The flora of India varies considerably in different parts of the country, both in specific identity and number of species which, by bio-diversity of species, may be unequalled in any other country of the world. Therefore the comparative studies have led to the differentiation of floristic or ecological regions. In the Himalayas with their lofty heights, there is a large proportion of endemic species which are native to the ecological zone. On the basis of flora of local habitat or site, ten ecological regions are usually recognized in India. However, these ecological regions may coincide with the 17 forest types (botanical regions or provinces). ***The following are the ten ecological zones usually recognized:***

(i) Western Himalayas
(ii) Eastern Himalayas
(iii)North-Eastern Hills
(iv)Desert Thorny Forest of the Indus Plain
(v) Gangetic Plain Moist Deciduous Forest
(vi)Assam Valley Tropical Evergreen to Semi-evergreen Forest
(vii)Open to Dry Mixed Deciduous and Sal Forest of central India
(viii)South Indian Tropical Dry Deciduous Forest
(ix)West Coastal Tropical Moist Evergreen to Semi-evergreen and Moist Deciduous Forest
(x) Wet Tropical Coastal Forest of Bay Islands

(i) Western HIimalayas

This region comprises of Jammu and Kashmir, Himachal Pradesh and Uttarakhand Hills with the climate and vegetation ranging from submontane tropical to temperate and alpine types. On the basis of vegetation available, this ecological zone has been divided into following sub-regions:

(a) Submontane Forest
(b) Upper West Himalayan Temperate Forest
{i} Moist Temperate Forest
{ii} Dry Temperate Forest and
(c) Alpine Region

(a) Submontane Forest

This region consists of the area between 300 and 1,500 meters height and it comprises mainly the Siwalik Hills and adjoining submontane areas of Jammu and Himachal Pradesh.

In the hills and denuded south-facing slopes in Jammu and Himachal Pradesh are found a sub-tropical dry evergreen forest. It is primarily a mixed scrub vegetation of Acacia modesta which seems to be a pioneer species establishing itself on the open exposed and skeletal soils of this submontane dry evergreen forest. On the porous alluvium, comprising sand and shingle of riverine tracts khair, a medium-sized tree is found frequently. In this region where rainfall received is 100 centimeters annually, rich forests of sal are found. In the upper slopes of the Siwalik Hills, there are almost pure forests of chir pine.

(b) Upper West Himalayan Temperate Forest

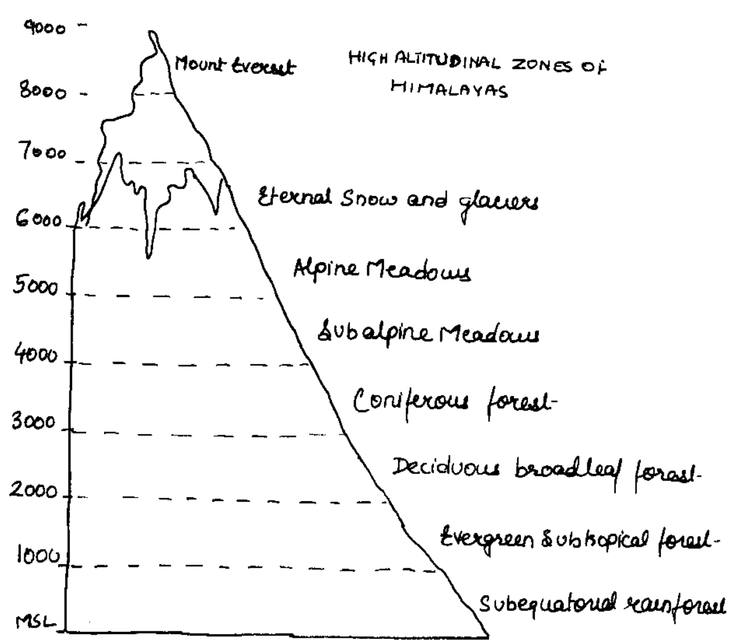
(i) Moist Temperate Forest: Some of the prominent timber species are found in this zone. This is the most widespread Himalayan type, extending over the whole length of the Western Himalayas from the foothills to the tree-line bordering the snows. The chir pine continues above an elevation of 1,200 meters on the slopes of the Himalayan foothills. However, it is replaced at higher altitudes of 1,600 meters by the blue pine. It is well distributed in the Western and Central Himalaya at about 2,000 meters. It is a large evergreen tree with bluish foliage and suffers more from snow damage than any other species. It occurs in a pure form or mixed with some other species and is known for profuse natural regeneration wherever conditions are favorable. Deodar, the Himalayan cedar occurs in almost pure stands or occasionally as a mixture with other conifers or broadleaved trees. It is found abundantly between 1,600 and 1,900 meters height and it is a large majestic evergreen tree with a dark green to silvery, fairly dense foliage. The crown of deodar is well developed and like the blue pine it is also well known for profuse natural regeneration and can sustain snow. Further higher up occurs, a moderate sized evergreen tree, known as the oak at altitudes between 2,100 to 2,500 meters. The oak is a large sized broadleaved, evergreen tree with height up to 25 meters. It is widely distributed over the high Himalayas with a number of species known as kharsu oak, ban oak and moru oak. The oak and other broadleaved species occur in moist, shady depressions whereas the silver fir and spruce are found on exposed sites. The silver fir is widely distributed in the Western Himalayas at an altitudinal range of 2,500 to 3,500 meters or even more up to the alpine meadows or the snowline in certain well exposed areas. It is a majestic coniferous tree with a well developed crown. It occurs either in a pure form or in association with the Himalayan spruce and blue pine. Requiring fewer nutrients and equipped with defences to endure climatic severity, this high level fir forest marks the uppermost limits of trees in the Himalayas. The mean summer temperature is 20° C and in winter the mercury drops to far below the freezing point. Thus in this forest the bulk of the annual precipitation is in the form of snow that covers the ground for several weeks together.

In Kashmir, the valley flat rests at 1,500 meters while the surrounding karewas and mountains soar over 5,000 meters. In the Kashmir Valley some species are common, for example, the birch, poplar, willow and chinar become visible as one leaves behind the floating and rooted hydrophytes of the lakes like Wular, Dal and Nagin. Though occurring in a discontinuous fashion, these trees attract attention, especially in autumn when the leaves of these trees are tinted in a color-riot with all shares of ochre, chestnut brown and amber red, lending a pictorial character to the Kashmir Valley landscape. The karewas of the Kashmir Valley are also known for saffron and walnut apart from several horticultural trees namely, apples, almonds, peaches, cherries and pomegranates.

