PLANT SUCCESSION

Plant Succession

- The gradual replacement of one type of plant community by the other in the development of vegetation towards a climax which is the culmination stage for a given environment is referred to as *Plant Succession*.
- E.P. Odumn,- "Plant succession is an orderly process of community change in an unit area."

- Salisbury -
- "Plant succession is a competitive drift in which at each phase, until the climax, the constituent species render the habitat more favourable to their successors than to themselves."
- Succession is a complex universal process which begins, develops, and finally stabilize at the climax stage.
- The climax is the final mature, stable self-maintaining and self-reproducing stage of vegetational development in a climate unit.

Causes of Succession

- The main causes of succession are :

  a) Climatic causes

  b) Topographic *causes ,like erosion*

  c) Biotic causes *like grazing, cultivation*

Succession and Climax Concept

- Plant succession is an orderly change of vegetation.
- It involves gradual and successive replacement of one plant population by the other.
- The whole sequence of communities that replaces one another in a given area is called the "Sere".
- Its various intermediate stages are called the *seral stage*
- Communities representing these stage are called the *seral communities*.
- Though the seral communities are not clearly distinct, yet they are recognized because of some dominant plant species growing in them.

- The relatively transitory communities are variously called development stages or **pioneer** stages,
- While the terminal stabilized system is known as **climax**.
- Species replacement in the sere occurs because populations tends to modify the physical environment, making conditions favourable for other populations until an **equilibrium** between **biotic** and **abiotic** is achieved.

- **Plant succession is not a series of steps or stages but is continuous and very slowly changing complex.**
- **The replacement of vegetation takes place individual by individual. There is no jump from one dominant community to other.**
- **Dominant spp. of one community will persist along with some new migrants for several generations in a given area and bring about several changes in the habitat by their deeper shades and leaf litter.**

- **When the habitat becomes extremely non-tolerable for the existing plants then the plants of next community, that are well suited to that habitat, will come and become dominant.**
- After several such changes, a will stage may come when the habitat becomes occupied by most tolerant species that can reproduce and perpetuate well.

- Thus, the process leads to establishment of climax community; a mature, dominant, self-maintaining and slow changing plant community.
- Climax dominants are the species best adjusted to habitat and are able to take possession of the habitat and hold it against the new invading species.

Development and Evaluation of the Ecosystem

- Ecosystem development, commonly known as **ecological succession** is defined as
- **“Act of repeated following up of one another in order of time at a given space”.**

Origin and development of communities

Stage 1. **Nudation** – exposure of new surface.

Stage2.**Migration** – arrival of seed/ propogules to area from neighbouring.

Stage 3. **Germination** of seed/propogules. When optimum condition exists.

Stage 4. **Ecesis** – only few germinated seeds/propogules establishes successfully. The successful establishment is called Ecesis.

