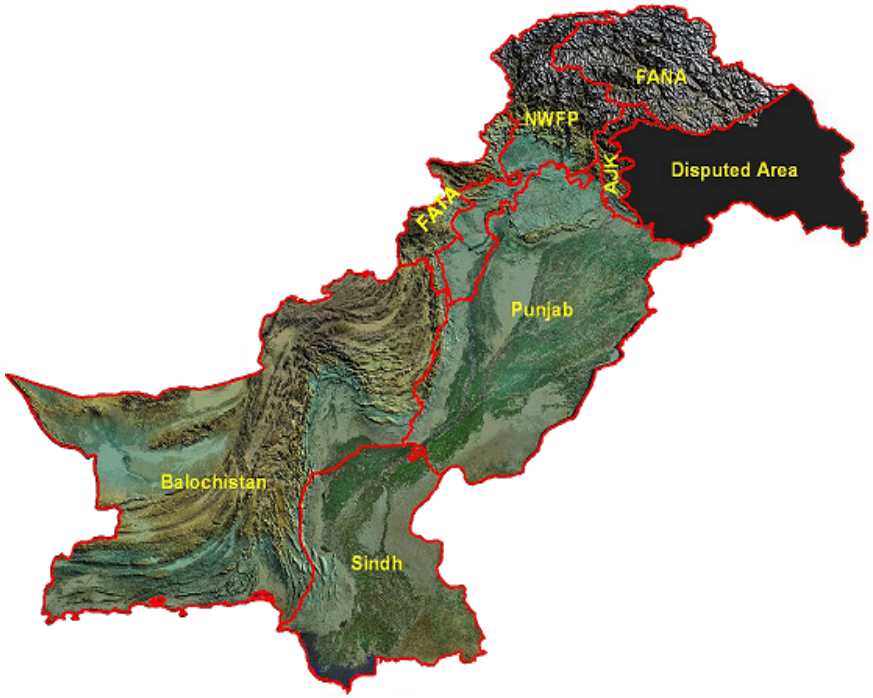
LAND USE ATLAS OF PAKISTAN



NATIONAL LAND USE PLAN PROJECT

Ministry of Environment
Government of Pakistan

Minister's Message

Preparation of Land Use Atlas of Pakistan is a major landmark for the Ministry of Environment and the country. I am happy to note that the National Land Use Plan Project has successfully completed this task which, in addition to immense value to the Ministry, also has great potential utility for other line ministries, and institutions dealing with environment and sustainable development.

The Atlas presents an integrated spatial database through Geographical Information System. Looking at the coverage of the Atlas, I see that it has wide utility ranging from interpreting the state of environment in the country to prediction of future climate change and desertification and for identification of areas prone to environmental risks and hazards.

The Atlas is the product of a combination of remote sensing and geographical information technologies. It opens a new era of analytical framework that would go a long way in promoting sustainable development in the country.

The preparation of the Atlas, however, is only the first step. There is a need to widely disseminate it to stakeholders in order to effectively utilize the information. I am glad that steps have already been taken by the Ministry to distribute CDs of the Atlas widely to its potential users.

Hameedullah Jan Afridi

Federal Minister for Environment

FOREWORD

The National Land Use Plan Project (NLUP) was launched by the Ministry of Environment in 2004 to undertake an inventory of land cover/land use and associated features in Pakistan through satellite imageries to collect and consolidate the digital data and utilize it effectively in environmental planning and management. A major output of the project is the Land Use Atlas of Pakistan. The Atlas covers a wide ranging area including land cover, forest, alpine pastures and rangelands, snow cover and water bodies, agricultural land and waste land. The themes and subthemes covered have been highlighted in the table placed at the beginning of the Atlas.

The Atlas holds a great promise for policy planning and implementation. It also establishes a database and a benchmark with a good overview of the contemporary situation. However, the land use changes in time and space, it is therefore important to continue the exercise so that temporal changes could be monitored for their sustainability. It is for the same reason that the Ministry wishes to continue the effort in future in association with the network of present institutions that collaborated with the Ministry in this endeavor as well as other relevant organizations.

The data for the Atlas has been obtained from a number of sources and collaborating organizations particularly those, which had conducted useful studies in the country on various aspects of land use including Space and Upper Atmosphere Research Commission (SUPARCO), National Agricultural Research Centre, International Water and Salinity Research Institute, Soil Survey of Pakistan, and Survey of Pakistan.

I would like to thank the collaborating organizations for providing the appropriate data. I would also like to thank the Director of NLUP and his team especially the GIS analyst for the hard and diligent efforts in compiling the related information. Last, but not the least, I would like to put on record my deep appreciation to the University of Peshawar, in particular Dr. Mohammad Aslam Khan, foreign faculty for his commendable effort in giving final shape to this Atlas.

I would welcome inputs and comments from the professionals, experts, scientists, and academicians for making the Atlas more useful.

Kamran Lashari

Secretary,
Ministry of Environment

Land Use Atlas of Pakistan

Table of Themes & Sub-Themes

Land Use / Land Cover						
Thematic Layers						
Administrative Areas	Land Use / Land Cover	Snow cover & Water Bodies	Forest	Pasture & Range Land	Agriculture	Waste Land
Pakistan	✓	✓	✓	✓	✓	✓
NWFP	✓	✓	✓	✓	✓	✓
Punjab	✓	✓	✓	✓	✓	✓
Balochistan	✓	✓	✓	✓	✓	✓
Sindh	✓	✓	✓	✓	✓	✓
Land Resources						
Administrative Areas	Elevation (Contours)	Soil Type	Soil Erosion	Water Logging & Salinity	Soil Salinity Sodacity	
Pakistan	✓	✓	✓	✓	✓	
NWFP	✓					
Punjab	✓			✓		
Balochistan	✓					
Sindh	✓			✓		

Water Resources

Administrative Areas	Rainfall			Snow cover & Water Bodies	Hydro-geological	Canal Command	Water Table Depth variability		Underground Water Quality
	Annual	Summer	Winter				June	October	
Pakistan	✓	✓	✓	✓	✓	✓	✓	✓	✓
NWFP				✓		✓	✓	✓	✓
Punjab				✓		✓	✓	✓	✓
Balochistan				✓		✓	✓	✓	✓
Sindh				✓		✓	✓	✓	✓

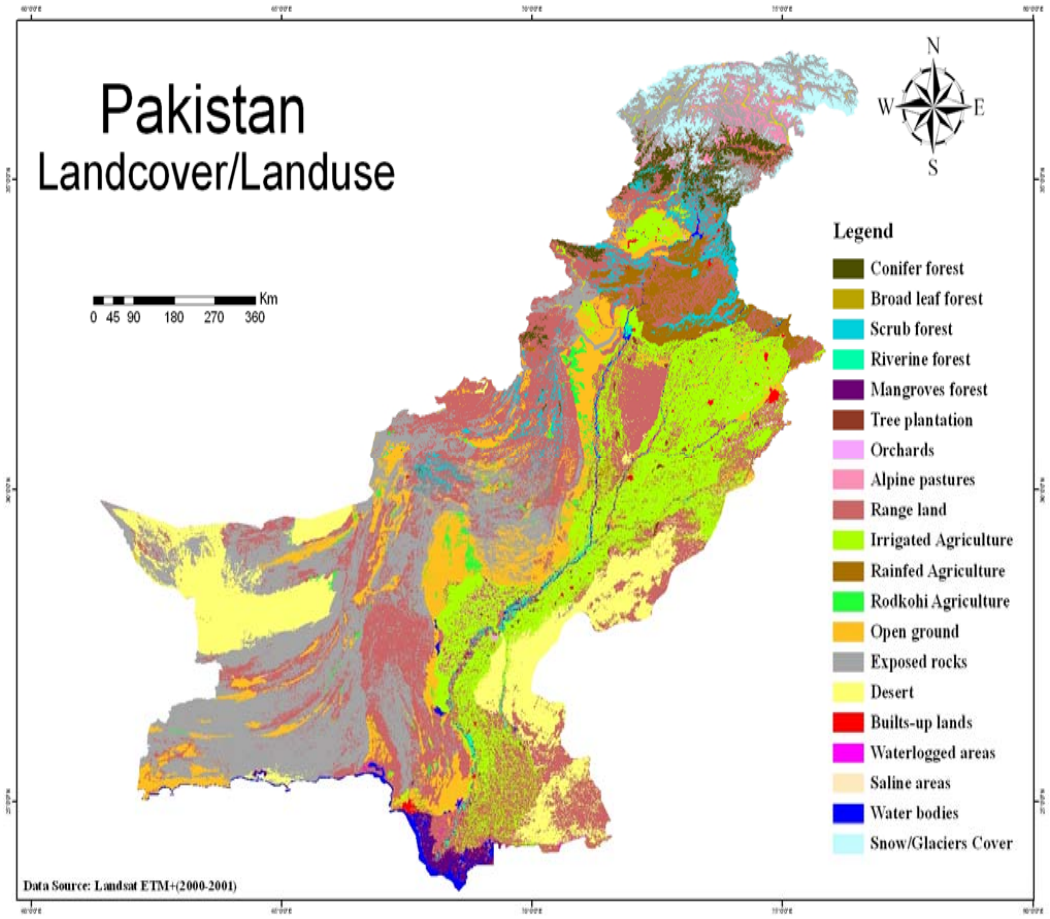
Agriculture

Administrative Areas	Aridity Classes			Crop Growth Classes			Cropping Pattern	Engro Ecological Zones	Water Logging & Salinity
	Annual	Kharif	Rabi	Annual	Kharif	Rabi			
Pakistan	✓	✓	✓	✓	✓	✓	✓	✓	✓
NWFP							✓	✓	
Punjab							✓	✓	✓
Balochistan							✓	✓	
Sindh							✓	✓	✓

Population & Human Settlements

Administrative Areas	Population Density	Human Settlements	Roads	Railway
Pakistan	✓	✓	✓	✓
NWFP			✓	✓
Punjab			✓	✓
Balochistan			✓	✓
Sindh			✓	✓

LAND COVER / LAND USE



1. Land cover/ Land use:

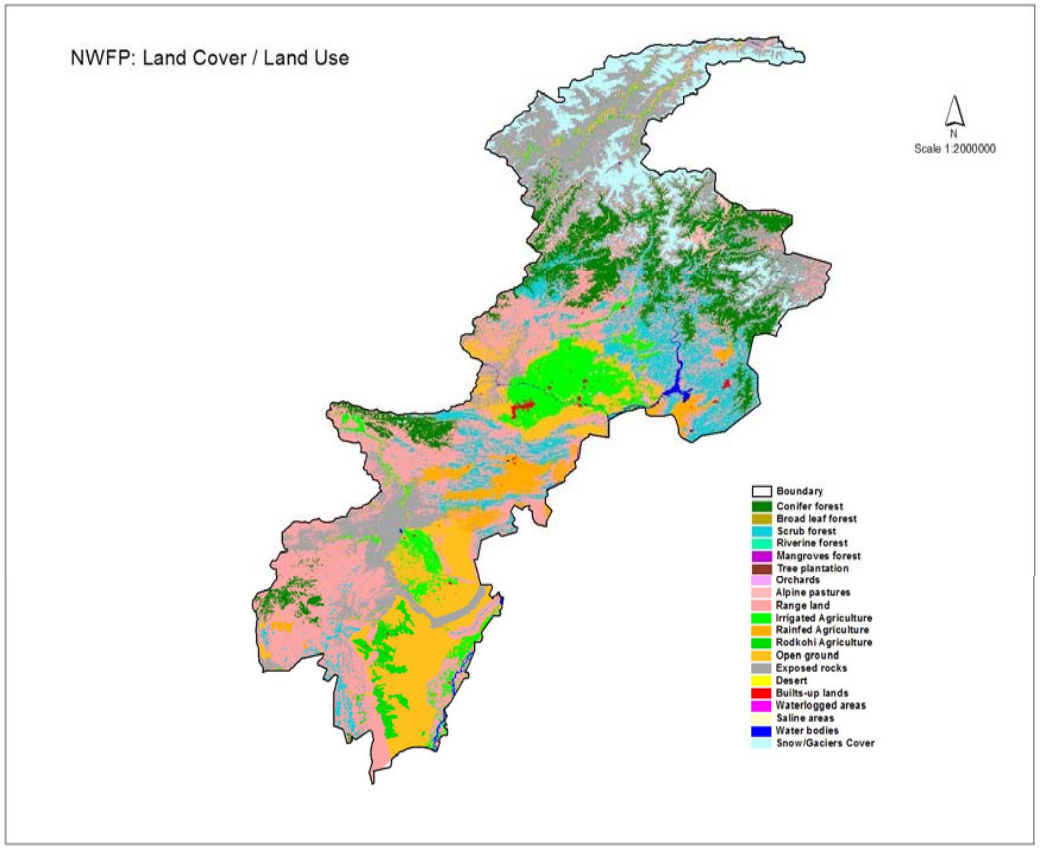
Pakistan

Land cover/land use classification using ten categories in Pakistan developed from Landsat ETM image data is shown in table below. Forest cover including scrub, riverain, mangroves and plantation is about 5 percent in the country. Agricultural land including irrigated, rainfed and rodkohi agriculture extracted from spectral reflectance of crop cover is about 20 percent. It does not include the fallow land which has been covered under open space/ground class (covering about 10% area of country). Rangelands covered over 27 percent areas, while rock outcrops occupied another quarter of the country. The snow/glacier coverage was recorded at about 2 percent. Deserts have about 10 percent area and other uses (built up area, waterlogged and saline land and water bodies together accounted for a little more than one percent). Patterns of land use in Pakistan have evolved through centuries and been influenced by environmental and physical factors such as landform, soil, climate, water availability etc. as well as human factors such as population size, growth, economic demands, and cultural practices or customs. The interprovincial variations clearly depict the influence of these factors. For example in NWFP and Northern Areas, which are comparatively high altitude hilly regions, with relatively higher rain show a higher level of snow and glacier coverage (13 percent), as compared to none in other provinces. Likewise NWFP also has higher forest coverage about 17 percent as against 4 Percent in Punjab, 1.5 percent in Balochistan and some 6 percent in

Sindh. Balochistan on the other hand has comparatively larger grazing area as in that province; besides rangeland even the exposed rocks during rains gets some vegetation cover, which provides forage for livestock. On the contrary, in the Punjab (about half the area of the Province) and Sindh (about a third area of the Province) agricultural land is predominant, primarily because of extensive system of canal irrigation which has developed through history and seen large expansion during British and post independence period.

