DESERT ECOSYSTEM IN INDIA

T.S.Chouhan
Department of Geography, University of Rajasthan, Jaipur, India

U.K.Sharma
Ministry of Rural Development (NLM), Government of India.

Keywords: Precipitation, evaporation, humidity, cold desert, hot desert, landform, peneplains, sand dunes, topography, sand plains, inter-dunal, marshy, playas, ranns, genesis, wasteland, fallow land, deforestation, gully, saline, alkaline, encroachment, agro-ecology, gypsyferros, geology, hydrology, ground water, operational holding, land use, natural fertility, drought, human interface, livestock, degradation, chemical fertilizers, chemical pesticides, desertification, vegetation, bio-fertilizer.

Contents

UNESCO – EOLSS SAMPLE CHAPTERS

Summary

The ecosystems of Indian deserts are governed by location, temperature and climatic conditions where landforms have their distinctive role. The main problems of desert regions are large scale deforestation and uncontrolled use of ground water. Desert regions have generally degraded lands where vegetative land cover has been constantly cleared for cultivation requirements and aridity has increased. Natural fertility has vanished due to excessive use of chemical fertilizers and chemical pesticides. Ground water level has gone down to a serious critical level where further over-exploitation may cause serious implications. Salinity and alkalinity are the resultant impacts of human interface. Most of the desert regions have no perennial water resources. The availability of surface water in some desert regions has created water logging problems.

The ecosystems of Indian desert regions have been severely disturbed and there is immediate necessity to take reversal measures to save desert regions from devastation. The remedial measures need people's participation for using minimum water for drinking and irrigation needs and ground water resources need to be used as

supplemental. Water harvesting measures can change the total ecosystem and it is practical by replication of some successful efforts made. Thirty percent of the land needs to be put under forests where reserve and protected areas need to be managed by government and social forestry activities with peoples' participation as their requirement for fuel wood, fodder and industrial are to be met from these areas. Conventional practices of rain water harvesting and plantation activities linked with ethnic values practiced in some areas are useful tools for changing desert ecosystems.

1. Introduction

India is situated between 8*4' N to 37*6' N and 68*7' E to 97*25'E and spread over 3.29 million sq km of area. Geologically, the country represents monumental assemblage of land pieces varying in age from pre-Cambrian to recent origin. The peninsular massif is part of the super continent Gondwana land till its rupture and drift sometimes in the mid-Mesozoic era, lay somewhere near the South Pole along with Australia, South Africa and South America, as has been observed in Palaeontological, Palaeobotanical, Palaeomagnetic and glaciological formations, at present lying distantly apart. Flat summits, entrenched valleys, dykes, folds and faults all speak of alternating periods of disturbances and inactivities responsible for the present landform configurations. Deserts formed in various regions are situated on the western side over a long stretch from the north-west including coastal regions, which is a general phenomenon with the world desert regions. Deserts arise due to a very slow process of land degradation but human activities lead to environmental degradation and resource depletion. Indiscriminate use of natural resources leads to increasing difficulties in maintenance of these resources in a sustainable manner. Most of the desert regions had been dense forest and fertile cultivated lands and their present set up is a combination of natural and human interfaces. However, it is difficult to shoulder the responsibility, as the total degradation process was due to the impact of inter-related factors.

For the past thousand years, Indian deserts remained unique human ecosystems as all life-forms human, animal and vegetation survived by evolving delicate and precarious relationship with the fragile ecosystems with symbolic relationship between man and environment. Most marvelous inheritance of this desert civilization is its great physio-cultural institutions and biotechnological capacities to sustain variety of life forms. These regions have very high biotic concentration of human and livestock population. Over time, a unique socio-ecological organism, multi-ethnic, multi-caste hierarchical society was born, interwoven in symbolic relationship.

Indian desert regions are characterized by sparse and highly variable precipitation and high evaporation. Drought is characteristic of deserts due to lack of moisture. These areas are sharply delineated by vegetation consisting of plants, which are either xerophytes or short-lived annuals. Vegetation is sparse due to limited availability of water and adverse climatic conditions. Great adjustments are made by plants to enable them grow in this zone. Drought escaping plants grow on availability of good rainfall. Plants growing in this zone have high degree of drought resistance. Crop or pasture production is possible with most efficient use of available water and require detailed study of plant climate relationships while selecting the best suitable crops or pasture species to be grown with occurrence of monsoon. Desert regions face various problems

UNESCO – EOLSS SAMPLE CHAPTERS

of fundamental climatic elements of evapotranspiration, where measurement or prediction of these elements is difficult. This is dependent upon timely and widespread occurrence of monsoon, physical properties of soil, and physiology of plant cover.

Various efforts have been made to classify desert regions of India based on meteorological observations, as rainfall is most important and critical for vegetation in the desert regions. Earlier efforts made by various geographers, environmentalists and other specialists had various limitations in terms of area and assumptions but now National Remote Sensing Agency (NRSA), Department of Space, Government of India, provides quite authentic and accurate information. Data analysis made by various agencies includes efforts made by National Bureau of Soil Survey & Land Use Planning, Unit of Indian Council of Agriculture Research etc. Accordingly, desert regions of India have been classified into hot and cold deserts. Cold desert exist in Jammu & Kashmir State of India, while hot desert is spread over in six states viz. Rajasthan, Punjab, Haryana, Gujarat, Andhra Pradesh and Karnataka.

