METEOROLOGICAL TELECONNECTIONS

- Refers to long distance relationship between the weather phenomenon that occur at widely separated locations on the Earth
- The concept of teleconnections was first noted by British meteorologist Sir Gilbert Walker in the late 19th century
- Teleconnections refer to the climate anomalies being related across large distances, often due to atmospheric circulation patterns
- These connections are crucial for understanding how climate anomalies in one region can influence weather patterns in another distant region.

MAJOR PHENOMENA INFLUENCING MONSOON RAINFALL

Good Monsoon (Normal Year)	Bad Monsoon (Abnormal Year)
La nina	El nino
Walker cell	Reverse walker cell
LNSO	ENSO
SOI +	SOI-
IOD+	IOD-

- Walker Cell: Atmospheric circulation pattern affecting tropical weather
- Southern Oscillation: Periodic fluctuation of air pressure differences across tropical Pacific.
- Southern Oscillation Index: Measurement tool for assessing ENSO-related air pressure changes
- Indian Ocean Dipole: Variations in sea surface temperatures influencing regional climates

	Pressure conditions	Ocean currents	Atmospheric circulation
Normal	○Low Pressure Australian coast ○High Pressure Peruvian coast	○Westward warm surface current	○Trade winds westward
El-Nino	○High Pressure Australian coast ○Low Pressure Peruvian coast	○Eastward warm surface current	○Trade winds Eastwards
La-Nino	○Low Pressure Australian coast ○High Pressure Peruvian coast	○Westward very warm surface current	○Trade winds westward

Normal Conditions:

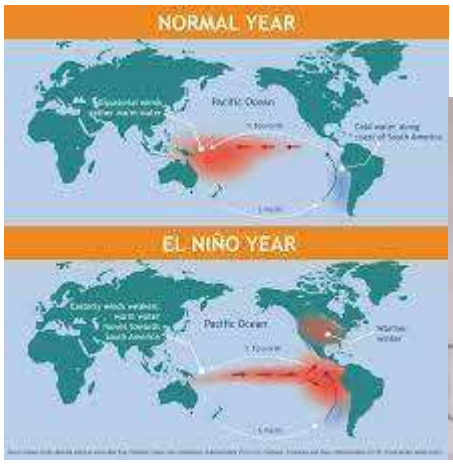
- warming and cooling of Pacific Ocean is key concern for India's Monsoon .

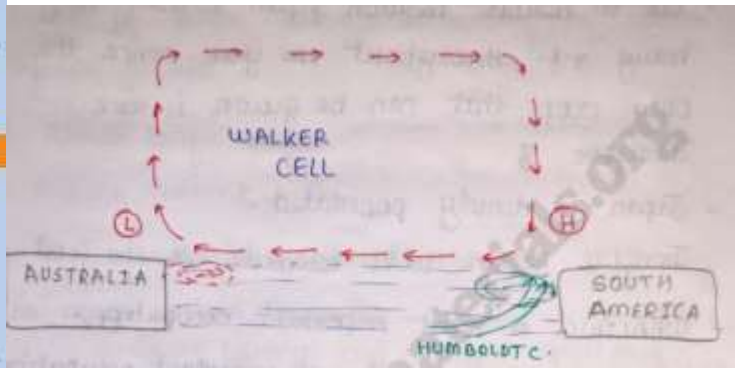
A Normal Year conditions :

- A sea surface LP area develops in the region of North Australia & Indonesia and HP system develops over the coast of Peru.
- As a result, the Trade winds over the pacific ocean moves strongly from east to west .
- The easterly flow of trade winds carries warm surface water westward, bringing convective storms (thunderstorms) to Indonesia and coastal Australia.
- Along the Peru coast , cold bottom nutrient rich water wells up to the surface to replace warm water that is pulled to the west .

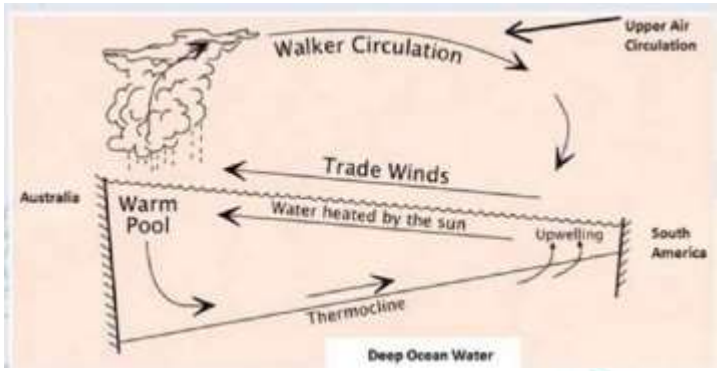
Normal Conditions :

- Warm water accumulation in Western Pacific and cold water upwelling in Eastern Pacific ocean bring thunderstorms in Western Pacific and Calm conditions in Eastern Pacific
- benefits to India for good monsoon due to warming of Western Pacific ocean and cooling of Eastern Pacific ocean





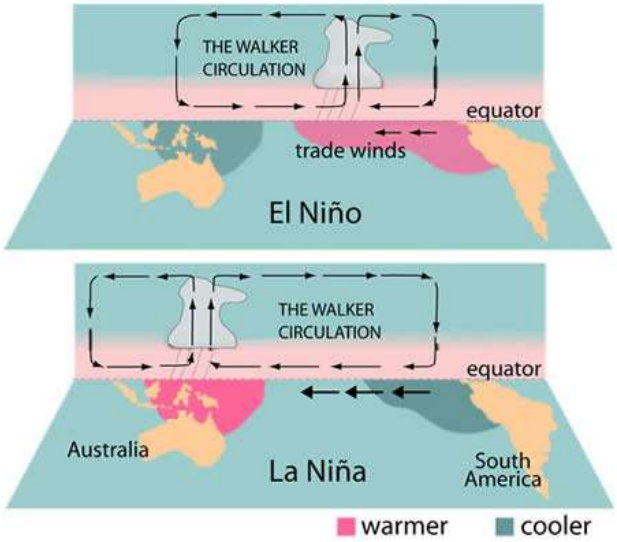
- Normal Year : Walker Cell or Circulation
- Abnormal Year : El Nino or Reverse Walker Circulation



CONCEPT OF WALKER CIRCULATION (WALKER CELL)

- Atmospheric circulation pattern affecting tropical weather.
- it is atmospheric phenomenon describes the east west flow of air in the Tropics, particularly over the equatorial Pacific Ocean
- Walker Cell: A pressure gradient from east to west creates an air circulation from the Eastern Pacific i.e. along the coast of Peru-Chile to western Pacific (Australia-New Guinea).
- The pattern of low and high pressures gives rise to vertical circulation along the equator with its rising limb over low pressure area and descending limb over high pressure area. This is known as Walker Circulation
- Driving Force behind this circulation are primarily temperature and pressure gradient created by uneven heating of ocean waters.
- **caused by pressure gradient force that result from HP system over the eastern PO and LP system over Indonesia**
  good for India Monsoon (like La Nina)

[UPSC 2002] For short-term climatic predictions, which one of the following events, detected in the last decade, is associated with occasional weak monsoon rains in the Indian subcontinent?
a) La Nina
b) Movement of Jet Stream
c) El Nino and Southern Oscillations
d) Greenhouse effect at global level
Ans c El Niño-related changes in wind patterns can weaken the Indian monsoon, leading to reduced rainfall over the subcontinent.



Only El Nino == [Warm water in Eastern Pacific + Cold water in Western Pacific].

Why does EL Nino and La Nina occur ?

- Exact reason for why does they occur is still not understood.
- They results from interaction between the surface layers of the ocean and the overlying atmosphere in tropical Pacific.
- It is the internal dynamics of the coupled ocean-atmosphere system that determine the onset and termination of El Nino events.
- It is also believed that Pacific oceans' shape & geometry also influence El-Nino events.
- The system oscillates between warm (El Nino) to neutral (or cold) conditions with a natural periodicity of roughly 3-4 years.
- External forcing from volcanic eruptions (submarine or terrestrial) have no connection with El Nino. Nor do sunspots as far as we know.

