

Geography of Health

What is the geography of health?

The **geography of health**, sometimes called **medical geography**, uses the tools and approaches of geography to tackle health-related questions.

Geographers focus on the importance of variations across space, with an emphasis on concepts such as location, direction, and place.



Photo by Helen Hazen

In thinking spatially, geographers distinguish between **space**, which is concerned with locating where things are, and **place**, which refers to the cultural meaning of a particular setting. Both these aspects of geography inform health geographers' work.

Spatial questions consider how and why things are distributed or connected in the way they are.

Questions related to place consider how cultural constructions of a place influence the people who live there.

What is the geography of health?

Some questions posed by a health geographer could include:

How does a particular environment influence health?

How does human activity affect health in different locations?

How does disease spread across space?

How do people's interactions with and feelings about a particular place influence their health?



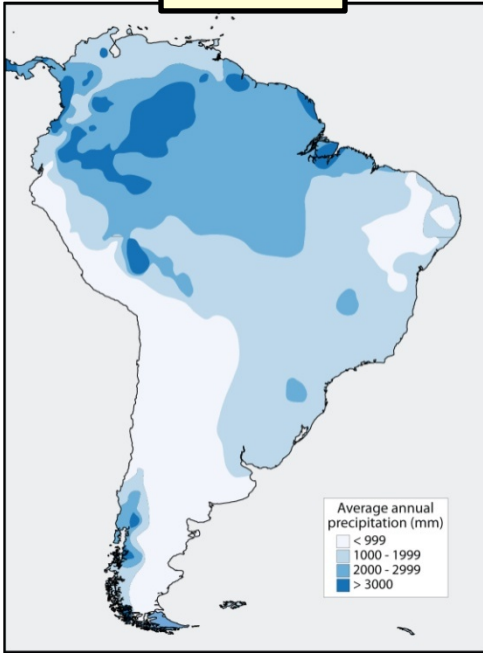
Which of these three factors seems to be the most closely related to malaria?

Beyond these physical factors, what else might help explain the distribution of malaria?

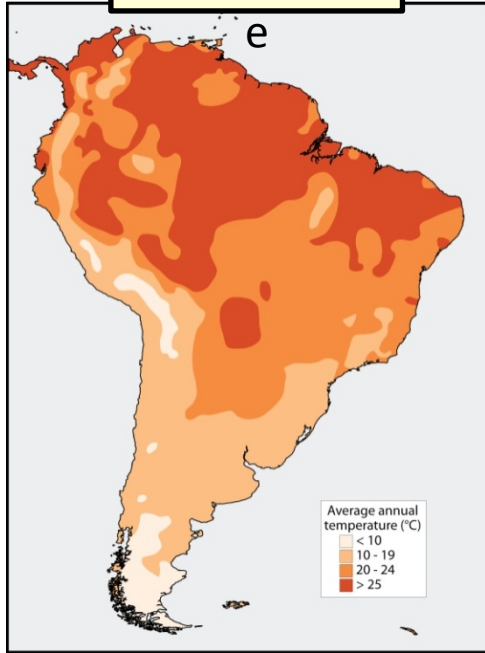
Elevation



Rainfall



Temperatur



Approaches to Health Geography

Traditionally, health geographers have referred to their sub-discipline as “**medical geography**.” Recently, a group of critical scholars has argued that this term emphasizes biomedical approaches to health over others. Today, many health geographers use the term “**health geography**” for their sub-discipline, in recognition of its emphasis on social as well as biomedical aspects of health.



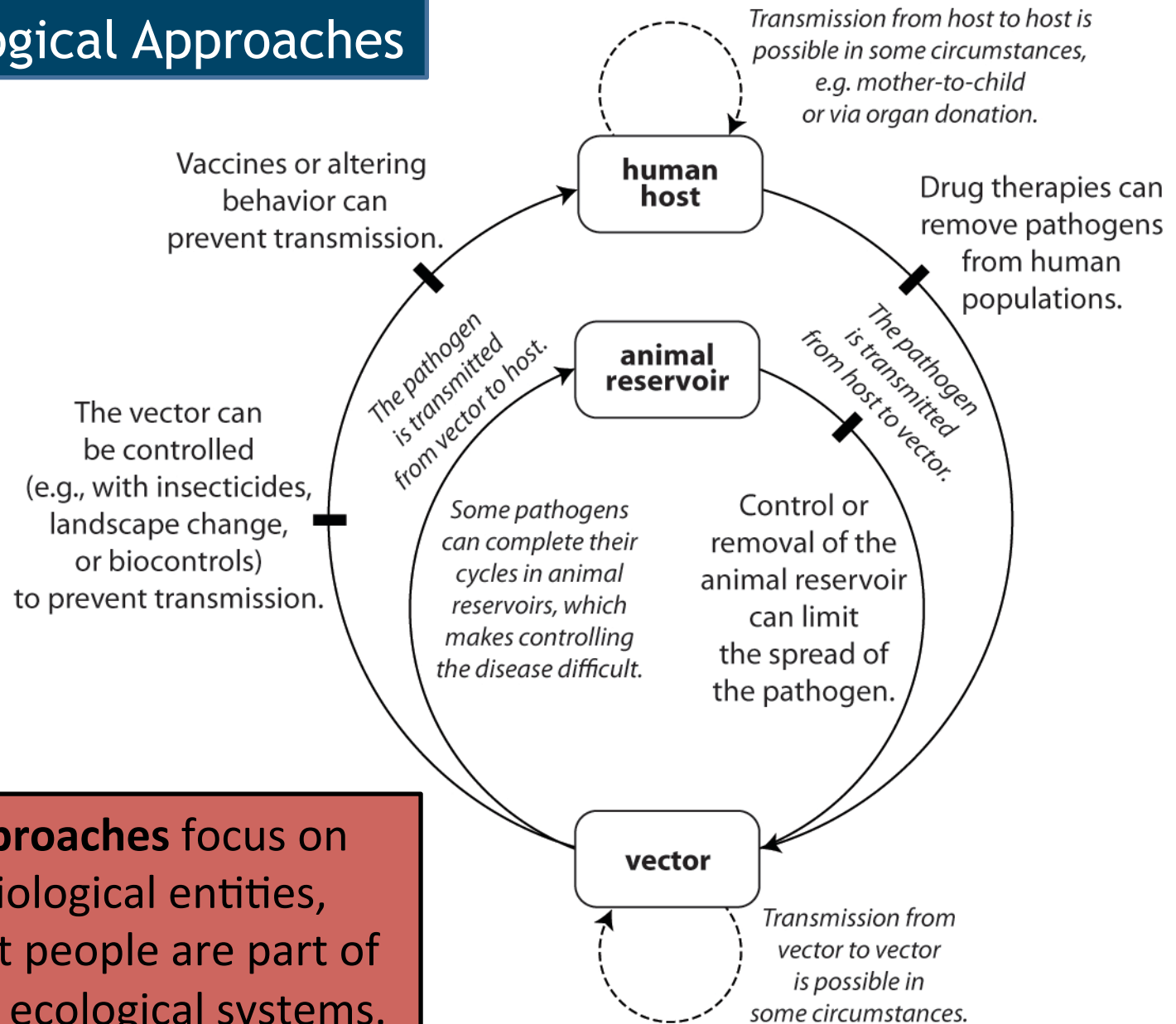
These doctors are conducting research at the Enteric Bacteriology Unit at the Communicable Disease Center (now known as the Centers for Disease Control).

Source: Centers for Disease Control (1980)

We can recognize three broad approaches to studying the geography of health:

- 1) ecological approaches**
- 2) social approaches**
- 3) spatial approaches**

Ecological Approaches



Ecological approaches focus on humans as biological entities, recognizing that people are part of interdependent ecological systems.

Social Approaches



Social approaches consider the ways in which human health and well-being are influenced by social, rather than biological, factors.

Photo by Peter Anthamatten

Spatial Approaches

Spatial-analytical techniques explicitly investigate the importance of spatial attributes such as location and connectivity.



Photo by Peter Anthamatten

Environmental Exposures



Image Source: CDC, Jenkins, B., and NIOSH (1946); photo by Roy Perry

Non-living Agents of Disease

Geogens are non-living agents of disease.

People are exposed to geogens through the air they breathe, the food and water they ingest, and other substances they come into contact with.



Photo by Heike Alberts (2006)

Naturally-occurring Geogens

Although many people think of synthetic (human-made) compounds as most dangerous to health, naturally-occurring substances can also cause health problems.