Cold desert region is limited to Ladakh in Himalayan Mountain while hot desert areas are spread over a large part , situated on north-western part of country. The cold desert region of Ladakh is a unique feature of cold snow covered area but this can be termed as a fringe area with characteristics different from other parts of Jammu & Kashmir state. The cold desert is limited to one district of Jammu & Kashmir state but situated in a large part of more than 70 thousand sq km of area. The remaining 36 districts are hot deserts of which 28 districts are part of the Thar Desert. Andhra Pradesh and Karnataka desert regions are shadow deserts of coastal range. The total Indian desert is spread over in 442 289 sq km situated in 37 districts wholly or partly belonging to seven states of the Indian Union. In area terms total area covered by these 37 districts is 512 503 sq km and desert regions constitute 86.30 percent of their geographical area which is evident from the concentration of deserts in interlinked zones. However the total desert land is 13.52 percent of the country's geographical area. The details of geographical area and desert portions of 37 districts are given in Table 1. Rajasthan is a single largest state having 47.20 percent of its total desert area spread over 2 districts. Three districts of Andhra Pradesh and five districts of Karnataka represent fringe deserts representing 6.22 and 5.26 percent of the total country's desert. Ladakh is a single largest district having total geographical area of 82 665 sq. km of area of which 70 300 sq. km desert containing 37 555 sq. km. The second largest desert district is Kachchh in Gujarat with 45 652 sq km and Jaisalmer ranks third with 38 401 sq km of area. Rajasthan, Gujarat, Punjab and Haryana are part of the Great Indian Desert- Thar and possess very difficult conditions for survival of people, livestock and vegetation. Indian desert is most densely populated among the world's desert regions, which is due high density of the country's population and people inhabiting in the desert regions have no alternative except to survive in adverse climatic conditions.

UNESCO – EOLSS SAMPLE CHAPTERS

S.No	State/ District	Total Geog. Area (Sq. Km)	Desert Area (Sq.Km)	% to Total Geographical Area of district	% to total Desert Area
I.	RAJASTHAN				
1.	Barmer	28387	28387	100.00	6.42
2.	Bikaner	27244	27244	100.00	6.16
3.	Churu	16830	16830	100.00	3.80
4.	Ganganagar	10978	10978	100.00	2.48
5.	Hanumangarh	9656	9656	100.00	2.18
6.	Jaisalmer	38401	38401	100.00	8.68
7.	Jalore	10640	10640	100.00	2.41
8.	Jhunjhunu	5928	5928	100.00	1.34
9.	Jodhpur	22850	22850	100.00	5.17
10.	Nagaur	17718	17718	100.00	4.01
11.	Pali	12387	12387	100.00	2.80
12.	Sikar	7732	7732	100.00	1.75
	Total- Rajasthan	208751	208751	100.00	47.20
II	ANDHRA PRADESH				
1.	Anantapur	19130	19130	100.00	4.33
2.	Kadapa	15359	3856	25.11	0.87
3.	Kurnool	17658	4517	25.58	1.02
	Total Andhra Pradesh	52147	27503	52.74	6.22
III	GUJARAT				
1.	Banas Kantha	10757	10757	100.00	2.43
2.	Jam Nagar	14125	14125	100.00	3.19
3.	Kachchh	45652	45652	100.00	10.32
4.	Mehsana	4384	2076	47.35	0.47
5.	Rajkot	11203	5568	49.70	1.26
6.	Surendra Nagar	10489	5417	51.64	1.23
	Total Gujarat	96610	83595	86.53	18.90
IV	HARYANA				
1.	Bhiwani	4778	4778	100.00	1.08
2.	Fatehabad	2538	1257	49.53	0.28
3.	Hissar	3983	3983	100.00	0.90
4.	Mahendragarh	1899	947	49.87	0.22
5.	Sirsa	4277	4277	100.00	0.97
	Total Haryana	17475	15242	87.22	3.45
V	JAMMU & KASHMIR				
1.	Ladakh	82665	70300	85.04	15.89
VI	KARNATAKA				
1	Bellary	8419	8419	100.00	1.91
2.	Bijapur	10494	7897	75.25	1.79
3.	Chitra Durga	8440	2316	27.44	0.52
4.	Dharwad	4230	1082	25.58	0.24
5.	Raichur	6828	3546	51.93	0.80
	Total Karnataka	38411	23260	60.56	5.26
VII.	PUNJAB				
1.	Ferojpur	5303	5303	100.00	1.20
2.	Faridkot	1469	1469	100.00	0.33
3.	Bhatinda	3385	3385	100.00	0.77
4.	Nawan Shahr	1267	1267	100.00	0.28
5.	Sangrur	5020	2214	44.10	0.50
	Total Punjab	16444	13638	82.94	3.08
	GRAND TOTAL	512503	442289	86.30	100.00

Source: India: National Action Programme to Combat Desertification (2001), Ministry of Environment & Forests, Government of India.

