Energy → Pollution → Health

23 March 2007
28th class meeting

READINGS,
Friday 23 March:
None assigned
Saturday 24 March:
Mt Lemmon (see lab website, bring handouts)
Monday 26 Mar:
See Ozone link through EPA

Lab 21/23 Mar:
Energy Lab
(see website or your email)
Saturday 24 March MT LEMMON!
BSE 7am, return 6pm
Lab 28/30 March:
meet in lab

Environmental Biology (ECOL 206)
University of Arizona, spring 2007

Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA

http://eebweb.arizona.edu/courses/Ecol206/206_Page2007.html

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Mt. Lemmon Ski Area, March or April 2005

Mt. Lemmon this Saturday…

24 March

Meet 0700h at S side of BSE (corner of 4th and Highland)
"Be on time or get left behind."
Return around 1800h to campus

Please Bring:

Food (snacks and lunch)
We will bring a cooler with ice for you to put stuff in if you wish.
Water (bring a small **bottle**, we will bring big jug for refills)
Hat
Clothes for variable weather conditions. Up top it *might* be in the 30s F and raining or snowing.
Be prepared to enjoy yourself no matter the weather.

Small Notebook, Writing Instruments, Handout from 206 lab website
Sunscreen?
Binoculars?
Camera?
Money?

Please don't bring personal music devices, no text-messaging or phone calls, etc.
We will be interacting as a group all day.

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SNR Special Seminar Information
Thanks to financial support from the Graduate Student and Professional Council, Institute for the Study of Planet Earth, and USGS, we are honored to welcome **Dr. Sharon Collinge** from The University of Colorado at Boulder for a visit to SNR on March 27th and 28th. Dr. Collinge will be giving a talk entitled Got plague?: Links between landscape change and disease occurrence in western USA grasslands, as part of the School of Natural Resources Seminar Series (Wednesday, March 28th at noon in the Old Chem Bldg (across the quad) room 209).
Dr. Collinges current research focuses on the role of landscape spatial heterogeneity in shaping ecological processes, including responses of individual organisms, populations, and communities to spatial variation in landscape structure. More information on Dr. Collinges lab can be found at <<http://www.colorado.edu/eeb/EEBprojects/CollingeLab/index.html>.

A selection of Dr. Collinges papers can be found by following this link (http://www.u.arizona.edu/~obrienc/research/collinge/collinge.html).

Tuesday, March 27th
Undergraduate student luncheon, 12:00 1:00 pm, room 218 BSE
Break-out session (professional development and research), 1:15 2:15, room 218 BSE

Wednesday, March 28th
SNR Noon Seminar, 12:00-1:00, Old Chem Bldg room 209
Potluck social, 6:00 9:00 (more information to come)

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March 20, 2007, NYTimes
Material Shows Weakening of Climate Reports
By ANDREW C. REVKIN and MATTHEW L. WALD

WASHINGTON, March 19 — A House committee released documents Monday that showed hundreds of instances in which a White House official who was previously an oil industry lobbyist edited government climate reports to play up uncertainty of a human role in global warming or play down evidence of such a role.
In a hearing of the House Committee on Oversight and Government Reform, the official, Philip A. Cooney, who left government in 2005, defended the changes he had made in government reports over several years. Mr. Cooney said the editing was part of the normal White House review process and reflected findings in a climate report written for President Bush by the National Academy of Sciences in 2001.
They were the first public statements on the issue by Mr. Cooney, the former chief of staff of the White House Council on Environmental Quality. Before joining the White House, he was the "climate team leader" for the American Petroleum Institute, the main industry lobby.
He was hired by Exxon Mobil after resigning in 2005 following reports on the editing in The New York Times. The White House said his resignation was not related to the disclosures.
Mr. Cooney said his past work opposing restrictions on heat-trapping gases for the oil industry had had no bearing on his actions once he joined the White House. "When I came to the White House," he testified, "my sole loyalties were to the president and his administration."
Mr. Cooney, who has no scientific background, said he had based his editing and recommendations on what he had seen in good faith as the "most authoritative and current views of the state of scientific knowledge."
Mr. Cooney was defended by James L. Connaughton, chairman of the environmental council and his former boss.
The hearing was part of an investigation, begun under the committee's Republican chairman last year, into accusations of political interference in climate science by the Bush administration.It became a heated and largely partisan tug of war over the appropriate role of scientists and political appointees in framing how the government conveys information on global warming.
The hearing …

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March 20, 2007, NYTimes
Material Shows Weakening of Climate Reports
By ANDREW C. REVKIN and MATTHEW L. WALD

