Protecting the Environment

A Half Century of Progress

Study Guide

EPA Alumni Association

September 2017

Former managers and staff of the U.S. Environmental Protection Agency (EPA) have formed an EPA Alumni Association (EPA AA). The association has developed a set of essays as part of its Half Century of Progress (HCP) project, headed by an integrated summary, Protecting the Environment: A Half Century of Progress. Seven supporting pollution-specific essays and other materials are also available here on the EPA AA website.

The Association has developed these materials to inform high school and college students and others about the major environmental problems and issues encountered in the United States over the last 50 years, as well as the actions taken and progress made in mitigating these problems. We hope that, besides summarizing the history of U.S. environmental programs, these essays might inspire some students and others to consider careers in the environmental field.

This Study Guide is a companion to the Half Century of Progress essays. It is intended to facilitate and enrich the use of these materials in high school and college environmental science curricula. It supports independent study with section review and data interpretation questions that are linked to major topics in the HCP integrated summary essay. These questions were extracted from the HCP Teacher's Resource, which is available to all environmental educators on request through the HCP website. It was developed in response to comments from educational professionals from EPA and secondary AP Environmental Science (APES) programs. Over twenty retired EPA program managers and subject matter experts worked together to produce the HCP essays. Many of these EPA alumni also contributed to the development and review of the questions included here. This Study Guide also reflects suggestions provided in reviews and comments from a number of APES teachers. APES teachers Kristin Shapiro and Elizabeth Spike (see photo credits), Chris Freeman (Kellam H.S. Virginia Beach, Va.), and retired Chapel Hill and Durham N.C. APES teacher Gail Boyarsky have been particularly helpful.

This Study Guide is available to all educators, students, and others interested in the use of science and policy in U.S. environmental protection over the last half century. We continue to solicit written or verbal comments that would improve its utility for students and teachers. You may email written comments or a request for a telephone discussion directly to: johnbachmann@bellsouth.net.

***Cover Photo Credits**: Left: Kristin Shapiro, APES and AP Biology, East Plano H.S., Plano, TX.; Right: Elizabeth Spike, APES and Chemistry, St. John's School, Houston, TX.*

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Protecting the Environment: A Half Century of Progress

Study Guide

Introduction

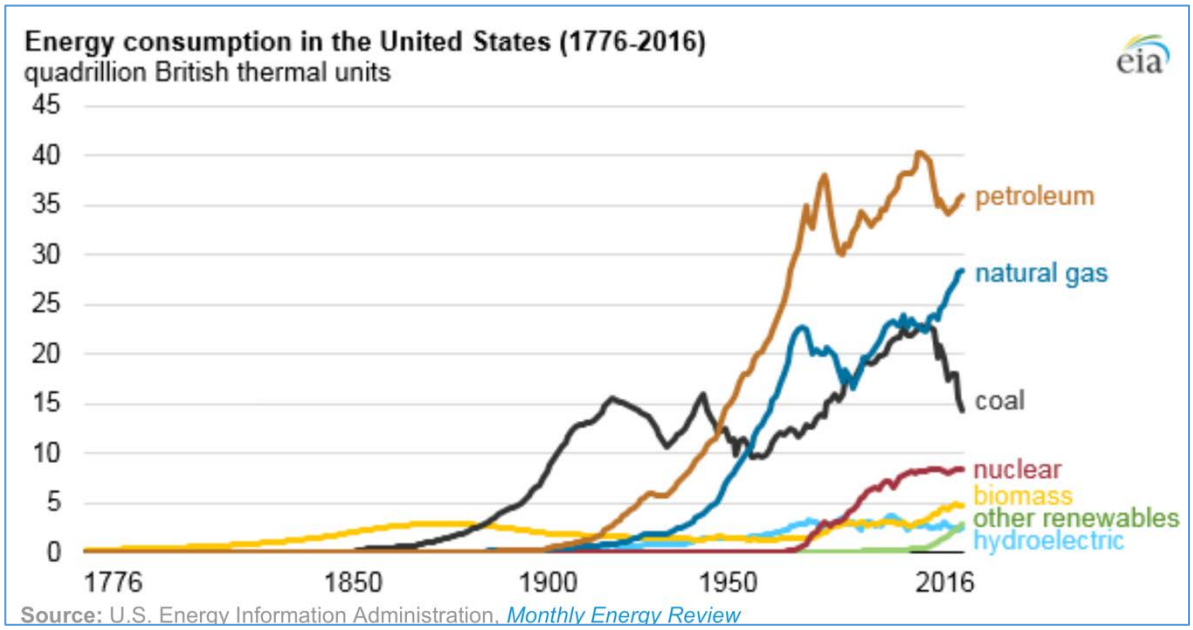
This Study Guide is a companion to the EPA Alumni Association's *Protecting the Environment - Half Century of Progress* (HCP) essay (http://www.epaalumni.org/hcp/). This essay, together with seven supporting essays, is intended to inform high school and college students and others about how the nation confronted the major environmental problems and issues encountered in the United States in the last 50 years. The essays also provide some discussion of continuing challenges for the future. This document is a resource for AP Environmental Science (APES) students, teachers, and others who may be interested in the topics covered in the HCP essays. This Study Guide includes questions intended to reinforce concepts and/or to stimulate critical thinking, and is drawn from the HCP Teacher's Resource, which includes suggested responses to these questions, as well as some suggested activities and other resources for students and teachers. The Teacher's Resource is available to APES and other teachers through the Association website, or by request to the email link on page 2 above.

This Resource is organized according to the major sections and subsections in the HCP essay. The major emphasis is on section 2 of the HCP essay, which includes overviews of progress in seven specific environmental programs: air, water, drinking water, solid waste, Superfund, pesticides, and toxic substances. The titles of the seven relevant sub-sections in section 2 of this document are hyper-linked to the corresponding more detailed program essays that support the HCP essay. Each program area (e.g., air) includes a series of questions drawn from material in the HCP essay and from the more detailed supporting essay relevant to the topic. These include free response questions requiring interpretation of graphs or tables modeled after those found in the APES exam.

Section 1. Growing Environmental Concerns in the Last Century

1. List three of the key events that led to expanding and intensifying public concern about the environment in the 1960s? (See HCP essay pages 5-6). What major steps did the U.S. take to address these concerns?

2. Reports and photos of dense smoke and gases associated with emissions from urban factories and home heating during the industrial revolution began in the late 19th century (air essay, pages 7-9). It was first called *smog* (smoke+fog) in 1905. Yet modern *photochemical smog* did not begin to appear in Los Angeles until the 1940s (air essay, pages 8,14-15). The graph below shows trends in U.S. energy consumption, which are largely responsible for the appearance of these two kinds of smog.



(a) Use the data provided in the graph to respond to the following:

i) Identify which energy source is most likely responsible for the classic smog events with high levels of directly emitted particles and sulfur oxides that developed in Pittsburgh, New York, London and other industrial cities beginning around 1900.

ii) Identify which energy source is most likely responsible for the early appearance of *photochemical* smog, which formed in the atmosphere in southern California in the 1940s-50s, and later in other major U.S. cities?

iii) Describe two negative social, economic, and/or environmental impacts that might have happened if the emissions from these energy sources had not been subject to regulations.

iv) The data show a decrease in coal consumption that takes place in the 1930s and again in 2009-2016. Identify and describe the factors that contributed to each of these changes in coal consumption.

(b) Both "classic" and photochemical smog have been shown to produce significant health effects, but have some important differences in origin, composition, and control.

i) Identify a key difference between the origins of classic and photochemical smog.

ii) Identify two of the most important pollutant emissions responsible for smog episodes in London and New York and for the photochemical smog episodes in Los Angeles.

iii) Describe at least one major approach that would 1) reduce industrial smoke pollution and one that would 2) reduce photochemical smog.

3. List three events that increased public awareness and concern about environmental issues in the 1960s.

4. Before the 1960s, states and municipalities had jurisdiction over environmental issues, but agencies had limited capabilities that varied by location. The major legislation passed in the early 1970s created new governmental roles and responsibilities in addressing environmental protection for air, water, and solid waste (HCP page 7) for the new EPA, states, and local and tribal programs.
    a. Identify which government entity had primary responsibility for establishing national science and technology based standards and control requirements
    b. Identify which government entity played the lead role in designing, implementing and enforcing programs consistent with national standards for environmental quality and technology-based standards for major sources.
    c. Identify the government entity with direct responsibilities for licensing pesticides and overseeing production and use of new chemicals.

