ENVIR 202: Lesson No. 19

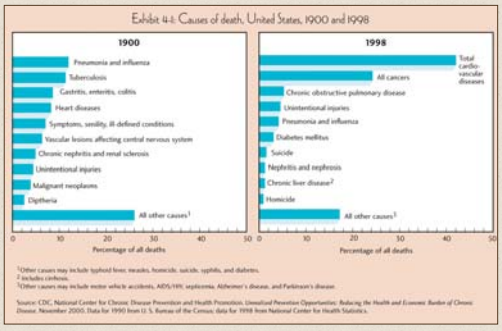
Toxic Risks & Chronic Disease

February 17, 2006

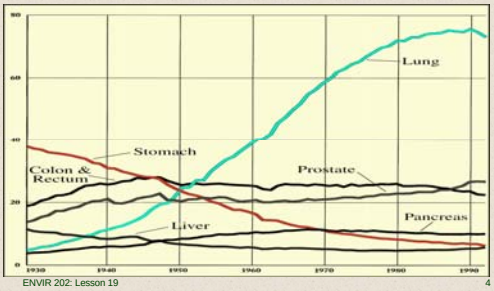
Chuck Treser
University of Washington
Department of Environmental & Occupational Health Sciences

Urbanization

20th Century Mortality

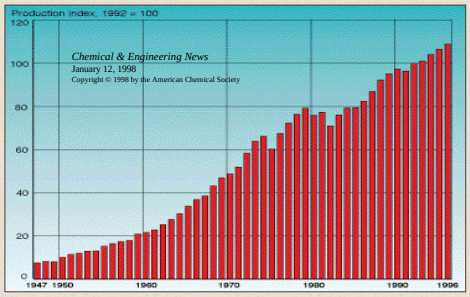


Cancers



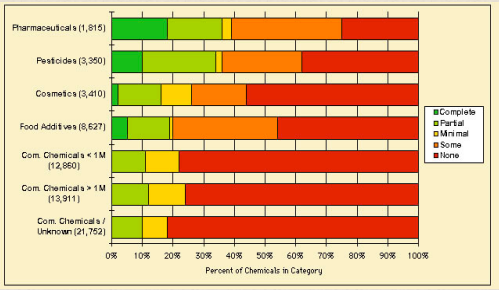
ENVIR 202: Lesson 19 4

Chemicals



ENVIR 202: Lesson 19 5

Chemicals



ENVIR 202: Lesson 19 6

Fundamental Rules

1. "The Dose Makes the Poison"

"All substances are poisons. There are none that are not. The dose separates the remedy from the poison."

Peracelsus
(Theophrastus Bombastus von Hohenheim, 1493-1541)

ENVIR 202: Lesson 19 7

Fundamental Rules

2. Exposure must occur for the chemical to present a risk

3. The magnitude of risks is proportional to <u>both</u> the *potency* of the chemical and the *extent* of exposure

Risk = Hazard **x** Exposure

ENVIR 202: Lesson 19 8

Routes of Exposure

1. Direct Exposure
(through Use and/or Accident)

a) Ingestion
(children; intentional)

b) Skin contact
(e.g., acids, solvents, pesticides)

c) Inhalation
(e.g., paints, pesticides)