Photo by Helen Hazen

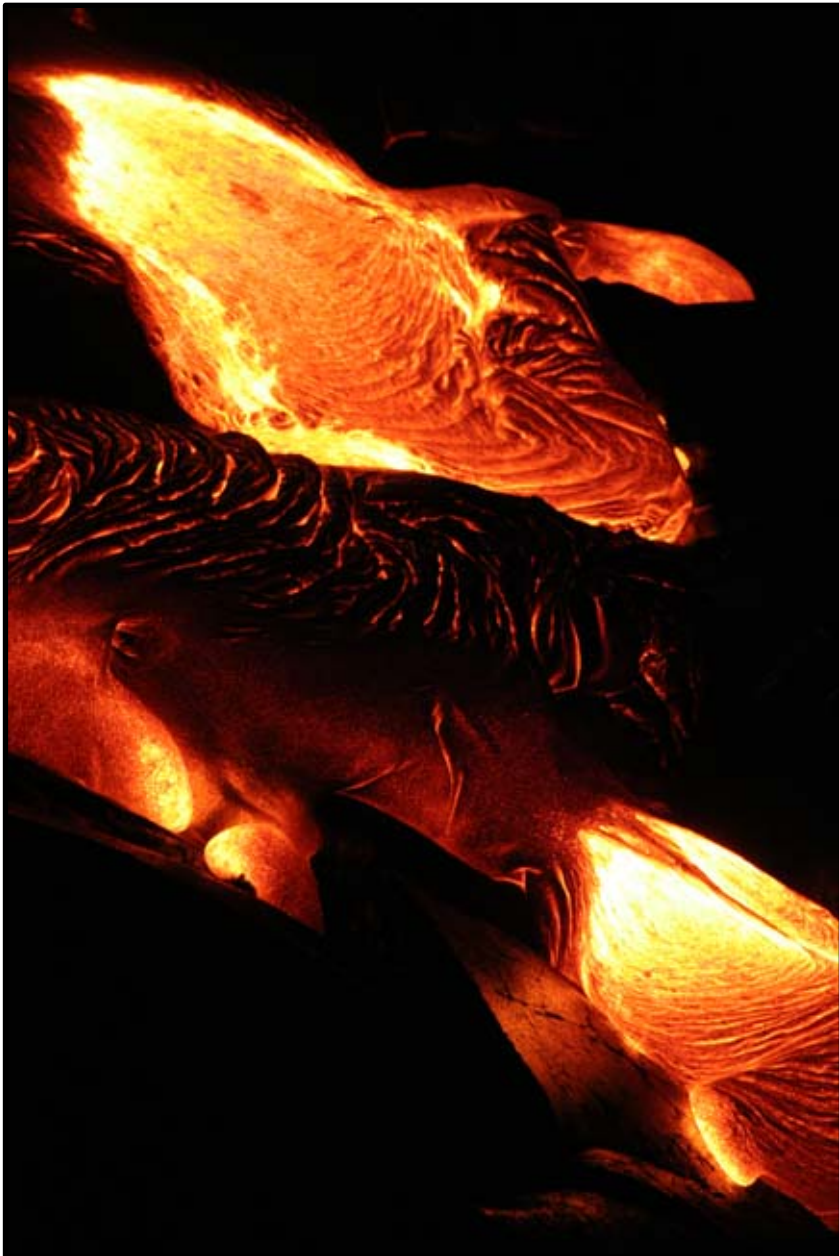


Photo by Helen Hazen

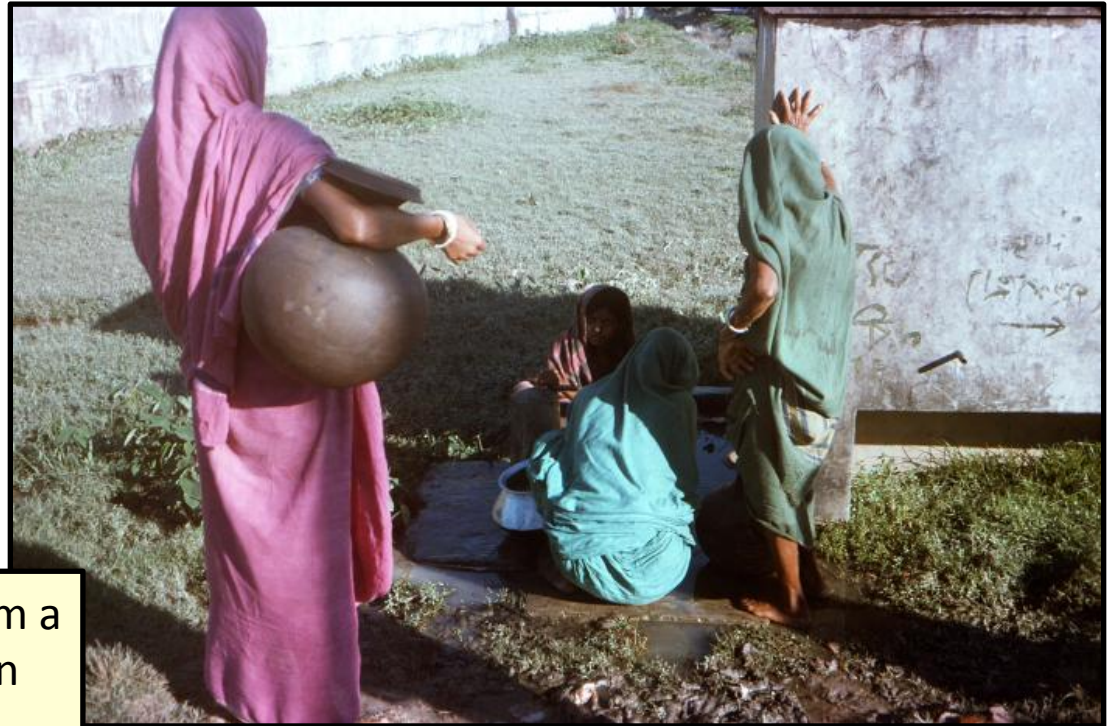
Naturally-occurring geogens include:

- Lead
- Radon
- Smoke from wood fires
- Volcanic gases
- Heavy metals in water

Arsenic in Bangladesh

Naturally-occurring arsenic in groundwater in Bangladesh has caused what is sometimes referred to as the “greatest episode of mass poisoning in history.”

As many as 80 million people are at risk from poisoning (WHO 2001).



Women gathering water from a communal well in southern Bangladesh.

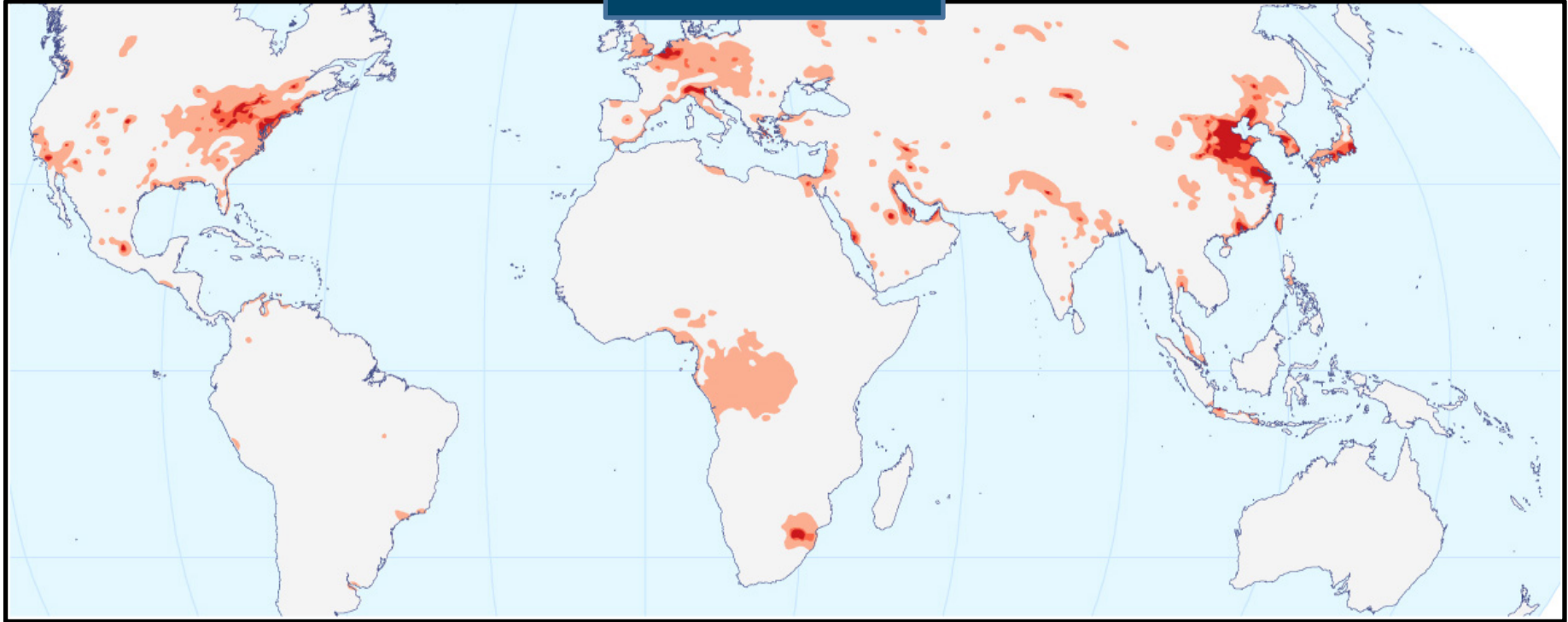
Image Source: CDC / Michael Schwarz, 1975

Pollution

A **pollutant** is a substance that contaminates water, air, or soil because it is found at higher concentrations than would be expected to occur naturally.

Determining the health impacts of pollutants is difficult, but it is clear that pollution contributes significantly to the global health burden.

Air Pollution



Data Source: ESA 2002

This map shows air pollution as measured by satellites in 2002. Darker shades of red represent higher levels of pollution.

Describe the patterns you see on this map.

What factors appear to be associated with high levels of air pollution?

The US Environmental Protection Agency (EPA) has designated six major air pollutants.

Is air pollution a health concern in Lubbock?

What are some of the sources?

Pollutant	Human Health Impacts
Ozone	airway irritation, coughing, aggravated asthma, lung damage
Particulate Matter	respiratory symptoms, decreased lung function, aggravated asthma, bronchitis, heart attacks
Carbon Monoxide	low exposures: chest pain, damaged ability to exercise, vision problems high exposures: reduced ability to learn or work, reduced manual dexterity, death
Nitrogen Oxides	airway inflammation, aggravated asthma
Sulfur Dioxide	breathing difficulty, respiratory illness, cardiovascular illness
Lead	causes damage to nervous system, reduces oxygen-carrying capacity of the blood, high blood pressure, lower IQ (among children)

Acute, or short-term, effects of pollution are usually caused by high levels of exposure. Health effects attributed to short-term exposure include:

- Mortality
- Respiratory and cardiovascular problems
- Days of restricted activity
- Work and school absenteeism
- Acute symptoms (wheezing, coughing, phlegm production, respiratory infections)
- Physiological changes (e.g., lung function)



