Geology is the science of processes related to the composition, structure, and history of Earth and its life. Geology is an interdisciplinary science, relying on aspects of chemistry (composition of Earth's materials), physics (natural laws), and biology (understanding of life forms).

Engineering Geology is the application of the geological sciences to engineering that's mean provides the use of geological data for practical engineering purposes.

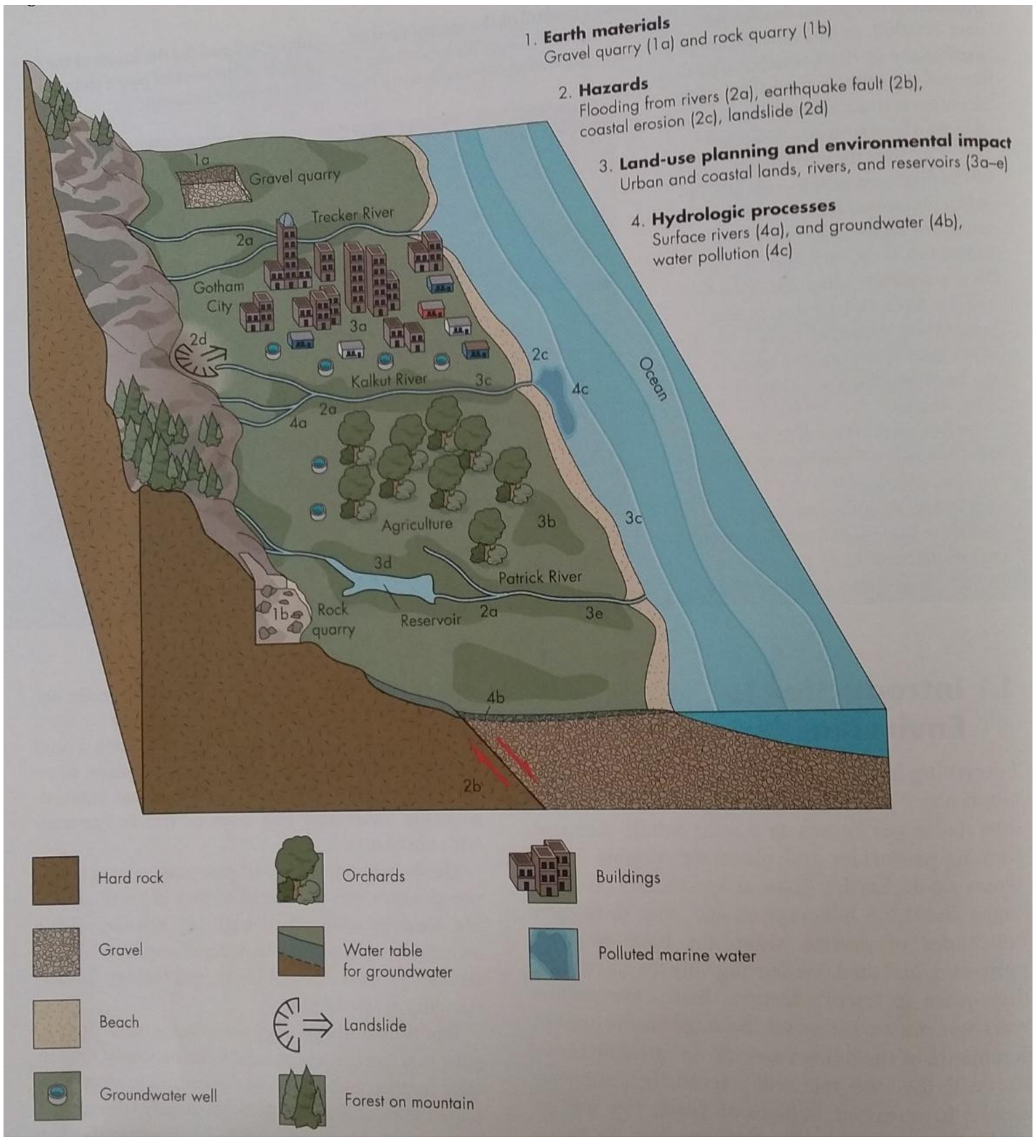


Fig.1 Components of environmental geology idealized diagram illustrating four main areas of study for environmental geology. Geologic processes encompass all four areas. These offer employment opportunities for geologists, engineers and hydrologists.

