

### CLIMATE CHANGE AFFECTS ECOSYSTEMS

- Threats to coral reefs:
  - Warmer waters (coral bleaching)
  - Ocean chemistry is becoming more acidic
    - Impairing coral growth
  - Will greatly reduce biodiversity
- Increased precipitation (in some areas)
  - Will increase erosion and flooding
    - Which will pollute aquatic systems
- Decreased precipitation (in some areas)
  - Will reduce surface waters
- Ecosystem goods and services will decrease

---

---

---

---

---

---

---

---

### CLIMATE CHANGE EXERTS SOCIETAL IMPACTS

- Human society
  - Beginning to feel the impacts of climate change
- Forestry:
  - Increased insect and disease outbreaks
  - Invasive species
  - Forest fires (especially in rainforests)
- Agriculture:
  - Droughts, floods
  - Decreased yields, worsened hunger

---

---

---

---

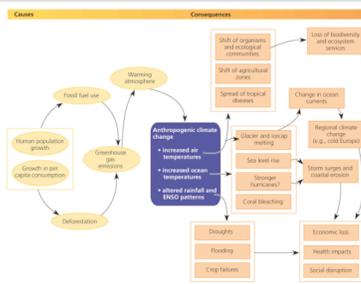
---

---

---

---

### CAUSES AND CONSEQUENCES OF CLIMATE CHANGE




---

---

---

---

---

---

---

---

IMPACTS WILL VARY REGIONALLY

*Temperature changes are greatest in the Arctic.*

- Ice sheets are melting
- Sea ice is thinning
- Storms are increasing
- Polar bears are starving
- Melting permafrost
  - Destabilizing buildings
  - Drunken forests



© 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

---

---

---

---

---

---

---

---

U.S. GLOBAL CHANGE RESEARCH PROGRAM (2008)

TABLE 18.2 Some Predicted Impacts of Climate Change in the United States

*Past effects and predicted future impacts of climate change*

- ▶ Average temperatures will rise 3–5° C (5.4–9.0° F) in 100 years.
- ▶ Droughts and flooding will worsen.
- ▶ Drought and other factors could decrease crop yields, but longer growing seasons and enhanced CO<sub>2</sub> could raise yields.
- ▶ Snowpack will decrease; water shortages will worsen.
- ▶ Greater temperature extremes will increase health problems and human mortality. Some tropical diseases will spread north.
- ▶ Forest growth may increase in the short term, but in the long term, drought, pests, and fire may alter forest ecosystems.
- ▶ Alpine ecosystems and barrier islands will begin to disappear.
- ▶ Southeastern U.S. forests will break up into savanna/grassland/forest mosaics.
- ▶ Northeastern U.S. forests will lose sugar maples.
- ▶ Sea level rise will cause loss of coastal wetlands and real estate.
- ▶ Melting permafrost will undermine Alaskan buildings and roads.

---

---

---

---

---

---

---

---

ARE WE RESPONSIBLE FOR CLIMATE CHANGE?

- The IPCC 2007 report
  - Concluded that it is more than 90% likely that most global warming is due to humans
- 2005
  - National academies of 11 nations
    - Issued a joint statement urging political leaders to take action
- Debate
  - Fanned and funded by industry skeptics
  - Industry aims to cast doubt on the scientific consensus
- Media
  - Try to present two sides to the story
    - Even with overwhelming scientific evidence that climate is changing

---

---

---

---

---

---

---

---

**SHALL WE PURSUE MITIGATION OR ADAPTATION?**

- **Mitigation**
  - Pursue actions that reduce greenhouse gas emissions
    - To lessen severity of future climate change
  - Renewable energy, efficiency, farm practices
    - To protect soil integrity, preventing deforestation
- **Adaptation**
  - Accept climate change is happening
    - Pursue strategies to minimize its impacts
  - Uses technology and engineering
    - Adjusting farming to cope with droughts, etc.
  - Criticized as sidestepping
- Both are necessary

---

---

---

---

---

---

---

---

**ELECTRICITY GENERATION**



*A coal-fired, electricity-generating power plant*

- Largest source of U.S. CO<sub>2</sub> emissions
- Two ways to reduce fossil fuel use: conservation and efficiency
  - Arise from technology and individual choices
  - Removing or storing CO<sub>2</sub> somewhere (underground?)
  - Use renewable fuels

---

---

---

---

---

---

---

---

**WE CAN REDUCE EMISSIONS**

- Use advances in agriculture, forestry, and waste management
  - Use sustainable land management
  - Grow renewable biofuels
  - Reforestation, sustainable forestry, forest preservation
  - Recovering methane from landfills, wastewater treatment
  - Recycling, composting, and reduction or reuse of materials
- *There is no single magic bullet for mitigating climate change.*