Table 1. District wise area under Indian desert

UNESCO – EOLSS SAMPLE CHAPTERS

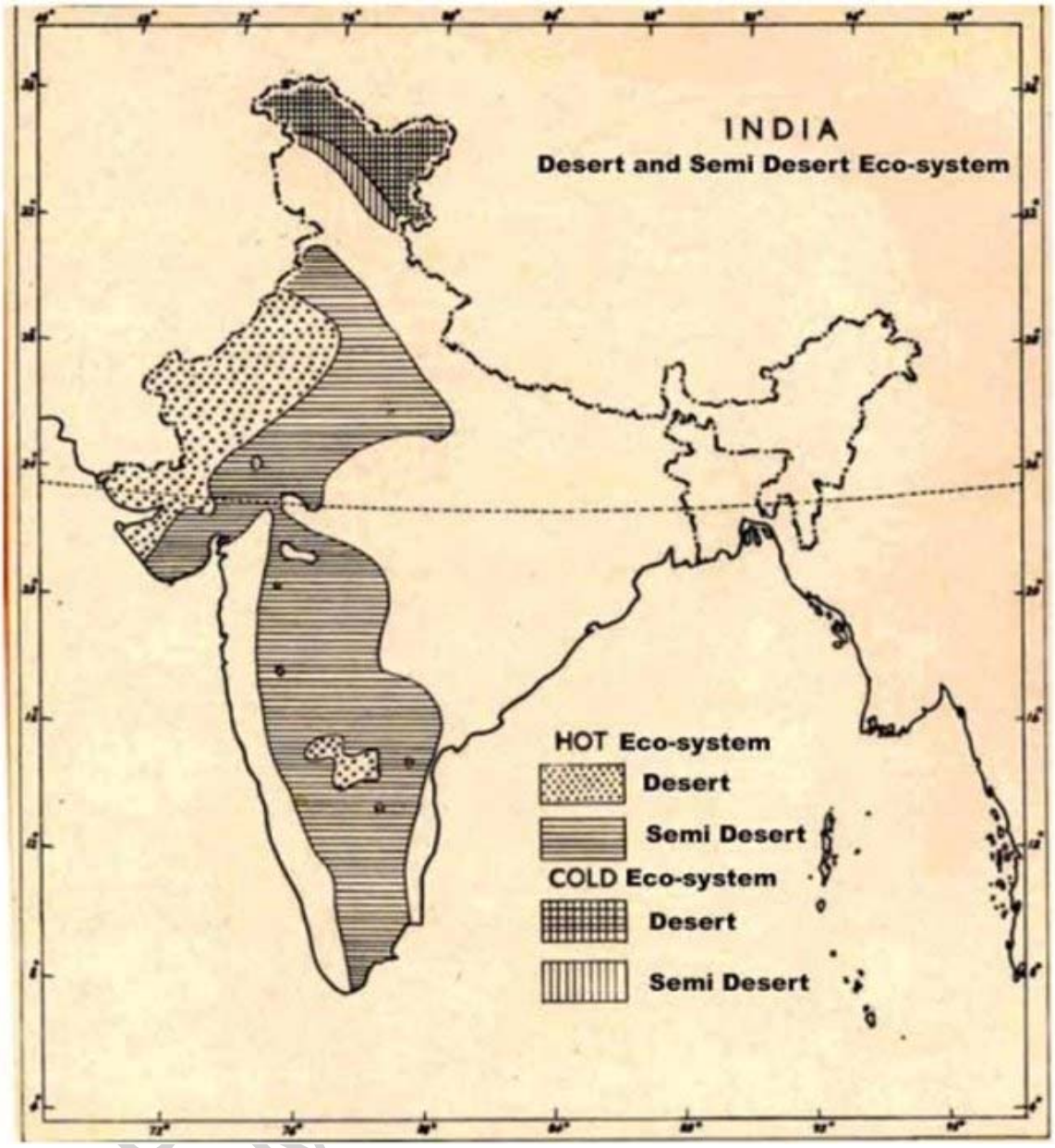

Figure 1. Location Map of Indian Desert Eco-system

2. Physiography of Indian Desert Regions

Physiography of India desert regions is quite varied in landscape, soil structure, precipitation, temperature, humidity and evaporation. This is also relevant that formation of desert regions have distinguished conditions, which resulted into desert. There is no common factor of aridity in desert regions and even there are inter-regional variations in the total desert regions. Landforms with associated characteristics are given in Table 2. These formations are based on ecological features of landscape, soil types, slopes, availability of water and natural vegetation etc. as detailed in Table 2.

Landform	Major shaping force	Soils	Dominant plant	Adaptive character
1. Mountains and Hills	Chemical and physical	Exposed bed rock	Anogeissun latifolia Acacia Senegal, Compiphora wightii	Regions with rainfall less than 25 cm
2. Upper piedmont zone	Water erosion	Sandy loam	Salvadora oleoides, Capparis deciduas, Acacia Senegal (sparse)	Evergreen shrubs with low diffuse roots
3. Lower piedmont merging with plains	Water erosion	Sandy loam to loamy sand	Acacia arabica, Prosopis cpicigera, Salvadora oleoides, Acacia senegal, Capparis deciduas (rainfall less than 25 cm)	Evergreen with deep tap root Evergreen tree & shrub
4. Depression (saline)	Water deposition	Clay loam	Salvadora persica, Tamarix dioica, Halophytic succulents	No vegetation when salinity is high.
5. Water courses	Water erosion	Coarse sand	Acacia arabica, Salvadora olecodes	Deep tap root
6. Depression (non-saline)	Water deposition	Clay loam	Acacia arabica	Deep tap root.
7. Sandy plains	Wind erosion and deposition	Wind deposited sand	Prosopis cineraria, Capparis decidua	Deep tap root
8. Sand dunes	Wind deposition	Fine sand	Calligonum polugonodes	Deep tap and shallow side roots
9. Inter dunes	Water deposition	Clay loam covered with sand	Capparis Haloxylon	Deep tap root
10. Flood plains (old)	Water deposition	Clay loam	Saloxylon salicornicum and H. recurvum	Deep tap root

Source: Indian Desert: Resources and Potential Development (1994).

Table 2. Landforms with associated characteristics

UNESCO – EOLSS SAMPLE CHAPTERS

2.1. Landscape

The landscape of desert regions has changing nature due to natural and other factors. Thar Sea of sand, sand hills, silt covered valleys, flat sandy soil lying in impervious clay, salt lakes, plateau etc. are nature landscape positions, which are old alluvium and deltaic plains. Landscape and landforms differ in formation and possess specific features.