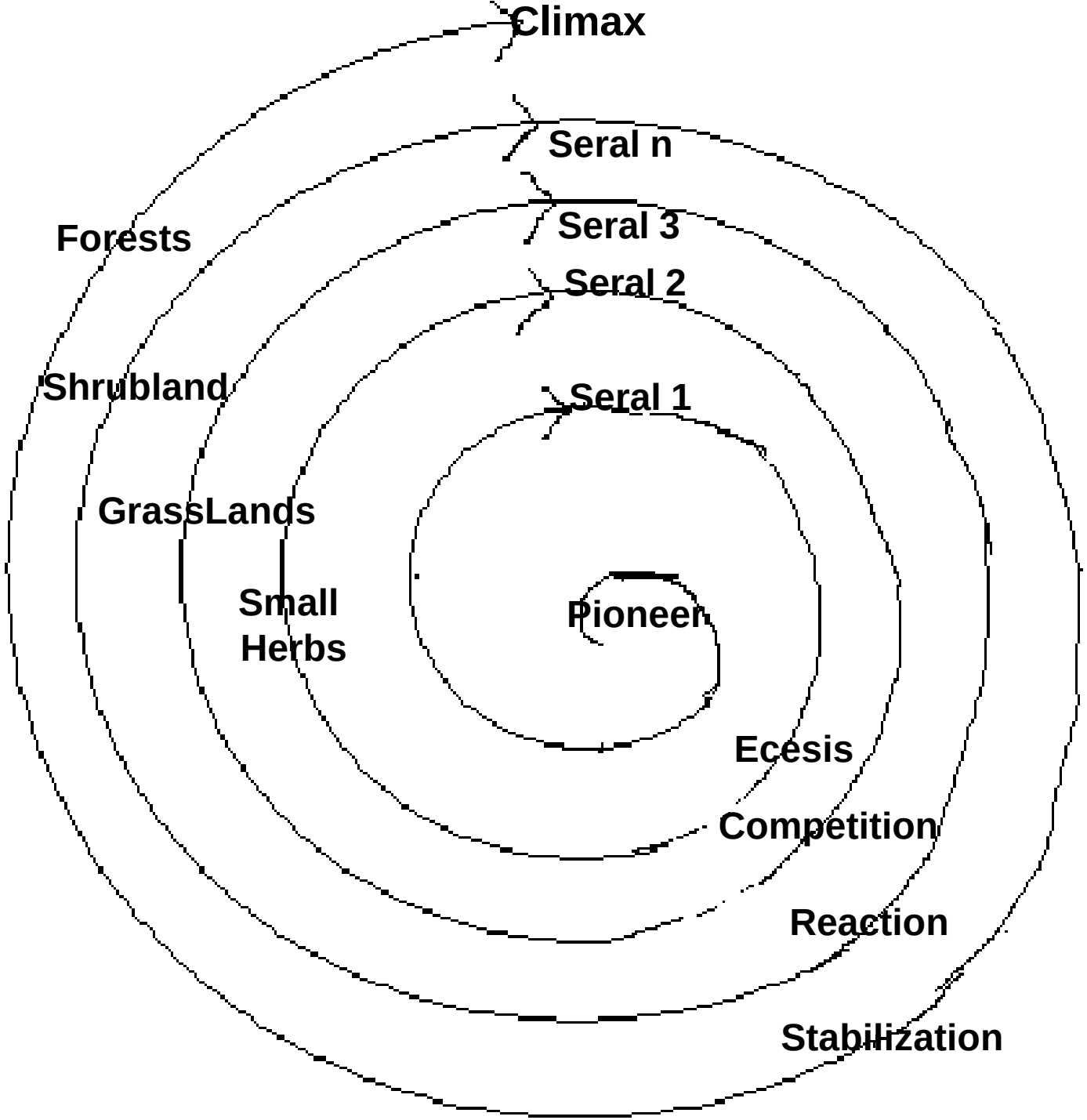
Stage 5. **Aggregation** – number of individual and species increases. This process is aggregation.

Stage 6. **Colonization** – the plant that initially colonize and aggregate are called **pioneers**.

Stage 7.**Competition**

Stage 8. **Invasion** – newer and more aggressive species

Stage 9. **Stabilization** – leading to **climax vegetation**.


Climax
Seral n
Seral 3
Seral 2
Seral 1
Forests
Shrubland
GrassLands
Small
Herbs
Pioneer
Ecesis
Competition
Reaction
Stabilization

Ecological succession have following three parameters

1) It is an orderly process of community development that involves changes in specified structure and community process with time; it is reasonably directional and, therefore, predictable.
2) It results from modification of physical environment determines the pattern, the rate of change, and often sets limit as to how far development can go.
3) It culminates in a stabilized ecosystem in which maximum biomass and symbiotic function between organisms are maintained per unit of available energy flow.

Strategy of Succession

The strategy of **succession** is mainly based on theory **of law** of **maximum energy** in **biological system.**

- In **early stage of Ecological succession** (young nature),
- **Rate of primary production (Photosynthesis – P) exceeds the rate of community respiration (R), so that P/R is > 1.**

(a) In **heterotrophic succession (development sequence) R > P**

(b) In **autotrophic succession P > R**

(c) In **climax (mature) ecosystem P/R approaches 1.**

Example of Plant Succession

- Evoluation of Sal forests from a pioneer plant association of Acacia catechu and Dalbergia Sissoo in gangetic alluvium of UP is an example of plant succession.
- The stages in succession of Sal are:-

(i) Acacia Catechu – Dalbergia Sissoo

(ii) A. Catechu – Holoptelea - Adina – Albizzia

(iii) Holoptelea – Adina – Lagestroemia parviflora – Salmalia – Terminalia belerica.

