Lesson/Week XI

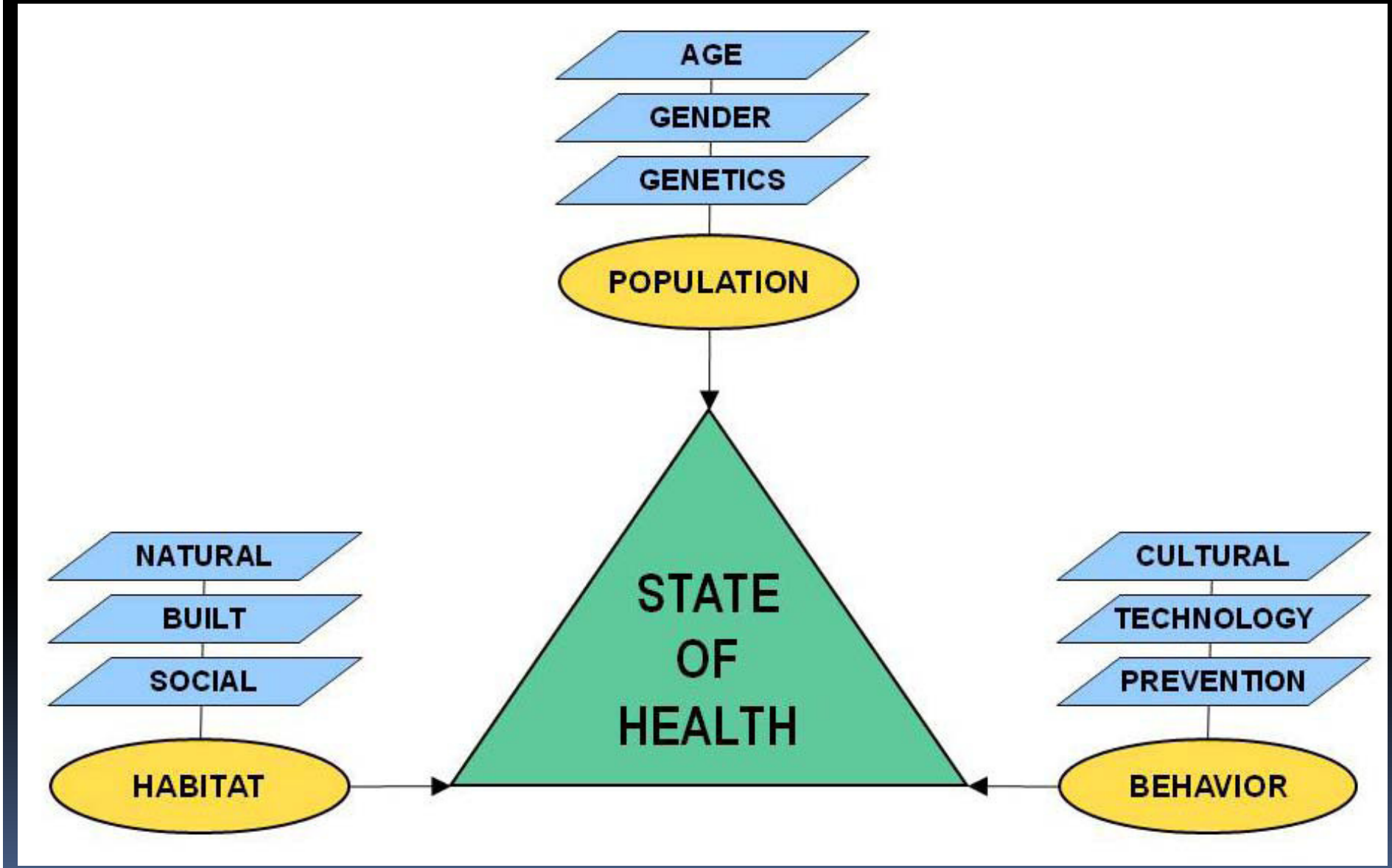
Environment and Health: A Global Perspective

- ✓What is the "Environment" in the Context of Health?
- ✓What is Meant by the " Attributable Fraction" of A Risk Factor?
- ✓Estimates Of The Environmental Attributable Fraction, by Disease
- ✓Chemical and biological pollution of water, air, and soil

"Approximately one-quarter of the global disease burden, and more than one-third of the burden among children, is due to modifiable environmental factors."

http://www.who.int/quantifying_ehimpacts/publications/preventingdisease.pdf

The triangle of human ecology: POPULATION, BEHAVIOR, HABITAT.



Important questions:

1. How Significant is the Impact of Environment on Health?
2. In Which Regions of the World is Health Most Affected by Environmental Factors, and How?
3. Which Populations Suffer the Most from Environmental Health Hazards?
4. What Can Policymakers and The Public do About Environmental Risks to Health?

1. How Significant is the Impact of Environment on Health?

✓Of the 102 major diseases, disease groupings and injuries covered by the *World Health Report in*2004, environmental risk factors contributed to disease burden in **85 categories**.