Table: Pakistan: Land cover/Land use (000, hectares)

S.No	Land use/land cover	Balochistan	Sindh	NWFP	Punjab	Pakistan	%
1	Forest	508.1	848.3	2311.9	855.1	4523.4	5.4
2	Rangeland	9255.8	3961.1	3848.7	5385.7	22451.3	26.9
3	Agricultural land	822.2	4465.0	1174.1	10143.4	16604.7	19.9
4	Open Ground/ fallow	4494.7	911.5	1290.5	1618.8	8315.5	10.0
5	Exposed rocks	16425.1	201.4	3451.1	318.4	20396.0	24.5
6	Desert	3189.4	3140.8	-	1796.9	8127.1	9.7
7	Built- up area/land	6.7	90.2	26.4	196.6	319.9	0.4
8	waterlogged and saline land	15.2	294.3	0.2	130.4	440.1	0.5
9	Water bodies	1.8	178.9	57.1	179.8	417.6	0.5
10	Snow/Glaciers	-	-	1829.6	-	1829.6	2.2
	Total	34719.0	14091.4	13989.7	20625.1	83425.2	100.0

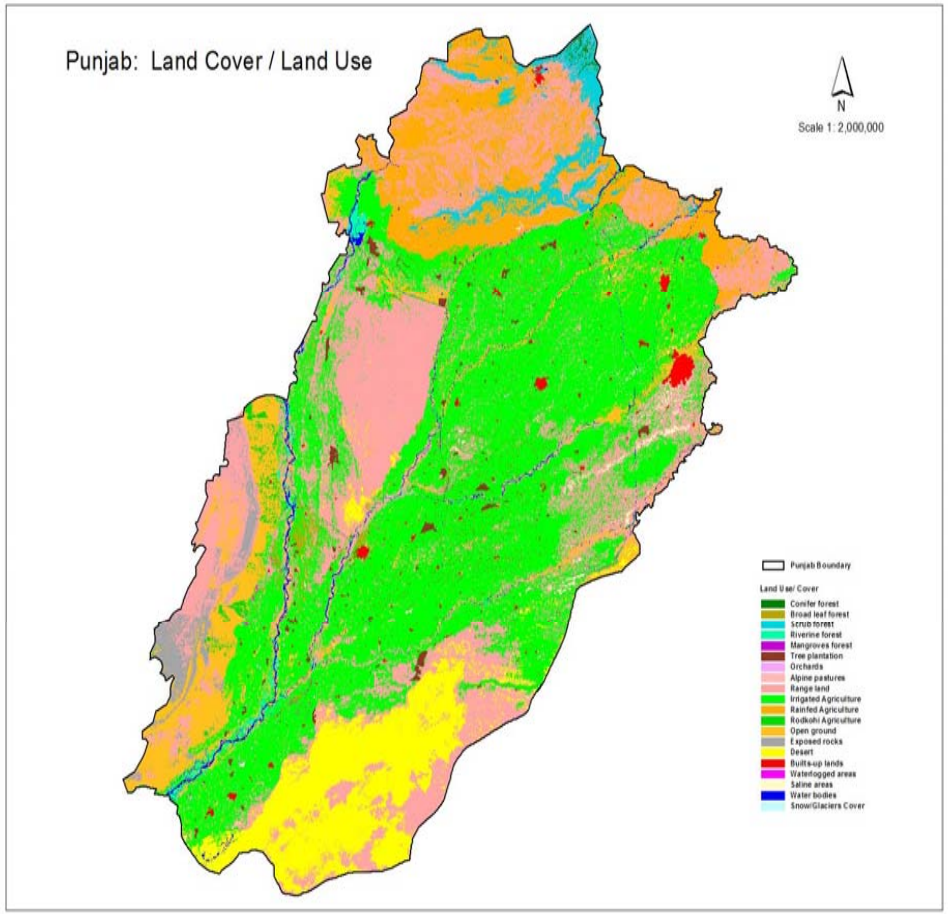


North West Frontier Province

The forest cover about 17 percent area of the province, out of which the conifers are predominant (9.8%) followed by Scrub forest (6.6%) in the province. The coniferous forests are present mainly in the northern mountainous area. Rangelands constitute another major land use type covering about 28% of the province followed by exposed rocks occupying a quarter area of the province. Agricultural land is around 8 percent covering the central and south eastern parts of the province, - mostly in the areas where irrigation facility is available. Current fallow or open ground is not included and accounts for about 9 percent share in the land use. The snow cover and glaciers are almost totally concentrated in the high altitude mountainous areas and account for about 13 percent of the province. Other lands including waterlogged and saline land, built up area and water bodies together occupy less than 1 percent area of the province.

Table: NWFP: Land cover /Land use

S.No.	Land cover/land use	Area (000' ha)	% age
1	Forest	2311.9	16.5
2	Rangeland	3848.7	27.5
3	Agricultural land	1174.1	8.4
4	Bare Soil/Current fallow	1290.5	9.2
5	Exposed rocks	3451.1	24.7
6	Built- up area/ land	26.4	0.2
7	Water logged and saline	0.2	0.0
8	Water bodies	57.1	0.4
9	Snow/Glaciers	1829.6	13.1
	Total	13989.7	100

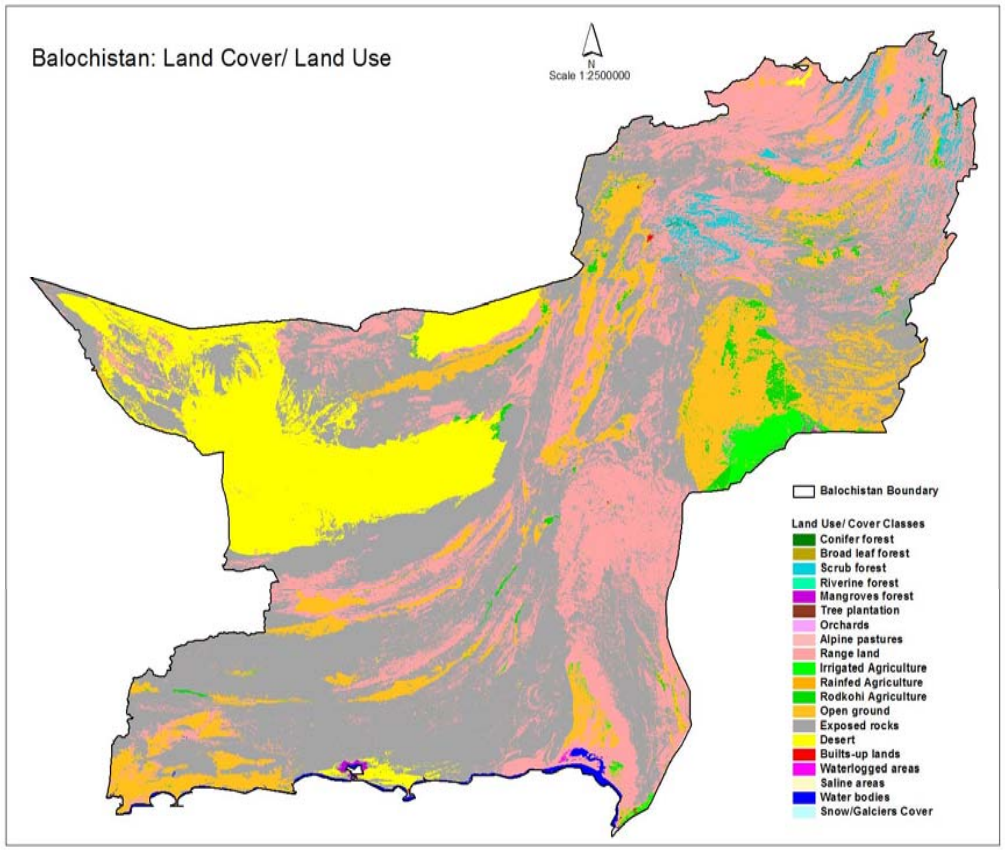


The Punjab

In Punjab the forest cover is limited, only about 4 percent. It is predominantly scrub forest (2%). Riverain and broad leave forests cover only 0.7% each. The coniferous forests are mainly present in the northern mountainous area. Almost half of the area of the Punjab province is under agricultural land use Irrigated agriculture is predominant and is mainly in the area drained by the Indus River and its tributaries. Rangeland is another major land use type covering about 27% of the province. Desert covers about 9% whereas open ground/current fallow account for a little more than 7% area. It is mainly concentrated along the foothills of the western mountains where Rod Kohi agriculture is practiced in patches. Within the irrigated areas are pockets of waterlogged and saline lands which as a whole account for some 0.6% of the provincial area.

Table: Punjab: Land cover/Land use

S.No.	Land cover/land use	Area (000' ha)	% age
1	Forest	855.1	4.2
2	Rangeland	5385.7	26.1
3	Agricultural land	10143.4	49.2
4	Bare soil	1618.8	7.9
5	Exposed rocks	318.4	1.5
6	Desert	1796.9	8.7
7	Built- up area/land	196.6	1.0
8	Waterlogged and saline	130.4	0.6
9	Water bodies	179.8	0.9
	Total	20625.1	100

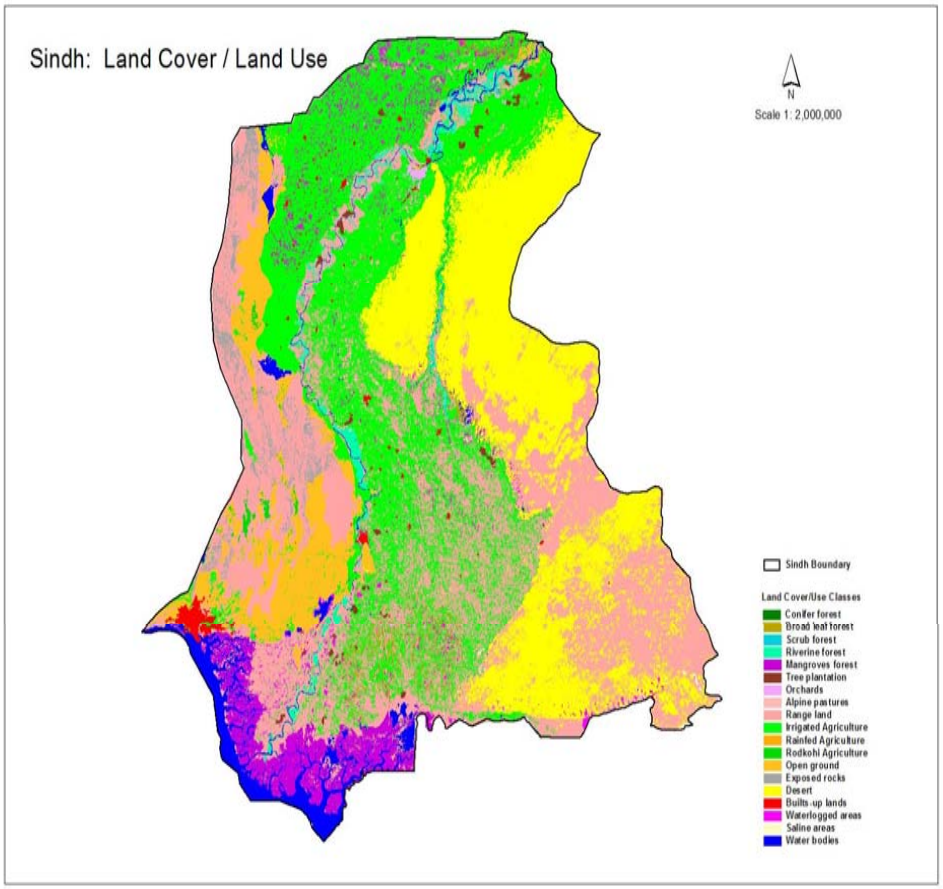


Balochistan

The forest cover is very limited – less than 2 percent area of the province. The major land use in Balochistan is rangeland. They constitute about 27% area of the province but the open grounds and exposed rocks which occupy another 47 percent area of the province are also used as grazing lands in wet seasons. They stretch over the vast mountainous ranges extending north to south, and in the south western parts as well as along the coastal belt of the province. In the north-western part of the province there are extensive desert areas (12.9%). Agricultural land is very limited, a little more than 2 percent. Irrigated agriculture is limited to the central-eastern part and covers only about1% of the area. Rod Kohi agriculture is practiced in the foothills of mountainous areas.

Table: Balochistan: Land cover /Land user

S.No.	Land cover/land use	Area (000' ha)	% age
1	Forest	508.1	1.5
2	Rangeland	9255.8	26.7
3	Agricultural land	822.2	2.4
4	Bare soil	4494.7	13.0
5	Exposed rocks	16425.1	47.3
6	Desert	3189.4	9.2
7	Built- up area/land	6.7	0.02
8	Waterlogged and saline	15.2	0.04
9	Water bodies	1.8	0.01
	Total	34719	100

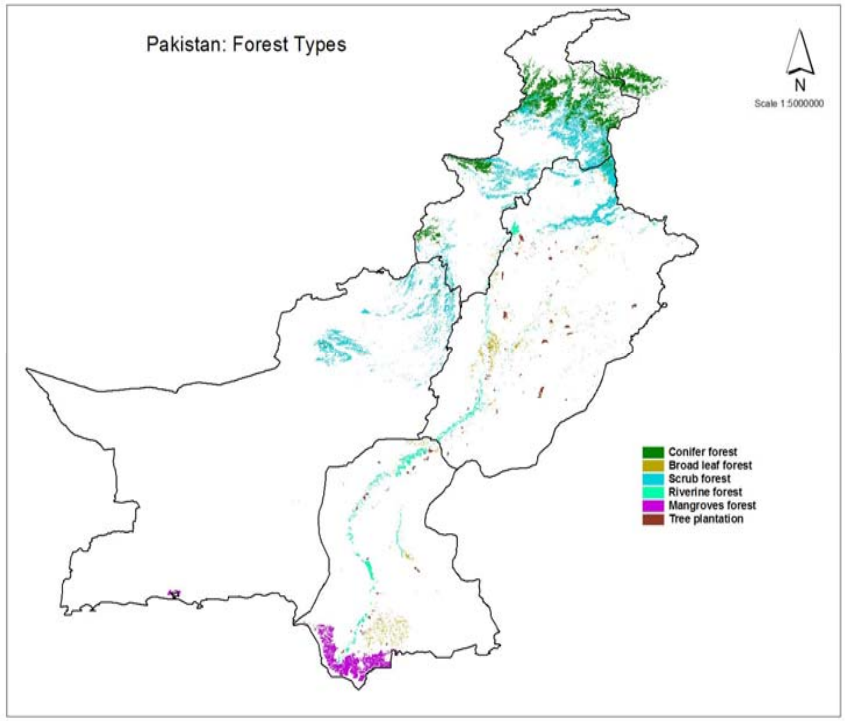


Sindh

Mangroves main forest types covering 3.5 % of the province (Table below). These are concentrated on Indus delta in the southern part of the province. Along the Indus River there are Riverain Forests covering an area of 1.4%. Tree plantation and orchards are mainly in the farm lands. The predominant agriculture is irrigated cultivation that covers 25.8% area of the province. Some Rod-kohi agriculture is also practiced in the province. Deserts in the west cover about 22% area of the province. Due to low gradient, water logging and salinity problem has occured and covers about 2% of the area in the province. There are big lakes besides the Indus River and, therefore, the area coverage of water bodies is 3.5%.