2.1.1. Desert Peneplains

This region referred as Rajasthan Bangar, has Aravalli range as the most striking feature of landscape, which extends from north Gujarat plains to Delhi northeastwards. This region also defines the eastern limit of Thar covering an area of about 75,000 sq. km in Rajasthan. River Luni divides this landscape into two parts, to the north of this river sand dunes persist, appear undulating whale backs of sand i.e., dead or non-mobile type in contrast to living and mobile sand dunes. In the northwest, this landscape extends to Jhunjhunu, Sikar, Churu, Jodhpur, Pali, Barmer and Jalore. South Churu is full of sand levees, where short discontinuous sand levees strike north-east-south-west on a plateau

enclosing in between them as playas. Dispersed and fairly dense settlements in this area indicate that isolated sand hills don not interfere in the normal agricultural pursuits of the local farmers. Wells are shallow with saline water.

Further east, in Shekhawati region, sand thins out little further and due to closeness of Aravalli hills and receives watercourses flowing down the western flank of the range. Density of Prosopis cinereria exceeds 25 trees per hectare. The shape and color of crown is darker and denser as compared to plants recorded in other parts of the desert. This is a country with green fields and prosperous villages. At one or two spots dense forests of Salvadora oleoides are recorded where the sub-soil is heavier in texture. Zizyphus nummularia, a shrub of the plains is common and usually preserved in cultivated fields for its dry thorns for fencing houses and dried leaves locally called as Pala for fodder during the lean period of fodder availability. To the south of Shekhawati lie two large elongated playa lakes, Didwana and Sambhar, with high salt concentration, the former producing half million tones of salt annually. Two smaller playa lakes are near Khatu and Kuchaman. River Luni, the only river traversing the Indian desert, has little upper reaches in Bagar country. It rises in the Aravallis and flows westwards, receiving most of its tributaries including Sukri in the left bank. Its water becomes brackish after Balotra.

The southern half forms a vast vowel rimmed by flat topped hills of sand stone and limestone of Vindhyan age in the north called Bhankars near Jodhpur, granite and rhyolite hills in south, breached by Luni, Sukri and Jawai seasonal rivers at both the eastern and the western ends. Water gaps carved on limestone between Khatu and Bilara indicate superimposed topography of Luny river system. The upper slopes of bolson, especially in the north, represent predominantly built on sand stones on which Jodhpur town stands, upper down gradational slopes of type of Bajada are met with especially on the left bank of Luni river. On the hills, trees of Anogeissus pendula and Acacia Senegal stand out only in protected conditions. Vegetation has been dedicated to some village deity, otherwise straggling shrubs of Anogeissus pendula are seen along with a few clumps of Grewia tenax, Euphorbia caducifolia, a cactiform Euphorbia dominates the entire landscape from which sometimes saplings of Anogeissus pendula, Acacia Senegal, Salvadora aleoides and Maytenus enaginata are seen protruding as protection offered to them. Residual low hills or inselbergs rise above floor of bolson near Pali, Chanod and Siwana. Natural vegetation here too is very much degraded comprising mainly shrubs of Capparis deciduas, having physiognomy of scattered shrubs. Pediment plains lying at the floor of the Aravallis are watered by innumerable short streams coming down the western flank of range fertile Godwar plain showing green fields with surface irrigation.

Residual hills and escarpments are steep sided premontries in the form of domes, bosses, meas, scarps, knolls and inselbergs, rise abruptly from the surrounding plain. In most cases, these residual masses are monolithic remnants of sub aerial weathering, denudation and scarp retreat. Hill streams have occupied major joints. Granitic domes and bosses range in height up to 100 meters above the ground level. Scarps have developed in sedimentaries of Barmer, Jodhpur, Jaisalmer and Kolayat (Bikaner) tracts. The area between Jaisalmer and Ramgarh has moderate relief with few small hillocks, scarps and ridges. Jaisalmer town is situated on limestone plateau. Other scraps are

UNESCO – EOLSS SAMPLE CHAPTERS

composed of Bhadesar, Baisakhai and Parihar sandstone.

Piedmont plains and pediments have their upper regions adjacent to hills consisting of boulders, rock fragments and regolithic material. Angular to sub-angular rock fragments of 2.5 to 10 cm diameter are found at an approximate distance of 1 to 5 meters, where slopes are convex and declivities varying 3 to 6 degrees. The area in lower slope of 2-3 degree consists of coarse deposits mixed with angular to sub-angular rocks fragments. Plains situated down incised by streams of 1-3 m width. Incision is more in non-cohesive sandy deposits and badland topography has developed. Sediments of piedmont plains are poorly graded and assorted. Gravel layers are laid down in these plains by torrents and finer aggregates by sluggish sheet floods. In Nagaur, Bap, Jodhpur, Jaisalmer, Pali, Jalore and Bikaner areas, vast extensive rocky plains with thin veneer of sediments clearly indicate erosional plains with several scarps, formed by a process of sharp recession.

2.1.2. Sand Dunes of Marusthali

This region is a sandy part of the Thar desert considered as typical young tropical desert with all characteristic features, covers more than 100,000 sq. km where sand driven by wind is piled up on heaps and ridges or spread out in sheets, sometimes obliterating pre-desert fluvial topography. Peneplains of Aravalli ranges, Punjab-Haryana plains in north and northern Gujarat are its other limits. The influence of the south-west monsoon wind is apparent in the orientation of sand dunes which support scattered shrubs of Colligonum polygonoides and clumps of panium turgidum. These wind drifted dunes are of different types- longitudinal, transverse and barchans. Okhali the concentric dunes of composed of fresh sand deposits are located near Jaisalmer, bare dunes without vegetative cover.

Long narrow ridges of seif type run parallel in north-east and south-west directions, enclosing in between them dune lakes called Dhands or Tibbas. These longitudinal sand dunes are very common to the west and south of Jaisalmer city, occasionally develop transverse tibbas of barchan type. Flat floored depressions also occur sandwiched between two longitudinal tibbas, providing site for verdant oases, their length and width appear much restricted in areas of rapidly moving sands. In the Malani region, sand dunes are more or less fixed while in the north these are mostly moving. On fixed sand dunes trees like Prosopis cinereria get established.