The relationship between Geological Engineering and other engineering sciences

- Civil Engineering (safe and economical construction of buildings)

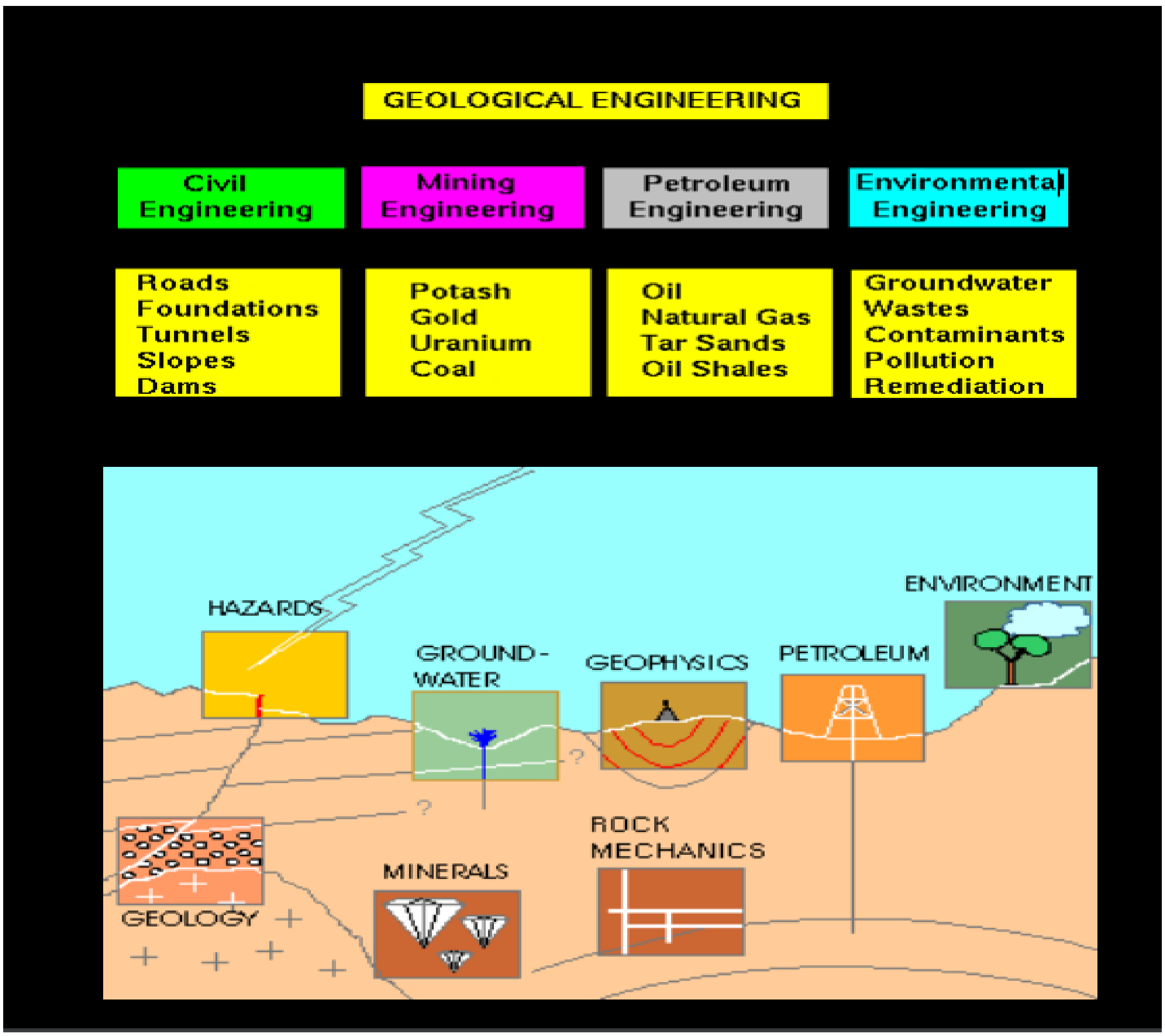
- Mining Engineering (safety and economic factors in mining deposition operating and development)

- Petroleum Engineering (Economic design for extracting petroleum and obtaining petroleum products)

- Geophysical Engineering (earth physical proper sties and its engineering applications)

- Architecture (project designing)

- City and Regional Planners



Environmental geology is applied geology. Specifically, it is the use of geologic information to help us solve conflicts in land use, to minimize environmental degradation, and to maximize the beneficial results of using our natural and modified environments. The application of geology to these problems includes the study of the following (Fig.1):

1- Earth materials, such as minerals, rocks, and soils to determine how they form, their potential use as resources or waste disposal sites, and their effects on human health
2- Natural hazards, such as floods, landslides, earthquakes, and volcanic activity, in order to minimize loss of life and property.
3- Land for site selection, land use planning, and environmental impact analysis.
4- Hydrologic processes of ground water and surface water resources and water pollution problems.
5- Geologic processes, such as deposition of sediment on the ocean floor, the formation of mountains, and the movement of water on and below the surface of Earth, to evaluate local, regional, and global change.