(ii) Dry Temperate Forest: In the inner dry valleys of the Main Himalayan as well as in the Trans-Himalayan regions, dry temperate forests are found. These forests are of open type, somewhat xerophytic, and they are found at heights of over 1,500 meters. Poplars and willows become stunted in Ladakh and are found near the flows of glacial melt water. Conifers including deodars and junipers predominate with scattered oak and other broadleaved trees confined to moist, shady depression. In the dry zone of the Central and Trans-Himalaya are found the almost pure forest of Neoza or Chilgoza pine with a shrub layer of plants such as Daphne oleoides and a ground layer of various grasses and oak seedlings. Further up between elevations of 3,000 to 3,600 meters are found the dry blue pine forest in the dry zone of the Central-and-Trans-Himalayas.

(c) Alpine Region

This region represents the uppermost limit of tree growth at over 3,300 meters and gradually merges into the region of permanent snow which is above the timber (or tree) line at 3,500 meters. The alpine region thus occupies the topmost tree zones in the Himalayas merging with the alpine shrubs near the snowline.



This region is characterized by the limited growing season of 60 to 80 days with a mean summer temperature of 20° C when nature bursts into life. Then an alpine tundra of grass, flowering herbs, sedges and mosses form a rolling down landscape of alpine meadows, locally known as margs, namely Khilanmarg, Gulmarg, Tanmarg and Sonmarg. Again, when vegetation is reduced to dwarfed and stunted trees of willow and juniper, the alpine scrub makes its appearance. This happens near 3,600 meters where, spreading their fibrous roots into the rocky skeletons, these plants structurally adapt themselves to limited soil and moisture. The alpine stony desert with scree and bits of rock heavily encrusted with lichens and mosses occur below the snowline. Occupying the altitude between 3,700 to 4,200 meters, this zone appears to be bleak and barren; however, some species of trees like rhododendron, betula, and junipers are found in abundance on lower levels of the alpine zone.

(ii) The Eastern HImalayas

This area comprises the Darjeeling Hills, Sikkim and Arunachal Pradesh. It consists of very rich and dense forests. This ecological zone is very similar to the Western Himalayas in vertical zonations in respect to climate and vegetation. The chief differences are due to higher rainfall and warmer conditions (due to lower latitude) prevailing in the Eastern Himalayas compared to those in the Western Himalayas and hence the forests have found a natural home in this ecological zone. The type of forests which have developed in this zone are in direct response to the prevailing topographical and climatic conditions available at sub-regional levels in this ecological zone here. ***The sub-regions are:-***

(a) Submontane Evergreen Forest
(b) Temperate Evergreen Forest
(1) Lower Mixed Temperate Forest
(2) Upper Dry Temperate Forest
(c) Alpine Forest

(a) Submontane Evergreen Forest

This forest extends from the plains at the foot of the hill ranges to about 1,800 meters.

Here, tropical trees of the sal are found in a dense form. In the riverine regions up to 900 meters, association of shisham and khair is found. Mixed forests of some deciduous trees are also found. There are other important sub-tropical trees and grasslands that characterize the forests of this area.

(b) Temperate Evergreen Forest

This zone ranges from about 1,800 to 3,500 meters. It is further divided into Lower Mixed Temperate Forest and Upper Dry Temperate Forest.The **Lower Mixed Temperate Forest** is a dense evergreen forest mixed with hillock, chir, blue pine or kail of the coniferous species. This mixed temperate forest is found well developed in Sikkim and in the Darjeeling Hills.

The **Upper Dry Temperate Forest** is found above the elevation of 2,800 meters. It is cooler and is full of dominant conifers like the silver fir, spruce, oak and fir. In Sikkim and Arunachal

Pradesh, there is an open forest of juniper and birch above an elevation of 2,800 meters. Further up in higher regions are found the rhododendron as the dominant species.

(c) Alpine Forest

The alpine forest of the Eastern Himalayas is considered the uppermost zone and is found over the areas of 3,500 meters. However, above 3,800 meters altitude, the vegetation is generally devoid of trees.

The flortistic affinities of this region have some species of Chine origin as in the Western Himalayas where some southwest Asian elements have entered n a broad front. This zone of alpine forest distributed all over Sikkim and Arunachal Pradesh above an elevation of 3,000 meters is the highest tree forest in the eastern Himalayas. The principal species are the deciduous like oaks, hillock, conifers like pines, silver fir, cedar, etc. and rhododendrons, the last growing to over 4,000 meters height are found in abundance. With increasing heights, most of the trees get crooked and tend to branch low down on the bole. Due to its rich flora, this region is also recognized as one of the richest floristic regions of the world, but in the inner dry valleys of Sikkim of the Zemu and Lonokh Valleys, at heights between 2,700 to 3,500 meters, mixed coniferous forest develops with scrub of Lareh forest further high at elevations of 3,000 meters in Sikkim and Arunachal Pradesh.

(iii) North Eastern Hills

This zone is composed of a series of hill ranges of Assam, Meghalaya, Tripura, Nagaland and Mizoram. This region receives the heaviest rainfall and Cherrapunji is the place that receives the heaviest rainfall in the world. The main ranges of this region are the Garo, Khasi, Jaintia, Mikir and Mishmi Hills which have a dense evergreen forest at lower heights known as (a) Khasi Sub-tropical Wet Hill Forest and (b) the Sub-tropical Pine Forest. The main constituent species of the former forest are found to be the arjun, sal, bamboo and needlewood. Further high, above the elevation of 800 meters height in the Khasi-Mikir-Jaintia-Naga Hills and Manipur is found the sub-tropical pine forest in which pine forms the main forest of which the principal species are found to be Pinus khasya or PInus insubris.

(iv) Desert thorny forest of transgangetic plain

This is the outer Ganga Plain comprising the desert of Western Rajasthan and desert fringe areas of Gujarat and Punjab-Haryana Plain. Here, generally dry conditions prevail with low rainfall (less than 75 centimeters) and wide variations in diurnal temperatures. The natural vegetation is degraded to intensive grassy areas in the region by human interference and at present comprise of bushy and thorny plants, namely, on the Aravali Hills. The dominant vegetation is found in association with khair and shisham. Apart from being known for light timber, both these species are very good fodder trees and they are widely developed for feeding livestock including camels.