Table6: Sindh: Land cover /Land use

S.No.	Land cover/land use	Area (000' ha)	% age
1	Forest	848.3	6.0
2	Rangeland	3961.1	28.1
3	Agricultural land	4465.0	31.7
4	Bare soil	911.5	6.5
5	Exposed rocks	201.4	1.4
6	Desert	3140.8	22.3
7	Built- up area/land	90.2	0.6
8	Waterlogged and saline	294.3	2.1
9	Water bodies	178.9	1.3
	Total	14091.4	100



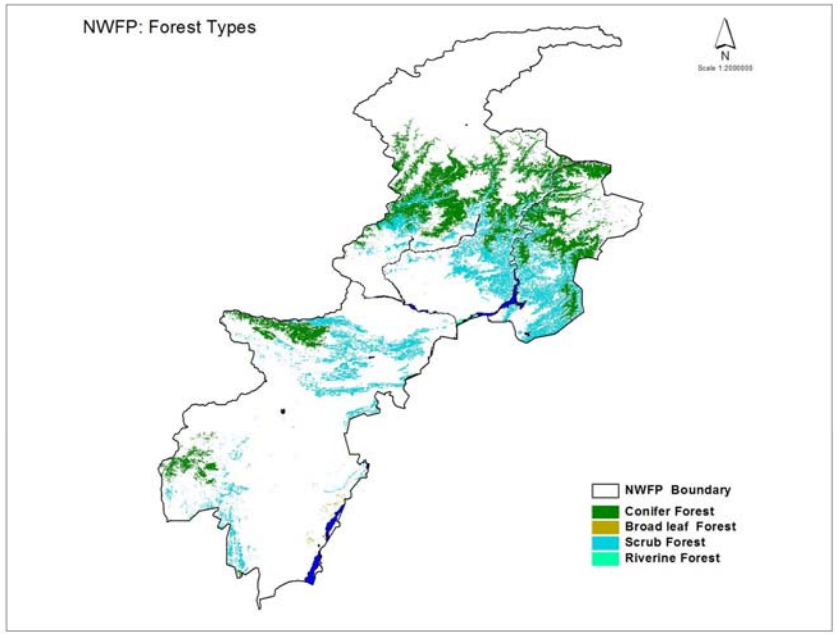
1.1. Forest

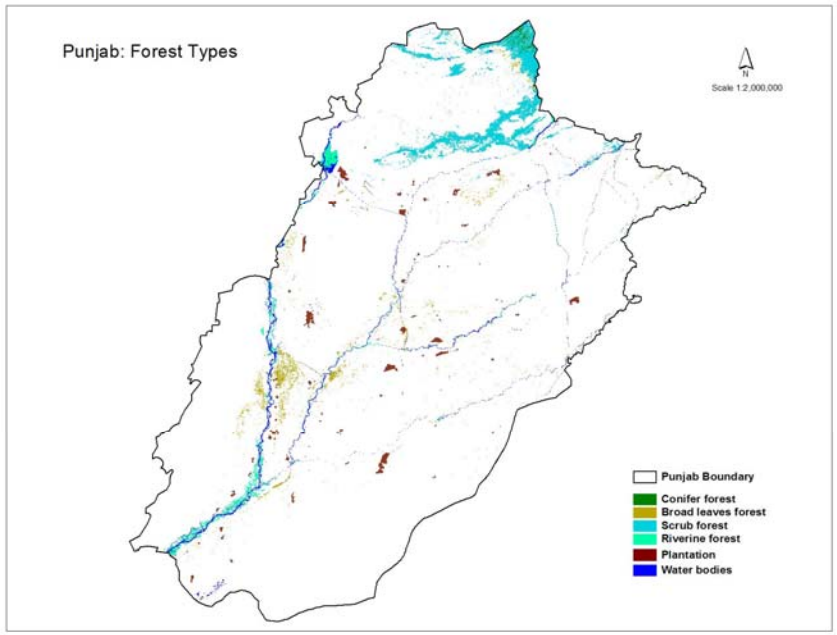
To identify the major plant associations/communities of natural vegetation, the image classification was verified by extensive field visits. Besides national scale, the classification was done at provincial level and four maps representing each province were completed.

Pakistan is poor in forest resources. Province wise NWFP has the highest percentage area under forests followed by Sindh, the Punjab and NWFP. The major forest types in Pakistan include the coniferous forests, broad leave, Riverain, scrub and mangrove forests.

Conifer Forest

Conifer forest is situated in ecozones named sub tropical pine forests, montane moist temperate forests, dry temperate forests and subalpine/alpine forests. The range is found in Kashmir, Dir, Swat, Chitral, the Gilgit Agency and Hazara. The main commercial tree species found are Chir pine (*Pinus roxburhii*), Blue pine (*Pinus wallichiana*), Deodar (*Cedrus deodara*), Fir (*Abies pindrow*), Spruce (*Picea smithiana*) and Chilgoza (*Pinus gerardiana*). Chir pine occurs between 1000 m and 1800m in Azad Kashmir, Punjab and NWFP in the sub-tropical pine forests. The moist temperate, dry temperate and sub-alpine/alpine forests are situated between 1800 m and 3300 m on much steeper slopes.





Broad Leaved Forest

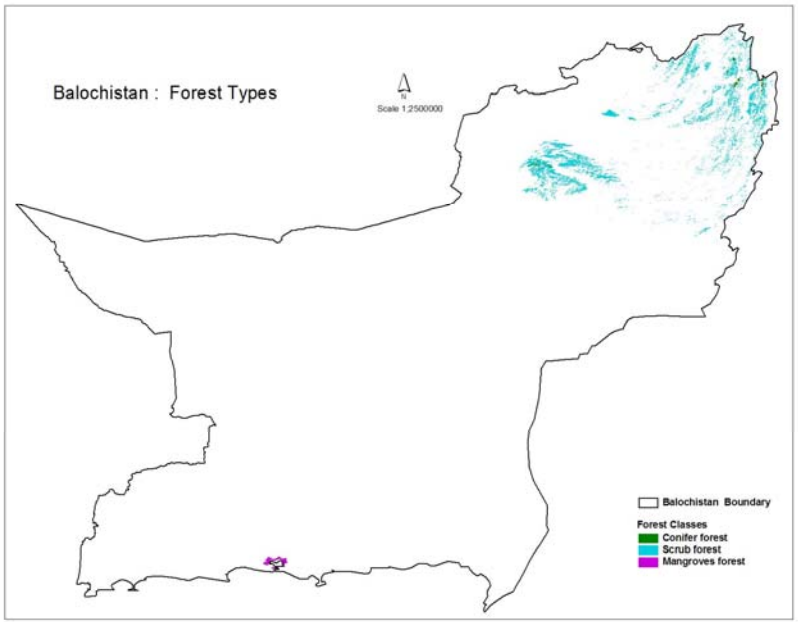
The tree cover often thorny with small evergreen leaves generally lies on hilly to plain areas of the country. It provides fuel wood for local consumption and forage for the domestic and wild animals. Some of the tree species include Phulai (*Acacia modesta*), Ber (*Zizyphus mauritiana*), Kachnar (*Bauhinia racemosa*), Kikar (*Acacia nilotica*), etc.

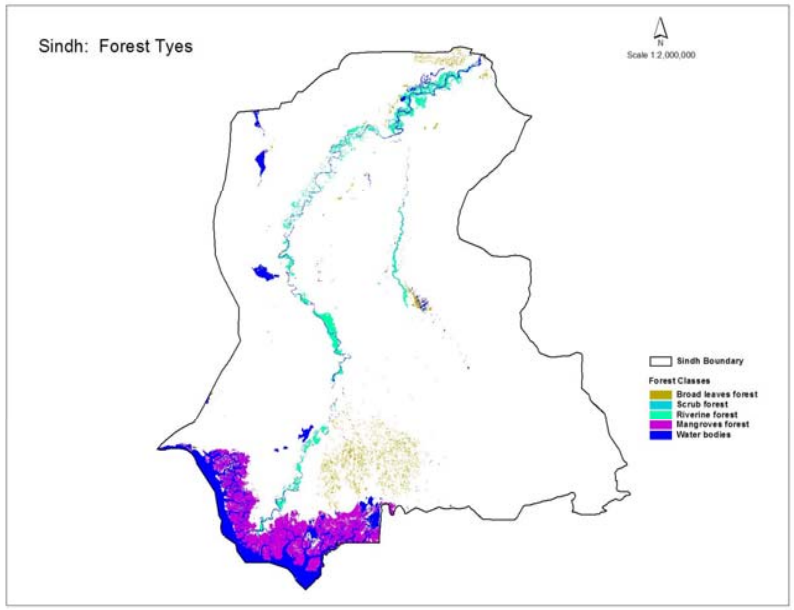
Riverain Forest

These forests grow in the active flood plains of Indus river system from the foothills to Arabian Sea. They occur mainly in the Punjab and Sindh. The main indigenous species are Kikar (*Acacia nilotica*), Jand (*Prosopis cineraria*), Obhan (*Populus euphratica*), Khagal (*Tamarix articulata*) and Shisham (*Dalbergia sissoo*)

Scrub Forest

These are generally semi-evergreen forests that exist in the dry subtropical zone on altitudes varying from 500 m to 1800 m. Covering a wide geographic range latitudinally, they are best sub-divided into southern and northern zones. In the southern zones they occupy lower valleys of Baluchistan, eastern or outer fringes of North Waziristan, and Khyber and Mohmand





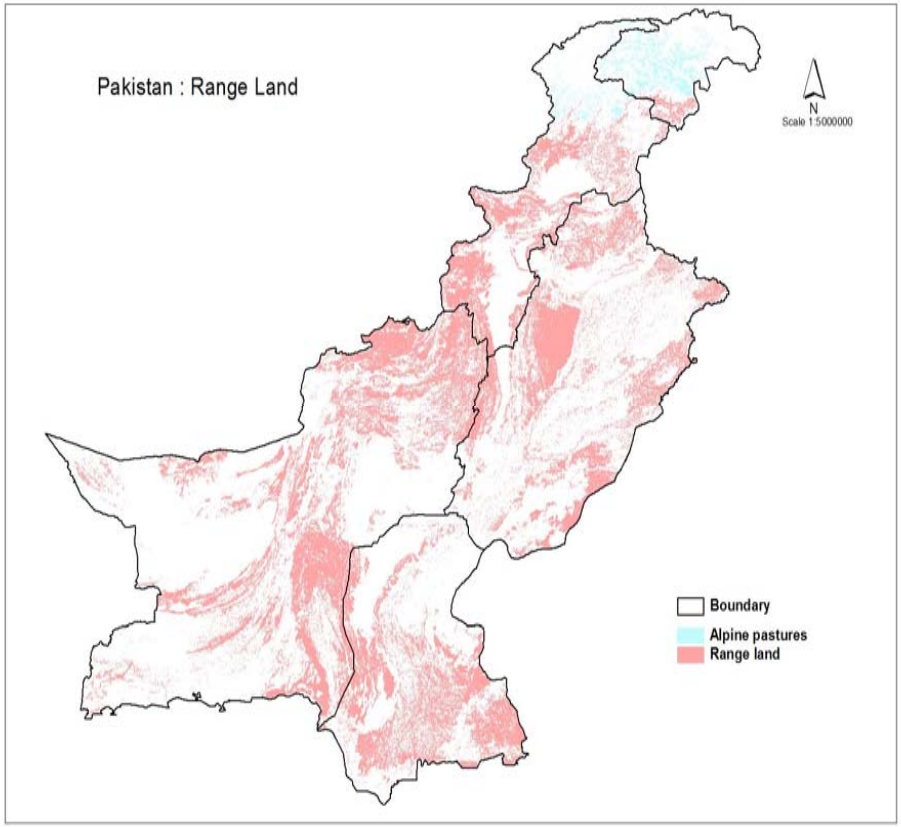
Agencies. In the northern zone, they occupy the lower slopes in the southern part of Chitral, Dir, Malakand Agency and Kohistan and parts of Upper Punjab. The characteristic trees are Olive or Kau (*Olea cuspidata*), Phulai (*Acacia modesta*), Amaltas (Cassia fistula) and Ber (Zizyphus mauritiana) etc.

Mangrove Forest

More or less dense forest; mangroves are of very low average height, often 3-7 meter high. They are found on the muddy coast of the Arabian Sea along parts of Sindh and Baluchistan. Extremely important as habitat for fish and marine life, these are being degraded due to intrusion of sea water, pollution and deforestation.

Plantations

Plantations especially the irrigated plantations constitute the most important man-made forest type in Pakistan. These are the main source of revenue earning in the Punjab and Sindh. Some of the main species grown are Shisham (*Dalbergia sisso*), Mulberry (*Morus alba*), Poplar (*Populus euramericana*), Eucalyptus (*Eucalyptus camaldulensis*), Kikar (*Acacia nilotica*) and Bakain (*Melia azedarach*).



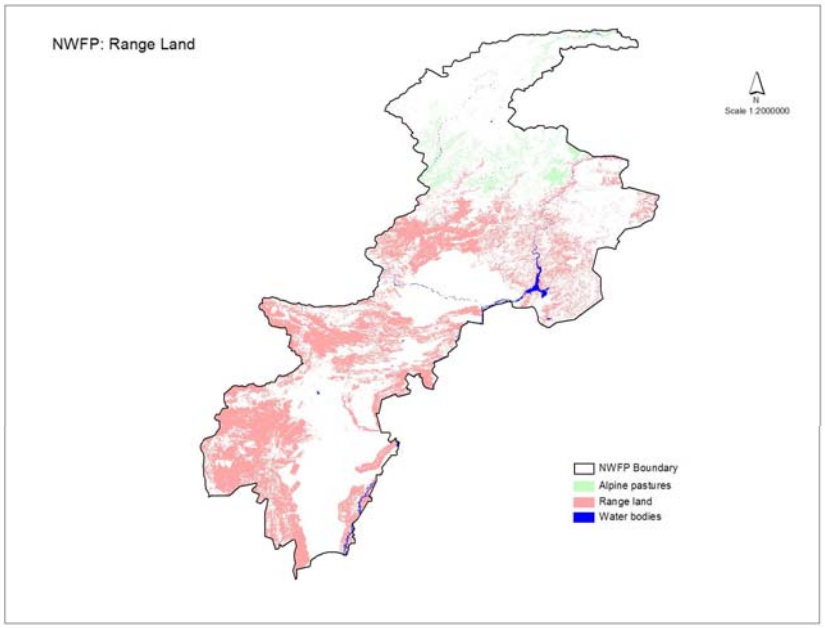
1.2. Alpine Pastures and Rangelands

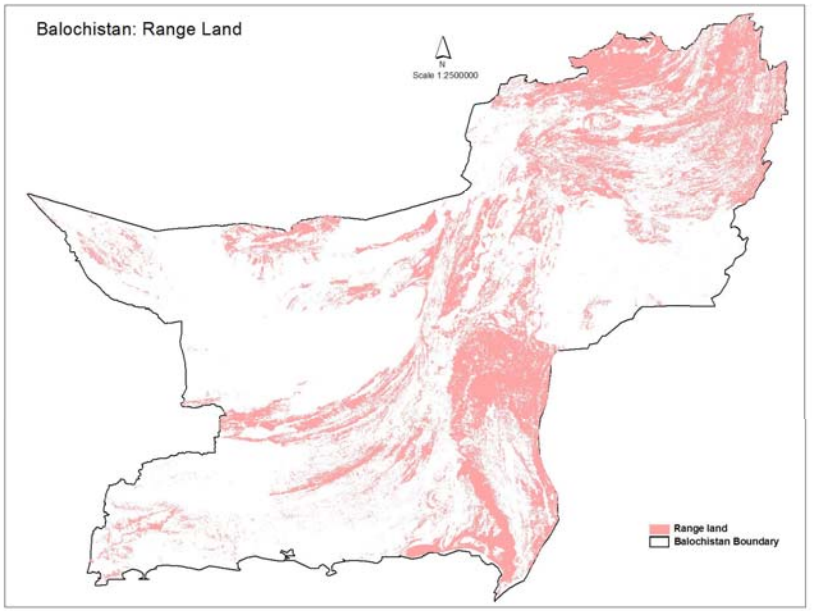
Alpine Pastures

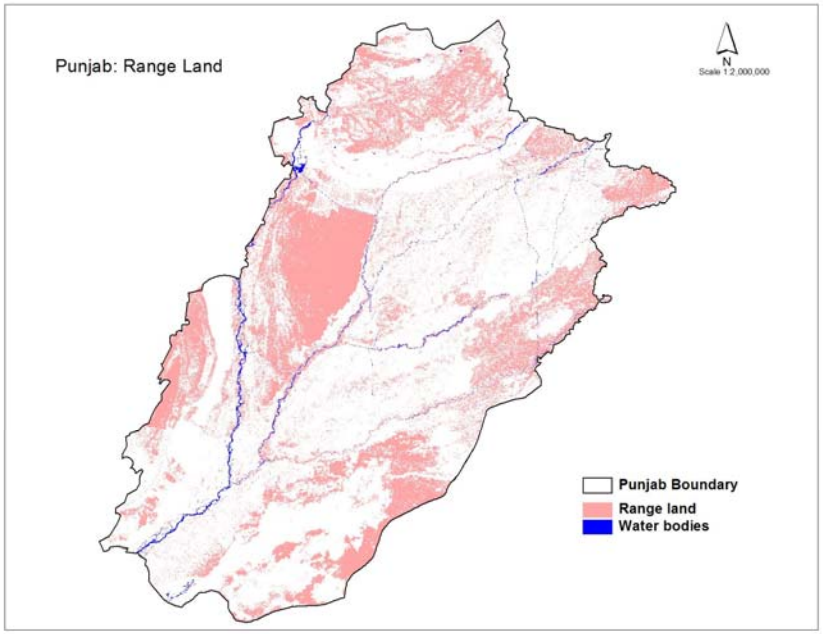
Important for summer grazing, these are generally but not always found above the birch zone and in patches, sometimes extensive within it, probably conditioned by edaphic and biotic factors.