The hearing also produced the first sworn statements from George C. Deutsch III, who moved in 2005 from the Bush re-election campaign to public affairs jobs at NASA. There he warned career press officers to exert more control over James E. Hansen, the top climate expert at the space agency.
Testifying at the hearing, Dr. Hansen said editing like that of Mr. Cooney and efforts to limit scientists' access to the news media and the public amounted to censorship and muddied the public debate over a pressing environmental issue. "If public affairs offices are left under the control of political appointees," he said, "it seems to me that inherently they become offices of propaganda."
Republicans criticized Dr. Hansen for what they described as taking political stances, for spending increasing amounts of time on public speaking and for accepting a $250,000 Heinz Award for environmental achievement from the Heinz Family Philanthropies, run by Teresa Heinz Kerry, the wife of Senator John Kerry, Democrat of Massachusetts.
Representative Darrell Issa, Republican of California, proposed that Dr. Hansen, by complaining about efforts to present two sides on global warming research, had become an advocate for limiting the debate.
Dr. Hansen replied, "What I'm an advocate for is the scientific method."
Mr. Deutsch said his warnings to other NASA press officials about Dr. Hansen's statements and news media access were meant to convey a "level of frustration among my higher-ups at NASA."
Mr. Deutsch resigned last year after it was disclosed that he had never graduated from Texas A&M University, as his résumé on file at NASA said. He has since completed work for the degree, he said Monday.
Democrats focused on fresh details that committee staff members had compiled showing how Mr. Cooney made hundreds of changes to government climate research plans and reports to Congress on climate that raised a sense of uncertainty about the science.
The documents "appear to portray a systematic White House effort to minimize the significance of climate change," said a memorandum circulated by the Democrats under the committee chairman, Representative Henry A. Waxman of California.

6

Speth
Red Sky at Morning
Chapter 2, Lost in Eden

Biologists

Harold Mooney and Paul Ehrlich correctly observe that "ignorance of the services that natural ecosystems supply to the human enterprise—of the reasons that the economy is a wholly owned subsidiary of those systems—amounts to a condemnation of schools, colleges, universities and the print and electronic media."[11] This area is one of many where we are paying a high price for our neglect of environmental education at all grade levels.

p.27

7

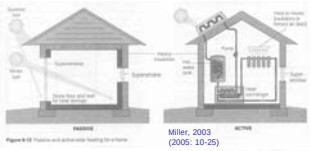
Energy Sources

Solar – passive or active
Hydrogen - (green algae??)
need to decompose water

Hydropower
Wind
Biomass
Geothermal

Fossil Fuels
Oil
Natural Gas
Coal

Nuclear



Miller, 2003 (2005: 10-25)

Miller, 2003 (2005: 10-7)

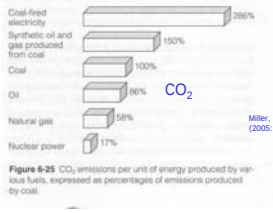
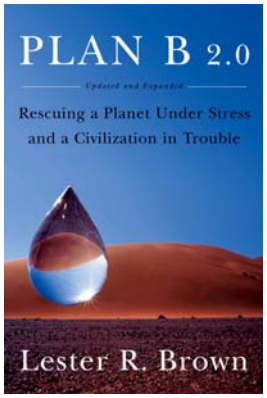
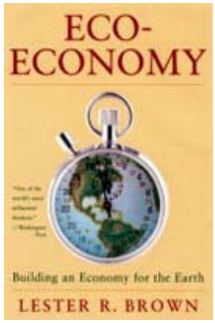


Figure 6-25 CO_2 emissions per unit of energy produced by various fuels, expressed as percentages of emissions produced by coal.

Miller, 2003 (2005: 10-5)





http://www.earth-policy.org/Books/index.htm

http://www.earth-policy.org/Books/index.htm

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The Energizer

Amory Lovins has a vision: The U.S. economy keeps going and going and going—without any oil As told to Cal Fussman

Photography by Ben Stechschulte

AMORY LOVINS IS A PHYSICIST, ECONOMIST, INVENTOR, AUTOMOBILE DESIGNER, CONSULTANT TO 18 HEADS OF STATE, AUTHOR OF 29 BOOKS, AND COFOUNDER OF ROCKY MOUNTAIN INSTITUTE, AN ENVIRONMENTAL THINK TANK. MOST OF ALL, HE'S A MAN WHO TAKES PRIDE IN SAVING ENERGY. THE ELECTRICITY BILL AT HIS 4,000-SQUARE-FOOT HOME IN OLD SNOWMASS, COLORADO, IS FIVE DOLLARS A MONTH, AND HE'S CONVINCED HE CAN DO THE SAME FOR ALL OF US. HIS BOOK *WINNING THE OIL ENDGAME* SHOWS HOW THE UNITED STATES CAN SAVE AS MUCH OIL AS IT GETS FROM THE PERSIAN GULF BY 2015 AND HOW ALL OIL IMPORTS CAN BE ELIMINATED BY 2040. AND THAT'S JUST FOR STARTERS.

11

WIND

IF I COULD DO JUST ONE THING TO SOLVE OUR ENERGY PROBLEMS, I WOULD allow energy to compete fairly at honest prices regardless of which kind it is, what technology it uses, how big it is, or who owns it. If we did that, we wouldn't have an oil problem, a climate problem, or a nuclear proliferation problem. Those are all artifacts of public policies that have distorted the market into buying things it wouldn't otherwise have bought because they were turkeys.

ELECTRICITY

A QUESTION I ASK A LOT IS, WHAT'S THE RIGHT SIZE FOR THE JOB? I HAVE A book called *Small Is Profitable: The Hidden Economic Benefits of Making Electrical Resources the Right Size*. It points out 207 benefits of distributed resources, such as solar and wind power. When I begin to describe them, you'll find them really obvious:

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ENERGY

Until then, the energy problem was generally considered to be: Where do we get more energy? People were preoccupied with where we could get more energy of any kind, from any sources, for any price—as if all our needs were the same. I started instead at the other end of the problem: What do we want the energy for?