(v) Gangetic plain moist Deciduous forest

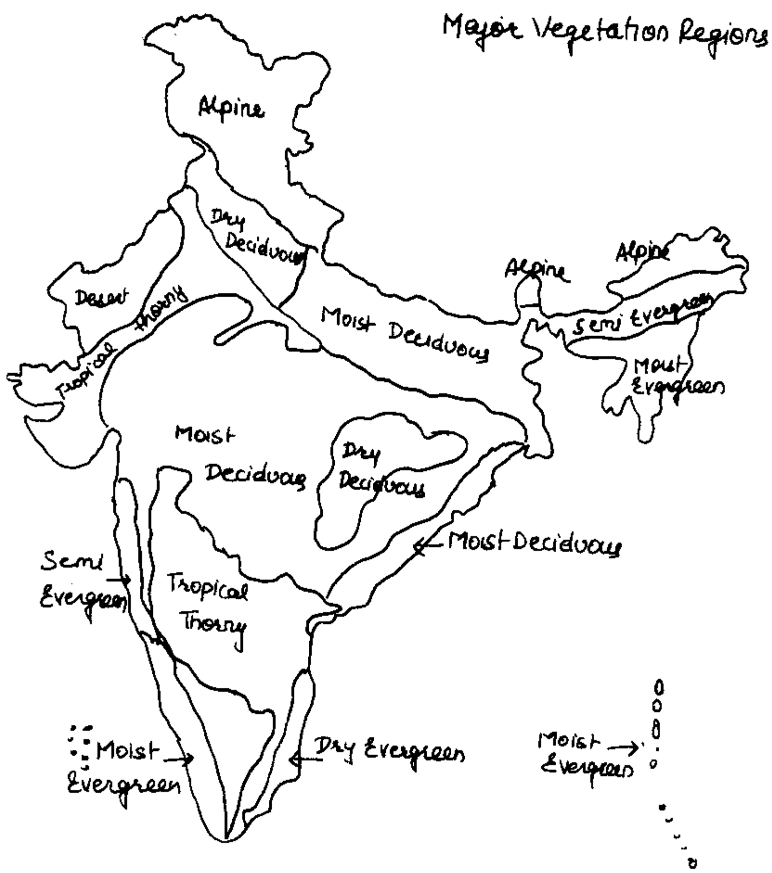
The entire Gangetic Plain comprising Uttar Pradesh, Bihar and West Bengal has been largely stripped of the natural vegetation (for carrying on cultivation) except the foothills in the terai and the tidal swamps in the Ganga delta. In western Uttar Pradesh, apart from khair, the species include arjun. In eastern Uttar Pradesh and Bihar, as a whole, woodland is practically in the riverine strips and the village groves. The common trees are sain, dhak, haldu, eucalyptus, tendu and mahua. Shrub forests are also met within the region which includes shrubs like Ziiyphus jujube. These trees individually give a mark to the vegetation over considerable areas but they do not form any assemblages.

Another sub-zone in the Gangetic Plain is the tidal swamp forest of the Sunderbans. Very prominent and luxuriant species of mangrove trees and scrub are found here.

The very common trees in the village groves are neem, mango, peepal and tamarind.

(vi) Assam valley tropical evergreen to semi evergreen forest.

All along the northern banks of River Brahmaputra, on the alluvial deposits of Lakhimpur and in the heavy rainfall (200 to 1,000 centimeters) areas of cachar and Goalpara foothill tracts are found the species like hillock, hollong, behera, mokai and bamboo. The canopy of this forest is not very dense and individual trees may grow upto more than 20 meters tall. Bamboos form dense brakes, sometimes an impenetrable thorny thicket, composed of canes, climbers and evergreen bushes.



(vii) Open to dry mixed decuduous and sal forest of central India.

This zone mainly comprises of Madhya Pradesh along with some parts of Orissa and Gujarat. This zone is more or less higher than that of the Indo-Gangetic Plain. This zone has small ranges, namely the Aravalis in the west, Satpuras in the southwest, Vindhyas to the north and the South Bihar Plateau to the east.The topography here is of disturbed type and the terrain witnesses the severe erosion problems. The differences in distribution and intensity of rain, soil and terrain conditions, intense land-man relationships by way of lopping, felling of timber and grazing have all given rise to degraded forests here. Depending upon all these features, three types of forest have been identified. Scrub and arid type of vegetation are witnessed most frequently in central India leading to an open or thorny forest. Dry mixed deciduous forest forms the major portion of the vegetation. In favored peaks in the plateaus and in the hills of central India, the rich sal forest has developed. Along the Orissa Coast on the beaches and dune fringes, casuarinas are common.

(viii) Southern India tropical dry Deciduous forest.

This ecological zone lies to the south of the central Indian zone. This zone includes parts of the states of Maharashtra, Andhra Pradesh, Tamil Nadu, Karnataka and Kerala. In this zone the annual mean temperature lies between 24° and 28° C and the total rainfall received is less ranging from 75 to 100 centimeters.

In this drier part of southern India, the area is blessed with the forests of teak. The central region with the Nilgiri Hills and Tamil Nadu Highlands has floral species of sandalwood and harra.

(ix) West coast tropical moist evergreen to semi-evergreen and moist Deciduous forest

This zone is all along the Western Ghats, called the Konkan Coast in the north and the Malabar Coast in the south. This west coast extends from the Gujarat Coast in the north to Kannyakumari in the south. This area receives very heavy rainfall from the moist-bearing South West Monsoon winds from the Arabian Sea. The Western Ghats and the Nilgiri Hills are the two prominent mountain ranges of this region. The hill tops of these two ranges form the Tropical Moist Evergreen Forests which are indeed very luxuriant in floral diversity and multi-storeyed growth. The trees grow to a height of 30 to 35 meters forming close canopies. The undergrowth has bamboo and canes on wet ground. The ground species are few with little grass. Shisham and sain are the important species. The west coast semi-evergreen forest is found in the Western Ghats forming a narrow strip between the evergreen and the moist deciduous. Several important wood species, namely shisham, rosewood and moist teak occur in this narrow subzone. The most deciduous forest occurs along the Western Ghats and in the moist shady depressions of the Deccan plateau. The proportion of evergreen species in this subzone is more than that in the tropical semi-evergreen forest mentioned above.

