

1 ☐ Air Quality Issues: Part 2 - Acid Deposition, Greenhouse Gases

EVPP 111 Lecture

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2 ☐ Air Quality Issues

- Air Pollution
- Indoor Air Pollution
- Acid Deposition
- Greenhouse Gases & Global Warming

3 ☐ Air Quality Issues: Acid Deposition

- **Acid deposition**
 - accumulation of potential acid-forming particles on a surface
 - acids can result from
 - natural causes
 - human activities

4 ☐ Air Quality Issues: Acid Deposition

- **Acid deposition**
 - combustion
 - produces sulfur dioxide and oxides of nitrogen
 - converted to sulfuric acid and nitric acid in presence of water and oxidizing agents

5 ☐ Figure 17.9: Acid Deposition

6 ☐ Air Quality Issues: Acid Deposition

- acid-forming reactions classified as
 - **wet (precipitation)**
 - reactions occur in atmosphere
 - acids come to earth in precipitation
 - **dry (deposition)**
 - particles related to acid settle onto a surface
 - reactions occur when these materials mix with water

7 ☐ Air Quality Issues: Acid Deposition

- **Acid rain**
 - collective term used to refer to all acid forming processes

- pH of “normal” rain
 - between 5.6 and 5.7
 - slightly acidic due to
 - formation of carbonic acid when carbon dioxide reacts with atmospheric moisture

8 Figure: Typical pH Values

9 Air Quality Issues: Acid Deposition

- **Acid rain**
 - scope of problem
 - global
 - high acid rain damage
 - » Canada, England, Germany, France, Scandinavia, US
 - can have concentration of acid a thousand times higher than normal
 - rain in NH, 1969, pH=2.1 ~ lemon juice
 - rain in NE US and Ontario has average pH=4.0-4.5

10 Figure: US Acid Precipitation

11 Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - human-made materials
 - erosion of buildings and monuments made of limestone
 - corrosion of metal surfaces
 - ecosystems
 - terrestrial
 - aquatic

12 Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - ecosystems
 - terrestrial
 - forests in NE US
 - » ~50% mortality of red spruce in some areas
 - forests in central Europe
 - » death of ~14.8 million acres of trees

13 Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - ecosystems
 - terrestrial
 - link between tree decline and acid rain
 - » soils become acidic
 - » aluminum interferes with ability of plant roots to absorb nutrients

14 ☐ Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - ecosystems
 - aquatic
 - healthy lakes have pH ~6.0
 - increase in acidity leads to progressive loss of many kinds of organisms

15 ☐ Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - ecosystems
 - aquatic
 - experimental acidification of lakes
 - » pH 5.5, many desirable species of fish are lost
 - » pH 5, only a few starving fish remained
 - » pH 4.5, lake was nearly sterile

16 ☐ Air Quality Issues: Acid Deposition

- Acid rain causes damage to
 - ecosystems
 - aquatic
 - scope of problem
 - » 14,000 lakes in Canada
 - » 11,000 lakes in US
 - » Scandinavia

17 ☐ Air Quality Issues: Acid Deposition

- Acid rain
 - extent of damage to ecosystems depends on
 - nature of bedrock in area
 - proximity to acid-forming pollution sources

18 ☐ Air Quality Issues: Acid Deposition

- Acid rain
 - extent of damage to ecosystems depends on
 - nature of bedrock in area
 - soils from igneous rock
 - » can't buffer acid rain
 - soils from sedimentary rock
 - » such as limestone
 - » release bases that neutralize acid rain

19 Air Quality Issues: Acid Deposition

- Acid rain
 - eastern Canada and NE US
 - prevailing west to east winds
 - soils have high proportion of granite rock

20 Fig. 17.3

21 Figure: Acid Rain Damage

22 Air Quality Issues

- Air Pollution
- Indoor Air Pollution
- Acid Deposition
- Greenhouse Gases & Global Warming

23 Air Quality Issues: Greenhouse Gases & Global Warming

- Emission of gases to atmosphere
 - increasing due to human activities
 - activities
 - burning fossil fuels
 - deforestation
 - industrial processes
 - gases
 - carbon dioxide
 - chlorofluorocarbons
 - nitrous oxide
 - methane

24 Air Quality Issues: Greenhouse Gases & Global Warming

- in 1980s, concern that earth may be getting warmer

- in past 100 years, earth's
 - average temperature has \uparrow 0.3-0.6 °C
 - sea level has \uparrow 10-25cm
 - 1998 was warmest year on record
- correlation between temperature increase and “greenhouse gases”
- human activity increases amounts of these gases

25 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- Areas of concern related to global warming and climate change
 - human health effects
 - rising seas levels
 - disruption of water cycle
 - changing forests and natural areas
 - challenges to agriculture and food supply

26 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- what causes global warming?
 - several gases in atmosphere
 - transparent to light
 - allowing sunlight to penetrate atmosphere and be absorbed by earth's surface
 - absorb infrared radiation
 - sunlight energy that is absorbed by earth's surface is re-radiated as infrared radiation
 - » which is absorbed by gases

27 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- what causes global warming?
 - gases in atmosphere
 - allow heat to enter (as sunlight) but retard loss of heat
 - producing process called **greenhouse effect**
 - » atmospheric gases contributing to effect are called **greenhouse gases**

28 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- what causes global warming?
 - **greenhouse gases**
 - most important are
 - **carbon dioxide**
 - **chlorofluorocarbons (CFC)**
 - **methane**
 - **nitrous oxide**

29 ☐ Figure 17.17: Greenhouse effect

30 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- **Carbon dioxide**
 - most abundant greenhouse gas
 - produced as waste product of
 - cellular respiration in living organisms

- energy production
- levels have been increasing for 40 years

31 Air Quality Issues: Greenhouse Gases & Global Warming

- **Carbon dioxide**
 - reducing emissions would help slow global warming
 - methods to reduce emissions
 - increase efficiency of energy usage
 - increase amount of carbon dioxide removed from atmosphere
 - » via photosynthesis which requires it

32 Figure: Carbon dioxide concentration in Hawaii

33 Figure: Carbon dioxide levels

34

35 Air Quality Issues: Greenhouse Gases & Global Warming

- **Chlorofluorocarbons**
 - present in atmosphere in minute quantities
 - extremely efficient greenhouse gases
 - ~15,000 times more efficient at retarding heat loss than is carbon dioxide
 - entirely the result of human activity
 - refrigerant gases in refrigerators and air conditioners
 - cleaning solvents
 - propellants in aerosol containers
 - expanders in foam products

36 Air Quality Issues: Greenhouse Gases & Global Warming

- **Chlorofluorocarbons**
 - in 1970s, CFCs linked to depletion of **ozone layer**
 - located in stratosphere
 - absorbs most ultraviolet radiation that is potentially damaging to life
 - reactive chlorine is released when CFCs are destroyed after reaching upper atmosphere
 - can enter into reactions that deplete ozone
 - leading to increase in amount of UV radiation reaching earth

37 Figure: Ozone destruction

38 Air Quality Issues: Greenhouse Gases & Global Warming

- **Methane**
 - enters atmosphere primarily from biological sources
 - released by
 - bacteria
 - » abundant in wetlands and rice fields
 - » in guts of termites and ruminant animals (such as cattle)
 - some enters from fossil fuel sources

39 ☐ Air Quality Issues: Greenhouse Gases & Global Warming

- **Nitrous oxide**

- minor component of greenhouse gases
- enters atmosphere primarily from fossil fuels and fertilizers

40 ☐ The End