Concept of El Nino

- complex weather system that appears once every three to seven years, bringing droughts, floods and other weather extremes to different parts of the World .
- The system involves oceanic and atmospheric phenomenon with the appearance of warm ocean current off the coast of Peru in the Eastern Pacific and affects weather in many places including India .
- Here Peruvian or Humboldt cold current temporarily replaced by warm current due to weak trade winds and altered atmospheric pressure systems
- This increases in sea surface temperature of water on Peruvian- Chile coast and brings rainfall in region and affects fish diversity (warm water temp creates downwelling of nutrients)
- Weakening the trade winds in the Region
- Spanish word - Child Christ- because this current appears around Christmas in December.
- December is summer month in Peru (Southern Hemisphere)
- Warming of central and eastern pacific Region is known as El nino

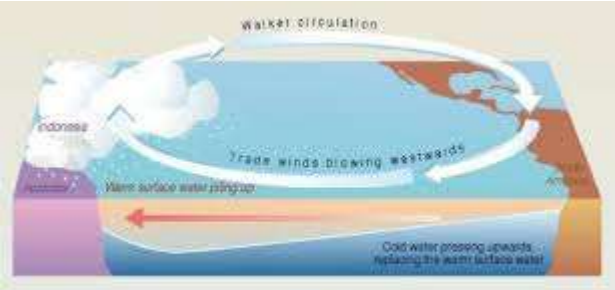
EFFECTS OF - EL NINO

- **heavy rainfall in drought region of Peru Chile coast and Atacama Desert**
- **Good for agriculture in Peru Chile Region but impacts fish Industry**
- **India , Australia , Indonesia - weak Monsoon and causes drought and forest fires**
- **Large scale bleaching of coral reefs in Australia**
- **Hp conditions in Indian ocean and western pacific ocean (anticyclone conditions)**
- related with reverse walker cell

Concept of - La Nina

- Cold event - in Spanish called as " little girl"
- abnormal cooling of the ocean temperatures in eastern and central pacific region
- Cold Ocean Current in Eastern Pacific Ocean
- Heavy Rainfall in Australia, Indonesia and India
- LP in Indian Ocean

- abnormally heavy monsoons in India and Southeast Asia
- chances of cyclones in Indian Ocean
- Anticyclones in Pacific ocean
- cold winter in western Canada and North western USA
- winter drought in the southern USA
- called as Normal walker cell



(Southwest Climate Change Network, 2013)

	El Nino Event	La Nina
Define	warming phase of the waters in the eastern Pacific,	cooling phase
Ocean Temp changes	Sea surface temperature increases	Sea surface temperature decreases
Trade Winds	Trade winds weak	Trade winds strengthen and pushing warmer waters further west
Weather conditions	Wetter conditions in eastern pacific region and dry in western pacific region	Wetter conditions in south east Asia and Australia and dry in eastern pacfic region
Historical context	Fisherman noticed warming ocean temperature called " boy child "	
		Good for monsoons and cyclogenesis in the Bay of Bengal Suppressed cyclogenesis in the Arabian Sea

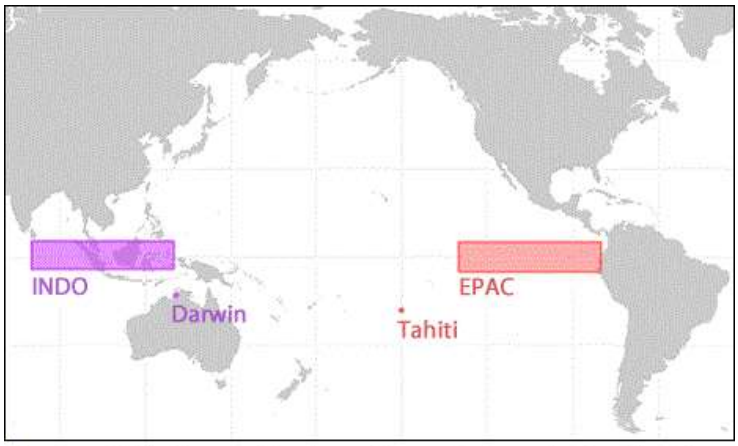
- Southern Oscillation: Periodic fluctuation of air pressure differences across tropical Pacific.
- Southern Oscillation Index: Measurement tool for assessing ENSO-related air pressure changes
- Indian Ocean Dipole: Variations in sea surface temperatures influencing regional climates.

SOUTHERN OSCILLATION:

- refers to climatic phenomenon
- Periodic change in pressure conditions called as SO
- Sea Saw Effect of Walker Cell called Southern Oscillations
- (oscillation of low-pressure and high-pressure cells) between the eastern and western tropical Pacific Ocean
- Only SO == [Low Pressure over Eastern Pacific + High Pressure over Western Pacific
- refers specifically to the atmospheric component of the ENSO.

SOUTHERN OSCILLATION INDEX - SOI :

- term used to describe changes in air pressure, temperature, and sea surface temperatures between the Pacific and Indian Oceans
- Rainfall in India can be predicted by analyzing the positive and negative values of the SOI
- Southern Oscillation Index used to measure pressure difference between two location Tahiti in French Polynesia, Pacific Ocean 18 degree South and Darwin in North Australia about 12 degree South



Source: http://www.climate.gov/news-features/understanding-climate/climate-variability-southern-oscillation-index

Southern Oscillation Index (SOI)

Positive SOI	Negative SOI
Tahiti pressure greater than that of Port Darwin	Reverse
Pressure high over eastern Pacific and low over	Reverse
Drought conditions in Eastern Pacific and good rainfall in Western Pacific (Northern Australia and Indonesia)	Reverse
Good for Indian Monsoons	Bad for Indian Monsoons

- if the pressure difference were negative between two places - mean below average and late monsoons
- Positive SOI is good for Indian Monsoon
- When Walker circulation enters La Nina Phase - the SOI is positive
- When walker circulation enters it elnio phase, SOI is strongly negative
- A positive SOI value (> +7) indicates La Niña conditions.
- A negative SOI value (< -7) suggests El Niño conditions.
- La Nina Southern Oscillation: LNSO: Good For India/ Walker Cell: LP in Indian Ocean HP in Pacific Ocean
- El Nino Southern Oscillation : ENSO : Bad for India / Reverse Walker cell, HP in Indian Ocean and LP in Pacific Ocean

ENSO

- The formation of an **El Nino (Circulation of Water)** is linked with Pacific Ocean circulation pattern known as the **southern** oscillation (circulation of atmospheric pressure).
- Southern Oscillation, in oceanography and climatology, is a coherent inter-annual **fluctuation of atmospheric pressure** over the tropical Indo-Pacific region.
- El Nino and Southern Oscillation coincide most of the times hence their combination is called **ENSO - El Nino Southern Oscillation.**

Condition	Temperature & Pressure conditions
Only El-Nino	Warm water in eastern pacific. Cold water in western pacific.
Only SO	Low pressure over eastern pacific. High pressure over western pacific.
ENSO	Warm water & low pressure over eastern pacific. Cold water & high pressure over western pacific.

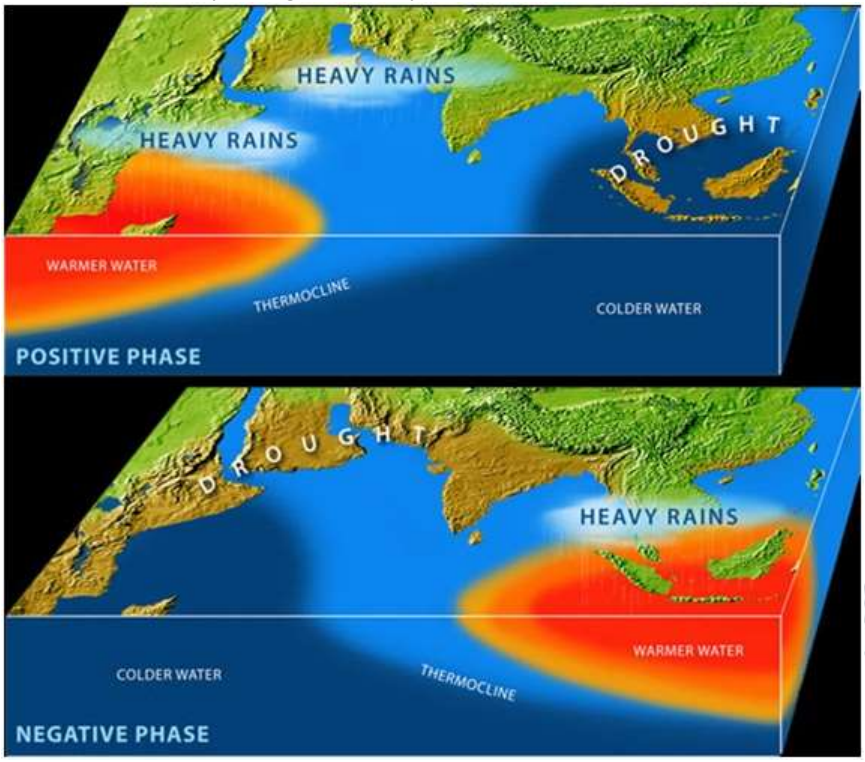
El Niño–Southern Oscillation

- Southern Oscillation coinciding with El Nino is called ENSO.
- refers to the large-scale ocean-atmosphere climate across Pacific Ocean
- ENSO encompasses both the oceanic and atmospheric interaction components of El Nino

- ENSO = [Warm water in Eastern Pacific + Low Pressure over Eastern Pacific] + [Cold water in Western Pacific + High Pressure over Western Pacific]

Indian Ocean Dipole (IOD)

- However, it was later discovered that just like ENSO was an event in the Pacific Ocean, a similar seesaw ocean-atmosphere system in the Indian Ocean was also at play
- it is climatic phenomenon (discovered in 1999)
- is an atmosphere-ocean coupled phenomenon in the tropical Indian Ocean
- it has two poles: western pole in the Arabian sea (western Indian Ocean) and an eastern pole (eastern Indian Ocean) south of Indonesia
- involves fluctuations (difference) in sea surface temperatures (SST) across the Western Indian Ocean near the Arabian Sea and the eastern counterpart near Indonesia in the Indian Ocean.
- Positive IOD is good for monsoon despite of an El Nino year
- Positive IOD: When the western part of the Indian Ocean experiences higher SSTs compared to that over the eastern Indian Ocean, it signifies a positive IOD, which tends to be conducive for the stronger than normal Indian monsoon.
- Conversely, a negative IOD phase results in weaker than normal Indian monsoon.