You don't generally want lumps of coal or barrels of sticky black goo. You want comfort, illumination, mobility, baked bread, and

OIL

LET'S START WITH ONE BASIC PROBLEM. SAUDI ARABIA HAS A QUARTER OF the world's oil reserves. It is the sole swing producer with significant capacity to increase output, and therefore it controls the world price.

DEFENSE

A MAJOR PLAYER IN OUR ENERGY FUTURE WILL BE THE PENTAGON. HERE'S why: Trailing behind every half-mile-a-gallon Abrams tank—a peerless fighting machine if you can get it there—are two unarmored fuel trucks. Guess what the bad guys shoot at?

56 DISCOVER FEBRUARY 2006

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WEIGHT

A MODERN CAR, AFTER 120 YEARS OF DEVOTED ENGINEERING EFFORT SINCE Gottlieb Daimler built the first gasoline-powered vehicle, uses less than 1 percent of its fuel to move the driver. How does that happen?

Well, only an eighth of the fuel energy reaches the wheels. The rest of it is lost in the engine, drivetrain, and accessories, or wasted while the car is idling. Of the one-eighth that reaches the wheels, over half heats the tires on the road or the air that the car pushes aside. So only 6 percent of the original fuel energy accelerates the car. But remember, about 95 percent of the mass being accelerated is the car—not the driver. Hence, less than 1 percent of the fuel energy moves the driver. This is not very gratifying.

PLASTIC

HENRY FORD SAID YOU DON'T NEED WEIGHT FOR strength. If you did need weight for strength, your bicycle helmet would be made of steel, not carbon fiber. And if you want to know how strong a very light material can be, try eating an Atlantic lobster with no tools.

HYDROGEN

MANY AUTOMAKERS ARE STARTING TO UNDERSTAND THAT WHOEVER GOES ultralight first will take the lead in the hydrogen fuel-cell race.

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American Solar Energy Society
WORKING TOWARD A SUSTAINABLE ENERGY FUTURE

http://www.ases.org/index.htm

2833 N Country Club Rd
Tucson, AZ 85716
Phone: 520-322-5180
FAX: 520-322-9531
Toll Free: 877-264-6374

http://www.solarstore.com/

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Windfarm off coast of Denmark

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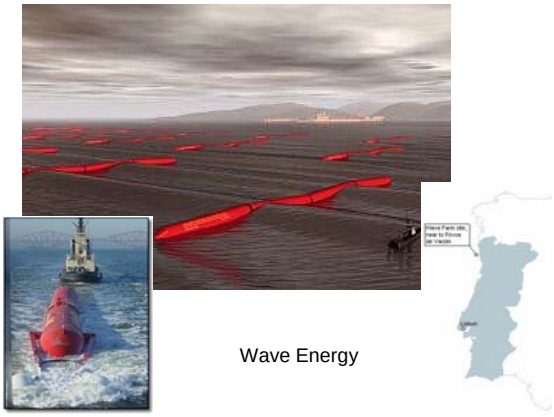
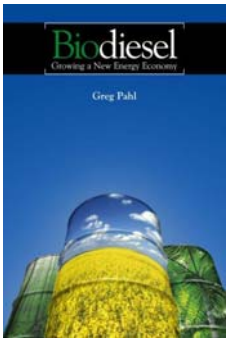


Wave Energy

BioMass and Biofuels



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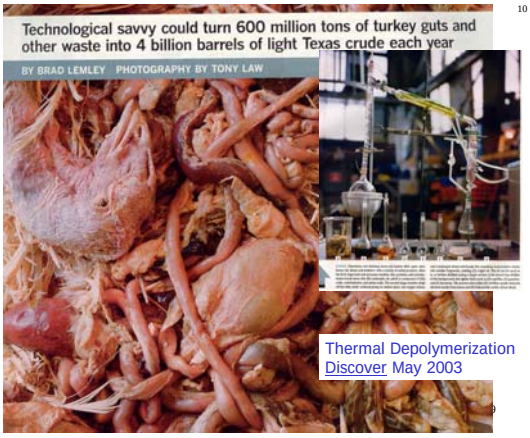


Thermal Depolymerization
Discover May 2003

Thermal Depolymerization
Discover May 2003

Thermal Depolymerization
Discover May 2003

Ethanol

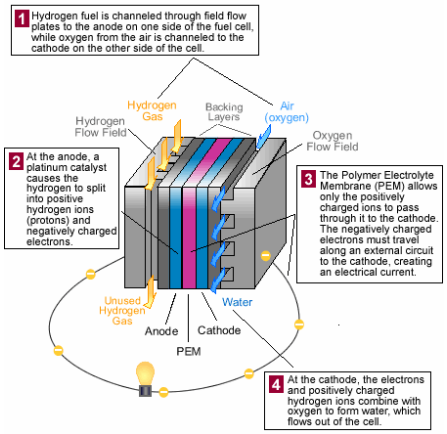
E85

Net Energy?