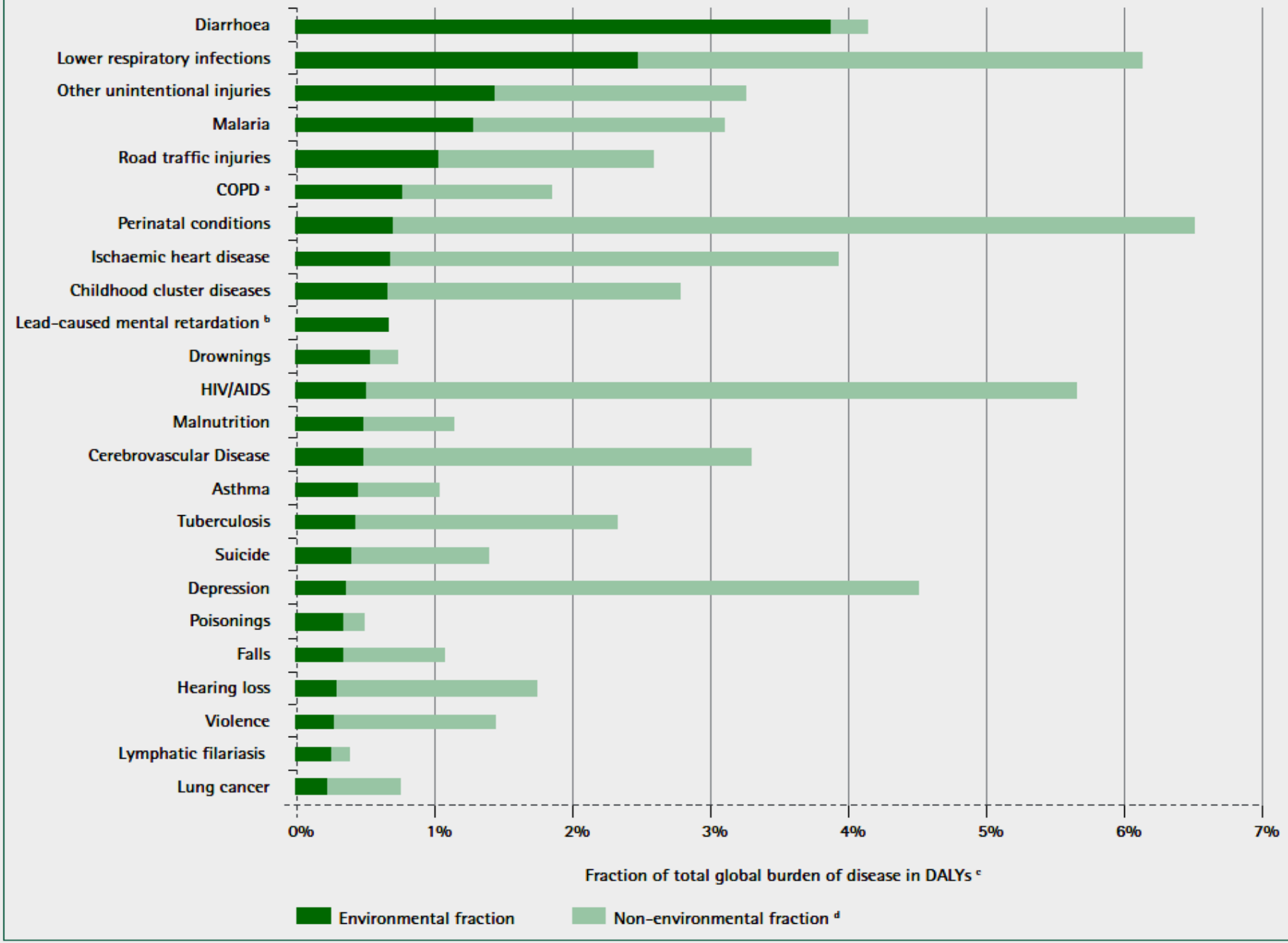
✓The specific fraction of disease attributable to the environment varied widely across different disease conditions.

✓Globally, an estimated 24% of the disease burden (healthy life years lost) and an estimated 23% of all deaths (premature mortality) was attributable to environmental factors.

✓Among **children** 0–14 years of age, the proportion of deaths attributed to the environment was as high as 36%.

✓There were **large regional differences** in the environmental contribution to various disease conditions –due to differences in environmental exposures and access to health care across the regions. For example, although 25% of all deaths in developing regions were attributable to environmental causes, only 17% of deaths were attributed to such causes in developed regions.

DISEASES WITH THE LARGEST ENVIRONMENTAL CONTRIBUTION



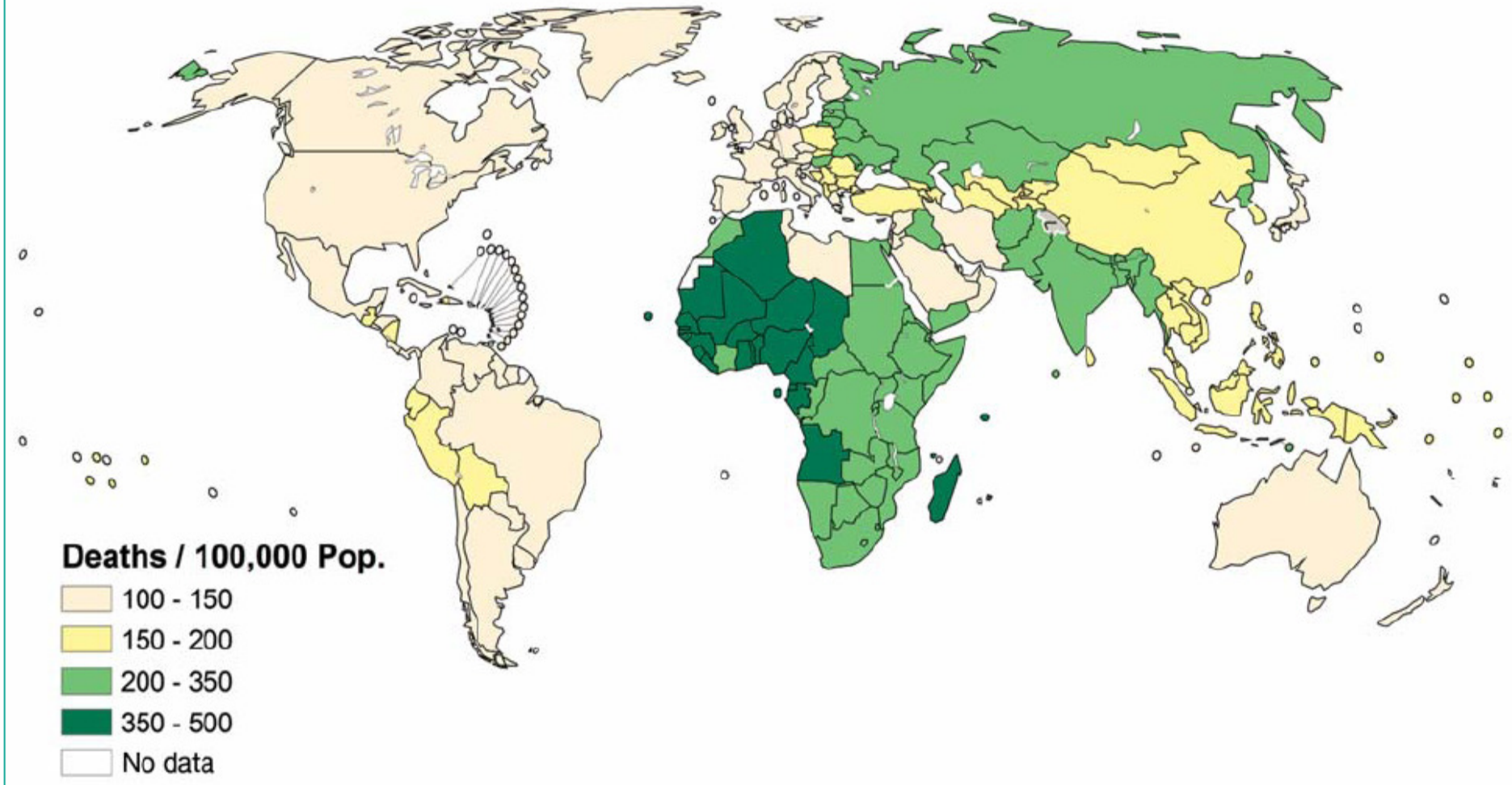
✓Diseases with the largest absolute burden attributable to modifiable environmental factors included: **diarrhoea**; **lower respiratory infections**; **'other' unintentional injuries**; and **malaria**.

