ECOLOGY AND POLLUTION

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Ecology

Ecology

Introduction:

Ecology is the branch of biology that draws all of the other components together. It demands a synthesis of physiology, anatomy, morphology, genetics and other aspects of biology.

The word *ecology* is derived from the Greek *oikos,* meaning "household," and *logos,* meaning "study." Thus, the study of the environmental house includes all the organisms in it and all the functional processes that make the house habitable. Literally, then, ecology is the study of "life at home" with emphasis on "the totality or pattern of relations between organisms and their environment.

Ecology is the scientific study of the interaction of organisms with each other, along with their relationship with other organisms and their ecosystem.

brief history of ecology:

Man has been interested in ecology in a practical sort of way since early his history. In primitive society every individual to survive, needed to have definite knowledge of his environment, i.e. ,of the forces of nature and of the plants and animals around him. Civilization, in fact, began when man learned to use fire and other tools to modify his environment. It is even more necessary than ever for mankind as a whole to have an intelligent knowledge of the environment if our complex civilization is to survive.

Like all phases of learning, the science of ecology has had a gradual if spasmodic development during recorded history. The writings of Hippocrates, Aristotle, and other philosophers of ancient Greece clearly contain references to ecological topics. However, the Greeks did not have a word for ecology. The word *ecology* is of recent origin, having been first proposed by the German biologist Ernst Haeckel in 1869.Haeckel defined *ecology* as "the study of the natural environment including the relations of organisms to one another and to their surroundings". Before this, during a biological renaissance in the eighteenth and nineteenth centuries, many scholars had contributed to the subject, even though the word *ecology* was not in use. For example, in the early 1700s, Antoni van Leeuwenhoek, best known as a premier microscopes', also pioneered the study of food chains and population regulation, two important areas of modern ecology.

The Scope of Ecology and it is relation with other sciences:

Perhaps the best way to delimit modern ecology is to consider it in terms of the concept of levels of organization, visualized as a sort of biological spectrum as shown in down (Scheme.- 1)

Atom → Molecules → Organelles → Cells → Tissues → Organs →

Organisms →Populations → Communities →Ecosystems → →Ecosphere

(Scheme.- 1) **(Levels of Organization or biological spectrum)**

1. Organism: An individual
2. Population: all the members of a species inhabiting a given location
3. Community: all the interacting populations in a given area
4. Ecosystem: the living community and the physical environment functioning together as an independent and relatively stable system

Biome: A large group of **ecosystems** that share the same climate and have similar types of communities.

Includes:

- Tundra
- Taiga
- Desert
- Temperate deciduous forest
- Temperate rain forest
- Tropical rain forest, and grassland

5. Biosphere: that portion of the earth(All **biomes** together the Earth)

   where life exists,

a. The biosphere is composed of numerous complex ecosystems.

b. An ecosystem involves interactions between abiotic (physical) and biotic (living) factors. The members of the community in the ecosystem and environment must interact to maintain a balance.

Divisions of ecology:

First)<u>Ecology is divided into three main environmental:</u>

1- Aquatic ecology.

It is study aquatic organisms and relationship with each other and their abiotic factors which surround living things.

Aquatic ecology to include:

- Marine Ecology.
- Estuaries Eco.
- Fresh water ice.

2- Terrestrial Eco.

It is study organisms in any location on earth and also study the organism's relationship with each other and their abiotic factors this study it is easy for archaeologists because scientist can reach to any location on earth.

A) Perhaps we can terrestrial ecology divide depend on earth topographic example:

- Mountain Eco.
- Plateau Eco.
- Plain Eco.
- Hill Eco.
- Desert Eco.

B) We can divide terrestrial ecology upon the location from the equator:

- Tropical Eco.
- Subtropical Eco.
- Temperate Eco.
- Polar Eco.

C) Terrestrial ecology also divided depending on kinds of ecosystems to :

- Forest Eco.
- Crop Eco.
- Grassland Eco.
- Weed Eco.
- Greenland Eco.
- Urban Eco.

D) Terrestrial ecology, divided depending on different animal classification too:

- Birds Eco.
- Insects Eco.
- Mammals Eco.
- Reptiles Eco.

3- Air Eco.

It is studying the air

Second)In regard to subdivision, ecology is some time divided into:

1- Autecology:

autecology deals with the study of the individual organism or an individual species

2- Synecology:

Sociology deals with the study of the groups of organism which are associated together as a unit.

Thus, if a study is made of relation of a white Oak tree (or of white oak trees in general) or wood thrush (or of wood thrushes in general) to the environment ,the work would be autecological in nature , If the study concerned the forest in which the white oak or the wood thrush lives, the approach would be synecological

Third) Ecology is divided upon the species and number of organisms:

Divided into:

- Individual Eco.
- Population Eco.
- Community Eco.
- Biosphere Eco.

Forth) Ecology is divided upon its relation of other sciences: divided Into:

- Ecophysiology.
- Geographical Eco.
- Pale ecology.
- Behavior Eco.
- Applied Eco.

Fifth) Although organisms in natural consist of plants and animals so ecology is divided into :

- Plant ecology.
- Animal or zoo ecology.

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The Ecosystem

The term ecosystem is a combination of two words "Ecological" and " system". Arthur Tansley, a British ecologist, was the first person to use this term in a published work.

The Ecosystem: is a system formed by the interaction of a community of organisms with their environment in a particular area.

Any ecosystem is composed of two constituents:

i- Abiotic (non-biological) constituents include minerals, climate, soil, water, sunlight, and all other nonliving elements.
ii- biotic constituents consist of all its living members (plants, animals, bacteria & viruses).

The biosphere is composed of numerous complex ecosystems.

. An ecosystem involves interactions between abiotic (physical) and biotic (living) factors. The members of the community in the ecosystem and environment must interact to maintain a balance.

- An ecosystem is self-sustaining if the following requirements are met:

1. A constant source of energy and a living system capable of incorporating this energy into organic molecules.

2. A cycling of materials between organisms and their environment.

- In all environments, organisms with similar needs may compete with each other for resources, including food, space, water, air, and shelter.

Components of ecosystem :

1) Abiotic factors:

- those physical and chemical factors which affect the ability of organisms to survive and reproduce

Some Abiotic Factors:

1. intensity of light

2. range of temperatures

3. amount of moisture

4. type of substratum (soil or rock type)

5. availability of inorganic substances such as minerals

6. supply of gases such as oxygen, carbon dioxide, and nitrogen

7. pH

** Each of the prior listed abiotic factors varies in the environment and, as such, may act as a limiting factor, determining the types of organisms that exist in that environment.

Some examples:

1. A low annual temperature common to the northern latitudes determines in part the species of plants which can exist in that area.
2. The amount of oxygen dissolved in a body of water will help determine what species of fish live there.

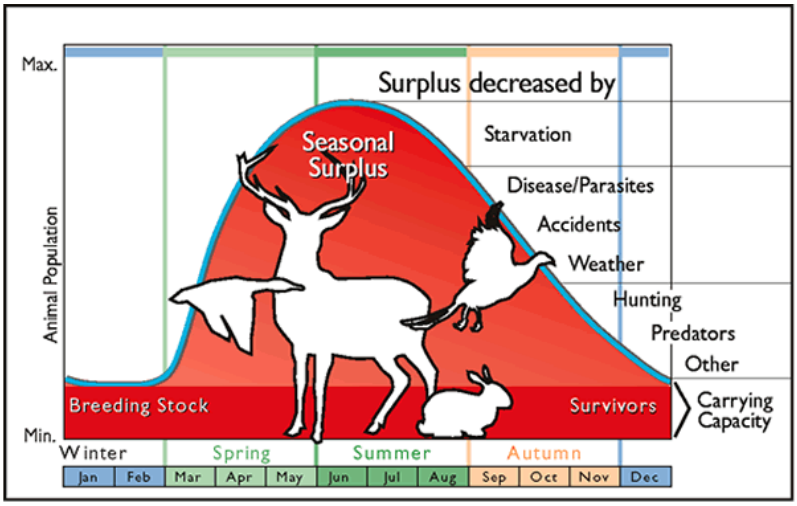
3. The dry environment of desert regions limits the organisms that can live there.

Biotic factors:

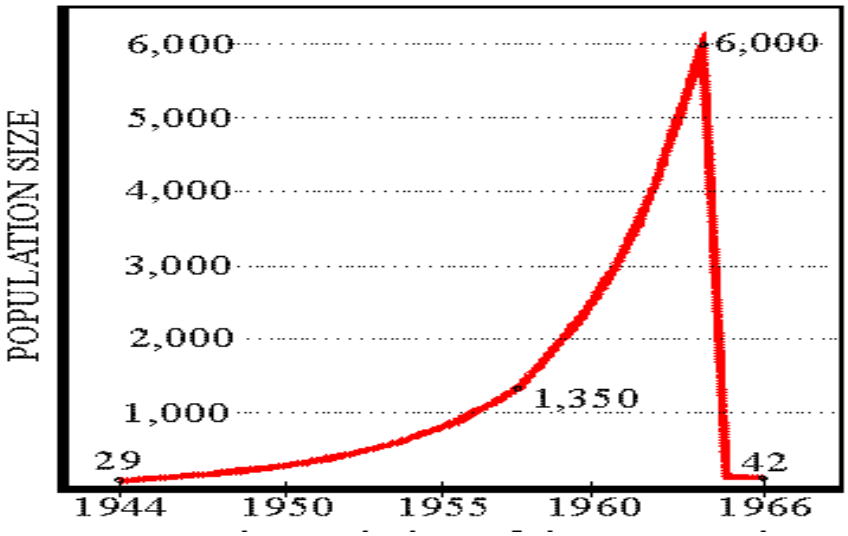
- all the living things that directly or indirectly affect the environment

Carrying Capacity:

- the maximum number of organisms the resources of an area can support
- The carrying capacity of the environment is limited by the available abiotic and biotic resources, as well as the ability of ecosystems to recycle the residue of dead organisms through the activities of bacteria and fungi.
- **or** - largest number of individuals of a particular species that an ecosystem can support over time.



- Steady State - this occurs when the population remains relatively constant over a number of years. This will occur when the number of births equals the number of deaths.



The Figure shows Herd of Reindeer on St.Matthew Island near the coast of Alaska .

(جزيرة سانت ماثيو **St.Matthew** هي جزيرة نائية في بحر بيرينغ في ألاسكا ، تم ادخال ٢٩ غزال الرنة إلى جزيرة سانت ماثيو في عام ١٩٤٤ ثم زاد عددها من ٢٩ حيوانًا إلى ٦٠٠٠ في صيف عام ١٩٦٣ ، وهو تجاوز كبير في القدرة الاستيعابية للجزيرة مما تسبب في وفاة الغزلان في الشتاء التالي وبقاء ٤٢ حيوانًا. بناءً على حجم الجزيرة والتنافس والامراض والمناخ .....الخ)

في الطبيعة يتحدد حجم الجماعة باختلاف العوامل البيئية وتحافظ الجماعة على بقائها ضمن حدود معينة حسب توفر الموارد ،إنها سعة الحمل للبيئة (Carrying capacity). ويعود الفرق بين الإمكانية الحياتية وسعة الحمل إلى المقاومة البيئية.

Nutritional Relationships:

A. **Autotrophs**: can synthesize their own food from inorganic compounds and a usable energy source.

$6CO_2 + 6H_2O + \text{light} + \text{chloroplasts} \longrightarrow C_6H_{12}O_6 + 6O_2$

B. **Heterotrophs**: cannot synthesize their own food and are dependent on other organisms for their food

Types of Heterotrophs:

1- **Saprophytes**: include those heterotrophic plants, fungi, and bacteria which live on dead matter - decomposers
2- **Herbivores**: plant-eating animals
3- **Carnivores**: animals -eating meat
4- **Omnivores**: consume both plants and meat

Types of Carnivores:

- **Predators:** animals which kill and consume their prey
- **Scavengers:** those animals that feed on other animals that they have not killed

Symbiotic Relationships:

Symbiosis: living together with another organism in close association

Types of (symbiosis):

1- **Commensalism:** one organism is benefited and the other is unharmed

ex. barnacles on whales, orchids on tropical trees

2. **Mutualism**: both organisms benefit from the association ex. nitrogen-fixing bacteria on legume nodules, certain protozoa within termites (also ruminants)

3. **parasitism** : the parasite benefits at the expense of the host

ex. athlete's foot fungus on humans, tapeworm and heartworm in dogs .

figure(1) Commensalism between barnacles on whales

figure(2) Commensalism between orchids and tropical trees

figure(3) Mutualism between certain protozoa and termites

Types of ecosystems

Ecosystem is division depending on components abiotic and biotic:

1- Natural ecosystem (open ecosystem):
That is system which contain all components biotic and abiotic such as forest , river, pond, marsh….. etc.

2- incomplete ecosystems (closed ecosystem):
That is the system which disappearance one or more of basic components for ecosystem.

There are many incomplete ecosystems:

(A) incomplete ecosystem need to producers :-
such as deep of ocean and closed caves which just found consumers and decomposers, this type of ecosystem depended on exteriors production which it falls from highest surface layers of ocean ,and also the same thing for cave depended on exteriors production that is enter into cave via flowing water.

(B) incomplete ecosystem need to consumer :
in this type of ecosystem just appear producers and decomposers excluding consumers ,example some toxic algae which it release toxins into aquatic ecosystem to kill the consumers this case occur in Florida is called (red tide)**.**

(c) **incomplete ecosystem need to organisms :**
Moon considers from incomplete ecosystems also in southern pole and rising smoke from copper mines prevent growth of organisms .

Characteristics of ecosystems :

1- continuance.

2- Ecosystems are not independence (separation) but linked with each other such as: ponds and lakes obtain nutrients via rainfall or by flowing water

Structure of ecosystem:

Ecosystem make up :

1- Biotic include producers ,consumers and decomposers.
2- Abiotic involve:
a) Inorganic such as $MgSO_4$,NaCl,H_2O…est
b) Organic example, proteins and carbohydrates….etc.
c) Climatic factors are: temperature, rainfall, moisture and winds.. etc.

Food Chains & Food Webs

Do you like to play games? If you do, you will need energy. Every time you run or jump, you are using up energy in your body. How do you get the energy to play? You get energy from the food you eat. Similarly, all living things get energy from their food so that they can move and grow. As food passes through the body, some of it is digested. This process of digestion releases energy.

A **food chain** shows how each living thing gets its food. Some animals eat plants and some animals eat other animals. For example, a simple food chain links the trees & shrubs, the giraffes (that eat trees & shrubs), and the lions (that eat the giraffes). Each link in this chain is food for the next link. A food chain always starts with plant and ends with an animal.

trees & shrub ⟶ giraffes ⟶ lions
(first trophic level) (Second trophic Level) (third trophic level)

A diagram -1- showing a food chain that begins with the plant and ends with the animal

1. Plants are called **producers** because they are able to use light energy from the Sun to produce food (sugar) from carbon dioxide and water. The process by which plants make food is called **photosynthesis**.
2. Animals cannot make their own food so they must eat plants and/or other animals. They are called **consumers**. There are three groups of consumers.

a-Animals that eat only plants are called **herbivores** (or primary consumers).

b- Animals that eat other animals are called **carnivores**.

- carnivores that eat herbivores are called secondary consumers.
- carnivores that eat other carnivores are called tertiary consumers.

phytoplankton → small fishes → seal → killer whale

A table -١-

Food chain	Phytoplankton الهائمات النباتية	small fishes الاسماك الصغيرة	Seals فقمة	killer whales القرش القاتل
called	first trophic level	second trophic level	tertiary trophic level	quaternary trophic level
called	**producers**	primary consumers	secondary consumers	tertiary consumers

c- Animals and people who eat both animals and plants are called **omnivores**.

