

APES Ch. 15 Notes ~ Environmental Hazards and Human Health

15.1 Notes

I. Links Between Human Health and the Environment

1) General info.

- a) **Environmental health**—“*health and quality of life by preventing or controlling those diseases or deaths that result from interactions between people and their environment*” (from the CDC)
- b) In this context, the **environment** is all the biotic and abiotic factors with which humans have contact
- c) **hazards**
 - *can cause injury or death*
 - *can damage personal or public property*
 - *can cause environmental damage or destruction*
- d) **risk**—*the probability of being affected by a hazard*
- e) **morbidity**—“*a disease or the incidence of disease within a population. Morbidity also refers to adverse effects caused by a treatment.*” (from NCI - National Cancer Institute)
- f) **mortality** – *the incidence of death in a population*
- g) **vector**—a carrying agent for disease

2) U.S. Public Health: **Center for Disease Control and Prevention**

www.cdc.gov

a) Key Topics:

Air Quality
Bioterrorism Agents/Diseases
Chemical Agents
Environmental Hazards and Exposure
Food Safety
Hazardous Substances
Hazardous Waste Sites
Herbicides
Hydrocarbons

Laboratory Measurements in People
Lead
Natural Disasters
Pesticides
Smoking and Tobacco Use
Urban Planning for Healthy Places
Vessel Sanitation and Health
Water Quality

b) CDC’s Disease Listings (very useful for research):

<http://www.cdc.gov/az.do/id/0900f3ec8000e035#J>

3) Public Health in other countries

- a) Ministry of Health-type structures
- b) U.N. **World Health Organization (WHO)**

From <http://www.who.int/about/en/>

“The World Health Organization is the United Nations specialized agency for health. It was established on 7 April 1948. *WHO’s objective, as set out in its Constitution, is the attainment by all peoples of the highest possible level of health. Health is defined in WHO’s Constitution as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.*

WHO is governed by 193 Member States through the World Health Assembly. The Health Assembly is composed of representatives from WHO’s Member States. The main tasks of the World Health Assembly are to approve the WHO programme and the budget for the following biennium and to decide major policy questions.”

c) **Life expectancy**—*the average life span of a newborn*

From ABOUT.com:

- used as an indicator of the overall health of a country
- can fall due to famine, war, disease and poor health
- improvements in health and welfare increase life expectancy
- more developed regions of the world generally have higher life expectancies
- life expectancy rose rapidly in the twentieth century due to improvements in public health, nutrition and medicine
- contrast with **longevity**—*lifespan* or lifetime of an individual

Trends (projections) in life expectancy, from WHO

http://www.who.int/whr/1998/media_centre/press_release/en/index3.html

“By the year 2025, 26 countries will have a life expectancy at birth of above 80 years. It will be highest in Iceland, Italy, Japan and Sweden (82 years) followed by Australia, Canada, France, Greece, Netherlands, Singapore, Spain and Switzerland (81 years).

It will be 80 years in Austria, Belgium, Barbados, Costa Rica, Cyprus, Finland, Germany, Ireland, Israel, Luxembourg, Malta, New Zealand, the United Kingdom and the **United States**. Other examples for 2025 include China (75 years) the Russian Federation (72 years) and India (71 years).

The countries with the lowest life expectancies in 2025 will be Angola, Burkina Faso, Burundi, Chad, Mozambique, Niger and Somalia (60 years); Mali and Uganda (59 years); Gambia and Guinea (58 years); Afghanistan, Malawi and Rwanda (57 years); Guinea Bissau (56 years) and Sierra Leone (51 years).”

d) Two Worlds: Developed vs. Developing Countries (Review Ch. 5)

- **Demographic Transition**—*causal link between modernization and decline in birth and death rates*
 - Phase I – “primitive stability” with high CBR and high CDR
 - Phase II – epidemiologic transition; declining CDR
 - Phase III – significant population growth; declining CBR from declining fertility rates
 - Phase IV – “modern stability” with low CBR and CDR
- **epidemiologic transition**—*pattern of changes in mortality factors; declining CDR from modernization*
- CBR = crude birth rate = # births per 1000, per year
- CDR = crude death rate = # deaths per 1000, per year

4) Environmental hazards

- a) **Cultural hazards**—*associated with chosen behaviors* such as drug use, smoking, alcohol consumption, food choices, sexual activity (STDs, HIV, etc.), sun exposure, exercise, criminal behavior, risky hobbies, etc.
- b) **Biological hazards**—*biological agents (bacterial, viruses, fungi, parasitic worms, etc.) that cause infection and death* (common, familiar diseases are still the leading causes of mortality) some info from FSU...
 - i. acute respiratory infections
 - **tuberculosis (TB)**—bacterial infection of the lungs (*Mycobacterium tuberculosis*); drug-resistance is a problem