✓• **Diarrhoea. An estimated 94% of the diarrhoeal burden of disease is attributable to** environment, and associated with risk factors such as **unsafe drinking-water** and **poor** sanitation and **hygiene**.

✓• **Lower respiratory infections. These are associated with indoor air pollution related largely to** household **solid fuel** use and possibly to **second-hand tobacco smoke**, as well as to **outdoor air pollution**.

✓In developed countries, an estimated 20% of such infections are attributable to environmental causes, rising to 42% in developing countries.

Environmental disease burden by WHO subregion (2002) [a]



http://www.who.int/quantifying_ehimpact

✓• **'Other' unintentional injuries. These include injuries arising from workplace hazards,** radiation and industrial accidents; 44% of such injuries are attributable to environmental factors. **(See US example: next slide)**

✓• **Malaria. The proportion of malaria attributable to modifiable environmental factors (42%)** is associated with policies and practices regarding land use, deforestation, water resource management, settlement siting and modified house design, e.g. improved drainage.

✓The use of insecticide-treated nets was not considered an environmental management measure.

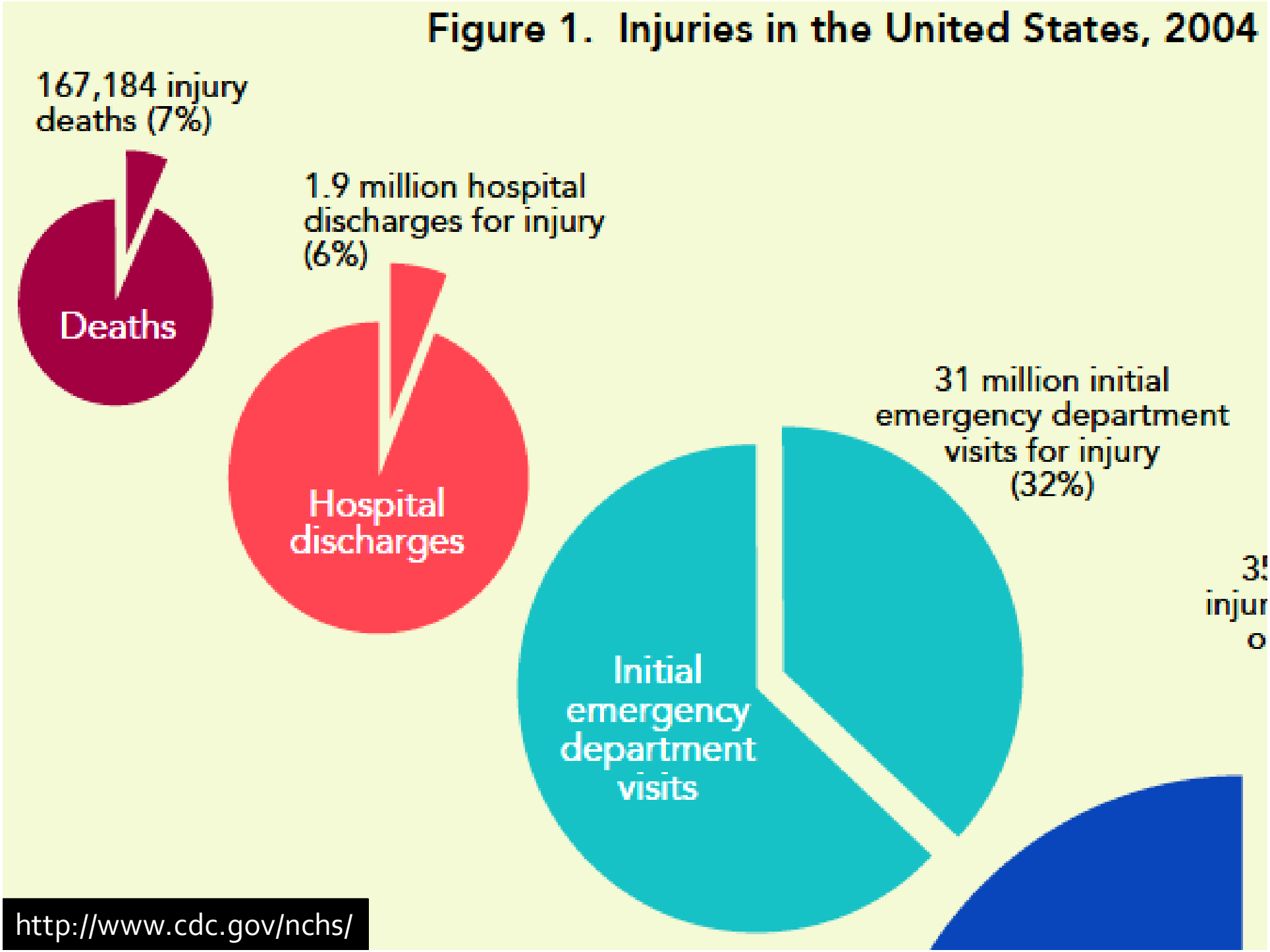


Figure 1. Injuries in the United States, 2004
167,184 injury deaths (7%)
Deaths
1.9 million hospital discharges for injury (6%)
Hospital discharges
31 million initial emergency department visits for injury (32%)
Initial emergency department visits
http://www.cdc.gov/nchs/

2. In Which Regions of The World is Health Most Affected by Environmental Factors, and How?

✓**Developing regions carry a disproportionately heavy burden for communicable diseases and injuries.**

✓The largest overall difference between WHO regions was in infectious diseases.