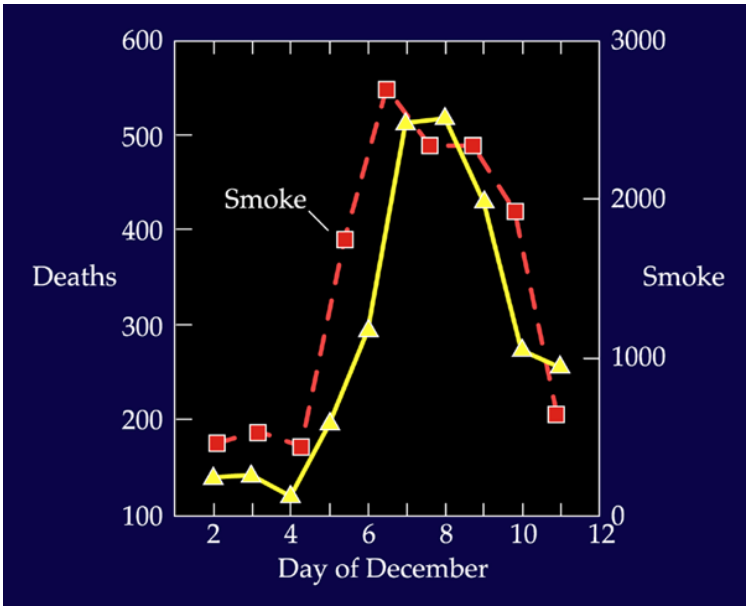
5. Watch the short video about William Ruckleshaus, the first Administrator of EPA [HCP essay, page 6]. What did he have to say regarding the need for establishing EPA and an increased Federal role in environmental protection?

Section 2. Progress in Seven Specific Environmental Programs

A. Cleaning the Air We Breathe

1. Describe two major provisions included in the 1970 Clean Air Act Amendments that have continued to form the basis for new air regulations (see HCP, page 8; air essay, pages 11-12)

2. Air pollution episodes provided the first clear evidence of significant health effects of air pollution. The graph below is a “time series” plot of daily air pollution (red) and daily mortality data (yellow) collected during the 1952 London air pollution episode [Air essay p 9].



a) Use the data provided in the graph to respond to the following:
   i) Compare the increase in pollution with the increase in deaths. Explain what these data suggest about the association between air pollution and health effects.
   ii) Do these data reveal anything about the effect of air pollution over a longer time-period (months to years)?
b) Identify and describe additional data or studies that would be helpful in showing that air pollution causes premature mortality.

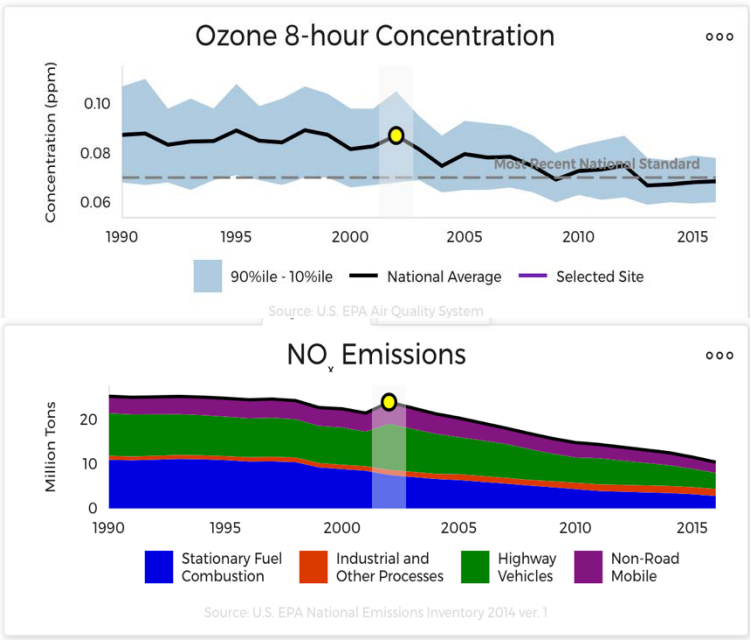
The London episodes in the 1950s and 60s provided extreme cases of high coal combustion, both to power major industries, but also to heat homes and business. Accordingly, peaks tended to occur in the wintertime. High levels of sulfur dioxide accompanied the smoke and, in the presence of high humidity in the fogs, produced high levels of acid sulfate particles.

c) Identify a major U.S. city that was subject to periodic episodes of smoke and sulfur dioxide pollution in the 1960s.
d) Identify one or more major international cities that today are subject repeated episodes of air pollution from combustion of coal and other solid fuels for industry and home heating.

3. The following population groups have been identified in scientific studies as particularly susceptible to the adverse health effects of air pollution:
   - Children
   - Infants
   - People with preexisting heart related (cardiovascular) disease.
   - People with preexisting respiratory diseases, such as asthma, chronic obstructive pulmonary disease (COPD).
   - People with certain genetic predispositions that increase sensitivity to air pollution.
   - Elderly people
   - People who exercise or work outdoors during periods of high pollution
   - People who live near major highways

a) What is the difference between the first six groups and the last two?
b) Identify two reason that children might be more at risk from air pollution than adults?
c) Identify one or more steps that susceptible individuals take to reduce their risk from air pollution [See EPA Air Quality Index Brochure].

4. Important strengths of the Clean Air Act are the heavy reliance on monitoring to evaluate progress and the periodic updates of national air standards and implementation strategies to reflect the latest scientific information on health effects and atmospheric chemistry and transport. The graph below[1] shows recent progress in reducing ozone (a major component of photochemical smog) from 1990 to 2016.



Top: air quality trends for ozone, 1990-2016. *Dashed gray line* - current national standard (0.70 ppm - a measure of peak 8-hour ozone concentrations). *Black line*- national average for all monitors. *Blue band* - the range of results from the highest (90th percentile) and lowest (10th percentile) monitors reporting.

Bottom: trends in national emissions of nitrogen oxides (NO_x), 1990-2016.

a) Use the data in the ozone and NO_x charts to respond to the following:
   i) Describe the national ozone trends, paying attention to any differences before and after 2002 (yellow dot).
   ii) Describe how the trends in ozone compare to the trends in national emissions of NOx, one of the major precursors to the formation of ozone.
   iii) Identify the two largest sources of NO_x emissions in 1990 and describe their contribution to the trends in NO_x.
   iv) Determine whether the national average of all ozone monitors met the level of the national ozone air quality standard in 2010. What about 2016?. Did *all* monitoring sites meet the standard in 2016?
   v) Identify factors that might contribute to annual variations in peak ozone concentrations from year to year.

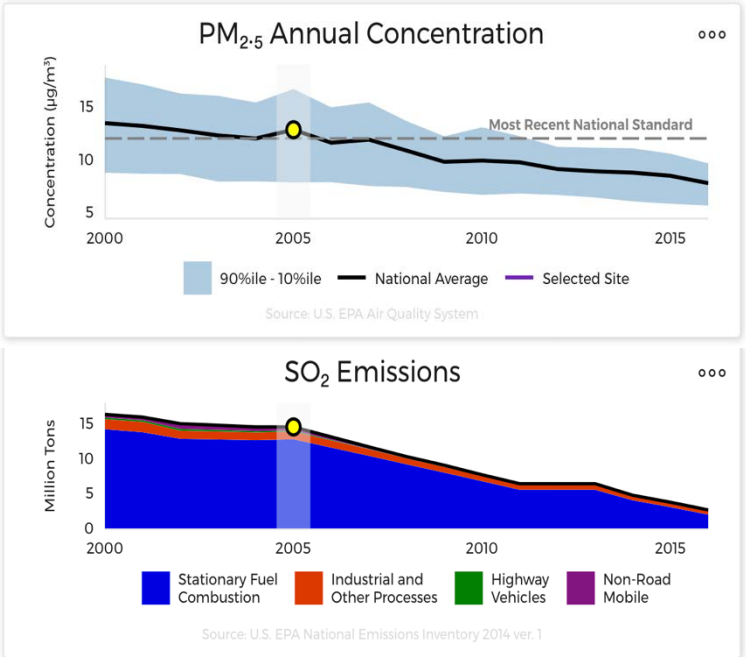
Scientific advances affected ozone policy in two major ways in the 1990s and 2000s: 1) new studies of human exposures to ozone in chambers and in the field found that ozone caused

[1] These charts come from EPA's 2017 web-based report ***Our Nation's Air.*** The NAAQS Trends (page 11) provide interactive data on air quality and emissions trends for multiple pollutants.

health effects at lower concentrations, resulting in tightening of the ozone standard in 1997 and 2015 and 2) improved air modeling and analyses found that the summertime emissions of natural organic chemicals (e.g, from trees) in large regions of the eastern U.S. meant that meeting the standard would require large NO_x reductions from anthropogenic sources over this multistate area. These emissions reductions resulted from new provisions in the 1990 Clean Air Act Amendments and subsequent EPA and state actions.

b) Describe whether the ozone air quality results appear consistent with expectations, given the reductions in NO_x emissions. Identify some limitations with comparing national emissions of a single ozone *precursor* with national air quality data.
c) Identify two potential benefits of reducing NO_x emissions to water quality.