3. Then there are **decomposers** (bacteria and fungi) which feed on decaying matter.
   These decomposers speed up the decaying process that releases mineral salts back into the food chain for absorption by plants as nutrients .

Food chain: involves the transfer of energy from green plants through a series of organisms with repeated stages of eating and being eaten.

Trophic levels:

The location of the organism in the food chain is inferred by what is known as the Trophic level. So any food chain consists of different levels as shown below:

1- The first trophic level:
   Called : producer level
   Occupied by: the green plants = producers.

2- The second trophic level:
   Called : primary consumer level
   Occupied by: the plant eaters = the herbivores.

3- The third trophic level:
   Called : secondary consumer level
   Occupied by: the herbivores eaters = the primary consumer.

4- The quaternary trophic level:
   Called : tertiary consumer level
   Occupied by: the primary consumer = the secondary consumer.

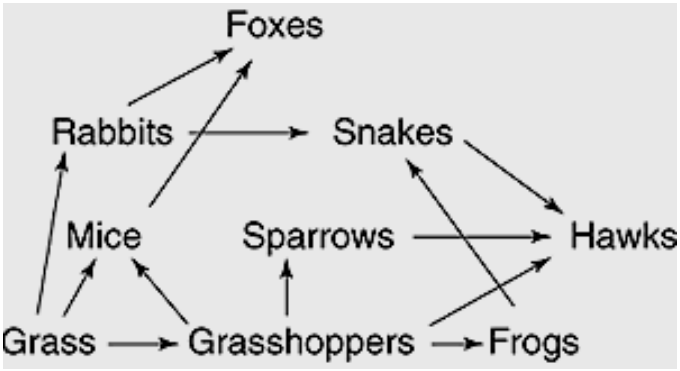
A table -2- showing trophic levels

Food chain	Phytoplankton الهائمات النباتية	small fishes الاسماك الصغيرة	Seals فقمة	killer whales القرش القاتل
	first trophic level	second trophic level	third trophic level	quaternary trophic level
called	**producers**	primary consumers	secondary consumers	tertiary consumers
Occupied by **يشغل من قبل**	green plants = producers	plant eaters = the herbivores	herbivores eaters = primary consumer	primary consumer = secondary consumer

Kinds of food chain: food chain are of two basic types :

1- Grazing food chain:
   Which ,starting from a green plant, goes to grazing herbivores and goes to carnivores for example :
   trees & shrub ⟶ giraffes ⟶ lions
2- Detritus food chain:
   Which ,starting from organic matter dead to microorganisms and then to detritivores and their predators for example:
   organic matter dead ⟶ microorganisms ⟶ detritivores ⟶ predators

Food web: Overlapping food chains are called food webs.



Ecological Pyramids

The Ecological Pyramids *or* Trophic Pyramids:
Are schematic forms that express data related to living organisms at each level of trophic, i.e. it is the trophic levels of living organisms, so that each is distributed according to its functional nutritional role in the form of a pyramid.

The British ecologist (Charles Elton, 1927) is the first advanced the concept of environ-mental pyramids. As he noted, in one of his studies, that the number insects are less than the number of plant that feed upon, the number of birds is less than the number of insects that feed upon and the number of foxes are less than the number of birds that feed upon.

Weeds > Insects > Birds > Foxes

When he converts these numbers to a graph he get a structure looks like a pyramid called it *environmental pyramid*.

Each ecological pyramid is characterized by:

- Base of this pyramid represent the producers (the weeds)
- The apex represent the secondary carnivores (the foxes).
- Base is the widest part of the pyramid
- Width of the pyramid becomes narrows toward apex.

Elton pyramid named *pyramid of numbers* since it depicts the number of individual organisms at different trophic levels of food chain.

After (Elton) scientists realized that there are other formulas to express the status of organisms in each trophic level, like measurement of biomass (as wet weight wet, dry weight or content of calories) as well as measuring the rate of energy flow between the various trophic levels (productivity).

Accordingly, we have the following three types of ecological pyramids:

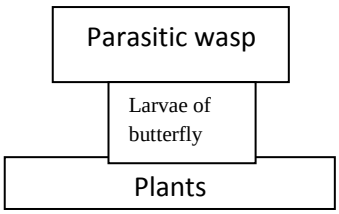
1-Pyramid of numbers.
2-Pyramid of biomass.
3-Pyramid of energy**.**

1- The pyramid of numbers:

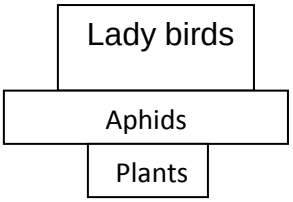
Type of pyramids provide opportunity to make comparison between the numbers of organisms in different trophic levels in a given time. This type of pyramids has a traditional form (with a broad base and gradually narrows toward the top), however, there is a possibility to be inverted (upside down) in exceptional cases:

First: When there are large numbers of small animals feed on a large plant, as aphids when they feed on a large tree shape -1-.

Second: When there are a large numbers of parasites live in or on the body of large host, as a large numbers of head lice infect human and also as a numbers of parasitic wasps feed on the larvae of butterfly shape -2-.
Unit of measurement is the number of individual per unit area



shape -1-

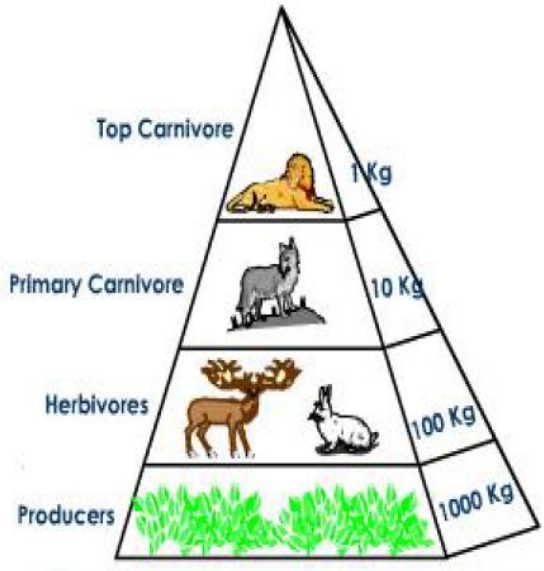


shape -2-

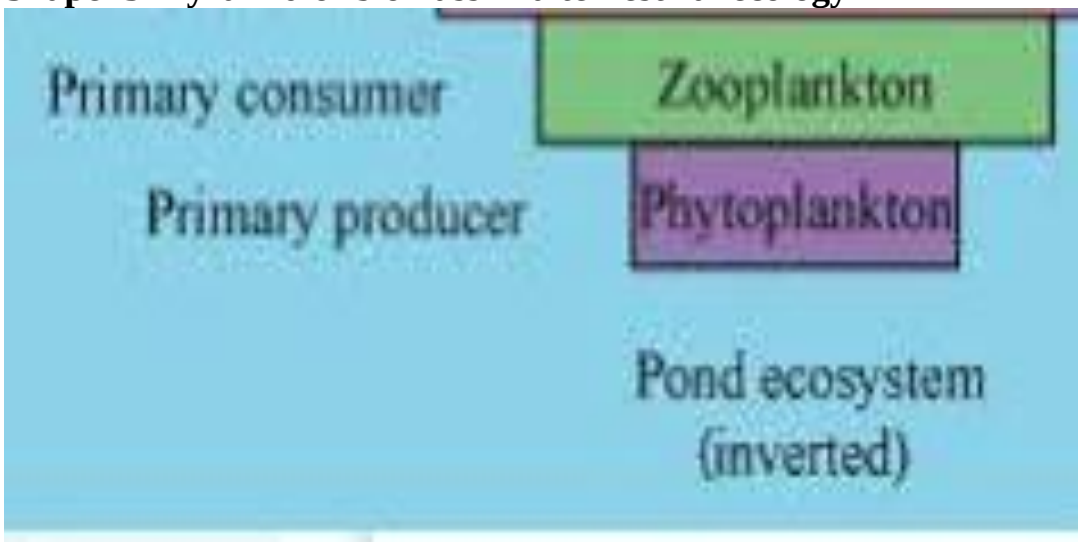
2- Pyramid of biomass

This type of pyramids provide opportunity to make comparison between masses of the organisms in different trophic levels in a given time.
Biomass is a measure of the total amount of living matter in any time. It is measured either as a wet weight (fresh weight), as a dry weight or as a calories content.
It is measured in gram per meter^2, or calories per meter^2.

This type of pyramids has a traditional form (with a broad base and gradually narrows toward the top)ship-3-, Pyramids of biomass, could be inverted ,ship-4- For example, the living mass in products (algae) found in a specific area of marine water ١ amounting to 4 g / m^3 while the living mass in zooplankton (herbivores) and benthic fauna is 21 g / m^3 and this is due to the rapid reproduction of herbivores where the mass production rate in consumers less is higher From him in Products**.**



Shape -3- Pyramid of biomass in a terrestrial ecology



Shape -4- inverted pyramid of biomass in an aquatic ecosystem.

3- Pyramid of Energy: :

Type of pyramids provides opportunity to make comparison between the amount of energy that flow between the different levels within a specified period of time.

Pyramids of energy have always a traditional forms (with a broad base and gradually narrows toward the top), with no exception cases to be inverted. The unit which used with these pyramids are (gram / m^2 / year or calories / m^2 / year).

Why pyramid of energy never be inverted?

It can never be inverted for the following reasons:

Natural & healthy ecosystems must have long lives. In order to achieve that, the amount of energy available in the lower trophic levels have to be much higher than the amount of energy available in the higher levels. In this case, only, the organisms can maintain the stability of the population & communities of the ecosystem.and part of the energy inevitably lost during the transition from one level to the next.

Pyramid of Energy

Shape -٥-

The Energy flow in ecosystem

The solar radiation when reaches to the atmosphere it will distribution following:

30% from solar radiation when reached will reflected to external space .

20% Absorbed by atmosphere.

50% Absorbed by surface of soil and bodies water, besides greenness covers.

0.02% absorbent by plants.

Energy flows through ecosystems in one direction, from the Sun, through photosynthetic organisms, including green plants and algae, through herbivores, to carnivores, and finally decomposers.

There is a decrease in the overall energy in each level as you move up the food web. and this means that there is much more energy in the producer level in a food web than at the consumer levels. Also, this means that there is more energy at the primary consumer level than at the secondary consumer level.

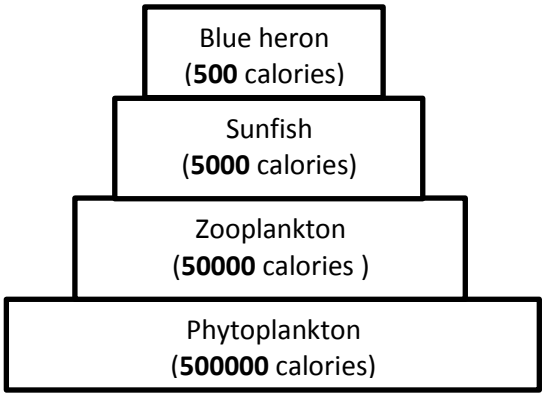
Energy Transfer and ecological efficiency :

How much energy is lost from one level to the next? Scientists say that on average 90% of the available energy is used for life processes such as respiration, photosynthesis, and reproduction before an organism is consumed. This means only about 10% of the original energy is left to feed the next level.

This 10% is stored in the tissues (leaves, stem, muscles, organs, fat, etc.) of the organism.

To understand this more clearly, let's look at the energy pyramid that occurs in some ecosystems (shape -1-) :

Here producers such as phytoplankton are producing 500,000 calories of energy from sunlight each day ,since only about 10% of this energy reaches the zooplankton, this leaves about 50,000 calories of energy to support the zooplankton each day , since only about 10% of this energy reaches the sunfish, this leaves about 5,000 calories of energy to support the sunfish each day ,since only about 10% of this energy reaches the great blue herons, this leaves about 500 calories of energy to support herons each day.



Shape -1- Pyramid of energy

Ecological efficiency :it is flux energy ratio through different trophic levels. Plants have less than 1% of efficiency that is mean 1% from solar energy absorbance , also herbivores and consumers have efficiency between (5-20) % that is mean this ratio stores in their tissue and remain between (80 – 95)% lost as form heat .

show table below it explain ecological efficiency:

Organisms	Eco. Efficiency %	Energy move or absorbance Calories	Consumption %	Store %	calories
Producers	1	15000	40	60	9000
Herbivores	20	1800	90	10	180
Secondary consumer	30	54	90	10	5.4
Tertiary	40	1.08	90	10	0.018

The Productivity:

The photosynthesis process represents the basic production capacity of all ecosystems containing green plants.

Ecologists divided productivity into two main types, *primary productivity* & *secondary productivity*.

The primary productivity of the ecosystem, society or individual is defined as follows:

The rate at which the sun's energy is stored by photosynthesis or chemosynthetic by the producers in the form of organic materials that can be used as food.

It is usually expressed in units of mass per unit area (or volume) per unit time, for instance grams/ m^2/day.

Types of primary productivity:

a- **Gross primary productivity = GPP**

GPP: is the total energy fixed by photosynthesis per unit time.

b- **Net primary productivity = NPP**

NPP: is the total energy fixed by photosynthesis minus losses due to plant respiration per unit time.

NPP can be expressed by the following formula

NPP = GPP – R (respiration)

Secondary productivity: The rate of biomass formation تكوين or energy fixation by heterotrophic organisms..

Factors affecting primary productivity:

They are the same factors that affect the photosynthetic rate :

1- Quantity & quality of light.
2- Quantity & quality of water.
3- Nutrient availability in soil.
4- Type of the soil.
5- Photosynthetic pigments.
6- Air temperature.
7- Distance between individuals.
8- Depth of light zone (in aquatic ecosystems).

The biogeochemical cycles (substance turnover)

- The term “biogeochemical” tells us that biological, geological and chemical factors are all involved in cycles.
- A cycle is a series of change which comes back to the starting point and which can be repeated.

A **biogeochemical cycle** is a pathway by which a chemical element or molecule moves through both biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) compartments of Earth.

Ecosystems have many biogeochemical cycles operating as a part of the system. The basic elements move through the biotic & abiotic component of the ecosystems in a series of naturally occurring physical, chemical and biological processes.

The cycling elements are divided into two categories :
:

1- **macronutrients** : required in relatively large amounts ,this category, in turn is divided to two sub categories as follows:

a- The primary macronutrient "big six":
carbon, hydrogen, oxygen, nitrogen, phosphorous, sulfur

b- the secondary macronutrients:
Potassium, calcium, iron, magnesium

2- **micronutrients** : required in very small amounts, (but still necessary)

Any biogeochemical cycle include the following three processes:

1. **The production**, by which organic compounds are synthesized.
2. **The consumption**, by which organic matter are assimilated.
3- **The decomposition**, by which complex organic compounds are break down into simpler one, so it can be used in production again.

Types of biogeochemical cycles:

Biogeochemical cycles are basically of two types:

a) Gaseous cycles like as carbon dioxide, oxygen, nitrogen, water, etc.
b) Sedimentary cycles like sulphure, phosphorus, calcium, Iron, etc.

In *gaseous cycles*, the elements have a main reservoir in the gaseous phase, and the reservoir pool is the atmosphere or water. The biogenetic materials involved in circulation pass through a gaseous phase before completing the cycle.

In *sedimentary cycles*, the element's main reservoir pool is lithosphere and the biogenetic materials involved in circulation are non-gaseous. The sedimentary cycles are usually very slow as the elements may get locked up in rocks and go out of circulation for long periods.