FUEL CELLS 2000
www.fuelcells.org

What is a fuel cell?
A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its by-product. As long as fuel is supplied, the fuel cell will continue to generate power. Since the conversion of the fuel to energy takes place via an electrochemical process, not combustion, the process is clean, quiet and highly efficient – two to three times more efficient than fuel burning. No other energy generation technology offers the combination of benefits that fuel cells do. In addition to low or zero emissions, benefits include high efficiency and reliability, multi-fuel capability, siting flexibility, durability, sand ease of maintenance. Fuel cells are also scalable and can be stacked until the desired power output is reached. Since fuel cells operate silently, they reduce noise pollution as well as air pollution and the waste heat from a fuel cell can be used to provide hot water or space heating for a home or office.

http://www.fuelcells.org/



http://www.chevrolet.com/electriccar/

http://www.chevrolet.com/fuelcell/

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Wednesday, February 16, 2005 / Arizona Daily Star • A3

Smog linked to cancerous genetic changes in fetuses

WASHINGTON — Air pollution from traffic and power plants seems to cause genetic changes — the kind linked to cancer — in developing fetuses, a federally funded study released Tuesday has concluded.

A first-of-its-kind study of 60 pregnant women in poor areas of New York City used backpacks to monitor the women's exposure to airborne carcinogens and then tested their babies' umbilical-cord blood after birth. Babies whose moms were exposed to higher pollution levels had 55 percent more aberrations in their chromosomes. Other studies have shown that these types of chromosomal changes increase the risk of cancer.

"This finding shows the process can begin as early as the womb as a result of air pollution," said study author Frederica Perera, the director of Columbia University's Center for Children's Environmental Health. "We know that these pollutants make their way across the placenta."

Perera's study didn't determine what parts of the babies' genes changed or if they all changed in the same areas.

The peer-reviewed study — funded by the Nati[illegible] of Environmental [illegible]ences and publis[illegible] month's journal [illegible]demiology Biomar[illegible]ers — links chromosome dama[illegible] el exposure to po[illegible]matic hydrocarbon[illegible]

There are mu[illegible] PAHs, which are th[illegible] of combustion, i[illegible] and truck exhaust, emissions, tobacco even the smoke [illegible]ments. Fifteen of t[illegible] mon PAHs are lis[illegible] gen in the official list of cancer-caus[illegible]

"This is not a[illegible] pregnant women a[illegible]ers to be alarmed [illegible]

But Perera and [illegible]en, director of the [illegible]stitute of Environ[illegible] Sciences, said th[illegible] should make fed[illegible] look toward bet[illegible] prevention method[illegible]

▶ Japan marks eva[illegible] Kyoto global warm[illegible]

Health & Science

It's good riddance to Frank, so David is just fine, thank you

WASHINGTON — A 9-year-old boy who nicknamed his brain tumor "Frank" — that's short for Frankenstein — is celebrating the intruder's departure.

"Frank is now dead and gone and never to return," David Diagman-Grover said Tuesday. He was wearing a T-shirt that read, "Cancer is not who I am."

Frank the Tumor gained national attention when David's mother created "Frank Must Die" bumper stickers, which the family mailed out after to delay the costs of surgery.

Tuesday, Tuesday showed the tumor was no longer cancerous.

When the boy from Sterling, Va., outside Washington was diagnosed with a grapefruit-sized tumor in 2003, the family was told the size and location in the center of his skull made it difficult — perhaps impossible — to remove.

Doctors used chemotherapy and radiation to shrink the tumor to the size of a peach pit. That alleviated the child's headaches and temporary blindness, but doctors still needed to remove the tumor.

Traditional brain surgery, called craniotomy, involves cutting through the patient's face and skull. The surgeon spread the face and skull, but a tumor occurred — too risky. The tumor was surrounded by three arteries responsible for supplying blood flow to the brain.

David's mother used the internet to find out about an alternative procedure.

Out through the nose

Dr. Henry Shabtaian of the Skull Base Institute in Los Angeles used fiber-optic instruments to remove the tumor through the nose. Dr. Ralph Dubinett, a Dallas pediatrician, was a Cedars-Sinai Medical Center.

"There were no cuts on his face," Shabtaian said.

"David would have most likely died if we had done the surgery the other way," said [illegible]

Tiffani Diagman-Grover, "I'm just so grateful that I have the chance to continue to be David's mother."

David will be 10 on March 1 and he had no doubts he would see this birthday.

"I knew the Lord would guide me through this," he said. "I'm very happy. I just want to go home and live a normal life again." He will spend the coming months recovering from chemotherapy and radiation, which has left his immune system low and his muscles weak.

The surgeon did not charge for the procedure, which usually would cost about $[illegible] including hospital fees, anesthesia and [illegible]

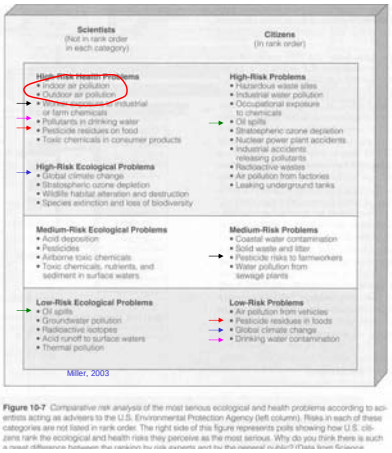
The family has de[illegible] $[illegible] they received to a[illegible] try to help other children [illegible] cancers.

Asked why he did the surgery for free, the doctor sh[illegible] reporters a pebble the boy [illegible] him that he now carries [illegible] wallet. On it is the [illegible] "courage."

AZDStar, 16 Feb 2005

FRANK MUST DIE!

