CE 107: Introduction to Civil and Environmental Engineering

Spring 2011
Class started on 17.04.2011

Course Teacher

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Shamima Aktar

May 25, 2011

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Lecture Plan

Lecture 1	Introduction
Lecture 2	Importance of Civil and Environmental Engineering, Branches of civil Engineering
Lecture 3	Water and Environment, Man and Environment
Lecture 4-5	Basic population dynamics
	Class Test -1
Lecture 6–7	Water Resources, River system in Bangladesh
Lecture 8–9	Water Pollution
Lecture 10-11	Components of Environment, Ecosystem Flow of matter & energy through an ecosystem Biodiversity
Lecture 12-13	Environmental issues in Bangladesh, Urban and Rural, Natural Habitat
Lecture 14	Global Warming
Lecture 15-16	Air Pollution
	Class Test - 2
Lecture 17	Acid rain, renewable and non-renewable energy

Reference Books

- Introduction to Environmental Engineering and Science – *Gilbert M Masters*
- Environmental Science: Earth as a living Planet (Third Edition) – *Botkin Keller*
- Environmental Science (Fifth Edition) – *William P. Cunningham and Barbara Woodworth Saigo*

Assessment

Credit hours : 2.0

- Class assessment 30%

(attendance: 10, Min. 2 Class test, Home work: 20)

- Mid Term Examination 20%
- Final Examination 50%

Definition of Environment

- **Defined as that whole outer physical and biological system in which man and other organism live – is a whole, albeit a complicated one with many interacting components.**

The wise management of that environment depends upon an understanding of those components: of its rock, minerals and waters, of its present and potential vegetation, of its animal life and potential for livestock husbandry and of its climate.

Introduction

Petronas Twin Towers were the world's tallest building from 1998 to 2004.

Civil Engineering is a professional engineering discipline that deals with the design, construction and maintenance of the physical and natural built environment, including works such as bridges, roads, canals, dams, and buildings. It is the oldest engineering discipline after military engineering.

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Branches of Civil Engineering

- Structural Engineering
  - Wind engineering
  - GIS
  - Materials Engg.
  - Coastal Engg
  - Surveying
  - Construction Engg.
- Transportation Engineering
- Geotechnical Engineering
- Water Resources Engineering
- Environmental Engineering

Civil Engineering Education

Civil engineers typically possess an academic degree with a major in civil engineering. The length of study for such a degree is usually four years and the completed degree is usually designated as a Bachelor of Engineering, though some universities designate the degree as a Bachelor of Science. The degree generally includes units covering Physics, Mathematics, Project management, Design and specific topics in civil engineering. Initially such topics cover most, if not all, of the sub-disciplines of civil engineering. Students then choose to specialize in one or more sub-disciplines towards the end of the degree.

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Careers

There is no one typical career path for civil engineers. Most engineering graduates start with jobs of low responsibility, and as they prove their competence, they are given more and more responsible tasks, the details of a career path can vary. More senior engineers can move into doing more complex analysis or design work, or management of more complex design projects, or management of other engineers, or into specialized consulting.

Environmental Engineering

A filter bed,
a part of sewage treatment

Environmental engineering deals with the treatment of chemical, biological, and/or thermal waste, the purification of water and air, and the remediation of contaminated sites, due to prior waste disposal or accidental contamination. Environmental engineers can be involved with pollution reduction and green engineering.

Environmental engineering also deals with the gathering of information on the environmental consequences of proposed actions and the assessment of effects of proposed actions for the purpose of assisting society and policy makers in the decision making process

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Burj Dubai, the world's tallest building, currently under construction in Dubai

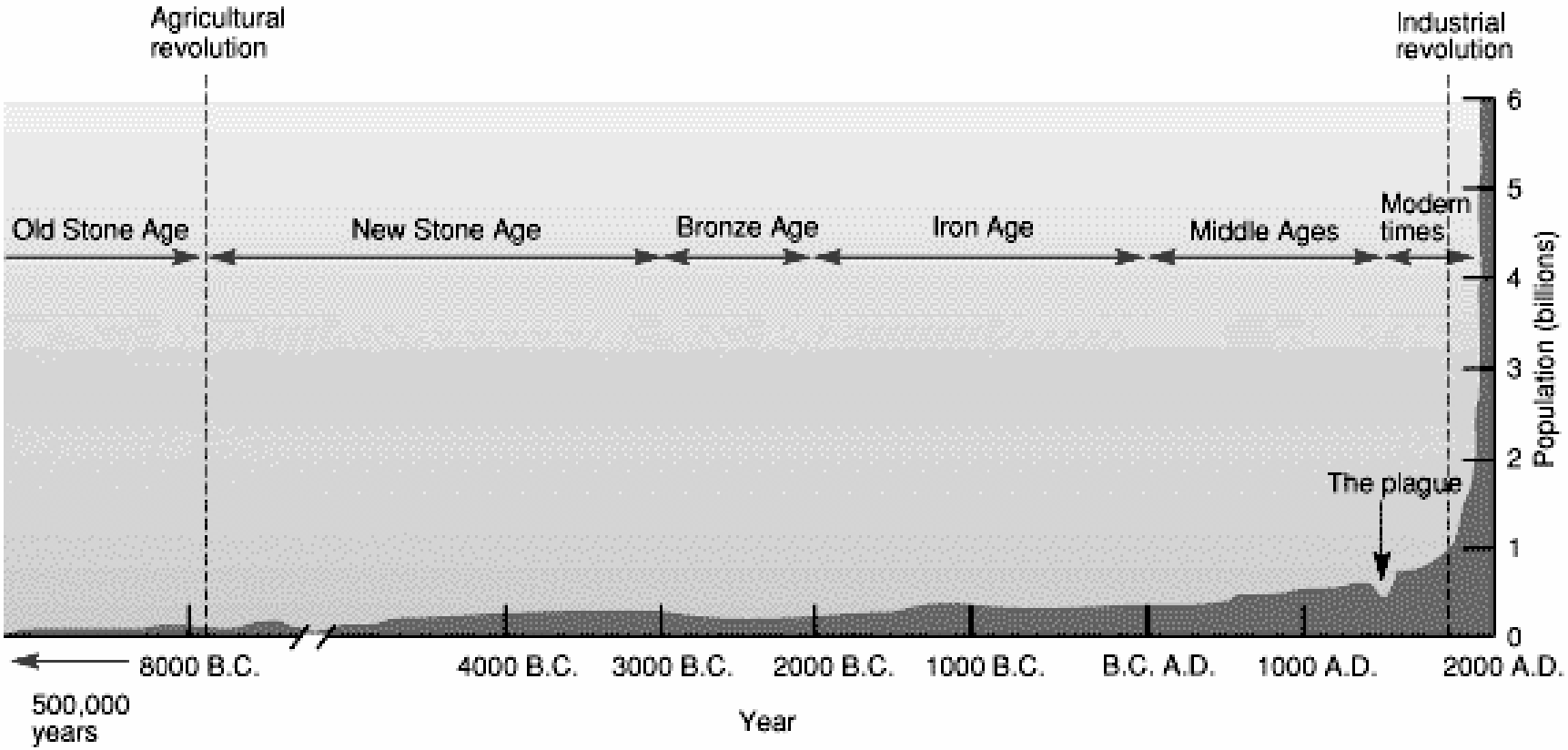
Petronas Twin Towers were the world's tallest building from 1998 to 2004. Designed by Architect Cesar Pelli

Hoover dam

Clifton Suspension Bridge, designed by Isambard Kingdom Brunel, in Bristol, UK

Basic Environmental Issues

- **Human Population**: All environmental problems are due to increasing human population.


Agricultural revolution
Industrial revolution
Old Stone Age
New Stone Age
Bronze Age
Iron Age
Middle Ages
Modern times
The plague
Population (billions)
0
1
2
3
4
5
6
500,000 years
8000 B.C.
4000 B.C.
3000 B.C.
2000 B.C.
1000 B.C.
B.C. A.D.
1000 A.D.
2000 A.D.
Year

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Basic Environmental Issues

- **Sustainability**: means that a resource is used in such a way that it continues to be available.

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Basic Environmental Issues

- **A Global Perspective**:
  Human activity causes global environmental change.