Longitudinal and parabolic dunes are composed of fine to very fine sands occurring in fairly narrow strips both northwest to south and south-east hills. Some degrees of cementation also occur in these dunes and carbonate content usually amounts to approximately 6-11 percent. Dissection of dunes is only minor with less than 20 m height. Elongated depressions occur between longitudinal and parabolic sand ridges stretching in the direction of dominant south westerly winds. These dunes support both psammophytic and lithophytic plants among which *Acacia senegal, Maytenus emarginata, Aerva persica, Lycium barbarum and Sericostemma pauciflorum* are dominant. Obstructional effects of hills on air currents sometimes give different direction to dunes. Locally reworking of these dunes led to formation of flat hummocky sand sheet.

UNESCO – EOLSS SAMPLE CHAPTERS

Various types of dunes are formed in the Indian desert mainly on top of old alluvium. Kankar horizon of lime concretions thus occur underneath, and as a result, precipitation in these areas generally cannot contribute to deeper ground water. However, large masses of fine grained sand are capable of retaining considerable amount of water causing increased moisture contents in the lower part of sand slopes— particularly depressions between dunes. Most of the parabolic dunes have fused together and transverse fronts across wind have formed with limited supply of loose sand, where the velocity of wind is moderate, barchan dunes have formed of height up to 8 m. In the extreme part of the desert, longitudinal dunes of seif type are formed on top of barchan dunes. Sand parts have been derived from weathering rocks, mineralogical analysis indicates availability of mica in the eastern part of the desert.

2.1.3. Sandy Plains

Sand covered plains are the most distinguishing feature of deserts. These are scattered in the entire Thar desert, chiefly in Punjab-Haryana sector, north Gujarat and pasts of Bikaner, Jaisalmer and Barmer districts of Rajasthan. These are studded with occasional sand hills. This part is relatively flatter than the north-western dune infested country. Soils are of Aeolian origin derived from various parent materials with fine sand to loamy sand. Two broad landform units- old and younger alluvial plains are easily distinguished. Old alluvial plains are most extensive in the central desert of Rajasthan, where plains are flat, but hummocky topography is found in some localities distinguished as level plains and slightly undulating plains with sandy hummocks. The slope of the terrain is less than one or two percent near the lower piedmont zone and decreases at greater distance from the hills and marked somewhat lighter color tone associated with different soil texture and vegetation. Darker phototones are characteristic where hydromorphic soils occur in shallow depressions mainly of calcareous clays. .

Unvegetated saline parts are however very light toned with the exception of heavy saline soils. Vegetation comprises of mainly *Prosopis cinereria, Capparis deciduas* and *Zizyphus nummularia*. Percentage composition and growth characters depend mainly upon the depth of the soil and its texture. *Salvadora oleoides* is associated with soils where sub-soil layers consist of loam or silty loam or clay layer. Among shrubs, *Calotropis procera* and *Crettalaria burhia* are most common. Hydromorphic soils are sometimes completely covered with *propopis juliflora*, which form dense thorny thickets in Jalore and Pali districts. During the post-monsoon period, the most conspicuous plants are *Pulicaria wightiama, Crotalaria burhia and Aerva persica*. Few shrubs of *Capperis deciduas* sometimes act as barrier for sand movement and small hummocks are formed near these shrubs. As regards regenesis, it is difficult to narrate whether vast plains are erosional or depositional in character since sediments are shallow and coarse grained in most parts of this zone. The thickness of alluvial deposits is more in enclosed basins than on vast extensive flat surfaces.Plains are almost devoid of surface drainage but some fossil drainage lines exist. Some ephemeral channels can be traced near the hills that feed artificial storage lakes of tanks. This particularly exists whereon dune belts occur between hills and plains that intercept ephemeral sheet flood waters. The presence of impervious lime concretions at shallow depth is the main characteristic of this unit. The upper limit may usually be found from 30 to 150 cm

UNESCO – EOLSS SAMPLE CHAPTERS

below the surface. These concretions play critical role in hydrological and agricultural conditions as precipitation falling on old alluvial plain cannot contribute to ground water to any considerable extent and a fair portion evaporates.

The piedmont zone separates old alluvium from residual hills. Some lime concretions are normally lacking or poorly developed in the upper piedmont zone, sub-surface water may flow underneath the concretion layer and thus may contribute to deeper ground water. Young alluvial plains occur relatively as a narrow belt on both sides of the present river channels. Soils are mostly loamy sand to sandy loam but coarser material like sand and gravel is also common. No lime concretions are normally found in this unit and permeability therefore is good. There normally exists free exchange of water that percolates through the sand of the river channel. In the dry parts of the year, there are losses to river channel, whereas there is recharge of wells after rains and floods. Numerous wells occur in this zone having sufficient yield for irrigation. Natural vegetation consists of *Acacia nilotica ssp Indica, Acacia jacquemontii* and *Tamarix sp*. In forward areas of Luni having saline water, *Tamarix dioica* and *Salvadora persica* sometimes gain dominance. On the riverbed Tamarix are profuse in dry spells and cover sandy beds extensively.