(x) Wet tropical coastal forests of bay islands

The Andaman and Nicobar Islands in the Bay of Bengal form a distinct ecological zone. The floristic affinities of these islands have links with the Malaysian realms. The islands comprise the climate of the typical tropical coast type and they receive very heavy rainfall. Rainfall is almost evenly spread out all through the year and the mean annual temperature is about 26 C. All these conditions provide a climax giant evergreen forest to semi-evergreen in this ecological zone. Dab, dipterocarb, mayera and gumer form a few of the prominent species of this zone. In the giant evergreen forest of the Andamans are found the various magnitudinal epiphytic growths of climbers, shrubs and ferns.

GRASSLANDS

The coastal grasslands

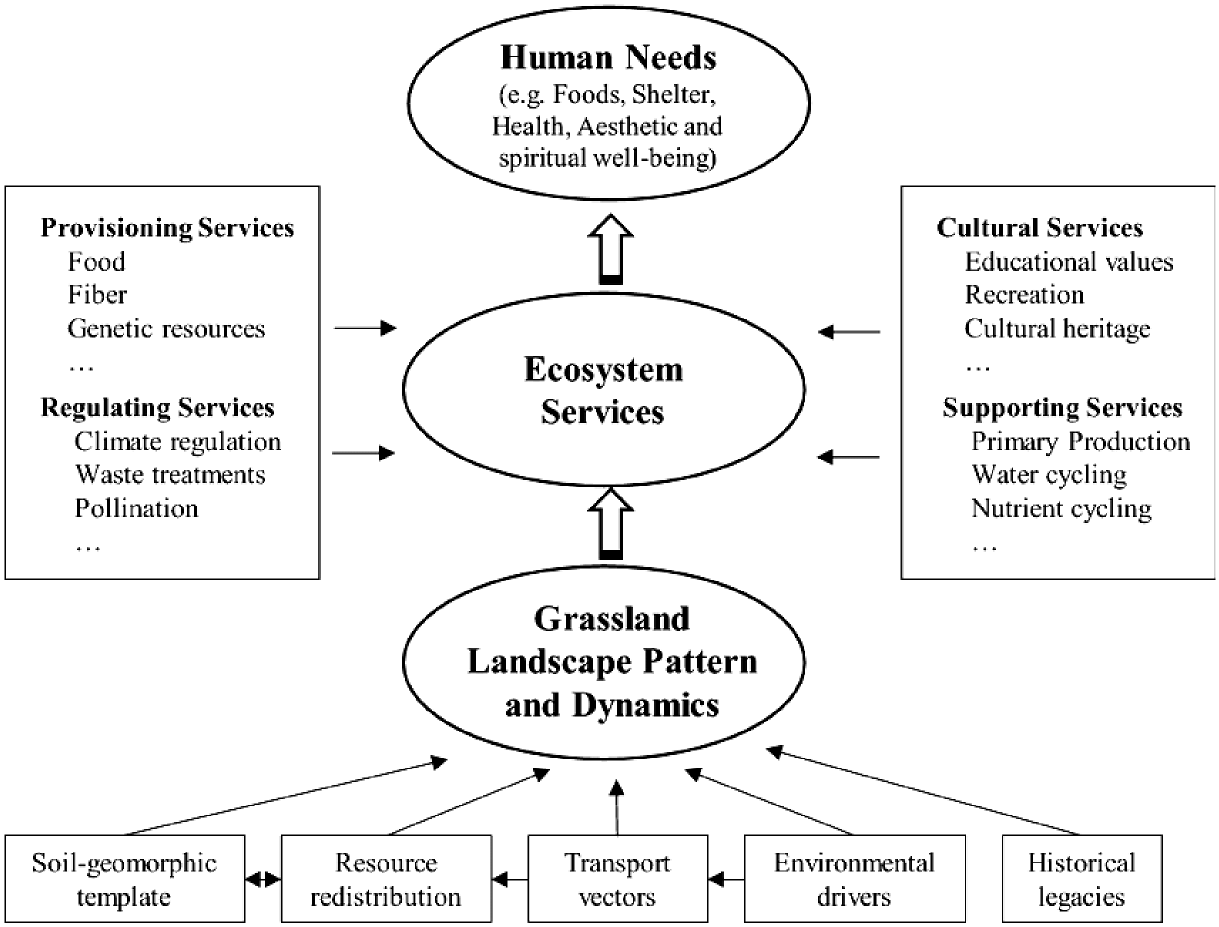
The grassland vegetation that is unique to the coastal regions across the world so far has not found any place in the classification of grassland communities. These are mostly found as gregarious single species communities. Such grasslands can be broadly classified into the following categories:

(a) **Grasslands of the sea beaches:** The grasslands found on sea beaches can be broadly classified into the following:

1. **Mainland beaches:** These are grasslands communities found on the sea beaches of the tropical coasts. The most important grass species in these grasslands is the Rolling Dallis grass ,which spreads along the sand dunes and beach sand over large areas with its long rhizomatous stolons. The male and female inflorescences are found on separate plant colonies. The female has large globular spiny inflorescences which once detached from the plant can roll in the wind along the beach sand thus enabling its dispersal. They are circum-global in nature and are found usually in pure patches or intermixed with Ipomoea pes-caprae on most of the undisturbed beaches in the equatorial regions of Asia, Africa and the Americas. Trachys muricata is another important grass species found on sea beaches. Stenotaphrum dimidiatum also form dense mats under coconut groves situated near the seashores.
2. **Island beaches:** Seashores of the islands across the world are inhabited by a short grass community They are seen as patches of green carpets on the sea beaches especially in the Andaman & Nicobar Islands and Lakshadweep. The fruit of this grass has a protrusion which grows into the sand thus enabling the germination of its seeds in the hostile environment.

(b) **Salt marsh grassland:** These are grasslands dominated by Aleuropus lagopoides found in extensive patches on saline areas frequently submerged by tidal waters of the seas. The Rann of Kachchh is one of the major habitats of this community and is found as pure gregarious population as well as associated with other herbaceous salt tolerant plants .This grass has been red-listed on account of small number of herbarium collections in the past but later on it was found that this status was as a result of under-exploration and the plant is found abundantly at several localities of coastal salt pans on the western and eastern coast of India.