The graph below shows recent progress in reducing fine particles ($PM_{2.5}$) from 2000 to 2016.



Top: latest air quality trends for $PM_{2.5}$. *Dashed gray line* - current national standard (12 ug/m^3 annual average).[2] *Black line* - national average for all monitors. *Blue band* - the range of results from the highest (90th percentile) and lowest (10th percentile) monitors reporting.

Bottom: trends in national emissions of sulfur oxides (SO_x).

d) Use the data in the $PM_{2.5}$ and SO_2 charts to respond to the following:
i) Describe the national $PM_{2.5}$ trends between 2000 and 2016.
ii) Describe how the trends in $PM_{2.5}$ compare to the trends in national emissions of SO_2, which contributes to $PM_{2.5}$ by forming acid-sulfate particles in the atmosphere.
iii) Identify the major source of SO_2 emissions, including the specific fuel combusted.
iv) Identify the approximate year when the national average of all $PM_{2.5}$ sites began to meet the level of the national $PM_{2.5}$ air quality standard. Did all sites meet the standard in 2016?

Scientific developments also affected policy for particle pollution: 1) A growing body of studies found serious effects, including mortality, at levels below the old standards. This led directly to adding new standards for fine particles (measures as $PM_{2.5}$) in 1997. Subsequent reviews of additional studies resulted in the need to strengthen those standards in 2006 and 2013. 2) Monitoring in the 1980s and 90s revealed that, in many areas, particles formed in the

[2] These trends do not show average concentrations for the daily PM2.5 standard (35 ug/m3), which, when met, limits 24-hour peak concentrations.

atmosphere from gases could be as or more important than direct particle emissions. In the eastern US, with much of the nation's coal fired power plants, sulfates from SO_2 often made up over half of $PM_{2.5}$. This resulted in new policies that expanded the market-based acid rain program, providing additional reductions in SO_2, as well as NO_x. Revised tailpipe standards for new diesel powered vehicles began to reduce direct emissions of fine particles.

e) Describe whether the $PM_{2.5}$ air quality trends appear consistent with expectations, given the reductions in SO_2 emissions and the fact that the sulfate contribution to fine particles is largest in regions with the highest SO_2 emissions. Identify some limitations in comparing trends in these national emissions of this single pollutant with national $PM_{2.5}$ trends.

5. The HCP and air essays list several examples of the benefits that came from implementing clean air regulations, including reduced emissions of key pollutants, improved air quality in Los Angeles and in the nation, as well as some measurements and estimates of improvements more directly related to reduced effects on public health and the environment. Describe a) two examples of health benefit estimates and b) one example of environmental benefits from Clean Air Act programs.

6. What U.S. cities have the highest levels of photochemical smog, as indicated by measurements of ground level ozone? Which cities have the highest levels of fine particle pollution ($PM_{2.5}$), which may be directly emitted from sources as well as formed in the atmosphere? You can find recent data on the most polluted cities here.

7. Identify two ways in which air pollution can be linked to climate change. (See Air essay, pages 33-36).

B. Protecting and Restoring our Water Resources

Study Questions – Water resources. Based on HCP and water essay topics – for individual study, including data interpretation modeled on APES free response questions; optional use for class discussion.

1. What were some of the key issues that prompted passage of the Clean Water Act of 1972?

2. Identify three of the five major objectives of the Clean Water Act

3. As summarized in the HCP essay, a major first step in addressing water pollution was to address polluted discharges from major point sources. Identify some of the key actions taken by EPA and the states to address the most important sources, and describe the benefits that resulted from reducing the pollution in these effluents.

4. The Clean Water Act also authorized federal water criteria and state water standards, specifying science-based levels of pollutants allowable for habitat, swimming, and other uses. Given the permit program required for point sources, why were these additional requirements needed to address water quality issues?

5. The table below, compiled by EPA,[3] shows the total amount of surface water resources (miles, acres, or square miles) assessed by the states for each type of water body (e.g., rivers, lakes, bays) for the most recent year reported, typically between 2010-16. The assessed waters are those for which monitoring or other types of information have been used by the states to judge whether water quality standards for designated uses are being met. A waterbody is considered "impaired" if one or more water quality standards for any one of its uses are not met. "Threatened" waters are those meeting standards, but with levels and/or trends suggesting they may become impaired in the future. "Good" waters meet all the designated uses and related water quality standards.

Summary of Water Quality Status of Assessed Waters in the United States

	Size of Water							
	Rivers and Streams (Miles)	Lakes, Reservoirs, and Ponds (Acres)	Bays and Estuaries (Square Miles)	Coastal Shoreline (Miles)	Ocean and Near Coastal (Square Miles)	Wetlands (Acres)	Great Lakes Shoreline (Miles)	Great Lakes Open Water (Square Miles)
Good Waters	506,668	5,221,976	9,326	987	617	569,328	102	
Threatened Waters	4,517	30,026						
Impaired Waters	616,158	13,065,756	47,094	3,642	6,263	665,494	4,354	39,183
Total Assessed Waters	1,127,343	18,317,758	56,420	4,629	6,881	1,234,822	4,457	39,183
Total Waters	3,533,205	41,666,049	87,791	58,618	54,120	107,700,000	5,202	196,343
Percent of Waters Assessed	31.9	44.0	64.3	7.9	12.7	1.1	85.7	20.0

Use the data in the table to respond to the following questions:

a) Identify two of the eight categories of waterbodies that received the highest priority in terms of area monitored to assess water quality.
b) Explain why wetlands might have such a very low percentage of water quality monitoring?
c) Identify two categories of assessed waterbodies that are most likely to be impaired.
d) Determine whether freshwater systems appear more - or less - likely to be impaired compared with salt water systems?
e) Describe characteristics of the data in the table that make a definitive comparison of the level of impairment between salt and freshwater systems difficult.

6. One of the major achievements of water protection programs was to greatly slow the loss of wetlands since the 1960s. Why is preservation of wetlands important?

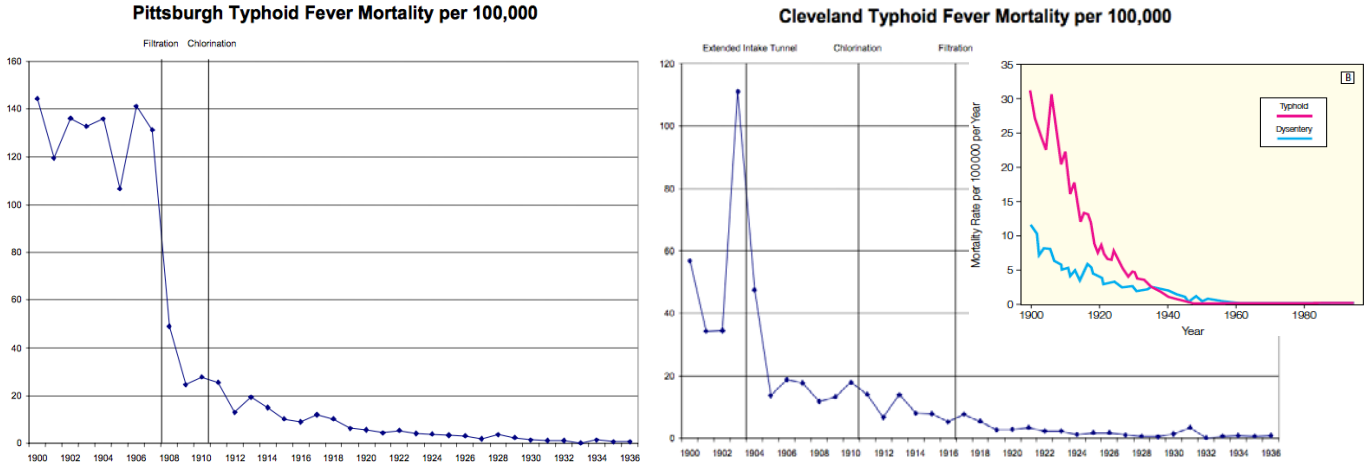
7. The HCP and water essays highlight several significant continuing challenges for water resource management. One of these is the difficult issue of polluted runoff from streets, farms, septic tanks, and other land uses as well as deposition of air pollutants, all of which are considered as "non-point" sources.
   a) Describe how the Clean Water Act (CWA) addresses contamination from non-point sources.
   b) Identify some of the major pollutants issues that come from these sources?

8. How might continuing changes to climate affect water resources?

[3] Click on title of the table above to go to the most recent version on the EPA site.