With reference to Indian Ocean Dipole . sometimes mentioned in the news while forecasting the Indian Monsoon, which of the following statements is/ are correct ? (upsc 2017)

1. IOD phenomenon is characterised by a difference in sea surface temperature between Tropical Western Indian Ocean and tropical Eastern Pacific Ocean.
2. An IOD phenomenon can influence an El nino impact on the monsoon.

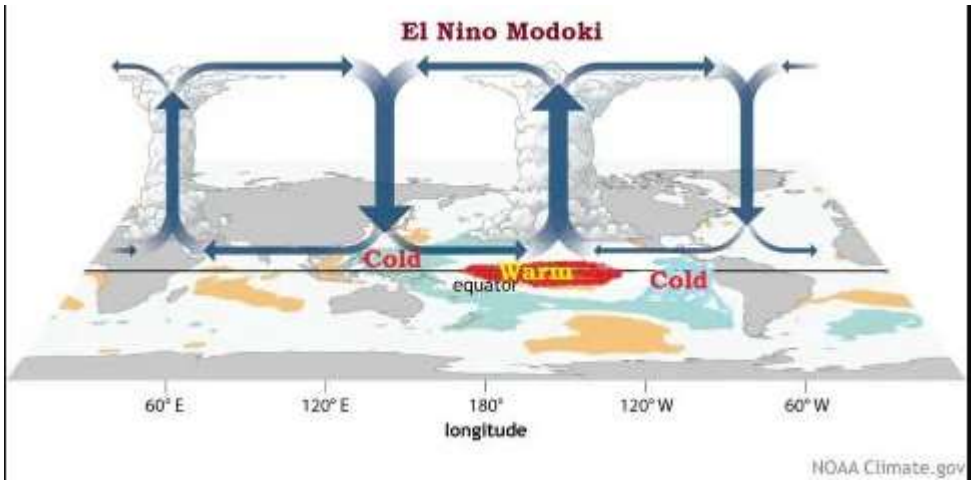
Select the correct answer :

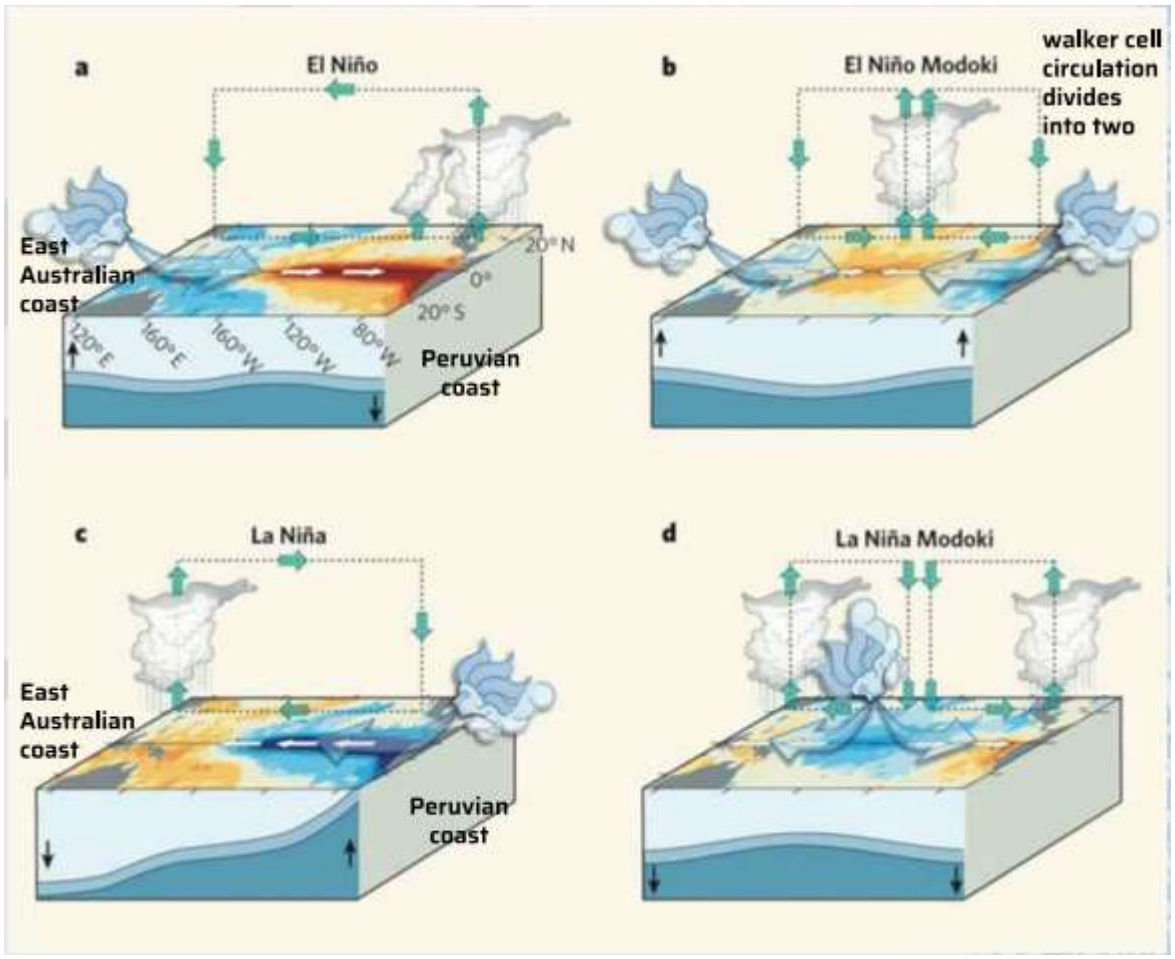
1 only
2 only
both
none

Answer : B

In summary:

- Southern Oscillation: Periodic fluctuation of air pressure differences across tropical Pacific.
- Walker Cell: Atmospheric circulation pattern affecting tropical weather.
- Indian Ocean Dipole: Variations in sea surface temperatures influencing regional climates.
- Southern Oscillation Index: Measurement tool for assessing ENSO-related air pressure changes



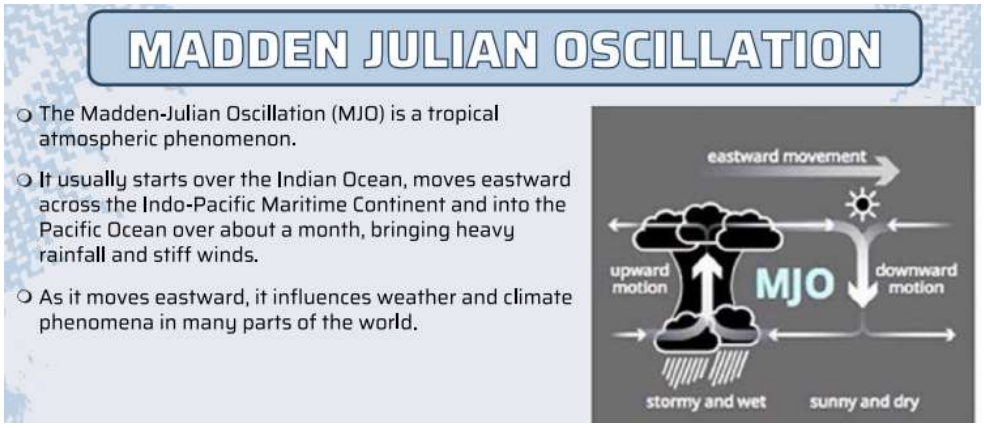


El Nino Modoki

- Refers to Atmospheric - Ocean Coupled Phenomenon in Tropical Pacific Region.
- Refers to warming of Central Pacific Ocean leads to enhanced rainfall in the region and cooling of Western and Eastern Pacific Ocean which suppressed rainfall in this region
- Related with Two Cell walker circulation Mechanism
- Bay of Bengal Region close to Western Pacific has few cyclonic activity because of descending limbs of walker cell, which cause dry conditions not conducive for cyclone formations
- Arabian sea witnessed more cyclonic activity during this Phase due to -change in wind patterns lead to favorable conditions for cyclogeneisis; Increases Sea Surface Temperature over Arabian Sea and Reduced vertical Wind Shear /gradient (A decrease in vertical wind shear can facilitate cyclone formation and intensification.)
- The term "Modoki" comes from the Japanese word meaning "similar but different,

La Nino Modoki

- Refers to Cooling of Central PO and Warming of Eastern and Western PO
- Also Related with Two Cell Walker Circulation
- More Cyclones in Bay of Bengal Region and Less in Arabian Sea