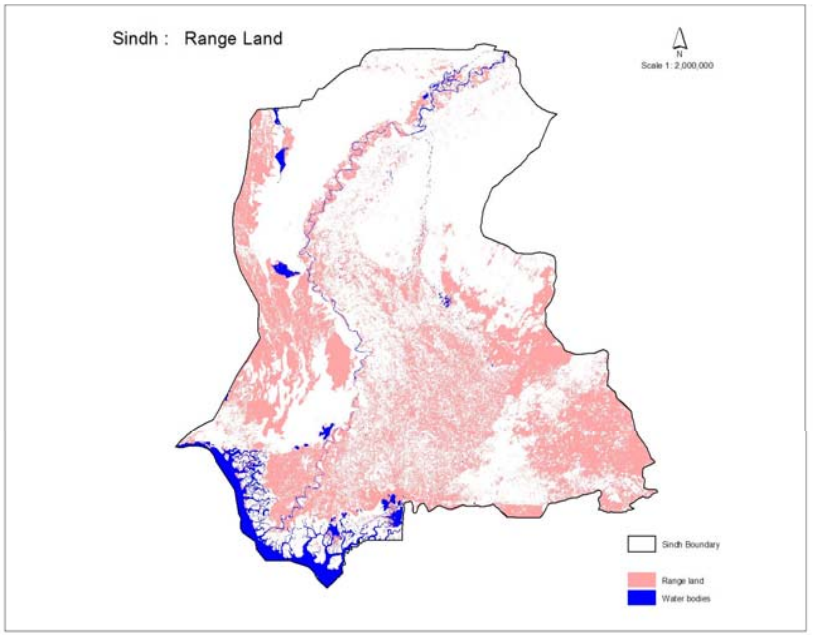
Rangelands

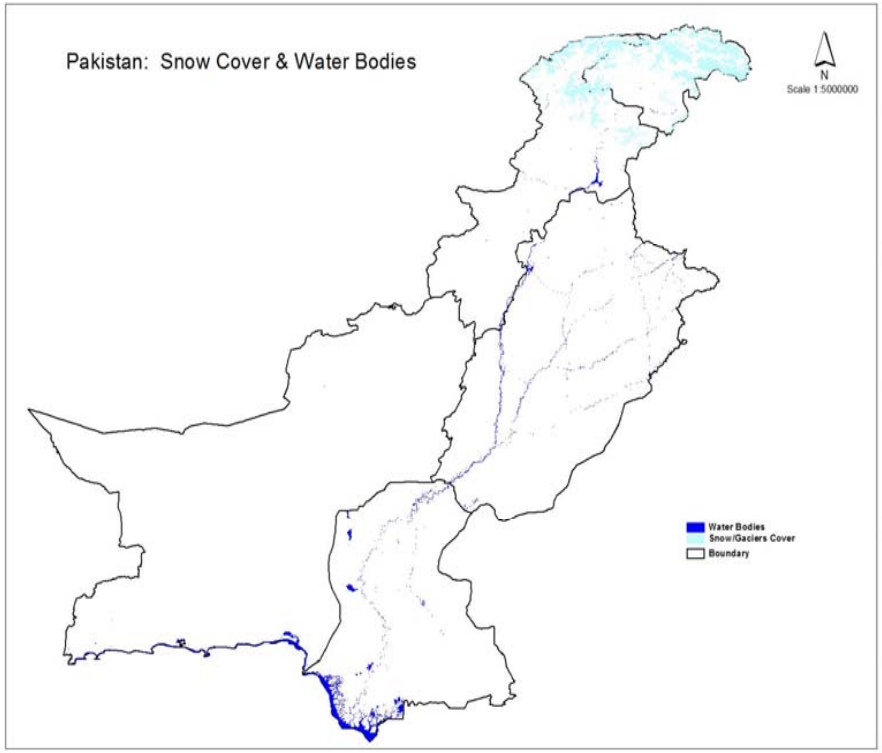
Pakistan has some 22.5 million hectares of range land. Balochistan has the largest share followed by Punjab, Sindh and N.W.F.P respectively. According to Biodiversity Action Plan for Pakistan, 90% of the rangeland has been degraded. Degradation of rangeland reduces the diversity of flora and changes the vegetative composition. Increased competition for grazing affects wild herbivore populations (rodents, lagomorphs and ungulates) and the reduced pray base can then only support smaller population of predators.


NWFP: Range Land
N
Scale 1:2000000
NWFP Boundary
Alpine pastures
Range land
Water bodies


Balochistan: Range Land
N
Scale 1:2500000
Range land
Balochistan Boundary


Punjab: Range Land
N
Scale 1:2,000,000
Punjab Boundary
Range land
Water bodies


Sindh : Range Land
N
Scale 1: 2,000,000
Sindh Boundary
Range land
Water bodies

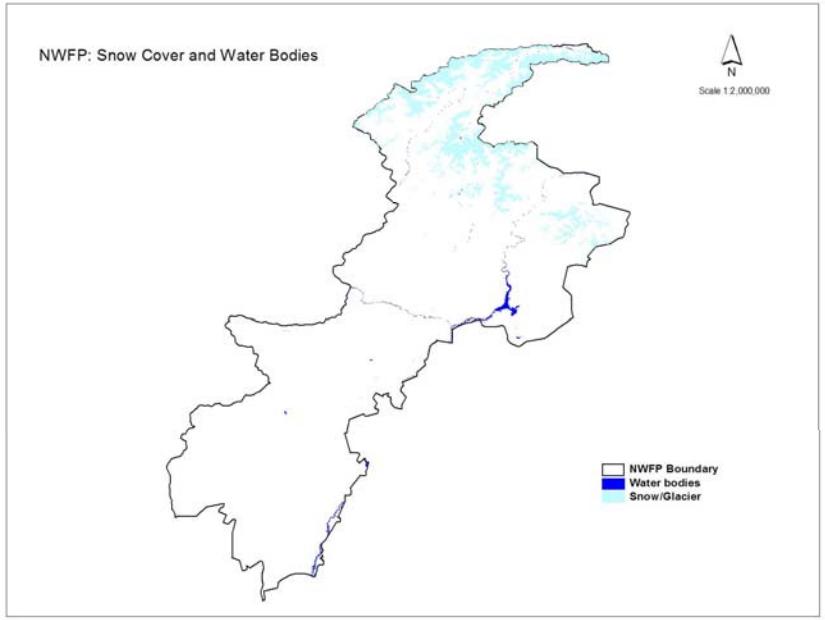


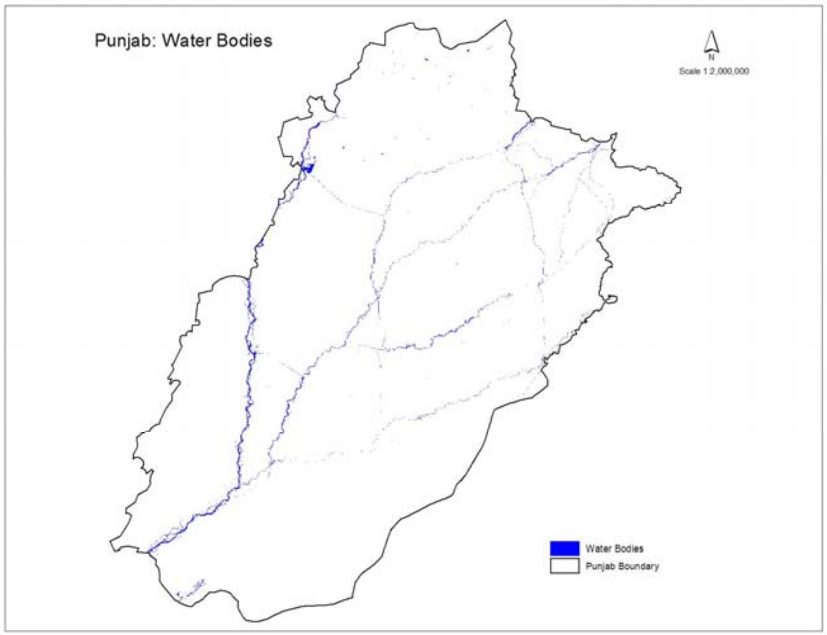
1.3. Glaciers, Snowfields and Water bodies

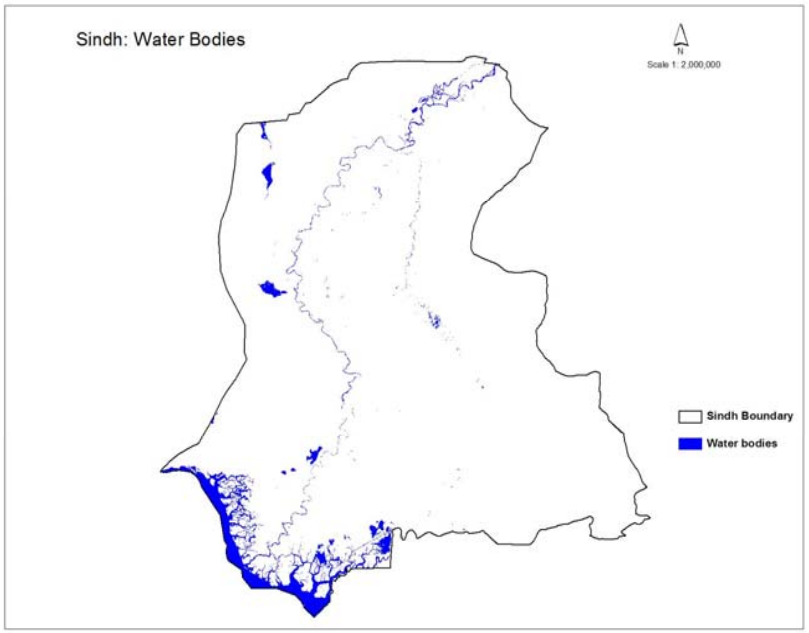
In Pakistan, there are more glaciers than any other land outside the north and south poles. The glacial area of the country covers some 13,680 sq. km which represents an average of 13 per cent of mountain regions of the upper Indus Basin. Baltistan in the north eastern corner and in the heart of Karakorum provides the world's most magnificent mountain scenery and glaciers and snowfield.

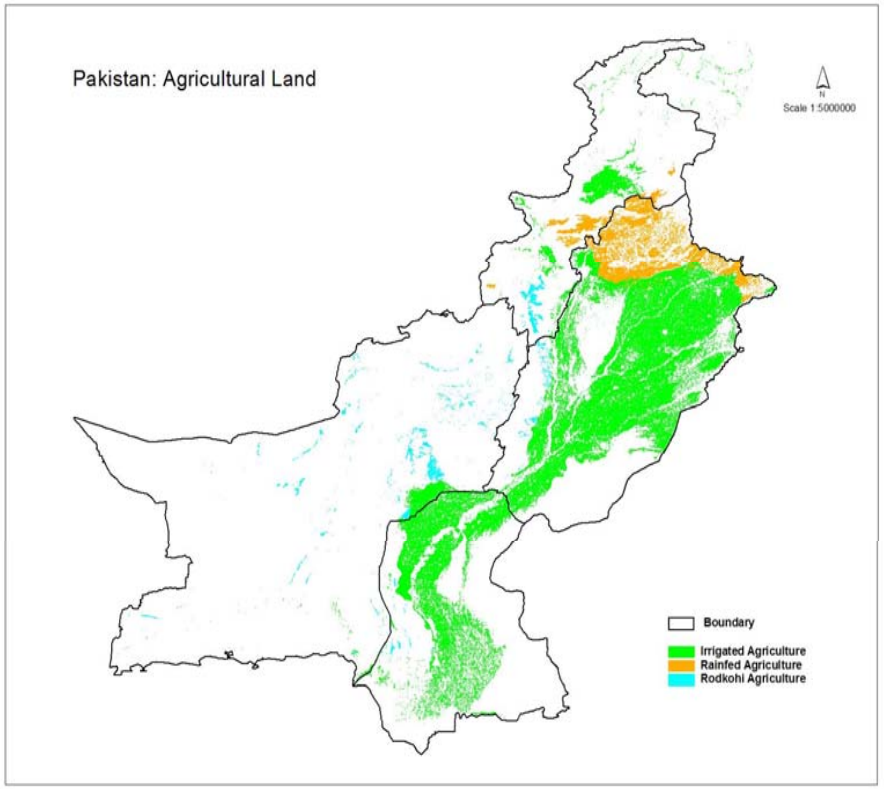
The glaciers in Pakistan can rightly claim to possess the greatest mass and collection of glaciated space on the face of earth. In fact, in the lap of Karakorum Mountains alone there are glaciers, the total length of which would add up to about 6,160 sq. km. To put it more precisely, as high as 37 per cent of the area of Karakorum is under its glaciers against Himalayas' 17 per cent and European Alps' 22 per cent. The Karakorum has one more claim to proclaim; its southern flank (east and west of the enormous Biafo glacier) has a concentration of glaciers which constitute about 59 per cent of the area.

The glaciers and snowfields feed the Pakistan's irrigation system, one of the biggest in the world. The longest and the largest river in Pakistan is the Indus River, which is also called the 'Lifeline of Pakistan', as the river and its tributaries are the largest water source in Pakistan. Around two-thirds of water supplied for irrigation and in homes comes from the Indus and its associated rivers. The tributaries of Indus River are Jhelum, Chenab, Ravi, Sutlej, Kabul, Swat and Chitral Rivers. Other tributaries include Astore. Gilgit, Gomal, Kurrum, Shigar, Shyok and Soan Rivers. Pakistan is also home to several natural and man-made lakes and reservoirs. The largest lake in Pakistan is the Manchar Lake, which is also the largest lake in South Asia. The lake is spread over an area of over 160 square Kilometres.