C. Delivering Safe Drinking Water

1. HCP essay notes that in the early 20th century, waterborne diseases like typhoid fever and cholera accounted for a substantial number of deaths. The charts below show the trends in death rate from Typhoid fever for Pittsburgh and Cleveland, along with when steps were taken to provide cleaner drinking water by filtration, chlorination, and moving the drinking water intake to a location in the river or lake with cleaner water.[4] The timing of these kinds of actions by health departments were typical of most major cities. The yellow insert shows the national trends in typhoid fever and dysentery, another disease that is spread through drinking water.[5]



Based on information in the drinking water essay [DW essay, page 3) and the data in these charts, address the following:
a) Discuss how filtration, chlorination, and moving the drinking water intake work to reduce these waterborne diseases.
b) Discuss what the data from these two cities suggest about the timing and effect of the steps relative to the trends in national rates shown in the yellow insert.
c) How do the mortality rates for typhoid fever in these two large cities compare with the national rates?
d) What additional mortality benefits (not shown in the charts) resulted from widespread application of improved sanitation and water treatment in major cities in the first 35 years of the 20th century?

2. What new concerns led to the passage of the Safe Drinking Water Act of 1974?

3. Describe the major provisions of the Safe Drinking Water Act (SWDA)?

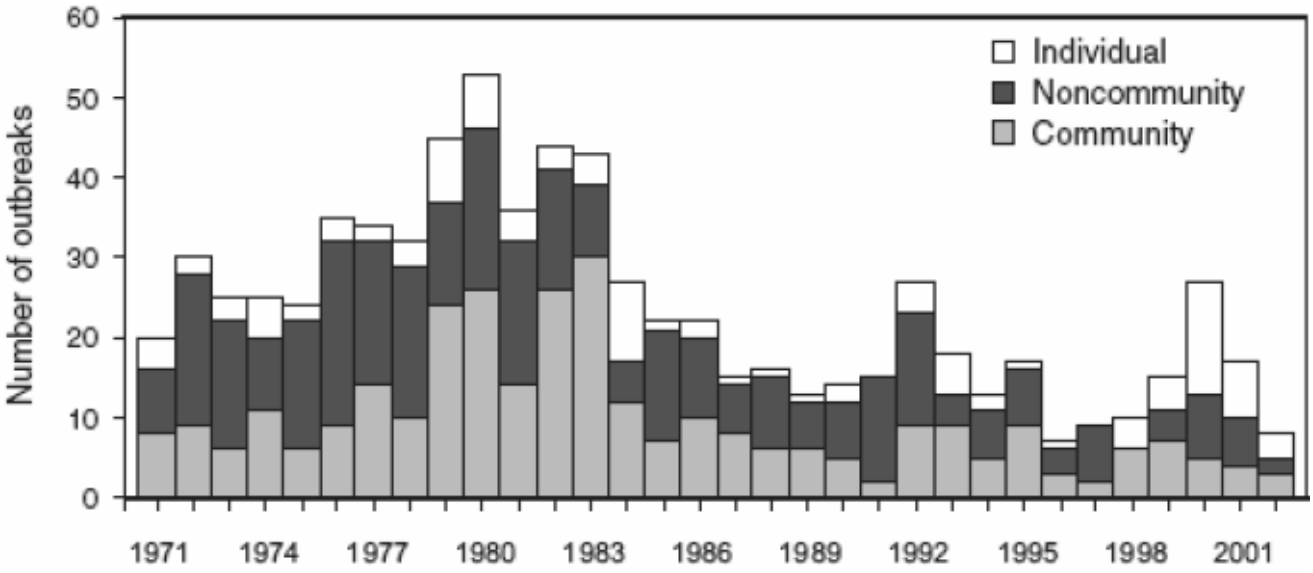
4. With the passage of the Safe Drinking Water Act, EPA developed an implementation strategy called "One step at a time" to address the requirements of the Act. Some of the more

[4] http://scholar.harvard.edu/cutler/files/cutler_miller_cities.pdf
[5] http://jamanetwork.com/journals/jama/fullarticle/768249

important steps taken are listed below in a) to e). Using key dates in the HCP and Drinking Water (DW) essays, list the steps in the order in which they were actually implemented.

a) Issuing the first corrosion control rule to reduce the levels of lead and copper in water distribution systems, including household plumbing.
b) Release of an EPA sponsored study of health risks from drinking water contaminants by the National Academy of Sciences.
c) Provision of guidance and federal funds for building state and local capacity to implement and enforce EPA drinking-water regulations.
d) Issuing "interim standards" for drinking water.
e) Compliance reached a level where 90% of the U.S. population got it's drinking water from systems that consistently met EPA health based standards.

5. The CDC data in the chart below shows a consistent drop in drinking water related disease outbreaks beginning in the early 1980's. Early implementation of the Clean Water Act in 1974 helped authorities provide more complete data on these outbreaks over the years

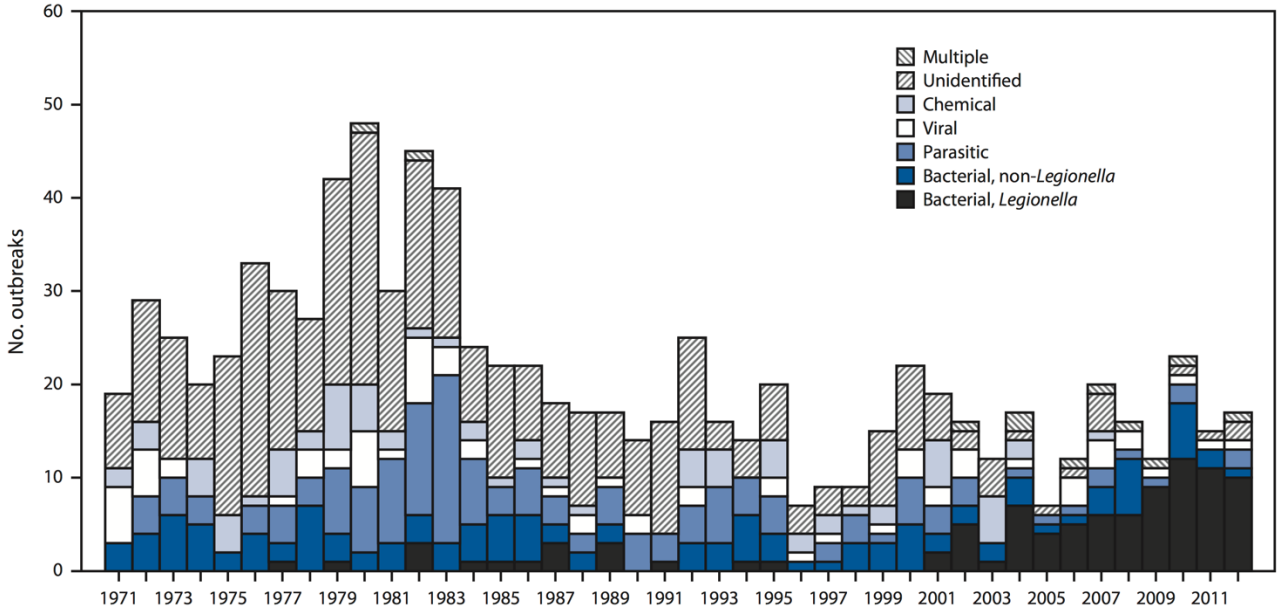


The Number of drinking water disease outbreaks reported in the United States, 1971–2002. Individual—private or individual water systems (9 percent of U.S. population or 24 million users); Community—systems that serve > 25 users year round (91 percent of U.S. population or 243 million users); Noncommunity—systems that serve < 25 users and transient water systems such as restaurants, highway rest areas, parks (millions of users yearly). Source: NAS, 2006.

Use the data in the chart to address the following:

a) Describe the overall trends in water disease outbreaks between 1971 and 2002.
b) How might the increased inclusion of more complete data on outbreaks after 1971 bias the observed trends?
c) What do the data suggest about the relative success of the stepwise approach to regulation for community vs. non-community (<25 served) and individual water systems that are not regulated under the Safe Water Drinking Act?
d) Is the timing of apparent improvements after 1980 consistent with the "One step at a time" regulatory approach for this measure of program benefits?

A 2015 CDC Report includes an extended version of the drinking water disease outbreaks chart that focuses on the organisms that caused the total outbreaks for all classes of water systems. This chart, reproduced below, shows some significant trends that continue beyond 2002.



Etiology of 885 drinking water-associated outbreaks by year- United States, 1971-2012*

*Legionaires disease outbreaks first reported to the CDC in 2002; earlier legionella related outbreaks added retrospectively by CDC.

Use the data provided in this chart to address the following:

e) Describe how the *causes* of outbreaks change over time.

f) Identify the most frequent cause of water related disease outbreaks for the most recent data

g) Looking at both CDC charts, what explains the *decrease* in the worst outbreaks since 1980 and the recent *increase* caused by the most significant agent today?

6. Why do drinking water experts generally agree that the most significant continuing challenge for water systems is the need to upgrade and replace aging infrastructure? Identify some of the health and economic problems associated with this issue.