(c) **Mangrove grasslands:** These are grassland communities found along the marshy intertidal zone of the coastal regions and are usually found in patches between adjacent mangrove forests or areas close to sea beaches. They are also found on the field bunds of cultivation or prawn hatcheries located near such mangrove zones. The mangroves of Bhitarkanika, Sunderbans, Pichavaram on the east coast and the mangroves of Goa, Bombay, Calicut, Kadalundi, Payyannur, and Quilon on the west coast are some of the areas where one or more of these species can be found



The riverine alluvial grasslands

The riverine alluvium along the banks of major rivers is usually colonized by a primary successional tall grassland community dominated Kans. This grass has long stolons which spread across vast stretches of alluvial beds of the rivers. This primary successional community often gives way to riverine tree vegetation as one moves away from the flood bank. Such grasslands are common along the Ganga and Brahmaputra rivers and also in several other rivers in peninsular India like the Mahanadi, Godavari, Cauvery, Krishna, Narmada and Bharatapuzha. The rivers of the Punjab also have such riverine alluvial grasslands. Such grasslands in Northern India are also dominated by Munj, which forms regular dense clumps. These grasslands are also habitat to a variety of birds and mammals.

Ecologically, they provide soil binding services stabilizing and preventing the river beds and banks from erosion. The grasslands of Kaziranga National Park south of the Brahmaputra are also an example of riverine alluvial flood plain grasslands.

Montane grasslands

The mountainous regions of the country have different types of grassland communities based on their altitude, slope, aspect and rock strata. They occur as multi-species herbaceous communities over large tracts of land as well as intermixed with shrubs or as undergrowth in open to moderately dense forest areas. The montane grasslands of India can be broadly recognized into the following categories:

(a) Himalayan Sub-tropical grasslands: These are grasslands found on the southern slopes of the Himalaya between an altitudinal range of 1000 to 1800 m and are usually found on steeper rocky slopes with shallow soils. They are also found as lush undergrowth in Pine forests during the rainy season. These grasslands are dominated by several species of grasses, legumes and herbs from other families. These grasslands are highly vulnerable to forest fires during the dry summer season, but being fire hardy, the new shoots soon emerge from the underground rootstock providing valuable fodder to the grazing wild herbivores and domestic livestock during the lean season. These grasslands are used by the local communities for fodder collection during the winter after the seeds have fallen and stored for making hay for future use.

(b) Himalayan Temperate grasslands: These are grasslands found on the slopes of the Himalayas in an altitudinal range of 1800 to 3000 m and are usually found on rocky slopes with shallow soils where there is sparse tree growth. These grasslands are dominated by several grasses, sedges and are also rich in terrestrial orchids. The blades of such grasslands are used by the villagers for thatching purposes.

(c) Alpine meadows: The grasslands found above the tree line on the southern face of the Greater Himalaya above an altitude of 3000 m and upto 5200 m are usually referred to as the Alpine meadows. They are known as Marg in Kashmir, Bugyal in Uttarakhand and by various other local names across the mountain range. Being above the tree line, these grasslands extend over several square kilometers and are usually under snow for a large part of the year and thus form a climatic climax community. However, certain lower sub-alpine areas also have similar grasslands forming edaphic climax due to the rocky substrata unsuitable for tree growth. The most dominant species found in these Alpine meadows is provides nitrogen rich fodder to grazing sheep and other livestock and also to wild herbivores. The alpine meadows are very rich in a variety of medicinal plants which are harvested by the local communities to sustain their livelihoods. Some of the shrubs also are found intermixed with these grasslands. The Chhipla Kedar alpine meadows in Pithoragarh district and Bedini Bugyal of Chamoli district of Uttarakhand are among the most extensive and contiguous patches of alpine meadows found in the Himalaya, each of which is above 300 sq km in expanse. The alpine meadows above 3800 m also forms the habitat of the highly valuable the caterpillar mushroom which is harvested soon after snow melt before the grasses grow to cover them up.

(d) Trans-Himalayan steppes: These are alpine meadows found in the northern face of the Great Himalaya, usually known as the Trans-Himalaya. These areas on account of their location in the rain-shadow region of the South West Monsoons, are arid and very cold due to their proximity to Tibetan plateau and very high altitudes usually above 4000 m asl. Such grasslands are found in Ladakh in Jammu & Kashmir, Lahul, Spiti and Kinnaur districts of Himachal Pradesh and in Nilang, Niti, Malla Johar, Malla Darma and Lapthal areas of Uttarakhand, and Tso Lhamu plateau of Sikkim. These grasslands are dominated by short grasses which can be classified as 'Steppe' as per the global classification of grasslands. These areas are often interspersed with lakes and marsh meadows. The Trans-Himalayan grassland communities of India are mostly extensions of the Tibetan floral elements.

(e) Grasslands of the North East Hills: These are found in sub-tropical to temperate areas of the North Eastern Hill States south of the Brahmaputra. The major grasslands include Dzukou valley in Nagaland and Manipur, Ukhrul grasslands of Manipur, Saramati grasslands of Nagaland, and the rolling downs of Shillong. These grasslands are characterized by a mixture of floral elements of the Himalayan region, South East Asia and peninsular India and hence form a unique biodiversity rich area.. The lower hill slopes are rich in species of variety of montane bamboos.

f() Grasslands of Central Highlands: These grasslands are found in the Central Indian highlands viz., Vindhyas and Satpuras. These hill ranges are considered the corridors between the Western Ghats and the Himalayas for migration of species. These grasslands are found intermixed with tropical dry deciduous forests on rocky patches among sparse to open tree growth and can be ideally called montane or hill savannas.

(g) Western Ghats: The grasslands of the Western Ghats are found on the rocky hill slopes, the high altitude rolling downs and on rocky plateau tops. These grasslands can be broadly classified into the following categories:

1. Plateaus of North Western Ghats: These are grasslands found on the plateaus of the Western Ghats in Karnataka, Goa, and Maharashtra. They are usually short grasses and are ephemeral in nature seen as a green flush during the monsoons and thereafter drying up the seeds dispersed waiting for the rainfall next monsoon. Such grassland communities are common in Panchgani, Mahabaleshwar, Ratnagiri, and Kaas plateau.