- ii. **malaria**—tropical disease caused by parasitic protozoans from the genus *Plasmodium*
 - parasite incubates in the gut of the *Anopheles* mosquito
 - migrates to salivary gland, transmitted to humans by bites
 - reproduces in the human liver
 - released into human bloodstream, where they multiply and destroy red blood cells
 - a mosquito bites an infected person to acquire parasite
- iii. **diarrhea diseases**
 - life-threatening bacterial intestinal infection
 - often simple to cure if basic oral rehydration medicines are available
 - can be spread through person-to-person contact, and/or contaminated drinking or food supplies (*E.coli*, *Campylobacter*)
 - more severe forms
 - epidemic **dysentery**: *Shigella*
 - **cholera**: *Vibrio*
 - typhoid fever: *Salmonella*
- iv. **West Nile Virus**
 - mosquito-borne disease
 - can cause encephalitis (inflammation of the brain)
 - mosquito becomes infected by biting a bird which carries the virus
- c) **Physical hazards**—*earthquakes, floods, hurricanes, tornadoes, volcanic eruptions, forest fires, landslides, avalanches, monsoons, tsunamis*, other natural disasters
 - i. ProVention

From <http://www.proventionconsortium.org/?pageid=1>

“The ProVention Consortium is a global coalition of international organizations, governments, the private sector, civil society organizations and academic institutions dedicated to increasing the safety of vulnerable communities and to reducing the impacts of disasters in developing countries.”

- provide loans for relief/ rebuilding with improvements
- ii. Global climate changes bring on droughts, increases hurricane activity, more tornadoes, heat waves, etc.
- **The United Nations Framework Convention on Climate Change (UNFCCC)**

From http://unfccc.int/essential_background/convention/items/2627.php

“The Convention on Climate Change sets an overall framework for *intergovernmental efforts to tackle the challenge posed by climate change*. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, with 189 countries having ratified.

Under the Convention, governments gather and share information on greenhouse gas emissions, national policies and best practices; launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial

and technological support to developing countries; cooperate in preparing for adaptation to the impacts of climate change.”

- **UNFCCC Least Developed Countries Fund**

http://unfccc.int/cooperation_support/least_developed_countries_portal/ldc_fund/items/4723.php

“The LDCF was established to support a work programme to assist Least Developed Country Parties (LDCs) carry out the preparation and implementation of national adaptation programmes of action (NAPAs). The Global Environment Facility (GEF), as the entity that operates the financial mechanism, has been entrusted to operate this fund.”

- **UNFCCC Special Climate Change Fund**

http://unfccc.int/cooperation_and_support/financial_mechanism/special_climate_change_fund/items/3657.php

“The SCCF... was established in 2001 to finance projects relating to adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification.”

- d) **Chemical hazards**, from anthropogenic and natural sources
- i. CDC NIOSH (National Institute for Occupational Safety and Health) pocket guide to chemical hazards:
<http://www.cdc.gov/niosh/npg/>
 - ii. *exposure* and *dosage* are issues
 - iii. exposure: ingestion, inhalation, absorption through skin, direct contact, etc.
 - iv. ScoreCard.org is “THE pollution information site” to search
 - v. Cancer
 - **carcinogen**—*cancer-causing substance*
 - **malignant**— cancerous; a growth that tends to spread into nearby normal tissue
 - **metastasis**—the spread of cancer from its primary site to other parts of the body
 - **carcinogenesis**—*the growth of cancer*

From FSU... “To grow and maintain metabolism, cells divide over a certain period of time and then undergo cell death at an appropriate time. Cancer is a cellular process in which cell division proceeds unchecked; normal control over growth has been lost.”