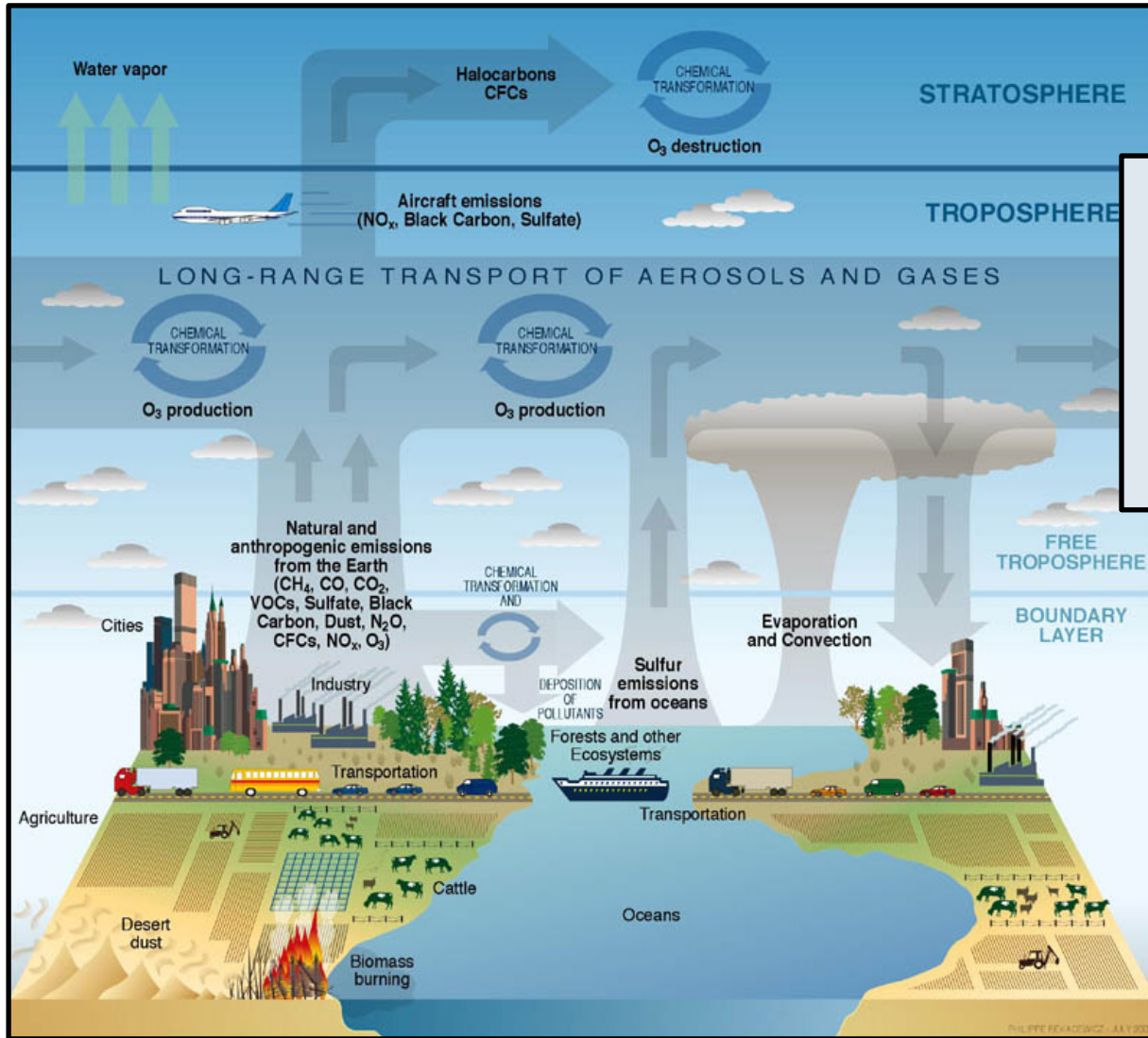
Image Source: Courtesy of the U.S. Department of Energy, National Renewable Energy Laboratory (1995)



Image Source: Courtesy of the U.S. Department of Energy, National Renewable Energy Laboratory and W. Gretz (1995)

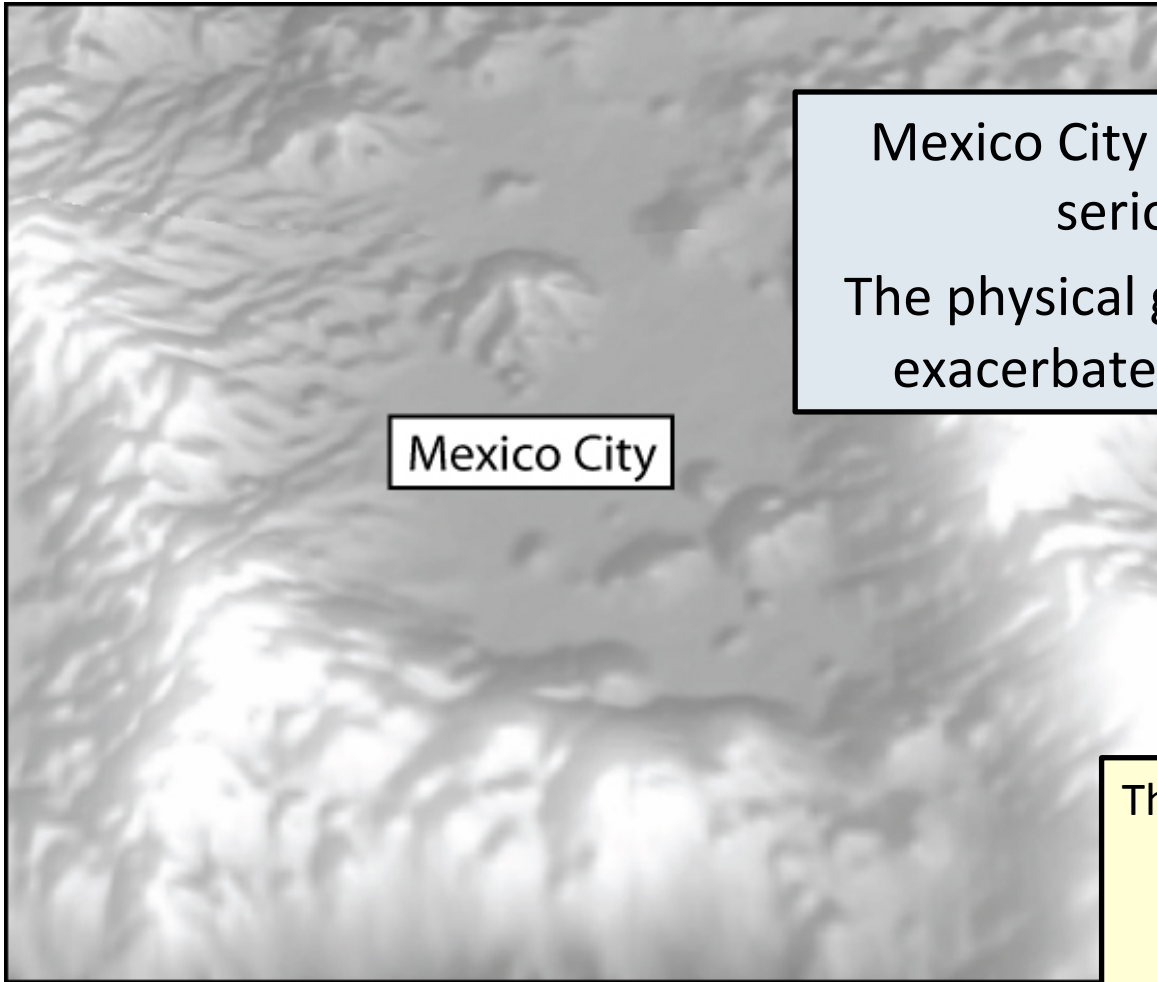
The greatest health impacts of exposure to air pollution are from prolonged exposure. Health effects attributed to long-term exposure include:

- Mortality due to cardiovascular and respiratory disease
- Chronic respiratory disease (e.g., asthma, chronic pathological changes)
- Chronic changes in physiologic functions
- Lung cancer
- Chronic cardiovascular disease
- Intrauterine growth restriction



Patterns of air pollution are tied to the local physical environment, including windflow and precipitation patterns.

Source: Climate Change Science Program and Subcommittee on Global Change Research 2003

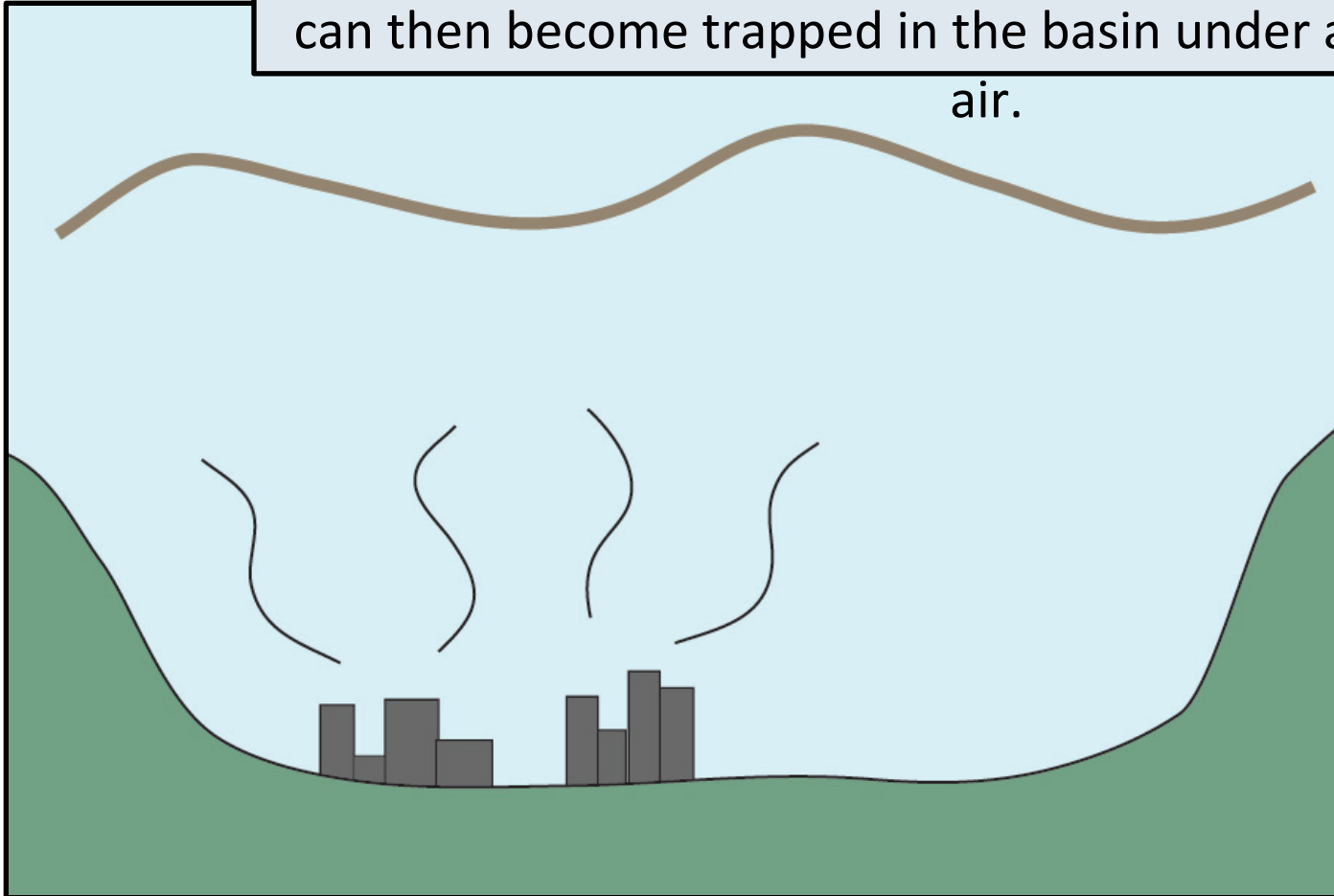


Mexico City

Mexico City experiences particularly serious air pollution.
The physical geography of Mexico City exacerbates its pollution problem.

This map shows the topography of Mexico City.
Mexico City is subject to temperature inversions that trap pollution over the city.

Normally, cold air is found at higher elevations than warm air. In basin-shaped formations, the cold air from higher elevations can roll into the bottom of the basin, a temperature inversion. This cold air, and any pollutants in it, can then become trapped in the basin under a layer of warm air.