D. Managing the Generation and Disposal of Waste Streams

1. What problems prompted Congress to essentially replace solid waste legislation passed in 1965 with the Resource Conservation and Recovery Act (RCRA) in 1976?

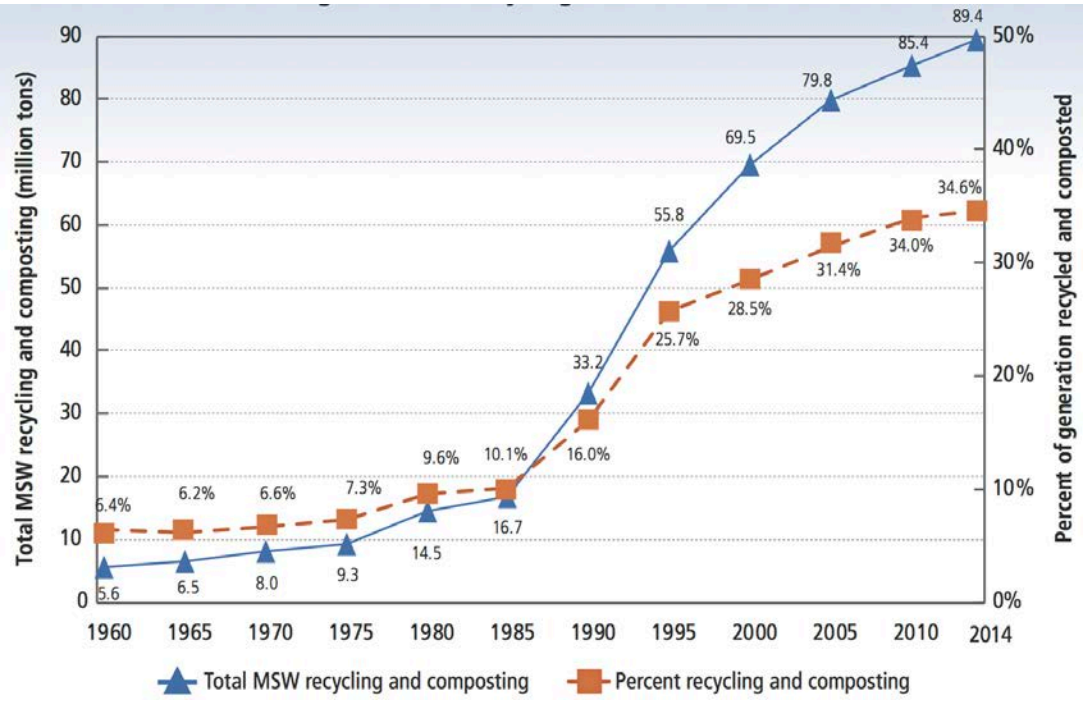
2. Which of the four major goals of RCRA are different from traditional environmental programs that focus on controlling releases from pollutant sources, e.g. “end-of-pipe” controls.

3. Describe the respective roles of federal and state governments in implementing RCRA provisions. Include a short description of the national requirements for the two kinds of major waste streams covered under the law.

4. What requirements were added to RCRA by the 1984 Hazardous and Solid Waste Amendments, which created the *Corrective Action, Land Disposal Restrictions*, and *Underground Storage Tank* programs?

5. Municipal solid waste (MSW) is the trash collected from households and businesses. The graph below shows trends in *recycling* of municipal solid waste in the United States from 1960 to 2014.

Municipal Solid Waste (MSW) Recycling Rates, 1960 to 2014



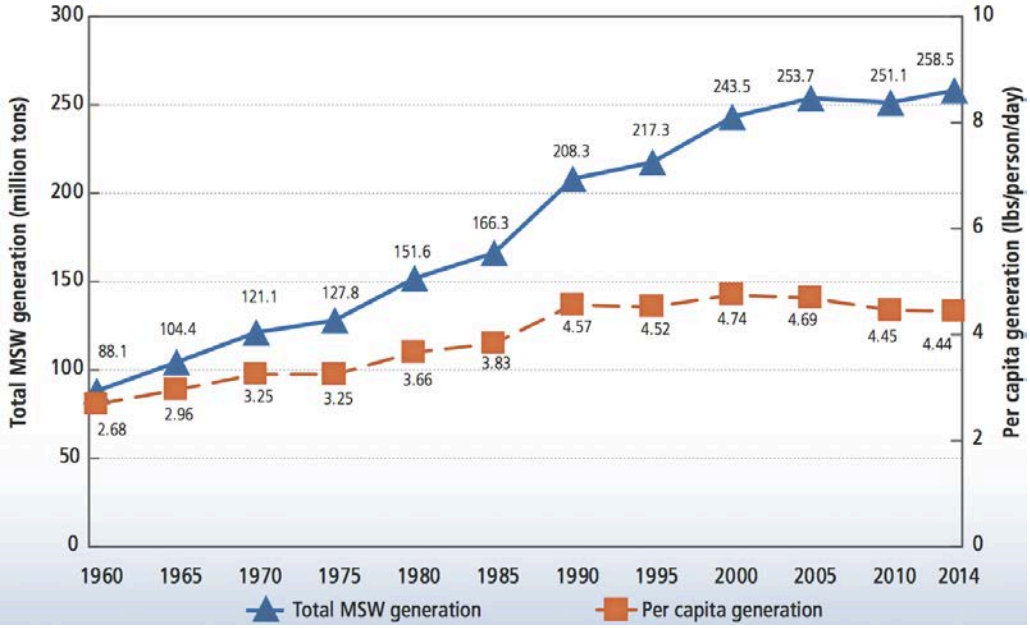
a) Use the data provided in the graph above to respond to the following.

i) Calculate the percent increase in the total weight of MSW recycled and composted between 1980 and 2014.

ii) Explain what factors likely prompted the increase in recycling after 1985.

The graph below shows trends in *generation* of municipal solid waste in the United States from 1960 to 2014.

Municipal Solid Waste Generation Rates, 1960 to 2014



b) Use the data provided in the graph above to respond to the following:

i) Explain the likely causes of the difference between the trends in total and per capita MSW between 1980 and 2014.

ii) Explain whether the apparent flattening of the growth in per capita generation is consistent with the major goals of RCRA.

c) Describe two actions households could take to reduce their annual generation of solid waste.

6. Describe the major benefits from RCRA requirements regarding 1) industrial and commercial hazardous waste and 2) land disposal of such wastes.

7. Rank the following approaches in order from most to least effective in addressing the environmental effects of solid waste.
   a) Recycling
   b) Recovery – burn for energy
   c) Landfilling
   d) Re-use
   e) Reduce generation

E. Superfund - Containing and Restoring Hazardous Waste Sites

1. What major growing environmental issue was addressed by the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), known as "Superfund."

2. What were the major approaches in the superfund (CERCLA) legislation towards addressing the problems of hazardous waste sites?

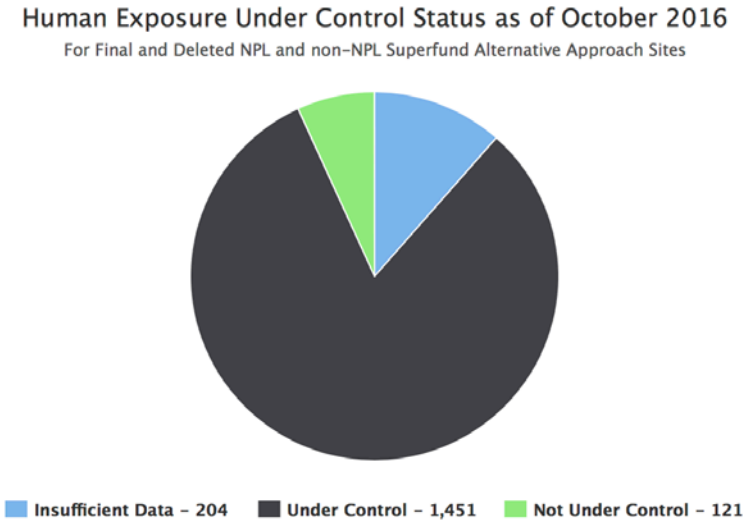
3. Identify the three major *response actions* that the Superfund Cleanup Program may take to deal with abandoned hazardous waste sites?

4. Who pays for cleaning up superfund sites?

5. While Superfund began with successful emergency response actions to reduce immediate threats, for example the 'Valley of the Drums' action begun in 1983, progress was more difficult on long-term actions. What were some of the major issues faced by the program over time?

6. Summarize the progress made in cleaning up the over 1700 sites that have been placed on the Superfund National Priorities List over the years, based on EPA's latest data.

