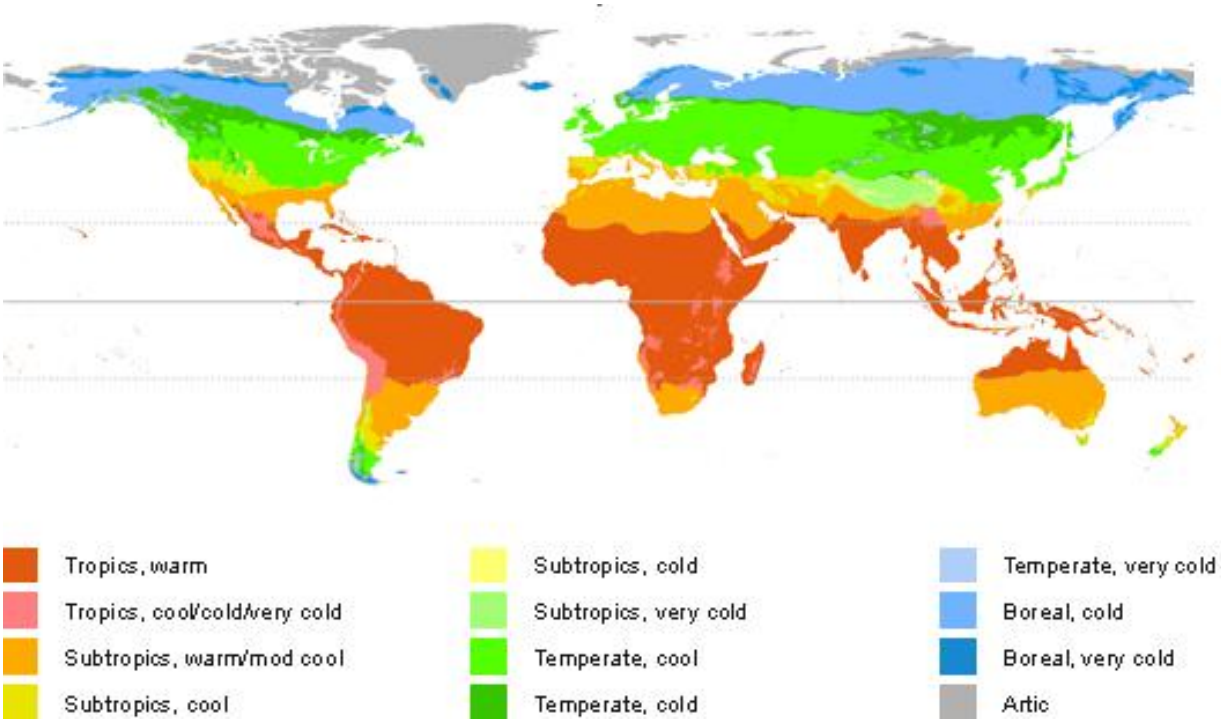
AGRO-ECOLOGICAL ZONES

By
Prof.A.Balasubramanian
Centre for Advanced Studies in Earth Science,
University of Mysore,
Mysore



Introduction:

India is a rich country in terms of the available natural resources.
These natural resources are being used for various activities including agriculture.
Agriculture has been the primary occupation of the people of India, since ancient times.
Agriculture is one of the oldest occupation of the people.
Agriculture is a historically a significant factor of Indian economy.
Indian agriculture produces a very wide range of crops, vegetables and other products. Several of the country's agricultural produces are in global exports and get substantial benefits.
Agriculture in India depends on so many factors.

The major determinants of agriculture, in India are:

a) Physiography (Topography)
b) Climate-which encompasses the seasons, rainfall, temperature and evaporation
c) Water resources (surface and groundwater resources)
d) Soil resources
e) Length of Growing Periods (LGP).

The Agricultural regions, Forest Regions and the Livestock rearing zones are fully controlled by a set of inter-related geographic factors. They are:

a) Climatic factors
b) Soil properties and
c) Physiographic settings(topography & drainage).

Based on these three major parameters , the land area of India is classified into several classes of regions and sub-regions. The Length of Growing Period (LGP) of crops vary depending upon these factors and also the genetic characteristics of crops grown. LGP is related to the moisture availability to the crops grown which is controlled by those three major factors of agriculture.

Over a period of time, experts and geographers found that it is possible to delineate the zones of agriculture with reference to all these features.