Examples of Biogeochemical cycles:

The water cycle:

The water cycle Fig.(1), also known as the hydrologic cycle or the H_2O cycle, describes the continuous movement of water on, above and below the surface of the Earth. The mass water on Earth remains fairly constant over time, but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processesofevaporation, condensation, precipitation, infiltration, runoffan dsubsurface flow. In so doing, the water goes through different phases: liquid, solid (ice), and gas (vapor). The water cycle involves the exchange of energy, which leads to temperature changes. For instance, when water evaporates, it takes up energy from its surroundings and cools the environment. When it condenses, it releases energy and warms the environment. These heat exchanges influence climate**.**

The vapor and gravity these drive the water cycle

Precipitation: Condensed water vapor that falls to the Earth's surface**.**

Runoff: The variety of ways by which water moves across the land. This includes both surface runoff and channel runoff. As it flows, the water may seep into the ground, evaporate into the air, become stored in lakes or reservoirs, or be extracted for agricultural or other human uses.

Infiltration: The flow of water from the ground surface into the ground. Once infiltrated, the water becomes soil moisture or groundwater.

Evaporation: The transformation of water from liquid to gas phases as it moves from the ground or bodies of water into the overlying atmosphere.

Condensation: The transformation of water vapor to liquid water droplets in the air, creating clouds and fog.[

Transpiration: The release of water vapor from plants and soil into the air.

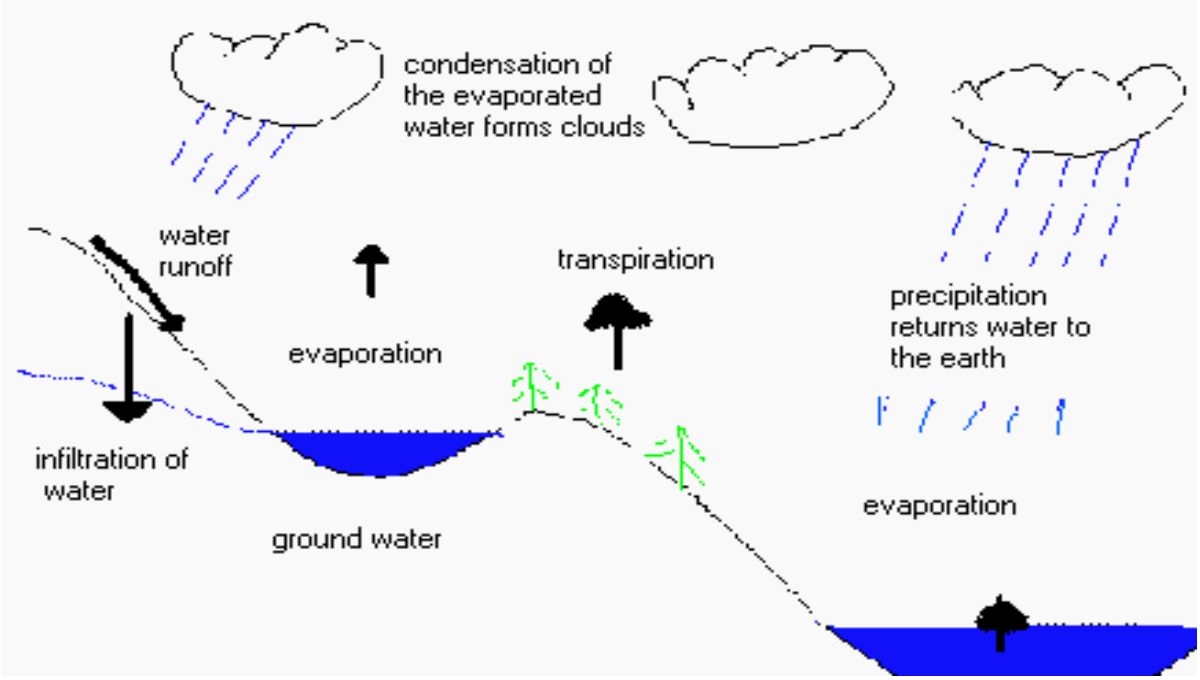


Fig.(1) The Water Cycle

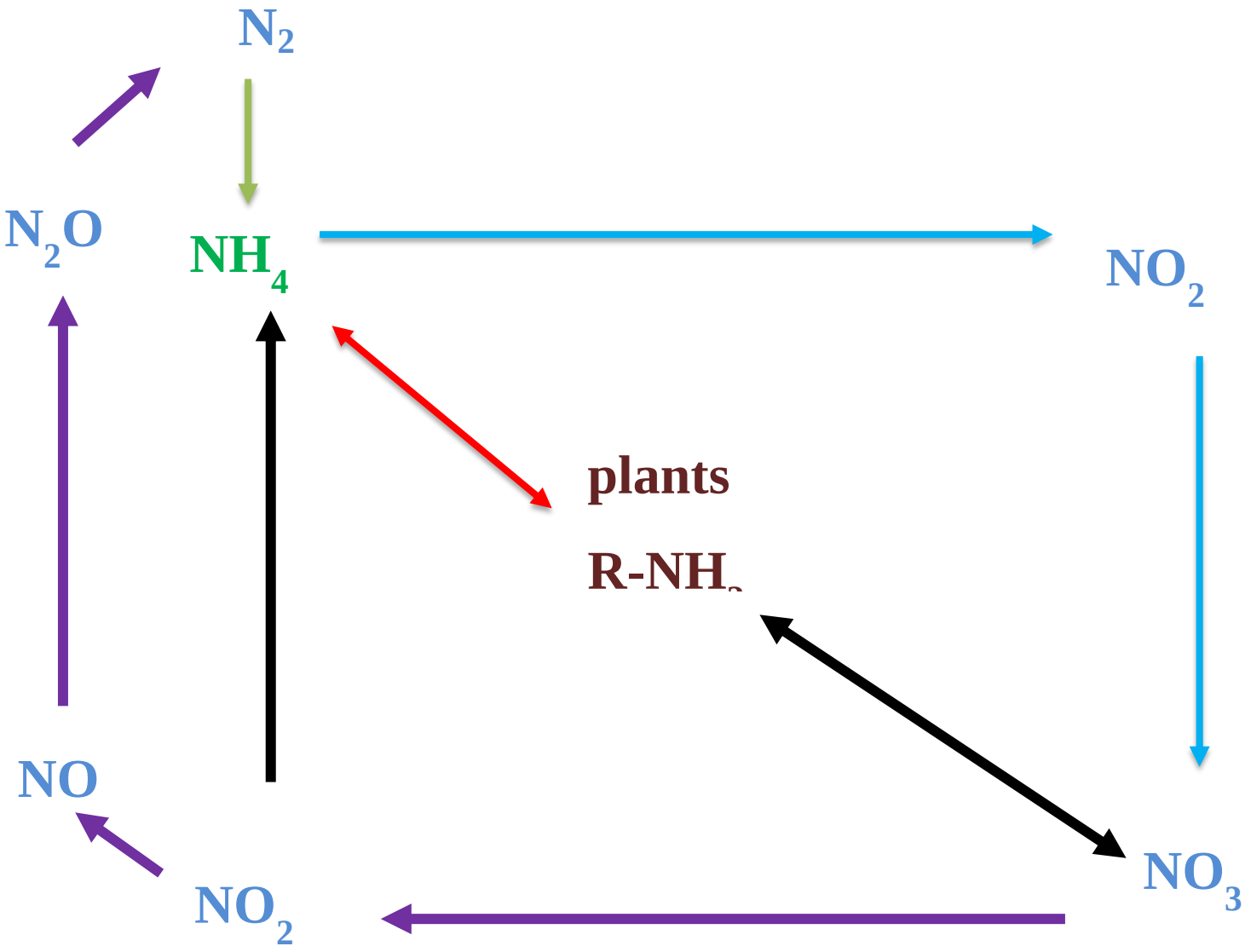
1- <u>Nitrogen cycle</u>: (gaseous cycle Fig.(2))

Nitrogen is a very important element in that it is part of both proteins (present in the composition of the amino acids that make those proteins) as well as nucleic acids, such as DNA and RNA (present in nitrogenous bases).Hence the nitrogen cycle is by far the most important nutrient cycle for plant life.

The largest reservoir of nitrogen is the atmosphere, in which about 78 percent of which made up of nitrogen gas (N_2).

- Nitrogen gas is "fixed," into **nitrate** (NO_3) in a process called **nitrification** occurred by lightning, industrial methods (such as for fertilizer), nitrogen-fixing bacteria that present in the soil, roots of legumes and also cyanobacteria, or blue-green algae, in water.
- **Nitrates** can then be used by plants or animals (herbivores & carnivores).
- Decomposers and detritivores ingest the detritus from plants and animals and convert Nitrate into **ammonia** (NH_3).
- **Ammonia** is toxic and cannot be used by plants or animals, but **nitrosomonas bacteria** present in the soil can take ammonia and turn it into **nitrite.**
- **Nitrite** is also unusable by most plants and animals, **nitrobacter bacteria** convert nitrites back into nitrate, usable by plants and animals.

- Some nitrates are also converted back into nitrogen gas through the process of **denitrification,** which is the opposite of nitrogen-fixing.



Nitrogen Fixation **Nitrification** **Ammonification or Mineralization**

Denitrification

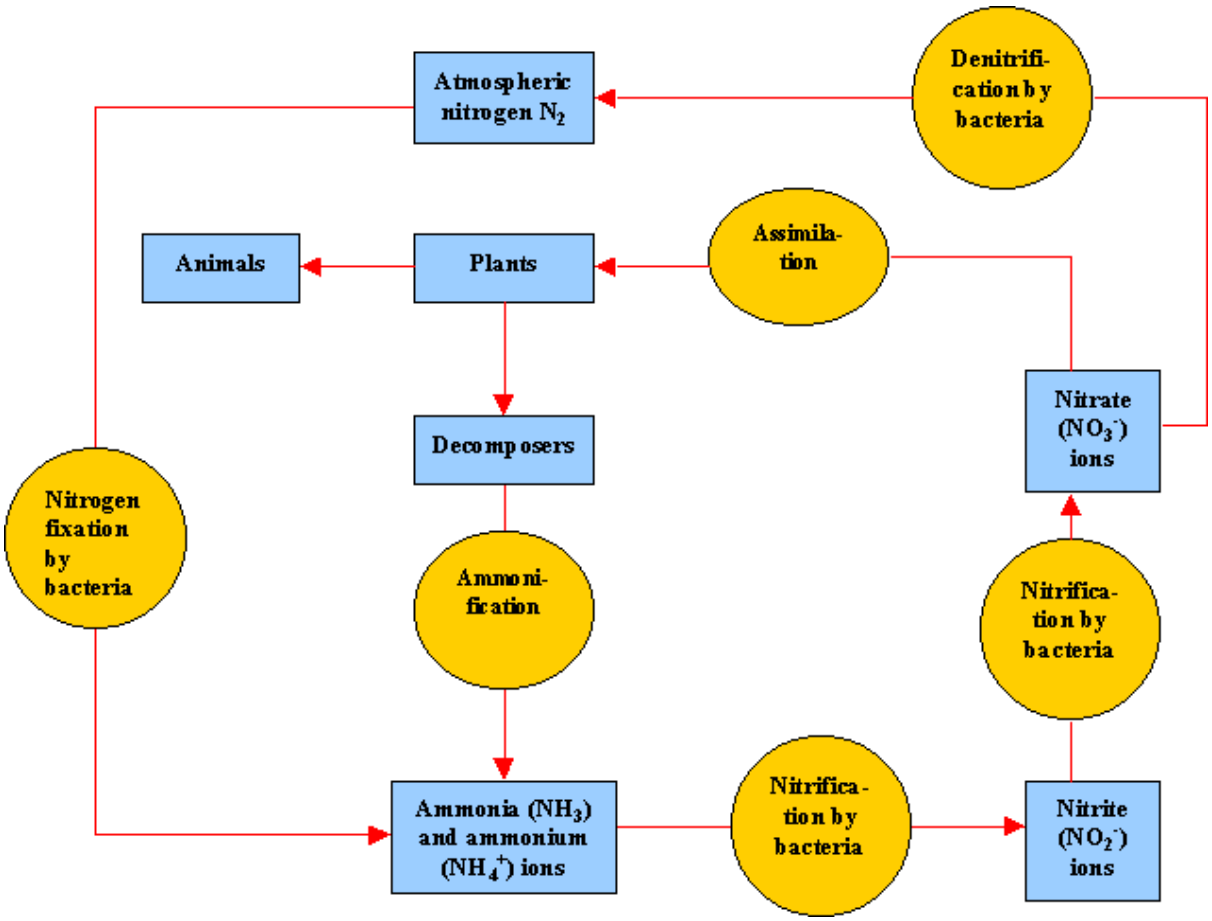


Fig.(2) The Nitrogen cycle

2- Carbon cycle: (gaseous cycle)

Carbon is a very important element, as it makes up organic matter, which is a part of all life. The concentration of carbon in living matter (18%) is almost 100 times greater than its concentration in the earth (0.19%). So living things extract carbon from their nonliving environment.

Carbon exists in the nonliving environment as:

- carbon dioxide (CO_2) in the atmosphere and dissolved in water (forming HCO_3^-)
- Carbonate rocks (limestone and coral = $CaCO_3$)
- Deposits of coal, petroleum, and natural gas .
- Dead organic matter, e.g., humus in the soil

Carbon enters the biotic world through the action of autotrophs:

- primarily **photoautotrophs**, like plants and algae, that use the energy of light to convert carbon dioxide to organic matter.
- and to a small extent, **chemoautotrophs** — bacteria and archaea (**Archaea** are single-celled microorganisms with structure similar to

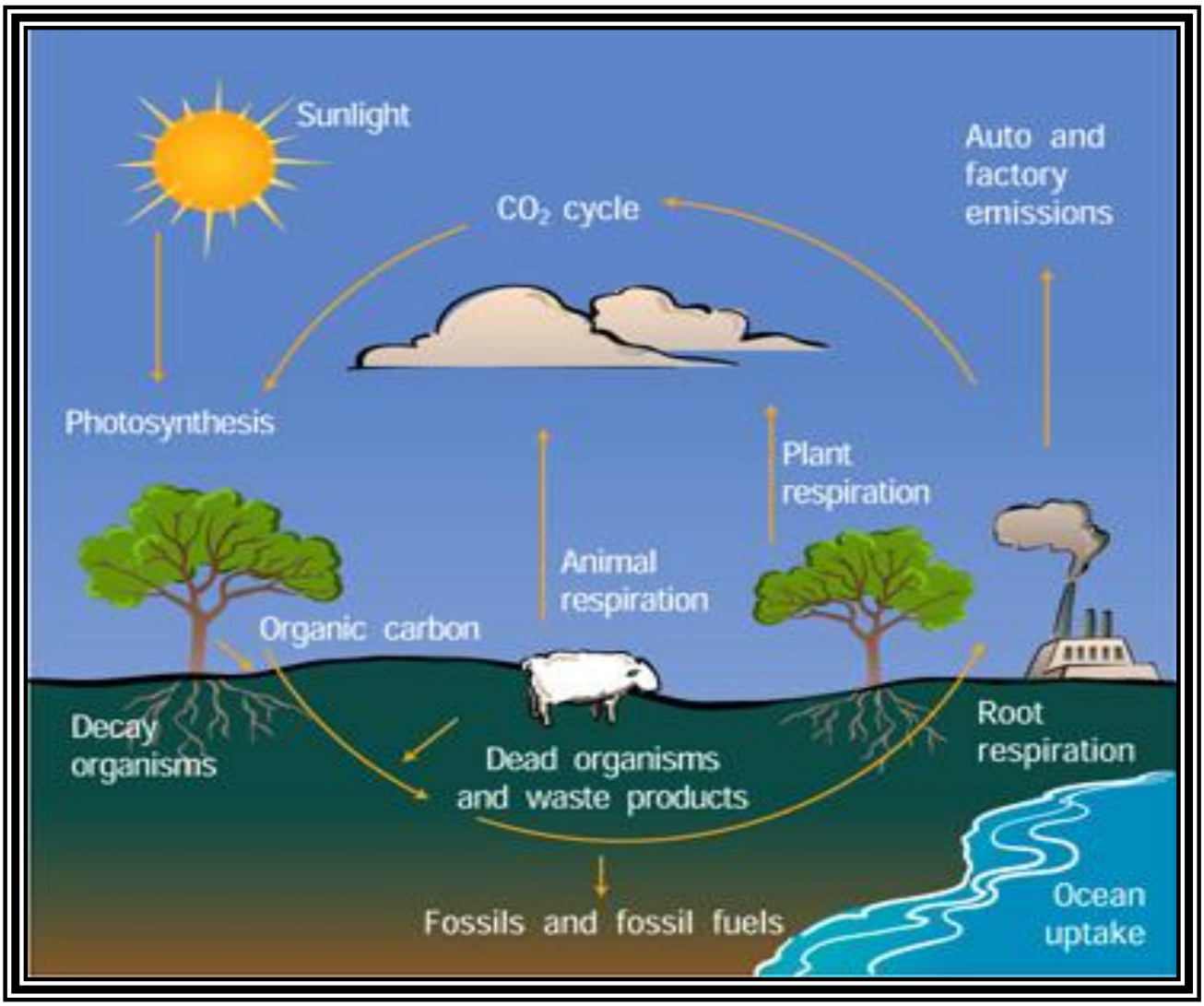
bacteria.) that do the same but use the energy derived from an oxidation of molecules in their substrate.