Madden Julian Oscillation (MJO

- It was discovered in 1971 by Roland Madden and Paul Julian of the American National Center for Atmospheric Research (NCAR).
- Refers to atmospheric and ocean coupled phenomenon in the Tropics Region
- It is not stationary phenomenon, but traversing phenomenon from east towards west over Indian Ocean to Pacific Ocean.
- is an equatorial travelling pattern of anomalous rainfall that is planetary in scale
- it is having intraseasonal variability and bipolar mechanism ie More rainfall region one side and No or less rainfall in other side .
- Each cycle lasts approximately 30–60 days. Also known as the 30-60 day oscillation, 30-60 day wave, or intra seasonal oscillation (ISO).
- involves variations in wind, sea surface temperature (SST), cloudiness, and rainfall
- MJO = over Indian Ocean during Monsoon= good rainfall over Indian Subcontinent
- MJO= over Pacific Ocean= bad news for Indian Monsoon

WORLD CLIMATE

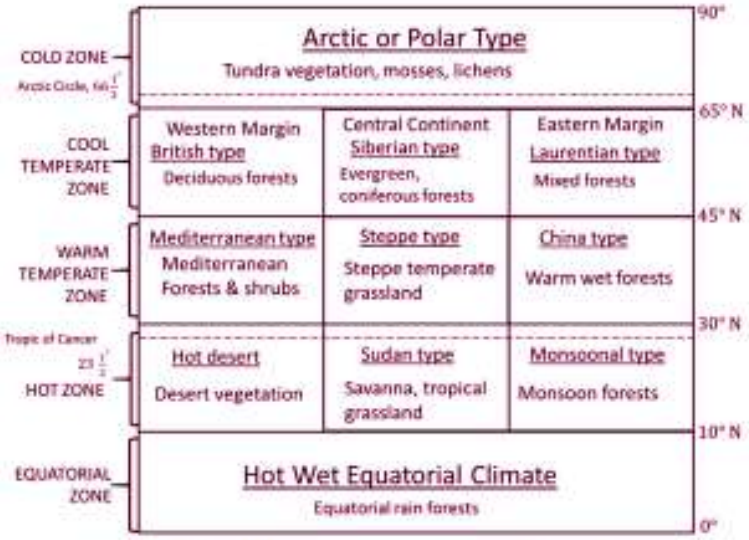


Fig.: Climatic Regions of the World

Hot wet equatorial climate

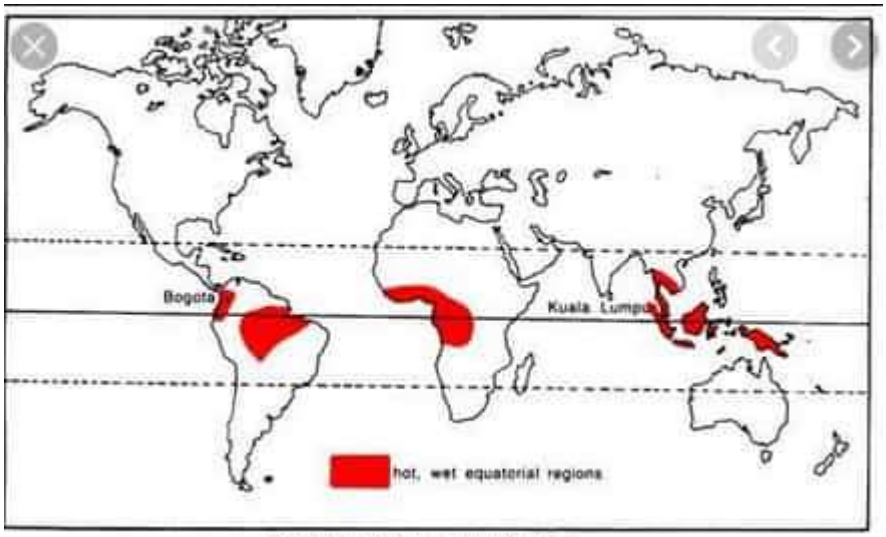


Fig. 121 The hot, wet equatorial regions

Distribution:

- Between 5-10 degrees north and south of the equator

Climate (Temperature & Precipitation):

- Uniformity of temperature throughout the year.
- Both diurnal and annual range of temperature is small.
- Heavy rainfall (60-100 inches) well distributed throughout the year with double rainfall peaks
- The highest rainfall occurs at the time of equinoxes and least rainfall at the time of summer and winter solstice
- Throughout the year, precipitation is abundant and evenly distributed
- Seasons do not exist.
- The annual average is always greater than 150 cm

Vegetation & Wildlife:

- Tropical rainforest type vegetation
- 'Selvas'- Dense rainforest with the dense canopy
- Evergreen trees e.g. ebony, mahogany, greenheart, cabinet woods and dyewoods.

Major Tribes:

- Indian tribes of Amazon basin
- Pygmies of Congo basin
- Orang Asli of Malaysia

Equatorial Climate Soil

- The majority of the soil is nutrient-deficient.
- A thin layer of fertile soil forms on the surface as the dead leaves decay.
- Because of its high iron content, it is reddish in colour.
- Excessive rains quickly flush nutrients out of the soil.
- Oxisols : Equator soil . Some oxisols have been previously classified as laterite soils.

TAIGA AND TUNDRA CLIMATE

Tundra Region Climate

- **tundra** is a type of biome where the tree growth is hindered by frigid temperatures and short growing seasons.
- Extreme type of climate
- Tundra climates ordinarily fit the Köppen climate classification *ET*,
- Tundra vegetation is composed of dwarf shrubs, sedges, grasses, mosses, and lichens
- Notable plants in the Arctic tundra include blueberry , crowberry, Labrador tea
- Vegetation also include: Dwarf Willows, Cotton grass, Birches and Sedges, rushes

- Notable animals include reindeer (caribou), musk ox, Arctic hare, Arctic fox, snowy owl, ptarmigan, northern red-backed voles, lemmings, and even polar bears near the ocean
- Alpine tundra occurs in mountains worldwide.
- The tundra soil is rich in nitrogen and phosphorus
- The soil also contains large amounts of biomass and decomposed biomass that has been stored as methane and carbon dioxide in the permafrost, making the tundra soil a carbon sink.
- As global warming heats the ecosystem and causes soil thawing, the permafrost carbon cycle accelerates and releases much of these soil-contained greenhouse gases into the atmosphere, creating a feedback cycle that increases climate change.
- Gelisols soils of permafrost region . (International classification)

Economy:

- **Human activities** of the tundra are **mostly restricted to the coast**. Where plateaus and mountains (permanently snow-covered) increase the altitude, it is uninhabitable
- The few people of this region live a semi-nomadic life and have to adapt themselves to a severe environment
- Apart from the efforts of the different governments of the world in assisting the advancement of the Arctic inhabitants the Eskimos, Lapps, Samoyeds etc., new settlements have sprung up due to the finding of minerals LIKE iron ore from labrador region of canada; Gold petrol and coal from Alaska, copper of canada

In the Eurasian tundra live the other **nomadic tribes** viz.

Lapps	Northern Finland & Scandinavia
Samoyeds	Siberia (From the Ural mountains & Yenisey basin)
Yakuts	Siberia (Baikal Mountains & Lena River Basin)
Koryuks & Chuckchi	North East Asia

Taiga vegetation

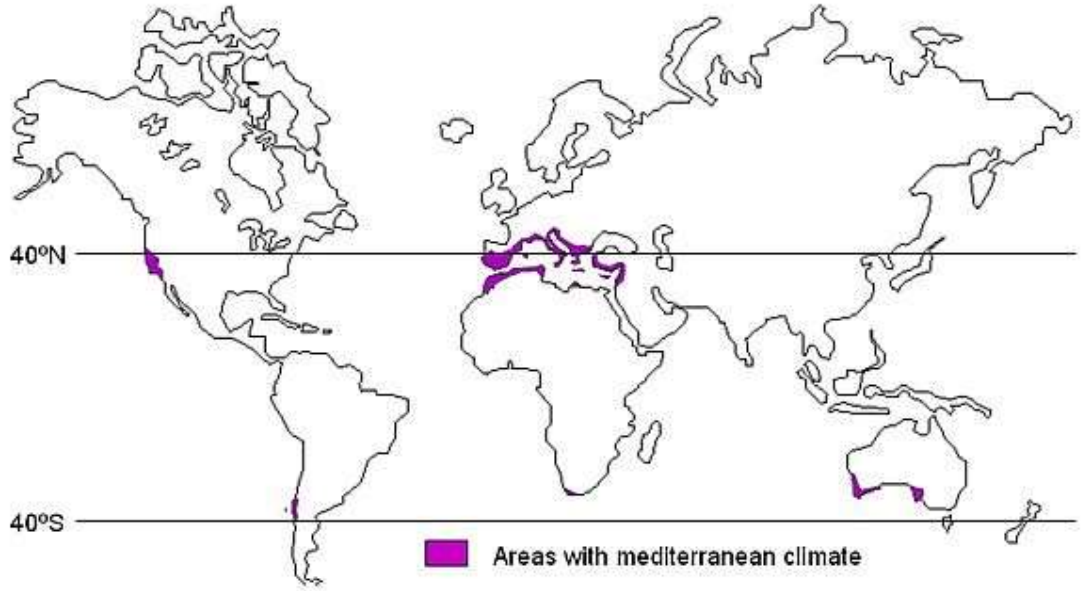
- **Taiga** referred to in North America as a **boreal forest** or **snow forest**, is a biome characterized by coniferous forests consisting mostly of pines, spruces, and larches.
- The taiga or boreal forest has been called the world's largest land biome
- The largest areas are located in Russia and Canada.
- The taiga is found throughout the high northern latitudes, between the tundra and the temperate forest, from about 50°N to 70°N, but with considerable regional variation.
- Taiga has a subarctic climate
- This climate is classified as *Dfc*, *Dwc*, *Dsc*, *Dfd* and *Dwd* in the Köppen climate classification scheme
- Boreal or snow forest include moss and lichens fungi also . Moss They grow well in acidic soils such as the one that is found within the forest because of the fallen coniferous needles that lower the pH of **the soil.**