Perception of Risk



Scientists (Not in rank order in each category)

Citizens (In rank order)

High-Risk Health Problems
- Indoor air pollution
- Outdoor air pollution
- High exposure to industrial or farm chemicals
- Pollutants in drinking water
- Pesticide residues on food
- Toxic chemicals in consumer products

High-Risk Health Problems
- Hazardous waste sites
- Industrial water pollution
- Occupational exposure to chemicals
- Oil spills
- Stratospheric ozone depletion
- Nuclear power plant accidents
- Industrial accidents releasing pollutants
- Radioactive wastes
- Air pollution from factories
- Leaking underground tanks

High-Risk Ecological Problems
- Global climate change
- Stratospheric ozone depletion
- Wildlife habitat alteration and destruction
- Species extinction and loss of biodiversity

Medium-Risk Ecological Problems
- Acid deposition
- Pesticides
- Airborne toxic chemicals
- Toxic chemicals, nutrients, and sediment in surface waters

Medium-Risk Problems
- Coastal water contamination
- Solid waste and litter
- Pesticide risks to farmworkers
- Water pollution from sewage plants

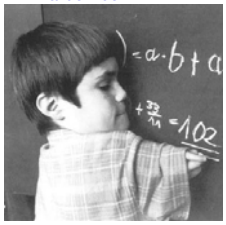
Low-Risk Ecological Problems
- Oil spills
- Groundwater pollution
- Radioactive isotopes
- Acid runoff to surface waters
- Thermal pollution

Low-Risk Problems
- Air pollution from vehicles
- Pesticide residues in foods
- Global climate change
- Drinking water contamination

Miller, 2003

Figure 10-7 Comparative risk analysis of the most serious ecological and health problems according to scientists acting as advisers to the U.S. Environmental Protection Agency (left column). Risks in each of these categories are not listed in rank order. The right side of this figure represents polls showing how U.S. citizens rank the ecological and health risks they perceive as the most serious. Why do you think there is such a great difference between the opinion by risk experts and by the general public? (Data from Science

Thalidomide

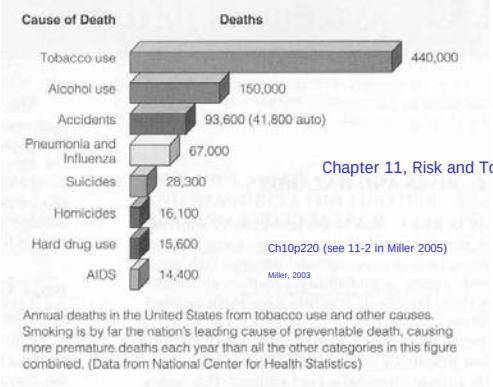


Thalidomide is a drug that was introduced on to the market on October 1, 1957 in West Germany. Thalidomide soon became a drug prescribed to pregnant women to combat symptoms associated with morning sickness. When taken during the first trimester of pregnancy, Thalidomide prevented the proper growth of the foetus resulting in horrific birth defects in thousands of children around the world. These children were born in the late 1950's and early 1960's and became known as "*Thalidomide babies*".

Of the 10,000 babies with "seal-like" limbs, only seventeen were born in the United States. The number was low because Dr. Frances Kelsey blocked the sale of the drug in this country.

Precautionary Principle

What are humans dying from?



Chapter 11, Risk and Toxins

Ch10p220 (see 11-2 in Miller 2005)

Miller, 2003

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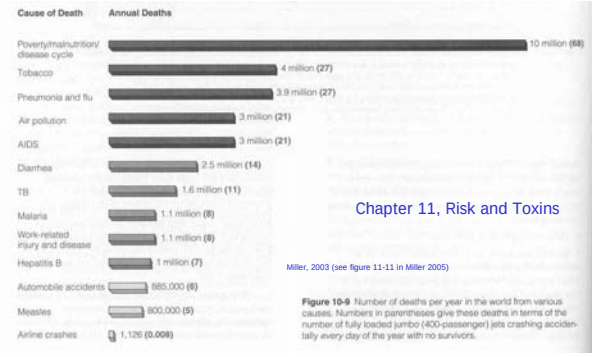
What are humans dying from?



Chapter 11, Risk and Toxins

Miller, 2003 (see figure 11-11 in Miller 2005)

Miller, 2003

Shortening Lifespan in the U.S.

Miller, 2003 (see figure 11-12 in Miller 2005)

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Ending Hunger and Disease (Miller p. 155):

-Immunizations

-Breast Feeding

-Sugar+Salt+Water to fight dehydration from diarrhea

-Vitamin A 2x/year to prevent blindness

-Family planning services

-Educate women
nutrition, sterilize drinking water, child care

Cost: $5-10/child/year

34

Speth
Red Sky at Morning
Chapter 2, Lost in Eden

Biophilia (Kellert&Wilson)

Threats:
1. Land Use Conversion (1/3 forests gone, ½ wetlands)
2. Land Degradation
3. Freshwater Shortages
4. Watercourse Modifications
5. Invasive Species
6. Overharvesting
7. Climate Change
8. Ozone Depletion
9. Pollution

Only need ~$30 billion/year to set aside 15% land area

35

Blaustein

Pollution
1-natural
2-anthropogenic
urban and industrial areas
industrial agriculture

