**Chapter 14**

Risk:

Risk = Prob. of a specific undesired consequence

When several different kinds or magnitudes of injury or loss may occur, risk is sometimes defined as a product of the probability and the size of the loss:

Risk = (Prob. of an undesired consequence) x (size of loss)

To reduce risk, we need to reduce the size of the loss or the prob. that the loss will occur

-Two categories of health risks: 1. Cancer due to chemicals (carcinogenic) 2. All other illnesses and disease due to chemicals (damage to the organs or tissue such as liver, kidney, or nerves)

Zero risk from environmental contaminants means zero consequences from exposure or zero prob. of exposure

NRC (national research council, 1983) 4 step process for risk assessment:

1. Hazard assessment: to determine whether there is any potential problem from exposure to a given chemical

2. Dose-Response assessment: to quantify the relationship between the dose and the resulting effect or response

Zero threshold is used for carcinogens whereas nonzero is used for other health effects

3. Exposure assessment: to quantify the dose actually received in a particular situation

Many foods, especially vegetation and fish, can accumulate and store certain chemicals found in contaminated water and soil – a process known as bioaccumulation

4. Risk characterisation: combine the results of the previous 2 to yield the expected incidence of adverse effects

Assessing risk for carcinogens:

CDI: Chronic Daily Intake. Average daily dose of a chemical over the lifetime of an individual, normalized in his/her body weight  
CDI = average daily dose (mg/day) **/** body weight (kg)

PF: Potency Factoris the incremental cancer risk for a CDI of 1 mg/kg-day

Incremental lifetime risk = CDI x PF (This is the added risk of developing cancer over and above the background risk)

Levels of acceptable risk (lifetime): 10^-6 or less is acceptable, 10^-6 to 10^-4 is a grey area, 10^-3 or greater is serious.

Assessing risk for non-carcinogens:

NOAEL (No observable adverse effects level) is the dosage of a chemical below which no adverse effects are observed. Doses of a chemical at or below this level are considered safe.

UF = uncertainty factor, MF = modifying factor

RfD (reference dose) is a key parameter used in risk assessments to characterize the safe dose of a noncarcinogenic chemical.

Hazard quotient (HQ) = ratio of the average daily dose (ADD) of a chemical divided by the reference dose

Acceptable risk for a noncarcinogen = HQ <= 1.0

Risk management:

Risk management is the process of defining an acceptable risk in the content of a particular situation, and for deciding on the appropriate action to reduce, control, or eliminate an unacceptable risk.

Options for dealing with unacceptable risks:

1. **The source of the risk can be reduced or eliminated**, such as by removing contaminated soil, closing a facility, or installing environmental control technology to reduce emissions.
2. **The exposure pathway can be modified or avoided**, such by installing an engineered barrier that prevents contaminant migration through the soil, or a tall chimney that disperses pollutant beyond the local community.
3. **Human exposure to the contaminants can be reduced or eliminate**d, such as by relocating the affected population or prohibiting access to a contaminated area.
4. In the least desirable option, **effects can be treated or compensated for after they occur**, such by medical treatment or monetary payments from parties responsible for the contamination.

Infuence diagrams:

An influence diagram is a way of visualizing the important connections among different elements of a problem. It is represented by a series of ovals which can influence the decision or outcome.

Chance event (variable) OVAL

Decisions RECTANGLE

Calculations (constants) RECTANGLE WITH ROUNDED CORNERS

Objectives HEXAGON

Decision trees:

The purpose of a decision tree is to explore the consequences of choosing a decision.

At a decision node we must choose which branch to follow, each branch represents a discrete choice

At a chance node, each node represents one of the several possible outcomes with their probabilities

Expected value at a chance node = sum of (probability of each branch x value of each branch)

**Chapter 15**

Forecast vs scenario:

The term forecast is generally used when one purports to know what will actually happen in the future.

Scenario attempts to describe what would happrn given some specified set of circumstances. Rather than trying to predict what will happen it the future, scenarios describe a range of possible outcomes from different assumptions.