It is necessary to delineate the agro-climatic and agro-ecological zones of India, for planning and development of Agriculture.

For this, a systematic appraisal of the Agro-ecological zones is needed.

There are two concepts which are used here.

One is the Agro-climatic zone and the other one is the Agro-ecological zone.

Agro-climatic zone is a land unit classified in terms of major climate, and correlated with the Length of Growing Period (moisture availability period).

Agro-ecological zone is a land unit, carved out of climatic zone, correlated with landforms, climate and the length of growing period (LGP). LGP refers to the number of days available for crop growth with suitable conditions.

In this lesson, the objectives are to understand the ;

1. Zoning Based on Physiographic Features

2. Zoning Based on Soil-Type
3. Zoning Based on Bio-Climatic Conditions
4. Zoning Based on Length of Growing Period
5. Agro-Ecological Zones of India

The parameters taken for the classification agro-ecological regions are the characteristics of: physiographical features, soil characteristics, bio-climatic types and length of the growing period. These are explained one by one briefly.

1. Zoning based on physiographic features:

'Physiography' of an area is the outcome of structure, process and the stage of development of a region. It depends on the rock types, landforms, relief, drainage and other features.

India is characterized by many diversified physiographic features.

The north has a vast expanse of rugged topography consisting of a series of mountain ranges, elevated peaks, beautiful valleys and deep gorges.

The south consists of stable plateaus and plains with highly dissected structures, denuded rocks and a series of scarps.

In-between these two major land masses, we have the great Indian Gangetic plains,

Based on various ecological, climatic, geological and topographical factors, India is basically divided into five major physiographic divisions. They are:
(1) The Northern Mountains
(2) The Great Indian Plains
(3) The Peninsular Plateau
(4) The Coastal belts
(5) The Islands and littoral zones.

These divisions are scientifically and structurally divided into 19 broad ecological regions, for multipurpose activities.

Let us see the distribution patterns of these physiographic sub-units.

1. Western Himalayas

The first one is the Western Himalayas. These mountains are located at the northern-most end of India. These mountains include
Karakoran Range,
Ladakh range,
Zaskar Range,
Shiwalik Range, and
Pir Panjal Range.

The notable physiographic features are
the Ladakh plateau,
the Kashmir Himalayas,
the Punjab Himalayas and
the Kumaun Himalayas.

2. Central Himalayas

This is a part of the Northern Mountains.
This region includes mainly the Nepal Himalayas, and the foot-hills of Tibetan zone of Himalayas.

3. Eastern Himalayas

The next portion of Northern Mountains in India includes, the Eastern Himalayan region.
This is distributed at the eastern-most regions of India. It includes the ranges in Arunachal Pradesh, Sikkim and Darjeeling Himalayas.

4. North-eastern Hills

The Northeastern hills are unique physiographic features present in the Northeastern region of India.
This includes Meghalaya plateau, hills of Nagaland, Manipur, Mizoram and Tripura regions. The Khasi, Garo and Jaintia hills belong to this region.

5. Western Ghats

One of the notable physiographic zone in India, is the western Ghats. They are distributed along the western border regions of India stretching from Mumbai to Cape Comorin.

This includes the northern, central and southern Sahyadris. There are several small hills and hillocks attached to this series of ghats, in south India.

6. Eastern Ghats and Tamil Nadu Uplands

This includes the Tamil Nadu upland, Eastern Ghat ranges and parts of Karnataka plateau, in south India.

7. Central Highlands

This includes the Malwa plateau, parts of Bundelkhand upland, the Vindhyan Scarplands, the Madhya Bharat Plateau, parts of the Avavalli ranges, Gujarat plains and parts of Kathiawar peninsula.

8. Eastern Plateau

This includes parts of Baghelkhand Plateau, Chhota-Nagpur Plateau, Gujarat hills, northern spurs of Eastern Ghats and Dandakaranya plateau.

9. Deccan Plateau

The Deccan trap region is a geologically significant zone of India.
It holds a unique physiographic division, in the Peninsular India.

This include Maharastra plateau, northern Karnataka plateau, Telangana plateau and western spurs of Eastern Ghats.

10. Kachchh and Kathiawar Peninsula

Along the western-most part of India, in the middle, we have the Kachchh and Kathiawar regions. These are mini peninsular regions, existing in Gujarat.

11. Western Plains

This includes the south-western parts of Punjab and Haryana Plains, Rajasthan Bagar, Marusthali; and other regions.