✓The total number of healthy life years lost per capita as a result of environmental burden per capita was 15-times higher in developing countries than in developed countries.

✓The environmental burden per capita of diarrheal diseases and lower respiratory infections was 120- to 150-times greater in certain WHO developing country subregions as compared to developed country subregions. These differences arise from variations in exposure to environmental risks and in access to health care.

✓**However, in developed countries, the per capita impact of cardiovascular diseases and cancers is higher.

✓The number of healthy life years lost from cardiovascular disease, as a result of environmental factors, was 7-times higher, per capita, in certain developed regions than in developing regions, and cancer rates were 4-times higher.

✓Physical inactivity is a risk factor for various noncommunicable diseases including ischaemic heart disease, cancers of the breast, colon and rectum, and diabetes mellitus.

✓It has been estimated that in certain developed regions such as North America, physical inactivity levels could be reduced by 31% through environmental interventions, including pedestrian- and bicycle-friendly urban land use and transport, and leisure and workplace facilities and policies that support more active lifestyles.

✓Developing countries, meanwhile, carry a heavier burden of disease from unintentional injuries and road traffic injuries attributable to environmental factors.

✓In developing countries, the average number of healthy life years lost, per capita, as a result of injuries associated with environmental factors, was roughly **double** that of developed countries; the gap was even greater at the subregional level.

✓For **road traffic injuries**, there was a **15-fold** difference between the environmental burden of disease in the best performing and worst performing subregions

3. Which Populations Suffer the Most from Environmental Health Hazards?

✓**Children** suffer a disproportionate share of the environmental health burden.

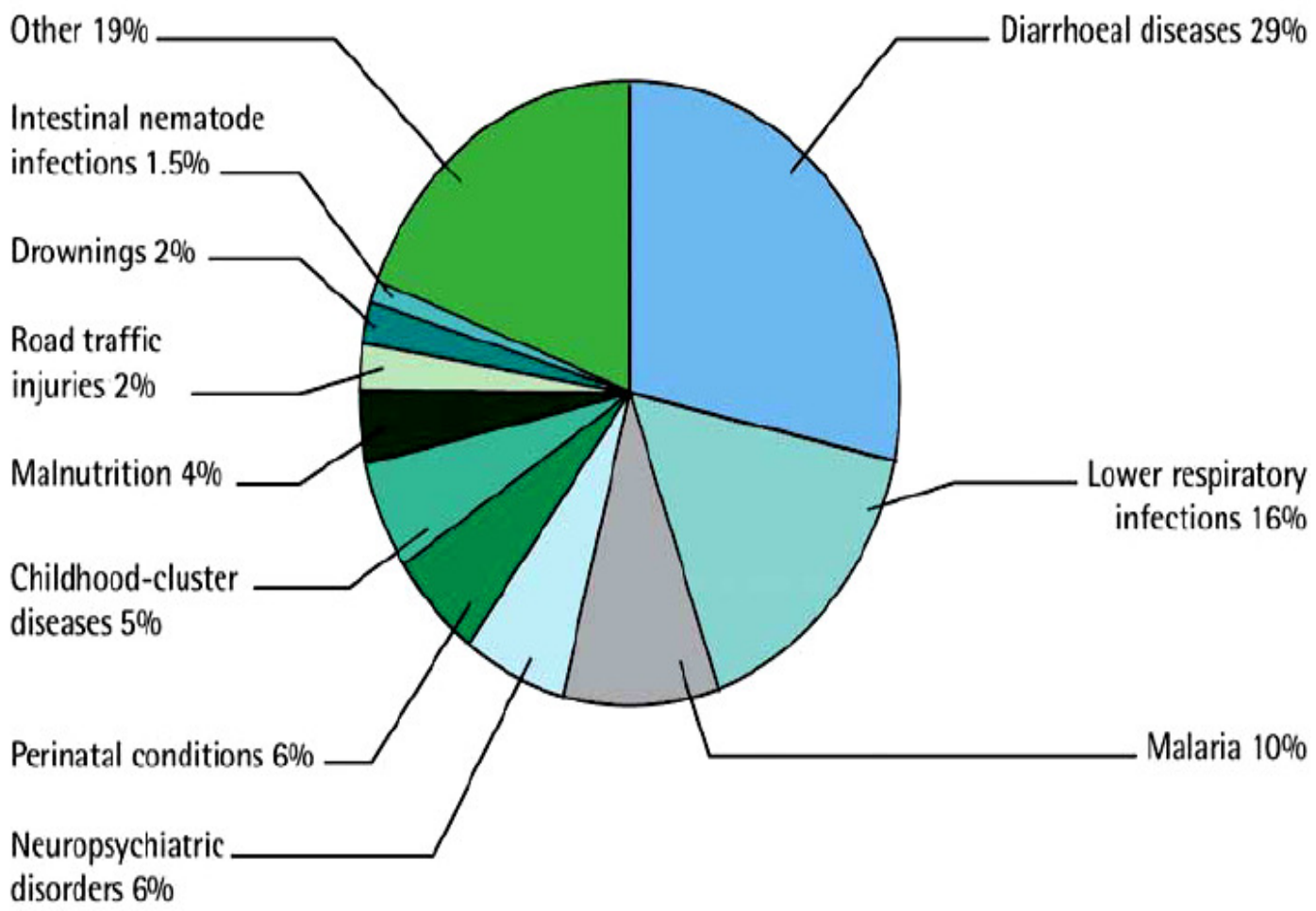
✓Globally, the per capita number of healthy life years lost to environmental risk factors was about 5-times greater in children under five years of age than in the total population.

✓Diarrhoea, malaria and respiratory infections all have very large fractions of disease attributable to environment, and also are among the biggest killers of children under five years old.

✓In developing countries, the environmental fraction of these three diseases accounted for an average of 26% of all deaths in children under five years old.

✓Perinatal conditions (e.g. prematurity and low birth weight); protein-energy malnutrition and unintentional injuries – other major childhood killers – also have a significant environmental component, particularly in developing countries.

MAIN DISEASES CONTRIBUTING TO THE ENVIRONMENTAL BURDEN OF DISEASE AMONG CHILDREN 0-14 YEARS [a]



http://www.who.int/quantifying_ehimpact

✓On average, children in developing countries lose 8-times more healthy life years, per capita, than their counterparts in developed countries from environmentally-caused diseases.