2.1.4. Indus Plains

This area exists in the east of the lower valleys of Indus, Sutlej, extensive areas between Jhelam, and Chenab, where plain area of undulating sand hills, slopes upwards gradually to north-east. Elevations are generally below 160 m and its north-east portion is channel of large dry water course of Ghaggar, the seasonal river. The southern part of this region is frost free; light winter frost occurs annually in the northern part. Vegetation is generally sparse consisting of xerophytic shrubs like *Haloxylon salicornicum, H. recurvum* etc but localized area supports lush grasses and shrubs like *Acacia arabica, Capparis deciduas, Zizyphus nummularia* and *Calotropis procera*. The terrain is formed of Pleistocene and recent alluvial deposits in layer comfortable with flat surface. Deposits vary considerably with massive beds of clay and sand and in some areas with calcareous concretions and silt. Brown sand occupies considerable part. Sand deposits are loessic in origin and deposited in most part after Pleistocene. Indus valley remained under sea up to sub-recent times and plain originated from unfelling of foredeep. Any unevenness of surface is due to older banks and deserted channels of river but local relief is insignificant.

2.1.5. Flood Plains

There are old flood plains of dried Ghaggar river system in Ganganagar and Bikaner districts of Indian desert. Ghaggar bed is about 5-9 km wide and bounded by sandy banks attaining some height forming hummocks. In the north-east of Ghaggar flood plains, soil is fine textured, clay loam to silty clay, sometimes saline. Some shrubs like *Haloxylon salicornicum, H. recurvum and Capparis deciduas* can be seen over vast treeless horizon. Several succulents like *Suaeda fruticosa* and *Sensuvium portulacastrum, Cressa Cretica* are most common. Now it has been fed by permanent canal of about 800 km long Tectonic movement in later part of tertiary caused both highlands to attain steeper gradients, which aggravated the erosive power of streams

UNESCO – EOLSS SAMPLE CHAPTERS

produced more detritus to be transported. Overloaded streams started depositing sediments in fore deep. Gravelly material are found below finer sediments, finer particles have been swept by wind and resorted in the form of dunes, drop sediments in their flood plain areas which constitute this unit. Alluviation of this region is still in operation.

2.1.6. Marshy Land

This is a marine zone with mangrove swamps and salt water creeks. Mudflats with or without mangroves, make up most of coastal area in Gujarat and Rajasthan states near the Gulf of Kachchh. Part of Kachchh district is also covered by these lands- the Great Rann from the north to the west and little Rann to the south-east of this district. These are vast areas inundated during monsoon under the combined affect of vast marshes and obstruction in flow of rainwater. Soils are halomorphic, dark grey to black in color. During the dry season, white crust of salts of few mm thick is deposited on the surface, usually showing polygonal cracks. Since the coastal zone is submerged occasionally by sea water, soils are deep and argillious. Halophytic vegetation is *Suaeda fruticosa, Salsola foetide, Arthrocnium indicum, Atriplex stocksii, Salicornia brachaita* and *Sensurium portulacastrum* etc. Among grasses, *Aeluropus lagopoides, Sporobolus sp* and *Halopyron mucronatum* are common. In some marshes, *Cressa cretica* is an important plant. This zone is periodically submerged by seawater and is rich in soluble salts in greater and little Rann of Kachchh. There is practically no vegetation except some halophytic grasses on the borders like *Aeluropus lagopoides, Sporobolus helvolus, S. morginatus, S. coromandelianum, Urochandra setulosa, Dactyloctenium aegyptium, Chloris virgata* and *Eleusine compressa*. Plantations of *Prosopis juliflora* raised on the saline bed are sometimes not very successful due to hard sub-soil surface.

Marshy depressions occurring inland are also inundated during the monsoon season and show salt efflorescence. Common plant species recorded are *Cassia auriculata, Tamariz dioica, Salvadora persica, Cressa cretica, Vitex negundo, indigofera oblongifolia* along with some grasses e.g. *Sporobolus marginata, Eleusine compressa* and *Dichanthium annulatum*. On intercoastal zone on elevated soils and coastal creeks mangrove vegetation of *Avicennia officinalis, Rhyzophora mucronata, Burguiera conjugata, Aegiceras corniculata* and *Acanthus ilicifolius* is seen. This provides fuel, which is the main cause for degradation of this formation.

2.1.7. Salt Playas

Saline depressions or lakes are scattered throughout desert region important among them being Sambhar lake, Pachpadra, Loonkaransar and Didwana. There are small playa lakes near Khatu, Pokaran, Sujangarh and Kuchaman. In the hilly and sandy dune tracts, there are enclosed basins and local runoffs possessing clayey soils with evaporate deposits like sodium chloride gypsum, gypsite, nitrate etc when dried during summer. Like the saline lands of West Australia, there are some relics of the once extensive river system. Rann of Sanwarla, Pachpadra salt basin and other minor depressions in the northern part of central Luni basin are 'wet playas'. Centripetal drainage system was not conspicuous at all and channels connected from headwater branched after dryland conditions were set in. The highly saline surface limits crop

UNESCO – EOLSS SAMPLE CHAPTERS

production. Stream which originates from high lands of Shergarh- Kailana- Jodhpur drains into this basin is underground surface drainage enriched by high dunes. In the Luni basin or in alignment with it, most of these salt lakes occur while others are along the periphery of Barmer Bikaner dune free country located at Pokaran, Phalodi, Bap and Lunkaransar.

Heavy textured saline soils occur in some localized depressions which are clay loam, shallow to moderately deep loamy sand overly strong clay loam in upper reaches, where sand sheets occur. The extent of sand cover ranges from 10 to 80 cm, the upper sand cover is calcareous and non-saline sometimes supporting crop in 30 cm deep conditions. Deep to moderately deep, medium to coarse textured soils, slightly affected by salts at a lower depth also occur in the low-lying locations. Plant association in these depressions varies depending upon the degree of salinity in the soil. Various micro-reliefs show a spectrum of plant associations. In the centre, where pH of the top soil layer is more than 9.9 and Ec of saturation extract, high white salt incrustation is present and no vegetation exists. Under low salt concentrations and pH values, vegetation mostly comprising of grasses and sedges like *Cyperus iria, Sporobolus helvolus, S. marginatus, Aeluropus lagopoides, Dactyloctenium aegyptium, Chloris virgata, Aristida sp* are recorded. Among succulent members of chenopodiaceae family are most common comprising of species like *Haloxtlon salicornicum, Suaeda druicosa, Atriplex sp* and *Salsola sp* etc. *Cressa cretica*, a small herb is extensively found on this habitat. These depressions are marginally exploited for grazing by sheep and goat during the rainy season. Tal Chhapar is a similar depression under forest game sanctuary of black deer. These details are enumerated in Table 2.