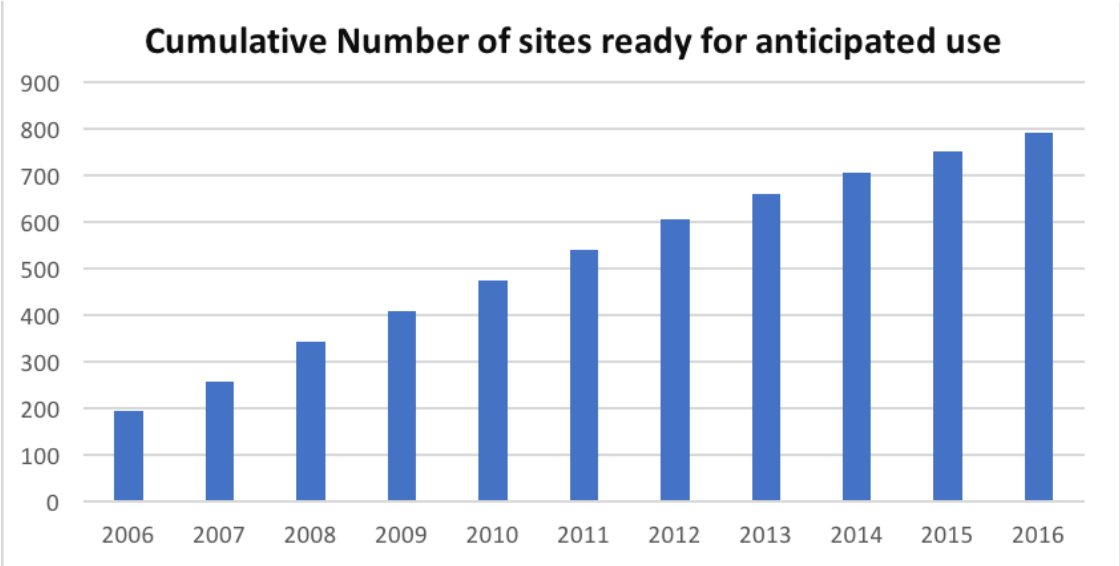
7. The chart below shows the recent status of Superfund sites with respect to potential human exposures to unacceptable levels of hazardous wastes. Source: EPA Status Report



a) Based on the data in the chart above, calculate the percentage of sites that were under control in October 2016 with respect the potential for human exposure to hazardous chemicals.

In 2002, 1,199 out of 1,494 Superfund sites were reported as under control for human exposure.
b) Calculate the percentage of Superfund sites under control in 2002 and compare it to the percentage you calculated for 2016. Explain why the progress made from 2002-2016 made is greater than suggested by comparing these percentages.

In addition to reducing health risks, another goal of Superfund is to restore sites to a condition where the land can be safely dedicated to more productive uses, for example "Brownfield" development for industry or commerce. The graph below depicts trends in the number of Superfund sites where the entire site is ready for reuse, a measure EPA terms "sitewide ready for anticipated use." By 2016, 793 sites were ready for anticipated use.



c) Use the trend data in the chart above to determine whether the rate of cleaning up Superfund sites for use between 2002 and 2016 has increased, decreased, or remained the same.

8. How did EPA's Brownfields program, much of which was codified into law in 2002, enhance the benefits of the Superfund cleanup program?

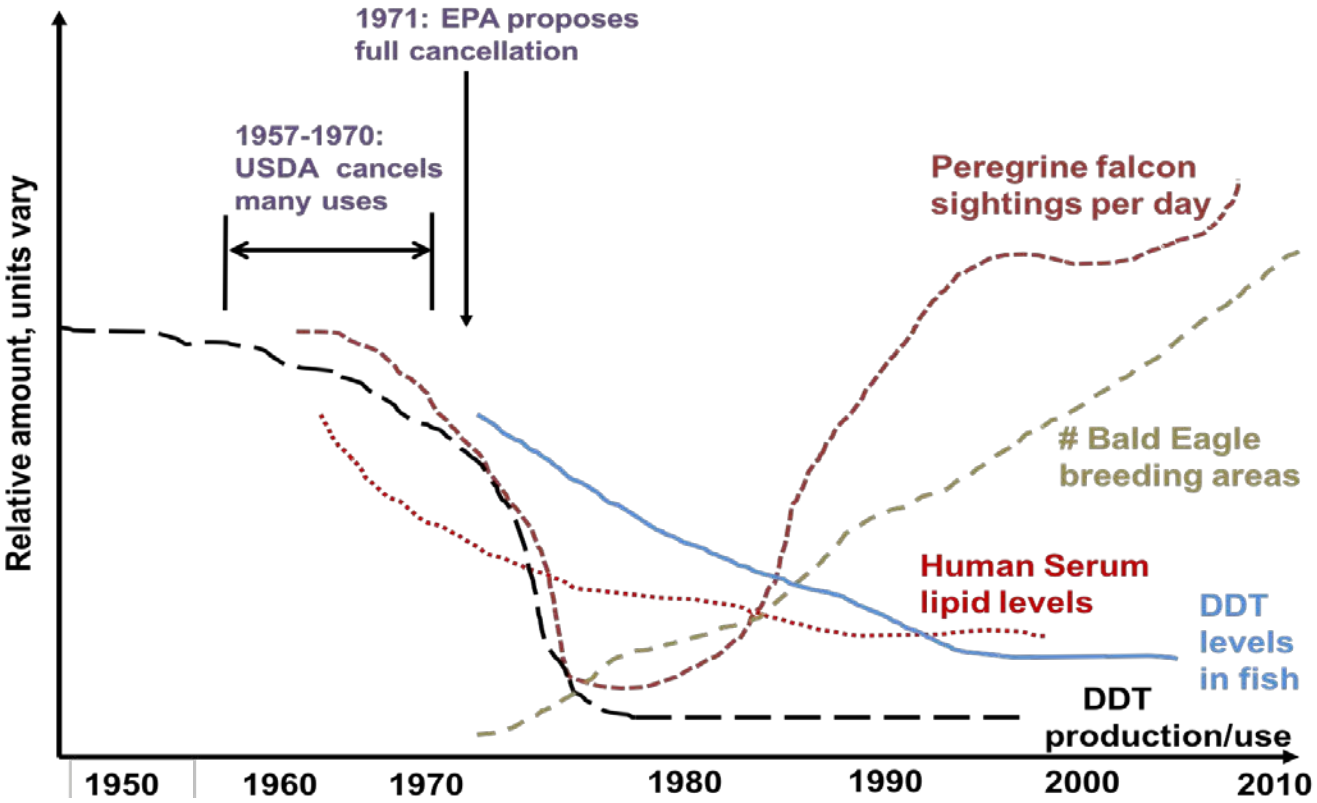
F. Controlling the Use of Dangerous Pesticides

1. How did America's views on pesticides, particularly DDT, change between the 1940s and the 1970s? What drove the change in perspectives?

2. A key discovery regarding DDT and other *persistent* toxic substances is that they bio-magnify in food chains. This means which of the following:
   a) Organisms at lower levels in the food chain accumulate lethal doses of the substance.
   b) Organisms at higher levels in the food chain acquire higher levels of the substance by feeding on contaminated organisms lower on the food chain
   c) Toxic substances build up in the tissue of an organism over its life
   d) The environment has higher levels of toxic substances than organisms in the food chain

3. What did the 1972 amendments to the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) require of EPA?

4. The chart below shows sequence of actions and consequences related to the partial (1957-70) and final (1972) ban of the use of the pesticide DDT in the United States.
   a) Explain the original basis for EPA's 1972 final ban of DDT.



*Note the space between 1970 and 1980 is expanded for clarity

b) Use the data provided in this chart to address the following:

i) Identify which of the five trend-lines measures would be expected to influence the other four.

ii) Identify which of the results depicted appeared to be the most responsive to USDA and EPA actions on DDT and which was slowest to respond.

iii) Determine approximately how many years after the 1972 ban it took for DDT levels in fish to move from a more rapid to a markedly slower rate of decline.

iv) Determine for approximately how long the number of bald eagle areas increased based on the time line shown in the graph.

v) Discuss whether the DDT ban achieved the goals EPA established.

The U.S. actions prompted other nations to ban DDT. In some areas of the world, this led to the unintended consequence of curtailing the use of DDT on mosquito populations that spread malaria. This contributed to a global increase in deaths from malaria between 1980 and 2004; the increase occurred mainly in Africa, while total deaths in rest of the world declined. The incidence of malaria did not increase in the U.S. after the ban.

c) Identify a factor that might limit the efficacy of continuing DDT use to prevent malaria?