✓In certain very poor regions of the world, however, the disparity is far greater; the number of healthy life years lost as a result of childhood lower respiratory infections is 800-times greater, per capita; 25-times greater for road traffic injuries; and 140-times greater for diarrhoeal diseases.

4. What Can Policymakers and The Public do About Environmental Risks to Health?

"Public and preventive health strategies that consider environmental health interventions can be very important. Such interventions are cost-effective and yield benefits that also contribute to the overall well-being of communities."

MILLENNIUM DEVELOPMENT GOALS (MGDs)

End Poverty and Hunger
Universal Education
Gender Equality
Child Health
Maternal Health
Combat HIV/AIDS
Environmental Sustainability
Global Partnership

MDG Targets

1a. Halve, between 1990 and 2015, the proportion of people whose income is less than $1 a day
1b. Halve, between 1990 and 2015, the proportion of people who suffer from hunger
2. Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling
3. Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015
4. Reduce by two thirds, between 1990 and 2015, the under-five mortality rate
5a. Reduce by three quarters the maternal mortality ratio
5b. Achieve universal access to reproductive health
6a. Have halted by 2015 and begun to reverse the spread of HIV/AIDS
6b. Achieve, by 2010, universal access to treatment for HIV/AIDS for all those who need it
6c. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases
7a. Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources
7b. Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation
8a. Develop further an open, rule-based, predictable, non-discriminatory trading and financial system
8b. Deal comprehensively with the debt problems of developing countries

http://www.un.org/millenniumgoals/global.shtml

What is the "Environment" in the Context of Health?

"The environment is all the physical, chemical and biological factors external to the human host, and all related behaviours, but excluding those natural environments that cannot reasonably be modified."

"This definition thus aims to cover those parts of the environment that can be modified by environmental management."

The modifiable parts include:

- ✓ pollution of air, water, or soil with chemical or biological agents;
- ✓ UV and ionizing radiation;
- ✓ noise, electromagnetic fields;
- ✓ occupational risks;
- ✓ built environments, including housing, land use patterns, roads;
- ✓ agricultural methods, irrigation schemes;
- ✓ man-made climate change, ecosystem change;
- ✓ behaviour related to the availability of safe water and sanitation facilities, such as washing hands, and contaminating food with unsafe water or unclean hands.

What is Meant by the "Attributable Fraction" of A Risk Factor?

"The 'attributable fraction' is the decline in disease or injury that could be achieved in a given population by reducing the risk."

"A second issue is the determination of what are "reasonably modifiable" environmental factors. Transport policy tradeoffs illustrate the difficulties implicit in such determinations. Banning cars entirely from cities as an air pollution reduction measure, for example, may not be practical or feasible, at least at present. However, the adoption of cleaner motor vehicle technologies and alternative modes of transport (e.g. rail, bus, cycling and walking) is very widely considered by policymakers. Such strategies would thus be considered as part of the modifiable environment, in the context of measures that could reduce urban air pollution and related diseases."
http://www.who.int/quantifying_ehimpact

To decide on the best option, factors such as the cost effectiveness of alternative interventions must be considered. However, environmental modification may offer several inherent advantages:

✓• Preventing disease before it arises eliminates associated health-care treatment costs, and no burden is borne by the population;
✓• Such interventions may be more generally sustainable (i.e. achieving a longer-term impact on health, as compared to medical treatment);
✓• Environmental modification is often the most equitable option, generating benefits across broad groups or populations.

Estimates Of The Environmental Attributable Fraction, for 7 Diseases.

RESPIRATORY INFECTIONS:

✓36% of lower respiratory infections worldwide were attributable to solid fuel use alone.

✓In developed countries, solid fuel use was not significant, and environmental tobacco smoke may play a proportionally more important role in these countries.

http://www.who.int/quantifying_ehimpact

DIARRHOEA

"A large proportion of diarrheal diseases is caused by fecal-oral pathogens. In the case of infectious diarrhea, transmission routes are affected by interactions between physical infrastructure and human behaviors. "

"Animal excreta also transmit pathogens. The predominant route will depend upon the survival characteristics of the pathogen, as well as local infrastructure and human behavior. Many interventions have proven efficient in interrupting the pathogen transmission cycle at various points."

"WHO recently estimated that **94%** of all cases of diarrhea globally were **attributable to water, sanitation and hygiene**"

http://www.who.int/quantifying_ehimpact

MALARIA

There are three main approaches to the environmental management of malaria:

- ***Modify*** *the environment. This approach aims to permanently change* land, water or vegetation conditions, so as to reduce vector habitats.
- ***Manipulate*** *the environment. This approach temporarily produces* unfavourable conditions for vector propagation and therefore needs to be repeated.
- ***Modify or manipulate human habitation or behavior****. This approach* aims to reduce contact between humans and vectors (WHO, 1982).

"It was estimated that 42% (30—53%) of the global malaria burden, or half a million deaths annually, could be prevented by environmental management, although the fraction amenable to environmental management varied slightly, depending on the region"

http://www.who.int/quantifying_ehimpact

INTESTINAL NEMATODE INFECTIONS

Ascariasis, trichuriasis and hookworm disease are all transmitted via soil and other media that are contaminated with excreta containing infective eggs or larvae.

These nematode infections can therefore be considered essentially 100% attributable to the environment, and they occur because of a lack of excreta management and inadequate hygienic practices.

CANCERS

"Malignant neoplasms at several sites of the body have been associated with exposures to occupational and environmental risk factors. Although cancers from environmental causes cannot be distinguished from cancers from other causes, as for many other diseases, the contributions of environmental causes have been highlighted by analyzing differences in cancer incidences by geography and over time, and by studying cancer rates in migrant populations"

"The effects of occupational carcinogens have been particularly well documented, with 28 agents considered to be definite, 27 agents probable, and 113 agents possible occupational carcinogens" http://www.who.int/quantifying_ehimpact

Lung and stomach cancers:

"It was estimated that environmental factors account for 31% of the global disease burden of lung cancer and 30% (6—55%) of the disease burden in developed countries, for both men and women. In developing countries, the attributable environmental fractions were 33% (6—65%) for men, and 25% (6—37%) for women."

"Lung cancer causes the largest disease burden of all cancers globally, or about 15% of the burden of all cancers. By far the largest risk factor for lung cancer is smoking, at 66%."