2. Shola grasslands: These are high altitudes grasslands of the Western Ghats having an altitude of above 1800 m upto the highest peak of Anaimudi at 2695 m above mean sea level. These grasslands are found between the shola forest patches that occur in the depressions created by watercourses flowing in these rolling downs. The grasslands of Eravikulam

National Park, Mukurti Sanctuary, Kodajadri, Bababudangiri, Agastyamalai, and Poochipara in Silent Valley National Park are all examples of shola grasslands. Unlike the plateau grasslands of Northern Western Ghats, these grasslands receive heavy rainfall throughout the year. One of the important tree species found at the edges of these grasslands is Rhododendron arboreum ssp. nilgiricum.

(h) South Western Ghats: The slopes of south Western Ghats of Waynad and Idukki districts of Kerala have more of forest grasses. Short grasses are also found in abundance as undergrowth in Bandipur, Nagerhole and Wynad wildlife sanctuaries.

(i) Eastern Ghats: The grasslands of the Eastern Ghats are comparatively drier due to lesser rainfall and lower altitudes of around 700 m above mean sea level. They are highly discontinuous and in small patches unlike the Western Ghats. The major grass community is in lower areas. The Shevroy hills of Yercaud, Javadi hills and Malkangiri represent such grassland communities.

(j) Montane bamboo brakes: These are grassland communities dominated by gregarious dwarf monopodial bamboo species, which when one looks from a distance gives the appearance of a normal grassland. These bamboos may be 1 to 5 metres tall depending on the species. They provide suitable habitat to a variety of pheasants and other birds and mammals and the young shoots are also food to a variety of animals including bears and rodents.

Sub-Himalayan tall grasslands in Terai region

These hygrophilous grasslands are found along the length of the Sub-Himalayan belt where the slopes of the foothills converge with the plains of the Gangetic basin. These regions are rich in artesian springs making it ideal for tall grasses. The term Terai refers to this naturally irrigated belt of land and extends from Jammu till Arunachal Pradesh The Terai grasslands are facing a severe threat due to draining out of water for irrigation purposes, land filling and development activities and rapid urbanization. The Terai grasslands are excellent habitat for the Great One-horned rhinoceros, which are present is limited to the flood plains of Assam, West Bengal and a few introduced populations in Dudhwa National Park in Uttar Pradesh.

Tropical savannas

These are vast stretches of tall tropical grasslands interspersed with isolated or groups of trees and are found in Central and Western India. The tropical savannas of India can be broadly classified into the following:

(a) Desert Savannas: These are savannas found in the Great Indian Thar Desert and are dominated by Lasiurus scindicus which is a good soil binder and sand dune stabilizer. Trees of Prosopis cineraria are found as isolated individuals or small groups. These grasslands are found in the Desert National Park and make a good habitat for the Great Indian Bustard and other animals. The Asiatic Cheetah once used to inhabit these grasslands before it became locally extinct.

(b) Tropical savannas of Peninsular India: These grasslands are found almost all over the Deccan plateau and Western India. The grasslands of Saurashtra in Western Gujarat represent one of the largest stretch of Tropical savannas of Peninsular India. The Deccan plateau areas of Karnataka and Maharashtra also have several patches of Tropical Savannas and form good habitat for several herbivores such as black buck and also birds like the Great Indian Bustard and Lesser Florican.

Banni Grasslands Reserve or Banni grasslands form a belt of arid grassland ecosystem on the outer southern edge of the desert of the marshy salt flats of Rann of Kutch in Kutch District, Gujarat State, India. They are known for rich wildlife and biodiversity and are spread across an area of 3,847 square kilometres. They are currently legally protected under the status as a protected or reserve forest in India. Though declared a protected forest more than half a century ago Gujarat state's forest department has recently proposed a special plan to restore and manage this ecosystem in the most efficient way. Wildlife Institute of India (WII) has identified this grassland reserve as one of the last remaining habitats of the cheetah in India and a possible reintroduction site for the species

The grasslands are home to mammals such as the nilgai (Boselaphus tragocamelus), chinkara (Gazella bennettii), blackbuck (Antilope cervicapra), wild boar (Sus scrofa), golden jackal (Canis aureus), Indian hare (Lepus nigricollis), Indian wolf (Canis lupus pallipes), caracal (Caracal caracal), Asiatic wildcat (Felis silvestris ornata) and desert fox (Vulpes vulpes pusilla) etc. among others. The last Indian wild ass (Equus hemionus khur) population, which had become confined to nearby Little Rann of Kutch, has been increasing in numbers since 1976 and has recently started spilling over into adjoining areas including Greater Rann of Kutch, Banni and the adjoining villages of the neighbouring Indian state of Rajasthan.

(c) Northern Tropical Hill Savannas: these are found as vast stretches of grasslands on hill slopes in the tropical areas of Northern India such as the Aravalis, Shiwaliks and the south facing slopes of the sub-Himalayan foothills. These grasslands are often intermixed with tree species such as Acacia

(d) Closed Sal Forest Grasslands: This is a unique kind of grasslands found amidst Sal forests of the sub-Himalayan belt and also in Central India. These are closed grassland communities surrounded by Sal forests on all sides and are dominated by grasses like Imperata which provides excellent habitat for herbivores for grazing with the protection of the nearby forest areas too. Such grasslands are usually frequented by herds of elephants and deer and also makes good hunting ground for Tigers. Such grasslands are found in Rajaji National Park, Corbett National Park, Dudhwa in the sub-Himalayan belt and Kanha National Park in Central India. The fringes of these grasslands are dominated by Chloris dolichostachya which is a shade loving forest grass.

Wet grasslands

The semi-aquatic or wet grasslands are vast stretches found in the water-logged areas of the sub-Himalayan tracts, Terai, abandoned paddy fields, seasonal pools and shallow lakes, low lying areas near the sea coasts, the Phumdis of Manipur and also high altitude lakes. The mid altitude wetlands have Glyceria tonglensis and Paspalum paspalodes as the dominant species. The most well-known wetland grassland is the Loktat Lake in Keibul Lamjao National Park, Manipur having unique species like Zizania latifolia along with Oryza, Phragmites and other tall needs. The swampy regions of the Terai have tall clumps of Erianthus ravennae along with Typha, Saccharum and Phragmites. The wetlands of Maharashtra are rich in grassland community dominated by Coix gigantea.