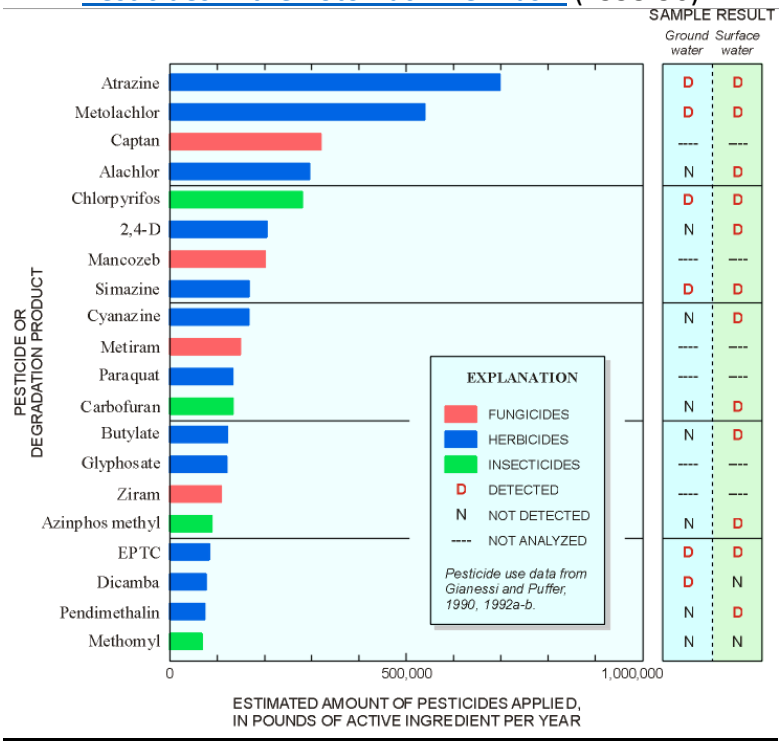
d) Identify another factor(s) that might have contributed to increased malaria in Africa.

5. What requirements relating to pesticides were added by the 1996 Food Quality Protection Act?
6. What did EPA do to address the limitations in scientific information to support necessary risk determinations for tens of thousands of pesticide products?

7. What did the reregistration of over 40,000 pesticide products under FIFRA and review of food tolerances under the Food Safety Act accomplish?

8. The chart below depicts partial results a US Geological Survey study that collected 384 water samples from surface and well waters in the Potomac River Basin. These results are for the top 20 pesticides used in the basin for both agricultural and other (*e.g*. home) uses.

Pesticides in the Potomac River Basin (1993-96)



For all 84 compounds analyzed, the study reported finding mostly higher levels in surface waters than in ground waters.

a) Determine whether the data in the chart are generally consistent with the overall finding.

b) Explain what might cause the difference in levels between samples taken from surface and ground waters.

G. Providing Information on and Protecting Against Risks from Toxic Chemicals

1. Some widely-used chemicals became identified with serious health and environmental concerns although originally thought not to be harmful. Identify the example chemicals highlighted in the Toxic Chemical (TC) essay on page 3. What kinds of problems did these chemicals cause?

2. Describe the Toxic Substances Control Act (TSCA) Inventory and how it distinguishes between "new" versus "existing" chemicals.
3. Information on the hazards/risks of widely used chemicals was limited or inaccessible in the 1970s. One of TSCA's goals when enacted was to make such information more widely available.

What tools did TSCA provide to EPA to deal with this problem? Note that TSCA was revised in 2016 after the Toxic Chemical essay was released. A summary of the revisions is available here.

4. What is Green Chemistry and why is it important?

5. New and emerging technologies can present environmental issues while also providing innovative new ways of meeting commercial issues and needs. Identify two emerging technologies discussed in the Toxic Chemicals essay (TC) that have presented challenges to EPA in evaluating risk under the Toxic Substances Control Act?

6. What kind of challenges does EPA confront in evaluating the safety of these two emerging technologies?

7. What tragic incidents at chemical plants in India and West Virginia prompted Congress to develop the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986?

8. This 1986 Emergency Planning law led to the development of the Toxics Release Inventory (TRI) by EPA. Identify the kinds of information collected and made publicly available by TRI. What are the potential benefits of providing this information over time?

9. Congress can also develop and enact laws that provide policy objectives for the US. An example of this is the Pollution Prevention Act (PPA) of 1990. What policy did the PPA encourage?

Sections 3-5. Other EPA Programs, Implementing Federal Environmental Laws, and Compliance and Enforcement; Looking Forward.

1. Why does EPA have voluntary programs, in addition to regulations? How many voluntary programs does EPA administer? *Discussion Question:* Why aren't all pollution reduction requirements voluntary?

2. Why is U.S. EPA concerned with international programs? Why not just focus on U.S. environmental issues? Are there pollution problems that extend beyond the U.S. borders?

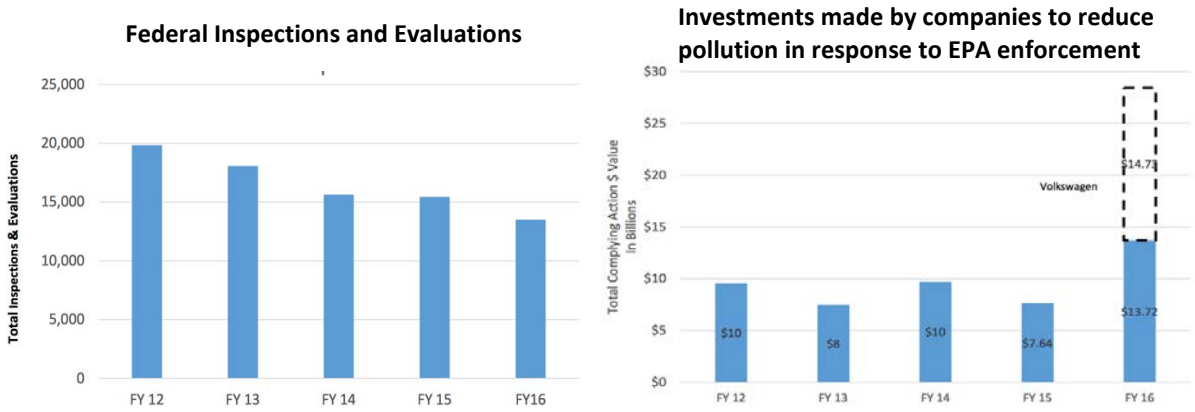
3. Much discussion has been directed at the costs as compared to the benefits of environmental regulations. What evidence do we have that the clean-ups mandated by U.S. regulations is worth it? If overall the benefits outweigh the costs does that mean that all regulations are worthwhile?

4. Why are compliance and enforcement essential components of environmental regulation? What governmental entities bear the major responsibility for compliance and enforcement?

5. The two charts below show trends relating to environmental enforcement. EPA funding for enforcement has declined resulting in fewer compliance activities over time (left chart), yet the investments companies have made to comply with regulation prompted by enforcement shows

no clear trend, with a peak in Fiscal Year (FY) 2016 (right chart; see EPA report for additional details). Why?

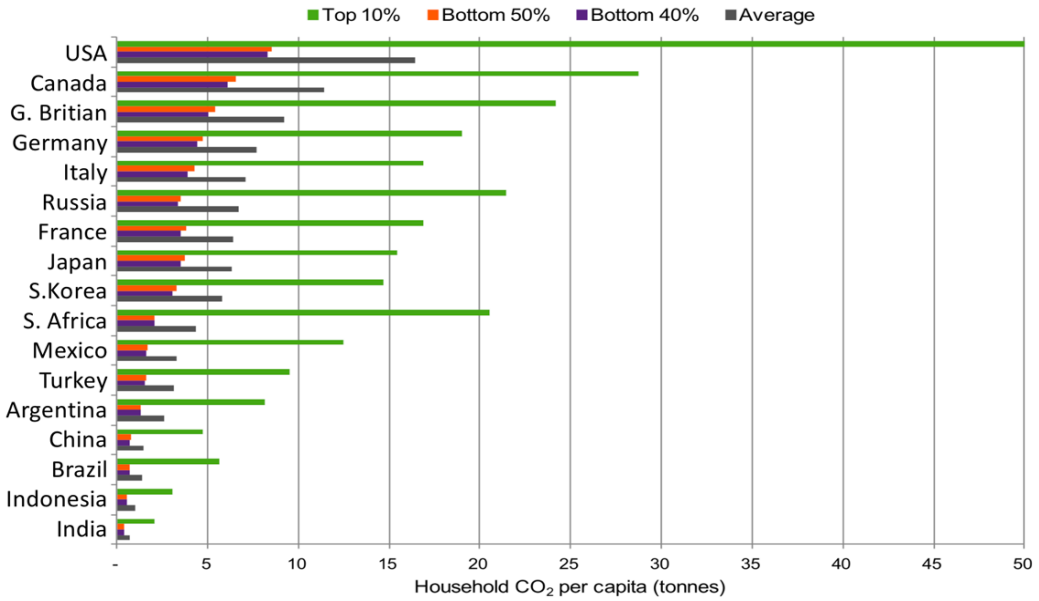
Trends in federal enforcement (EPA 2016).