Water Pollution

Comprising nearly two-thirds of the earth's surface, water is a key resource, sustaining life on earth.

Factors responsible for water quality decline include urban pollution, sewage discharge, municipal landfills, industrial dump sites, and agricultural fertilizers.



Image Source: Courtesy of the U.S. Department of Energy, National Renewable Energy Laboratory and W. Gretz (date unknown)

Solid Waste

The primary route of human exposure to toxins from solid waste is through ingestion. Toxins from waste can leach into food or water supplies that are consumed by humans.



Image Source: NOAA (1993)

Substance	Source	Acute Health Effects	Chronic Health Effects
Polychlorinated biphenyls	used as coolants and lubricants in electrical equipment, fluorescent lights	skin conditions such as acne and rashes	liver damage, immune system damage
Benzene	naturally occurring, vehicle exhaust, production of many synthetic materials	drowsiness, dizziness, headache, tremors, confusion, death	tissue damage, anemia, cancer (especially leukemia)
Cadmium	natural, used in batteries, pigments, metal coatings, and plastic	vomiting and diarrhea	cancer, kidney, lung, and bone damage
Polycyclic aromatic hydrocarbons	combustion of coal, oil, gas, garbage, tobacco; also found in charbroiled meat	skin and tissue damage, weakened immune system	skin and tissue damage, weakened immune system, cancer

Source: ATSDR (2009)

Industrial processes produce thousands of toxic chemicals.
This table shows four common industrial byproducts.

Urban Heat Island

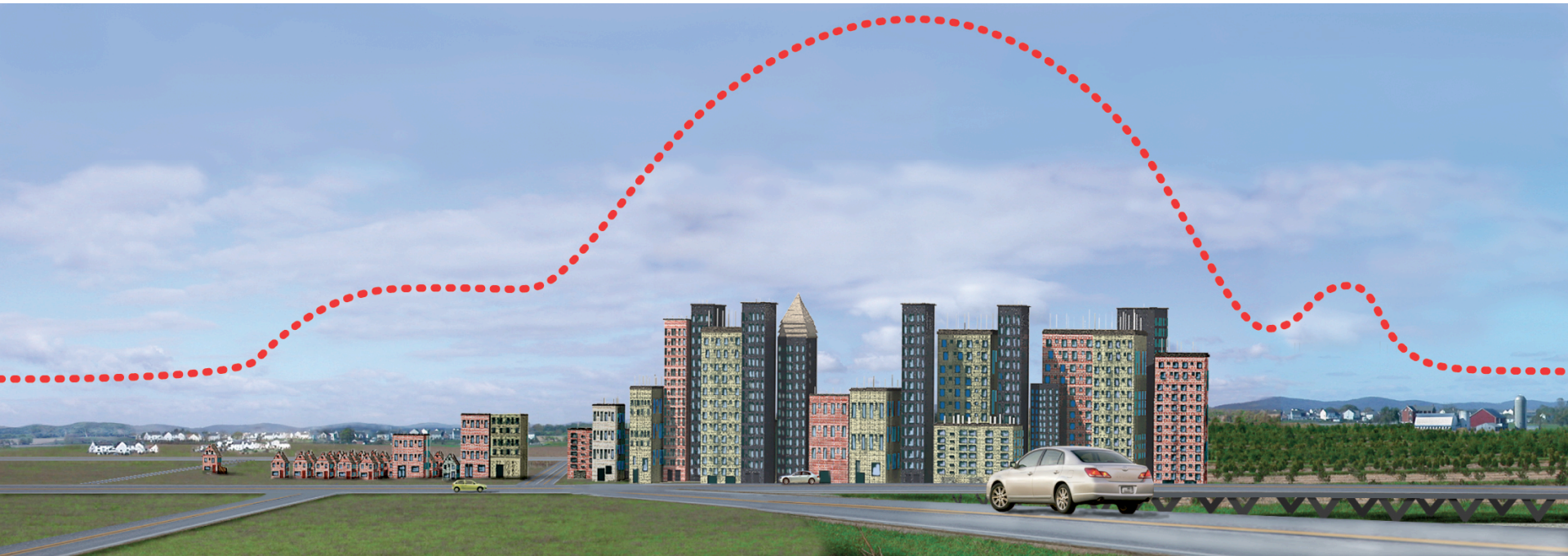
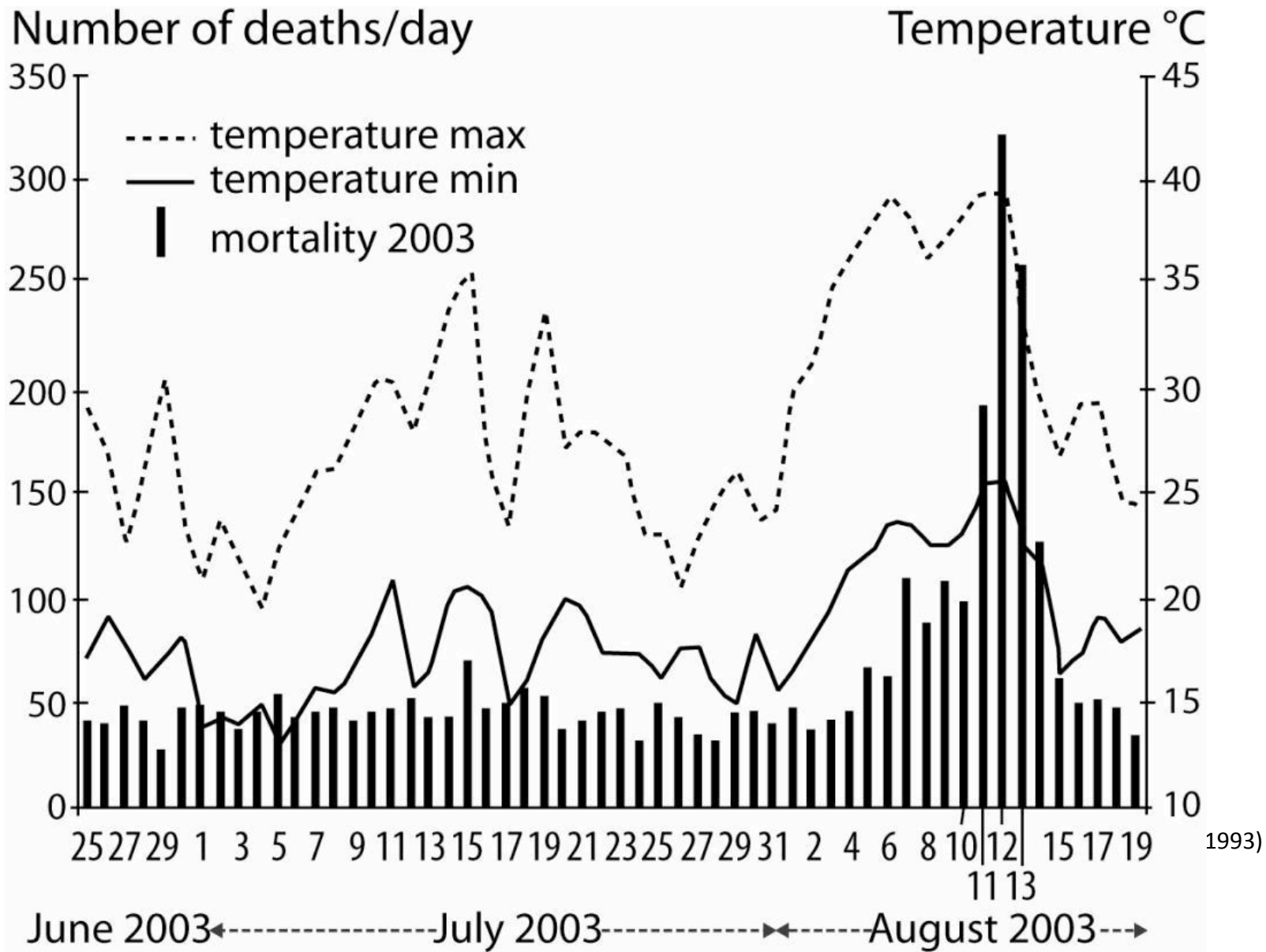


Image Source: NOAA (1993)

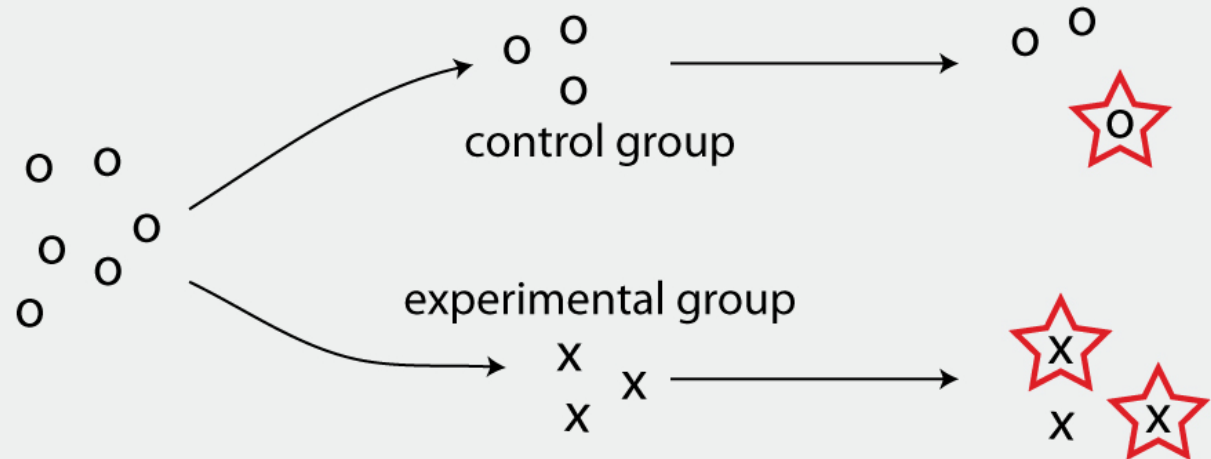
Urban Heat Island



Assessing Environmental Exposure

Much of our knowledge about the relationship between exposures and disease relies on work from the field of **epidemiology**.