NWFP: Snow Cover and Water Bodies
N
Scale 1:2,000,000
NWFP Boundary
Water bodies
Snow/Glacier


Punjab: Water Bodies
N
Scale 1:2,000,000
Water Bodies
Punjab Boundary


Sindh: Water Bodies
N
Scale 1: 2,000,000
Sindh Boundary
Water bodies



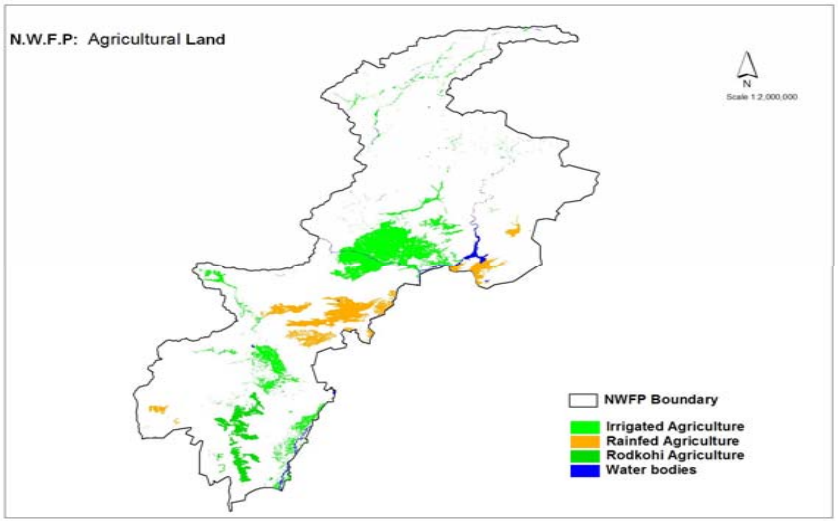
1.4. Agricultural Land Use

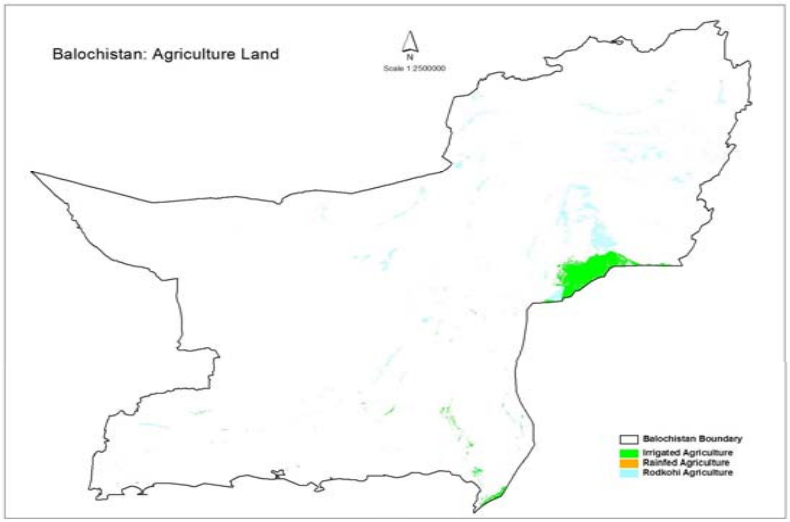
Agriculture constitutes the largest sector of Pakistan's economy. Majority of the population in the country, directly or indirectly, depends on this sector. It contributes about 24 percent of Gross Domestic Product (GDP) and accounts for half of employed labour force and is the largest source of foreign exchange earnings. The food security in the country is dependent on this sector. Realizing its importance, planners and policy makers are always keen to have reliable statistics showing various types of land use as well as area and production of agricultural crops well in time to assess the food situation in the country.

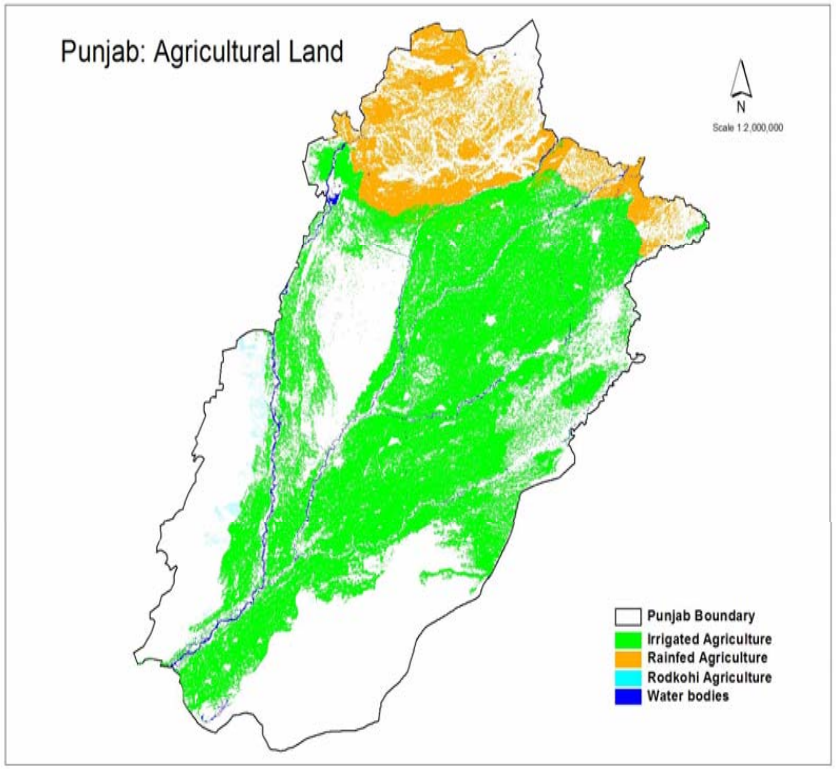
The spatial distribution of agricultural land use is also very important to assess the potential of agricultural land viz-a viz other factors such as landforms, soil type, soil erosion as well as water resources availability. The accompanying maps of Pakistan and the provinces show agricultural land use in Pakistan.

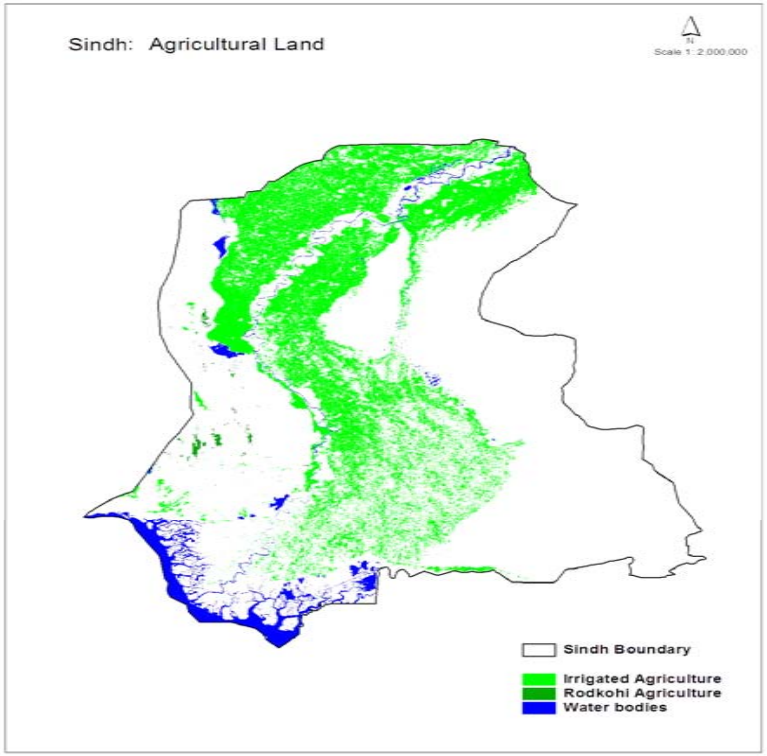
Among provinces, the leadership of the Punjab in cultivated area is based upon the vast alluvial plains and extensive irrigational facilities. On the other hand Balochistan possessing the largest land area has the smallest cultivated area due to rugged topography, intense aridity and limited irrigation facilities. Sindh and NWFP occupy third and fourth position in terms of land area. The proportion of cultivated area in Sindh is also comparatively high due to presence of flat area or plains and available irrigation facilities.

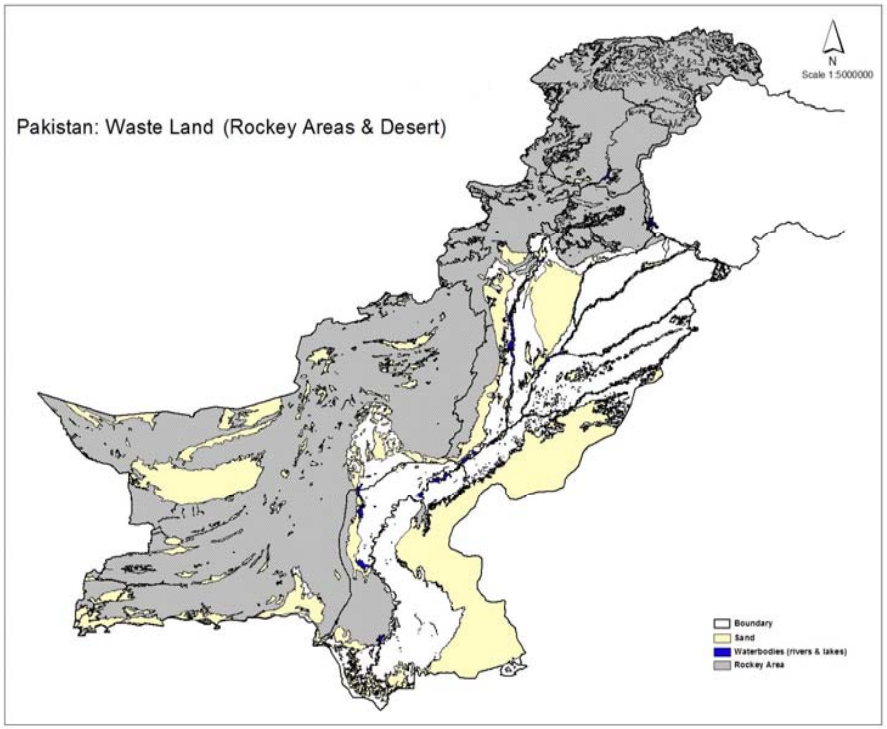
One noteable feature of agricultural land use in Pakistan is an increase in area sown more than once. It has increased almost five times since independence.


N.W.F.P: Agricultural Land
N
Scale 1:2,000,000
NWFP Boundary
Irrigated Agriculture
Rainfed Agriculture
Rodkohi Agriculture
Water bodies


Balochistan: Agriculture Land
N
Scale 1:2500000
Balochistan Boundary
Irrigated Agriculture
Rainfed Agriculture
Rodkohi Agriculture


Punjab: Agricultural Land
N
Scale 1:2,000,000
Punjab Boundary
Irrigated Agriculture
Rainfed Agriculture
Rodkohi Agriculture
Water bodies

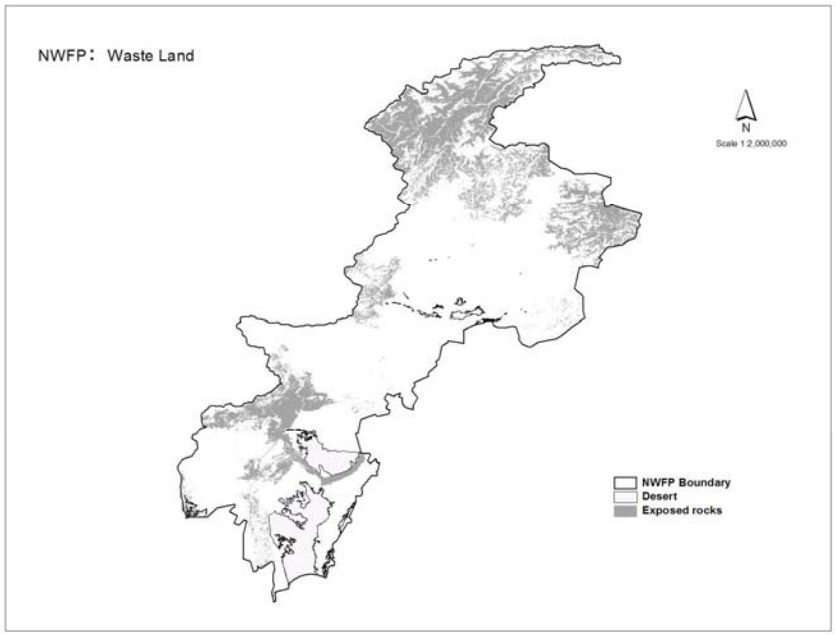

Sindh: Agricultural Land
N
Scale 1: 2,000,000
Sindh Boundary
Irrigated Agriculture
Rodkohi Agriculture
Water bodies