Carbon returns to the atmosphere and water by

- Respiration (as CO_2)
- Burning
- Decay (producing CO_2 if oxygen is present, methane (CH_4) if it is not.

The uptake and return of CO_2 are not in balance.

The carbon dioxide content of the atmosphere is gradually and steadily increasing. This increasing is probably began with the start of the industrial revolution due to human activities as burning fossil fuels (coal, oil, natural gas) & clearing and burning of forests.

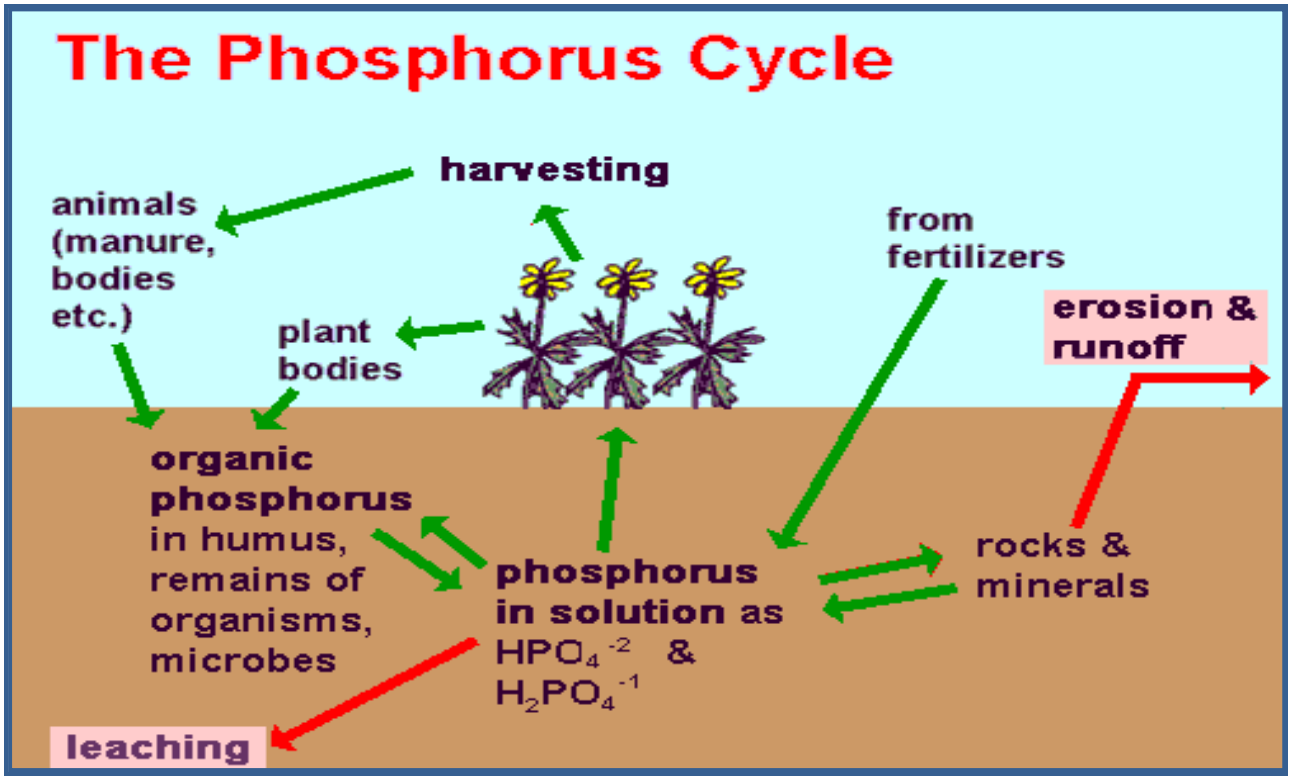


Fig(3) The carbon cycle

3- Phosphorous cycle: (sedimentary cycle)

Phosphorus is an essential nutrient for plants and animals, since it is a component of it is a component of (ATP), cell membrane, bones and nucleic acids (RNA and DNA).

- Phosphorus does not enter the atmosphere, remaining mostly on land and in rock and soil minerals.
- Phosphorus normally occurs in nature as part of a phosphate ion $(PO_4)^{3-}$. On land most Phosphorus is found in rocks and minerals. Phosphorus rich deposits have generally formed in the ocean or from guano, and over time, geologic processes bring ocean sediments to land.
- Weathering of rocks and minerals release Phosphorus in a soluble form where it is taken up by plants, and it is transformed into organic compounds.
- The plants may then be consumed by herbivores.
- After death, the animal or plant decays, and Phosphorus is returned to the soil.
- Runoff may carry a small part of the Phosphorus back to the ocean. Generally with time (thousands of years) soils become deficient in Phosphorus leading to ecosystem retrogression.



Fig(4) The Phosphorus cycle

4- Sulphur cycle:

The Sulphur cycle can be thought of as beginning with Sulphur dioxide gas (SO_2) or the particles of sulfate compounds in the air. These compounds reach earth's surface as they fall down or are rained out of the atmosphere.

From the soil, plants take up various forms of these compounds and incorporate them into their tissues.

Then these organic Sulphur compounds are returned to the land or water after the plants die or are consumed by animals.

Bacteria can transform the organic Sulphur to hydrogen sulfide gas (H_2S). In the oceans, certain phytoplankton produce a chemical that subsequently transforms to SO_2. These gases can re-enter the atmosphere, water, and soil, and continue the cycle.

Habitat

Concepts of habitat and the ecological niche.

Habitat:

A habitat (place) is an ecological or environmental area that is inhabited by a particular species of animal, plant, or other type of organism. for Example an ocean, a lake, a tree, a rotting log, the alimentary tract etc.

Ecosystem = habitat + community

The Ecological Niche:

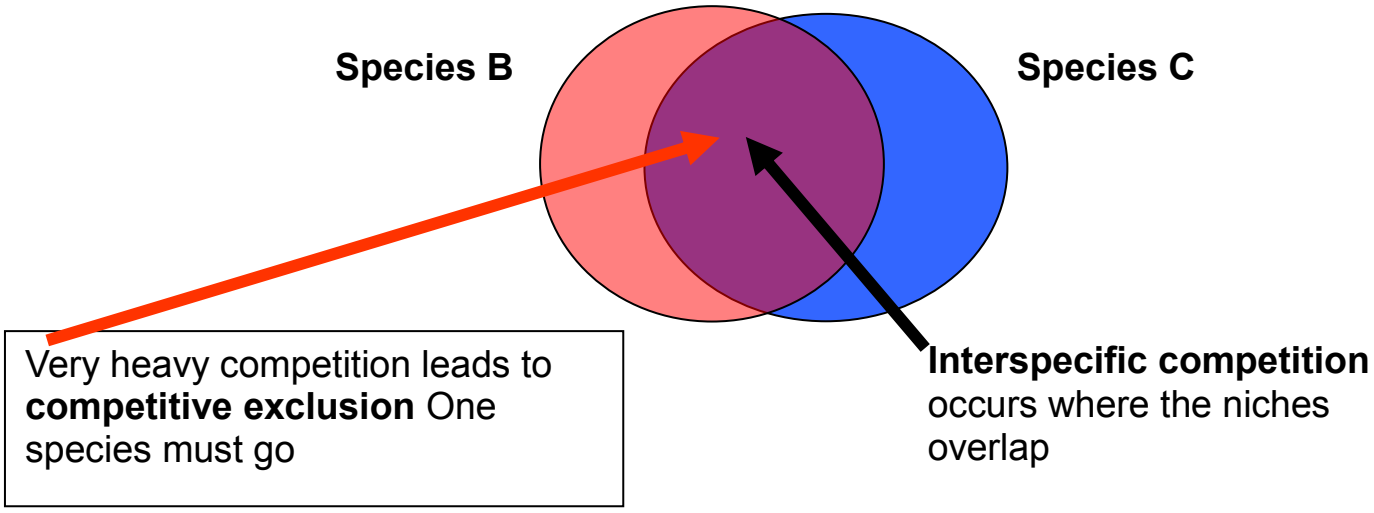
Niche the role (Job) of an organism in its habitat .If two species , with the same niche, coexist in the same ecosystem, then one will be excluded from the community due to intense competition.

The niche of a species consists of:

1. Its role in the ecosystem (herbivore, carnivore, producer etc.)
2. Its tolerance limits (e.g. soil pH, humidity)
3. Its requirements for shelter, nesting sites etc.

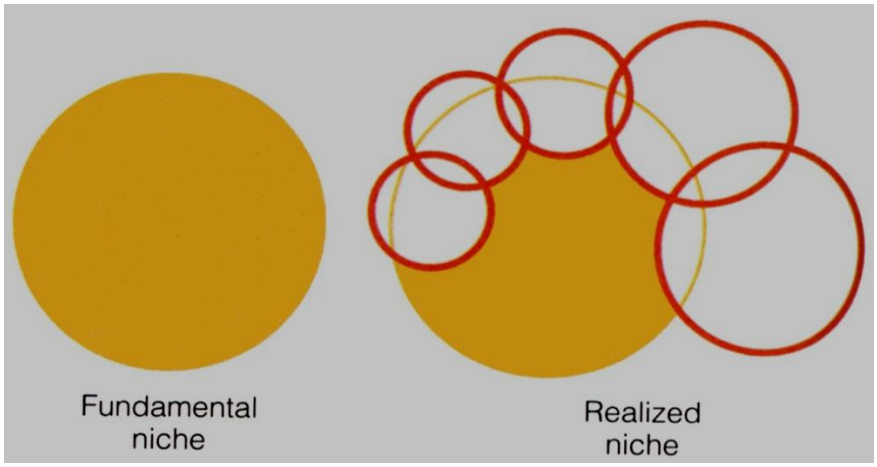
Separate niches: No overlap of niches. So coexistence is possible

Overlapping niches:Interspecific competition occurs where the niches overlap.



Niche in nature divided into two major types:

1- Fundamental niche it's micro place occupies it only one species from organisms without competing sp..
2- Realized niche that is niche which building new niche on Fundamental niche edge via other species with competing between species.



Without competing sp. With competing sp.

Here are a few examples to help you understand what we mean when we (ecologists) use the term "ecological niche**:**

Oak trees live in oak woodlands. The oak woodland is the habitat.

What do oak trees do?

Oak trees:

1. absorb sunlight by photosynthesis;
2. absorb water and mineral salts from the soil;
3. provide shelter for many animals and other plants;
4. act as a support for creeping plants;
5. serve as a source of food for animals;
6. cover the ground with their dead leaves in the autumn.

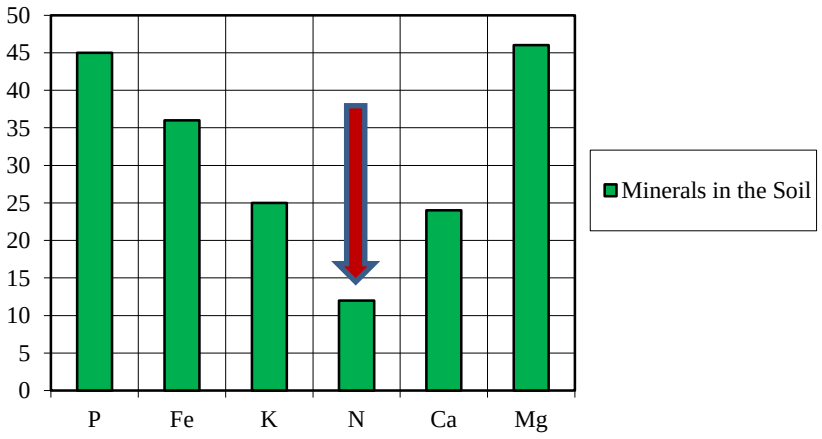
These six things are the "profession" or ecological niche of the oak tree; you can think of it as being a kind of job description. If the oak trees were cut down or destroyed by fire or storms they would no longer be doing their job and this would have a disastrous effect on all the other organisms living in the same habitat.

Principles pertaining to limiting factors:-

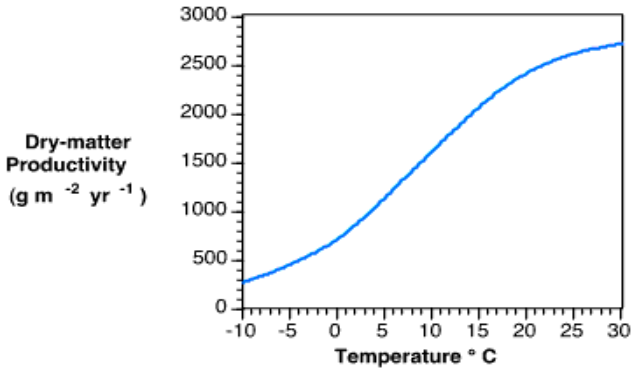
Liebige' "Law" of the minimum:-

In 1840, J. Liebig suggested that organisms are generally limited by only one single physical factor that is in shortest supply relative to demand**.**

Some abiotic and biotic factors affect the organisms sufficiently to limit population growth. These are known as limiting factors. The factor may be too little in quantity or too much.
For example, the limiting factor for a plant population near a chemical factory may be the soil ph.The success of an organism depends on several requirements, if one of these is present in minimal quantities this will limit the organism regardless of the abundance of the others these are known as**Liebig's Law of the Minimum.**



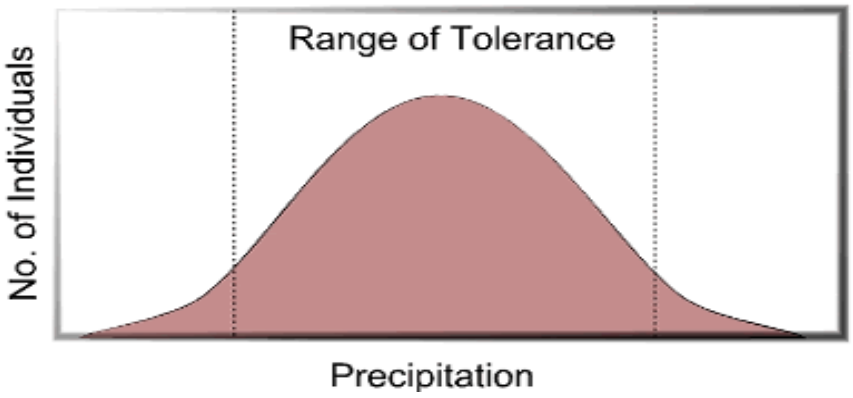
Look at figure above the minerals abundance but nitrogen is run out of so plants cannot grow. So nitrogen in this example is the limiting factor.
There are Some further examples of limiting factors such as water in a desert, Light in the ocean depths and phosphorus is very often limiting in freshwater systems
Show figure below temperature is a strong Limiting factor.