Clinical Study



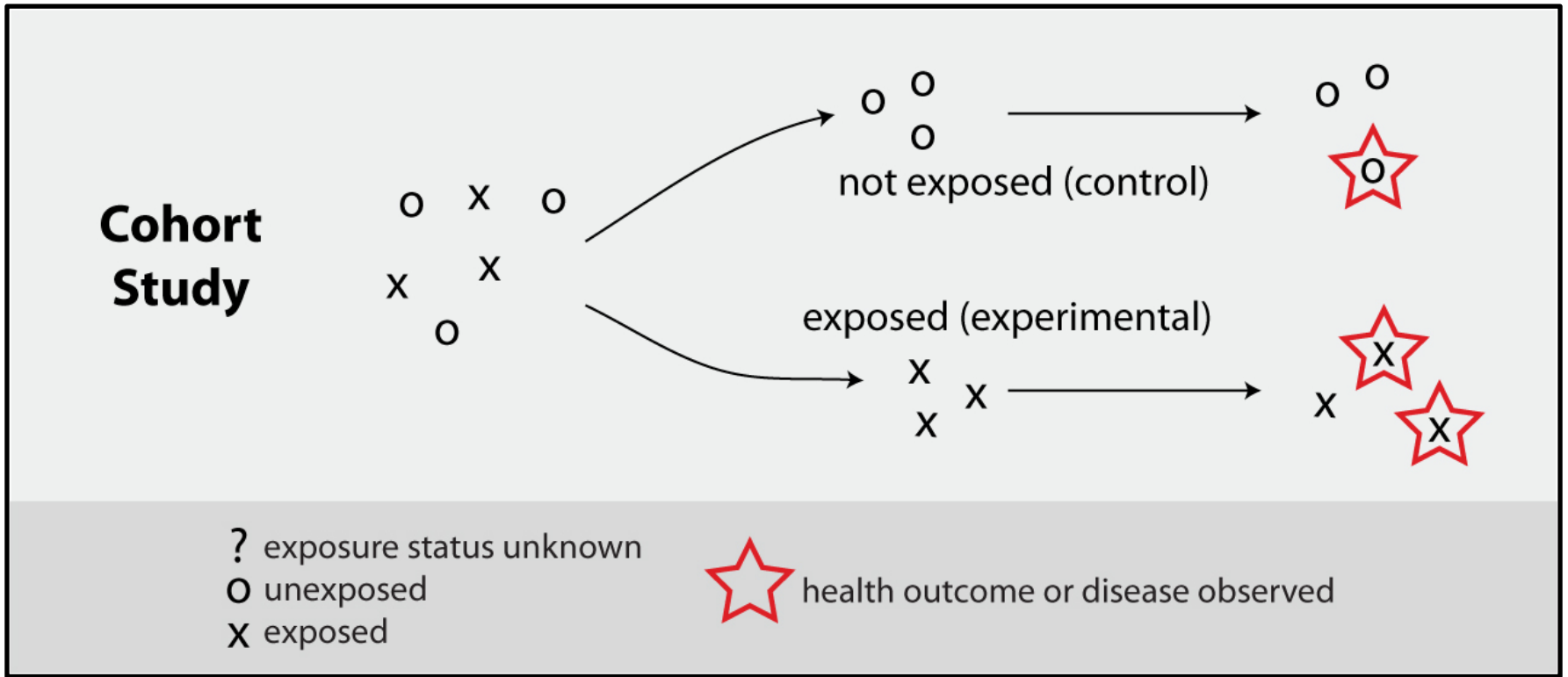
? exposure status unknown
O unexposed
X exposed

★ health outcome or disease observed

Clinical studies duplicate the conditions of a laboratory as closely as possible. After randomly assigning people to two groups, half are exposed to the exposure under study. Systematic differences between the two groups suggest the exposure may have had an effect.

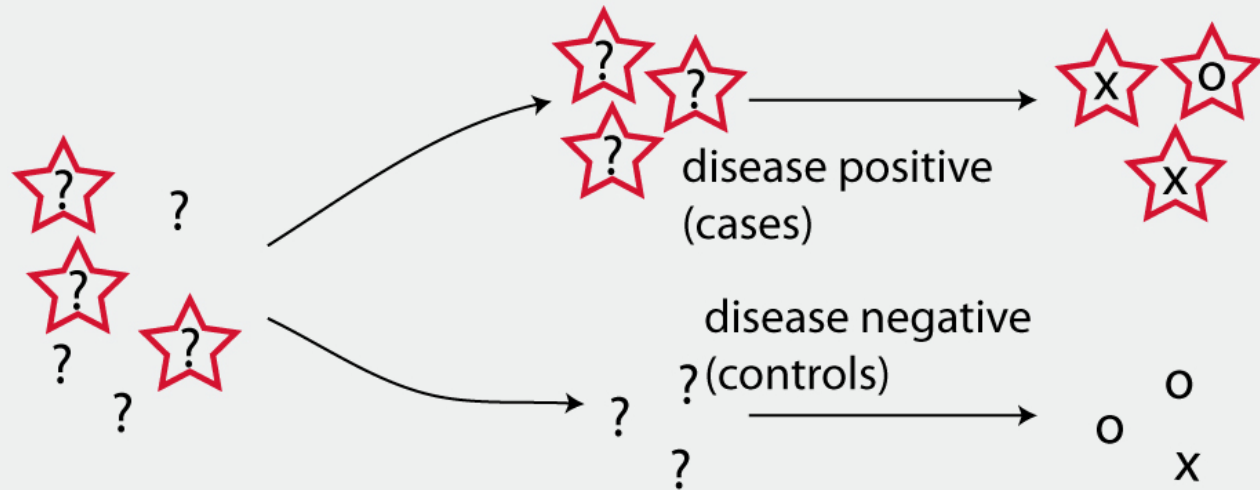
As it is not ethical to actively harm people in the name of science, many exposures cannot be investigated with **experimental studies**.

Consequently, other epidemiologic techniques have been developed to investigate pre-existing exposures. These are known collectively as **observational studies**.



In a **cohort study**, people are divided into groups according to their *exposure* status (such as smokers and non-smokers). The two groups are then followed to see if more of one group experiences a health effect.

Case-Control Study



In a **case–control study**, people are divided according to their *disease* status. The exposure histories of the groups are examined and compared for systematic differences that would suggest that a particular exposure is related to the disease.

Cross-sectional Study



? exposure status unknown
O unexposed
X exposed

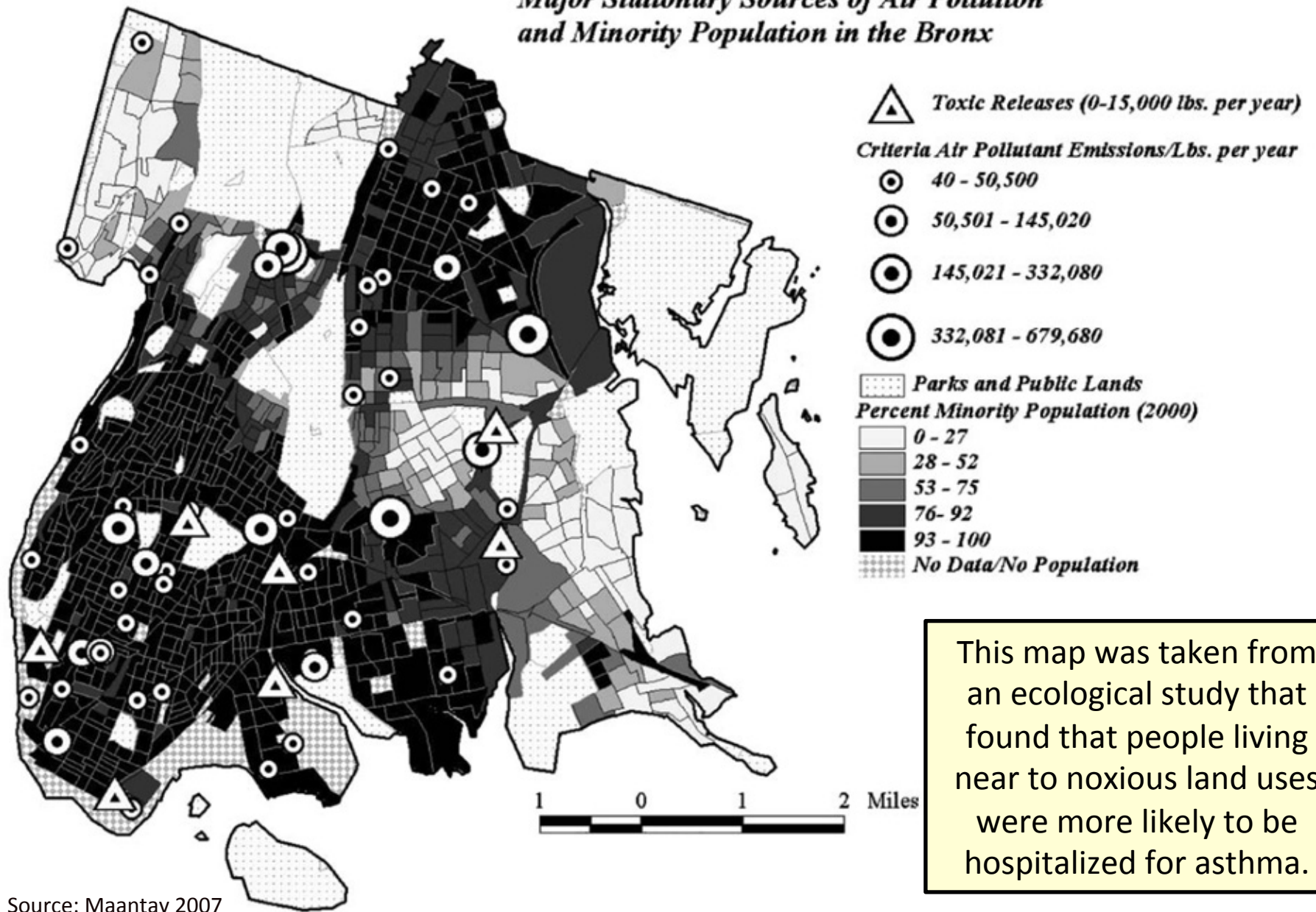
★ health outcome or disease observed

In a **cross-sectional study**, nothing is known initially about either exposure or disease status. People are sampled at a particular point in time and tested to see if there is an association between an exposure and a health outcome.

An **ecological study** uses aggregated data, such as data for a province or country.

An association between an exposure (such as living near a pollution source) and a health outcome (such as asthma) provides some preliminary evidence that the two are related.

