012. 'Historical Record from the Law Dome DE08, DE08-2, and DSS Ice Cores'. Division of Atmospheric Research, CSIRO, Aspendale, Victoria, Australia. Years 1976–2010: Data from Mauna Loa observatory; Tom A. Boden, Gregg Marland, and Robert J. Andres. 2010. 'Global, Regional and National Fossil-Fuel CO_2 Emissions'. Carbon Dioxide Information Analysis Center (CDIAC) Datasets. Note: This data is the same as in Figures 1.6a and 1.6b. Temperature is average northern hemisphere temperature.

Burning fossil fuels for power generation and industrial use leads to emissions of CO_2 into the atmosphere. These activities, together with CO_2 emissions from land-use changes, generate greenhouse gases equivalent to around 36 billion tonnes of CO_2 each year. Concentrations of CO_2 in the atmosphere have increased from 280 parts per million in 1800 to 400 parts per million, currently rising at 2–3 parts per million each year. CO_2 allows incoming sunlight to pass through it, but traps reflected heat on the earth, leading to increases in atmospheric temperatures and changes in climate. Some CO_2 also gets absorbed into the oceans. This increases the acidity of the oceans, killing marine life.

Figure 20.6 illustrates a key fact of climate science: that global warming is an effect of the amount of CO_2 and other greenhouse gases in the atmosphere. To use the language of Unit 10, where we discussed income (a flow) and wealth (a stock), climate change is caused by the stock of atmospheric greenhouse gases, not by the flow of our annual emissions. It's what's in the tub that matters. Figure 20.7 presents this new use of the bathtub model to illustrate the problem.

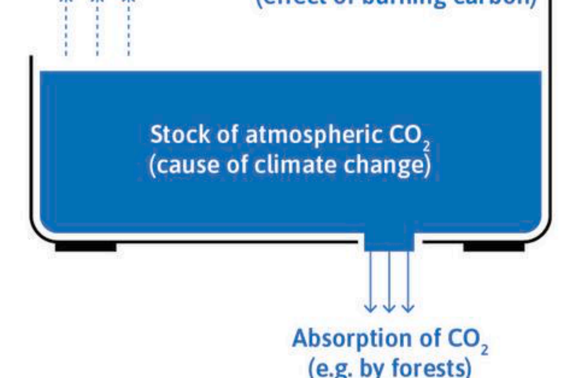

Figure 20.7 Another bathtub model: The stock of atmospheric CO_2.

The increase in CO_2 in the atmosphere is occurring because the processes reducing the stock (natural decay of the CO_2 and absorption of CO_2 by forests) are far less than the new emissions that we add annually. Moreover, deforestation in the Amazon, Indonesia and elsewhere is reducing the CO_2 'outflows' while also adding to CO_2 emissions. These forests are often replaced by agricultural activities that produce further greenhouse gas emissions in the form of methane releases from livestock and nitrous oxide releases from fertilizer overuse.

The natural decay of CO_2 is extraordinarily slow. Of the carbon dioxide that humans have put in the atmosphere since the mass burning of coal that started in the Industrial Revolution, two-thirds will still be there a hundred years from now. More than a third of it will still be 'in the tub' a thousand years from now. The natural processes that stabilized greenhouse gases in the atmosphere in pre-industrial times have been entirely overwhelmed by human economic activity. And the imbalance is accelerating.

Martin Weitzman argues there is a non-trivial risk of a catastrophe from climate change in an *EconTalk* podcast.

It is estimated that we can emit only a further 1 to 1.5 trillion tonnes of CO_2 into the atmosphere to give reasonable odds of limiting the increase in temperature to 2°C above pre-industrial levels. Should we manage to achieve this limit on emissions, there is still a probability of around 1% that temperature increases would be more than 6°C, causing a global economic catastrophe. If we exceed the limit and temperature rises to 3.4°C above pre-industrial levels, the probability of a climate-induced economic catastrophe would rise to 10%. 1

Figure 20.8 shows the relationship between estimated temperature increases and CO_2 emitted. It also shows the amount of CO_2 that would be emitted if we:

- burnt the fossil fuels that can be economically extracted at current prices and technology (**reserves**)
- burnt *all* fossil fuels in the earth's crust (**resources**)

Figure 20.8 indicates that keeping the warming to 2°C implies that the majority of fossil fuel reserves and resources should remain in the ground.