Mediterranean Climate

Areas -Location and Extent :

- The warm temperate western margin climate or the Mediterranean climate is found between 30° and 45° North and South of the Equator
- Mediterranean climate occurs in southern and southwestern Australia, central Chile, coastal California, the Western Cape of South Africa and around the Mediterranean Basin.
- Basic cause of this type of climate is the shifting of the wind belts

See Map



They are usually known by different names in different regions such as –

Maquis	Mediterranean
Chaparral	California
Matorral	Chile
Fynbos	South Africa
Mallee and kwongan	Australia

Four Mediterranean Type of Climate distinctive features :

1. A dry , warm summer with off shore trades winds
2. A concentration of rainfall in winter with on shore Westerlies .
3. Bright, Sunny weather with hot dry summer and wet , mild winters
4. The Prominence of local winds around the mediterrean sea

Key Lines :

- The concept of Mediterranean climate is characterized by mild wet winters and warm to hot, dry summers and occur on the west side of continents between about 30 to 31° and 40° latitude.
- The largest area with a mediterranean climate is the Mediterranean Basin, which has given the climate its name, although stretches of the Mediterranean coast (in Egypt, Libya and part of Tunisia) are too dry to be thus classified.
- More than half of the total mediterranean-climate regions on earth occur on the Mediterranean Sea.

According to Koppen Climate :

- mediterranean climate code : Cs (dry hot summer)
- this climate called Western Margin climate
- The warm temperate western margin climate or the Mediterranean climate is found between 30° and 45° North and South of the Equator

- This climate is witnessed in relatively fewer parts of the world and is almost entirely confined to the western margins of the continental landmasses.
- The basic cause of this climate is the seasonal shift of the wind belts.
- The Mediterranean climate is characterized by very distinctive climatic features with dry, warm summers and wet, cold winters and local winds.

Major cities : of mediterranean climate

Most historic cities of the Mediterranean Basin lie within Mediterranean climaticincluding Algiers, Athens, Barcelona, Beirut, İzmir, Jerusalem, Marseille, Monaco, Naples, Rome, Tunis, Valencia, and Valletta.

Current major cities with Mediterranean climates outside of the Mediterranean Basin include Adelaide, Cape Town, Casablanca, Dushanbe, Lisbon, Los Angeles, Perth, Porto, San Francisco, Santiago, Tashkent and Victoria.

The Mediterranean biome

- is also called as sclerophyll ecosystem or biome because of the development of special feature and characteristic in the dominant trees and shrubs to adapt to the typical environmental conditions of the Mediterranean climates (dry summer and wet winter).

Types of Mediterranean vegetation:

1 Evergreen forests:

- They are found only in climatically suitable regions with rainfall over 25inches and are open woodlands with evergreen oaks.
- The cork oaks are used for making wine-bottle corks.
- In Australia, the eucalyptus forests replace the evergreen oak.
- The giant sequoia or redwood is typical of the Californian trees.

2. Evergreen Coniferous forests

- They include various kinds of pines, firs, cedars and cypresses.
- They appear mostly in the cooler highlands and where droughts are not so severe.

3 Bushes and Shrubs

- This is the most prominent type of Mediterranean vegetation.
- The low bushes grow in scattered clumps and are often thorny.

4 Grass

- Since most of the rain comes during the cool season when the growth is slow, the conditions of this region do not suit grass.
- They are generally wiry and bunchy and are not suitable for animal farming.
- Thus cattle rearing is not an important occupation in the Mediterranean.

Que : Which local winds influence Mediterranean climatic region in Europe

1. **Sirocco**
2. **Mistral**
3. Bora:

Explain :

Local winds

- The Mediterranean climatic region in Europe experiences many local winds due to the topography of the region with the Alps in the North, the Sahara desert in the South, the continental interiors in the East, and the open Atlantic in the west. These create great differences in temperature, pressure, and precipitation. The two most important local winds are:

Sirocco

- This is a hot, dry and dusty wind.
- It originates in the Sahara desert and might occur at any time of the year but is mostly witnessed during spring.
- Normally it lasts only for a few days.
- It blows from the desert interiors of Sahara into the Mediterranean Sea and is usually associated with the depressions from the Atlantic ocean.
- After crossing the Sea, it is slightly cooled by the absorption of water vapour but is hot enough that it withers vegetation and crops of the region.
- Hence it is also called “Blood Rain” because it is carrying the red dust of the Sahara desert.

Mistral

- Mistral is a cold wind from the north.
- It rushes down the Rhone valley and its velocity is intensified by the funnelling effect in the valley between the Alps and the Central Massif[Plateau in France].
- In some extreme cases, the velocity of the wind is so high that trains can be derailed and trees are uprooted.
- In winter, if the Mistral is frequent the temperatures could go below the freezing point.

Other local winds

- Bora: Cold north-easterly wind along the Adriatic coast.
- Tramontana and Gregale: cold winds in the Mediterranean Sea.

Que : Examine the salient features of Mediterranean climate. What makes the Mediterranean the Orchard Land of the World? (250 words)

Economic Development

- The region is important for
  - Fruit cultivation, fruit canning and food processing

- Cereal growing, and flour mining
- Wine-making and
- Agricultural industries :
- Engineering and mining. The region is a net exporter of citrus fruits and the net importer of dairy products.

Orchard farming

- These regions are known as the world's orchard lands.
- A wide range of citrus fruits grows in the region. Examples: Sunkist oranges of California, Jaffa oranges of Israel. Seville oranges of Spain
- The fruit trees have long roots to draw water from depths during the long summer months.
- The olive tree is probably the most typical of all Mediterranean cultivated vegetation.
- Besides these, many nut trees like chestnuts, walnuts, hazelnuts and almonds are grown.: important for chocolate industry.
- Other important fruits are peaches, apricots, pears, cherries, plums and figs.

Crop cultivation

- Cereals are the most important crops and wheat is the leading crop followed by barley.
- Though the climatic conditions are not favourable for the extensive cultivation of wheat, the farmers have utilised the seasonal climatic rhythm to their best advantage.
- **Sheep rearing**
- The mountain pastures with cooler climate support a few sheep, goats and cattle.
- Transhumance is widely practised in the region.

Wine production

- Viticulture is speciality and tradition of Mediterranean region.
- The long, sunny summer allows the grapes to ripen.
- Regions bordering the Mediterranean Sea account for three-quarters of the world s production of wine.
- In Spain , Italy , France , Portugal wine is national drink

Wines name: Region and local name

- South Spain : Sherry
- Portugal: port wine
- Italy : Chianti, asti, marsala
- France : Champagne (paris basin), Burgundy in Rhone Saone valley

Grapes : Most of the inferior grapes are preserved as dried grapes and exported

Ex: name of grapes :

- Currants : from Levantine grapes
- raisins: from California
- Sultanas from Asia Minor/ Anatolia plateau, Turkey