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Basic Environmental Issues

- **The Urban World**: Quality of urban environment has suffered due to ever growing number of people are living in urban areas.
- **Values, Knowledge and Social Justice**: Solutions to environmental problems involves more than simply gathering facts and understanding the scientific issues of a particular problem. It also has much to do with our systems of values and issues of social justice

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Different Societies

- Hunter and gatherer societies
- Agricultural societies

  Important impacts due food surplus during agricultural societies are

  Without the threat of starvation population began to increase

  People cleared more and more land and began to shape the surface of the earth

  Urbanization began

- Industrial societies

Mathematics of Growth

Exponential Growth:

N_0 = initial amount

N_t = amount after t years

r = growth rate (fraction per year)

Then $N_{t+1} = N_t + r\,N_t = N_t\,(1+r)$

For example , $N_1 = N_0\,(1+ r)$; $N_2 = N_1\,(1+ r) = N_0\,(1+ r)^2$;

and in general, $N_t = N_0\,(1+ r)^t$

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Continuous Compounding

Rate of change of quantity N is proportional to N

$$dN/dt = rN$$

$$N = N_0 e^{rt}$$

Doubling Time

The doubling time (T_d) of a quantity that grows at a fixed exponential rate r is easily derived from

$$N = N_0 e^{rt}$$

Doubling Time

Doubling time can be found by setting $N=2N_0$ at $t=T_d$

$$2N_0 = N_0 e^{rt}$$

N_0 appears on both sides of the equation and can be canceled out and taking the natural log of both sides gives $\ln 2 = r\,T_d$

$$T_d = \ln 2/r = 0.693/r$$

If the growth r is expressed as a percentage instead of as a fraction , we get the following important result

$$\mathbf{T_d = 69.3/r(\%) = 70/r(\%)}$$

Problem

It took the world about 300 years to increase in population from 0.5 billion to 4.0 billion. If we assume exponential growth at a constant rate over the period of time, what would that growth rate be? Do it using both approach.

Logistic Growth

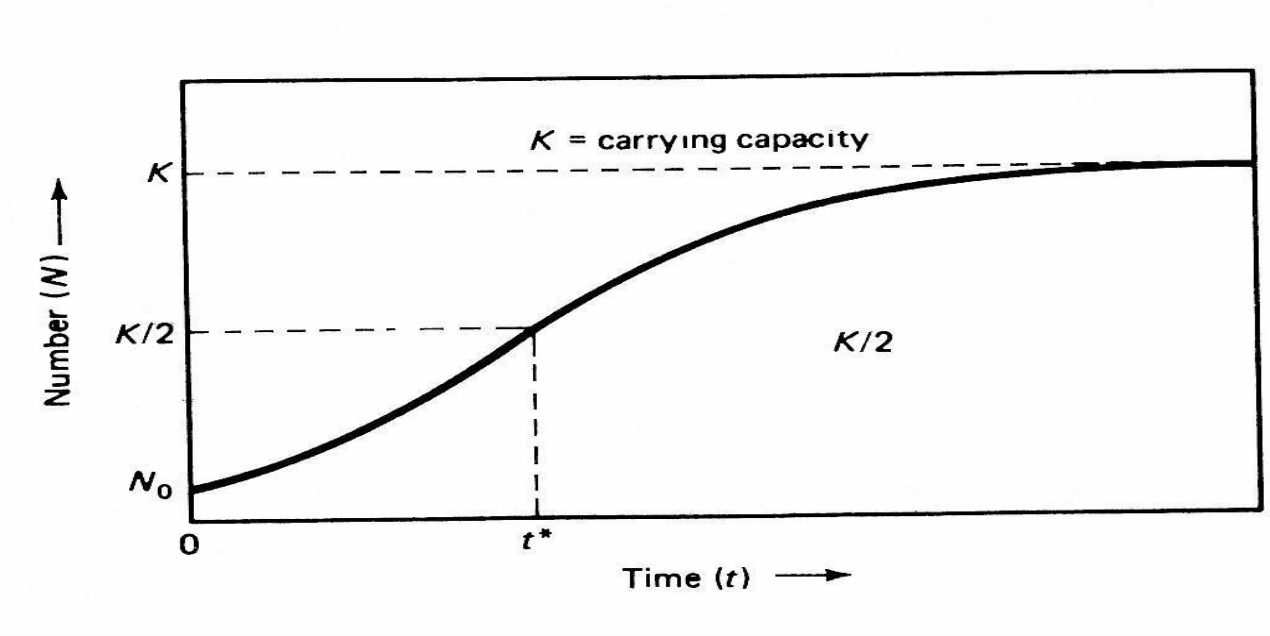


Figure : The logistic growth curve suggest a smooth transition from exponential growth to a steady – state population