Range of Tolerance:

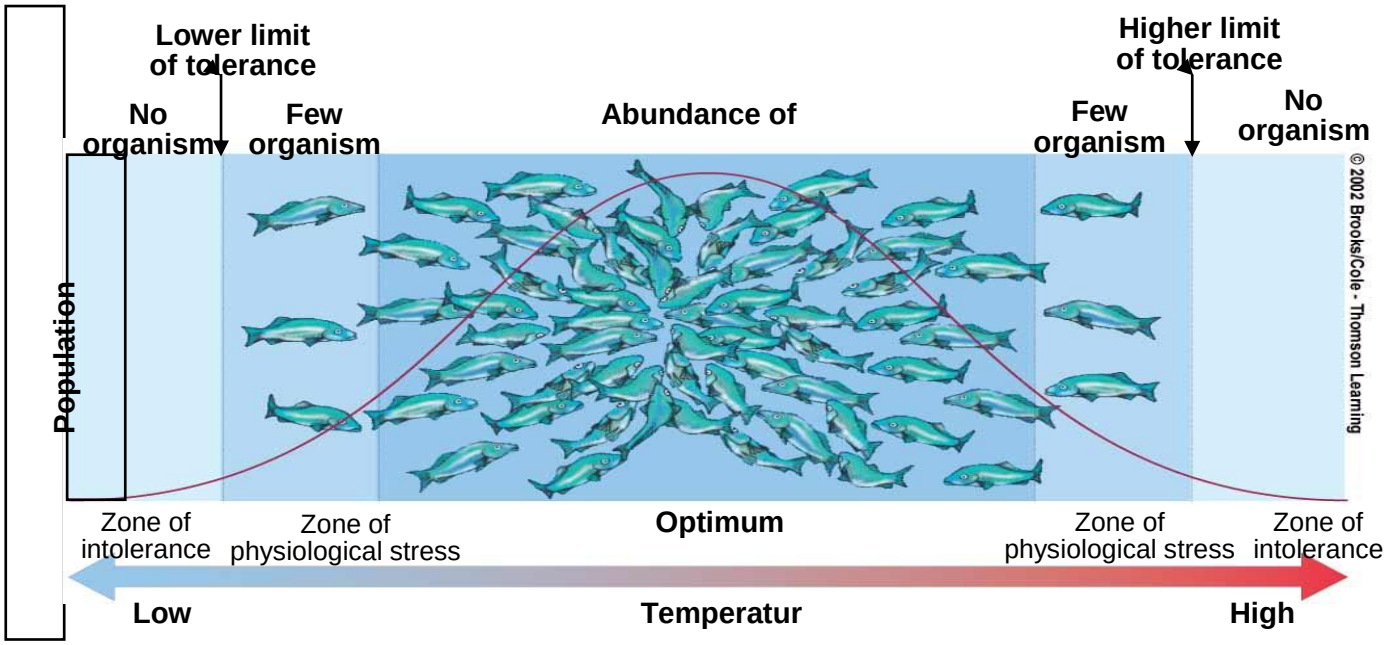
Every population thrives in an optimal range of abiotic factors. Beyond this range, one finds less and less numbers of these organisms. In an ecosystem, it is harder to represent what this optimal range is, since a host of factors affect the survivability of this population.

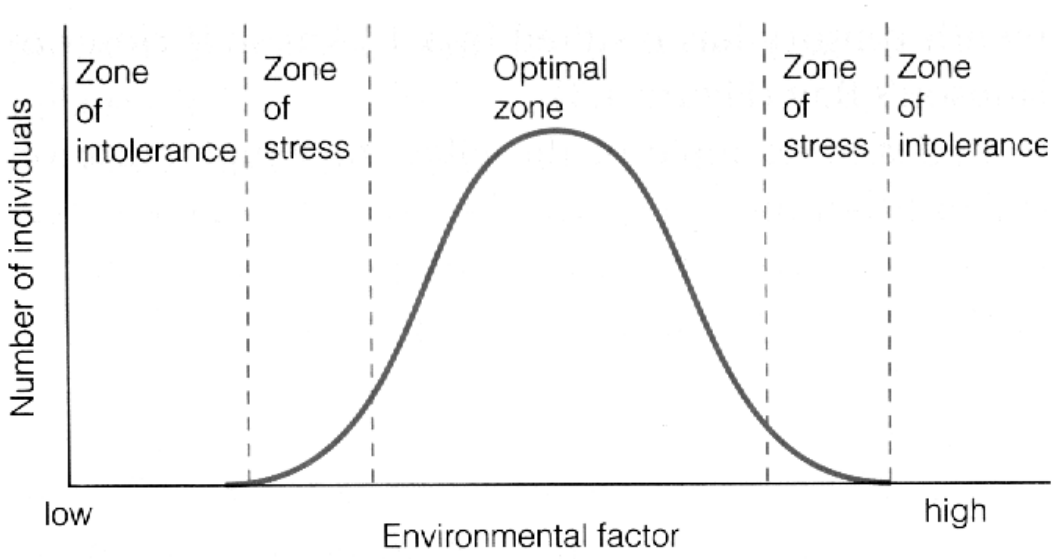
Often, the range is shown for each factor, and this is known as the range of tolerance.



Shelford's Law of Tolerance:

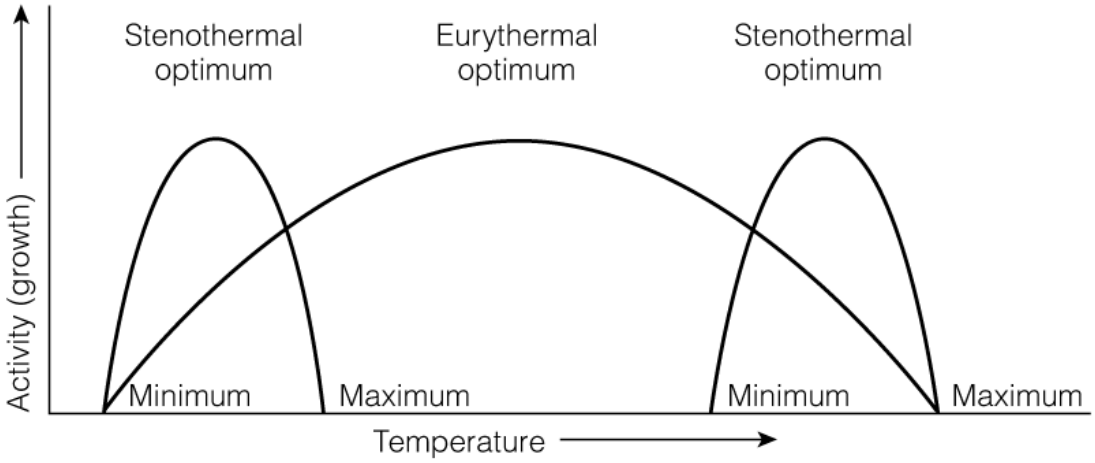
Organisms have an ecological maximum and minimum, with a range in between which represents the "limits of tolerance.





There are some terms uses in ecology : steno- means narrow but eury- means wide such as :

- Stenothermal---eurythermal. that is refer to temperature .
- Stenohydric ----euryhydricthat is refer to water.
- Stenohalic --- euryhalicthat is refer to salinity.
- Stenophagic --- euryphagicthat is refer to nutrition .
- Stenoecious –euryeciousthat is refer to habitat election.



The Abiotic Component of an Ecosystem (Soil, Water, Air & Climatic factors)

1- The Soil

It is the top layer of the land surface of the earth that is composed of disintegrated rock particles, humus, water, and air.

The science that deals with the study of soils as a natural resource is called ***soil science***.

The ***soil science*** may be divided to two branches, *Pedology* & *Edaphology*.

***Pedology*:**(from Greek: *pedon* = soil) is the study of soils in their natural environment. It deals with, formation morphology, and classification of soil.

Edaphology: (from Greek *edaphos* = ground) is concerned with the influence of soils on living things, particularly plants. The term is also applied to the study of how soil influences man's use of land for plant growth.

Soil play a great important role in the life of human & all other living organisms. It has numerous advantages & uses

Among these advantages & uses are:

- Provides a substrate for plants (roots anchor in soil).
- Supply a great variety of living organisms (autotrophs, decomposers & bacteria) with nutrient and water.
- Considered as a habit & shelter by a great diversity of organisms (from bacteria to burrowing mammals).
- Participate in the biogeochemical cycles, many Physical, chemical & biological changes for the minerals occurred in the soil.
- Soil absorbs rainwater and releases it later thus preventing floods and drought.
- Act as a medium for water filtration.
- Act as a major medium for decomposition of dead bodies of plants & animals and their remains in addition to organic pollutant.
- Used to get some metal ores such as gold, iron, copper, aluminum etc.
- Soil serves as a foundation for most construction projects. Massive volumes of soil can be involved in surface mining, road building, and dam construction.
- Physical stability and support buildings roads & air ports

Soil formation:

Soil is formed by ongoing natural processes occurred as a consequences of climatic, mineral and biological processes. It takes a very long period of time,1000 years or more an known as ***weathering*** process.

The surface rocks break down into smaller pieces through a process of weathering and is then mixed with lichen, mosses and organic matter. Over time this creates a thin layer of soil. Plants help the development of the soil. By attracting animals, and when the animals die, their bodies decay. Decaying matter makes the soil thick and rich. This continues until the soil is fully formed. The soil then supports many different plants.

Weathering**:** is the breaking down of rocks, soils and minerals through contact with the Earth's atmosphere, biota and waters.

There are three types of weathering processes, they are often go hand in hand. Water is a major player in all three,

1- The physical or mechanical weathering:
   It is the physical break-up of rocks Results in smaller pieces with the same chemical composition.
   Physical weathering acts in two ways, Fracturing and Abrasion, Like the difference between a hammer and sandpaper.

Types of mechanical weathering:

a- Thermal stress weathering (or insolation weathering):
   results from expansion and contraction of rock, caused by temperature changes. It is an important mechanism in deserts, where there is a large diurnal temperature range, hot in the day and cold at night.

b- Frost weathering:
   Freeze induced weathering action occurs mainly in environments where there is a lot of moisture, and temperatures frequently fluctuate above and below freezing point.

c- Pressure release
   In pressure release overlying materials are removed (by erosion, or other processes), which causes underlying rocks to expand and fracture parallel to the surface.

d- Hydraulic action

   Hydraulic action occurs when water (generally from powerful waves) rushes rapidly into cracks in the rock face, thus trapping a layer of air at the bottom of the crack, compressing it and weakening the rock. When the wave retreats, the trapped air is suddenly released with explosive force.

e-Salt-crystal growth

Salt crystallization causes disintegration of rocks when saline solutions seep into cracks and joints in the rocks and evaporate, leaving salt crystals behind. These salt crystals expand as they are heated up, exerting pressure on the confining rock.

2-Chemical weathering:

It is the decomposition and/or dissolution by chemical activity. Results in smaller pieces with different chemical composition. New or secondary minerals develop from the original minerals of the rock.

a- Dissolution and carbonation

In unpolluted atmospheres, carbonation occurs on rocks which contain calcium carbonate, such as limestone and chalk. This takes place when rain combines with carbon dioxide or an organic acid to form a weak carbonic acid which reacts with calcium carbonate (the limestone) and forms calcium bicarbonate according to the following reaction:

$$CO_2 + H_2O \rightarrow H_2CO_3$$

carbon dioxide + water → carbonic acid

$$H_2CO_3 + CaCO_3 \rightarrow Ca(HCO_3)_2$$

carbonic acid + calcium carbonate → calcium bicarbonate

In polluted atmosphere, gases as SO_2 and NO_2 react with rain water to produce strong acids (i.e) sulfuric acid & nitric acid which cause weathering to the rocks on which it falls.

b- Hydration

Mineral hydration is a form of chemical weathering that involves the rigid attachment of H+ and OH- ions to the atoms and molecules of a mineral.

When rock minerals take up water, the increased volume creates physical stresses within the rock. For example iron oxides are converted to iron hydroxides and the hydration of anhydrite forms gypsum.

c- Hydrolysis on silicates and carbonates

Hydrolysis is a chemical weathering process affecting silicate and carbonate minerals. In such reactions, pure water ionizes slightly and reacts with silicate minerals. An example reaction:

$$Mg_2SiO_4 + 4\ H^+ + 4\ OH^- \rightleftharpoons 2\ Mg^{2+} + 4\ OH^- + H_4SiO_4$$

olivine + four ionized water molecules ⇌ ions in solution + silicic acid in solution

$Mg_2SiO_4 + 4\ CO_2 + 4\ H_2O \rightleftharpoons 2\ Mg^{2+} + 4\ HCO_3^- + H_4SiO_4$

olivine + carbon dioxide + water ⇌ Magnesium and bicarbonate ions in solution + silicic acid in solution

d-Oxidation

Within the weathering environment chemical oxidation of a variety of metals occurs. The most commonly observed is the oxidation of Fe^{2+} (iron) and combination with oxygen and water to form Fe^{3+} hydroxides and oxides. This gives the affected rocks a reddish-brown coloration on the surface which crumbles easily and weakens the rock.

3-Biological activity:

Not really a process of its own can lead to both mechanical and chemical weathering .
A number of microorganisms, plants and animals may create chemical weathering through release of acidic compounds.

The most common forms of biological weathering are the release of chelating compounds by plants so as to break down aluminum and iron containing compounds in the soils beneath them.

Decaying remains of dead plants in soil may form organic acids which, when dissolved in water, cause chemical weathering.

Horizon layers of soil:

Soil is made up of distinct horizontal layers, called *horizons*. Each layer has its own characteristics that make it different from all of the other layers in properties such as color, structure, texture, consistence, and chemical, biological, and mineralogical composition. These characteristics play a very important role in what the soil is used for and why it is important.

Horizon layer: *Is a layer of soil that lies approximately parallel to the land surface.*

The typical soil has the following four horizons in order from top to bottom:

O Horizon - The top, organic layer of soil, made up mostly of leaf litter and humus (decomposed organic matter).

A Horizon-The layer called topsoil; it is found below the O horizon and above the E horizon. Seeds germinate and plant roots grow in this dark-colored layer. It is made up of humus (decomposed organic matter) mixed with mineral particles.

E Horizon- This leaching layer is light in color;. It is made up mostly of sand Sand and silt, having lost most of its minerals and clay as drips through the soil (in process of eluviation).

B Horizon - Also called the subsoil . It contains clay and mineral deposits (like iron, aluminum oxides, and calcium carbonate) that it Receives from layers above it when mineralized water drips from the soil above.