Fundamental Concepts of Environmental Geology

There are main five concepts for studying the environmental geology:

1- Human population growth, 2- Sustainability, 3- Earth as a system, 4- Hazardous earth process and 5- Scientific knowledge and values.

1-Human Population Growth

The number one environmental problem is the ever-growing human population. For most of human history, our numbers were small, as was our impact on Earth. With the advent of agriculture, sanitation, modern medicine and especially, inexpensive energy sources, such as oil, we have proliferated to the point where our numbers are a problem. The total environmental impact from people is estimated by the impact per person multiplied by the total number people. Therefore, as population increases, more resources are needed and given our present technology, greater environmental disruption results.

Factors in population change

Rates of birth, death, and migration determine whether a population grows, shrinks, or remains stable. Birth and immigration add individuals. Death and emigration remove individuals. Technological advances cause decreased deaths. The increased gap between birth and death rates resulted in population expansion. Natural rate of population change: change due to birth and death rates alone, excluding migration

The IPAT Equation

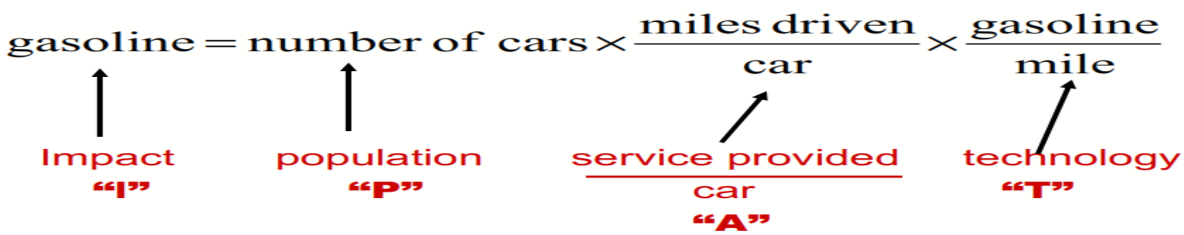
$$\text{Impact} = \text{Population} \times \frac{\text{Goods \& Services}}{\text{Person}} \times \frac{\text{Impact}}{\text{Goods \& Services}}$$

$$I = P \times A \times T$$

One of the earliest attempts to describe the role of multiple factors in determining environmental degradation was the IPAT equation. It describes the multiplicative contribution of population (P), affluence (A) and technology (T) to environmental impact (I). Environmental impact (I) may be expressed in terms of resource depletion or waste accumulation; population (P) refers to the size of the human population; affluence (A) refers to the level of consumption by that population; and technology (T) refers to the processes used to obtain resources and transform them into useful goods and wastes. The formula was originally used to emphasize the contribution of a growing global population on the environment, at a time when world population was roughly half of what it is now. It continues to be used with reference to population policy. For example:

1. Gasoline Used in Automobiles

What are the factors that influence the amount of gasoline we burn in automobiles?



2. Energy used to make pig iron

$$\text{Energy} = \text{number of factories} \times \frac{\text{pig iron}}{\text{factory}} \times \frac{\text{energy}}{\text{pig iron}}$$

$$\text{Energy} = \text{pig iron produced} \times \frac{\text{energy}}{\text{pig iron}}$$

Again the energy used per ton pig iron produced depends upon the technology used.

3. Carbon emissions

$$\text{Carbon} = \text{Population} \times \frac{\text{GWP}}{\text{Pop}} \times \frac{\text{Energy}}{\text{GWP}} \times \frac{Carbon}{Energy}$$

$$\frac{\Delta\text{Carbon}}{\text{Carbon}} = \;+1\% \quad +2\% \quad -1.25\% \quad -0.25\% \;=\; +1.5\%$$

2-Sustainability

Sustainability is development which ensures that future generations will have equal access to the resources that our planet offers. Sustainability also refers to types of development that are economically viable, do not harm the environment, and are socially just. Sustainability is a long-term concept, something that happens over decades or even hundreds of years.