Sources:
a. Point (smokestack, drainpipe, exhaust pipe)
b. Nonpoint (runoff with fertilizers and pesticides)

Characteristics of Pollution:
1. Chemical nature
2. Concentration
3. Persistence
-Degradable (human waste)
-Persistent (DDT, plastics)
-Nondegradable (lead, mercury)

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Air Pollution
- Primary
- Secondary

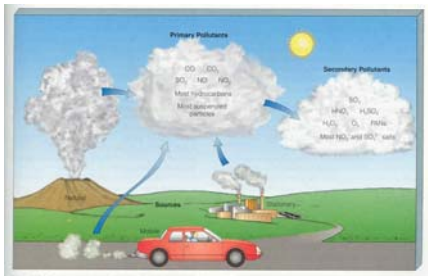


Figure 12-4 Sources and types of air pollutants. Human inputs of air pollutants may come from mobile sources (such as cars) and stationary sources (such as industrial and power plants). Some primary air pollutants may react with one another or with other chemicals in the air to form secondary air pollutants.

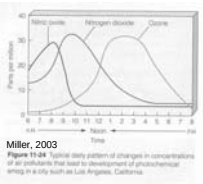
Miller 11-22, 2003
See Miller 2005 Fig. 12-20

Air Pollution

Table 11-2 Major Classes of Air Pollutants

Class	Examples
Carbon oxides	Carbon monoxide (CO), carbon dioxide (CO_2)
Sulfur oxides	Sulfur dioxide (SO_2), sulfur trioxide (SO_3)
Nitrogen oxides	Nitric oxide (NO), nitrogen dioxide (NO_2), nitrous oxide (N_2O) (NO and NO_2 often are lumped together and labeled NO_x)
Volatile organic compounds (VOCs)	Methane (CH_4), propane (C_3H_8), chlorofluorocarbons (CFCs)
Suspended particulate matter (SPM)	Solid particles (dust, soot, asbestos, lead, nitrate and sulfate salts), liquid droplets (sulfuric acid, PCBs, dioxins, pesticides)
Photochemical oxidants	Ozone (O_3), peroxyacyl nitrates (PANs), hydrogen peroxide (H_2O_2), aldehydes
Radioactive substances	Radon-222, iodine-131, strontium-90, plutonium-239
Hazardous air pollutants (HAPs), which cause health effects such as cancer, birth defects, and nervous system problems	Carbon tetrachloride (CCl_4), methyl chloride (CH_3Cl), chloroform ($CHCl_3$), benzene (C_6H_6), ethylene dibromide ($C_2H_4Br_2$), formaldehyde (CH_2O_2)

Miller, 2003, see Miller 2005 Table 12-2



Miller, 2003
Figure 11-24 Typical daily pattern of changes in concentrations of air pollutants that lead to development of photochemical smog in a city such as Los Angeles, California.

Photochemical Smog

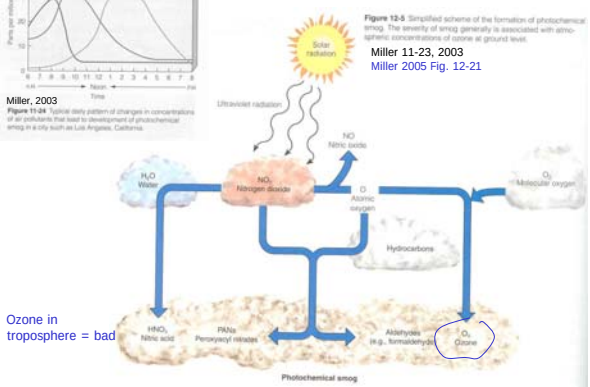


Figure 12-5 Simplified scheme of the formation of photochemical smog. The severity of smog generally is associated with atmospheric concentrations of ozone at ground level.

Miller 11-23, 2003
Miller 2005 Fig. 12-21

Ozone in troposphere = bad

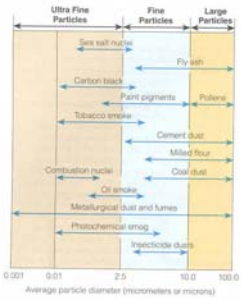
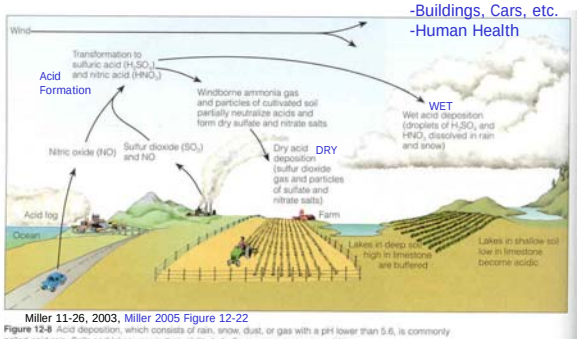


Figure 12-6 Suspended particulate matter consists of particles of solid matter and droplets of liquid that are small and light enough to remain suspended in the atmosphere for short periods (large particles) to long periods (small particles). Suspended particles are found in a wide variety of types and sizes, ranging in diameter from 0.001 micrometer to 100 micrometers (a micrometer, or micron, is one millionth of a meter, or about 0.00004 inches). Since 1987, the EPA has focused on *fine particles* smaller than 10 microns (known as *PM-10*). In 1997, the agency began focusing on reducing emissions of *ultrafine particles* with diameters less than 2.5 microns (known as *PM-2.5*) because these particles are small enough to reach the lower part of human lungs and contribute to respiratory diseases.