Time periods:

Near term means within the next few years or <10 years, midterm 10-30 years, long term could range from several decades to several centuries.

Spatial scales:

Local scale: urban areas 50 km or less. Problems include water pollution and urban air pollution.

Regional scale: encompasses a larger area hundreds of kilometres. Problems include acid rainand the land use impacts of human activities.

National or global scale: beyond that. Problems include global climate change and stratospheric ozone depletion.

Drivers of environmental change:

Population: projections about future number of people. More people means more environmental impact.

Standard of living: measured in economic terms such as GDP per capita. The more affluent the population, the greater the demand, the greater the environmental impacts per person.

Technology: The vehicle used to deliver the goods and services people demand. Methods used to provide goods and services. Measures involved: changes in environmental emissions, energy requirements, and natural resource requirements.

Population growth models:

-Annual growth rate model: assumes a constant annual growth rate which is a percentage or fraction of the total population.

-Exponential growth model: At any point in time, the rate of change in population is proportional to the total population at that moment; Continuous growth of population.

-Logistic growth model: The population grows exponentially but over time the growth rate slows down until it finally reaches zero. At that point the population stabilizes and the limit is known as the carrying capacity of the environment. It defines an equilibrium condition where demands by population are in balance with the capability of the environment to supply those needs.

-Demographic models: study of characteristics of human populations, which allows more detailed projection models. Growth rate = birth rate – death rate + immigration rate

Crude rates means they apply to the population as a whole, as opposed to segments of the population such as age group

The replacement fertility rate is the average number of live births needed to replace each female in the current population with one female in the next generation.

Economic growth models:

-Activity coefficients: specifies the amount of a product or service per person related to economic activity.

-Economic growth and energy use: higher per capita energy use as affluence increases; increase in energy consumption due to economic growth.

-Input/output models: Used to capture the interactions among different sectors and subsectors of an economy. This type of model quantifies the goods and services that each sector requires from other sectors to make its own product.

-Macroeconomic models: 3 classes of economic actors(firms, households, government) and 3 markets (labour, goods, financial)

Types of technological change:

Improvements to a current technology design: can reduce environmental impacts by improving energy efficiency or reducing pollutant emission rates

Substitution of an alternative technology: replacing current technology with different ones that reduce environmental emissions

New classes of technology: Technology that offers a whole new way of doing things

Change in technology utilization: deployment and utilization determine aggregate environmental impact

Rates of technology adoption: Specified rate of change, Specified market share, Consumer choice models

**Chapter 10**

Trace metals: small quantities of metals that have been released into the environment due to manufacturing processes.

Metals essential for nutrition: calcium, copper, iron, magnesium, phosphorous, potassium,. Sodium, zinc

Toxic metals: Lead, nickel, chromium, cadmium, mercury

Atmosphere over land contains: silicon, aluminum, iron; whereas air over the oceans contain sodium.

4 principal exposure routes: inhalation of air, ingestion of water, ingestion of food, ingestion of dust

Formula: Absorption of lead by the body:

Mass of lead absorbed by the body from air = Aair = Cair \* Uair \* Fair

C = g/volume of lead

U = amount of that source per day

F = factor of the source (air=0.3; water =0.5; food=0.5; dust = 0.5)

Aerodynamic diameter:

Nuclei mode: (0.02-0.05) x10^-6m

Accumulation mode: (0.2-0.5) x10^-6 m

Coarse particle mode : (10) x10^-6 or greater

Trace metals in air :

Can result from combustion of fossil fuels or mechanical processes

Trace metals in water:

Human activities such as fertilizers or pesticides that get into the water, metals from industries, contaminated acid rain, construction activities, lead pipes for drinking water

Trace metals in food:

Airborne particles containing metal, soldered cans, metal containing dust during food processing , ceramic containers or trays with improper glaze

Trace metals in dust and soil:

Lead Paint

Soil: outdoors, generally natural. Dust: airborne particles, indoors.

**Chapter 12**