- Maximum Sustainable Yield

$$dN/dt = rN\,(1 - N/K)$$

dN/dt = Maximum

Setting the derivative equal to zero gives

$$d/dt\,(dN/dt) = 0$$

$$d/dt\,(rN\,(1 - N/K)) = 0$$

$$d/dt\,(rN - rN^2 / K) = 0$$

$$r\,dN/dt - r/K\,d/dt\,(N^2) = 0$$

$$r\,dN/dt - r/K\,2N\,dN/dt = 0$$

$$r\,dN/dt\;(1 - 2N/k) = 0$$

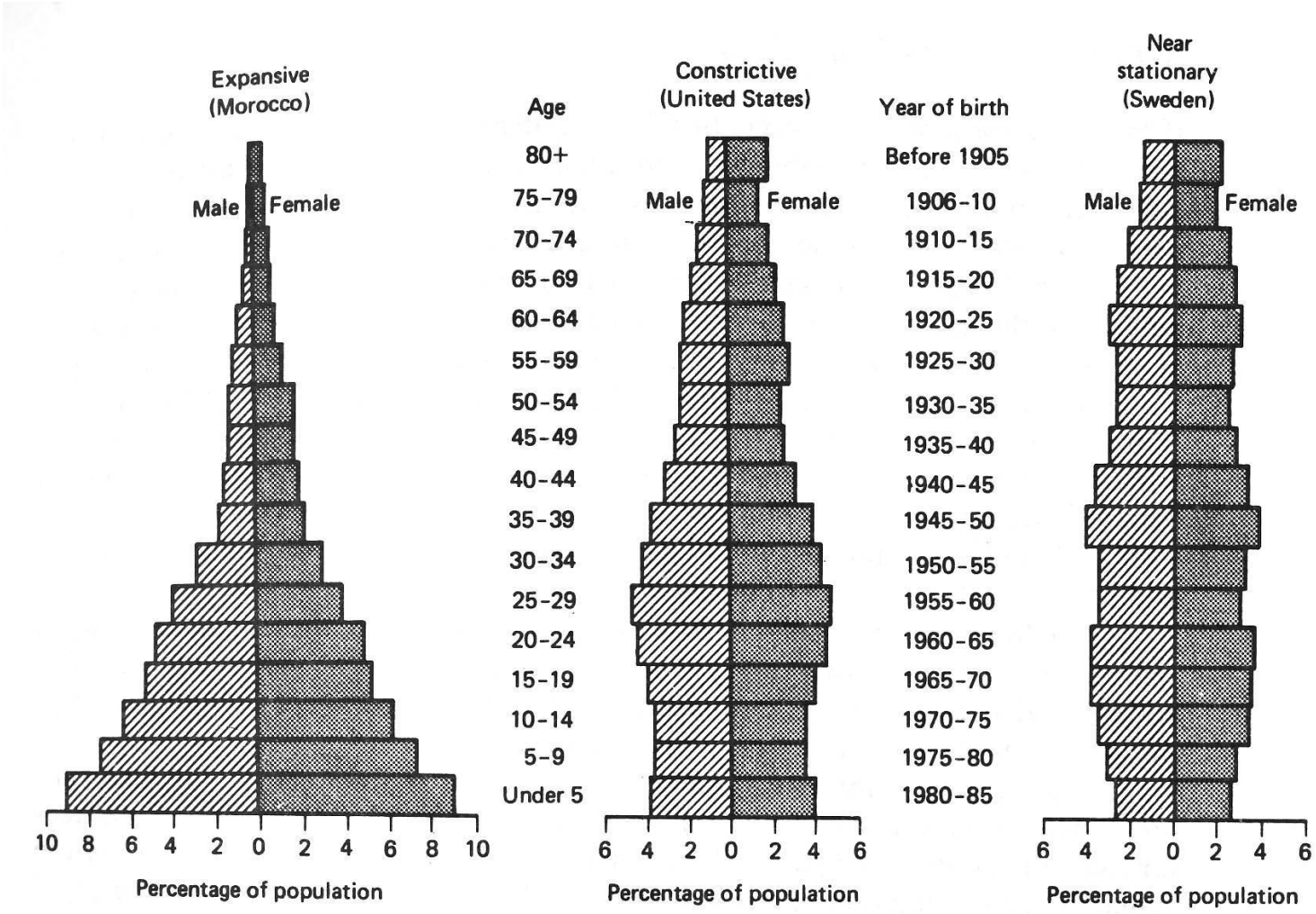
$$1 - 2N/k = 0$$

$$2N/k = 1$$

$$N = K/2$$

- Age Structure

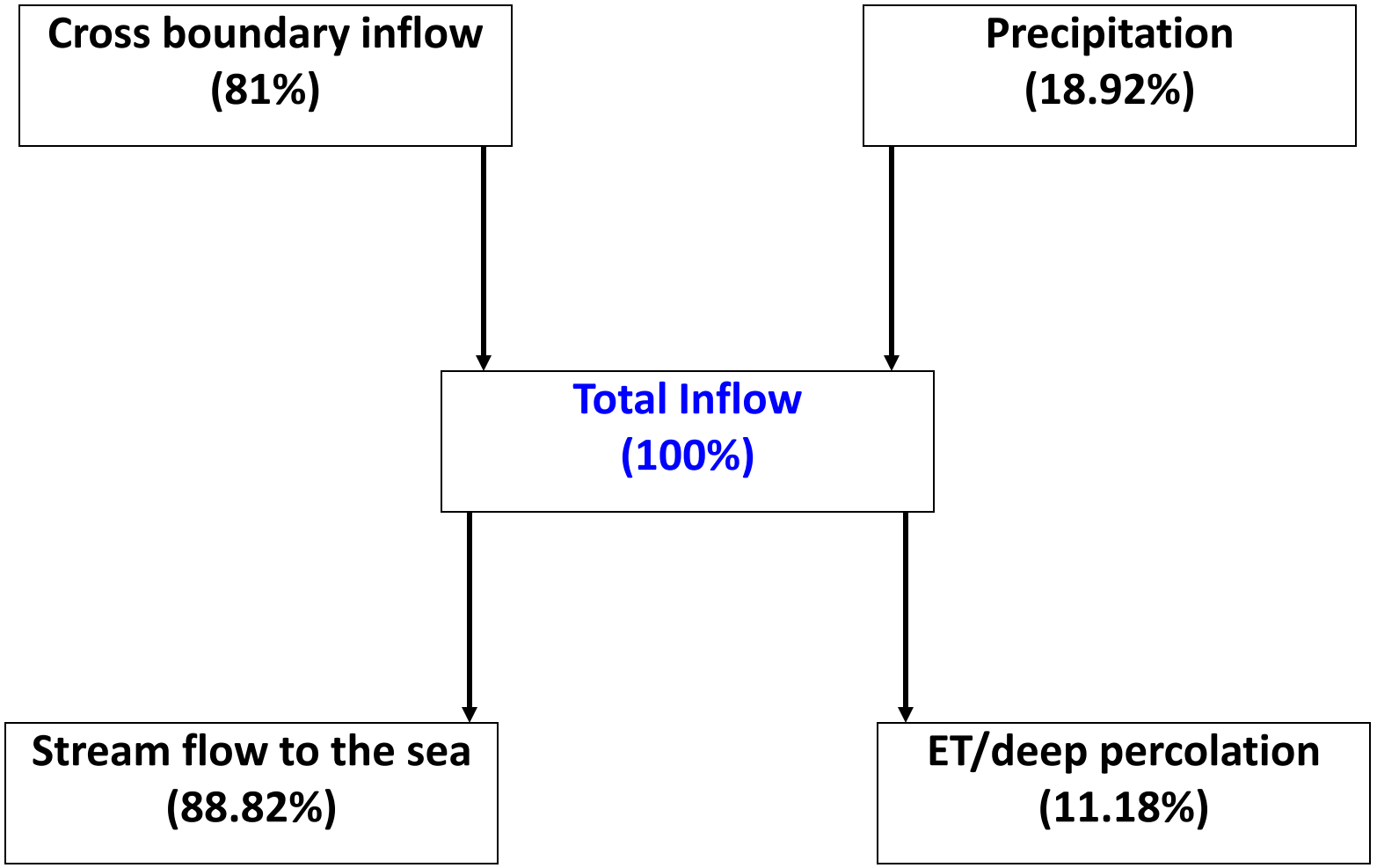
A graphical presentation of the data, indicating numbers of people in each age category, is called an age structure.



Water Resources in Bangladesh

- Water Budget: 1000 to 5000mm of rain. Over 200 large and small rivers, discharge about 175 billion cubic meter of water and 2.4 billion tons of sediment to the Bay of Bengal.
- Total catchment = 1.7 million sq. km, 8% in Bangladesh

Schematic water balance for average year



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Water Usage

- Water supply(Domestic use of water)
- Agricultural use
- Fisheries
- Navigation
- Hydropower

Water Issues

- Flood
- Drought
- Bank erosion
- Water logging
- Wetland conversion
- Water quality

Water Pollution

- Pollution: Degradation of water quality, how far it departs from the norm (standard), its effects on public health or its ecological impacts.
- Pollutant: Biological, physical or chemical substance that in identifiable excess is known to be harmful. Exp.: Excessive amounts of heavy metals, certain radioactive isotopes, fecal coliform bacteria, phosphorous, nitrogen, sodium, certain pathogenic bacteria and viruses.

Sources of Water Pollution

- *Surface Water:* Urban runoff, Agricultural runoff, Accidental spills of chemicals including oil, Radio active materials, Runoff from industrial sites, Leaks from surface storage tanks, Sediment from various source, Air fallout into rivers, lakes etc.
- *Groundwater:* Leaks from waste disposal sites, buried tanks and pipes, Seepage from agricultural activities, acid rich water from mines, septic systems, pesticides, herbicide nutrients, accidental spills and Salt water intrusion

Sources of Water Pollution

TABLE 20.1 Some Sources of Water Pollution

Surface Water	*Groundwater*
Urban runoff (oil, chemicals, organic matter, etc.) (U, I, M)	Leaks from waste disposal sites (chemicals, radioactive materials, etc.) (I, M)
Agricultural runoff (oil, metals, fertilizers, pesticides, etc.) (A)	Leaks from buried tanks and pipes (gasoline, oil, etc.) (I, A, M)
Accidental spills of chemicals including oil (U, R, I, A, M)	Seepage from agricultural activities (nitrates, heavy metals, pesticides, herbicides, etc.) (A)
Radioactive materials (often involving truck or train accidents) (I, M)	Saltwater intrusion into coastal aquifers (U, R, I, M)
Runoff (solvents, chemicals, etc.) from industrial sites (factories, refineries, mines, etc.) (I, M)	Seepage from cesspools and septic systems (R)
Leaks from surface storage tanks or pipelines (gasoline, oil, etc.) (I, A, M)	Seepage of acid-rich water from mines (I)
Sediment from a variety of sources, including agricultural lands and construction sites (U, R, I, A, M)	Seepage from mine waste piles (I)
Air fallout (particles, pesticides, metals, etc.) into rivers, lakes, oceans (U, R, I, A, M)	Seepage of pesticides, herbicide nutrients, and so on from urban areas (U)
	Seepage from accidental spills (train or truck accidents, for example) (I, M)
	Inadvertent seepage of solvents and other chemicals including radioactive materials from industrial sites or small businesses (I, M)

Key: U = urban; R = rural; I = industrial; A = agricultural; M = military.