Acid Deposition

-Soil
-Water
-Fish
-Buildings, Cars, etc.
-Human Health



Miller 11-26, 2003, Miller 2005 Figure 12-22
Figure 12-8 Acid deposition, which consists of rain, snow, dust, or gas with a pH lower than 5.6, is commonly called acid rain. Soils and lakes vary in their ability to buffer or remove excess acidity.

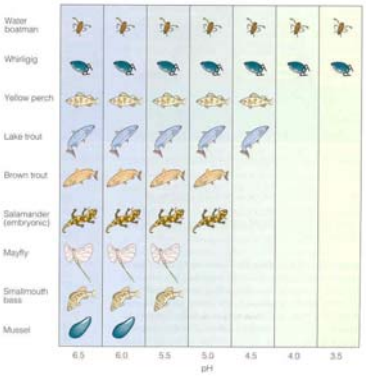
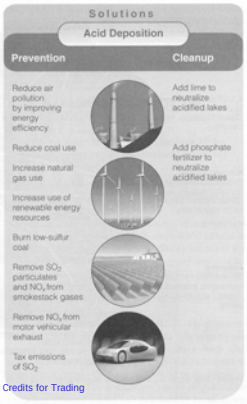


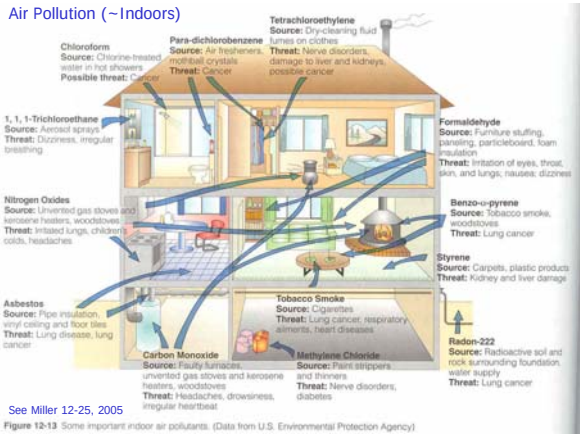
Figure 12-10 Fish and other aquatic organisms vary in their sensitivity to acidity. The figure shows the lowest pH (highest acidity) at which the various species can survive. Note that the greatest effects occur when the pH drops below 5.5.



Credits for Trading

Figure 12-24 Solutions: methods for reducing acid deposition and its damage. Miller, 2005

Air Pollution (~Indoors)



See Miller 12-25, 2005

Figure 12-13 Some important indoor air pollutants. (Data from U.S. Environmental Protection Agency)

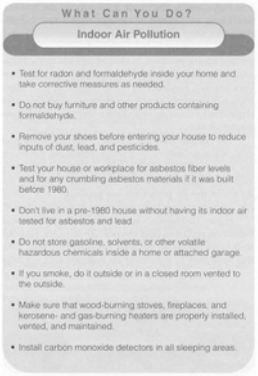


Figure 12-30 What can you do? Ways to reduce your exposure to air pollution. Miller 2005

Table 12-2 Major Outdoor Air Pollutants*

Carbon monoxide (CO)

Description: Colorless, odorless gas that is poisonous to air-breathing animals; forms during the incomplete combustion of carbon-containing fuels ($2C + O_2 \rightarrow 2CO$).

Major human sources: Cigarette smoking (Case Study, p. 238), incomplete burning of fossil fuels. About 77% (95% in cities) comes from motor vehicle exhaust.

Health effects: Reacts with hemoglobin in red blood cells and reduces the ability of blood to bring oxygen to body cells and tissues. This impairs perception and thinking, slows reflexes, causes headaches, drowsiness, dizziness, and nausea; can trigger heart attacks and angina; damages the development of fetuses and young children; and aggravates chronic bronchitis, emphysema, and anemia. At high levels it causes collapse, coma, irreversible brain cell damage, and death.

Nitrogen dioxide (NO_2)

Description: Reddish-brown irritating gas that gives photochemical smog its brownish color; in the atmosphere can be converted to nitric acid (HNO_3), a major component of acid deposition.

Major human sources: Fossil fuel burning in motor vehicles (49%) and power and industrial plants (49%).

Health effects: Lung irritation and damage; aggravates asthma and chronic bronchitis; increases susceptibility to respiratory infections such as the flu and common colds (especially in young children and older adults).

Environmental effects: Reduces visibility; acid deposition of HNO_3 can damage trees, soils, and aquatic life in lakes.

Property damage: HNO_3 can corrode metals and eat away stone on buildings, statues, and monuments; NO_2 can damage fabrics.

Sulfur dioxide (SO_2)

Description: Colorless, irritating; forms mostly from the combustion of sulfur-containing fossil fuels such as coal and oil ($S + O_2 \rightarrow SO_2$); in the atmosphere can be converted to sulfuric acid (H_2SO_4), a major component of acid deposition.

Major human sources: Coal burning in power plants (88%) and industrial processes (10%).

Health effects: Breathing problems for healthy people; restriction of airways in people with asthma; chronic exposure can cause a permanent condition similar to bronchitis. According to the WHO, at least 625 million people are exposed to unsafe levels of sulfur dioxide from fossil fuel burning.