ENVIR 202: Lesson 19 9

Exposure Routes Continued

2. Indirect Exposure

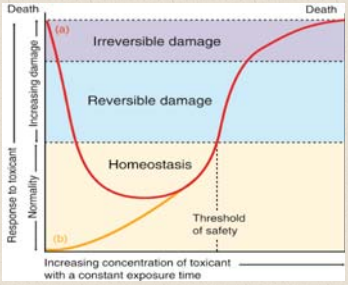
a) Contamination of drinking water

b) Contamination of soil / house dust

c) Contamination of indoor air

ENVIR 202: Lesson 19 10

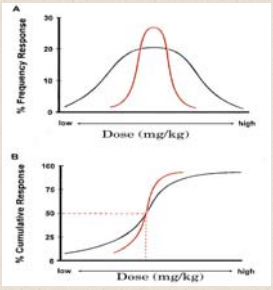
Dose-Response Relationship



The "individual", or continuous, dose-response curve

ENVIR 202: Lesson 19 11

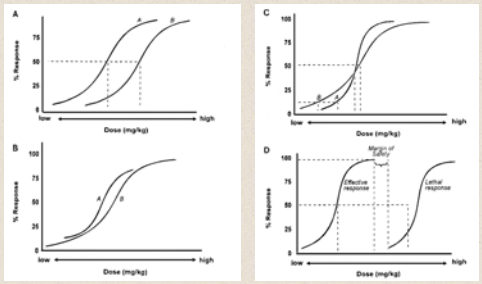
Dose-Response Relationship



The Frequency Distribution Curve

ENVIR 202: Lesson 19 12

Potency & Dose-Response



LD_{50} of Representative Substances

TOXIC AGENT	*LD 50*	*TOXICITY RATING*
Ethanol	10,000	Slightly Toxic
Sodium chloride	4,000	Moderately Toxic
Phenobarbital	150	Very Toxic
DDT	100	Very Toxic
Parathion	7	Extremely Toxic
Nicotine	1	Super Toxic
Curare	0.05	Super Toxic
Dioxin (TCDD)	0.001	Super Toxic
Botulinum Toxin	.00001	Super Toxic

Chemical Interactions

- **Additive:** **2 + 3 = 5**
- **Synergistic:** **2 + 3 = 20**
- **Potentiation:** **0 + 2 = 10**
- **Antagonism:** **4 + 6 = 8**
  4 + (-4) = 0
  4 + 0 = 1

Risk Assessment

ENVIR 202: Lesson 19 16

Understanding Risks

- Hazard identification
- Dose-response assessment
- Exposure assessment
- Risk Characterization
- Risk Management
- Risk Communications

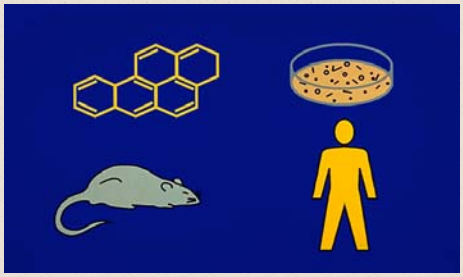
ENVIR 202: Lesson 19 17

Translation

- Is there a potential problem?
- What is the problem?
- Who has the problem?
- How bad is the problem?
- What should we do about it?
- Who and what do we tell?

ENVIR 202: Lesson 19 18

Toxicological Methods



ENVIR 202: Lesson 19 19

Comparing Risks

- Probability
- Expected Value
- Exposure
- Outrage
- Experts
- Avoidance

ENVIR 202: Lesson 19 20

Uncertainties in Life

"One of the brightest gems in the New England weather is the dazzling uncertainty of it."

. . . Mark Twain

ENVIR 202: Lesson 19 21

Comparative Risks

Event	Annual Risk
Car injury	1:100
Killed hang gliding	1:1,000
Killed mountain climbing	1:1,585
Cancer: 1 diet cola/day	1:10,000
Cancer: 4 tbsp. peanut butter/day	1:100,000

Event	Lifetime Risk
Hit by Lightning	1:631,000
Cancer: drinking chlorinated water	1:1,000,000
Win state lottery grand prize	1:10,000,000
Win Readers Digest sweepstake	1:250,000,000

ENVIR 202: Lesson 19 22

Comparing Risks

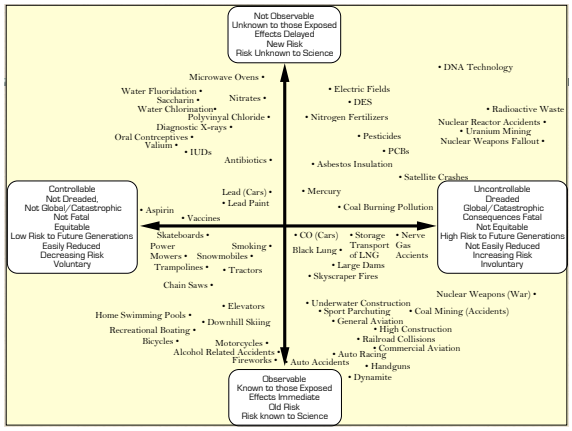
- **Activities that increase annual risk by 1:1,000,000**
  - **Smoke 1.4 cigarettes**
  - **Drink 0.5 liters of wine**
  - **Live 2 days in New York or Boston**
  - **Live 2 months with a cigarette smoker**
  - **Live 150 years within 5 miles of a nuclear power plant**

ENVIR 202: Lesson 19 23

Comparing Risks

- **Voluntary** *vs.* **Involuntary Risks**
- **Immediate** *vs.* **Delayed Effects**
- **Common** *vs.* **Rare (Dread) Events**
- **Affects Everyone** *vs.* **Special Groups**
- **Reversible** *vs.* **Irreversible Effects**

ENVIR 202: Lesson 19 24



Changing Risks

- Understand the risks
- Understand who is at risk
- Characterize the risk
- Consider the alternatives
- Consider "protective" measures
- ACT!!!