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Categories of Water Pollutants

- Dead organic matter
- Pathogens
- Organic chemicals
- Nutrients
- Heavy metals
- Acids
- Sediments
- Heat
- Radioactivity

Categories of Water Pollution

TABLE 20.2 Categories of Water Pollutants

Pollutant Category	*Examples of Sources*	*Comments*
Dead organic matter	Raw sewage, agricultural waste, urban garbage	Produces biochemical oxygen demand and diseases.
Pathogens	Human and animal excrement and urine	Examples: Recent cholera epidemics in South America and Africa; 1993 epidemic of cryptosporidiosis in Milwaukee, Wisconsin. See discussion of fecal coliform bacteria under "Waterborne Disease."
Organic chemicals	Agricultural use of pesticides and herbicides (see Chapter 11); industrial processes that produce dioxin (Chapter 14)	Potential to cause significant ecological damage and human health problems. Many of these chemicals pose hazardous waste problems (see Chapter 27).
Nutrients	Phosphorus and nitrogen from agricultural and urban land use (fertilizers) and wastewater from sewage treatment	Major cause of artificial eutrophication. Nitrates in groundwater and surface waters can cause pollution and damage to ecosystems and people.
Heavy metals	Agricultural, urban, and industrial use of mercury, lead, selenium, cadmium, and so on (see Chapter 14)	Can cause significant ecosystem damage and human health problems. For example, mercury from industrial processes that is discharged into water (see Chapter 14).
Acids	Sulfuric acid (H_2SO_4) from coal and some metal mines; industrial processes that dispose of acids improperly	Acid mine drainage is a major water pollution problem in many coal mining areas, damaging ecosystems and spoiling water resources.
Sediment	Runoff from construction sites, agricultural runoff, and natural erosion	Reduces water quality and results in loss of soil resources.
Heat (thermal pollution)	Warm to hot water from power plants and other industrial facilities	Causes ecosystem disruption (see Chapter 14).
Radioactivity	Contamination by nuclear power industry, military, and natural sources (see Chapter 18)	Often related to storage of radioactive waste. Health effects vigorously debated (see Chapters 14 and 18).

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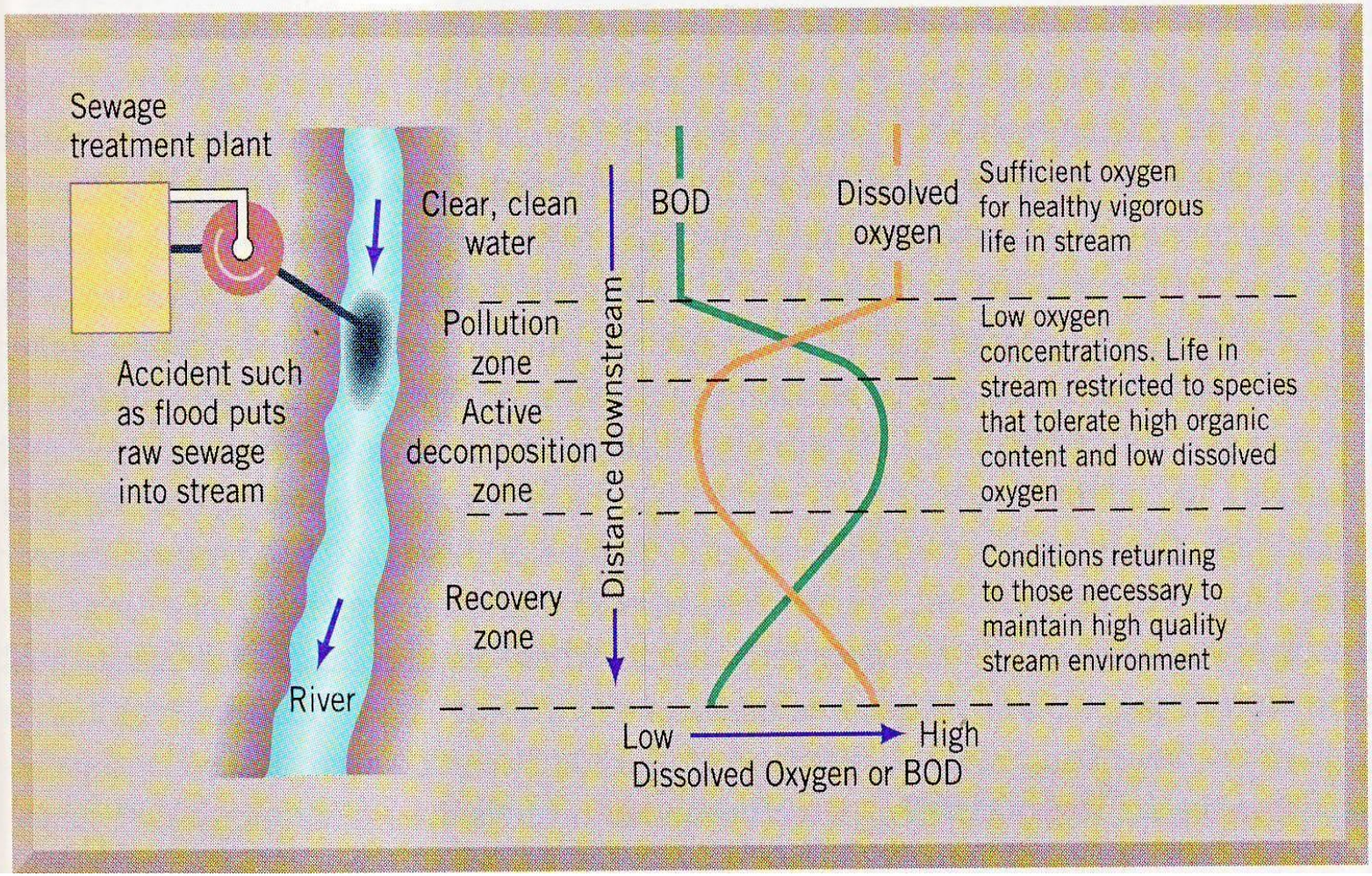
FIGURE 20.2 Relationship between dissolved oxygen and biochemical oxygen demand (BOD) for a stream following the input of sewage.