Sustainability related to respect to use of resources is possible for renewable resources such as air and water. Sustainability development with respect to nonrenewable resources such as fossil fuels and minerals is possible by:

- Extending their availability through conservation and recycling
- Focusing on when a particular nonrenewable resource is depleted, focusing on how that mineral is used and developing substitutes for those uses.

Environmental Crisis?

Demands made on diminishing resources by a growing human population and the ever-increasing production of human waste have produced what is popularly referred to as **the environmental crisis**. This crisis in world is a result of overpopulation, urbanization, and industrialization, combined with too little ethical for our land and inadequate institutions to cope with environmental stress.

The rapid use of resources continuous to cause environmental problems on a global scale, including the following:

1- Deforestation and accompanying soil erosion and water and air pollution occur on many continents.
2- Mining of resources, such as metals, coal, and petroleum, whatever they occur produces a variety of environmental problems
3- Development of both groundwater and surface water resources results in loss of and damage to many environments on a global scale.

3- Earth as a System

The earth system is itself an integrated system, but it can be subdivided into four main components, sub-systems or spheres: the geosphere, atmosphere, hydrosphere and biosphere. These components are also systems in their own right and they are tightly interconnected. The four main components of the earth system may be described briefly in the following way.

The geosphere - this is the part of the planet composed of rock and minerals; it includes the solid crust, the molten mantle and the liquid and solid parts of the earth's core. In many places, the geosphere develops a layer of soil in which nutrients become available to living organisms, and which thus provides an important ecological habitat and the basis of many forms of life. The surface of the geosphere is subject to processes of erosion, weathering and transport, as well as to tectonic forces and volcanic activity, which result in the formation of landforms such as mountains, hills and plateaux.

The atmosphere - this is the gaseous layer surrounding the earth and held to its surface by gravity. The atmosphere receives energy from solar radiation which warms the earth's surface and is re-emitted and conducted to the atmosphere. The atmosphere also absorbs water from the earth's surface via the process of evaporation; it then acts to redistribute heat and moisture across the earth's surface. In addition, the atmosphere contains substances that are essential for life, including carbon, nitrogen, oxygen and hydrogen.

The hydrosphere - this consists of those parts of the earth system composed of water in its liquid, gaseous (vapour) and solid (ice) phases. The hydrosphere includes: the earth's oceans and seas; its ice sheets, sea ice and glaciers; its lakes, rivers and streams; its atmospheric moisture and ice crystals; and its areas of permafrost. The hydrosphere includes both saltwater and freshwater systems, and it also includes the moisture found in the soil (soil water) and within rocks (groundwater). Water is essential for the existence and maintenance of life on earth. In some classifications, the hydrosphere is sub-divided into the fluid water systems and the **cryosphere** (the ice systems).

The biosphere - this contains all living organisms and it is intimately related to the other three spheres: most living organisms require gases from the atmosphere, water from the hydrosphere and nutrients and minerals from the geosphere. Living organisms also require a medium for life, and are adapted to inhabit one or more of the other three spheres. However, much of the biosphere is contained within a shallow surface layer encompassing the lower part of the atmosphere, the surface of the geosphere and approximately the upper 100 metres of the ocean. Humans are part of the biosphere, although they are increasingly responsible for the creation of systems that may be largely artificial (such as cities).

The Earth System and its Components

The main components of the earth system are interconnected by **flows** (also known as **pathways** or **fluxes**) of energy and materials. The most important flows in the earth system are those concerned with the transfer of energy and the cycling of key materials in biogeochemical cycles.