(iv) Adina – Lagerstroemia parviflora – Terminalia – Shorea

(v) Shorea – Lagerstroemia –Terminalia –Adina.

Plant Succession in Himalayas in the altitudinal zone of 2400 – 2700m.

- Shrub association – blue pines – mixed forests of blue pine, deodar and spruce - mixed coniferous forests of deodar, spruce and fur.

- Depending upon the nature of bare area on which it develops, the succession may be of two kinds: *Primary and Secondary.*

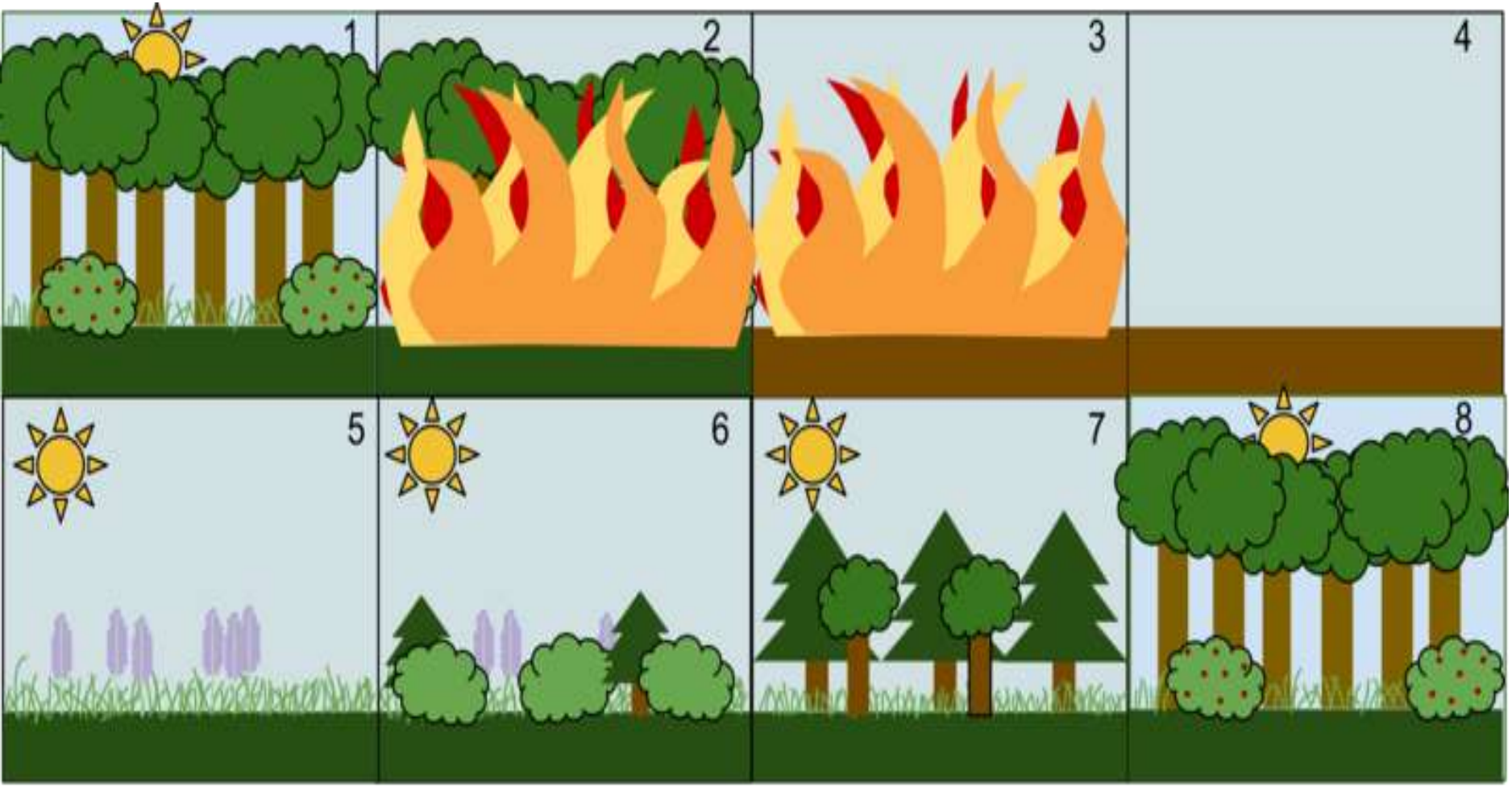
1) **Primary succession:** When the succession starts on the extreme bare area on which there was no previous existence of vegetation it is called *Primary succession or autogenic succession.*

- A forest rock surface expose by landslide
- A new lake formed by construction of a dam

2) **Secondary succession:** This type of succession starts on the secondary bare area which was once occupied by original vegetation but later become completely devoid of vegetation by any process of denudation. Secondary succession has fewer stages than the primary succession and the climax is reached very quickly in the secondary succession.