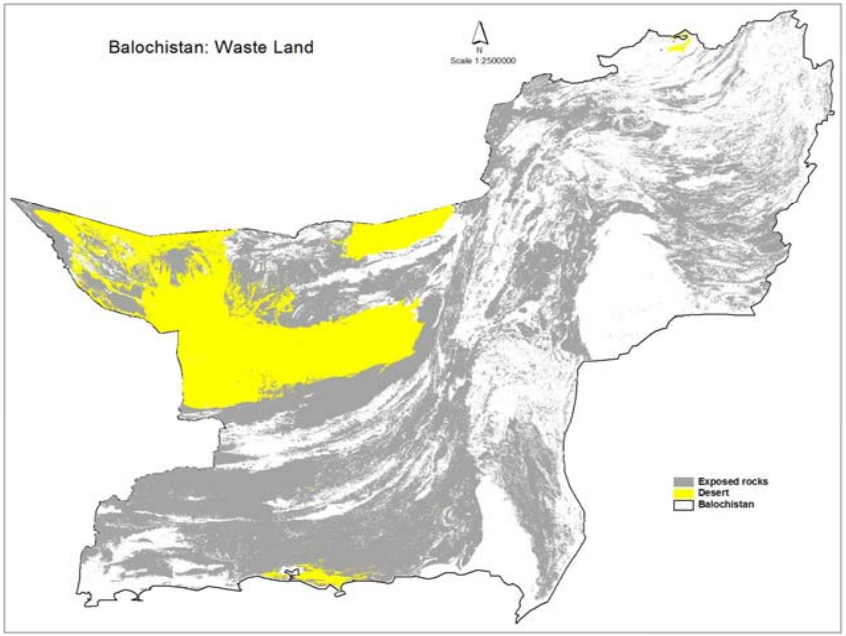


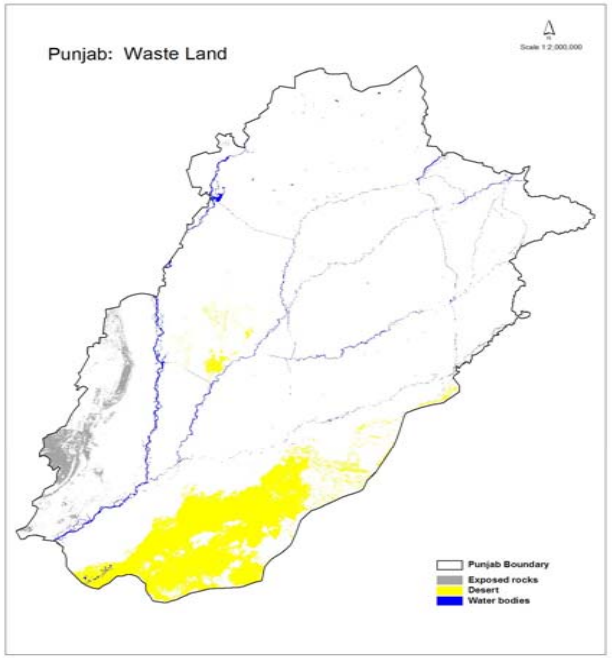
1.5. Waste land

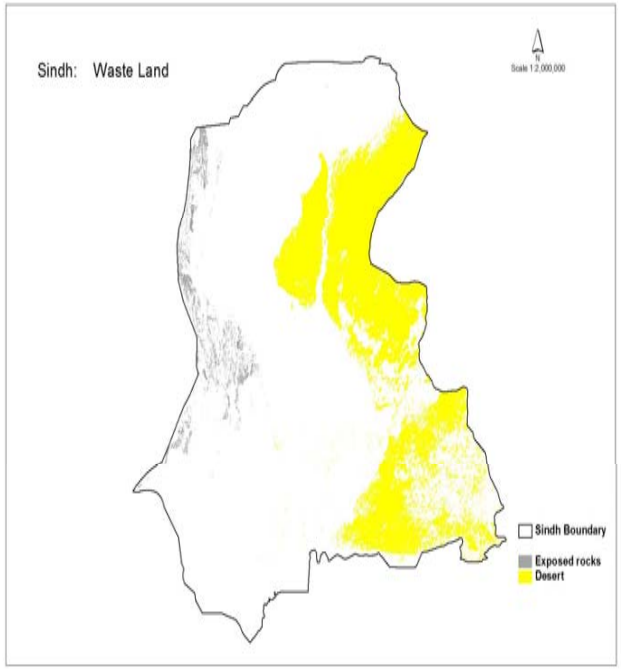
A considerable area of Pakistan is rugged and rocky or comprise of deserts. In the north (Federally Administered Northern Areas and north of NWFP) is most complex mountainous zone, where much of the area is waste land with lofty mountain peaks and steep slopes. Human settlements and agriculture are confined here to narrow river valleys like Gilgit, Astore, Swat, and Chitral. To the South of Complex mountainous north, topography becomes less rugged and mountainous but still pose a challenge in the wake of deficient rainfall or aridity. Together these factors contribute to the vast area of wasteland in NWFP and Baluchistan

In drier areas of the Punjab and Sind, deserts have existed for a long time. People of Pakistan have been able to reclaim some parts of these deserts such as in Thal through irrigation but still some large parts of Pakistan are deserts including Thar – Cholistan Desert occupying the eastern part of the country in Sind and the Punjab provinces. In Balochistan, Kharan Desert spreads over the western area of the province.

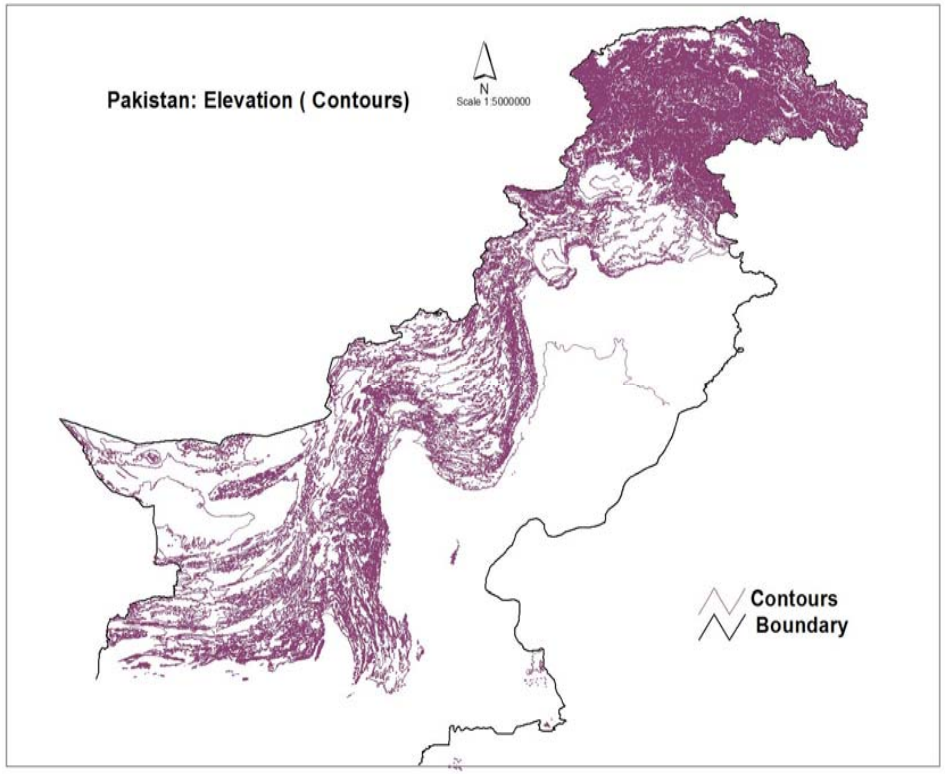

NWFP： Waste Land
N
Scale 1:2,000,000
NWFP Boundary
Desert
Exposed rocks


Balochistan: Waste Land
N
Scale 1:2500000
Exposed rocks
Desert
Balochistan


Punjab: Waste Land
Scale 1:2,000,000
Punjab Boundary
Exposed rocks
Desert
Water bodies


Sindh: Waste Land
Scale 1:2,000,000
Sindh Boundary
Exposed rocks
Desert

LAND RESOURCES



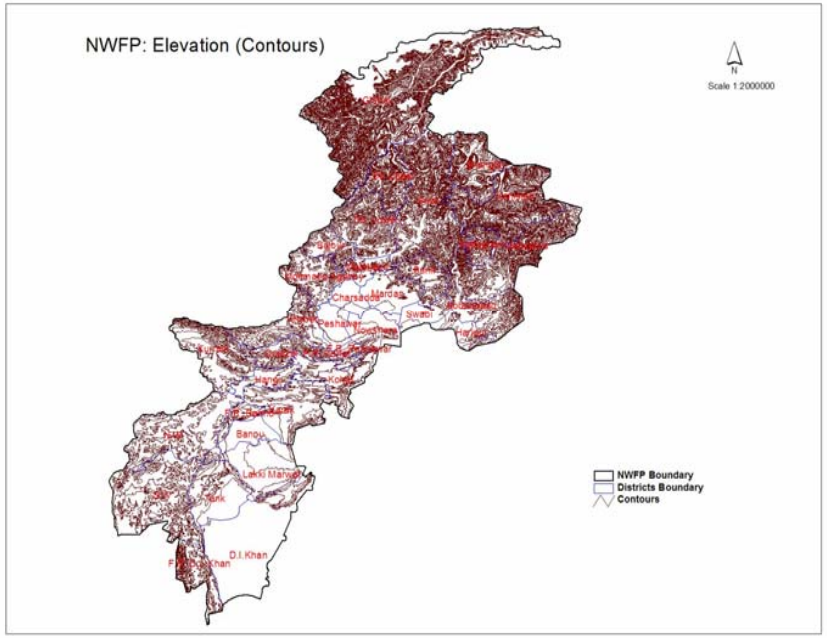
2.1. Land Forms

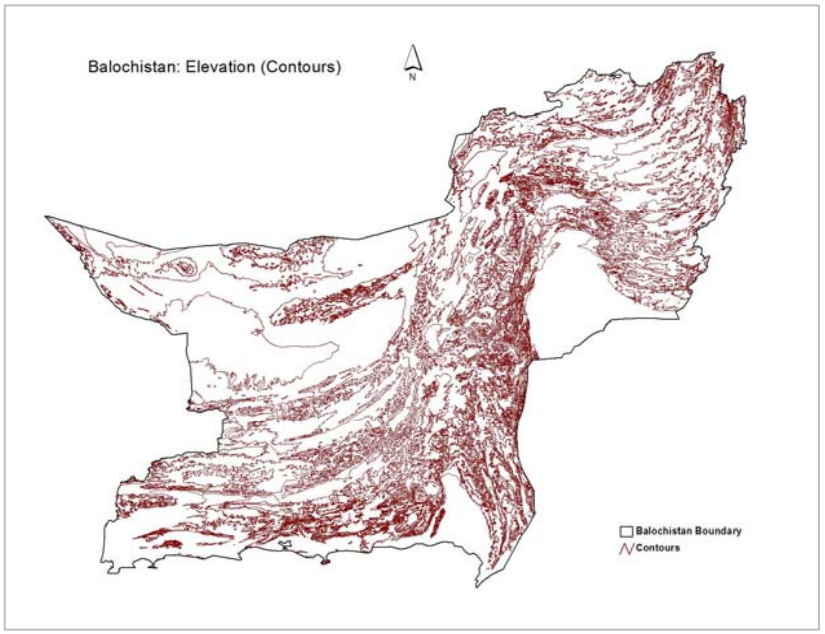
Pakistan is blessed with a varied landscape. There are high mountains, flat plains, barren deserts, valleys, and plateaus. The mountains lie in the Northern Areas and along the western borders. In the north three mountain ranges the Himalayas, the Karakorum and Hindukush meet. The Karakorum Mountains have some of the highest peaks in the world including K-2 at the height of 8611 meters, nest to Mt. Everest only. Nanga Parbat is the second highest peak in the Himalayas at 8126 meters. The average heights of these mountains vary between 3000 to 4800 meters above the sea level. However, the area has the largest concentration of high mountains in the world with over 121 peaks. It also has some of the longest glacier outside the Arctic region.

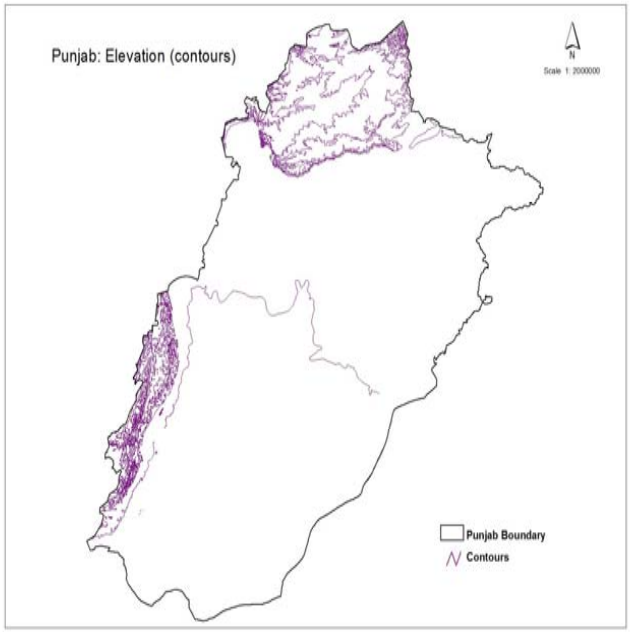
Along the west are other smaller mountain ranges like Suleiman Range, Salt Range, Koh Safaid, Toba Kakar Range, Kirthar Range, and Makran Coast Range. Apart from the mountains there are two important plateaus, the Balochistan plateau as well as the Potwar plateau. The later is located in the north eastern Punjab. There are also inter mountain valleys including Swat, Chitral, Peshawar, and Bannu valleys.

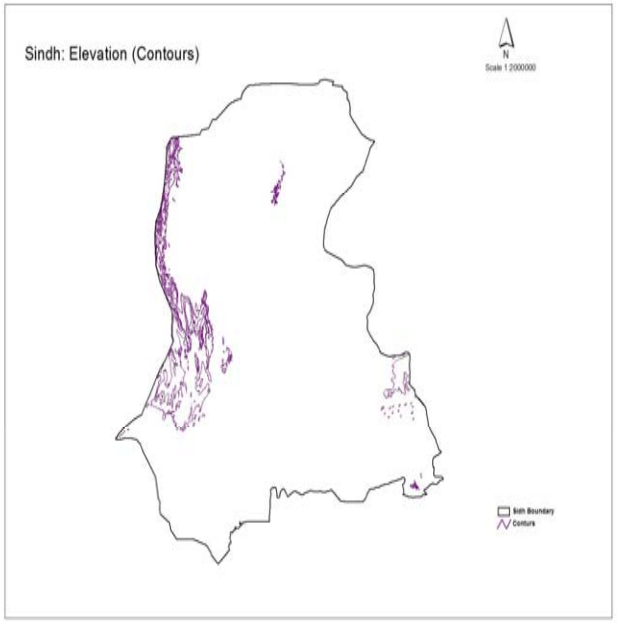
Extensive piedmont plains have developed between the Indus River and the Sulaiman – Kirthar Mountains. They were built by the alluvial fans developing along the rivers flowing eastward down the mountains. Two smaller areas of alluvial fans have emerged south of the Siwalik between the Jhelum and Chenab Rivers and between the Chenab and Ravi Rivers.

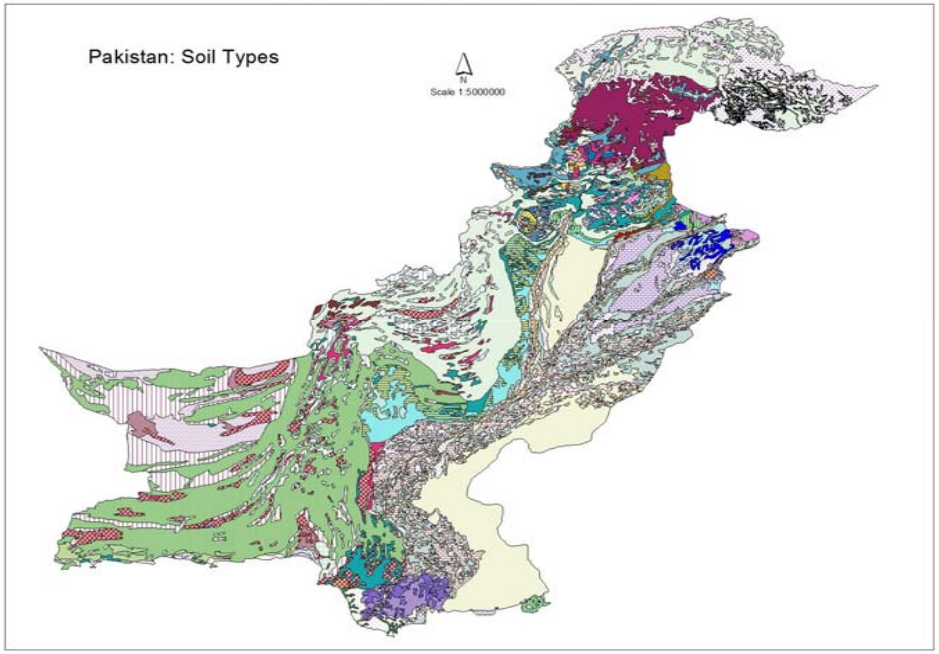
The Indus and its tributaries form vast plain areas in much of the Punjab and Sindh. The accompanying contour maps show the general physiography with flat lands in Sindh and the Punjab where the only exception are Potwar plateau in the north and the piedmont areas in the west. In NWFP and Balochistan on the other hand the area is more rugged and elevated with intermountain valleys.