Physiographic features of desert regions are varied and extensive. While comparing the desert conditions in Punjab, Haryana and canal fed areas of Rajasthan, it is clear that desert land can be converted into green lands. Most of desert lands are treatable as evident from these areas. Greenlands of desert regions are exemplary for other desert areas of the world, for adopting similar practices of treatment of their problems, though position arrived in canal-irrigated areas is quite costly, time consuming and need peoples' participation for making their efforts into success.

2.2. Geomorphic Evolution

The Thar desert is the western most fringe of Deccan mainland forming shield area of the Indian sub-continent during pre-Cambrian times. On the west rock exposures are less frequent but known to include Malani igneous rocks, Vindhya, Marine Jurassics and Eocene rocks. It is understood that this area was under sea during Jurassic times which is evident from fossils recovered in Jaisalmer district of Rajasthan. Highly fossiliferous marine deposits over Talchir beds show that species lived in more or less isolated arms of large sea spread over the Himalayan region. The sub-continent land was either up heaved or sea receded in sub-recent times. During Carboniferous period glacial climate prevailed over the desert region of the sub-continent. The Aravalli range was covered by ice sheet, which extended northwards over salt range. Middle and upper Pleistocene was period of repeated glaciations, northern India must have experienced temperate climate. It is presumed that rivers originating from Himalayas might have changed their course and disappeared. Saraswati river flowing through the Thar desert

UNESCO – EOLSS SAMPLE CHAPTERS

was the life line of the region and the area was prosperous covered with dense forests.

Indus plain, which forms downrap, has dominated the palaeogeography of the Thar desert from the Mesozoic time onwards. Segments which occupy the final position of the trough, oscillated east and west from Mesozoic times as evident from the marine transgressions. After the Eparchean interval the Aravalli geosyncline basin seems to have deepened and laid down the Delhi system of torrential streams as indicated by the vast quantity of conglomerate and sand with impure calcareous sediments. The Aravalli range was upheaved by oreogenic forces in the pre-Vindhyan times and thereafter the Vindhyan sediments were deposited on either side. Vindhyan rocks are nearly 100 cm thick in western Rajasthan and the geo-history of Rajasthan is obscure to middle carboniferous times. At the close of the carboniferous period, the Aravalli range was occupied by ice sheet stretched far north as salt range. Early Mesozoic period is marked by earth movements, which created a great boundary fault and rejuvenated Aravalli Mountains. As a result of geological features, Archaean rocks occur mostly in the Thar desert of Rajasthan. There is an intimate causal relationship between relief and geological structure, landforms are in extreme contrast.

2.2.1. Playas or Ranns

The origin of salt lakes or depressions indicates that brine of salt lakes was surface deposit as a result of desiccation of sea in the late tertiary period. There is possibility that salts are carried by winds from the Rann of Kachchh as particles or sprays of sea water and deposited over land, subsequently washed by rains and deposited in lakes. Structure, relief and morphogenesis of these playas are varying and they are important gathering ground of natural evaporates and ground water.

2.2.2. Genesis of Carbonate Pan

Generally carbonate pan is concealed under alluvial or blown sand deposit but sometimes exposed at the surface due to removal of soil by erosion. It is not encountered in inselberg zone, while in piedmont plains, it is found at about 45 cm depth, which gradually increases in depth towards the lower plains it is found at a depth range 65-100 cm. In alluvial plains it lies at 45-100 depth and at 120 cm depth in shallow saline depressions of internal drainage. In appearance it neither resembles rock nor alluvium or sand. These are very hard and impervious and penetration of roots is difficult. In piedmont zone, layers of pan are found where soil deposits are also observed. Rock fragments washed away from highlands are deposited in bands and become cemented with lime.

Development of pan is very much related with dry climate with rainfall varying 100-150 mm, high temperature and prolonged droughts. Glaciations in the Himalayas have considerably influenced climatic conditions of this tropical belt. It is surmised that glaciations of different intensities have resulted in climate declining towards more drylands. In between two glaciations or pluvials of low intensities, dunes of old system are formed and stabilized during pluvial period. In the present period, new dunes are formed due to extreme dryness

UNESCO – EOLSS SAMPLE CHAPTERS

2.2.3. Origin of Sand Dunes

Sand of dunes indistinguishable from seashore seems to have been transported to a great measure by monsoon winds. The fine grained sand seems to have been transported by drainage systems from the Aravallis which seems a major reason of variation. Orientation and distribution of sand dunes depend upon the source of sand and size of grains, since coarser grains drop at a short distance while fine grains continue their flight down the wind at varying distance depending on the velocity of the summit wind and violence of eddies in leeward side of dunes. In barchan dunes, the average size of sand grains increases with the size of the dune. Bigger sand grains contribute to more weight and pressure, require more wind energy to be carried vertically as well as horizontally. Near the Rann of Kachchh and in Barmer the density of dunes is comparatively high and gradually decreases in the north-east.