- **Clear felled forest areas and abandoned agriculture field**

Secondary succession



- Successions which depends upon the moisture condition of the place.

  Xerarch – Dry condition such as bare rock, wind blown sand, rocky slopes

- **Stage –I rocks, in hospitable environment**
- **Stage –II lichens, mosses- tolerating drought and production of organic matter**
- **Stage –III more shrubs**
- **Stage –IV tolerant trees**

- **Hydrarch succession – wet environment**
  - **Water, wet land, marshy land**
- Mesarch succession – moist environment mainly in deep and texture soils
- Mainly secondary succession

- Oligortrophic succession–poor nutrient envir-onment
- Mesotropic succession–balance nutrient envir-onment
- Eutropic succession–fertile and rich environments
- Allogenic succession–geological processes change the physical environment which in turn changes the biota

Hydrosere: The plant succession which start in the aquatic environment is called “hydrarch”. A series of changes taking place in the vegetation of hydrarch is called hydrosere.

b) **Halosere:** It is special type of sere which begins on a salty soil or in saline water.

c) **Xerosere:** When the vegetational succession develops in xeric or dry habitat, it is called xerarch or xerosere. Xerosere may be of two types:

i) **Psammosere:** It refers to the vegetational succession that begins on the sandy habitat.

ii) **Lithosere:** It refers to succession that occurs on rock surface.

Monoclimax and Polyclimax Theories

- Regarding the number of climax in a given habitat or climatic region there are two different theories:
- **Monoclimax theory:** According to Clementsian, *there develops only one true climatic climax in a particular climatic region.* This concept is generalized as monoclimax theory.
- As per FE Clements, in a given reason, all lands are faces, eventually tend to be occupied by a single kind of community which is a climax.
- The factors determining climax is regional climate. If regional climate is stable, climax community will maintain stability indefinitely.

Mono climax and Poly climax

- **Polyclimax theory: it** holds the view which is opposite to monoclimax concept. *It defines climaxes as the stabilized and self-maintaining plant communities and considers that a numbers of climaxes may exist in a given area.*
- In Poly climax hypothesis, different climax communities are possible on different sites.
- As per RH Whittaker, there is only **one big climax community** that varies according to soil, slope and other habitat factor.

SUCCESSION AND CLIMAX

- Types of new sites (primary succession) in India
  - Alluvial- riverian
  - Estuarine
  - Sand dunes
  - Land slips
  - Screes (dry/ cold area, mountainous areas)
- Colonization of the site
  - Riverian
    - Water as main source- Shisham, Trewia,
    - Air borne spp.- Khair, populus, alnus

- **Landslips**

  - Seed by wind dispersal
  - Alnus, populus, Blue pine

- **Sand dunes**

  - Coastal – casuarina
  - Shifting land sand dunes – herbs, shrubs

- Primary succession

- Vegetation established first
- Continuous change
- Soil formation
- Climate
- Rate of succession
- Normal due course - type of vegetation – primary succession
- Final stage is climax

➢ Typical succession (Riverian)

1. Saccharaum Munja, Saccharaum Spontaneum, Tamarix
2. Khair (Acacia catechu)- shisham
3. Khair – Holeptelia – Adina – Albizia
4. Holeptelia – Adina – Lagerstromia – Salmaila – Terminalia Ballerica
5. (a) Adina – lagerstromia- Terminalia – Shorea
   (b)Adina – Trewia Toona (Moist)
6. Shorea – Lagerstromia- Terminalia– Adina and Jamun

- Succession (coniferous)

1. Shrub
2. Blue pine
3. Deodar, Spruce, Blue pine
4. Spruce, Fir, Deodar

- Different types of climax
- Climatic climax – normal , due to climate
- Sub climax – due to interference
- Edaphic climax – soil factors
- Pyral climax – due to fire