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"The second most important neoplasm in terms of disease burden is stomach cancer, particularly in developing countries. Stomach cancer is associated with *Helicobacter pyloris infection, which is relatively common* in developing countries, and transmission may be facilitated by poor sanitation and crowding." http://www.who.int/quantifying_ehimpact

NEUROPSYCHIATRIC DISORDERS

"This large group of diseases includes disorders such as **Alzheimer** and other dementias, **bipolar** affective disorders, **Parkinson** disease, **schizophrenia**, **epilepsy**, **alcohol use** and **drug use** disorder, **multiple sclerosis**, **insomnia**, **migraine**, **panic disorder**, **post-traumatic stress disorder**, and **lead-induced mild mental retardation**. Of all the neuropsychiatric disorders, unipolar depressive disorder causes the largest disease burden. Many of these conditions have a small-to-moderate link to the environment or occupation."

Depression has been linked to occupational stress, insomnia to noise exposure and, more recently, conditions such as Parkinson disease have been linked to exposure to chemicals

" Drug use and alcohol disorder have been linked to the occupational environment, such as coca growing, or working in the entertainment or alcohol industry"

"Post-traumatic stress disorders have been linked to disasters such as floods, earthquakes and fires, which could be partly prevented by environmental measures."

Chemical Pollution of Land, Air, and Water

AIR Pollutants History:

Cleaner air is legacy left by Donora's killer 1948 smog
Pittsburgh Post Gazette
Thursday, October 29, 1998

By David Templeton, Post-Gazette Staff Writer

This is what Donora looked like at noon on Oct. 29, 1948, as a deadly smog created by a temperature inversion and industrial plant emissions enveloped the town.

Until October 1948, smoke belching from industrial plants in **Donora** and elsewhere was considered little more than a daily nuisance. Yes, it turned yards and hillsides barren. For sure, it sometimes made driving difficult. And, certainly, homeowners often had to repaint their houses to counteract the corrosive smoke.

But considering that U.S. Steel Corp.'s Donora Zinc Works and its American Steel & Wire plant employed thousands, Mon Valley residents were willing to live immersed in the billowing yellow smoke.

"It's like today, with pollution from cars," said Bill Schempp, an 81-year-old resident of the Washington County town. "That's the way it was here. It was a normal way of life."

Until this day 50 years ago, when thick smog created from a temperature inversion and factory smoke blotted out Donora. Over several days, it killed 20 people and sickened 6,000 in one of America's greatest environmental disasters.

Blinding smog opened people's eyes to the mortal dangers of air pollution. It gave rise to local, regional, state and national laws to reduce and control factory smoke and culminated with the nation's Clean Air Act of 1970.

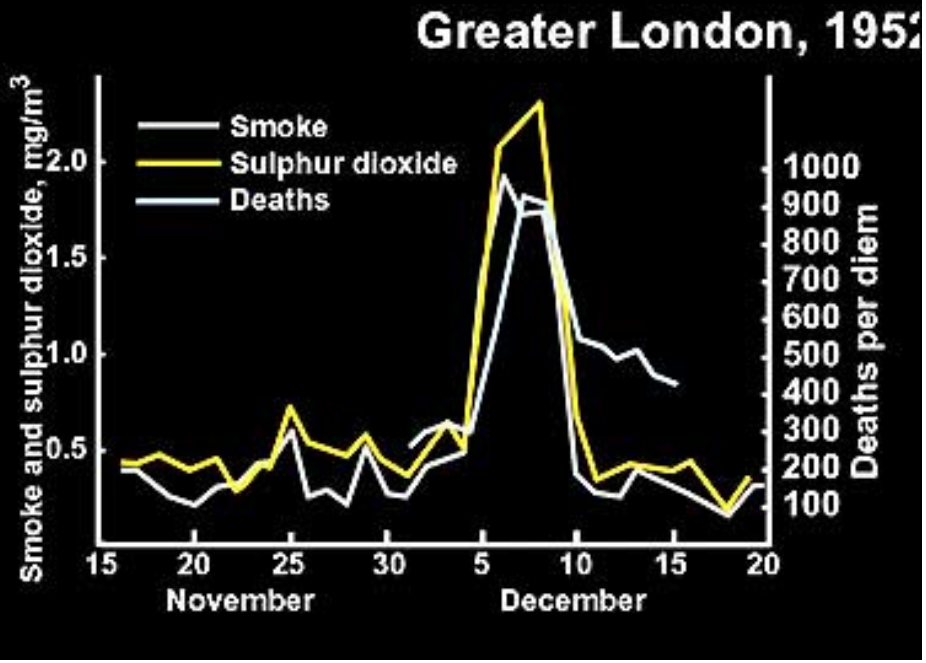
http://www.npr.org/templates/story/story.php?storyId=873954

NPR

December 11, 2002

Fifty years ago this month, **a toxic mix of dense fog and sooty black coal smoke killed thousands of Londoners in four days.** It remains the deadliest environmental episode in recorded history.

The so-called killer fog is not an especially well-remembered event, even though it changed the way the world looks at pollution. Before the incident, people in cities tended to accept pollution as a part of life. Afterward, more and more, they fought to limit the poisonous side effects of the industrial age.



Criteria Air Pollutants

- The Environmental Protection Agency - EPA - uses **six** "criteria pollutants" as indicators of air quality
- EPA established for each of them a maximum concentration above which adverse effects on human health may occur.

css.snre.umich.edu

"EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels."
http://www.epa.gov/oaqps001/urbanair/

Criteria air pollutants…..contd

- Nitrogen Dioxide: NO_2
  - brownish gas irritates the respiratory system originates from combustion (N_2 in air is oxidized); NOx sum of NO, NO_2, other oxides of N
- Ozone: ground level O_3
  - primary constituent of urban smog
  - reaction of VOC + NOx in presence of heat +sun light
- Carbon monoxide: CO
  - reduces bloods ability to carry O_2
  - product of incomplete combustion

- Lead: Pb
  - causes learning disabilities in children , toxic to liver, kidney, blood forming organs
  - tetraethyl lead – anti knock agent in gasoline
    - leaded gasoline has been phased out
- Particulate Matter: PM10 (PM 2.5)*
  - respiratory disorders
- **Sulfur Dioxide: SO_2**
  - formed when fuel (coal, oil) containing S is burned and metal smelting
  - precursor to acid rain along with NOx

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*PM2.5 describes the "fine" particles that are less than or equal to 2.5 µm in diameter. PM10 refers to all particles less than or equal to 10 µm in diameter (about one-seventh the diameter of a human hair).
http://www.epa.gov

US History: Cuyahoga River Fire, June 22, 1969

"Some River! Chocolate-brown, oily, bubbling with subsurface gases, it oozes rather than flows. "Anyone who falls into the Cuyahoga does not drown," Cleveland's citizens joke grimly. "He decays". . . The Federal Water Pollution Control Administration dryly notes: "The lower Cuyahoga has no visible signs of life, not even low forms such as leeches and sludge worms that usually thrive on wastes." It is also -- literally -- a fire hazard."