- **environmental carcinogens**—chemicals that bind to DNA and disrupt the “life span” of a cell, leading to abnormal cell growth and division

15.2 Notes

II. Pathways of Risk

A. The risk of being poor: according to WHO, poverty is the world’s greatest killer

1) WHO World Health Report – 2002 defined the ten leading *risk factors*:

(* = issues in developed countries)

Underweight
Unsafe sex
*High Blood pressure**
*Tobacco consumption**

*Alcohol consumption**
Unsafe water, sanitation,
hygiene
*High cholesterol **

Indoor smoke from solid
fuels
Iron deficiency
*Overweight**

Measured in **DALYs (Disability-Adjusted Life Years)** = a loss of one healthy year of life

2) WHO World Health Report – 2006

From <http://www.who.int/whr/2006/en/index.html>

“ ‘Working together for health’ contains an expert assessment of the current crisis in the global health workforce and ambitious proposals to tackle it over the next ten years, starting immediately. The report reveals an estimated shortage of almost 4.3 million doctors, midwives, nurses and support workers worldwide. The shortage is most severe in the poorest countries, especially in sub-Saharan Africa, where health workers are most needed...”

- 3) factors associated with poverty that lead to increased environmental hazards
 - a) decreased education and less ability to read, understand, and communicate medical information
 - b) reduced nutrition
 - c) infrequent governmental sponsorship of national health programs
 - d) lack of safe drinking water
 - e) indoor air pollution from burning fuel
- 4) wealth
 - a) *generally, wealth is directly proportional to health*
 - b) access to medical care
 - c) education
- 5) priorities: health care may suffer due to...
 - a) spending on the military
 - b) development of power sources
 - c) distribution of wealth within a country



NO SMOKING

B. The cultural risk of tobacco use

- 1) Health effects of smoking among young people

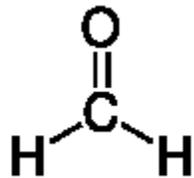
From http://www.who.int/tobacco/research/youth/health_effects/en/

- Among young people, the short-term health consequences of smoking include respiratory and non respiratory effects, addiction to nicotine, and associated risk of other drug use.
- Most young people who smoke regularly continue to smoke throughout adulthood.
- Cigarette smokers have a lower level of lung function than people who have never smoked.
- In adults, cigarette smoking causes heart disease and stroke. Studies have shown that early signs of these diseases can be found in adolescents who smoke.
- Smoking hurts young people's physical fitness in terms of both performance and endurance—even among young people trained in competitive running.
- On average, someone who smokes a pack or more of cigarettes each day lives 7 years less than someone who never smoked.
- Smoking at an early age increases the risk of lung cancer. For most smoking-related cancers, the risk rises as the individual continues to smoke.
- Teenage smokers suffer from shortness of breath almost three times as often as teens who don't smoke, and produce phlegm more than twice as often as teens who don't smoke.
- Teenage smokers are more likely to have seen a doctor or other health professionals for an emotional or psychological complaint.
- Teens who smoke are three times more likely than nonsmokers to use alcohol, eight times more likely to use marijuana, and 22 times more likely to use cocaine.

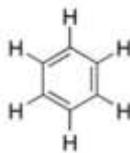
- 2) Secondhand smoke: The EPA has classified **environmental tobacco smoke (ETS)** as a Class A (known human) carcinogen
- 3) Cigarettes are one of few products which can be sold legally which can harm and even kill you over time if used as intended.

- 4) Currently there are ongoing lawsuits in the U.S. which aim to hold tobacco companies responsible for the effects of smoking on the health of long term smokers.

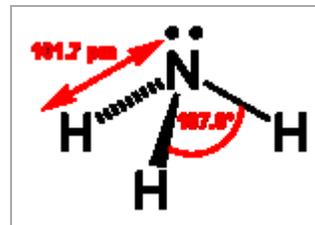
COMMON CHEMICALS IN CIGARETTE SMOKE:



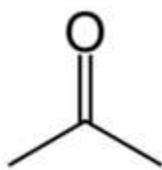
FORMALDEHYDE



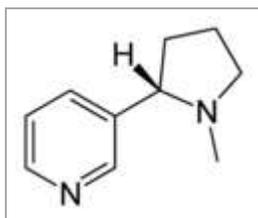
BENZENE (3 ways)



AMMONIA



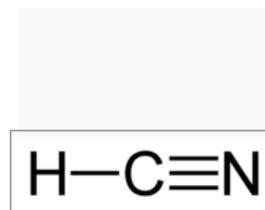
ACETONE
(CH_3COCH_3)



NICOTINE



CARBON MONOXIDE



HYDROGEN CYANIDE

From <http://www.quit-smoking-stop.com/harmful-chemicals-in-cigarettes.html>

Benzene (C_6H_6 ; petroleum additive, industrial solvent)

A colorless cyclic hydrocarbon obtained from coal and petroleum, used as a solvent in fuel and in chemical manufacture, and contained in cigarette smoke. It is a known carcinogen and is associated with leukemia.