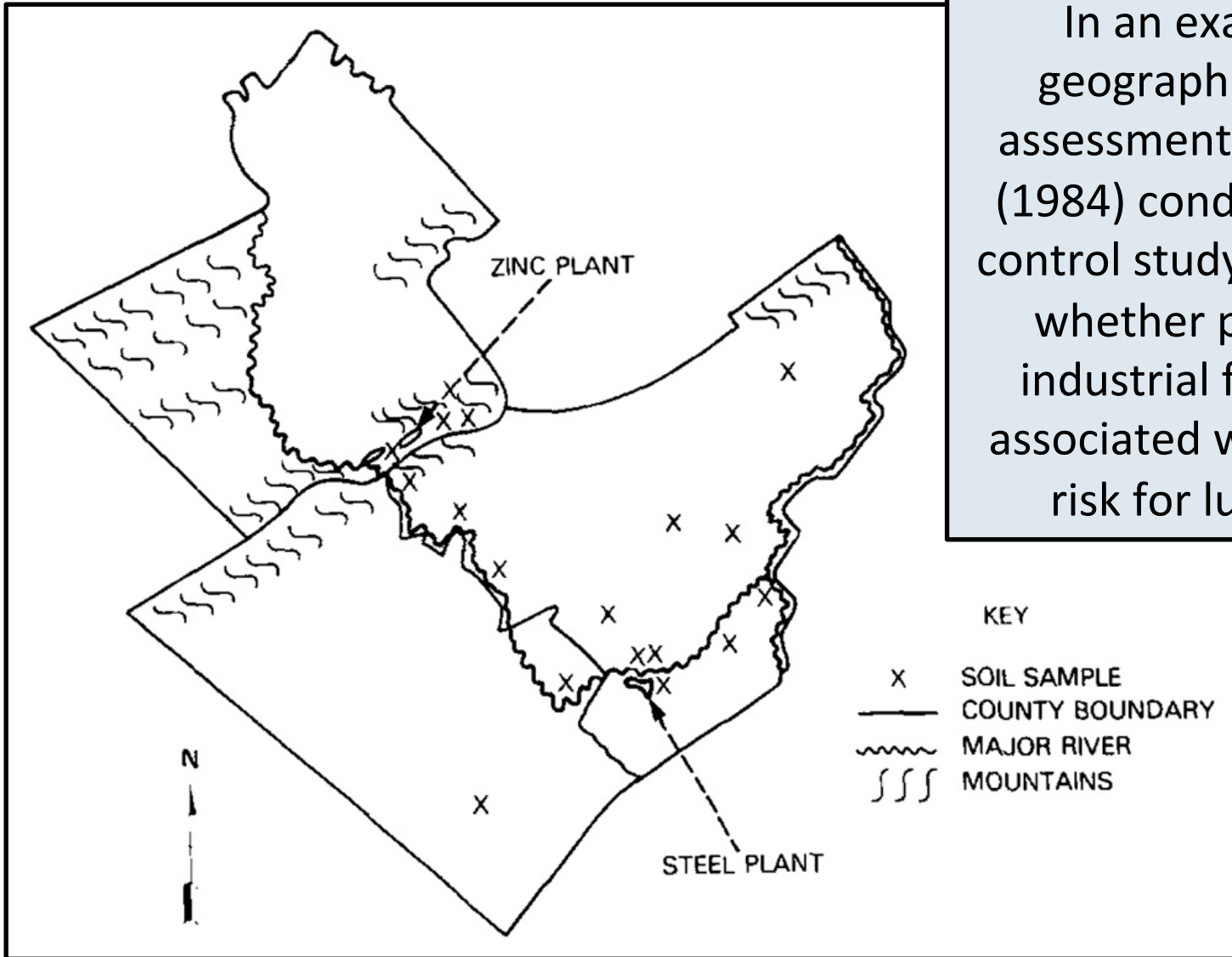
Major Stationary Sources of Air Pollution and Minority Population in the Bronx



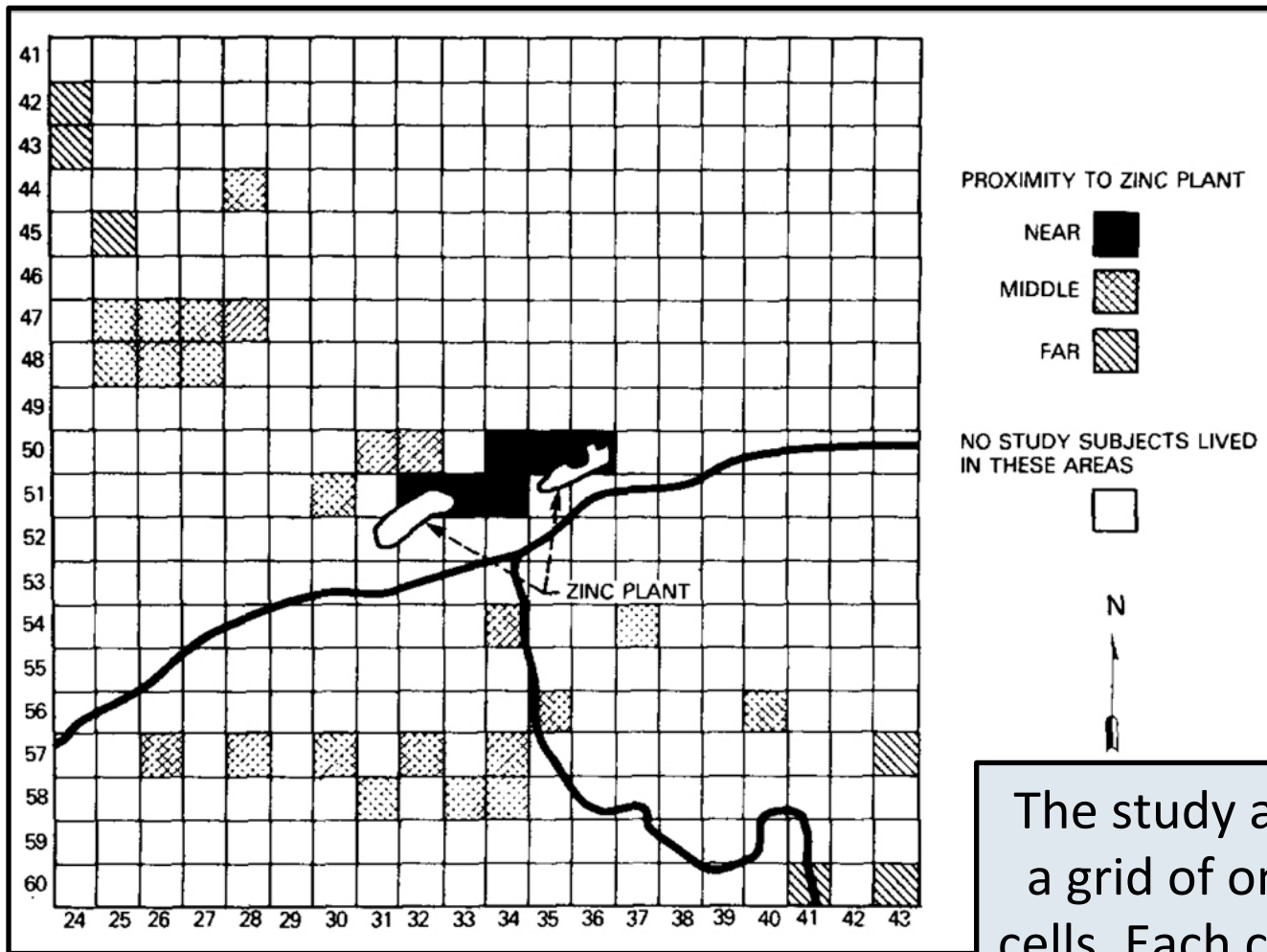
This map was taken from an ecological study that found that people living near to noxious land uses were more likely to be hospitalized for asthma.

Source: Maantay 2007

In an example of a geographic exposure assessment, Brown et al. (1984) conducted a case-control study to determine whether proximity to industrial facilities was associated with increased risk for lung cancer.

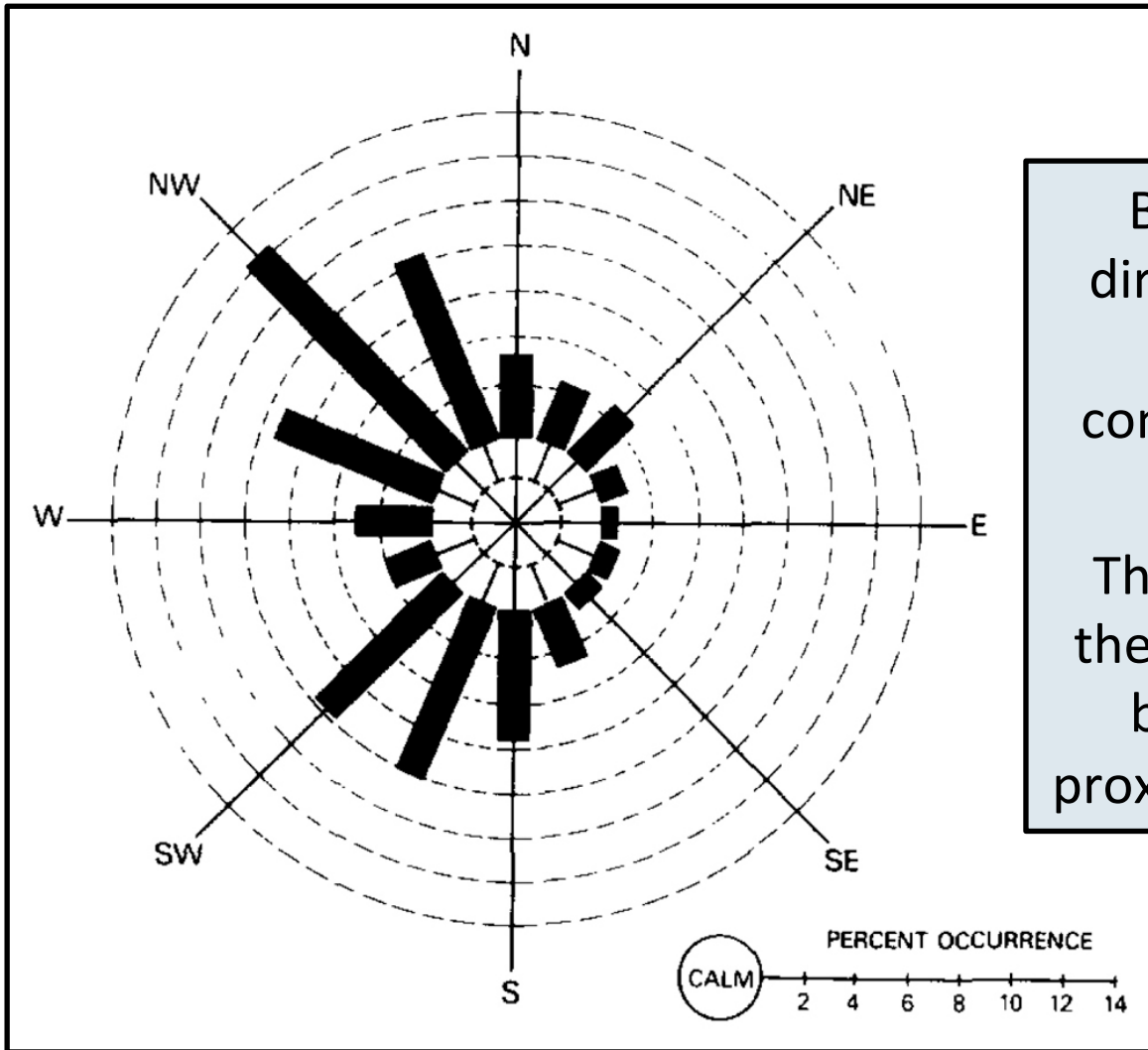


Reprinted from *Environmental Research*, vol. 34, Brown, L, Pottern, L., and W. Blot, "Lung cancer in relation to environmental pollutants emitted from industrial sources", page 251, © 1984, with permission from Elsevier.