---

---

---

---

---

---

---

---

### WE NEED TO FOLLOW MULTIPLE STRATEGIES

- Most reductions can be achieved
  - Using current technology
- To eliminate 15 billion tons of carbon/year by 2050:
  - Double fuel economy and halve miles driven
  - Maximize building efficiency
  - Double efficiency of coal power plants
    - But switch to natural gas (temporarily)
  - Capture and store carbon from coal, hydrogen, and synfuel plants
  - Increase hydrogen fuel production and nuclear power plants
  - Increase wind, solar, ethanol production
  - Stop deforestation, reforest, and conserve croplands

*Achieving just 7 of these would stabilize our emissions.*

---

---

---

---

---

---

---

---

### THE FCCC

- **UN Framework Convention on Climate Change (FCCC)**
  - Plan for reducing greenhouse gas emissions to 1990 levels
    - By the year 2000
    - Through a voluntary, nation-by-nation approach
  - By the late 1990s, it was clear that the voluntary approach would not succeed
  - Most developed nations did not voluntarily cut emissions
- **Kyoto Protocol**
  - Mandates that, between 2008-2012
    - Signatory nations must reduce emissions
      - Of six greenhouse gases to levels below those of 1990
  - This treaty took effect in 2005
    - After Russia became the 127th nation to ratify it
      - We did not, and have not

---

---

---

---

---

---

---

---

### THE KYOTO PROTOCOL SEEKS TO LIMIT EMISSIONS



- The United States will not ratify the Kyoto Protocol
  - It requires industrialized nations to reduce emissions
    - But not rapidly industrializing nations (China and India)
- Governments and businesses in industrialized nations
  - Feel they have more to lose economically from restriction
    - But they can gain more
      - By inventing, developing, and marketing new technologies

---

---

---

---

---

---

---

---

## OTHERS ARE ADVANCING CLIMATE CHANGE POLICY

- U.S. state and local governments
  - Advancing policies to limit greenhouse emissions
  - Mayors from 850 cities
    - Agreed to pursue policies to “meet or beat” Kyoto Protocol guidelines
- California
  - Is determined to cut greenhouse gas emissions 25% by the year 2020
- 10 northeastern states
  - Set up a cap-and-trade program for carbon emissions from power plants



(A) Greg Nickels  
Copyright © 2009 Pearson Education, Inc., publishing as Pearson Benjamin Cummings



(B) Arnold Schwarzenegger  
Copyright © 2009 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

---

---

---

---

---

---

---

---

## MARKET MECHANISMS ADDRESS CLIMATE CHANGE

- Permit trading programs
  - Harness the economic efficiency of the free market
    - To achieve policy goals
      - While allowing businesses flexibility
    - Polluters choose how to best reduce their emissions
- A cap and trade emissions trading program
  - Each state decides who needs to participate
  - Each sets a cap on allowable carbon emissions
  - Each emissions source gets one permit
  - The source can buy or sell permits
  - Any source emitting more than its permitted amount will face penalties

---

---

---

---

---

---

---

---

## CARBON OFFSETS ARE IN VOGUE

- Emissions trading programs
  - Allow participants to buy carbon offsets
- Carbon offset
  - Voluntary payment to enable another entity to reduce emissions that one is unable to reduce oneself
  - Popular among utilities, businesses, universities, governments, and individuals
    - Trying to achieve **carbon-neutrality**, where no net carbon is emitted
  - A simple, convenient (but expensive) way to reduce emissions
    - without changing habits
- Carbon offsets fall short
  - Needs oversight to make sure that the offset money accomplishes what it is intended for

---

---

---

---

---

---

---

---

## TOP 10 SOLUTIONS TO CLIMATE CHANGE

TABLE 14.5 Top Solutions to Climate Change, as Voted on by *Focus the Nation* participants

1. Invest in the clean energy revolution	13%
2. Cleaner cars, California-style	12%
3. Create green jobs, save energy	12%
4. Build green: Carbon neutral by 2030	12%
5. Get efficient—cut energy, save money	11%
6. Support stronger forests	11%
7. Tax global warming pollution	9%
8. No new coal plants without “capture and sequestration”	7%
9. Cap CO <sub>2</sub> emissions, share the auction revenues	7%
10. Jumpstart low polluting biofuel	6%

Data from Eban Goodstein and Focus the Nation, [www.focus.thenation.org/](http://www.focus.thenation.org/)  
Copyright © 2009 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

---

---

---

---

---

---

---

---

---

---

---

---

## CONCLUSION

- Many factors influence Earth's climate
  - Human activities play a major role
- Climate change is well underway
  - Further emissions will cause severe impacts
- More and more scientists and policymakers are urging immediate action
  - Reducing emissions, and mitigating and adapting to a changing climate
    - Represents the foremost challenge for our society

---

---

---

---

---

---

---

---

---

---

---

---

## QUESTION: REVIEW

“Global warming” is defined as:

- a) Atmospheric conditions at localized sites
- b) Atmospheric conditions over hours or days
- c) An area's long-term atmospheric conditions
- d) An increase in Earth's average temperature
- e) Trends and variations in Earth's precipitation

---

---

---

---

---

---

---

---

---

---

---

---

QUESTION: REVIEW

“Global warming potential,” when referring to greenhouse gases, means:

- a) The ability of a molecule to contribute to global warming
- b) The ability of a molecule to prevent global warming
- c) Carbon dioxide is the most potent greenhouse gas
- d) Energy travels back to the Earth, after being emitted
- e) That all other molecules are measured against CFCs

---

---

---

---

---

---

---

---

QUESTION: REVIEW

Which of the following are major contributors of global warming?