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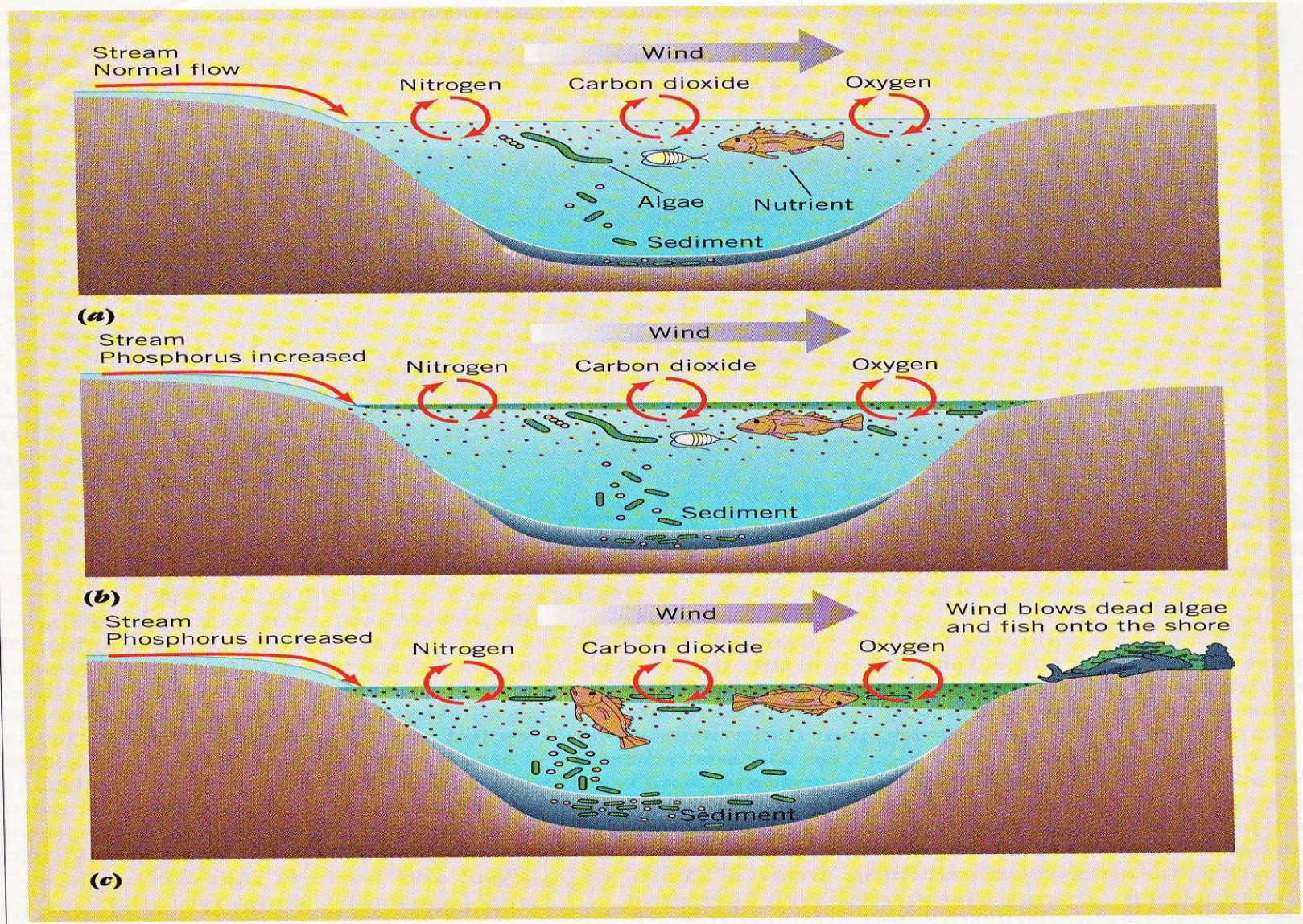
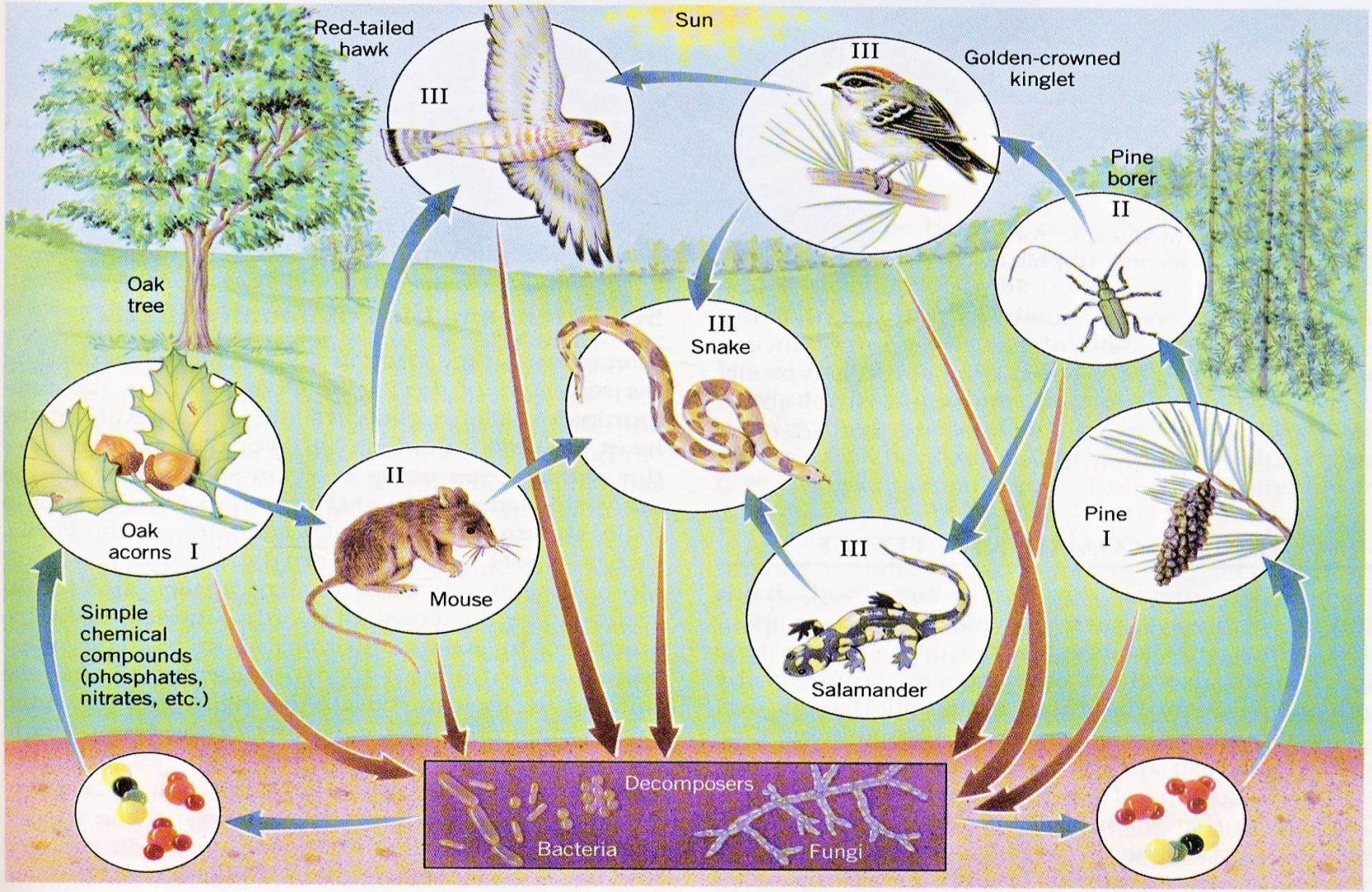


FIGURE 20.5 The eutrophication of a lake: (*a*) an oligotrophic, or low nutrient, lake; the algae (green) abundance is low, the water clear; (*b*) phosphorus is added to streams and enters the lake; algae growth is stimulated; a dense layer is formed; and (*c*) the algae layer becomes so dense that the algae at the bottom die; bacteria feed on the dead algae and use up the oxygen; fish die from lack of oxygen.

Ecosystem

- Biota refer to all living things (animals and plants including microorganisms) within a given area.
- For life to persist there must be several species within an environment that includes fluid media – air and water – to transport materials and energy.
- Life on earth is sustained by ecosystems that allow to them to sustain life.
- Sustaining life on earth requires more than individuals or species. The flow of energy and cycling of chemical elements.
- Components of ecosystem:
  - Producer
  - Consumer
  - Decomposer
  - Energy and chemical elements

FIGURE 6.3 Food webs: (*a*) a typical terrestrial food web. Roman numerals identify trophic levels.



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- Ecosystem is an open system in regard to energy and a closed system in regard to material.
- Biodiversity involves three different concepts: genetic diversity (the total number of genetic characteristics), habitat diversity (the diversity of habitat in a given unit area), and species diversity. Species diversity involves three ideas: species richness, species evenness and species dominance.

Environmental issues in Bangladesh

- Population: 40% people living below poverty line.
- 140 million will become 200 million soon. For the last 15 years we had less attention on population growth.
- Consequently pressure will built on our natural resources – wet land and forest.
- To meet the basic need – food, clothing, shelter, health care etc. population will be a big challenge. Villagers due to lack of job specially in agricultural sector moving towards urban area. Some are selling their last property to get better job in the middle-east or elsewhere.

Urban

- Air Pollution
- Noise Pollution
- Solid waste
- Hospital waste
- Water Pollution
- Encroachment of open space

Rural

- Arsenic
- Agricultural output
- Industrial output
- Indoor (Kitchen) air pollution
- Lack of sanitation