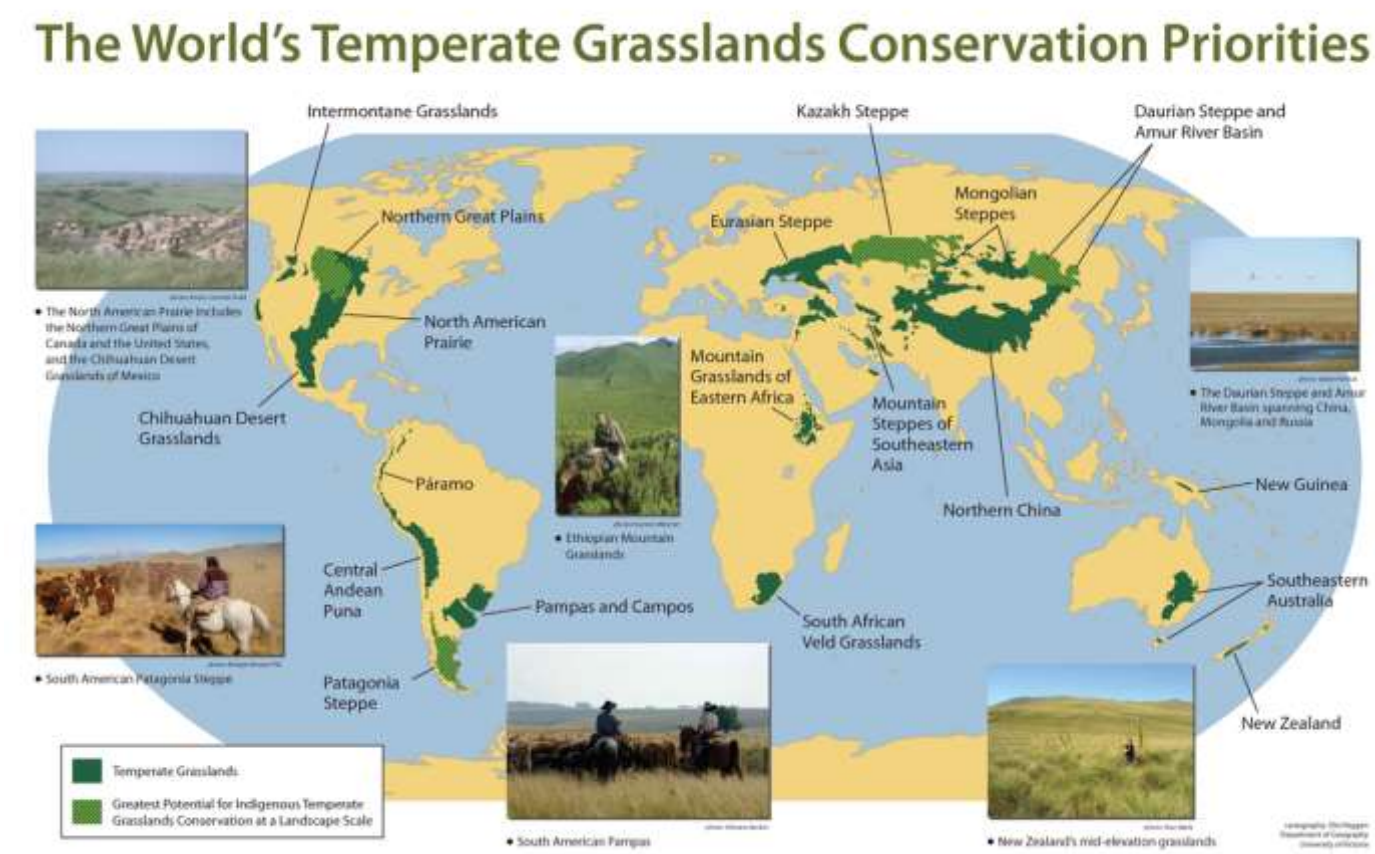
DESERT AND GRASSLAND VEGETATION

GRASSLAND VEGETATION

A **Grassland** : is a is a type of Habitat or Biome which is dominated by Grasses and other Herbaceous (non-woody) Flowering Plants and a variety of scattered Trees and Bushes. Grasslands occur in areas where there is not enough regular rainfall to support the growth of a Forest, but not so little as to form a Desert.

Tropical Grasslands - Tropical Grasslands are located near the equator, between the Tropic of Cancer and the Tropic of Capricorn. Most of the Tropical Grasslands are found in the interior part of continents between the Tropical Rain Forests and Tropical Deserts. Tropical Grasslands are also known as 'Savannahs'. Tropical Grasslands have a tropical continental climate

wherein wet and dry seasons come alternately.



Areas of Tropical Grasslands

- Llanos of the Orinoco basin of Venezuela and Colombia.
- Cerrado of Brazil.
- Pine Savannahs of Belize and Honduras.

Temperate Grasslands - Temperate Grasslands are located in the mid-latitudes, north of the Tropic of Cancer and south of the Tropic of Capricorn. They generally lie between Deserts and Temperate Forests. Temperate Grasslands have a temperate continental climate, which is cooler than Savannahs.

6 Areas of Temperate Grasslands

- Pampas in South America.
- Veld in Africa.
- Canterbury Plains in New Zealand.

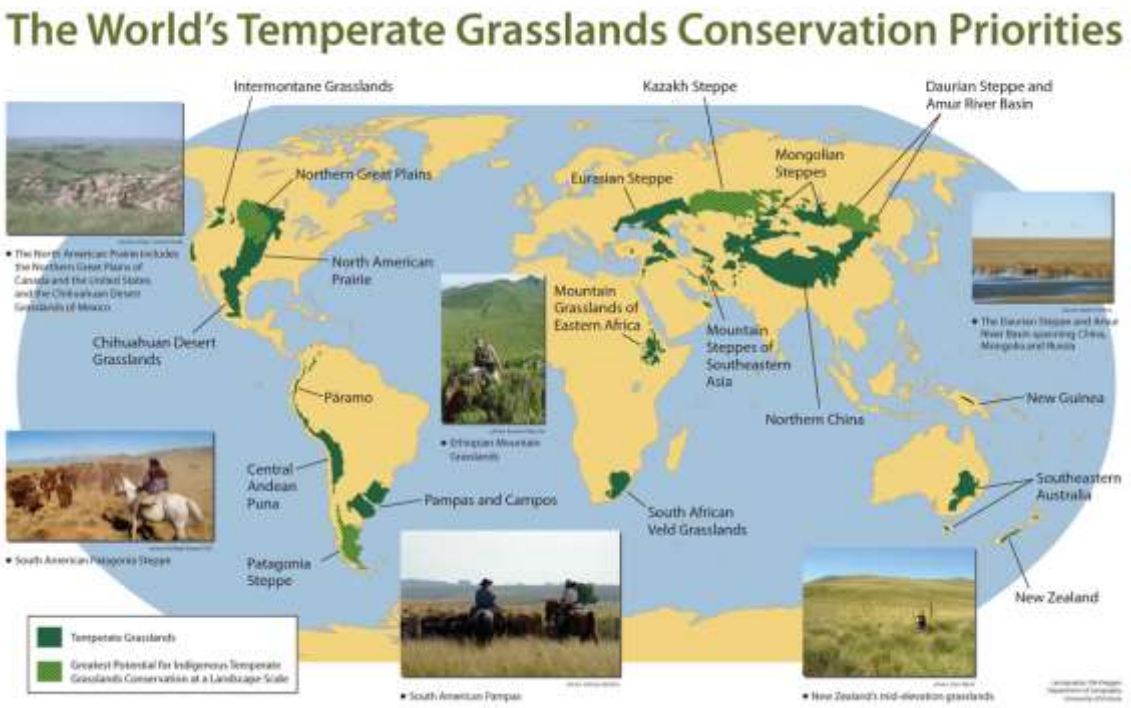
- Murray-Darling Basin in Australia.
- Prairies in North America.
- Steppes in Central Asia.

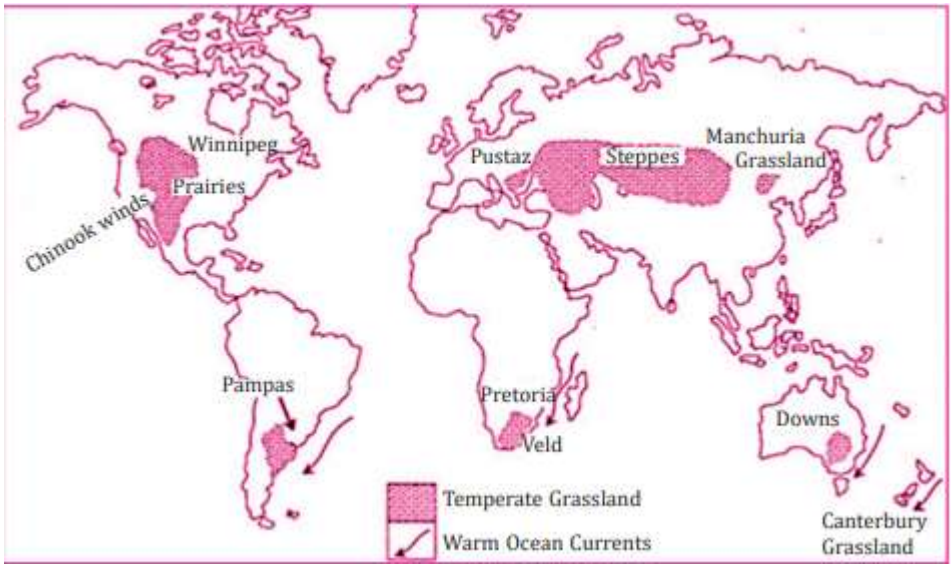
Grassland Regions

- Northern Prairie of North America.
- Patagonian Steppe in South America.
- Daurian Steppe in Asia

List of the Grassland of the World and their Location:

Grassland	Regions
Dawns	Australia
Pampas	South America (Argentina & Uruguay)
Prairies	North America
Savannah	Africa and Australia
Selvas	South America
Steppes	Europe and Northern Asia
Taiga	Europe and Asia
Velds	South Africa
Lianos	Venezuela (South America)
Pustaz	Hungary
Canterbury	New Zealand





DESERT VEGETATION

There are four types of desert found in the world: **sub-tropical desert; Coastal deserts; Cold desert; Polar Desert**. Sahara is the world's largest tropical desert (desert).