Environmental effects: Reduces visibility; acid deposition of H_2SO_4 can damage trees, soils, and aquatic life in lakes.

Property damage: SO_2 and H_2SO_4 can corrode metals and eat away stone on buildings, statues, and monuments; SO_2 can damage paint, paper, and leather.

Suspended particulate matter (SPM)

Description: Variety of particles and droplets (aerosols) small and light enough to remain suspended in atmosphere for short periods (large particles) to long periods; cause smoke, dust, and haze.

Major human sources: Burning coal in power and industrial plants (40%); burning diesel and other fuels in vehicles (17%); agriculture (plowing, burning off fields), unpaved roads, construction.

Health effects: Nose and throat irritation, lung damage, and bronchitis; aggravates bronchitis and asthma; shortens life; toxic particulates (such as lead, cadmium, PCBs, and dioxins) can cause mutations, reproductive problems, cancer.

Environmental effects: Reduces visibility; acid deposition of H_2SO_4 droplets can damage trees, soils, and aquatic life in lakes.

Property damage: Corrodes metal; soils and discolors buildings, clothes, fabrics, and paints.

Ozone (O_3)

Description: Highly reactive, irritating gas with an unpleasant odor that forms in the troposphere as a major component of photochemical smog (Figures 12-21).

Major human sources: Chemical reaction with volatile organic compounds (VOCs) emitted mostly by cars and industries) and nitrogen oxides to form photochemical smog (Figure 12-21).

Health effects: Breathing problems; coughing; eye, nose, and throat irritation; aggravates chronic diseases such as asthma, bronchitis, emphysema, and heart disease; reduces resistance to colds and pneumonia; may speed up lung tissue aging.

Environmental effects: Ozone can damage plants and trees; smog can reduce visibility.

Property damage: Damages rubber, fabrics, and paints.

Lead

Description: Solid toxic metal and its compounds, emitted into the atmosphere as particulate matter.

Major human sources: Paint (old houses), smelters (metal refineries), lead manufacture, storage batteries, leaded gasoline (being phased out in developed countries).

Health effects: Accumulates in the body; brain and other nervous system damage and mental retardation (especially in children); digestive and other health problems; some lead-containing chemicals cause cancer in test animals.

Environmental effects: Can harm wildlife.

*Data from U.S. Environmental Protection Agency

Miller 2005

"Are you saving the industry a billion dollars but taking away $10 billion worth of benefits for the general public?" Amar asked.

Mercury…

Mercury is a toxic metal emitted by industrial sources. U.S. power plants emit 48 tons a year, and the new rule establishes an emissions-trading program that is expected to lower emissions to about 31 tons by 2010 and to about 15 tons by 2026. The Harvard analysis was based on similar targets in President Bush's "Clear Skies" legislative proposal.

In most cases, mercury toxicity results from eating fish: Industrial emissions fall from the air into water and are taken up by fish. Because the metal does not break down, it moves steadily up the food chain to species that people consume. A major reason for the dramatic difference in the health benefit estimates was that the EPA looked only at the effects of reducing mercury levels in freshwater fish, but most of the fish Americans eat comes from oceans.

"Some very large share of mercury exposure comes from tuna," Hammitt said. "And while it's true that our power plants have less effect on tuna than on [freshwater] northern pike, if you ignore the saltwater pathway you'll miss a lot of the benefit."

Even though U.S. power plants contribute only about 1 percent of the mercury in the oceans, reducing even that small amount makes a difference, he said. The EPA has said that ocean species such as tuna, pollock, shrimp and halibut account for two-thirds of the mercury Americans consume, while catfish, the largest source of mercury among freshwater fish, accounts for only 3 percent.

By Shankar Vedantam
Washington Post Staff Writer
Tuesday, March 22, 2005; Page A01

Illinois

Why is the statewide methylmercury advisory only for predator species?

Mercury stays in the environment for a long time. Small organisms absorb mercury from water and sediment; these organisms then are eaten by smaller fish. Predator fish eat the smaller fish and methylmercury is accumulated up the food chain. Larger fish have the highest amounts of methylmercury stored in their bodies. **Predator species for Illinois include all species of black bass (largemouth, smallmouth and spotted), striped bass, white bass, hybrid bass, walleye, sauger, saugeye, flathead catfish, muskellunge and northern pike.**

How does methylmercury get into bodies of water in Illinois?

Mercury is a metal that occurs naturally in small amounts in the environment. It also comes from burning coal or trash and from industry. Mercury gets into lakes and rivers in several ways, including rain and runoff. When conditions are right in the water, certain kinds of bacteria change metallic mercury into the more toxic methylmercury. Methylmercury is stored in the muscle of fish, the part of the fish people eat.

What are the potential health effects for people who eat fish contaminated with methylmercury?

The developing nervous systems of fetuses and children could be damaged if exposed to even small amounts of methylmercury. At high doses, methylmercury can affect the central nervous system (causing such health problems as memory loss and slurred speech) and can cause kidney damage and failure, and gastrointestinal damage. The possible health effects depend on how much methylmercury is stored in the fish and how much fish is eaten over a period of time. Based on the amounts of methylmercury detected in predator sport fish in Illinois, it is unlikely that people would experience adverse health effects associated with exposure to high doses.