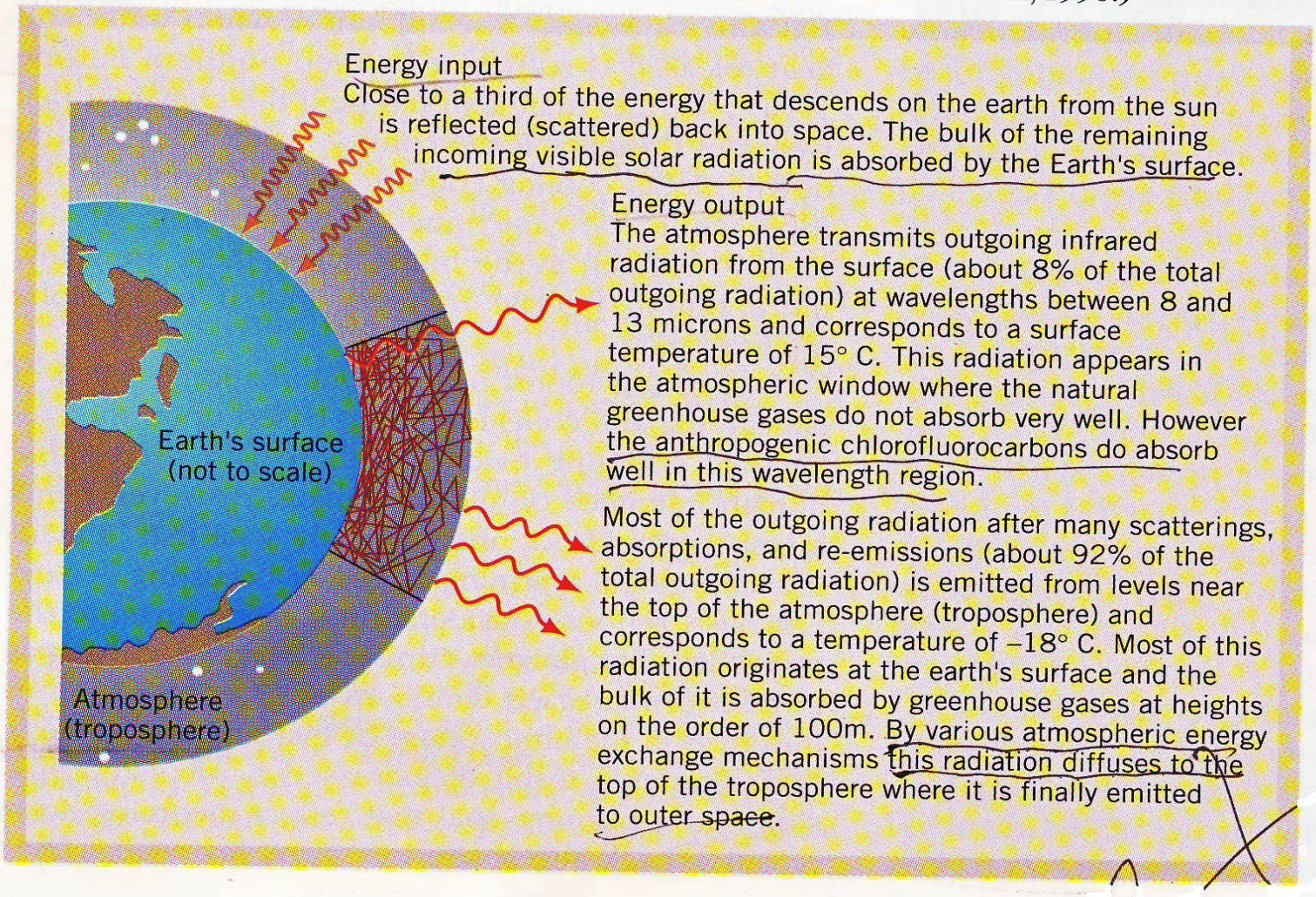
Natural Habitat

- Existing 5-7% forest coverage whereas 20-25% recommended
- Affect in Bio-diversity: 450 species were available now which will be reduced to 250.

Global Warming

- Increase in temperature
  - Extreme events like flood and drought will occur more frequently with high intensity. By 2050 about 50 m people will be affected due to flood and about 20 m people will be affected due to drought.
  - 6% low lying land will go under water and about 6 million people will Migrate and will create environmental refugee.
  - Trans-boundary issue: 75% of glacier in the Himalayas will vanish by 2030: Food security/Navigation/Agriculture

FIGURE 21.7 Idealized diagram showing greenhouse effect. Incoming visible solar radiation is absorbed by the Earth's surface to be reemitted in the infrared region of the electromagnetic spectrum. Most of this reemitted infrared radiation is absorbed by the atmosphere maintaining the greenhouse effect. (*Source:* Developed by M. S. Manalis and E. A. Keller, 1990.)



Adaptation

- Government, NGO, Civil Societies, Media
- Institutional weaknesses must be removed, more resources must be Diverted: DOE, inter-agency cooperation must be improved.
- Need regional cooperation like building reservoir in Nepal.
- Crop diversity, Floating Garden, Change profession etc.

Air Pollution

- **London smog:** December 1952 – air in London become stagnant and cloud cover blocked incoming solar radiation.

  In a week 4000 people died.
- **Slash and burn**

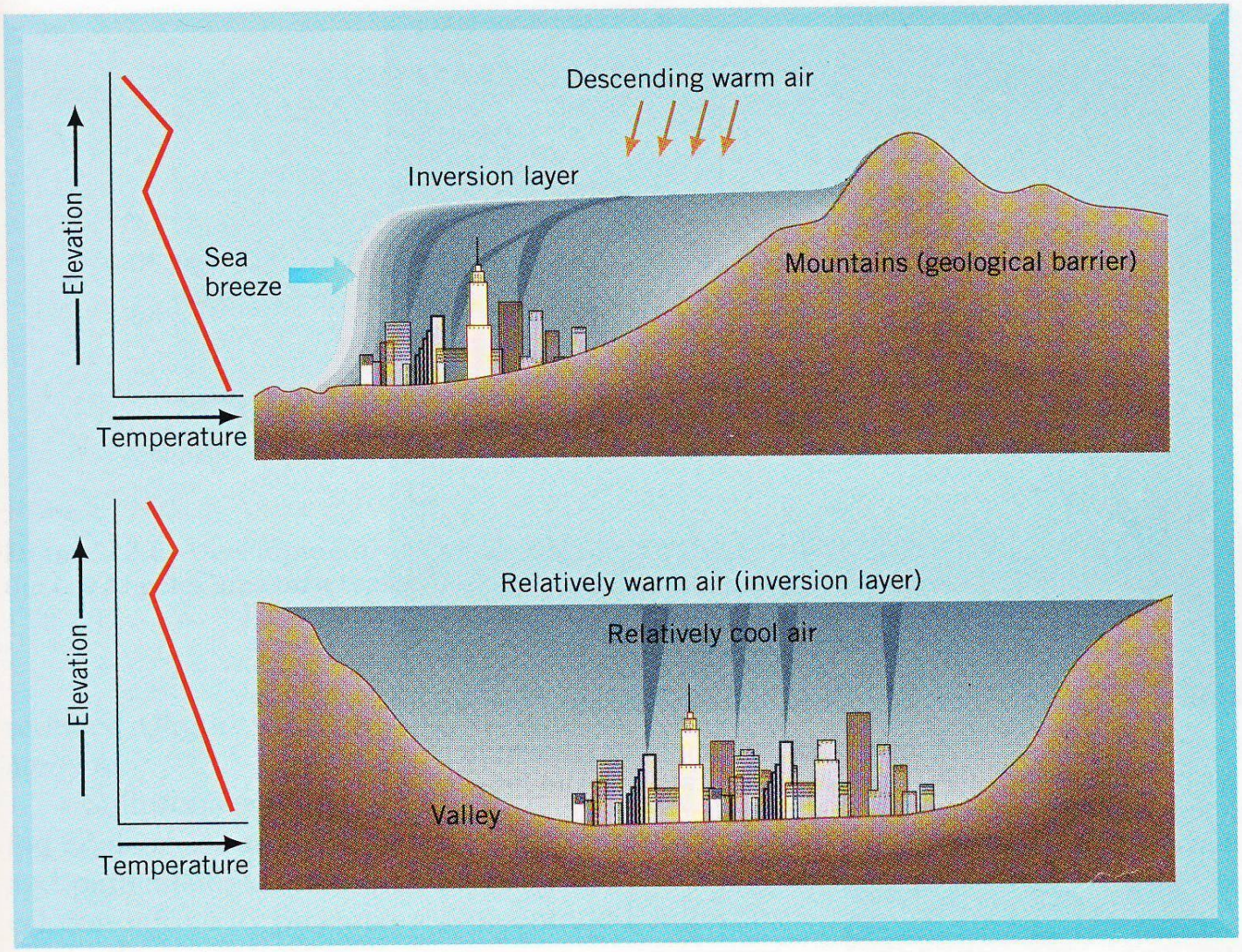
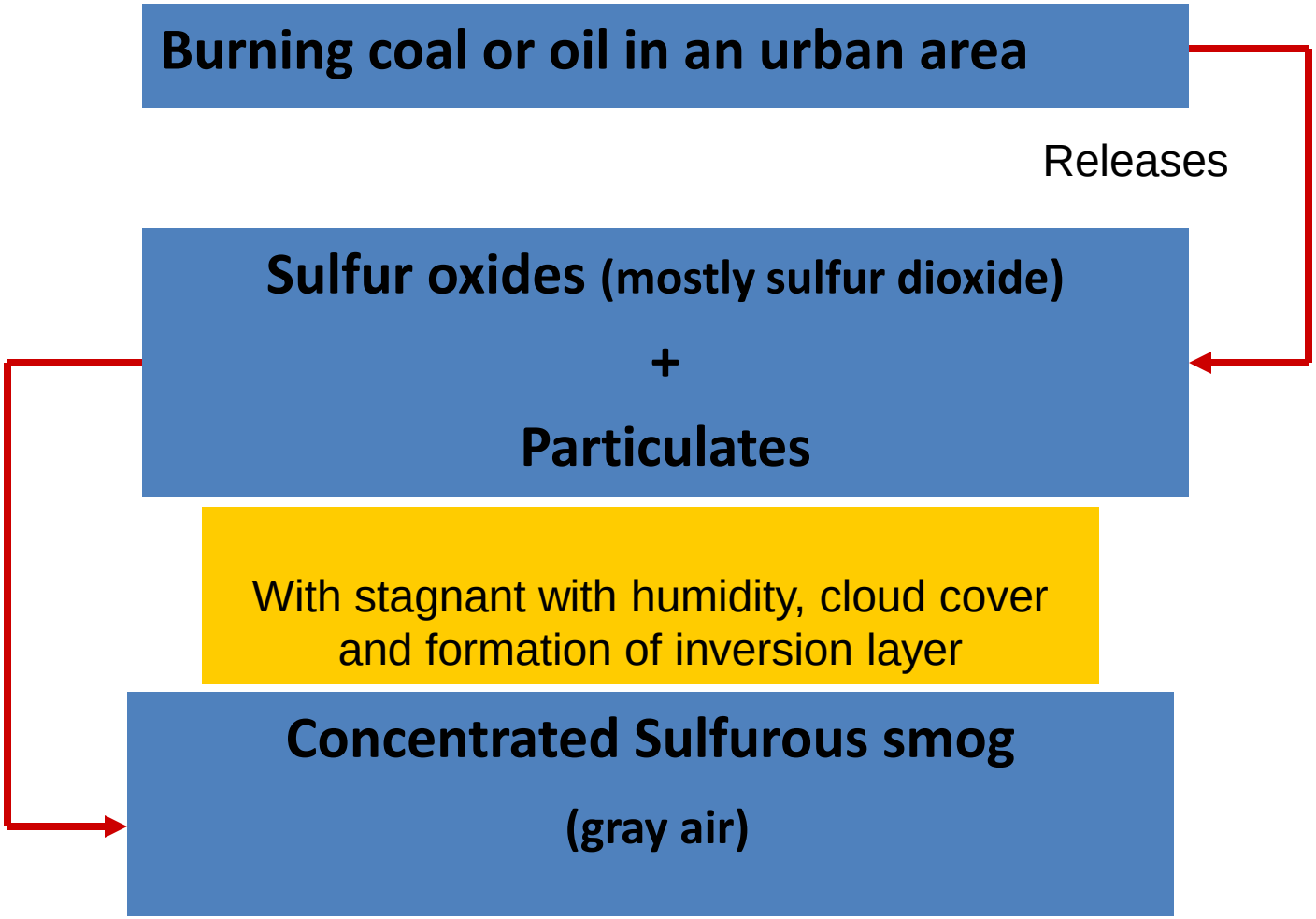