DESERT CLIMATE

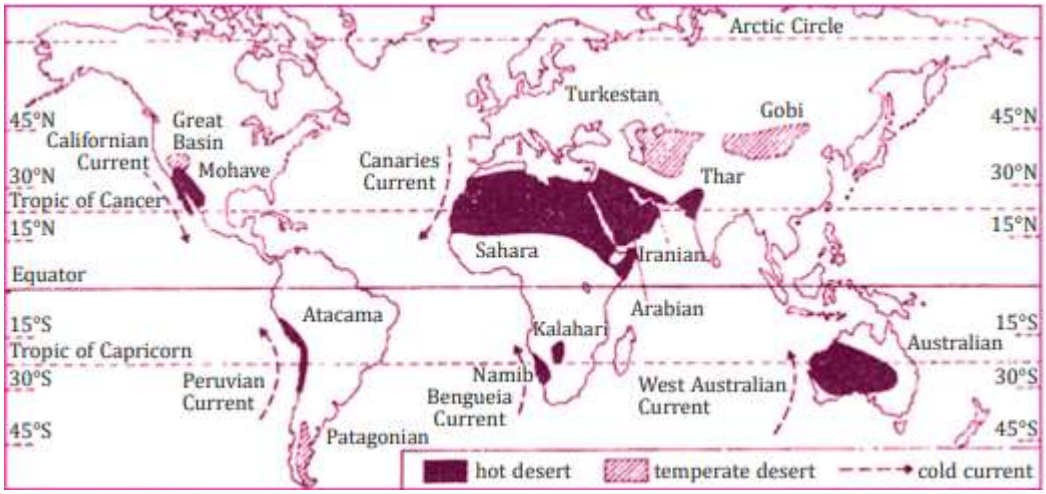
- Deserts are regions of scanty rainfall that may be Hot like the hot deserts of the Saharan type or Temperate as are the mid-latitude deserts like the Gobi

Hot Desert Climate

- Major hot deserts of the world are located on the western coasts of the continent between 15° and 30° N and S
- Aridity of the hot deserts is mainly due to the effects of off-shore Trade Winds; also called Trade Wind Deserts
- Sahara Desert, Great Australian Desert, Arabian, Iranian, Thar, Kalahari, Namib, Mohave, Sonoran, Atacama desert

Mid-Latitude Desert Climates

Among the mid-latitude deserts (usually between 30° and 50° N and S of the equator), many are found on plateaus



Climate Conditions in Hot Deserts (Trade Wind Deserts)

- Average summer temperature is around 30°C.

- Rainfall: scarce (less than 25 cm)and most unreliable.
- Aridity is high due to subtropical high-pressure belt (descending air), offshore trade winds, desiccating effect of cold current.
- Temperature: high throughout the year, coastal deserts due to maritime influence have much lower temperatures; desert interiors however experience much higher summer temperatures and winter months are rather cold.
- Diurnal temperature range is very great, frost may occur at night in winters.

Climate Conditions in the Mid-Latitude Deserts

- They are cutoff from the rain-bearing winds; Rainfall less than 25 cm.
- Occasionally depressions may penetrate the Asiatic continental mass or unexpected convectional storms may bring rain in summer and falls in winter.
- Rainless because of either continentality (Gobi Desert) or rain-shadow effect (Patagonian Desert).
- Patagonian Desert is drier due to its rain-shadow position on the leeward side of the lofty Andes than to continentality.

Vegetation

- Xerophytic/drought-resistant scrubs, grasses and plants;
- Most desert shrubs have long roots to gather moisture
- Few or no leaves; foliage is waxy, leathery, hairy, or needle-shaped to prevent moisture loss.

Economy

- Gold mining in Great Australian Desert (e.g., Kalgoorlie, Coolgardie); Diamonds and copper in Kalahari; Sodium nitrate extraction in Atacama.
- North American deserts (silver in Mexico, uranium in Utah, copper in Nevada)
- Oil exploration in Sahara and Arabian Deserts (Saudi Arabia, Iran, Iraq, Kuwait, Algeria, Libya, Lebanon, Nigeria)
- Tribes: Bedouin (Arabs), Bushman (Kalahari), Bindibu (Australia), Tuaregs (Sahara), Gobi Mongols (Gobi)

WARM TEMPERATE WESTERN MARGIN (MEDITERRANEAN) CLIMATE

Confined to the western portion of continental masses, between 30 and 45 degrees north and south of the equator. Basic cause of this type of climate is the shifting of the wind belts. Found in areas around Mediterranean sea, central Chile, California, south- western tip of Africa, Southern Australia and south west Australia

Climate

- Temperature: Monthly average in summer is around 25° C and in winter below 10°C.
- Dry, warm summer with offshore trade winds, a concentration of rainfall in winter with on shore westerlies; annual precipitation ranges between 35-90 cm

Local winds around the Mediterranean Sea:

- Sirocco- hot, dry, dusty wind which originates in the Sahara Desert (Most frequent in spring). Other names of Sirocco: Chili (Tunisia), Ghibli (Libya), Leveche (Spain), Khamsin (Egypt), Gharbi (Adriatic and Aegean sea).
- Mistral: cold wind from the north, rushing down the Rhone valley, intensified by the funnelling effect in the valley between the Alps and the Central Massif (Plateau in France).
- Bora: cold north easterly wind in Adriatic sea.
- Tramontana and Gregale: cold winds of Mediterranean sea;

Vegetation

Shrubs- Maquis (South France), Macchia (Italy), Chaparral (California), Mallee (Australia) Eucalyptus forests in Australia, and Giant Sequoias or Redwoods in California; Species found include Pines, Firs, Cedars. Bushes and Shrubs are the most predominant type.

Economic Activity

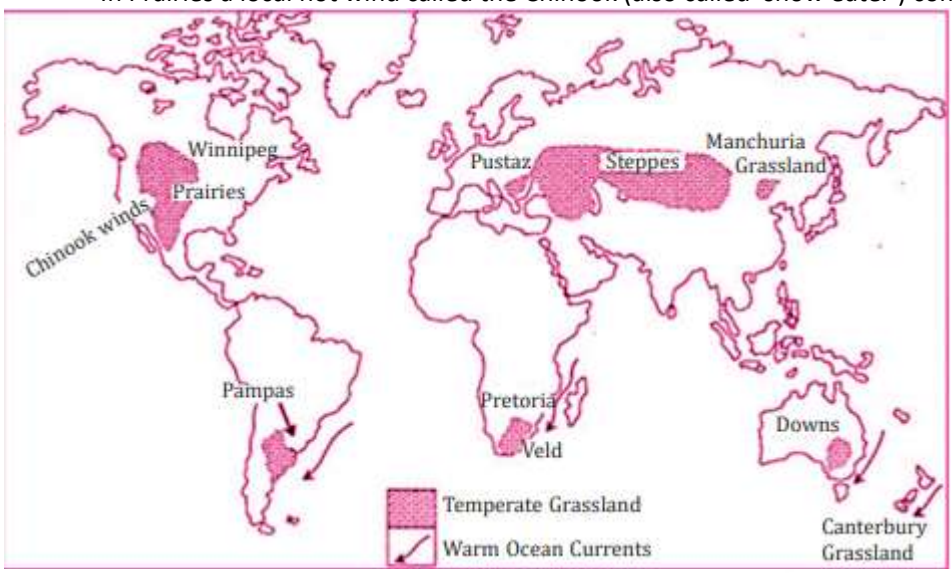
- World's orchard lands: famous for citrus fruitsSunkist oranges (California), Seville oranges (Spain), Jaffa oranges (Israel) etc;
- Wine production: Viticulture is by tradition a Mediterranean occupation, sherry (Wine from southern Spain), Port wine (Portugal), Chianti, asti and marsala (Italy), Champagne, Bordeaux and Burgundy (France).
- Nut-bearing trees like chestnuts, walnuts, hazelnuts, and almonds;
- Cattle Rearing: Mountain pastures, with their cooler climate, support sheep, goats and sometimes cattle. Transhumance is widely practised (moving up and down the hills in search of pastures according to seasons)

TEMPERATE CONTINENTAL (STEPPE) CLIMATE

- Lies in the westerly wind belt but they are so remote from maritime influence that the grasslands are practically treeless (between 40° and 55° N and S of the equator).
- They are known as Steppe (Eurasia), Pustaz (Hungary), Prairies (North America), Pampas (Argentina and Uruguay), Bush-Veld (North South Africa), High-Veld(Southern South Africa), Downs (Australia), Canterbury (New Zealand).