➢**Climatic climax – sal**

- Tropical wet evergreen
- Tropical moist deciduous
- Moist shiwalik and himalayan forests

Edaphic climax

- **The climatic climax is achieved where physical conditions of the substratum are not so extreme as to modify the effects of prevailing regional climates.**
- Climatic climax is term used for general climax.
- **Sometimes the climax is greatly modified by the physical conditions of soil such as its topography and water content. Such a climax is known as *edaphic climax*.**
- **Sal forests from a pioneer plant association of Acacia catechu and Dalbergia sissoo in the Gangetic alluvium of Uttar Pradesh is a typical example of plant succession.**
- Sal
- Heavy clay area – aegle (bel and terminalia)

- Edaphic climax

1. Northern Trop. Wet evergreen - Cane brakes
2. Southern Trop. Wet. evergreen -Bamboo brakes
3. Northern Moist Deciduous- T. Tomentosa.
4. Temperate Dry Deciduous- Anogeissus pendula
5. Temperate Dry Deciduous -Bosewellia serrata
6. Temperate Dry Deciduous–Babul
7. Temperate deciduous -Hardwickia

Pre climax

- In climatic zone, there may be sites which have relatively low, or high moisture supplies. The site with low moisture supplies carries a climax vegetation which is more xerophytic then general climax. This climax is called **pre –climax.**
- **Chir Pine forests** in exposed ridge in sub tropical broad leaved forests of oak is pre –climax.
- Moist teak adjoining evergreen forests in TN

Post climax

- A climax with more mesophytic vegetation on shelter sites, than the general climax is called **post climax.**
- **More cool and moist area**
- **Damp sites of semi evergreen forests in sal zone converted into evergreen forests**
- **Chir pine converted into oak**

Sub - Climax

- A vegetation which is not a climatic climax, but stable under continued influence of some biotic factor is called **sub-climax**.
- If biotic factor are removed or controlled, sub-climax will proceed towards general climax.
- **Teak and sal forests in moisture zones is sub-climax**.
- If these forests are not subjected to grazing and fire it will change into mesophytic vegetation of mixed species.