The study area was divided into a grid of one-by-one kilometer cells. Each cell was then assigned an exposure value based on proximity to a polluting stack and results from soil samples.

Reprinted from *Environmental Research*, vol. 34, Brown, L, Pottner, L., and W. Blot, "Lung cancer in relation to environmental pollutants emitted from industrial sources", page 251, © 1984, with permission from Elsevier.



Basic information on the direction and speed of wind was also taken into consideration in building the exposure assessments.

The authors concluded that there was a weak association between cancer risk and proximity to industrial sources.

Reprinted from *Environmental Research*, vol. 34, Brown, L, Pottern, L., and W. Blot, "Lung cancer in relation to environmental pollutants emitted from industrial sources", page 251, © 1984, with permission from Elsevier.



Sample of Children and Contour NO_x*SO₂

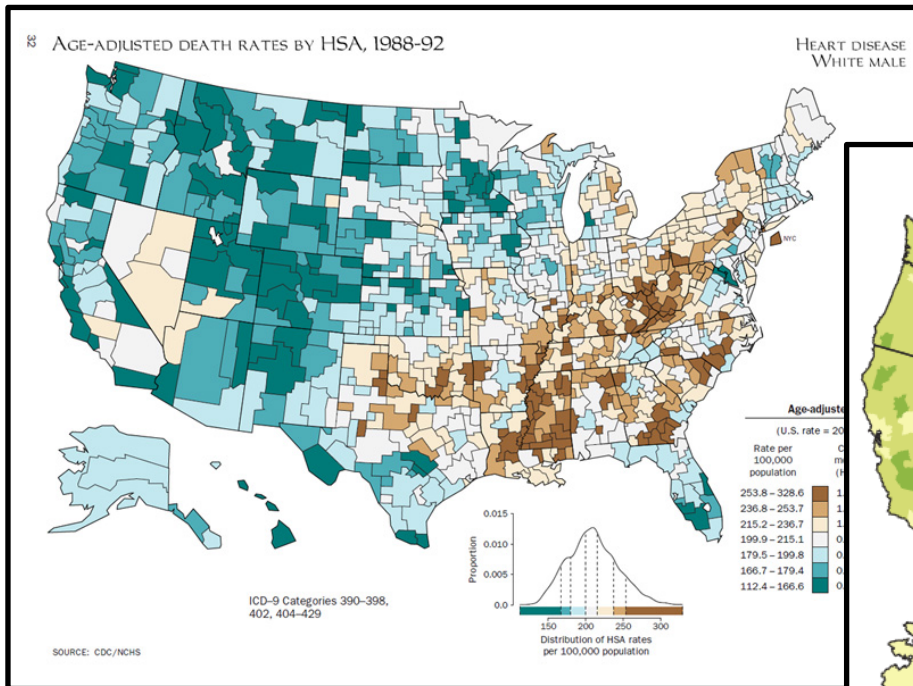
- NO_x* SO₂ Contour
- Sample of Children
- Main Roads
- 🏭 Power Station
- 🌊 Mediterranean Sea
- 📍 Hadera District



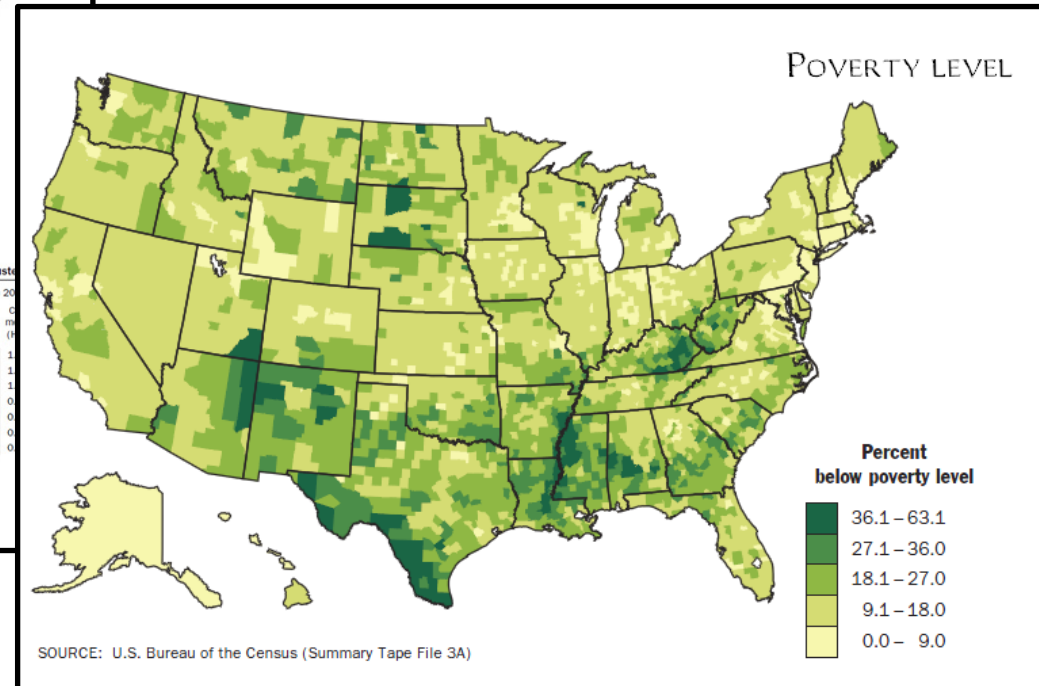
In another study, Dubnov et al. estimated children's exposure to nitrogen oxides and sulfur dioxide in Israel by interpolating measurements from monitoring stations.

Interpolation is a method for producing estimates for locations where no data were collected, based on information collected at other locations

Reprinted from *Environmental Research*, vol. 103, Dubnov, J., Barchana, M., Rishpon, S., Leventhal, A., Segal, I, Carel R., and Portnov, B., "Estimating the effect of air pollution from a coal-fired power station on the development of children's pulmonary function, page 89, © 2007, with permission from Elsevier.

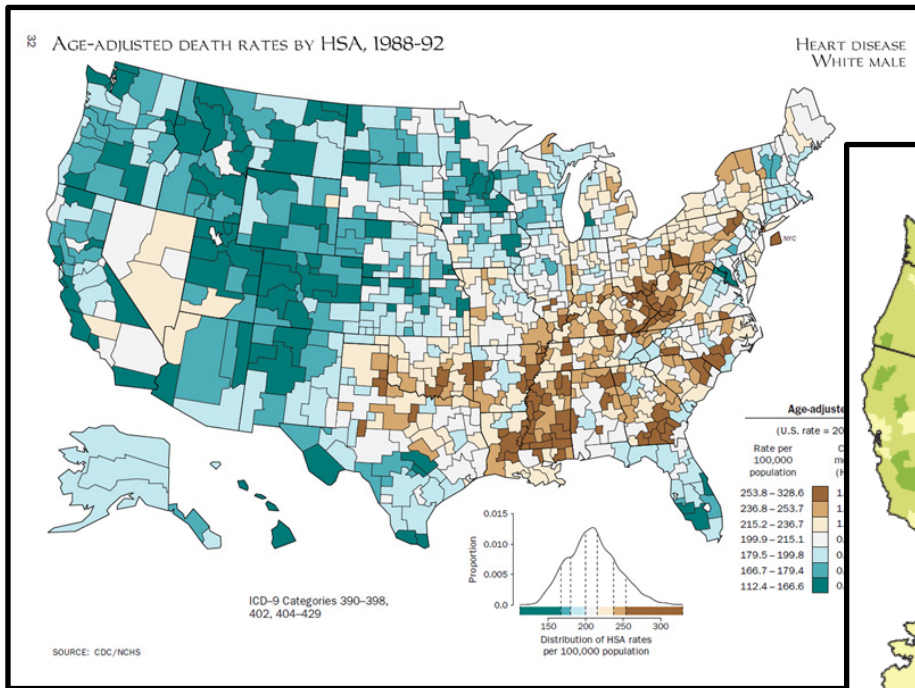


Source: Centers for Disease Control 1997

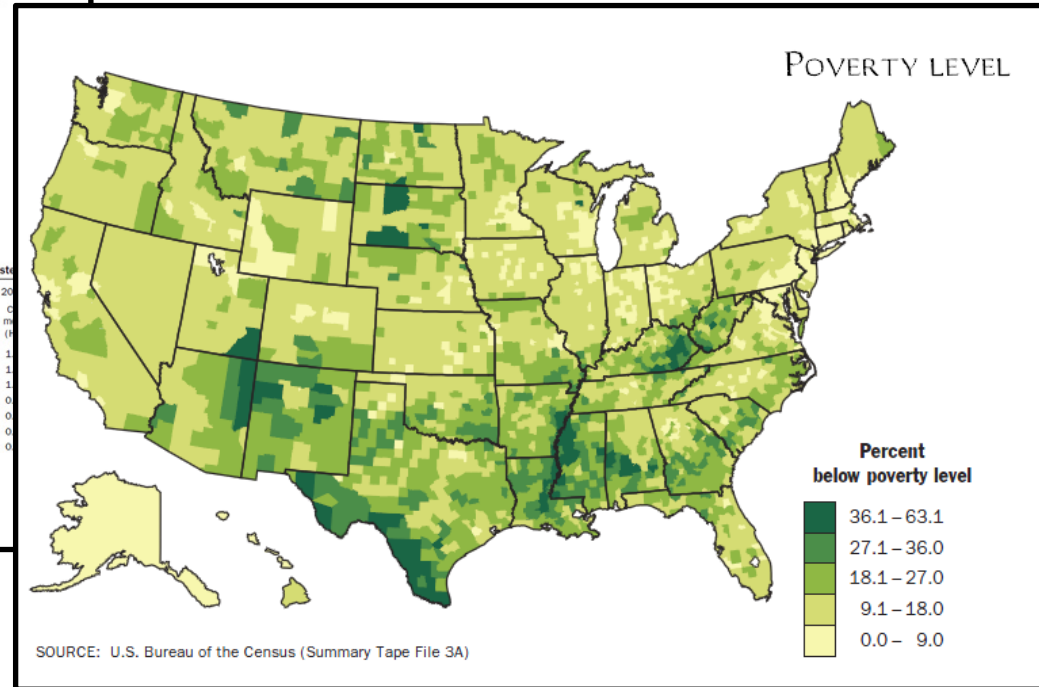


Ecological studies must be interpreted with great care to avoid committing the **ecological fallacy**.