ENVIR 202: Lesson 19 26

Risk Assessment Approaches

- Cost-benefit analysis
- Revealed preference
- Expressed preference
- Natural standards

ENVIR 202: Lesson 19 27

Cost-Benefit Analysis

Definition: A systematic attempt to compare the costs with the anticipated benefits of a technology, product, substance or process.

ENVIR 202: Lesson 19 28

Cost-Benefit Analysis

"Veg-E-Wax"

Benefits	Anticipated Value
Storage loss prevented	1,000,000
Nutritive value preserved	800,000
Total	$1,800,000

Costs	Anticipated Value
Application costs	100,000
Cancer in workers	100,000
Cancer in consumers	100,000
Unappealing appearance	1,600,000
Total	$1,900,000

ENVIR 202: Lesson 19 29

Cost-Benefit Analysis

Examples of Regulations Evaluated by Cost per Life Saved

Regulation	Status & Year	Annual Risk Estimate	Lives Saved Annually	Cost per Life Saved
Asbestos	Final 1972	4 in 10^4	296	$7,400
Benzene	Final 1984	9 in 10^4	4	$17,100
Asbestos	Final 1978	2 in 10^3	12	$92,500
Formaldehyde	Prop. 1983	7 in 10^7	<1	$72,000,000

ENVIR 202: Lesson 19 30

Revealed Preferences

Definition: The acceptable risk for a new technology is the level of safety associated with ongoing activities having similar benefits to society.

ENVIR 202: Lesson 19 31

Expressed Preferences

Definition: If people say it is safe, then it is safe enough.

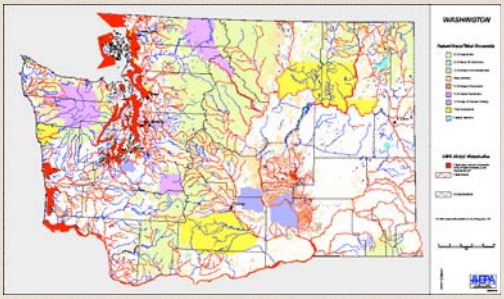
ENVIR 202: Lesson 19 32

Natural Standards

Definition: A technology is safe if its risk are no greater than those accompanying the development of the human species.

ENVIR 202: Lesson 19 33

Risk Assessment



Regulation Philosophies

- Count the bodies
- Engineering solutions (BAT)
- Uniform Risk/Equal Rights
- Cost-Benefit
- Delaney Approach

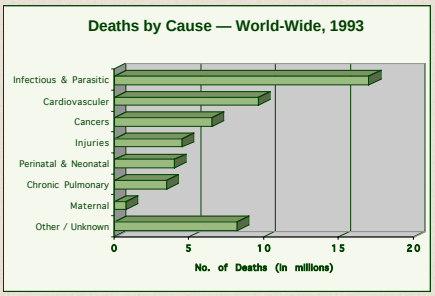
ENVIR 202: Lesson 19 35

Current Federal Issues

- Risk and Regulation
- Cost-Benefit Analysis

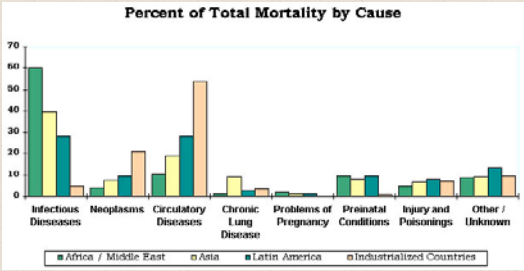
ENVIR 202: Lesson 19 36

World View

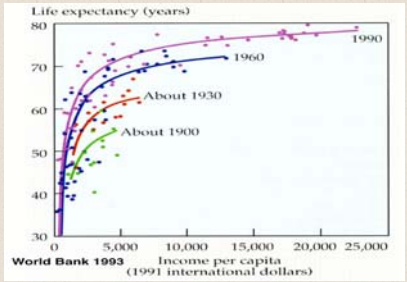


Source: The World Health Report 1995, WHO, Geneva, 1995

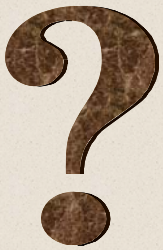
Variable Picture



Wealth & Health



Questions



ENVIR 202: Lesson 19 40

Uncertainties in Life

"Remember to change your underwear — you never know when you'll be in an accident."

Your Mother

ENVIR 202: Lesson 19 41

Next Lesson

Disasters: Natural and Unnatural

ENVIR 202: Lesson 19 42