Climate

- Temperature: Seasonal variations with warm to hot summers (often exceeding 30°C) and cold winters.
- Extremes of temperature in northern hemisphere, steppe type of climate in the southern hemisphere is never severe (maritime influence) and winters are mild
- Precipitation: Low annual rainfall (25-75 cm); the dry season is particularly pronounced in temperate grasslands adjoining desert
- Summer rainfall (Maximum) from convectional sources when continental interiors are heated
- Winter rainfall (lesser) by occasional depressions of the Westerlies.
- Maritime influence in the southern hemisphere, greater rainfall because of warm ocean currents.
- In Prairies a local hot wind called the Chinook (also called 'snow eater') comes melting the snow covered pastures

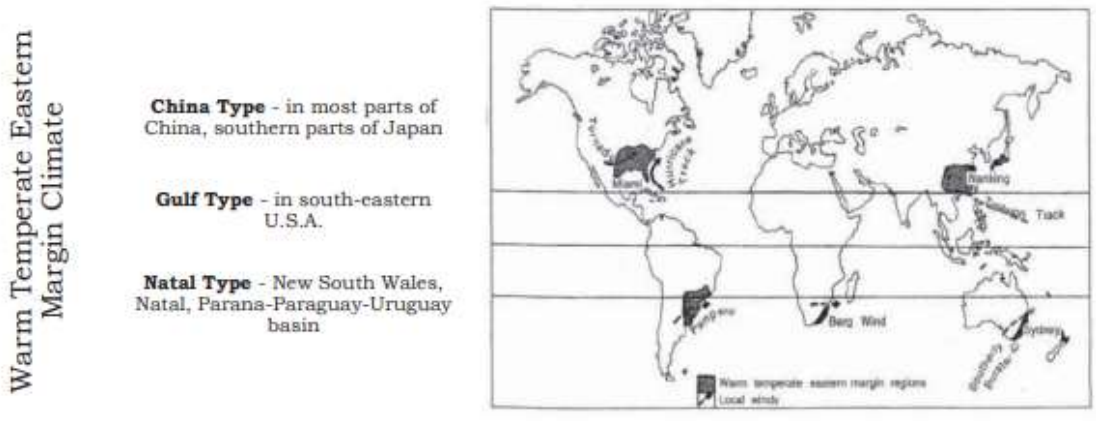


Vegetation

- Grasslands are practically treeless, grass is nutritious thus promoting livestock rearing in the region
- Grasses are not only shorter but also wiry and sparse. In arid areas like Asia's continental interiors, wiry grasses favour ranching over arable farming.
- Moving polewards, increased precipitation results in wooded steppes, where conifers gradually appear

Economic Activity

- Extensive mechanized wheat cultivation, nomadic herding, pastoral farming etc; Due to extensive, mechanised wheat cultivation they are known as the 'granaries of the world'.



WARM TEMPERATE EASTERN MARGIN (CHINA TYPE)

- It is a modified form of monsoonal climate, found on the eastern margins of continents in warm temperate latitudes. In summer, the regions are under the influence of moist, maritime airflow from the subtropical anticyclonic cells
- Climate: Warm moist summer and cool, dry winter; strong maritime influence; small annual temperature range
- In summer, the regions are under the influence of moist, maritime airflow from the subtropical anticyclonic cells
- Rainfall throughout the year (60 to 150 cm); Rainfall from Convectional sources or as orographic rain in summer, or from depressions in winter.

- Local storms: Typhoons (tropical cyclones), and Hurricanes, also occur

Subdivided Into Three Main Types

- China Type (Central and North China, South Japan): temperate monsoonal; great annual temperature range; rain in summer and winter; occurrence of typhoons in late summer;
- Gulf Type (South Eastern USA): slight monsoonal; no distinct dry period; occurrence of hurricanes and tornadoes
- Natal type: Natal, Eastern Australia, Southern Brazil, Paraguay, Uruguay and Northern Argentina and all warm eastern temperate margins of southern hemisphere; Dominance of maritime influence

Vegetation

- Lush vegetation with evergreen broad-leaved forests and deciduous hardwood trees in lowlands due to welldistributed rainfall all year round.
- Conifer species like pines and cypresses in highlands; z No dry or cold seasons, allowing uninterrupted perennial plant growth.

Economic Activity

- Warm temperate eastern margins are the most productive parts of the middle latitudes.
- World's greatest rice-growing areas, warm wet and lowland favour rice cultivation. Sugarcane, cotton, tobacco, maize, dairy products etc.
- Timber: Economic value in China and southern Japan (oak, camphor); Eucalyptus forests in Eastern Australia; Lowland deciduous forests in Gulf states of the U.S.A.

Local Winds Southerly Burster (Cold Wind in Australia) impacts New South Wales and Victoria ; Pampero (Cold Dry Wind in Argentina & Uruguay; Berg (Hot & Dry Wind in South Africa) bring

Cool Temperate Western Margin (British Type)

Found in Britain, North West Europe, British Columbia(USA), Southern Chile, Tasmania and most parts of New Zealand (between 40° and 65° latitude in the Northern Hemisphere)

Climate

- They are under the permanent influence of westerlies throughout the year;
- Regions of frontal cyclonic activity, typical of Britain, and are thus said to experience the British type of climate.
- High maritime influence on temperature and precipitation
- Temperature: Mild winters and cool summers (Mean annual temperature - 5 to 150C) z
- Rainfall: Throughout the year, with a tendency towards a slight winter or autumn maximum from cyclonic sources.
- Seasons are very distinct. Winter - short duration and mild (due to warming effect of North Atlantic Drift); Spring are driest; summer and autumn

Vegetation

Deciduous trees occur in pure stands. z Higher up the mountains deciduous trees (Shed leaves in winters to protect against snow and frost) are generally replaced by conifers. z Valuable temperate hardwood: oak, elm, birch, beech, poplar, Willows, Alder, Aspen, etc.

Economic Activity

- Market gardening, mixed farming, sheep rearing etc. z Fishing is important in Britain, Norway, and British Columbia.
- British-type climate suitable for crops and dairy farming. Mixed farming in north-western Europe with wheat, barley, and advanced dairy practices.

COOL TEMPERATE EASTERN MARGIN (LAURENTIAN):

Intermediate type of climate between the British and the Siberian type that is found in only two regions: north eastern North America (eastern Canada, north east USA and Newfoundland) and eastern coastlands of Asia, including eastern Siberia, North China, Manchuria, Korea and northern Japan.

In the southern hemisphere, this type of climate is absent.

Climate

- Temperature: Features of both continental and maritime climate; cold, dry winters and warm, moist summers.
- Arctic off-shore cold currents are instrumental in cooling the summer, otherwise, it would have been even hotter
- Rainfall: 75 - 150 cm of rainfall distributed throughout the year with a maximum during summer,
- Northern Hemisphere: Rainfall distribution is uniform due to Atlantic influence and the Great Lakes, high temperatures in summer and snowfall in winters;
- Asiatic regions: Rainfall is far less uniform, the rainfall regime is similar to that of the tropical monsoon type in India. Japan receives adequate rainfall from both the south east monsoon in summer and North West Monsoon in winter

Vegetation

- Coniferous (north of 50 Degree N latitude) and deciduous (south of 50 Degree N latitude); Oak, beech, maple, and birch are principal trees.

Economic Activity

- Lumbering important activity, agriculture is less important due to severity and length of winter.
- Fishing, particularly in the Grand Banks of Newfoundland.

THE COOL TEMPERATE CONTINENTAL CLIMATE (SIBERIAN)

Experienced only in the Northern hemisphere: North America (from Alaska across Canada into Labrador), Europe and Asia (between 50° and 70° N and S of the equator).

Climate

- Temperature Brief, warm summers (20-25°C) and long, extremely cold winters (-30 to -40°C); Occasional violent cold polar winds, like Canadian blizzards and Eurasian buran.
- Rainfall: Relatively dry year-round, low annual precipitation mainly in the form of snow ;
- Vegetation Mosses, lichens and sledgesIn more sheltered spots, stunted birches, dwarf willows, hardy grasses and reindeer moss are found.
- Tundra, taiga (boreal forest), and grasslands adapted to harsh conditions ;
- Conifers with adaptations like conical shape, thick needle-shaped leaves, and podzolized soils

Economic Life

- Lumbering is the primary economic activity, utilizing vast coniferous forests; Softwood logs transported downstream on rivers.
- Paper and pulp industry (Canada and the U.S.A.)
- Agriculture is challenging with limited crops due to extreme cold and short growing season

Arctic or Polar or Tundra Climate

- Found north of the Arctic Circle in the northern hemisphere and in the southern hemisphere in the continent of Antarctica; Extremely cold with long winters, devoid of tall trees or forests.
- Climate
- Temperature: Winters harsh, often below -37°C; summers brief with temperatures rarely exceeding 10°C.
- Precipitation: Generally low, with limited moisture in the form of snow and occasional freezing rain; Summer maximum precipitation in the form of rain or sleet

Vegetation

- Tundra vegetation limited to hardy, low-growing plants, mosses, and lichens
- Permafrost restricts the growth of deep-rooted plants
- Coastal lowlands support hardy grasses and reindeer moss;
- Brief summer bloom with the melting of snow, known as “Arctic Prairies
- Inhabitants like Eskimos, Lapps, and Samoyeds lead a semi-nomadic lifestyle, residing in compact igloos during winter.