Retrogression

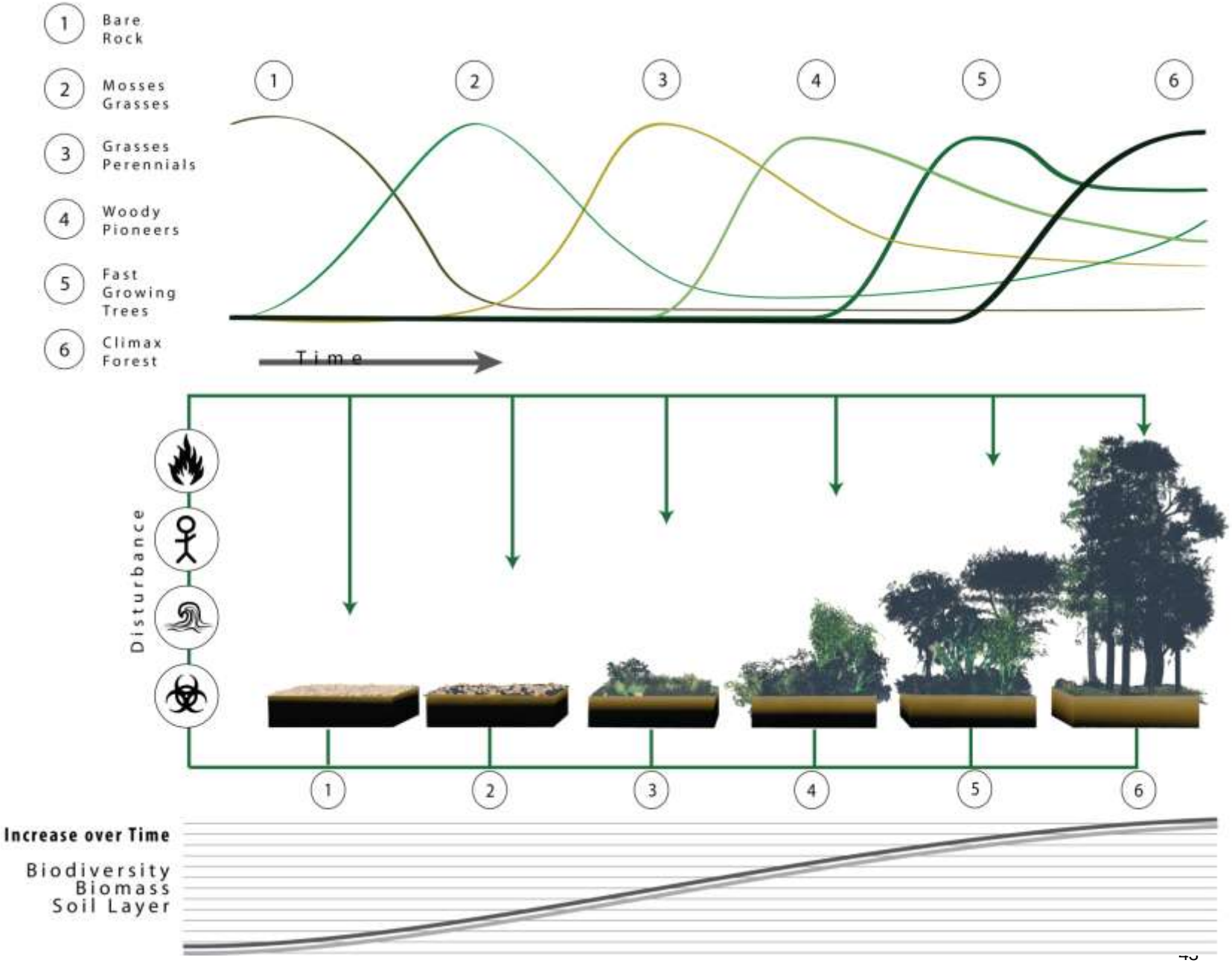
- Succession is a process of development and at early stages in succession, more developed plant communities are present, than the previous stages.
- The process of development of communities can be reversed by some adverse influences. These influences may be man made or natural.
- The plant communities may not be improved over previous stage but resemblances of what had existed in earlier stage. This is known as **Retrogression**.

- In Retrogression is marked by appearance of species which are lower in height and more xerophytic in character, than those they are replacing.
- Examples of retrogression :

(i) Profuse regeneration of Adina Cordifolia in Sal forests in South Raipur (MP)

(ii) Replacement of Oak (Quercus incana) in Himalaya by pure stand of Rhodoedendron.

Forest Succession Over Time In Six Stages



ECOLOGICAL INDICATORS

- The heredity and environment both are equally important in the expression of phenotypic characters.
- Heredity performs its action through environment. Species differ in their environmental requirements and establish themselves where conditions are favourable.
- It is found that certain species of plants, animals and microorganism have one or more specific requirements which very much limit their distribution.

- The occurrence, character and behaviour of a plant are thus indicator of the combined effects of all factors prevailing in a habitat.
- Since a plant species or plant community acts as a measure of environmental conditions, it is referred to as *biological indicator, bioindicator, phytoindicator.*

- In general plant communities are better indicators than individual plants.
- Individual plants and plants communities are used to determine the types of soil and other conditions of the environment.
- They indicate past or future conditions of the environment.

- The knowledge of plant indicators is helpful to determine local soil, thus it can be decided which crops should be cultivated in a particular soil and which should be left for pasture and other purposes.
- Plant indicators are also used to determine optimum use of land resources for forest, pasture, agricultural, crops.
- Many plants indicate the presence of particular mineral or metal. So the presence of precious metal can be detected by the growth of the specific plant in an area.

■Characteristic Features of Plant Indicators

1) Plants of large species are better indicators than the plants of small species.

2) Before relying on a single species or group of species as indicators, there often should be a abundant field evidence.

3) Numerical relationship between species, population, and whole communities often provide more reliable indicators than single species.

Plant indicators

Plant Indicators	Characteristic of Soil
Salvadora oleoides	High calcium and boron, good soil suitable for crop plants
Zizyphus nummularia	Good soil for agriculture
Prosopis cineraria	Good soil for crop plants provided irrigation is there
Peganum harmala	Soil is rich in nitrogen and salts and good for agriculture
Butea monosperma	Heavy alkaline

Plant Indicators	Characteristic of Soil
Capparis decidua	Alkaline soil
Rumex acetosella	Acid grassland soil
Pinus and juniperus	Uranium rich soil
Salsola, Sueda app.	Saline water condition
Andropogon scoparium	Sandy loam type soil
Argemone mexicana	Recently disturbed or flooded soil
Leppia nodiflora and Rumex species	Nitrate rich soils

Plant communities as ecological indicators for ground water in Indian deserts.