12. Northern Plains

The northern plains are the great Indian plains. This includes Western parts of Ganga-Yamuna plains, Punjab Plains, eastern Rajasthan Uplands, including part of Aravalli Range and Central Highlands.

13. Eastern Plains

This includes north Bihar Plain and parts of-south Bihar Plain and northern parts of Avadh Plain.

14. Gujarat Plains

This includes main lands of Gujarat.

I5. Bengal and Assam Plains

This includes Bengal Basins, north Bengal Plains (Teesta Valley) and Assam Plain along the Bramhaputra Valley.

16. Western Coastal Plains

This includes coastal areas of Saurashtra, Maharastra, Karnataka and Kerala.

17. Eastern Coastal Plain

This includes the coastal belts of Tamil Nadu, Andhra Pradesh, Odisha, and southern coastal belts of Bengal Basin.

18. Eastern Islands

This include the Andaman and Nicobar group of islands. As you are aware, that these islands are existing in the Bay of Bengal.

19. Western Islands

This include Lakshadweep group of Islands. These are existing in the Arabian sea.

2. Zoning based on soil-type

Soils are the products of weathering of rocks. They are the outcome of climate and vegetation on the parent rocks.
They are conditioned by the topography over a period of time.
Depending on the soil forming factors, a variety of soils -are formed and distributed.
Soils in India, are classified into 16 groups. This cetegorisation is helpful in classifying the agro-ecological regions of India.

The following are the major types of soils considered for this classification:

1. Red loamy soil
The red loamy soil occurs in the regions of eastern Himalayas, Eastern Ghats and Tamil Nadu uplands.

2. Red and lateritic soils
The Red and lateritic soil occurs in the eastern plateau, north eastern hills and Western Ghats and also in patches around Eastern Ghats.

3. Red and yellow soils
The red and yellow soil occurs in parts of eastern plateau adjoining the central highlands.

4. Shallow and medium black soils (with inclusions of deep phases)

The Shallow and medium black soils occur dominantly in the Deccan plateau region, including the central Maharastra and the Karnataka plateau.

5. Medium and deep black soils (with inclusions of shallow phases)

The Medium and deep black soils occur dominantly in the Central highlands and in Narmada valley, including Malwa plateau, Bundelkhand up land and Kathiawar peninsula.

6. Mixed red and black soils

The Mixed red and black soils occur dominantly in parts of the Deccan Plateau, including Telangana plateau, the western part of Eastern Ghats, Anantapur and Bellary region of northern Karnataka plateau.

7. Coastal alluvium-derived soils

Coastal alluvium-derived soils occur in the eastern coastal plains and in narrow strips along the western coastal plain.

8. Alluvium-derived soils

The Alluvium-derived soils occur in the Great Northern plains, in the western, northern and eastern parts of Gangetic plains, including Bengal and Assam plains.

9. Desert soils

The Desert soils dominantly occur in the south-western parts of Punjab and Haryana plains, Rajasthan Bagar, Marusthali and Kachchh peninsula regions.

10. Tarai soils

The Tarai soils mainly occur in the foot-hills of central and eastern Himalayas.

11. Brown and red hill soils

These occur in association with red loamy soils in parts of eastern Himalayas.

12. Saline and alkaline soils

The Saline and alkaline soils soils occur in the Kathiawar peninsula and also in the alluvial plain areas of Uttar Pradesh, Haryana, Punjab and Rajasthan.

13. Shallow and skeletal soils

The Shallow and skeletal soils are observed in Ladakh plateau and rugged ranges of Kashmir Himalayas.

14. Grey brown soils

The Grey brown soils occur along the foot-hills of Aravallis.

15. Brown forest and podzolic soils

The Brown forest and podzolic soils are observed in the north-west Himalayan regions.

16. Sandy and littoral soils

The Sandy and littoral soils occur in the Lakshadweep islands and in the coastal areas of Andaman and Nicobar Islands.

Each soil type plays an important role in the ecosystems, agricultural development and cropping patterns.

3. Zoning based on bio-climatic conditions :

The term bioclimate is used to denote the climatic condition for plant growth. Agricultural Crops require suitable climate to grow.
Every Crop, which is cultivated, needs water for transpiration and evaporation.

The plant roots suck or extract water from the soil to live and grow.
The main part of this water does not remain in the plant, but escapes to the atmosphere as vapour through the plant's leaves and stem. This process is called **transpiration.**
Transpiration happens mainly during the day time.