Energy flows

The earth is a vast, complex system powered by two sources of energy: an internal source (the decay of radioactive elements in the geosphere, which generates geothermal heat) and an external source (the solar radiation received from the Sun); the vast majority of the energy in

the earth system comes from the Sun. Whilst some variations in these two sources occur, their energy supplies are relatively constant and they power all of the planet's environmental systems. Indeed, energy both drives and flows through environmental systems, and energy pathways may be highly complex and difficult to identify. For instance, energy may take the form of latent heat which is absorbed or released when substances change state (for example, between the liquid and gaseous phases). An example of energy flow and
transformation through an ecosystem is illustrated in Fig.2 Energy is transferred within and between environmental systems in three main ways:

radiation - this is the process by which energy is transmitted through space, typically in the form of electromagnetic waves

convection - this is the physical movement of fluids (such as water or air) that contain energy in the form of heat; convection does not occur in solids

conduction - this is the transfer of energy in the form of heat through the substance of a medium (from molecule to molecule)

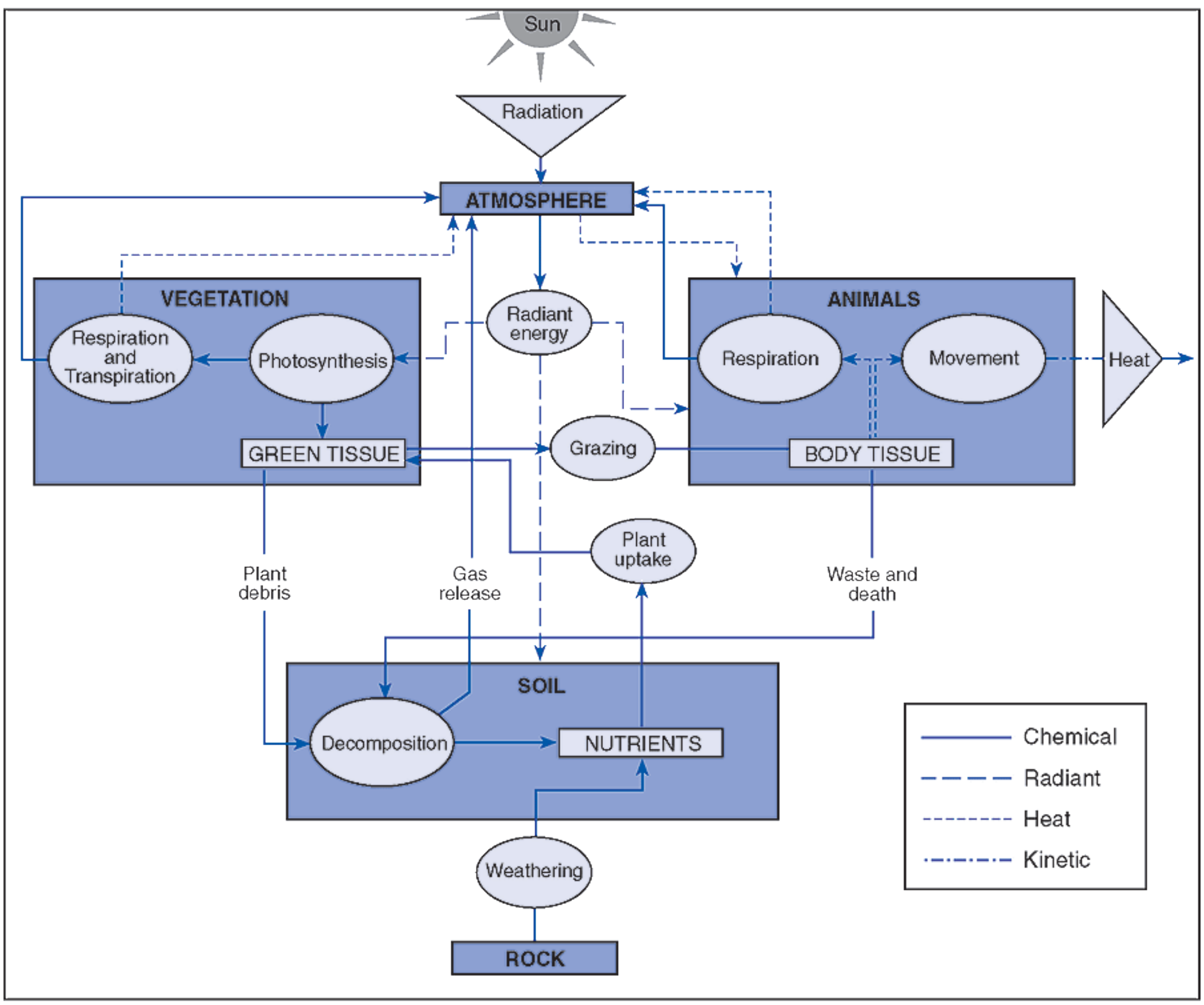
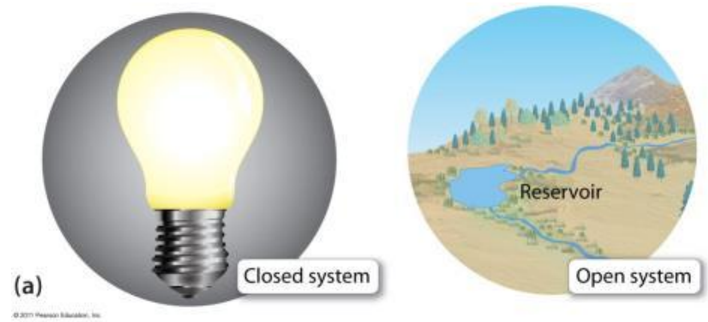