FIGURE 22.4 Two causes for the development of a temperature inversion, which may aggravate air pollution problems.

Sulfurous Smog



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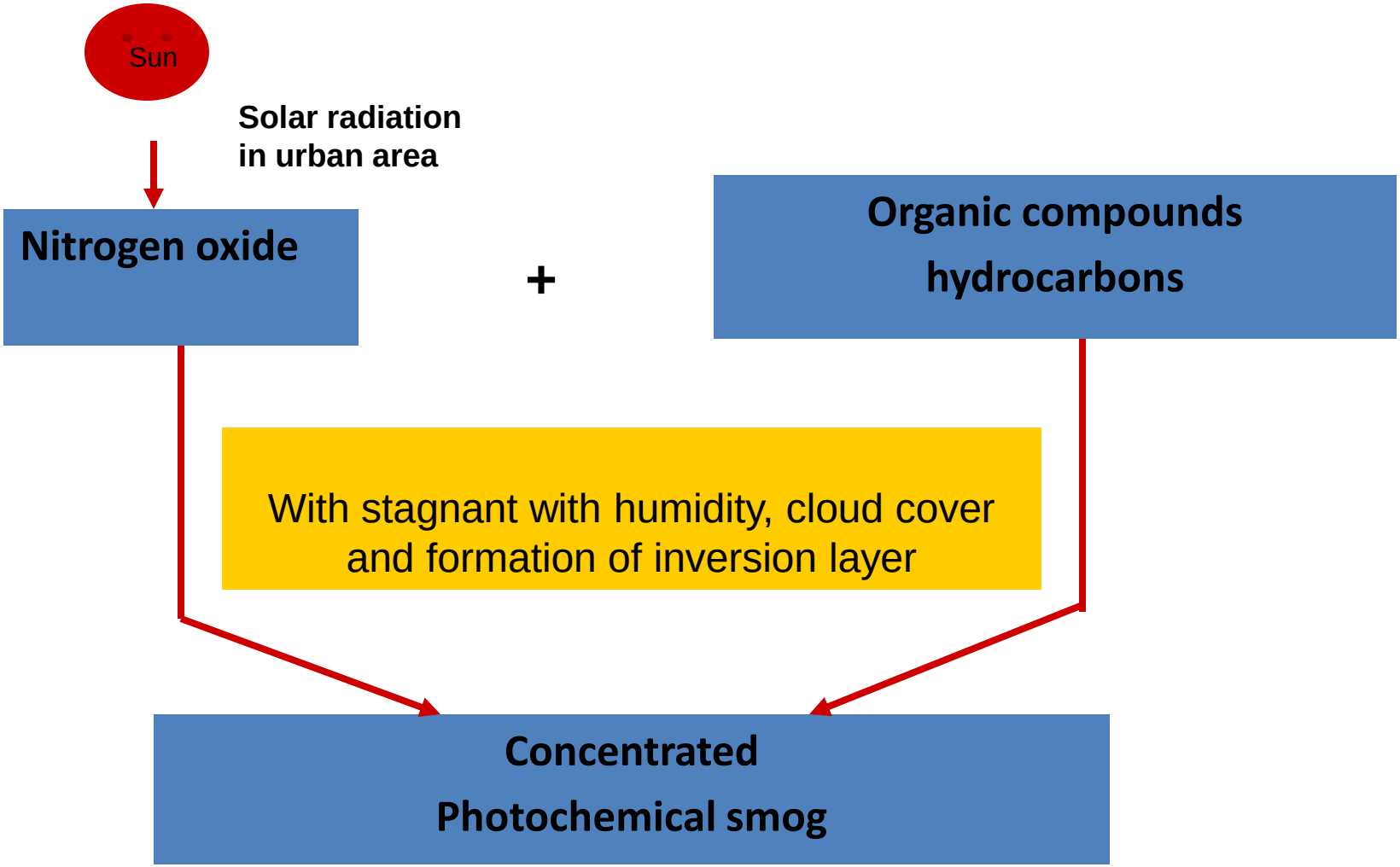
Photochemical Smog



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General Effects of Air Pollution

- **Visually aesthetic resources**
- **Vegetation**
- **Animals**
- **Soils**
- **Water quality**
- **Structures, and**
- **Human health**

Sources of Air Pollution

- **Stationary sources: Point sources, Fugitive sources and area sources**
- **Mobile sources**