NWFP: Elevation (Contours)
N
Scale 1:2000000
Charsadda
Mardan
Peshawar
Swabi
Swat
Banou
Lakki Marwat
Kohat
D.I.Khan
NWFP Boundary
Districts Boundary
Contours


Balochistan: Elevation (Contours)
N
Balochistan Boundary
Contours


Punjab: Elevation (contours)
N
Scale 1: 2000000
Punjab Boundary
Contours


Sindh: Elevation (Contours)
N
Scale 1:2000000
Sindh Boundary
Contours



2.2. Soil Types

A large variety of soils are found in Pakistan, which vary significantly in kind and distribution. This entails adopting different approaches to optimally and sustainably use this resource. Although the country's soil resources are vast, good quality soils that form prime agricultural land are limited. The extent of such soils can be increased only a little by improving a part of relatively poor quality soil, though this would be at formidable cost. Notwithstanding, Pakistan has to rely on the existing soil resources. The need of the day is to protect prime agricultural land from misuse that may result in its degradation or loss. Optimal use of this resource would not only ensure continued availability of the basic human needs for food, fibre and shelter, but also improve the overall environment.

Soil / land constitutes the crucially important pivot on which environmental equilibrium rests; misuse or mismanagement of this most valuable and non-renewable resource is bound to trigger environmental degradation.

Soil genesis is an interactive process involving: climate; living organisms; relief; parent soil material; water (both surface and sub-surface); man; and time. A change in any of these variables triggers different soil formation producing varied soil characteristics. Pakistan has a highly diverse landscape and environment that have given rise to a wide variety of soils. The Information Layer (Map) on Soil Types in the National Atlas of Land Use provides critically important information in respect of the characteristics of the soils as given in the following table.

Parent Material	Slope	Calcareousness	Base Saturation
Landform	Effective Thickness	Reaction	Organic Matter Content
Surface Configuration	Structure	Texture	Drainage

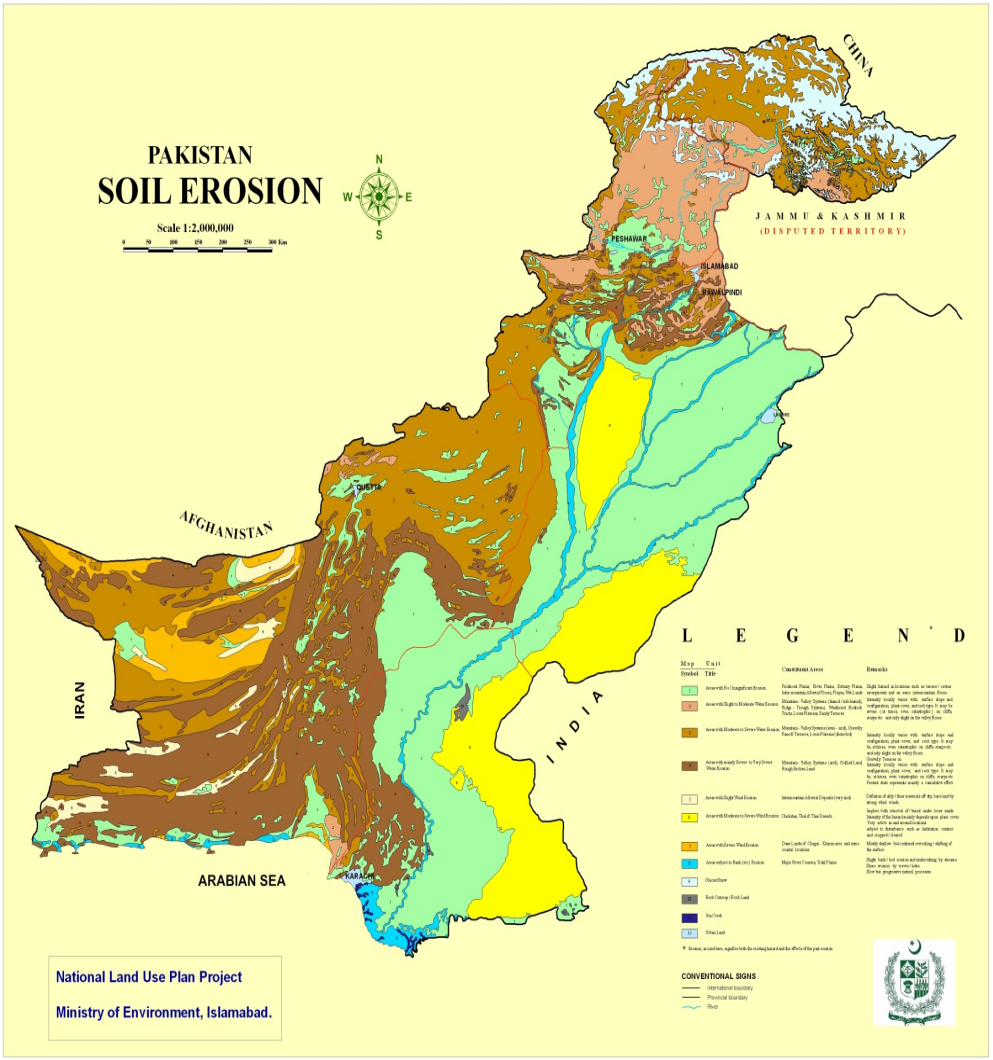
Pragmatic subdivision into classes important from the management / development point of view, are given in respect of soils of the country in the accompanying 'soil types' map showing distribution of various kinds of soil in Pakistan. The map's legend has been designed to be as comprehensive as possible in order to make the maps self explanatory and easy to understand.

The information presented on the maps is based upon data generated through standard reconnaissance level land resource surveys using 1:40,000 / 1:50,000 scale maps in the field. The findings were aggregated mostly at 1:250,000 scale, where the map units were constituted as groups of soil / land categories rather than the individual kinds. Estimated summary of soil classes is also shown in the table given here.

Table: Summary of Soil Classes of Pakistan

Frequency	Soil Types	Area (km^2)	% Age	Frequency	Soil Types	Area (Sq KM)	% Age
3	1	27444.57	3.17	3	36	130.74	0.02
18	2	9431.90	1.09	15	37	6670.84	0.77
3	3	2419.10	0.28	4	38	1770.50	0.20
52	4	13711.92	1.59	9	39	4138.43	0.48
52	5	101393.22	11.73	29	40	8841.26	1.02
28	6	149864.11	17.33	3	41	279.45	0.03
6	7	566.30	0.07	17	42	16438.47	1.90
184	8	33401.41	3.86	1	43	416.64	0.05
42	9	48127.67	5.57	5	44	1684.41	0.19
4	10	150.17	0.02	19	45	7092.06	0.82
11	11	1563.84	0.18	74	46	11348.97	1.31
2	12	2166.91	0.25	111	47	40051.08	4.63
8	13	1538.85	0.18	97	48	36634.26	4.24
5	14	239.85	0.03	52	49	4187.12	0.48
2	15	136.41	0.02	102	50	21444.15	2.48
3	16	130.09	0.02	13	51	4161.53	0.48
6	17	698.73	0.08	11	52	3681.34	0.43
24	18	3786.49	0.44	10	53	16183.72	1.87
15	19	3247.16	0.38	20	54	2613.04	0.30
2	20	1934.84	0.22	19	55	5059.86	0.59
7	21	996.20	0.12	11	56	7691.31	0.89
6	22	368.69	0.04	18	57	6727.67	0.78
13	23	632.09	0.07	11	58	86126.30	9.96
28	24	7228.45	0.84	4	59	1304.30	0.15
103	25	27748.29	3.21	8	60	1570.75	0.18
16	26	2204.16	0.25	23	61	5561.13	0.64
17	27	2261.23	0.26	8	62	22825.09	2.64
11	28	1394.19	0.16	52	63	32044.19	3.71
9	29	5540.91	0.64	13	64	1289.71	0.15
2	30	144.87	0.02	90	65	25622.23	2.96
19	31	1962.21	0.23	9	66	15726.97	1.82
25	32	2612.21	0.3	8	67	1201.52	0.14
9	33	832.87	0.1	6	68	879.46	0.10
38	34	1509.85	0.17	13	69	3559.90	0.41
8	35	641.96	0.07	5	70	1695.81	0.20
Total 458031.7			**52.99**	**Total**		**406654.2**	**47.01**
				G Total		**864685.93**	**100**

Source Soil Survey of Pakistan



2.3. Soil Erosion

Soil Erosion may be defined as the wearing away of land surface by detachment and transport of soil / rock materials through the action of moving water, wind, ice or other geological agents. Basically, the process is classified into two categories – the 'Geologic' and the 'Accelerated'. The former operates under natural conditions and is mainly responsible for evolution of the natural landscapes. The latter is man induced mainly as a result of disturbance of the natural landscape through human activities and is generally more rapid compared with the natural processes. While, the former – geologic – is operative on inherently vulnerable land surfaces, the latter becomes active on areas which are made vulnerable or where natural vulnerability is accentuated mainly through destruction of the protective plant cover.

Soil erosion is highly undesirable because of its detrimental effects. Initially it may only reduce the productivity but its continued unchecked activity would result in irreparable loss of the basic land resource. Apart from the aforesaid and a host of other direct adverse economic consequences, it affects the quality of life through environmental degradation, especially in terms of water and air pollution.

While natural geologic processes continue to operate all over Pakistan, extensive areas in the country are prone / subject to 'accelerated' erosion by water and by wind to various degrees as shown in the accompanying Soil Erosion map of the country. Water erosion mainly affects the sloping / elevated terrain characterizing the highlands. Marks of various types of water erosion - sheet, rill, gully, and landslides etc- are amply manifest in the country.

Erosion by wind, on the other hand, is a characteristic feature of areas of dry, loose, bare sands or finer materials subject to strong air currents. Vast sandy deserts – Cholistan, Thal, Chagai and Kharan – constitute major wind erosion

arena. Very arid silty or finer valley floors / terraces of western Baluchistan are also subject to erosion by wind.

Erosion by major streams along their courses, by waves/tides in the coastal plain, and by ice over the glaciated areas is also noteworthy in Pakistan. Basically, all these types of erosion are geologic in nature, operating in undisturbed natural environs. These are slow but progressive and may need to be attended to assess their adverse environmental impact in some locations.

The accompanying maps show spatial distribution of the soil erosion problem in Pakistan and the provinces. One can discern different types of erosion such as water, wind and bank etc. Where needed, soil erosion type has been further split into a number of classes based upon severity of the problem. These classes are of practical value in the assessment as well as amelioration / management of the problem.

Area affected by the intensity of wind and water erosion and their percentage coverage at two different times is shown in the two tables given here, while estimated extents of the map units are presented in the third table. Because of the generalization level at which the map has been produced and main causes of erosion shown in the maps, these figures are rather indicative only and should not be taken as definitive.

Table: Wind Erosion and %age of Wind Erosion Pakistan

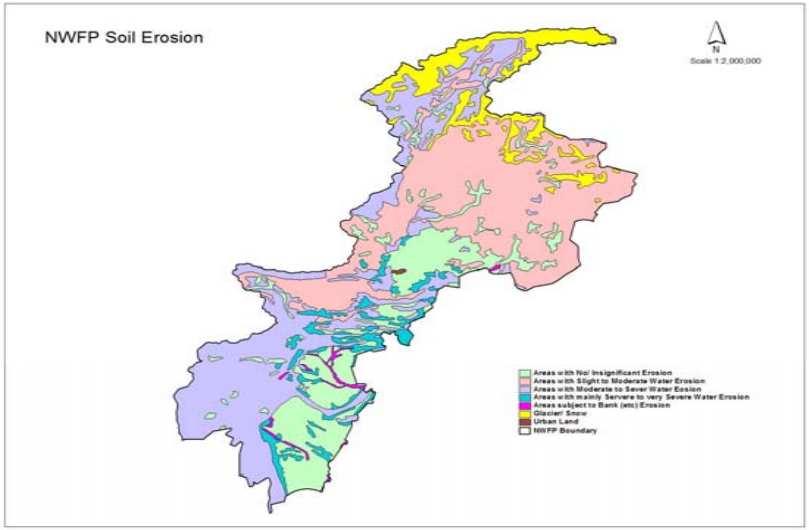
Intensity of Erosion (Class)	1998	2007
	Area (Mha)	Area (Mha)
Slight to Moderate Erosion	2.595	1.29
Moderate to Severe Erosion	0.496	9.456
Severe to Very severe Erosion	1.668	2.282
Total	**4.759**	**13.028**

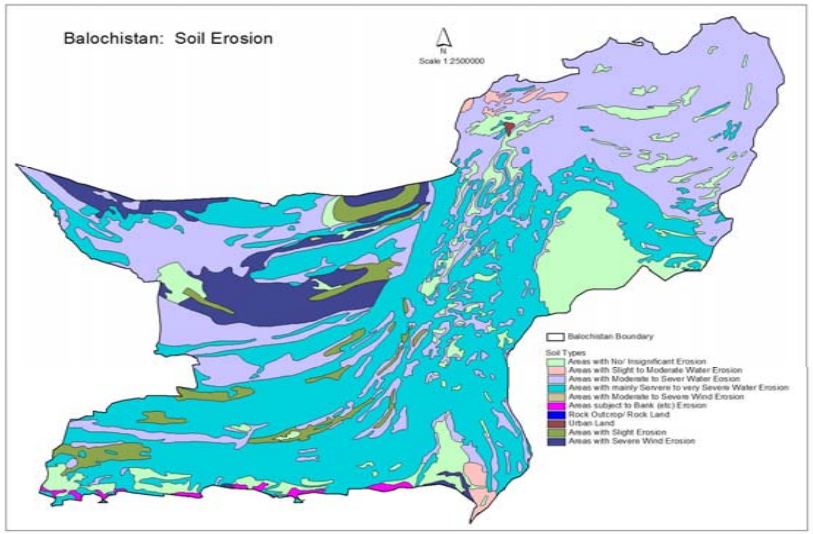
Table: Water Erosion and %age of Water Erosion Pakistan

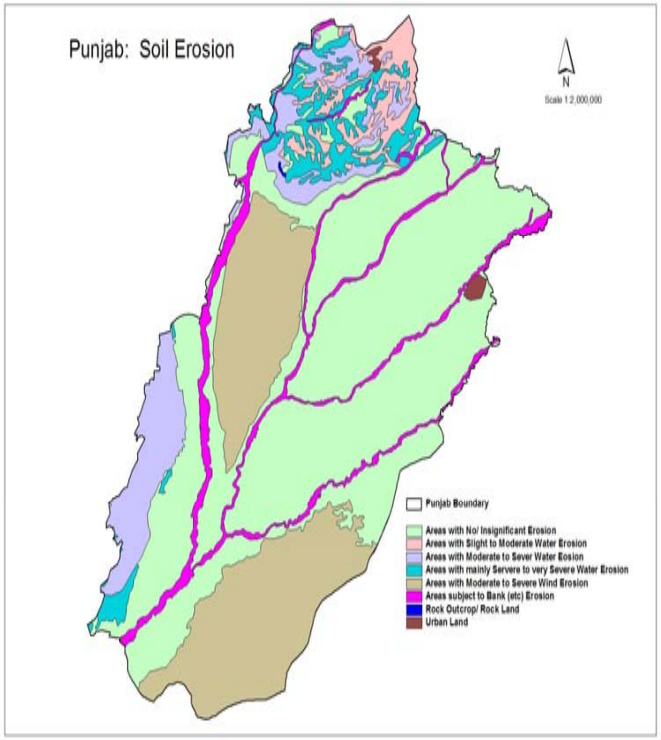
Intensity of Erosion (Class)	1998	2007
	Area (Mha)	Area (Mha)
Slight to Moderate Erosion	3.979	5.165
Moderate to Severe Erosion	3.581	20.003
Severe to Very severe Erosion	3.745	17.677
Bank Erosion	-	2.282
Total	**11.305**	**45.127**