Fig.2 energy flows and transformations in terrestrial ecosystems

Another definition of system is Any size group of interacting parts that form a complex whole, it can be open or closed systems. Fig.3

(a) A closed system is one that exchanges only energy with its surroundings.

(b) An open system can exchange matter as well. If a reservoir is an open system, its size will be affected by the relative amounts of flux in and flux out of the system. If transfers of energy and matter into and out of an open system are about the same, the system is said to be in a steady state



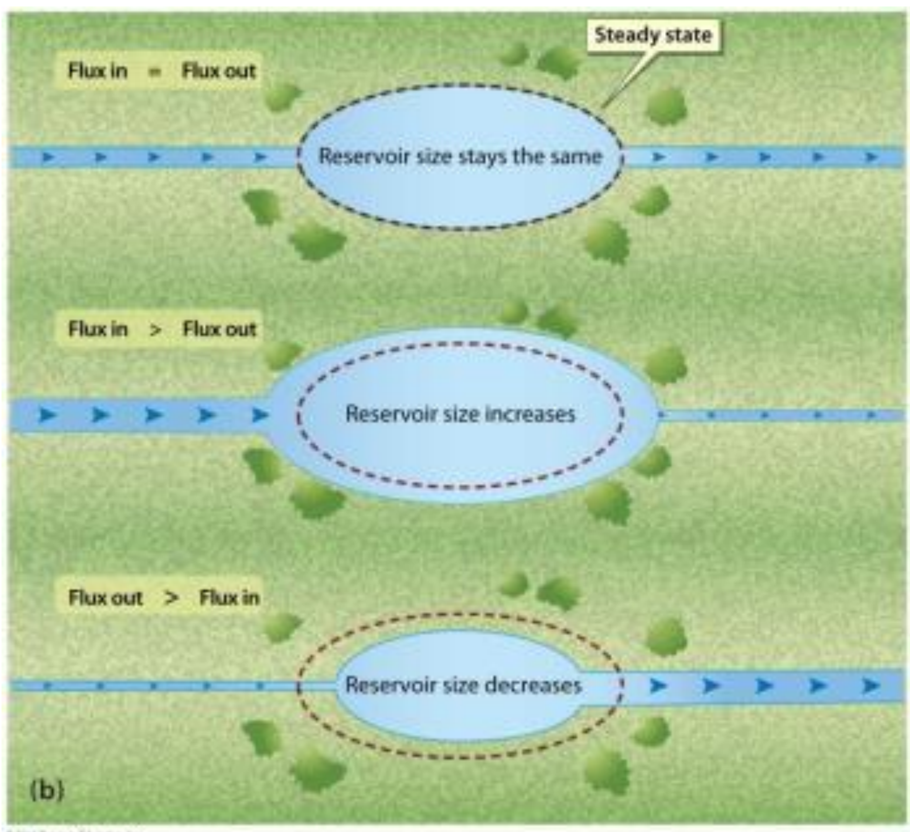


Fig.3 Reservoirs and Flux

4- Hazardous Earth Process

There have always been earth processes that are hazardous to people. These natural hazards (such as storms, floods, earthquakes, landslides and volcanic eruptions) must be recognized and avoided when possible, and their threat to human life and property must be minimized.

Natural hazardous that produce disasters are becoming super disasters called Catastrophes. An emerging principle concerning natural hazardous is that, as a result of human activity (e.g. population increase and changing the land through agriculture, logging, mining, urbanization) what are formerly disasters are becoming catastrophes. For example:

- Human population increase has forced more people to live in hazardous areas, such as in floodplains, on steep slopes (where landslides are more likely), and near volcanoes.
- Land-use transformations, including urbanization and deforestation, increase runoff and flood hazard and may weaken slopes, making landslides more likely.
- Burning vast amounts of oil, gas and coal has increased the concentration of carbon dioxide in the atmosphere, contributing to warming the atmosphere and oceans. As a result, more energy is fed into hurricanes. The number of hurricanes has not increased, but the intensity and size of the storms have increased.