C Horizon - It consists of slightly broken-up bedrock. Plant roots do not penetrate into this layer; very little organic material is found in this layer.

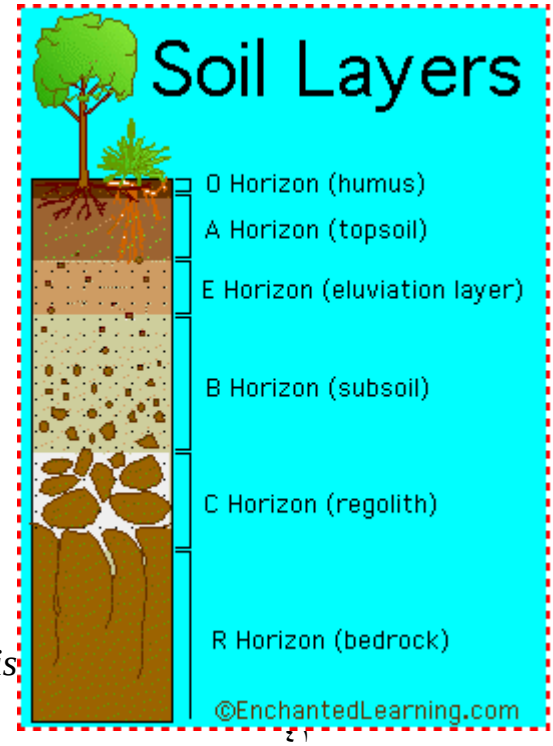
R Horizon - The unweather rock (bedrock) layer that is beneath all the other layers.

Soil profile:

Is a vertical section of soil from the ground surface to the parent rock showing the different horizons or layers

The soil profile is one of the most important concepts in soil science. It is a key to understanding the processes that have taken in soil development and is the means of determining the types of soil that occur and is the basis for their classification

The soil profile can be as little as 10 cm thick in immature soils and as deep as several meters in tropical areas where the climate is conducive to rapid alteration of the underlying rock to form soil. In temperate areas, the soil profile is often around a meter deep and in arid areas somewhat shallower than this.



Soil Texture: *is the relative*

proportion of sand, silt, and clay in a soil.

Soil texture profoundly affects soil drainage, water holding capacity, soil temperature, soil erosion as well as fertility and productivity.

Soil Particles are normally grouped into the following five classes:

- Gravel - particles greater than 2 mm in diameter
- Coarse sand - particles less than 2 mm and greater than 0.2 mm in diameter
- Fine sand - particles between 0.2 mm and 0.02 mm in diameter
- Silt - particles between 0.02 mm and 0.002 mm in diameter
- Clay - particles less than 0.002 mm in diameter

Soil texture classification:

Soil textures are classified by the fractions of each soil separate (sand, silt, and clay) present in a soil. USDA classify soil texture to (12) major classes. Classifications are typically named for the primary constituent particle size or a combination of the most abundant particles sizes, e.g. sand, loamy sands, sandy clay loam, sandy clay, silty clay, and clay and so on.

Loam: is soil composed of sand, silt, and clay in relatively even concentration (about 40-40-20% concentration respectively). Loam soils generally contain more nutrients, moisture and humus than sandy soils, have better drainage and infiltration of water and air than silty soils, and are easier to till than clay soils.
Loam is considered ideal for gardening and agricultural uses because it retains nutrients well and retains water while still allowing excess water to drain away.

Types of Water associated with the Soil

There are three basic types or forms of soil water. All these forms start as free water that is added to the soil by rain or snow or irrigation.
Each type is behaves differently in the soil.

1. Gravitational water: free water that moves through the soil due to the force of gravity.
   It is found in the macropores.
   It moves rapidly out of well-drained soil
   It is not considered to be available to plants.

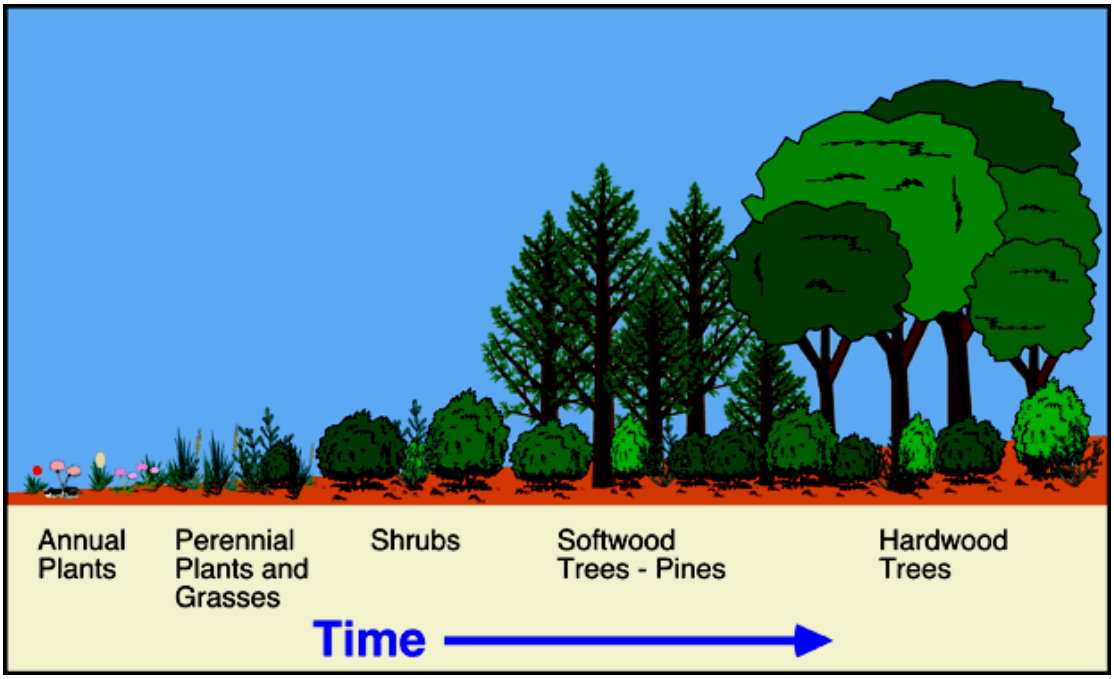
2- Capillary water: Water in the micropores, the soil solution. Most, but not all, of this water is available for plant growth

   Capillary water is held in the soil, against the gravity forces by cohesion (attraction of water molecules to each other) and adhesion (attraction of water molecule to the soil particle).

3- Hygroscopic water: This water forms very thin films around soil particles, no more than 0.0002 millimeters thick which is chemically bound to soil particles by adhesive forces in excess of 31 bars (sea level pressure is 1 bar). This makes the water unavailable to plants, as it can only be liberated from the soil by heating.

Community changes:-

Ecological Succession: replacement of populations in habitat as it moves toward a stable state because change in physical factors and biological .



- The environment may be altered in substantial ways through the activities of organisms, including humans, or when the climate changes.
- Although these alterations are sometimes abrupt (ex. Natural disasters), in most cases species replace others, resulting in long-term gradual changes in ecosystems.
- Ecosystems tend to change with time until a stable system is formed.
- The type of ecosystem that is formed depends on the climatic limitations of a given geographical area.

Primary Succession:-

Pioneer Organisms:

- The first organisms to inhabit a given location (ex. lichens on bare rock)
- Pioneer organisms modify their environment, thus establishing conditions under which more advanced organisms can live.
- (ex. seasonal die back and erosion, for example, would create pockets of "soil" in the crevices and hollows of the bare rock inhabited by the lichen)
- Each community modifies its environment, often making it more difficult for itself and, apparently, more favorable for the following community which infiltrates the first community over a period of years.
- **Primary Succession**: (Primary succession – takes where no soil exists)
- the development of plant communities on newly formed habitats that previously lacked plants (ex. a lava flow)

An example of a Primary Succession ex. (Adirondack Bog Succession)

1. water plants at pond edge

2. sedges and sediments begin to fill pond

3. sphagnum moss and bog shrubs fill

4. black spruce and larch

5. birches, maple, or fir

Secondary Succession:(takes place where soil is already present**)** return of an area to its natural vegetation following a disruption or removal of the original climax community

An example of a secondary succession:

1. plowed field

2. annual grasses

3. shrubs and briers

4. cherries, alders, and birches

5. climax community –

- **Climax Community**

- a self-perpetuating community in which populations remain stable and exist in balance with each other and their environment
- The climax community of a region is always its dominant plant species.
- Altered ecosystems may reach a point of stability that can last for hundreds or thousands of years.
- A climax community persists until a catastrophic change of a major biotic or abiotic nature alters or destroys it.
- (ex. forest fires, abandoned farmlands, floods, areas where the topsoil has been removed)

- After the original climax community has been destroyed, the damaged ecosystem is likely to recover in stages that eventually result in a stable system similar to the original one.
- Ponds and small lakes, for example, fill in due to seasonal dieback of aquatic vegetation and erosion of their banks, and eventually enter into a terrestrial succession terminating in a terrestrial climax community.
- FLORA - plant species - dominate in the sense that they are the most abundant food sources
- Plant succession is a major limiting factor for animal succession.
- Animal Succession- as the plant community changes so will the animals
- Climax communities are identified by the dominant plant species -- the one that exerts the most influence over the other species present.

POLLUTION

pollution

Preface:-

The word pollution is derived From the Latin word pollutes, which has many meanings for example is dirty, and musty etc.
The environmental pollution of the most serious disasters faced it by human our time. Pollution means the deterioration of environment as a result of occurrence incompatibility in elements which environment consist from it, so that it loses its ability to perform its natural role, especially in getting rid of pollutants by natural processes that occur in water, air and soil (self-purification)and earth…

Moreover, the pollution is a global influence has gained universality (global) characteristic because the pollutants have the ability to move from the far north to the far south, it unknowns geographic boundaries or political, there are many countries that do not have industrial activity or mining but it has pollution, winds , cloud sand water currents contribute to the transfer of pollutants from one country to another and from one continent to another until the spread of pollutants and covered all the earth and that evidence, you can find the pesticide (DDT) in Alaska.

the importance of pollution and capacity impacts that could affect the of living and non-living components for all ecosystems which founded in various regions of the earth. a large number of scientists from various countries of the world to give definition of pollution, each according to his point of view. In the below mention some of these definitions:

1- It is a change in the environment that surrounds organisms by human act and daily activities whereof leading to appearance some of the resources that do not fit with the place which organism live in it and lead to unbalance sit.
2- It is any change in a chemical, physicals and biological characteristics for basic environments (water, air and soil) whereat affect a negative impact on organisms, or the use of these environments and benefit from it in different purposes.

What is the difference between the two terms (Pollution & Contamination?

Pollution: when talking about pollution of something as big as a city or a forest or a river or lake etc.

Contamination: when talking about pollution of something as small such as food, drinking water or medicine or wound etc.

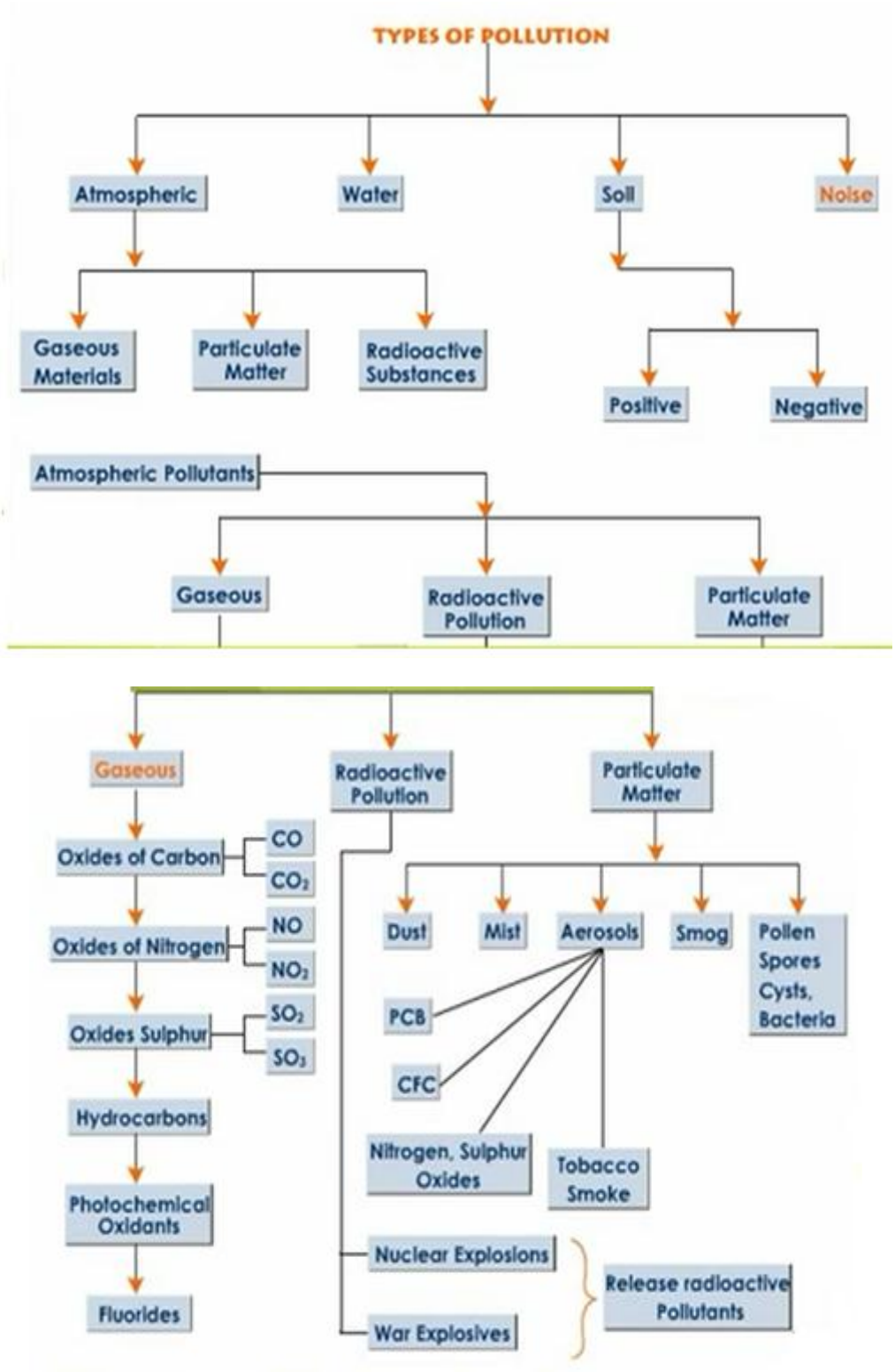
The universe from the atom to the galaxy is calculated quantities such the universe grows in a state of equilibrium. This state of equilibrium found in things as well as in the systems formed by a group of these things. This equilibrium found is starting from atom ,molecule, ,compound, cell, tissue, organ, system, organism, community and the ecosystem up to the all over universe.

As an example of the equilibrium mention a clear example we all know which is the human body. The natural human body or healthy is in a state of equilibrium because all of its components are within the ranges specified or estimated and that the interaction or overlap between these components being consistently. But what happens if changed, for example, the percentage of sugar in the blood, or percentage of hemoglobin decrease in it or changed any natural hormone ratios which excrete it by glands?

Pollution, Historical review:

. Pollution started from the prehistoric times when man created the first fires. According to a 1983 article in the journal *Science*, "soot found on ceilings of prehistoric caves provides ample evidence of the high levels of pollution that was associated with inadequate ventilation of open fires. The forging of metals appears to be a key turning point in the creation of significant air pollution levels outside the home. Core samples of glaciers in Greenland indicate increases in pollution associated with Greek, Roman and Chinese metal production, but at that time the pollution was comparatively less.