Dunes of the old system are of high relief and maturity and have developed into whale back ridges and rounded swells due to deflation and fusion processes which modify the sharpness of topography of the previously formed parabolic dunes. It has been observed that windward slope of these dunes is very gentle and quite often dissected by short streams, often subjected to wind sourcing while leeward side is very steep. Dunes of the new system contain freshly deposited loose sand and lack in characteristics of the old dune system. New dunes are formed by cutting of trees, intensive grazing and cultivation over old dunes as these practices set the surface of dunes in motion. Apart from distinct colonies of three types of dunes viz. longitudinal, transverse and barchans, there are concentrations of complex types where all types of dunes are found. Large quantity of sand also gets heaped against hill tops and under shrubs and bushes.

The phenomenon of sand movement is intimately connected with the velocity of surface wind, force exerted on sand grains and resistance offered by grains to passage of wind. Wind velocity falls nearer to the surface level, pebbles, grass blades or other surface irregularities. From this level upward it increases quite rapidly at first, becomes slow at significant height. Smaller clay or dust particles do not react unless stirred by flying sand grains. Hard rough surface remains stationary and not affected with blown wind. Wind speed ranges between 30 and 62 km per hour during the summer months of April to June.

-
-
-

TO ACCESS ALL THE **54 PAGES** OF THIS CHAPTER,
Visit: http://www.eolss.net/Eolss-sampleAllChapter.aspx

Bibliography

Chouhan, T.S. (1994) Indian Desert: Resources & Potential Development. National Bureau of Soil

Survey and Land Use Planning (ICAR) Nagpur, India.

Digest of Statistics 2004-05 Government of Jammu & Kashmir: Data source of cold desert.

Deshpande C.D. (1992) India- A Regional Interpretation, National Council of Social Sciences Research [The publication is helpful in regional interpretation of different ecosystems of the country. The problems of desert regions of India are helpful in understanding in situation of different desert areas of the country]

Desertification and Its Control (1978) Indian Council of Agriculture Research [The study is confined to north-western desert regions of India. [The conditions of hot and cold desert regions are detailed in terms of life support system].

Ground Water Resources of India (1995) Central Ground Water Board, Ministry of Water Resources, Government of India. [Data source related to districts. The areas falling in desert regions of the country can be seen in this publication].

Ground Water Statistics (2002) Central Ground Water Board, Ministry of Water Resources, Government of India. [Data source related to districts. The areas falling in desert regions of the country can be seen in this publication].

Gupta R.K. & Ishwar Prakash (1975) Environmental Analysis of the Thar Desert, English Book Depot Dehradun [The study is focused to Indian Thar Desert detailing the life support system in different environmental conditions]

India- National Action Programme to Combat Desertification (2001) Ministry of Environment of Forests, Government of India [Status of desertification in India and this is regional analysis of desert regions of country. National action plan refers to governmental efforts for combating desertification]

India (2006) Ministry of Information and Broadcasting, Government of India [Data source]

Resource Atlas of Rajasthan (1994) Government of Rajasthan, Jaipur [Data source]

Singh R.L., (ed) (1992)- India- A Regional Geography, National Geographical Society of India, Varanasi Regional geographical interpretation at macro and micro level in reference to states of India. [This publication is helpful in understanding geographical conditions of the country].

Socio-Economic Atlas India (2001) National Atlas & Thematic Mapping: Organization., Department of Science & Technology, Government of India [Data source]

Spate O.H.K and others (1960) India and Pakistan- A General and Regional Geography, Methuen & Co. Ltd. Regional interpretation of geography of India and Pakistan. [The publication also touches desert regions of the country].

Statistical Abstract Haryana 2003-04 Government of Haryana (2005) [Data Source]

Statistical Abstract of Punjab (2005) Government of Punjab [Data source]

Statistical Abstract Andhra Pradesh (2005) Government of Andhra Pradesh [Data source]

Statistical Abstract Rajasthan (2003) Government of Rajasthan [Data source]

Statistical Abstract of Gujarat State (2005) Government of Gujarat [Data source]

United Nations Environment Programme (1986) Arid land Development and the Combat against Desertification: An Integrated Approach: Guidelines for development of arid lands [Efforts for combating desertification are defined]

UNESCO – EOLSS SAMPLE CHAPTERS

Biographical Sketches

Dr. T.S.Chouhan is Senior Geographer in the Department of Geography, University of Rajasthan, Jaipur, India. He is engaged in teaching and research primarily in the fields of environmental geography, remote sensing and its applications, geography of arid lands, agricultural geography, cartography and GIS and GPS and Integrated Area Development. Dr. Chouhan has worked in reputed institutions of learning and research like the Central Arid Zone Research Institute, Jodhpur, Department of Geography, University of Jodhpur and National Remote Sensing Agency, Hyderabad. He was also awarded post-doctoral fellowship and research Associateship by the University Grants Commission, New Delhi. He has to his

credit more than 70 research papers published in reputed journals in India and abroad and is author of more than two dozen well acclaimed books. He has been guiding research work for the last more than two decades and supervised more than three dozen doctoral theses. Dr. Chouhan is a recognized consultancy expert to the Government of Rajasthan, Planning Department in various fields of Watershed Development, Forestry, Land Management, Water Conservation, Remote Sensing and Digital Cartography. He is also trained in GIS Application from National Institute of Rural Development, Hyderabad and using it for current projects. Dr. Chouhan visited Brazil and Morocco in connection of United Nations Workshops on Combating Desertification through Space Technology.

Mr. Uma Kant Sharma is an Economist and presently working as National Level Monitor in the Ministry of Rural Development, Government of India. He remained associated with preparation and implementation of World Bank assisted project on Poverty and also worked in World Bank assisted Watershed Development Project. Mr. Sharma visited Bangladesh for impact assessment of poverty eradication program. He has in credit various activities related to treatment of degraded lands, implementation and evaluation of rural development programs of Rajasthan state of India. He had prepared multi-sectoral Geographical Information System of Rajasthan on area and distance approach.

UNESCO – EOLSS SAMPLE CHAPTERS