- a) Burning fossil fuels and recycling
- b) Deforestation and nuclear energy
- c) Burning fossil fuels and deforestation
- d) Fossil fuels and nuclear energy
- e) Fossil fuels and planting forests

---

---

---

---

---

---

---

---

QUESTION: REVIEW

Which of the following greenhouse gases is not the most potent, but is extremely abundant?

- a) Methane
- b) Water vapor
- c) Carbon dioxide
- d) Nitrous oxide
- e) Aerosols

---

---

---

---

---

---

---

---

*QUESTION: REVIEW*

What would happen if the NADW (North American Deep Water) conveyor belt were disrupted?

- a) Europe would get warmer.
- b) Greenland would get warmer.
- c) The U.S. would get warmer.
- d) Europe would get cooler.
- e) Greenland would get cooler.

---

---

---

---

---

---

---

---

*QUESTION: REVIEW*

A "proxy indicator" for global warming is:

- a) Indirect evidence of global warming
- b) Indirect evidence that substitutes for direct evidence of global warming
- c) Direct evidence of global warming
- d) Direct evidence that substitutes for indirect evidence of global warming
- e) The argument global warming critics use to say climate change is not occurring

---

---

---

---

---

---

---

---

*QUESTION: REVIEW*

The 2007 Fourth Assessment Report of the Intergovernmental Panel on Climate Change made it clear that:

- a) Climate is changing
- b) Humans are the cause
- c) This change is already exerting impacts
- d) Observed trends in temperature are well documented
- e) All of the above are included in this report.

---

---

---

---

---

---

---

---

*QUESTION: REVIEW*

One result of climate change is that sea surfaces will rise, which means that:

- a) More ice will be formed in the Arctic
- b) Coral reefs will expand their range throughout the world
- c) Storms will be stronger and last longer
- d) The number of storms will increase, but not their strength
- e) Nothing will happen; climate change is still debatable

---

---

---

---

---

---

---

*QUESTION: REVIEW*

What happens as ice melts in polar regions?

- a) More heat is reflected into space
- b) Glaciers re-freeze at night
- c) Exposed soils absorb heat and make melting worse
- d) Polar bears learn to like the sun
- e) Eskimos can now sell their property at a profit

---

---

---

---

---

---

---

*QUESTION: WEIGHING THE ISSUES*

Do you think people in arid biomes deserve some sort of compensation from developed nations whose emissions have caused climate change and caused increased desertification and decreased crop production?

- a) Yes, because their way of life is being destroyed.
- b) Yes, but compensation should be in the form of helping them move to another area.
- c) No, they need to change their lifestyles to adapt.
- d) No, people have always had to adapt to new conditions.
- e) I don't care. My family does not farm.

---

---

---

---

---

---

---

QUESTION: WEIGHING THE ISSUES

If people are displaced from their homeland due to climate change, should industrialized nations have to take them in, since fossil fuel burning is responsible for their loss of homes?

- a) Yes, if we deprive them of their homes, we owe them new ones.
- b) Yes, but they should have to pay to enter this country.
- c) No, it's their tough luck.
- d) No, but we could send them air conditioners or heaters.
- e) Definitely not. It's not my problem.

---

---

---

---

---

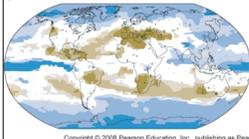
---

---

---

QUESTION: INTERPRETING GRAPHS AND DATA

According to this model, which area will have increased floods and potential crop losses?



Percent change in precipitation

- >20% decrease
- 10-20% decrease
- 5-10% decrease
- 5% decrease to 5% increase
- 5-10% increase
- 10-20% increase
- >20% increase

Copyright © 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

- a) The U.S.
- b) The tip of South America
- c) North Africa
- d) Europe
- e) Greenland

---

---

---

---

---

---

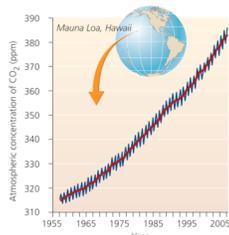
---

---

QUESTION: INTERPRETING GRAPHS AND DATA

Which statement is supported by this figure?

- a) CO<sub>2</sub> emissions have increased drastically.
- b) CO<sub>2</sub> emissions have stabilized recently.
- c) CO<sub>2</sub> emissions fluctuate only in Hawaii.
- d) CO<sub>2</sub> emissions average 320 ppm.
- e) CO<sub>2</sub> emissions don't generally fluctuate.



Copyright © 2008 Pearson Education, Inc., publishing as Pearson Benjamin Cummings

---

---

---

---

---

---

---

---