Threats to grassland communities

The grassland communities all over the sub-continent are facing several threats owing to severe anthropogenic pressures, land filling, grazing pressure, fragmentation, invasive species and to an extent climate change. Rapid urbanization and development of tourism amenities in and around natural, especially high altitude, grasslands have increased human interference and introduction of other grass species through construction material, viz., sand transported from other areas. Species such as Saccharum spontaneum have recently shown beginning of invasion in grasslands of mid altitude tourism destinations of Uttarakhand. The grasslands of the plateaus of the Western Ghats have seen sprouting of hotels and resorts thus destroying the local ecosystem. Species such as Rhynchelytrum repens, an ornamental grass, which had invaded several grasslands surrounding Bangalore and Hyderabad including several airports has now reached Dehradun, probably by dispersal of seeds by aircrafts plying all over the nation. The shola grasslands of Western Ghats have seen invasion of European bushes such as Cystisus scoparius and Ulex europaeus. Forest fires in grassland communities have played a major role in prevention of succession of grasslands into woodlands. However, frequent fires have also played a negative role in change in composition of grasslands from palatable species to non-palatable species, thus making it less suitable ecosystem for herbivores. Some of the examples are Cymbopogon distans taking over several areas of Pine forest grasslands in Almora district of Uttarakhand which otherwise was dominated by Chrysopogon fulvus, Pennisetum orientale, Heteropogon contortus, Themeda anathera and Arundinella nepalensis. Another grass which has taken over in frequent fire affected areas is Imperata cylindrica. The alpine meadows have also witnessed invasion of several species of Rumex and Polygonum, especially around livestock camps. Reduced snowfall in the treeline zone of alpine meadows have also resulted in invasion of lower altitude species into the tree line. Even grasses like Cynodon dactylon was found upto an altitude of 2900 m enroute to Kailas-Mansarovar in Pithoragarh towards the beginning of the alpine meadows of Chhialekh. Most of the semi-aquatic grasslands have witnessed rapid decline due to land filling for developmental activities. Even the abandoned rice fields are also victims of land filling and conversion of land use and agriculture systems for raising other crops such as Banana, Coconut, Rubber and vegetables.

INDIAN BIOGEOGRAPHIC REALMS

India, with varied terrain, topography, land use, geographic and climatic factors, can be divided into ten recognizable biogeographic zones (Rodgers 2000). These zones encompass a variety of ecosystems mountains, plateaus, rivers, forests, deserts, wetlands, lakes, mangroves, coral reefs, coasts and islands.

Trans-Himalayan Region, constituting 5.6 per cent of the total geographical area, includes the high altitude, cold and arid mountain areas of Ladakh, Jammu & Kashmir, North Sikkim, Lahaul and Spiti areas of HimachalPradesh. This zone has sparse alpine steppe vegetation that harbors several endemic species and is a favorable habitat for the biggest populations of wild sheep and goat in the world and other rare fauna that includes Snow Leopard (Uncia uncia) and the migratory Blacknecked Crane (Grus nigricollis). The cold dry desert of this zone represents an extremely fragile ecosystem.

Himalayan Zone, in the far North, constituting 6.4 per cent of the total geographical area includes some of the highest peaks in the world and makes India one of the richest areas in terms of habitats and species. The steep slopes, unconsolidated soils and intense rainfall render the zone extremely fragile. The alpine and
sub-alpine forests, grassy meadows and moist mixed deciduous forests provide diverse habitat for endangered species of bovids such as Bharal (Pseudois nayaur), Ibex (Capra ibex), Markhor (Capra falconeri), Tahr (Hemitragus jemlabicus), and Takin (Budoreas taxicolor). Other rare and endangered species restricted to this zone include Hangul (Cervus eldi eldi) and Musk Deer (Moschus moschiferus)

Indian Desert Zone, constituting 6.6 per cent of the total geographical area, includes the Thar and the Kutch deserts and has large expanses of grassland that supports several endangered species of mammals such as Wolf (Canis lupus), Caracal (Felis caracal), Desert Cat (Felis libyca) and birds of conservation interest viz., Houbara Bustard (Chamydotis undulate) and the Great Indian Bustard (Ardeotis nigriceps).

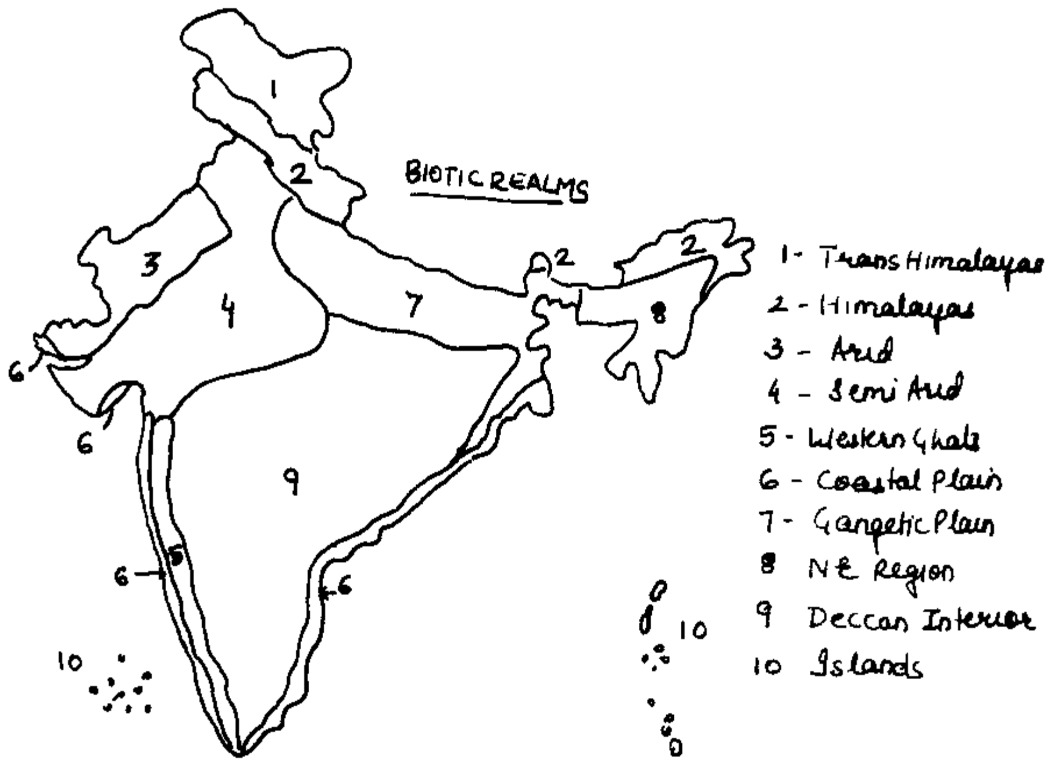
Semi-arid Region, constituting 16.6 per cent of the total geographical area, is a transition zone between the desert and the dense forests of Western Ghats. Peninsular India has two large regions, which are climatically semi-arid. This semi-arid region also has several artificial and natural lakes and marshy lands.