Formaldehyde (H_2CO ; embalming fluid)

A colorless liquid, highly poisonous, used to preserve dead bodies - also found in cigarette smoke. Known to cause cancer, respiratory, skin and gastrointestinal problems.

Ammonia (NH_3 ; toilet cleaner; dry cleaning fluid)

Used as a flavoring. It frees nicotine from the tobacco, turning it into a gas.

Acetone (CH_3COCH_3 ; nail polish remover)

Fragrant volatile liquid ketone, used as a solvent.

Tar

Particulate matter (PM) drawn into lungs when someone inhales when smoking. Once inhaled, smoke condenses and ~70 % of the tar in the smoke is deposited in the smoker's lungs.

Nicotine ($\text{C}_{10}\text{H}_{14}\text{N}_2$; insecticide/addictive drug)

One of the most addictive substances known to humans, a powerful and fast-acting medical and non-medical poison. This is the chemical which causes addiction.

Carbon Monoxide (CO ; car exhaust fumes)

An odorless, tasteless and poisonous gas, rapidly fatal in large amounts: it's the same gas that comes out of car exhausts and is the main gas in cigarette smoke. It is formed when the cigarette is lit.

Others you may recognize:

Arsenic (As: rat poison), **Hydrogen cyanide** (HCN: gas chamber poison)

5) Legally speaking...

http://www.cancer.org/docroot/PED/content/PED_10_12_Smoking_Legislation.asp?sitearea=PED

C. Risk and Infectious Diseases

1) **Epidemiology**—a branch of medical science that deals with the incidence, distribution, and control of disease in a population

2) *major risk pathway: contamination of food and water*

- not limited to developing countries
- food processing and distribution systems in developed countries are highly vulnerable
- rapid processing and shipping, often distant from where these products are consumed, increase the risk of large-scale food poisoning and water contamination

3) Tropical diseases

a) Malaria – Plasmodium parasites

b) yellow fever - Flavivirus

c) dengue fever - Flavivirus

d) West Nile Virus - Flavivirus

e) Japanese encephalitis - Flavivirus

f) lymphatic filariasis (elephantiasis) - from parasitic worms

g) African trypanosomiasis (sleeping sickness) – Trypanosoma protozoan

h) leprosy - Mycobacterium leprae

4) Good news

a) gene sequencing of parasites

b) use of mosquito netting for beds

D. toxic risk pathways

1) general categories

a) **chronic**—long-term, gradual effects

b) **acute**—quick onset, often fatal

c) **carcinogenic**—cancer-causing

2) indoor air pollution

EPA Indoor Air Quality (IAQ) page: <http://www.epa.gov/iaq/>

a) some types of products used indoors give off fumes

b) buildings are sealed and insulated, trapping pollutants inside

c) more and more people spend more time indoors

3) developing countries – biggest indoor pollution threat

- indoor burning of fuel—causes acute respiratory infections and chronic lung disease

4) asthma

a) constriction of the air passages

b) can be triggered by dust, mold, animal dander, particulates, etc.

5) **toxicology**—a science that deals with poisons and their effects, and with the problems involved (clinical, industrial, or legal)



15.3 Notes

III. Risk Assessment

“the characterization of the potential adverse health effects of human exposures to environmental hazards” (National Research Council)

A. the EPA pioneered risk assessment (from www.epa.gov/iris/intro.htm)

“In a risk assessment, the extent to which a group of people has been or may be exposed to a certain chemical is determined, and the extent of exposure is then considered in relation to the kind and degree of hazard posed by the chemical, thereby permitting an estimate to be made of the present or potential health risk to the group of people involved.

Risk assessment information is used in the risk management process in deciding how to protect public health. Examples of risk management actions include deciding how much of a chemical a company may discharge into a river; deciding which substances may be stored at a hazardous waste disposal facility; deciding to what extent a hazardous waste site must be cleaned up; setting permit levels for discharge, storage, or transport; establishing levels for air emissions; and determining allowable levels of contamination in drinking water.

Essentially, *risk assessment provides INFORMATION on the health risk, and risk management is the ACTION taken based on that information.*”

B. *Integrated Risk Information System (IRIS* from www.epa.gov/iris/intro.htm)

“The Integrated Risk Information System (IRIS), prepared and maintained by the U.S. Environmental Protection Agency (U.S. EPA), is an electronic database containing information on human health effects that may result from exposure to various chemicals in the environment. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on chemical substances for use in risk assessments, decision-making and regulatory activities. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.”