Plant communities	Indicated depth of ground water	Indicated total soluble salt in ppm in ground water
Euphorbia caducifolia	12-18 m	1,500-7,000
Acacia senegal Anogeissus pendula	12-18 m	500-1,500
Salvadora persica-Tamarix sp.	6 m	1,500-3,200
Salvadora oleoides-Prosopis cineraria	10-20 m	500-2,000

Plant communities	Indicated depth of ground water	Indicated total soluble salt in ppm in ground water
Prosopus Cineraria-Zizyphus nummularia-Capparis decidua	6-18 m	5,000-10,000
Salvadora oleoides-Capparis decidua	6-12 m	5,000-10,000
Salvadora oleoides-Zizyphus	18-28 m	5,000-10,000

Plant communities	Indicated depth of ground water	Indicated total soluble salt in ppm in ground water
Panicum turgidum-Calligonum ploygonoides	6-18 m	1,000-2,000
Crotalaria burhia-Leptadenia pyrotechnica	6-20 m	500-3,200
Suaeda fruticosa-Alurophus	6 m	11,000-12,000
Capparis decidua	12-20 m	180-15,000
Acacia indica-Prosopis cineraria- Salvadora oleoides	12-20 m	400-1,500

- **<u>Plant indicators for Over-grazing:</u>** Many plants are over-grazing which result in modification of grassland.
- Some plants show characteristics indication of overgrazing which can be recognized.
- The predominance of annual weeds and short-lived impalatable perennials indicate severe grazing.
- Such plants are ***Polygonum, Chenopodium, Lepidium and Verbena.***
- Some plants are less pronounced and show poor or no over-grazing.
- These plants are ***Opunitia, Grindelia, Vernonia*** etc.

- **Plant indicators of Forest:** Some plants indicate the characteristics types of forest that can grow in an area which is not disturbed.
- ***Narenga porphyrocoma*** is a grass which binds the soil. In such soil sal (*Shorea robusta*) can be cultivated.
- Viola species in western Himalayas is a suitable indicator for plantation of ***Cedrus deodara and Pinus wallicahiana.***
- Sometimes forest is destroyed due to fire, overgrazing and other environmental factors and the area is left to reach up to climax. In this, subdominant species get favourable chances for growth and survival. This indicates the future plants to come and establish.

Plant indicators for Humus:

- ***Monotropa, Neottia*** and mushrooms indicate the presence of humus in soil.
- ***Strobilanthes and Impatiens*** indicate the presence of high humus and litter which prevents regeneration of tree species.

Plant indicators for Moisture:

- The poor or very low moisture content in the soil. ***Saccharum munja, Acaia nilotica, Calotropis, Agave, Opuntia, Argemone***
- ***Citrullus Colocynthis, Eucalyptus*** lowers the water table.
- ***Echinops echinatus, Cassia auriculata*** are found in the area of deep water table.

- ***Typha, Phragmites and Vetiveria*** grow in water-logged soil.
- Growth of ***Typha, Phragmites, Juncus and Carex*** indicates the swampy conditions.
- Mangrove vegetation and ***Polygonum*** are found in water-logged saline soils.

- **<u>Plant indicators for Soil type:</u>** Many Plants indicate the characteristics soils.
- ***Casuarina equisetifolia, Ipomoea pes-caprae, Cittullus colocynthis, Calligonum polygonoides, Lycium barbarum and Panicum*** grow in sandy soil.
- ***Saccharum munja*** prefer to grow in sandy loams.
- ***Imperata cylindrica and Vetiveria zizanioides*** grow on clayey soils.

- **Plant indicators for Soil Reaction:** Many plants indicate whether the soil is acidic or basic.
- ***Rumex acetosa, Rhododendron, Polyrichum and Sphagnum*** indicate acidic soils.
- Many forest trees as ***Shorea robusta, Pinus roxburghii*** are calcium loving.

Thank You