The dominant grass and palatable shrub layer in this zone supports the highest wildlife biomass. The cervid species of Sambar (Cervus unicolor) and Chital (Axis axis) are restricted to the better wooded hills and moister valley areas respectively. The Lion (Leo persica), an endangered carnivore species (restricted to a small area in Gujarat), Caracal (Felis caracal), Jackal (Canis aureus) and Wolf (Canis lupus) are some of the endangered species that are characteristic of this region.

Western Ghats, constituting 4.0 per cent of the total geographical area, is one of the major tropical evergreen forest regions in India. The zone stretches from the hills to the South of the Tapti River in the North to Kanyakumari in the South and in the West, this zone is bound by the coast. This zone represents one of the biodiversity 'hot spots' with some 15,000 species of higher plants, of which 4,000 (27 per cent) are endemic to the region. The Western Ghats harbour viable populations of most of the vertebrate species found in peninsular India, besides an endemic faunal element of its own. Significant species endemic to this region include Nilgiri Langur (Presbytis jobni), Lion Tailed Macaque (Macaca silenus), Grizzled Giant Squirrel (Ratufa macroura), Malabar Civet (Viverricula megaspila), Nilgiri Tahr (Hemitragus bylocrius) and Malabar Grey Hornbill (Ocycerous griseus). The Travancore Tortoise (Indotestudo forstem) and Cane turtle (Heosemys silvatica) are two endangered taxa restricted to a small area in central Western Ghats.

Deccan Plateau, constituting 42 per cent of the total geographical area, is a semi-arid region that falls in the rain shadow area of the Western Ghats. This bio-geographic zone of peninsular India is by far the most extensive zone, covering India's finest forests, particularly in the States of Madhya Pradesh, Maharashtra and Orissa. Majority of the forests are deciduous in nature but there are regions of greater biological diversity in the hill ranges. The zone comprising of deciduous forests, thorn forests and degraded scrubland support diverse wildlife species. Species such as Chital (Axis axis), Sambar (Cervus unicolor), Nilgai (Boselapbus tragocamelus) and Chousingha (Tetracerus quadricornis) are abundant in this zone. Some other species like Barking deer (Muntiacus muntjak) and Gaur (Antilope cervicapra) are more frequent in, or are restricted to moister areas, but are still found in fairly large numbers.

Species with small populations include the Elephant (Elephas maximus) in Bihar-Orissa and Karnataka-Tamil Nadu belts.



Gangetic Plain, constituting 10.8 per cent of the total geographical area, is a flat alluvial region lying to the North and South of the Ganga River and its major tributaries and in the foothills of the Himalayas. The Gangetic plain is topographically homogenous for hundreds of kilometers. The characterstic fauna of this region include Rhino (Rhinoceros unicornis), Elephant (Elephas maximus), Buffalo (Bubalus bubalis), Swamp Deer (Cervus duvauceli), Hog-Deer (Axis porcinus) and Hispid Hare (Carprolagus bispidus). This zone gains considerable ecological significance in the context of increasing industrialization and pollution and the consequent environmental degradation and deforestation.

North-East Region, constituting 5.2 per cent of the total geographical area, represents the transition zone between the Indian, Indo-Malayan and Indo-Chinese bio-geographical regions as well as being a meeting point of the Himalayan mountains and peninsular India. The North-East is thus the biogeographical ‘gateway’ for much of India’s fauna and flora and also a biodiversity hotspot. A diverse set of habitats coupled with long term geological stability has allowed the development of significant levels of endemism in all animal and plant groups. Many of the species contributing to this biological diversity are either restricted to the region itself, or to the smaller localized areas of the Khasi Hills.

The country’s extensive **Coasts**, constituting 2.5 per cent of the total geographical area with sandy beaches, mangroves, mud Nepenthes Khasiana - commonly known as Pitcher Plant flats, coral reefs and marine angiosperm pastures make them the wealth and health zones of India. The coastline from Gujarat to Sunderbans is estimated to be 5,423 km long. A total of 25 islets constitute the Lakshadweep, which are of coral origin, and have a typical reef lagoon system, rich in biodiversity. However, the densely populated Lakshadweep islands virtually have no natural vegetation.

Andaman and Nicobar Islands, constituting 0.3 per cent of the total geographical area are one of the three tropical moist evergreen forests zones in India. The islands house an array of flora and fauna not found elsewhere. The elongated North-South oriented groups of 348 Andaman Islands have a biogeographical affinity with Myanmar. The Nicobar Islands, lying only 90 kms away from Sumatra have much stronger Indonesian and South-East Asian elements. These islands are centres of high endemism and contain some of India’s finest evergreen forests and support a wide diversity of corals. However, endemic island biodiversity is found only in the Andaman and Nicobar Islands. Wetlands occur in various geographical regions such as the cold arid zones of Ladakh, warm arid zones of Rajasthan, tropical monsoonic Central India, North Eastern region, South peninsular region and the coastal wetlands.

India is home to several well known large **mammals** including the Asian Elephant, Bengal Tiger, Asiatic Lion, Leopard, Sloth Bear and Indian Rhinoceros, often engrained culturally and religiously often being associated with deities. Other well known large Indian mammals include ungulates such as the rare Wild Asian Water buffalo, common Domestic Asian Water buffalo, Nilgai, Gaur and several species of deer and antelope. Some members of the dog family such as the Indian Wolf, Bengal Fox, Golden Jackal and the Dhole or Wild Dogs are also widely distributed. However,the **dhole** also known as the whistling hunter are the **most endangered** top Indian carnivore, and Himalayan Wolf is now critically endangered endemic species to India. It is also home to the Striped Hyena, Macaques, Langurs and Mongoose species.

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