C. four steps of risk assessment from the EPA:

1) **Hazard identification (hazard assessment)**

- a) “gathering and evaluating data on the types of health injury or disease that may be produced by a chemical, and on the conditions of exposure under which injury or disease is produced”
- b) **epidemiological study**—how illness spreads through a population
- c) Does exposure to a substance cause an increased likelihood of an adverse effect such as cancer?

2) **Dose-response assessment**

- a) “describing the quantitative relationship between the amount of exposure to a substance and the extent of toxic injury or disease”
- b) What is the relationship between the dose (amount or concentration of the substance) and the seriousness of the adverse health effect?

3) **Exposure assessment**

- a) “describing the nature and size of the population exposed to a substance and the magnitude and duration of their exposure.”
- b) How often, how long, and how much are humans exposed to the substance in question?

4) **Risk characterization** (transitional step to risk management)

- a) “the integration of the data and analysis of the first three components of the risk assessment process”
- b) What is the probability of an individual or population having an adverse health effect based on data from dose response assessment and exposure appraisal?

Risk assessment provides INFORMATION on the health risk, and risk management is the ACTION taken based on that information.

IV. Risk Management

- A. *taking action: the process of reviewing risk data and making regulatory decisions*
- B. influenced by consideration of costs and benefits and public perception
- C. major components
 - 1) **cost-benefit analysis** – assesses the case for a proposal
 - 2) **risk-benefit analysis** – compares the risk of a situation to the related benefits
 - 3) **public preferences** – public input
- D. general steps
 - 1) establish the context
 - 2) identification
 - 3) assessment
 - 4) **potential risk treatments** (www.businessdictionary.com)
 - a) *risk avoidance*
 - i. “take steps to remove a hazard
 - ii. engage in alternative activities
 - iii. otherwise end a specific exposure”
 - b) *risk reduction (risk mitigation)* – “systematic reduction in the extent of exposure to a risk and/or the likelihood of its occurrence”
 - c) *risk retention*—self insurance (insurance policies)
 - d) *risk transfer*—insurance policies and warranties shift responsibility to another party, away from the affected individual
 - 5) create the plan
 - 6) implementation
 - 7) review and evaluation of the plan

V. Risk Perception

- A. *a non-expert intuitive judgment about risks which often is not in agreement with the level of risk as judged by experts*
- B. *“outrage factor” is a high perceived risk*
- C. reasons for a distorted risk perception
 - 1) *lack of familiarity with the technology*
 - we tend to have an irrational fear of certain technologies or behaviors even though older, more familiar technology poses a greater risk
 - 2) *public impression of hazards*
 - major accidents or technological disasters are imprinted into public memory
 - we emphasize or downplay risks that suit our economic, political or social interests
 - 3) *extent to which the risk is voluntary*
 - we tolerate or downplay the risks associated with behaviors we choose, while we tend to object to risks we can’t control
 - 4) *overselling of safety*

- which specific hazards are reported in the news, as well as how they are reported, can produce a biased perspective on their relative risk—giving us an inaccurate picture of the real risks to which we are exposed
- 5) *morality*
 - we emphasize or downplay risks that suit our moral code of ethics
 - 6) *control*
 - we may have an unrealistic view of our ability to control our fate; we may be able to beat the odds because we're smarter or luckier than others
 - 7) *fairness*
 - we emphasize or downplay risks that suit our economic, political or social interests

D. role of the media

- 1) the media covers the “outrage factors” more than the hazard factors
- 2) **risk communication** should not be left to the mainstream media
- 3) *public concern drives public policy*

E. **Precautionary Principle**

- 1) info from <http://www.sehn.org/state.html#w>

“When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context, the proponent of an activity, rather than the public, should bear the burden of proof.

The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.”

- 2) The Essence of Precaution:
 - *When we have a reasonable suspicion of harm, and*
 - *scientific uncertainty about cause and effect, then*
 - *we have a duty to take action to prevent harm.*
- 3) Instead of asking the basic risk-assessment question “How much harm is allowable?”, the precautionary approach asks, "How little harm is possible?"
- 4) The precautionary approach suggests five actions:
 - a) Set goal(s)
 - b) Examine all reasonable ways of achieving the goal, intending to choose the least-harmful way
 - c) Monitor results, heed early warnings, and make mid-course corrections as needed
 - d) Shift the burden of proof: when consequences are uncertain, give the benefit of the doubt to nature, public health and community well- being
 - e) Throughout the decision-making process, honor the knowledge of those who will be affected by the decisions, and give them a real “say” in the outcome.