5-Scientific Knowledge and Values

The results of scientific inquiry to solve a particular environmental problem often provide a series of potential solutions consistent with the scientific finding. The chosen solution is a reflection of our value system. Fig.4 Science the steps in the scientific method

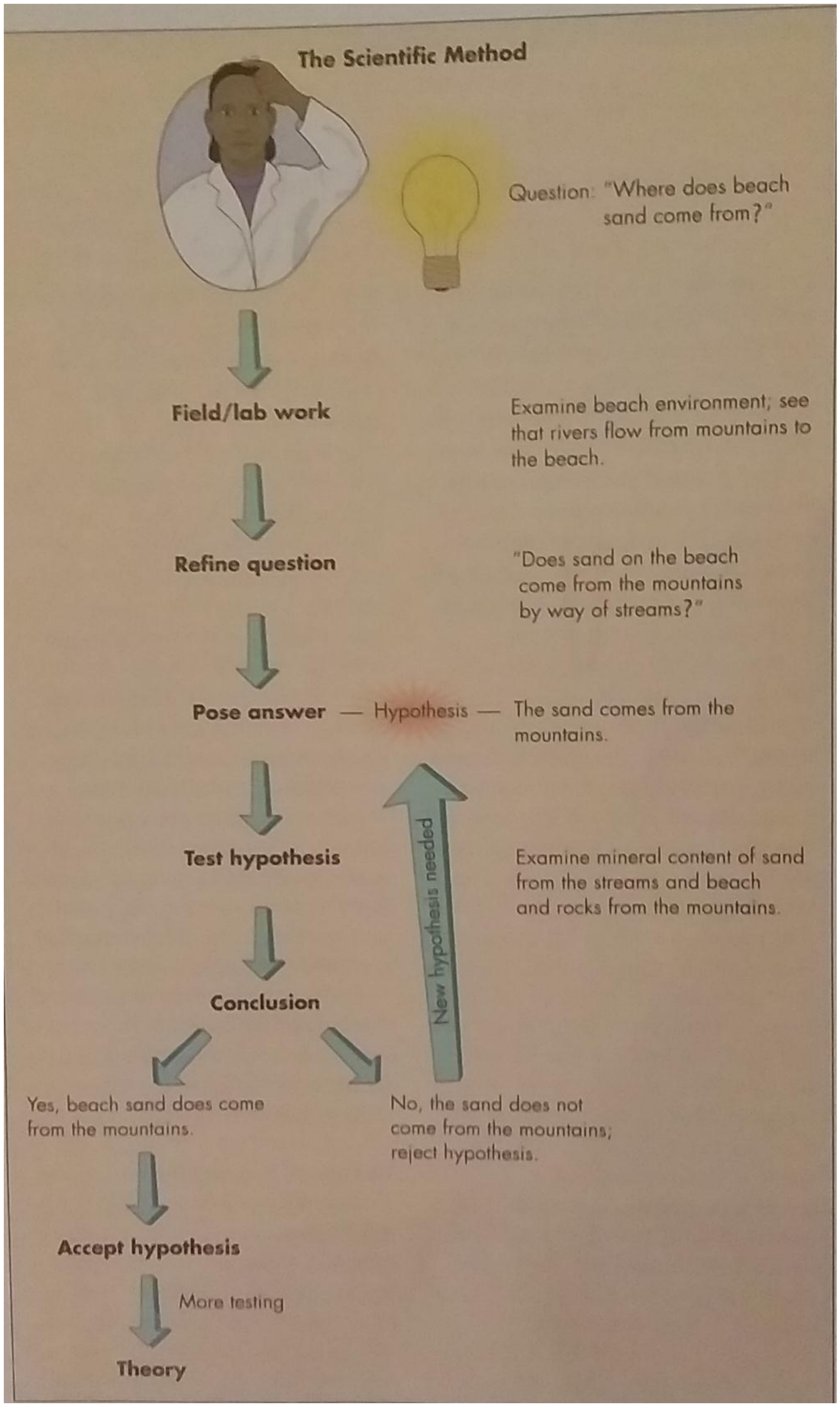


Fig.4 Science the steps in the scientific method