6. The final section of the HCP essay highlights significant continuing challenges for the future. Climate change is perhaps the most pressing as it encompasses multiple sources and effects on a global scale. Developing programs to address sources and cope with increasing effects such as sea level rise present major scientific, technical, economic, and policy dilemmas on a national and international scale.

   One of the major issues in negotiating global solutions for reducing carbon levels that postpone or prevent some of the most serious effects of climate change is the disparity between total greenhouse gas (GHG) emissions emitted by developed and both developing and undeveloped nations. The bar chart on the following page highlights some of these disparities, both among and within nations. The chart lists the per capita "lifestyle"[6] CO_2 emissions for a limited number of countries, stratified by individual economic status with each country. For comparison with the averages in the chart, the global average (all countries) per capita CO_2 emission is 4.5 metric tons/year. These estimates exclude the contribution of other GHG such as methane, which make up about 25% of the total GHG burden.

[6] "Lifestyle" emissions reflect purchase for transportation, home heating, food, and the like and exclude those related to government expenditures.



Per capita lifestyle consumption emissions in G20 countries for which data are available*

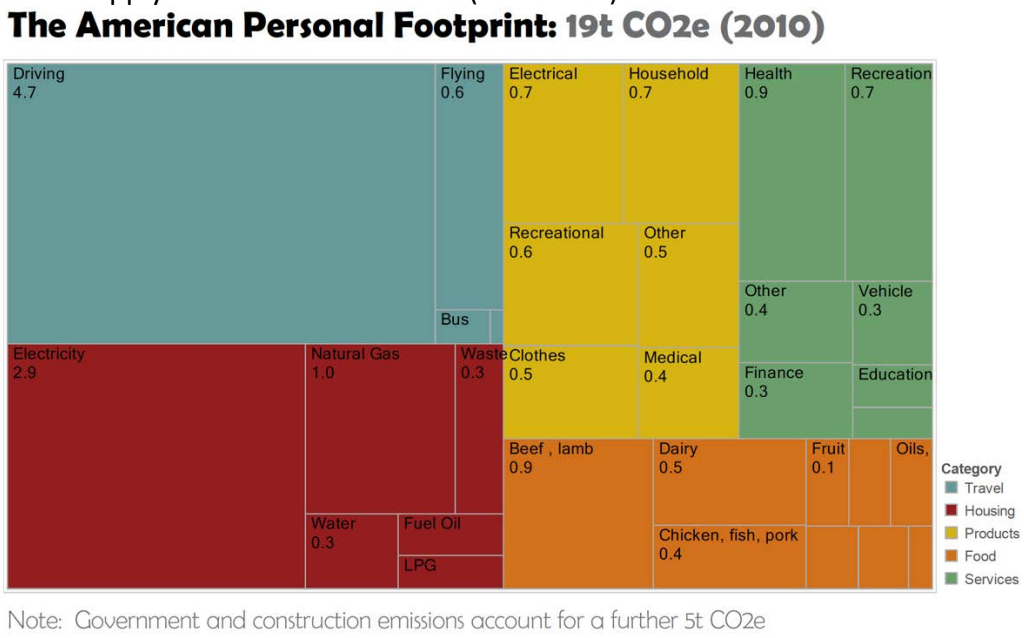
*Excludes non-CO2 gases. % refer to economic status – Top reflects the wealthiest, bottom the poorer fractions for each country.

a) Based on the data in this chart, address the following questions.

i) Calculate the approximate difference between average per capita emissions for the U.S. with the averages for China and India.

ii) Calculate the approximate difference between per capita emissions for the wealthiest 10% of Americans and 1) the bottom 40% in the US and 2) the wealthiest 10% in China.

Many people are interested in reducing their personal carbon "footprint." A number of sites and texts provide recommendations and rankings for specific actions, which can vary significantly. The following example chart breaks the U.S. average per capita lifestyle emissions into five major categories. These calculations are approximate, and address all major greenhouse gases* from a 2010 inventory. Note, these averages do not apply for all economic levels (see above) or locations.

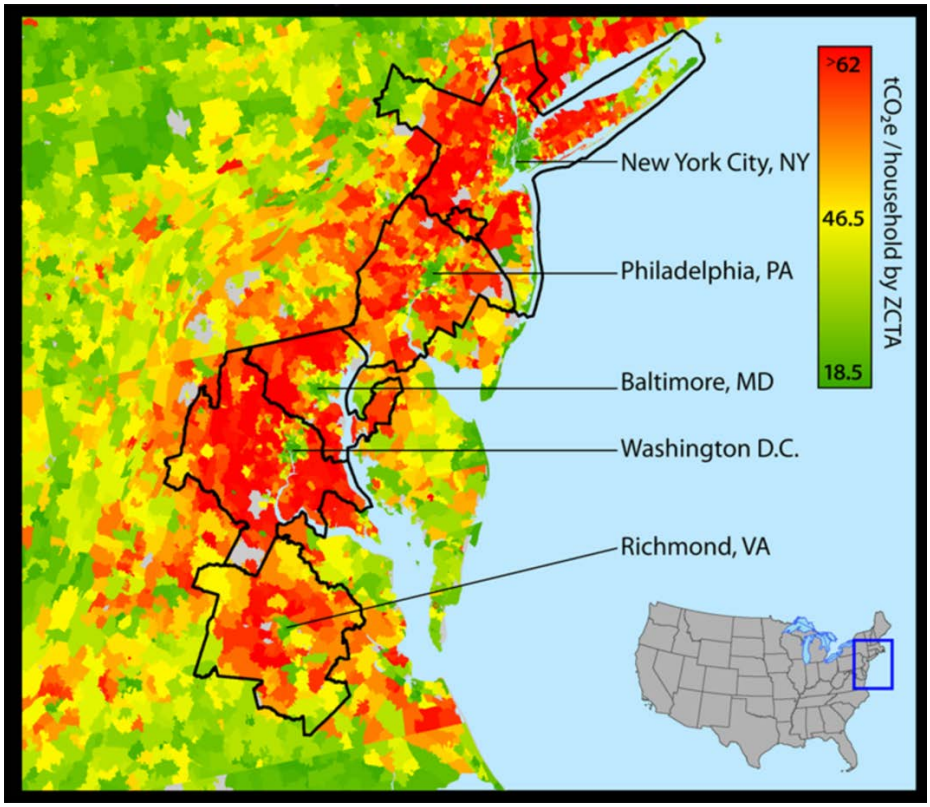


*Estimates from Wilson, 2013 . 19t CO_2e is 19 metric tons of CO_2 equivalents, including CO_2, methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC), hydrofluorocarbons (HFC), and sulfur hexafluoride (SF_6).

b) Assuming these numbers are representative, identify five effective steps individual Americans might take to reduce their carbon footprint.

You can check your suggestions by comparing them with several published *qualitative* lists [e.g.. Global Stewards, Mashable, and Climate Protection]. Several recent listings provide *quantitative* estimates of reductions of individual actions [e.g. Wynes and Kimberly (2017), EPA's Student's Guide to Global Climate Change, and little climate]. Recognize that different quantitative estimates can vary with the assumptions made by analysts as well as how comprehensive the available data on emissions and use are. Moreover, as indicated by the bar chart above, the effectiveness of any single individual action can vary significantly with economic status and location.

The map below, taken from an interactive *household*[7] emission map of the U.S., illustrates how where you live can have a big impact on your carbon footprint. One of the more interesting observations is the marked difference between emissions from households in the most densely populated five urban areas as compared to the surrounding suburbs.



From the CoolClimate Calculator map of household carbon emissions by ZIP code

c) Identify and describe at least two factors that might contribute to lower than average household emissions in large central urban areas and much higher in the surrounding suburbs. Hint, you can explore the breakdown of the emissions into the five categories[10] in zip codes for any of these cities and suburbs by clicking on the link to the interactive map.

[7]Here household emissions are the total from all energy, transportation, food, goods and services used by the household.

Optional Activity: Use the interactive map to compare the household emissions in your own ZIP code and community with other areas of the country. You can also use the individual Cool Climate Calculator to compare your household's emissions with others in your area. What regional patterns do you observe looking at the entire map? Can any of them be explained by obvious differences one or more of the categories?

The information in the above charts on per capita and household emissions has multiple uses. One is of course informing individual decisions on reducing carbon. Some sites and texts have encouraged individual actions as a way to lessen some effects of climate change.

d) What are the limitations of relying on voluntary actions by individuals and families to provide enough reductions in greenhouse gas emissions to avoid many of the more serious effects forecast[8] if global temperatures exceed 1.5 to 2^{o} C?

e) How could insights derived from the kind of household and personal emissions data inform better strategies for taking collective action by cities, states or the federal government?

[8] A 2014 Intergovernmental Panel on Climate Change (IPCC) summary provides risks estimates (e.g., page 13). These temperature limits were adopted as goals in the Paris Climate Agreement.