Chicago and Cincinnati were the first two American cities to enact laws ensuring cleaner air in 1881. Extreme smog events were experienced by the cities of Los Angeles and Donora, Pennsylvania in the late 1940.


TYPES OF POLLUTION
Atmospheric
Water
Soil
Noise
Gaseous Materials
Particulate Matter
Radioactive Substances
Positive
Negative
Atmospheric Pollutants
Gaseous
Radioactive Pollution
Particulate Matter
Gaseous
Oxides of Carbon
CO
CO2
Oxides of Nitrogen
NO
NO2
Oxides Sulphur
SO2
SO3
Hydrocarbons
Photochemical Oxidants
Fluorides
Radioactive Pollution
Nuclear Explosions
War Explosives
Release radioactive Pollutants
Particulate Matter
Dust
Mist
Aerosols
Smog
Pollen Spores Cysts, Bacteria
PCB
CFC
Nitrogen, Sulphur Oxides
Tobacco Smoke

WATER POLLUTION

- Water pollution is defined as the addition of some foreign substance to water, that constitutes a health hazard

The pollutants:-

When adding harmful substances or products into the environment causes changing undesired in it, regarding physical, chemical and biological characteristics .And one of the most important causes of pollution is the high rate of energy usage by growing populations.

Natural Pollutants: The pollution which comes out from natural sources such as forest fires volcanic eruption decomposition of organic matter & natural radioactivity.

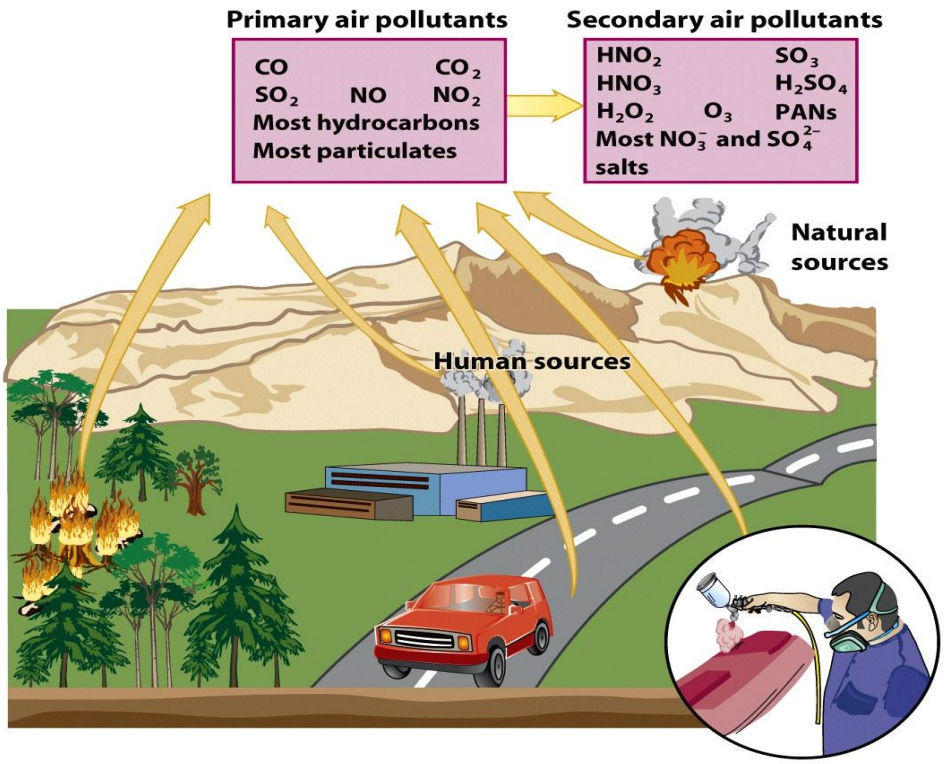
Primary Pollutants: Harmful chemical that directly enters the air as a result of human activity. These are deforestation ,burning of fossil fuel and industrialization warfare etc.

Secondary pollutants :These result from chemical reactions between two or more air components.

Formation of secondary pollutants

$$2SO_2+O_2 \longrightarrow 2SO_3$$

$$2SO_3+H_2O \longrightarrow H_2SO_4 \text{ (Secondary pollutant)}$$



The pollutants can be classified into two groups:

1- **Biodegradable pollutants**:

Biodegradable matter is generally organic material such as plant and animal matter and other substances originating from living organisms. The materials that are able to break down naturally into harmless simpler forms by actions of microorganisms. E.g. paper, some plastic, textiles.

2- Non-biodegradable pollutants:

Non-biodegradable waste originating from household and industrial products. These stay a very long time in the environment as they either can be broken down or they take very long .e.g. plastics, glass metals.

Biodegradable materials differ in speed decompose some of their very fast or fast or slow or very slow and is first and foremost will be removed from the environment or disappear entirely after decomposition of carbon dioxide, water, and the rest of the other primary elements. But this material can be converted into useful products by choosing the appropriate method of waste management methods (Waste management) such as :

1 - used as fertilizer by mixing with the soil (Composting)

2 - used to generate energy by anaerobically decomposition , and the production of methane gas , which can be a substitute for oil . The anaerobic decomposition of renewable energy sources (Renewable Energy). Note that the material remaining after decomposition it can be used as an organic fertilizer .

3 - used for heating or generating electricity by burning (Incineration) and turn them into ashes .

The technological development that enabled man of installation and manufacture of non-biodegradable and that made life easier , but their accumulation in the environment to make governments , organizations ,scientists and the general public perceive it as a problem and must be treatment and limitation. so there are many steps in this regard as follows:

1 - reuse or recycling of these materials to reduce the quantities of the environment.

2 - Search for alternatives to these materials where they can be analyzed via biodegradable such as plastic , shopping bags and detergents. that these materials are expensive compared with those of non-biodegradable .

Pollution's Sources:

Pollution sources may be divided into:

1- Point sources:

Point sources: are sources from which pollutants are released from one identifiable spot.

- Some point sources of water pollution include:
  - Waste products from factories
  - Waste from sewage system
  - Waste from power plants
  - Waste from underground coalmines
  - Waste from oil wells
- They are called point sources because they are direct sources of water pollution and can be reduced and monitored.

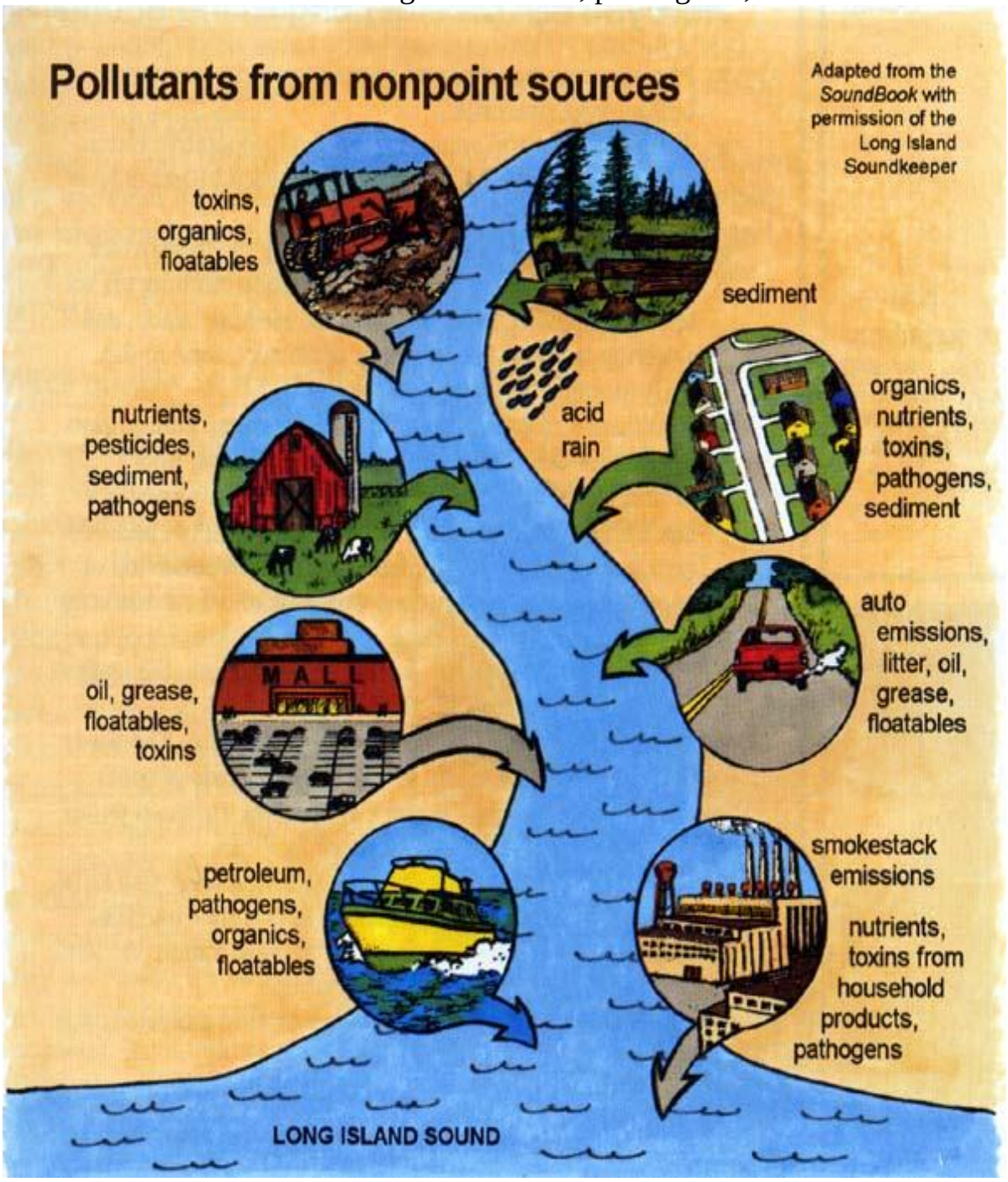
Example of a point source

2- Nonpoint sources:

The term non-point source encompasses a large range of sources such as:

a. when rain or snow moves through the ground and picks up pollutants as it moves towards a major body of water
b. the runoff of fertilizers from farm, animals and crop land
c. air pollutants getting washed or deposited to earth

d. storm water drainage from lawns, parking lots, and streets .



The nonpoint sources divided into:

1- Linear Sources**:**

It is pollutants that to be emitted with linear form (one way) such as pollution produce from cars and plane etc.

2- Area Sources**:**

It is polluted water bodies resulting from many resources discharge its water in the water bodies and in many regions such as big collections industrialism.

3- Volume Sources**:**

It is source with three dimensions as soil storm .

Pollution Types:

1- **Water Pollution**:

Sewage, industrial waste, oil, pesticides and fertilizers all pollute water.

Fertilizers and sewage can easily be washed into rivers, streams and lakes. The nutrients, phosphates and nitrates in these substances cause **eutrophication**. it is the accumulation of nutrients in water, which causes excessive algal growth. This leads to a reduction in oxygen levels and the death of aquatic life.

*Causes of water pollution and its effects on the environment are :

Livestock waste ,oil spillages. detergent in sewage, industrial effluents and residues of pesticides

Livestock waste: In Hong Kong waste from pigs and poultry have caused major pollution to our streams and rivers in the New Territories for a long time. When there is an excessive amount of organic matter discharged into water, the existing microorganisms will grow and multiply rapidly. Oxygen is rapidly depleted. With the depletion of oxygen, anaerobic bacteria begin to flourish. They break down the organic matter partially, releasing obnoxious and toxic gases like methane, ammonia and hydrogen sulphide. As a result, aquatic organisms will die.

Oil spillages :Oil floats on water. This blocks the oxygen supply to marine life and kills them. oil clots the feather of sea birds and prevents them from flying or swimming. They then die of starvation.

The impact of pollution hydrocarbons:

The spread of large spots oil floating on the surface of the water leads to several negative effects, including:

1 - blocking sunlight and the impact on the process of photosynthesis.
2 - prevent osmosis gases and the effect on the amount of dissolved oxygen.
3 - oil and its derivatives is toxic if entered into cavity of fish and birds.
4 - adhere to aquatic organisms such as birds, leading to kill her.

5 - the impact on life in the bottom of the ocean when the oil settles on the bottom.
6 - big damaging happens in the coast.

Detergent in sewage: Aquatic plants needs the elements nitrogen and phosphorus for proper growth. These elements are usually scarce in most natural bodies of water, and this shortage normally keeps the spread of vegetation under control. However, if a new source of nitrogen or phosphorus is introduced into the water, excessive plant growth occurs, and the population of primitive plants like algae explodes.

Industrial effluents: The toxic materials present in industrial effluents vary with the industry involved. They may contain cadmium, chromium, copper, mercury, nickel, lead, zinc, cyanides and polychlorinated hydrocarbons, etc.

Residues in pesticides: On entry into water , pesticides may either cause inflammable toxic effects on aquatic life, they accumulate along the food chain until a toxic level is reached to human, e.g. DDT is an organic- chloride pesticide widely used previously.

Water Quality:

- Dissolved oxygen (often abbreviated DO).as an indicator of oxygen content in water
- Biochemical Oxygen Demand (BOD) as an indicator of the extent of water pollution.

Dissolved oxygen: Animals and plants that live in an aquatic habitat depend on oxygen dissolved in the water for their survival. Oxygen is not very soluble in water, and the amount that does dissolve also depends on the temperature of the water. DO is measured in mg of oxygen per L of water or percentage saturation of oxygen. Fishes normally require 4-6 mg/L for survival.

Biochemical Oxygen Demand (BOD):

This is the amount of oxygen required to break down the organic matter resent in the water sample. The oxygen is required by

microorganisms, such as many forms of bacteria, to break down the organic matter that constitutes their food.

Ultimately, the micro-organisms will convert huge quantities of organic matter into the following end products like carbon dioxide, water, nitrogen, etc.

BOD can thus be used as an indicator of the extent of organic pollution. If water has a high BOD, it indicates that a lot of organic waste is present and a lot of oxygen is required to break down the waste. A low BOD indicates the presence of small amount of organic matter and there is a little organic pollution.

Chemical demined oxygen COD :-

In environmental chemistry, the chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L) also referred to as ppm (parts per million), which indicates the mass of oxygen consumed per liter of solution.

For many years, the strong oxidizing agent potassium permanganate ($KMnO_4$) was used for measuring chemical oxygen demand. Measurements were called *oxygen consumed* from permanganate, rather than the *oxygen demand* of organic substances. Potassium permanganate's effectiveness at oxidizing organic compounds varied widely, and in many cases biochemical oxygen demand (BOD) measurements were often much greater than results from COD measurements. This indicated that potassium permanganate was not able to effectively oxidize all organic compounds in water, rendering it a relatively poor oxidizing agent for determining COD.

Chemical oxygen demand (COD) does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to oxidize all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days.

Sources of water pollution:

water pollution is located between two extremism:

1 - water with a high degree of eutrophication (Eutrophic state) live in a society of many bio-diversity and has a high productivity.