Water pollution

- Organic sewage
- Eutrophication
- Infectious agents
- Organic chemicals
- Inorganic and miscellaneous chemicals
- Sediments from land corrosion
- Radioactive substances
- Waste heat from power plants and industry

eaglenet.lambuth.edu

Land pollution

- Pesticides – chemicals used to kill insects defined as pests.
- Herbicides – chemicals used to kill plant life, particularly weeds.
- Chemical wastes
- Radioactive fallout
- Acid rain
- Garbage

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US History: Love Canal

"NIAGARA FALLS, N.Y.--Twenty five years after the Hooker Chemical Company stopped using the Love Canal here as an industrial dump, 82 different compounds, 11 of them suspected carcinogens, have been percolating upward through the soil, their drum containers rotting and leaching their contents into the backyards and basements of 100 homes and a public school built on the banks of the canal."

Hooker Chemical sold this site to the Niagara Falls School Board for $1 on April 28, 1953

Greenhouse Gases

Carbon Dioxide
Deforestation Emissions
Methane
Chlorofluorocarbons

Carbon Dioxide

"Emissions from the combustion of fossil fuels account for about 65% of the carbon dioxide added to the atmosphere. The remaining 35% is derived from deforestation and the conversion of prairie, woodland, and forested ecosystems primarily into less productive agricultural systems. Natural ecosystems can store 20 to 100 times more carbon dioxide per unit area than agricultural systems. Both deforestation and natural land-use change reduce the amount of standing plant mass or biomass found on the Earth's surface. This reduction causes a net export of carbon stored in biomass into the atmosphere through decomposition and burning." http://www.eoearth.org

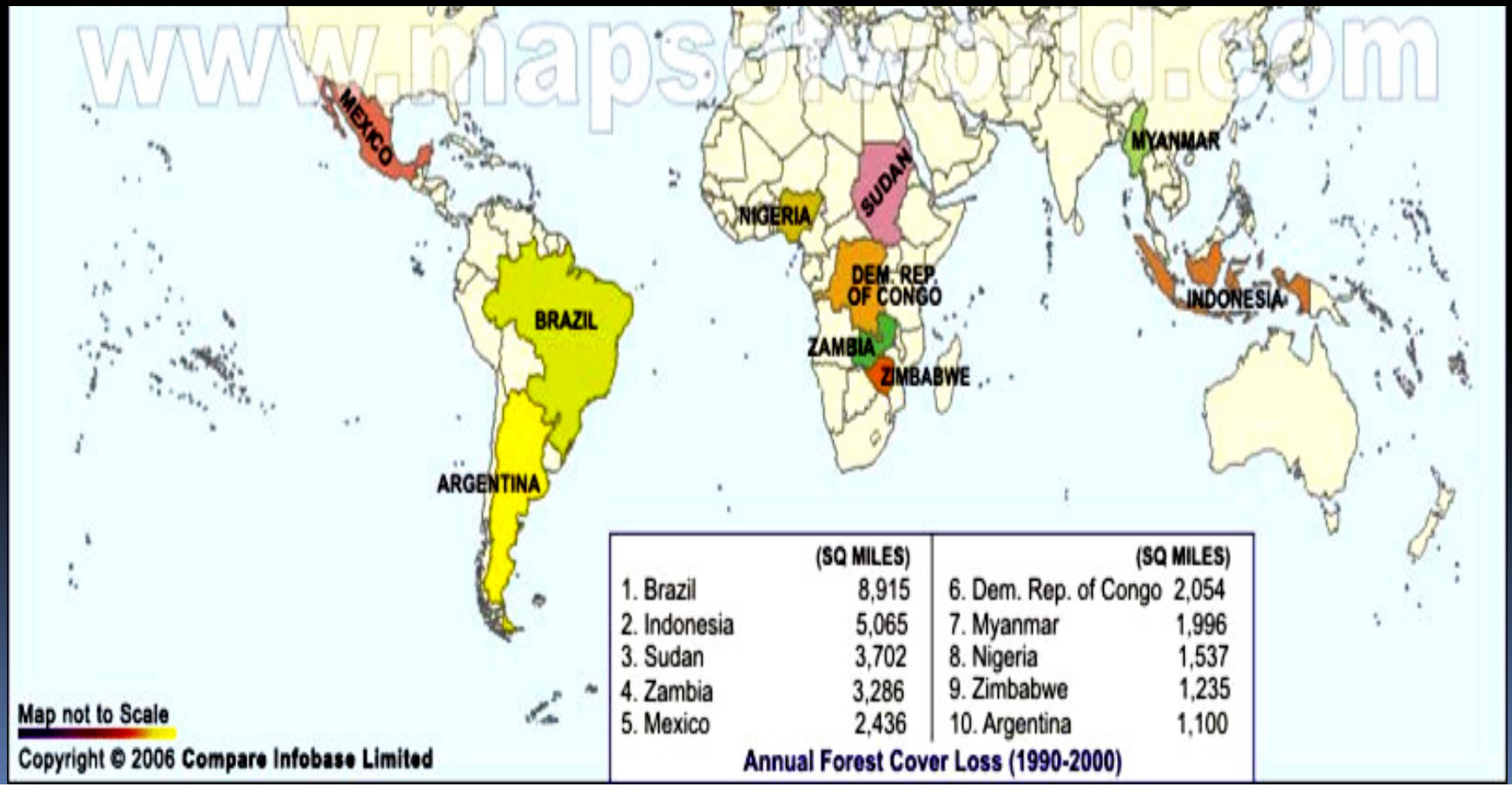
Top 5 emitters 2008

	Country	Total Emissions (Million Metric Tons of CO_2)	Per Capita Emissions (Tons/Capita)
1.	China	6534	4.91
2.	United States	5833	19.18
3.	Russia	1729	12.29
4.	India	1495	1.31
5.	Japan	1214	9.54

http://www.ucsusa.org

Deforestation Emissions

"Deforestation includes tree removal, charcoal production, slash-and-burn practises and forest degradation. In total, these activities contribute approximately 25% of the carbon added to the atmosphere, largely as carbon dioxide (Figure 3). Deforestation and land-use change can have a double impact on greenhouse gas fluxes: carbon is released when forests are burned or logged, and the land-based 'sink' of carbon dioxide (the long term uptake and storage of carbon by plants and soils) is reduced when forest is replaced by cropland or rangeland."
http://www.eoearth.org