Water from an open water surface also escapes as vapour to the atmosphere during the day.
The same happens to water on the soil surface and to water on the leaves and stem of a plant.
This process is called **evaporation.**
The water requirement of a crop thus consists of transpiration plus evaporation.
Therefore, the crop water need is also called **as "evapotranspiration".**

The water need of a crop is usually expressed in mm/day, mm/month or mm/season.

Suppose the water need of a certain crop in a very hot, dry climate is 10 mm/day.
This means that each day the crop needs a water layer of 10 mm over the whole area on which the crop is grown.

It does **not** mean that this 10 mm has to be supplied by rain or irrigation every day.
Sometimes, it may be possible to supply 50 mm of irrigation water once in 5 days.
The irrigation water will then be stored in the root zone and gradually be used by the plants: every day 10 mm.

The crop water need mainly depends on three major factors. They are :
1. the climate
2. the crop type
3. the growth stage.

In a sunny and hot climate, crops need more water per day than in a cloudy and cool climate.
Similarly, crops like rice or sugarcane need more water than crops like beans and wheat.
At the same time, grown-up crops need more water than very young crops that have just been planted.

Similarly, there is also an effect of major climatic factors on crop water needs:

Let us see the variations with reference to climatic factors like

a) Sunshine
b) Temperature
c) Humidity
d) Wind speed.

Crop water need may be high or low depending upon these factors.

Climatic Factor	Crop water need	
	High	**Low**
Sunshine	sunny (no clouds)	cloudy (no sun)
Temperature	hot	cool
Humidity	low (dry)	high (humid)
Wind speed	windy	little wind

The highest crop water needs are thus found in areas which are hot, dry, windy and sunny.
The lowest crop water needs are found when it is cool, humid and cloudy with little or no wind.

The most well-known source of water for plant growth is rain water.

If there is too much rain, the soil will be with full of water and there will not be enough air.
Excess water must be removed **drainage controls.**

If there is too little rain, water must be supplied from other sources like **irrigation.**
The amount of irrigation water which is needed depends not only on the amount of water already available from rainfall, but also on the total amount of water needed by the various crops.

With respect to the need for irrigation water, a distinction can be made among the three climatic situations: as Humid climates, Sub-humid & semi-arid climates, and Arid and desert climates.

1. Characteristic features of Humid climates:
More than 1200 mm of rainfall per year.
The amount of rainfall is sufficient to cover the water needs of the various crops.
Excess water may cause problems for plant growth and thus **drainage** is required.

2. Characteristic features of Sub-humid and semi-arid climates:
Between 400 and 1200 mm of rainfall per year.
The amount of rainfall is important but often not sufficient to cover the water needs of the crops. Crop production in the dry season is only possible with irrigation, while crop production in the rainy season may be possible but unreliable: yields will be less than optimal.

3. Characteristic features of Semi-arid, arid and desert climates:
Less than 400 mm of rainfall per year.
Reliable crop production based on rainfall is not possible; irrigation is thus essential.

On the basis of the rainfall, temperature, potential evapo-transpiration, altitude and vegetation, the Bio-climatic zones of India were evaluated by various experts.

An **aridity index** (AI) is a numerical indicator of the degree of dryness of the climate at a given location. This index helps to identify, locate or delimit the regions that suffer from a deficit of water, in a cropland.

The UNEP has adopted an Aridity Index.

It is determined by using the equation:

$AI = P / PET$

where PET is the potential evapotranspiration and P is the average annual precipitation.

Here also, PET and P must be expressed in the same units, e.g., in milimetres.

Classification	Aridity Index	Global land area
Hyper-arid	$AI < 0.05$	7.5%
Arid	$0.05 < AI < 0.20$	12.1%

Semi-arid	0.20 < AI < 0.50	17.7%
Dry sub-humid	0.50 < AI < 0.65	9.9%

This classification is related to the water balance of a region.

The water surplus or water deficit conditions of a region is determined using the climatological data.
It helps in determining the moisture index with positive or negative values showing the moist or dry climate depending on the PET.
Potential evapotranspiration is related to the climate and crop water requirement for a particular geographic location in the world.

If the rain fall is more than the PET then the moisture index is positive and if less than PET then it is negative.