The ecological fallacy is committed when one assumes that an association found at an aggregated scale also applies at a finer scale.



Source: Centers for Disease Control 1997



For example: we might notice a correlation between rates of heart disease and poverty at the aggregated scale, as is apparent in these two maps. This does not mean that this relationship found at the national scale will also hold at a neighborhood scale or among individuals.

Another major problem is **confounding**. Confounding can occur when a factor that is not being examined in the study is associated with both the exposure and the health outcome.

For example: a study finds that people who work at a rocket fuel plant are more likely to suffer from lung cancer than the general population. Unfortunately, the study overlooked the fact that plant workers were also more likely to smoke.

In this case, a correlation between working at the factory and smoking has made it appear that working at the factory causes lung cancer.

Can you think of another example of confounding?

Environmental Justice

The **environmental justice** literature argues that exposure to environmental toxins is not equally distributed.

Much research has focused on whether poor people and people of color are more likely to live in highly-polluted areas than are wealthier, whiter populations.

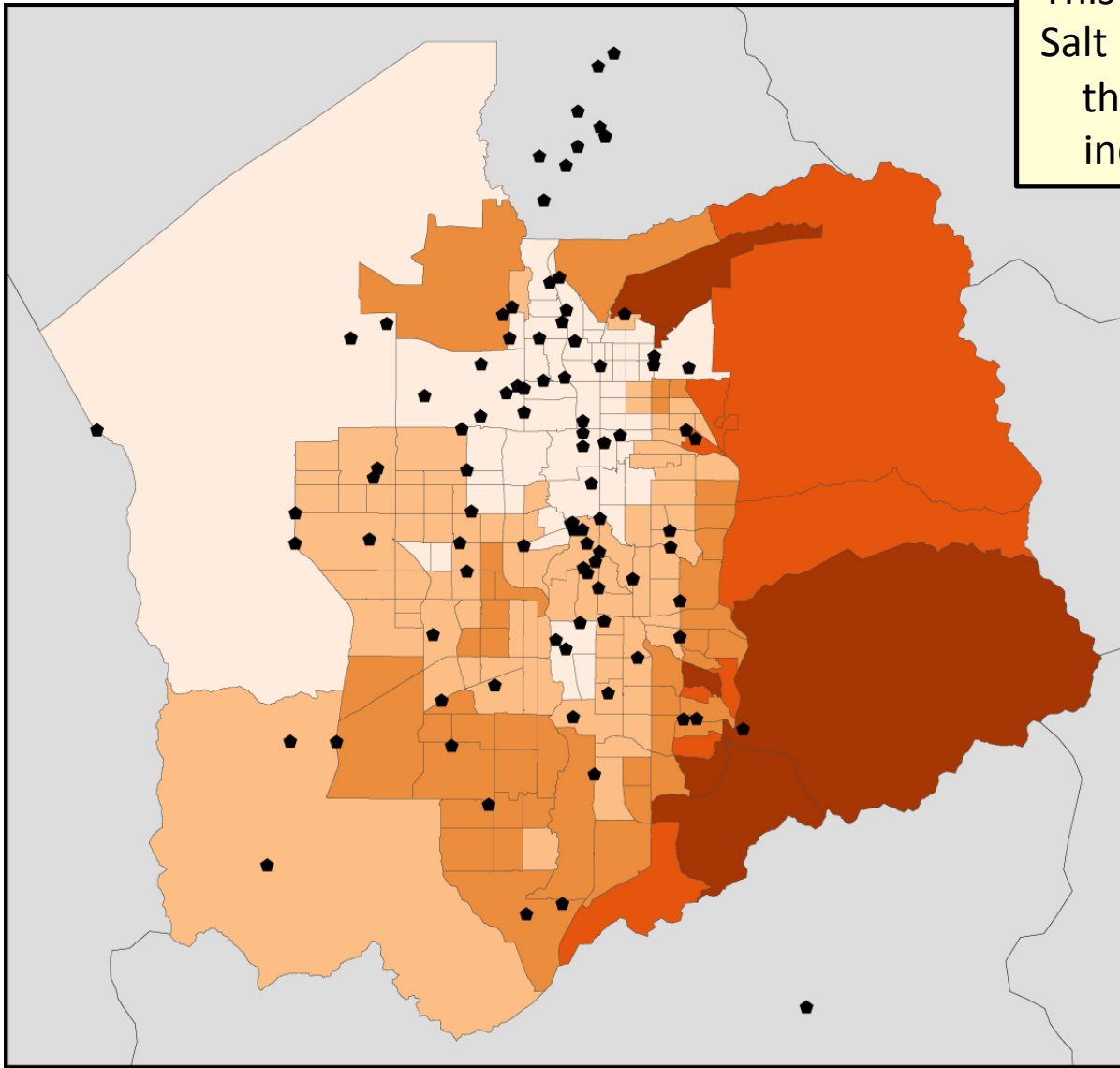
The study of environmental justice investigates inequalities by examining the social dimensions of exposures, focusing on three primary questions:

- 1. who bears the environmental health burden associated with industrial development?**
- 2. how can we develop policy to ensure that people are equitably protected from environmental exposures?**
- 3. how can we give all groups an equal voice in the development of environmental policy?**

This map shows toxic sites in Salt Lake City, as reported by the US government, and income by census block.

How might we use this map to demonstrate environmental injustice?

What further analysis would you like to do to confirm your hypotheses?



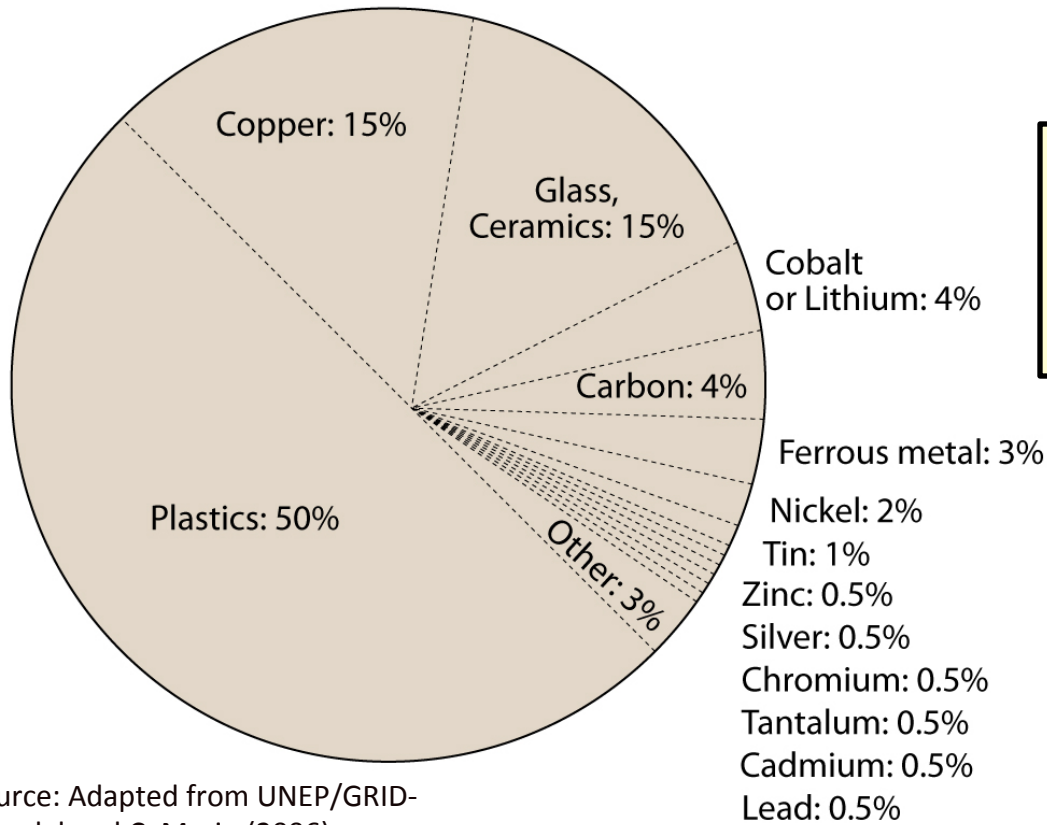
Income per capita
(\$US, 2000)

- 13,750 to 39,999
- 40,000 to 59,999
- 60,000 to 79,999
- 80,000 to 99,999
- 100,000 to 125,000

● Toxic Release Inventory
and Superfund Sites

Data Source: United States National Library of Medicine (2009), US Census Bureau (2009)

This diagram shows the composition of a common cell phone. Many of the components are highly toxic.



Source: Adapted from UNEP/GRID-Arendal and C. Marin (2006)

One example of environmental injustice that occurs on an international scale is **electronic waste**, or “e-waste.” E-waste contains a huge number of synthetic chemicals, including known toxins and hundreds of chemicals whose health impacts are not well understood.



In China, for example, it has been found that e-waste is responsible for birth defects, growth and development problems, and cancer.

Conclusion

The health impacts from environmental exposures are uneven, with some communities affected to a greater degree than others.

Environmental exposures are not only a critical area of ecological study, but also generate important questions of equity, invoking consideration of the ways in which societal structures influence who is subjected to the greatest risk from particular health hazards.

Discussion Questions

1. In what ways do geographic approaches lend themselves to the study of geogens? How might geographic approaches be combined with other approaches and techniques that address environmental exposures?
2. Do you perceive any issues of environmental injustice in your own city? Do these local issues relate to national-scale or global-scale processes in any way?

Readings

1. **Spatial Turn in Health Research (www.gis.ttu.edu/geog3340/documents/readings/spatial-turn-science.pdf)**
2. **Assessing Dynamic Exposure to Air Pollution(www.gis.ttu.edu/geog3340/documents/readings/air-pollution-kwan.pdf)**
3. **Project FRONTIER (www.gis.ttu.edu/geog3340/documents/readings/project-frontier.pdf)**

Assignment

1. For reading 1: please use **your own words (not quoting the original texts)** to describe why the authors argue that the health research is taking a spatial turn and how the authors support this argument (**half page, font 12, single space**).
2. For reading 2 and 3: please write a critical review of these two papers, starting from a summary of the papers including the problems the authors need to address, the data been collected, analysis been done to support the argument, and conclusions the authors drew, then please include your thoughts and critics about these work (e.g., what you think innovative and what you think is missing) (**1.5 pages, font 12, single space**).
3. Due Oct. 19th. 5:00pm.