Air Pollutants

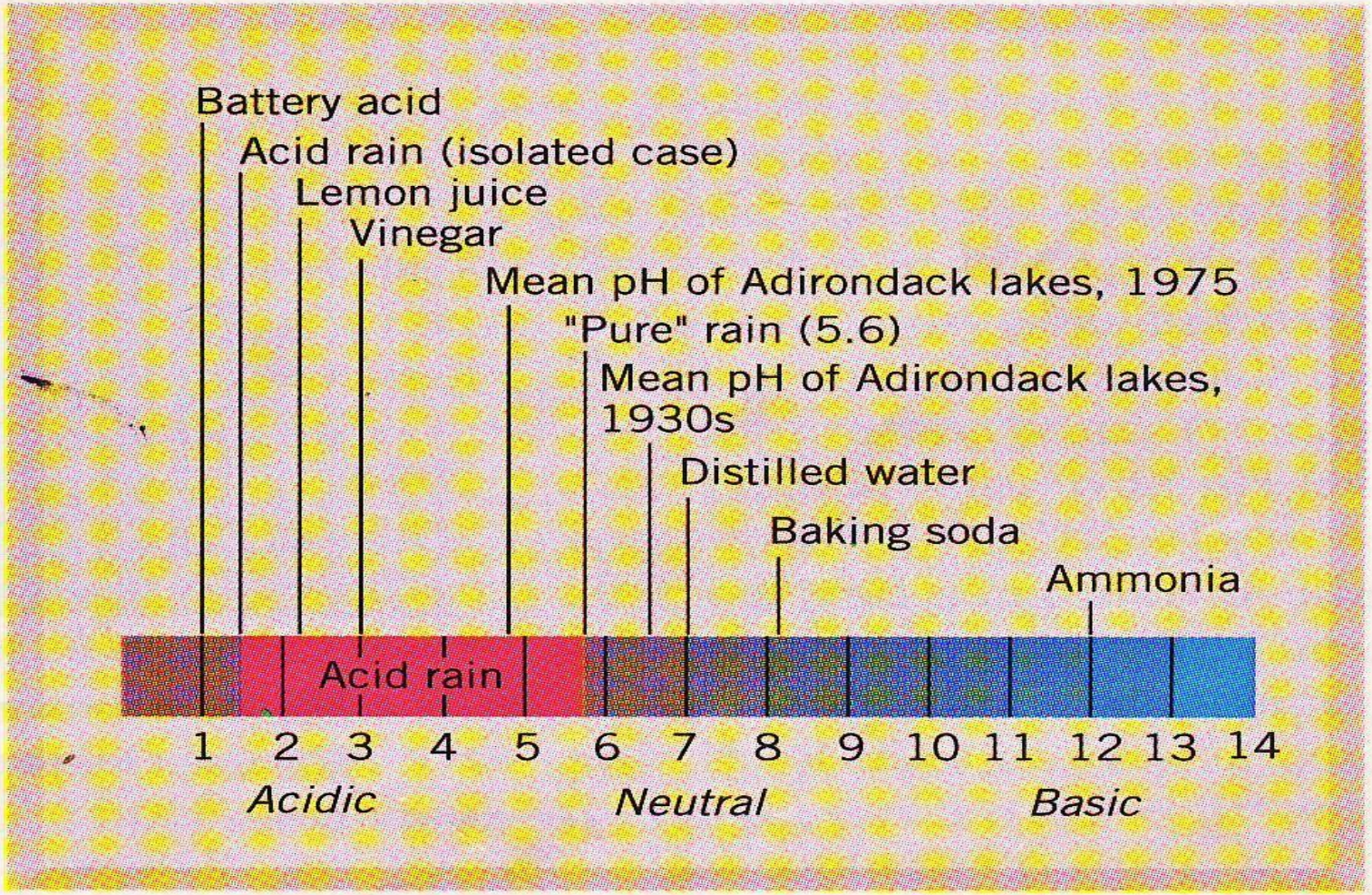
- **Primary pollutants: Particulates, Sulfur dioxide, Carbon monoxide, Nitrogen dioxide and hydrocarbon**
- **Secondary pollutants: ozone**

Acid Rain

Acid rain encompasses both wet (rain, snow, fog) and dry (particulate) acidic depositions that occur near and downwind of areas where major emissions of sulfur dioxide (SO_2) and nitrogen oxides (NOx) result from burning fossil fuels.

Acid rain is defined as precipitation in which P^H below 5.6

FIGURE 22.11 The pH scale. (*Source:* Modified after U.S. Environmental Protection Agency, 1980.)



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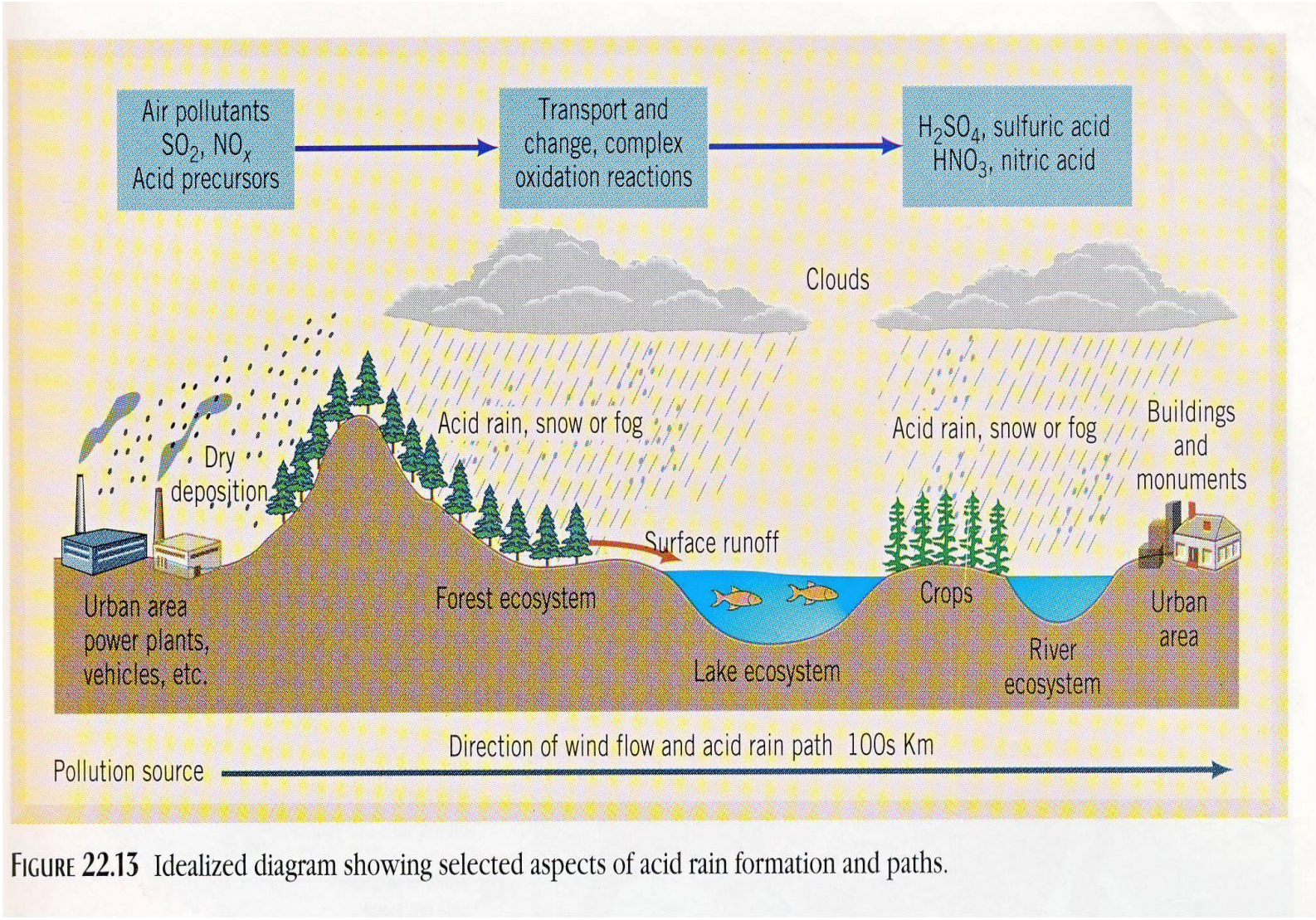

FIGURE 22.13 Idealized diagram showing selected aspects of acid rain formation and paths.

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Renewable Energy

The renewable sources are solar energy, water (hydro) power, wind power and energy derived from biomass.

Non – Renewable Energy

Fossil fuel