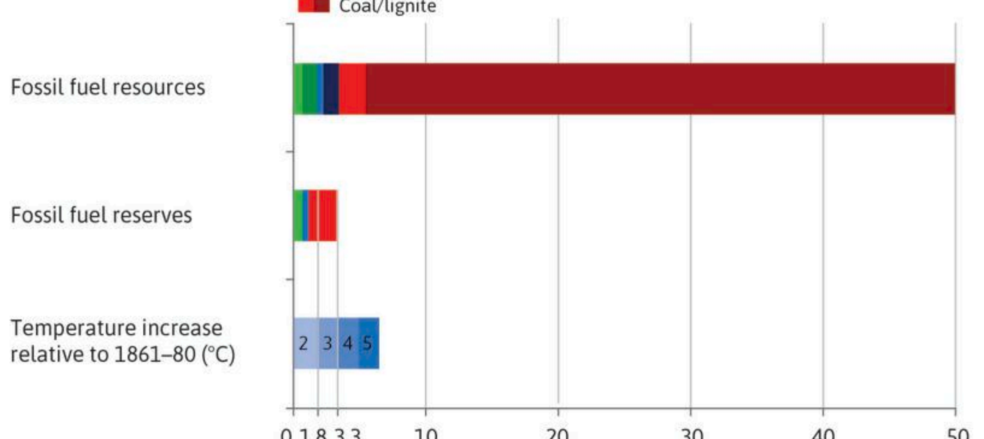

Figure 20.8 Carbon dioxide contained in fossil fuel reserves and resources, relative to the atmospheric capacity of the earth.

Calculations by Alexander Otto of the Environmental Change Institute, University of Oxford, based on: Aurora Energy Research. 2014. 'Carbon Content of Global Reserves and Resources'; Bundesanstalt für Geowissenschaften und Rohstoffe (The Federal Institute for Geosciences and Natural Resources). 2012. *Energy Study 2012*; IPCC. 2013 *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press; Cameron Hepburn, Eric Beinhocker, J. Doyne Farmer, and Alexander Teytelboym. 2014. 'Resilient and Inclusive Prosperity within Planetary Boundaries'. *China & World Economy* 22 (5): pp. 76–92.

EXERCISE 20.1 ASSESSING THE ECONOMIC IMPACTS OF GLOBAL WARMING LINK

In 1896, Swedish scientist Svante Arrhenius estimated the impact of doubling CO_2 concentrations in the atmosphere, and later suggested that 'the colder regions of the earth' might want to burn more coal so as to enjoy a 'better climate'.

In the next century, entire countries may disappear as the level of the oceans rise in response to the melting of the West Antarctic and Greenland ice sheets.

1. Find out what you can about which regions, industries, occupations, firms, or cities are likely to be:
   a. most positively affected by climate change
   b. most negatively affected by climate change
2. What are the main reasons why the effects of climate change differ across these groups?

EXERCISE 20.2 CLIMATE CHANGE CAUSES AND EVIDENCE LINK

Use information from the National Aeronautics and Space Administration web page on climate change, and the latest report of the Intergovernmental Panel on Climate Change to answer the following questions:

1. Explain what climate scientists believe to be the main causes of climate change.
2. What evidence is there to indicate that climate change is already occurring?
3. Name and explain three potential consequences of climate change in the future.
4. Discuss why the three consequences you have listed may lead to disagreements and conflicts of interest about climate policy. (Hint: You may find it useful to draw on your answers to Exercise 20.1 about the winners and losers from climate change.)

QUESTION 20.3 CHOOSE THE CORRECT ANSWER(S) LINK

Figure 20.8 shows the temperature increase arising from the CO_2 emitted, generated at different levels of use of fossil fuel reserves (which can be technically and economically extracted) and resources (estimated total amounts) in the earth's crust. For example, it states that a further 1 to 1.5 trillion tonnes of CO_2 emissions would be likely to lead to a 2°C increase in temperature, compared to the pre-industrial average.

You are also given that 36 billion tonnes of CO_2 are generated each year currently. Based on this information, which of the following statements is correct?

- [ ] The figure suggests that the world should stop using coal immediately.
- [ ] Using up all the reserves but none of the resources should keep the temperature from rising more than 2°C.
- [ ] Limiting further CO_2 emissions to 1 to 1.5 trillion tonnes will ensure that the temperature will not rise more than 2°C.
- [ ] Stabilizing the emission rate at the current level will not be enough to prevent the possibility of a climate-induced economic catastrophe.

Check my answers