Moisture index is a measure of the water balance of an area in terms of gains from precipitation (*P*) and losses from potential evapotranspiration (*PE*). The moisture index (*MI*) is calculated thus:

$MI = 100*(P - PE)*PE$

A moisture index compares wetting and drying, or more specifically, evaporation. Moisture indices have an established history in climate zoning for such applications as agriculture, vegetation, and human habitability in general.

Climatic Zone	Annual Rainfall (mm)	Wet period (months)
Desert	less than 100	0-1
Arid	100-400	1-3
Semi-arid	400-600	3-4
Sub - humid	600-1200	4-6
Moist sub-humid	1200-1500	6-9
Humid	more than 1500	9-12

Ultimately tile moisture index form the basis for the bioclimatic classification which is given as follows.

1. Per-humid zone
the Moisture Index is above + 100 cm.

2. Humid zone
the Moisture Index is + 80 to +20 cm.

3. Sub-humid zone
The moisture index is +20 to -33.3 cm.

4. Semi-arid zone
The moisture index is -33.3 to -66.1 cm.

5. Arid zone
The moisture index is -66.1 to -100 cm..

Thus, we have five bio-climatic zone in the order of decreasing soil moisture index.

4. Zoning based on length of growing period :

The length of the growing period (LGP) simply means the number of days available for crop to grow.

The length of the growing period is also classified into five divisions.

1. LGP class 1

This period is symbolized by the number "1" and the length of growing period is less than 90 days a year.

2. LGP class 2

This period is symbolized by the number "2" and the length of the growing period is between 90 to 150 days a year.

3. LGP class 3

This period is symbolized by the number "3" and the length of the growing period is between 150 to 180 days a year.

4. LGP class 4

This period is symbolized by the number "4" and the length of the growing period is between 180 to 210 days a year.

5. LGP class 5

This period is symbolized by the number "5" and the length of the growing period is above 210 days a year.

5. Agro-ecological zones of India:

Agro-Ecological zoning is the process of correlating the units of physiography, bioclimate, soilscapes and the length of growing period. Each one of these aspects have a very wide number of classess and subdivisions.

As we have seen that the Indian sub-continent exhibits a variety of landscapes and climatic conditions which are noticeable in the types of soils and vegetation.

In the past, several attempts have been made to understand and classify the agro-climatic regions as well as the agro-ecological regions of India.

The then Planning Commission of India, divided the country into 15 broad agro-climatic zones based on physiography and climate. This we have seen as the first part of this lesson.

Based on the four parameters which have been explained so far,

a) physiographic features,
b) Soil characteristics,
c) Bio-climatic features,
d) the Length of growing period, the land area of India is divided into 20 agro-ecological regions.

They are these zones:

1. Cold Arid Eco-region with Shallow Skeletal Soils
2. Hot Arid Eco-region with Desert and Saline Soils
3. Hot Arid Eco-region with Red and Black Soils
4. Hot Semi-Arid Eco-region with Alluvium Derived soils

5. Hot Semi Arid Eco-region with Medium and Deep Black Soils
6. Hot Semi-Arid Eco-region with Shallow and Medium (Dominant) Black Soils
7. Hot Semi Arid Eco-region with Red and Bla6k soils
8. Hot Semi-Arid Eco-region with Red Loamy soils
9. Hot subbumid (Dry) Eco-region with Alluvium- Derived Soils
10. Hot Subhumid Eco-region with Red and Black Soils
11. Hot Subhumid Eco-region with Red and Yellow Soils
12. Hot Subhumid Eco-region with Red and Lateritic soils
13. Hot Suhhumid (Moist) Eco-region with Alluvium-derived soils
14. Warm Subhumid to Humid with Inclusion of Perhumid Eco-region with Brown Forest and Podzolic Soils
15. Hot Subhumid (moist) to Humid (inclusion) of perhumid Eco-region with alluvium-derived soils
16. Warm Perhumid Eco-region with Brown and Red Hill Soils
17. Warm Perhumid Eco-region with Red and Lateritc Soils
18. Hot Subhumid to Semi-arid Eco-region with Coastal Alluvium-derived soils
19. Hot Humid Pemhumid Eco-region with Red, Lateritic and Alluvium-derived soils
20. Hot Humid/Perhumid Island Eco-region with Red loamy and Sandy Soils .

The Classified agro-ecological zones will be much useful,

- For promoting agriculture
- For promoting industrial sector
- For developing the economy and also
- For maintaining food security, in India .