2 - water with high concentrations of toxic chemicals destroy many organisms or even eradicated all forms of life. the water exposed for pollution belongs to many resources as in following diagram**:**

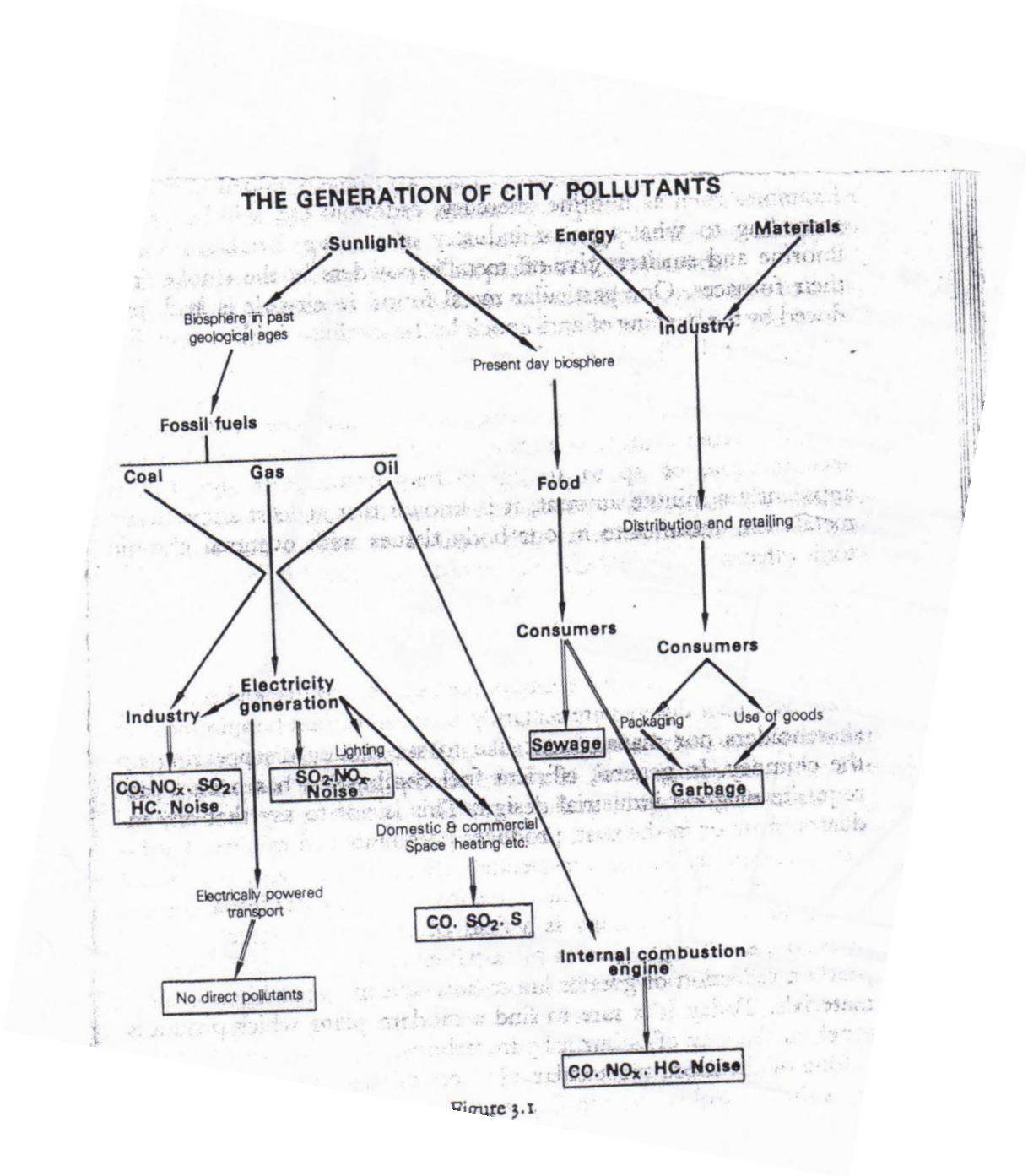


Figure 3.1

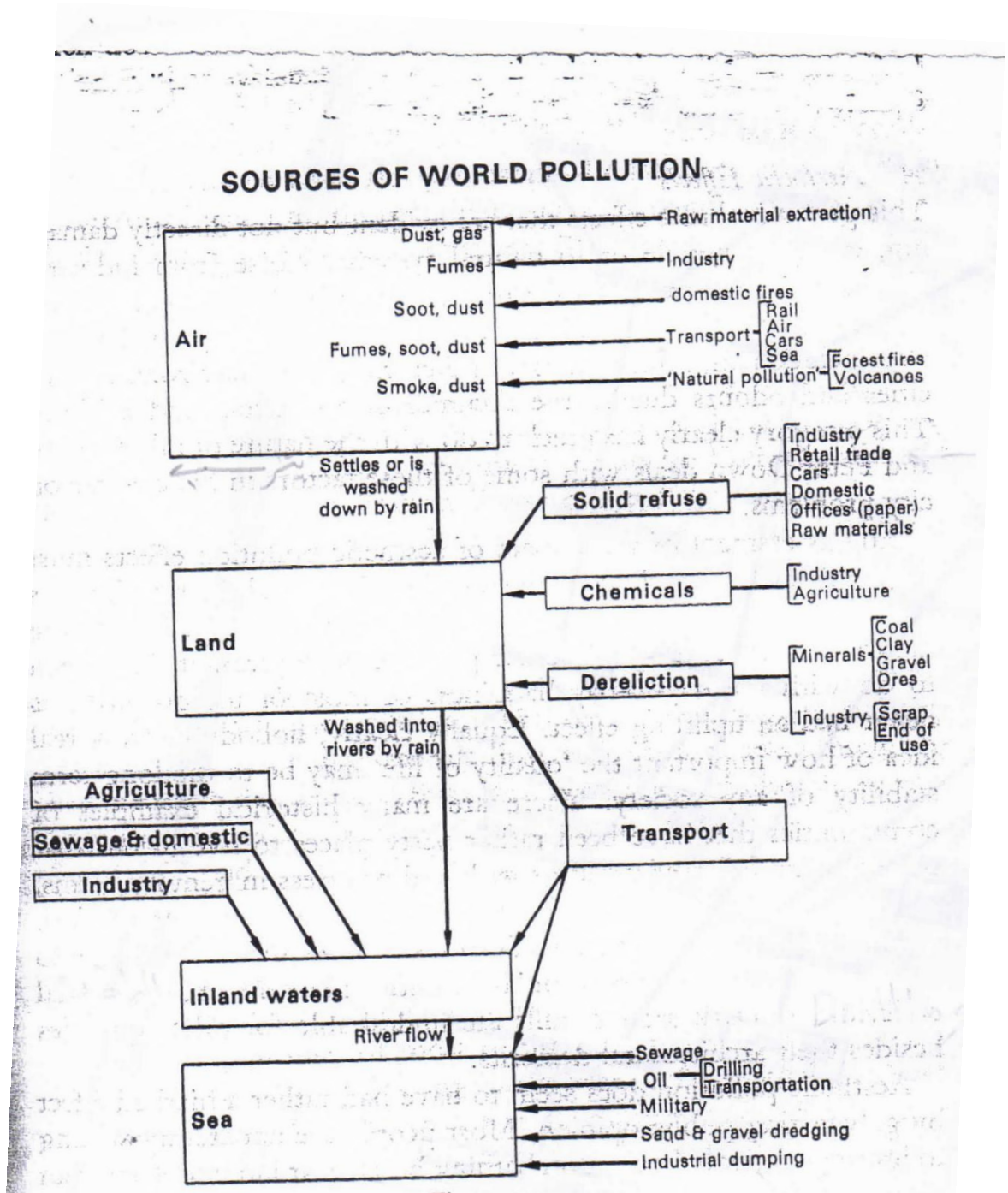

SOURCES OF WORLD POLLUTION
Air
Dust, gas
Fumes
Soot, dust
Fumes, soot, dust
Smoke, dust
Raw material extraction
Industry
domestic fires
Transport
Rail
Air
Cars
Sea
'Natural pollution'
Forest fires
Volcanoes
Settles or is washed down by rain
Solid refuse
Industry
Retail trade
Cars
Domestic
Offices (paper)
Raw materials
Chemicals
Industry
Agriculture
Land
Dereliction
Minerals
Coal
Clay
Gravel
Ores
Industry
Scrap
End of use
Washed into rivers by rain
Agriculture
Sewage & domestic
Industry
Transport
Inland waters
River flow
Sea
Sewage
Oil
Drilling
Transportation
Military
Sand & gravel dredging
Industrial dumping

Figure 2.2

Soil Pollution:

Soil pollution occurs when chemicals are released by spill or underground leakage. Among the most significant polluted are hydrocarbons, heavy metals, pesticides and chlorinated hydrocarbons

Causes of Land Pollution:

Four Main causes of land pollution are:

1- Construction: Buildings take up resources and land, the trees are chopped down and used to make buildings. Takes away from places for animals and other organisms to live.

2- Agriculture: As there are more and more people inhabiting the earth, food is in higher demand and so forests are chopped down and turned into farmland. In addition, herbicides, pesticides, artificial fertilizers, animal manure are washed into the soil and pollute it.

3- Domestic waste: Tons of domestic waste is dumped every day. Some waste from homes, offices and industries can be recycled or burnt in incinerators .There is still a lot of garbage, such as refrigerators and washing machines that are dumped in landfills simply because they cannot be reused in anyway, nor recycled.

4- Industrial Waste: Plastics factories, chemical plants, oil refineries, nuclear waste disposal activity, large animal farms, coal-fired, power plants, metals production factories and other heavy industry all contribute to land pollution

Consequences of Land Pollution:

1- Land pollution exterminates wild life.
2- Acid rain kills trees and other plants.
3- The vegetation that provides food and shelter is destroyed.
4- Land pollution can seriously disrupt the balance of nature, and, in extreme cases, can cause human fatalities.
5- Pesticides can damage crops; kill vegetation; and poison birds, animals, and fish.

Noise Pollution:

The term "noise pollution" has been recently used to signify the hazard of sounds which are consequence of modern day development, leading to health hazards of different type.

Health Effects:

- noise pollution affects the lives of millions of people.
- Noise pollution can damage physiological and psychological health.
- High blood pressure, stress related illness, sleep disruption, hearing loss, and productivity loss are the problems related to noise pollution.
- It can also cause memory loss, severe depression,

<u>Classification of Noise Pollution</u>:

There are two kinds of noise pollution are:

A) Community Noise/ Environmental Noise (non-industrial noise pollution).

- Aircraft noise
- Roadway noise pollution
- Under water noise pollution

B) Occupational Noise(industrial noise pollution)

Sources of Noise Pollution:

- Road Traffic noise - Air Craft . Noise from railroads .Construction Noise. Noise in Industry .Noise from Consumer products . Loud Speakers / Public Address Systems .Firecrackers

Some of the Solutions for Noise Pollution:

1) Planting bushes and trees .
2) Regular servicing and tuning of automobiles.
3) Buildings can be designed with suitable noise absorbing material for the walls, windows, and ceilings.
4) Workers should be provided with earmuffs for hearing protection.
5) Soundproof doors and windows can be installed to block unwanted noise from outside.
6) Factories and industries should be located far from the residential areas.

7) Social awareness programs should be taken up to educate the public about the causes and effects of noise pollution.

Measurement of noises:

*A decibel (db) is the standard for the measurement of noise:

- 20 db is whisper.
- 40 db the noise in a quiet office.
- 60 db is normal conversation.
- 80 db is the level at which sound becomes physically painful.

4- Radioactive pollution :

Radioactive pollution, like any other kind of pollution, is the release of something unwanted into the environment. Radioactive pollution can be a very dangerous thing because radiation mutates DNA, causing abnormal growth and possibly cancer, and this radiation remains in the atmosphere for years, slowly diminishing over time. There are many causes of radioactive pollution. The causes are as follows:

1- *Production of nuclear weapons.*
2- *Nuclear weapons.*
3- *Coal ash.*
4- *Medical waste.*
5- *Nuclear power plants* **.**

Radioactivity Units:

Measure the number of nuclear transformations
(disintegrations) which occur in a certain time period
Curie (abbreviated, Ci)
= 37,000,000,000 disintegrations per second (dps)
= 2,200,000,000,000 disintegrations per minute (dpm)
Radioactive pollution measures an amount of activity over a unit of surface area.

e.g. 5000 dpm/100 cm^2

Thermal pollution :

The earth have natural thermal cycle. The excessive thermal that happens noxious effect on long extent.Is a temperature changein natural water bodies caused by human influence.

Sources of thermal Pollution:

1. Power plants.
2. Increase concentration of some gases such as CO_2 , CH_4 , H_2O vapor etc.
3. Deforestation (removed the forests).
4. Expansion in a cities.

Visual Pollution:

visual pollution obtain via other types of pollutants can also gets landscapes harmful or disgusting. In some areas, reduce this kind of pollution or the level of quality of life may also affect psychological comfort in persons.

Visual pollution sources include:

1 - The distribution of power lines and electrical lines that connect electrical generators and subscribers.

2 - Zones under construction and reconstruction.

3 - Zones of abandoned buildings and derelict and polluted land.

4 - Garbage dumps and the landfill.

The effect of visual pollution:

Not for the visual pollution of a direct impact on public health or the environment, however, other types of pollutants that cause visual pollution which it have harmful impacts.

personal Pollution:

It is a person's body or harmful or harmful influence on the style or the way of life of people.

This includes the kind of pollution:

1 - excessive smoking and addiction to alcohol and drugs.

2 - physical and emotional harm.

3 - live under poor conditions.

4 - the physical structure of the person to be meager.

The personal pollution in some cases can be mitigated or cured by the care and attention it receives by other spers on. In some other cases requires active by volunteers.

Light pollution:

It is excessive lighting is issued from a certain area. And sources are :

1 - optical bulletins and billboards.

2 - the big cities.

3 - sporting events and celebrations that happen in the night.

The impact of light pollution:

Light pollution makes it difficult observation the stars and thus affect the astronomers who monitor the planets and stars. If the source of light pollution near residential areas they affect the rest of citizens.

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Air pollution:

One of the main causes of air pollution is the release of carbon dioxide into the atmosphere, this happens because of Deforestation and fossil fuel burning

Sulfur dioxide is another air polluter and is released into the atmosphere by the burning of sulfur containing compounds of fossil fuels. Sulfur oxides are very dangerous to humans at a high concentration. Sulfur in the atmosphere is responsible for acid rain

Chlorofluorocarbons (CFCs) also contribute to air pollution by reducing the amount of ozone the stratosphere. CFCs come from a variety of places such as:

- the burning of plastic foam items
- leaking refrigerator equipment
- spray cans

Natural air pollutants can include:

- Smoke from wild fires
- Methane released from livestock
- Volcanic eruptions

CO2 is a good transmitter of sunlight, but it also partially restricts infrared radiation going back from the earth into space, which produces the so-called greenhouse effect that prevents a drastic cooling of the Earth during the night

Increasing the amount of CO2 in the atmosphere reinforces this effect and is expected to result in a warming of the Earth's surface

CO2 in atmosphere→GLOBAL WARMING

One of the greatest threats caused by air pollution is **global warming**. Global warming is caused by a build-up of greenhouses gases, which leads to an increase in the Earth's temperature.

Key greenhouses gases include: carbon dioxide (CO_2) ,methane (CH_4) , water vapour (H_2O) ,nitrous oxide (N_2O)

*Human activity produces two main types of air pollutant:

a) **noxious gases** – These include carbon dioxide (CO_2), sulfur dioxide (SO_2) and nitrogen oxides (NO_x).

Sulfur dioxide, nitrogen oxides, ozone and peroxyacl nitrates (PANs), cause direct damage to leaves of crop plants and trees when they enter leaf pores (stomates)

b) **particulates** –These are tiny particles suspended in air (e.g. smoke) and which are usually produced by the combustion of fossil fuels.

Air pollution, global warming, acid rain, damage to the ozone layer and smog. Each of these has serious implications for the environment and human health.