	(SQ MILES)		(SQ MILES)
1. Brazil	8,915	6. Dem. Rep. of Congo	2,054
2. Indonesia	5,065	7. Myanmar	1,996
3. Sudan	3,702	8. Nigeria	1,537
4. Zambia	3,286	9. Zimbabwe	1,235
5. Mexico	2,436	10. Argentina	1,100

Annual Forest Cover Loss (1990-2000)

Methane

The primary sources for the additional methane added to the atmosphere are rice cultivation, domestic grazing animals, deep seabed frozen methane clathrate thawing, termites, landfill out-gassing, oil and gas extraction, and coal mining.
http://www.eoearth.org

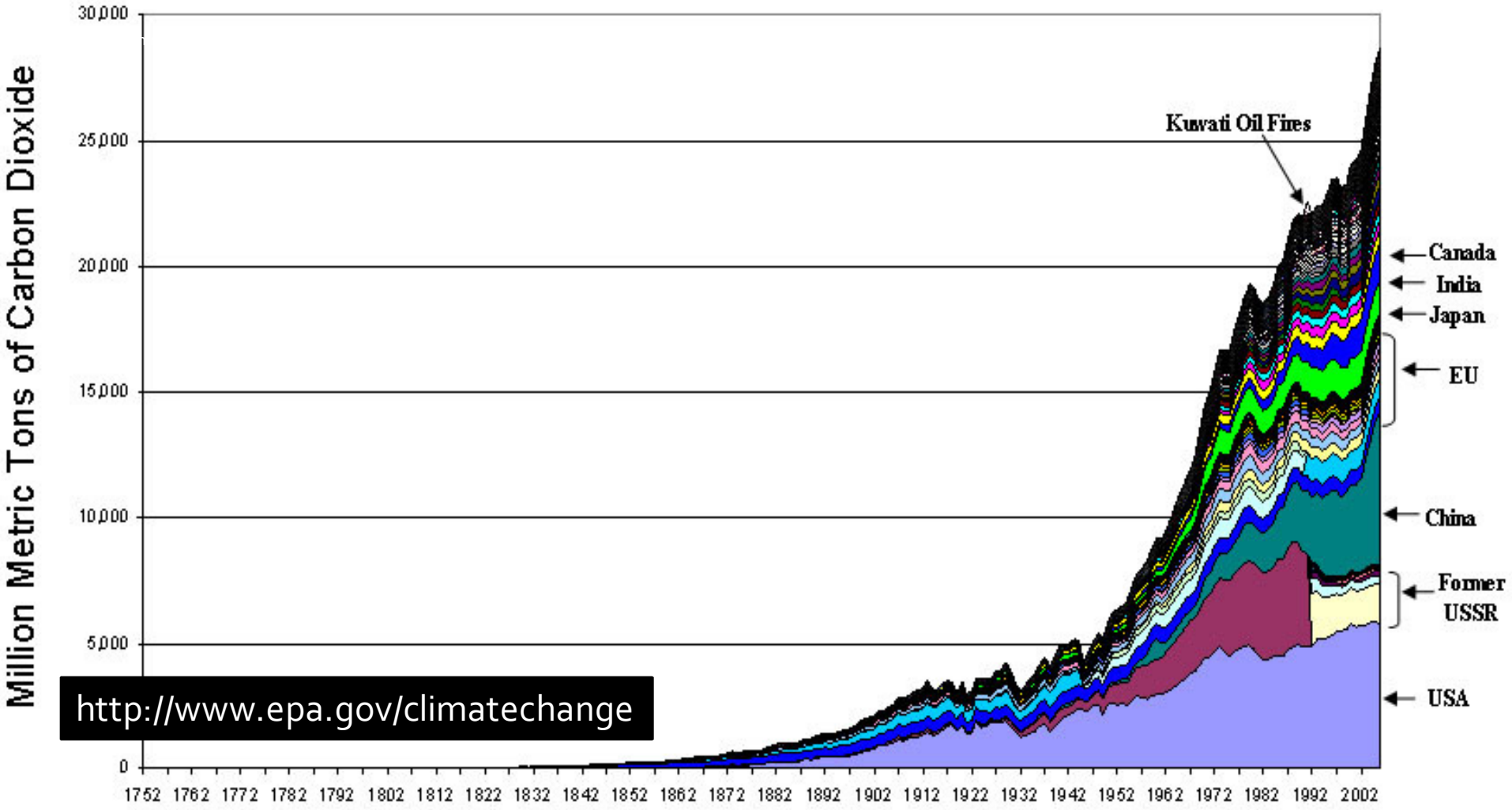
Which countries emit the most methane?

China, India, the United States, Brazil, Russia, Mexico, Ukraine, and Australia are estimated to be responsible for almost half of all anthropogenic methane emissions. The major methane emission sources for these countries vary greatly. For example, a key source of methane emissions in China is coal production, whereas Russia emits most of its methane from natural gas and oil systems. Landfills are the largest source of U.S. methane emissions.
http://www.epa.gov/globalmethane

Chlorofluorocarbons

"Chlorofluorocarbons are human-made chemicals that are highly persistent in the Earth's atmosphere. They are typically thousands of times more potent as greenhouse gases than carbon dioxide. While reductions in their use have been underway in Western Nations for over twenty years, the chemicals are growing in use in developing countries and other nations such as China and Brazil. The Montreal Protocol, the international agreement that phases out ozone-depleting substances, requires the end of chlorodifluoromethane production by 2020 in developed countries and 2030 in developing countries."
http://www.eoearth.org

Global Greenhouse Gas Data: Atmospheric concentrations of greenhouse gases are affected by the total amount of greenhouse gases emitted to and removed from the atmosphere around the world over time.



http://www.epa.gov/climatechange

Figure 3: Total Greenhouse Gas Emissions by Region