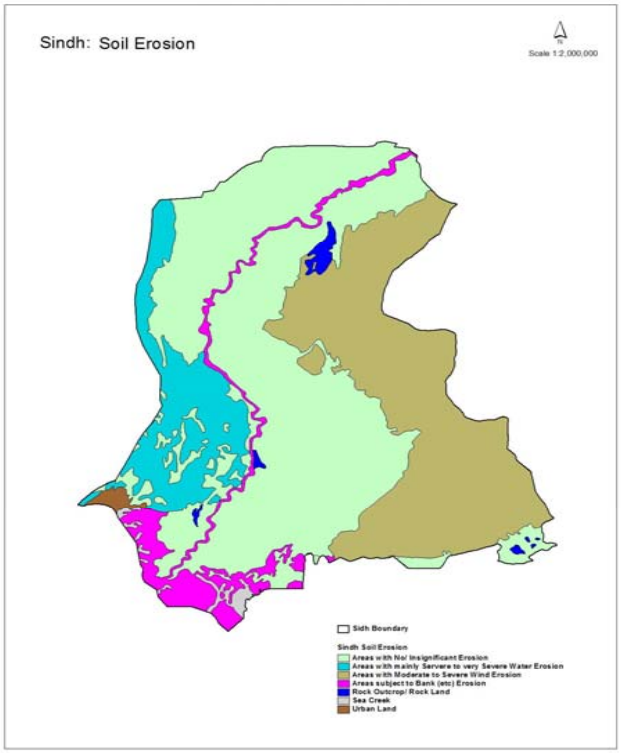
Table : Extent and %age of Soil Erosion Units-Pakistan

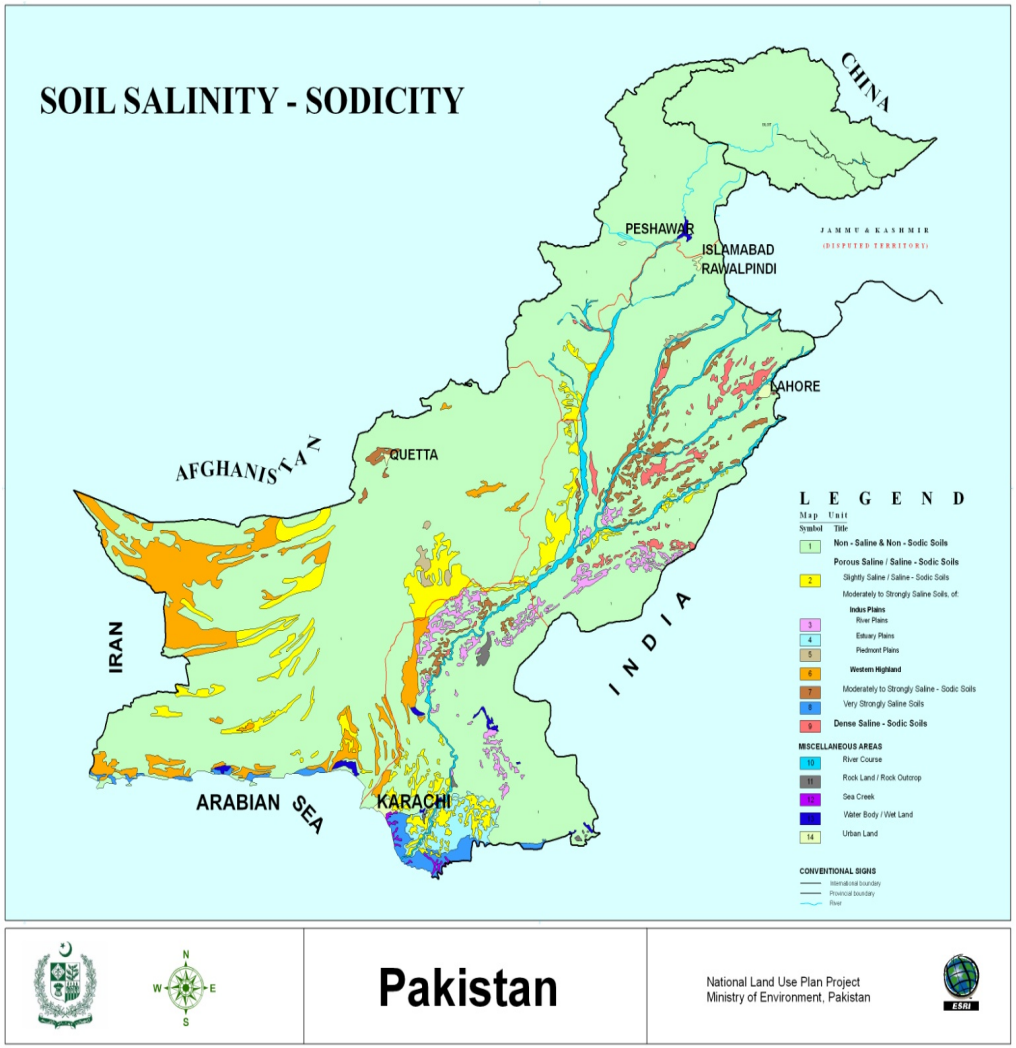
FREQUENCY	PKSLERNP 1	km^2	%AGE
1	0	0	0
236	1	247237.75	28.59
39	2	51658.94	5.97
196	3	200392.86	23.18
97	4	176776.2	20.44
16	5	12908.59	1.49
5	6	94562.44	10.94
8	7	22825.09	2.64
24	8	22483.12	2.6
57	9	32063.47	3.71
8	10	1201.52	0.14
6	11	879.46	0.1
5	12	1696.01	0.2
	Total	**864685.45**	**100.00**


NWFP Soil Erosion
N
Scale 1:2,000,000
Areas with No/ Insignificant Erosion
Areas with Slight to Moderate Water Erosion
Areas with Moderate to Sever Water Eosion
Areas with mainly Servere to very Severe Water Erosion
Areas subject to Bank (etc) Erosion
Glacier/ Snow
Urban Land
NWFP Boundary


Balochistan: Soil Erosion
N
Scale 1:2500000
Balochistan Boundary
Soil Types
Areas with No/ Insignificant Erosion
Areas with Slight to Moderate Water Erosion
Areas with Moderate to Sever Water Erosion
Areas with mainly Servere to very Severe Water Erosion
Areas with Moderate to Severe Wind Erosion
Areas subject to Bank (etc) Erosion
Rock Outcrop/ Rock Land
Urban Land
Areas with Slight Erosion
Areas with Severe Wind Erosion


Punjab: Soil Erosion
N
Scale 1:2,000,000
Punjab Boundary
Areas with No/ Insignificant Erosion
Areas with Slight to Moderate Water Erosion
Areas with Moderate to Sever Water Eosion
Areas with mainly Servere to very Severe Water Erosion
Areas with Moderate to Severe Wind Erosion
Areas subject to Bank (etc) Erosion
Rock Outcrop/ Rock Land
Urban Land


Sindh: Soil Erosion
N
Scale 1:2,000,000
Sidh Boundary
Sindh Soil Erosion
Areas with No/ Insignificant Erosion
Areas with mainly Servere to very Severe Water Erosion
Areas with Moderate to Severe Wind Erosion
Areas subject to Bank (etc) Erosion
Rock Outcrop/ Rock Land
Sea Creek
Urban Land



2.4. Soil Salinity/Sodacity

Salt affected soils of Pakistan can be classified at the highest level into two broad categories – Geogenic & Pedogenic. **Geogenic Salinity** would refer to the presence of excessive soluble salts inherently contained in the parent soil material, having been derived from either one or both of the source of sediments, and the depositing agent (mainly water). Such 'cogenital' salinity characterizes the intermontane floors of western Baluchistan. **Pedogenic Salinity** refers to the Salinization of an originally non-saline parent material (sediment) as the result of a peculiar interaction of the various soil-forming factors including human intervention. This kind of salinization is mainly a characteristic of the 'Indus Plains' and constitutes both the popularly labelled 'primary' and 'secondary' types of salinity. Pedogenic salinity occurs under similar environments in other geographic areas too within the country

Soil Salinity Classes

A Saline Soil is characterised by the presence of excess of soluble salts that interfere with the growth of most crop plants. The amount of salts is determined by measuring electrical conductivity (EC) of saturation extract of the soil,

Pakistan: Soil Salinity Classes

expressed in decisiemens / meters (dS/m), or millimhos / centimeter (mmhos/cm). The following classes of salinity are commonly recognized:

Class	Electrical Conductivity (dS/m or mmhos/cm)
Non saline	0 – 2
Very slightly saline	2 – 4
Slightly saline	4 – 8
Moderately saline	8 – 16
Strongly saline	> 16

The Salinity – Sodicity map of Pakistan produced here shows a number of categories based upon the kind as well as the severity of the problem. The information presented is based upon data generated through standard reconnaissance soil / land resource surveys using 1:40,000 / 1:50,000 scale maps. The findings were published mostly at 1:250,000 scale. Because of the scale, groups of soils rather than individual kinds of soils constituted the map units. Further generalization of the data to produce 1:500,000 scale maps have added to the complexity of the map units' compositions. While major proportion of a unit comprises the kinds of soil / land its title indicates, smaller extents of contrastingly different kinds may also have been included in the unit.

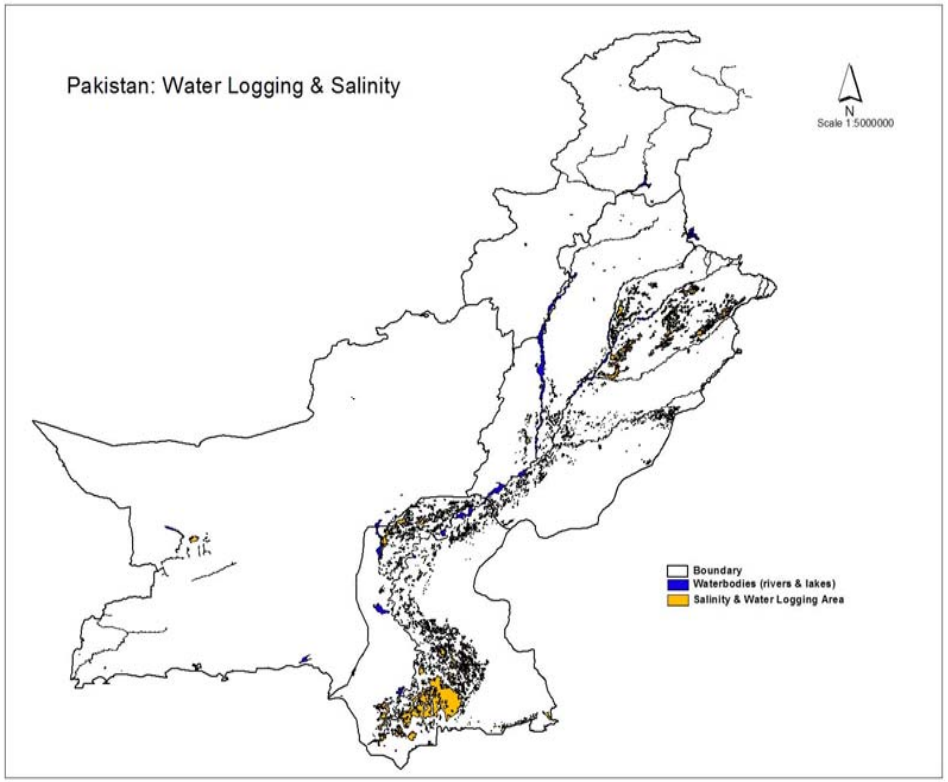
Estimated extents of the map units and salinity classes are presented in the following two tables respectively. Because of the generalization level at which the maps have been produced and salinity status shown, these figures are rather indicative only and should not be taken as definitive.

Table : Extent and %age of Salinity/Sodicity Units-Pakistan

FREQUENCY	PKSLSSYP 1	Area (km^2)	%AGE
56	1	710346.62	82.15
82	2	40082.26	4.64
40	3	11732.11	1.36
9	4	7573.29	0.88
6	5	2101.05	0.24
33	6	44383.63	5.13
57	7	10913.05	1.26
15	8	8068.43	0.93
46	9	7784.10	0.90
9	10	15768.77	1.82
7	11	1169.47	0.14
6	12	879.46	0.10
11	13	2187.97	0.25
5	14	1695.81	0.20
	Total	**864686.02**	**100.00**

Table : Salinity/Sodicity Status

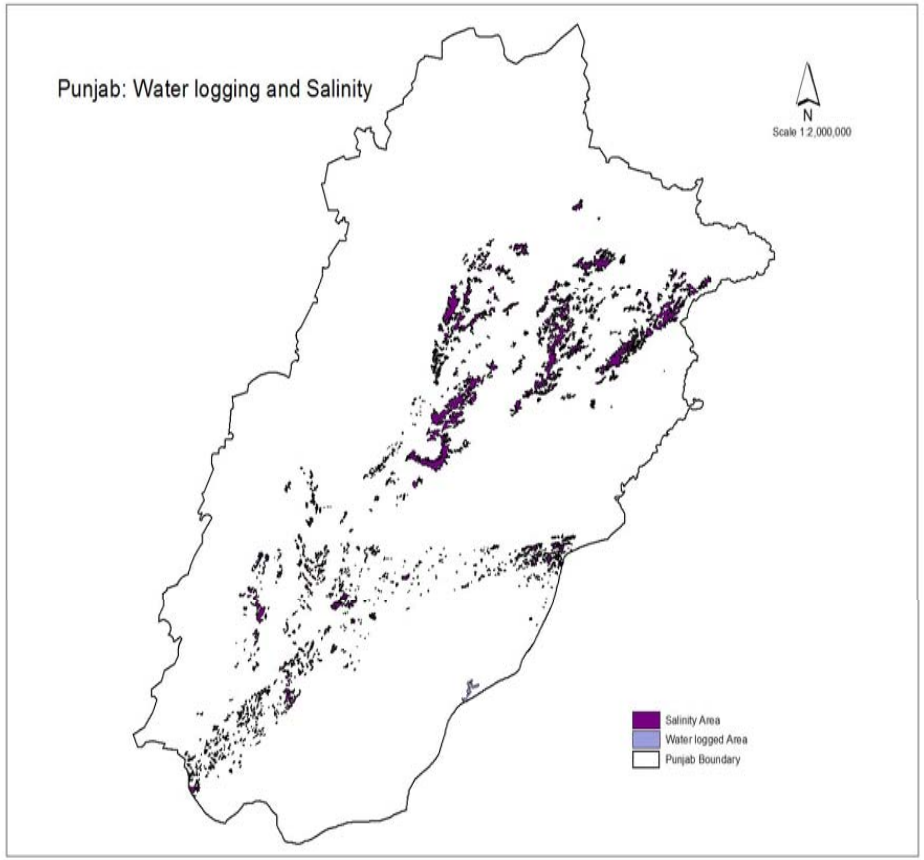
Salinity Class	Area (km2)	%age of Total
Non Saline	710346.62	82.15
Slightly Saline	105872.34	12.25
Moderately Saline	10913.05	1.26
Strongly Saline	8068.43	0.93
Miscellaneous Areas	29485.58	3.41
Total	864686.02	100.00

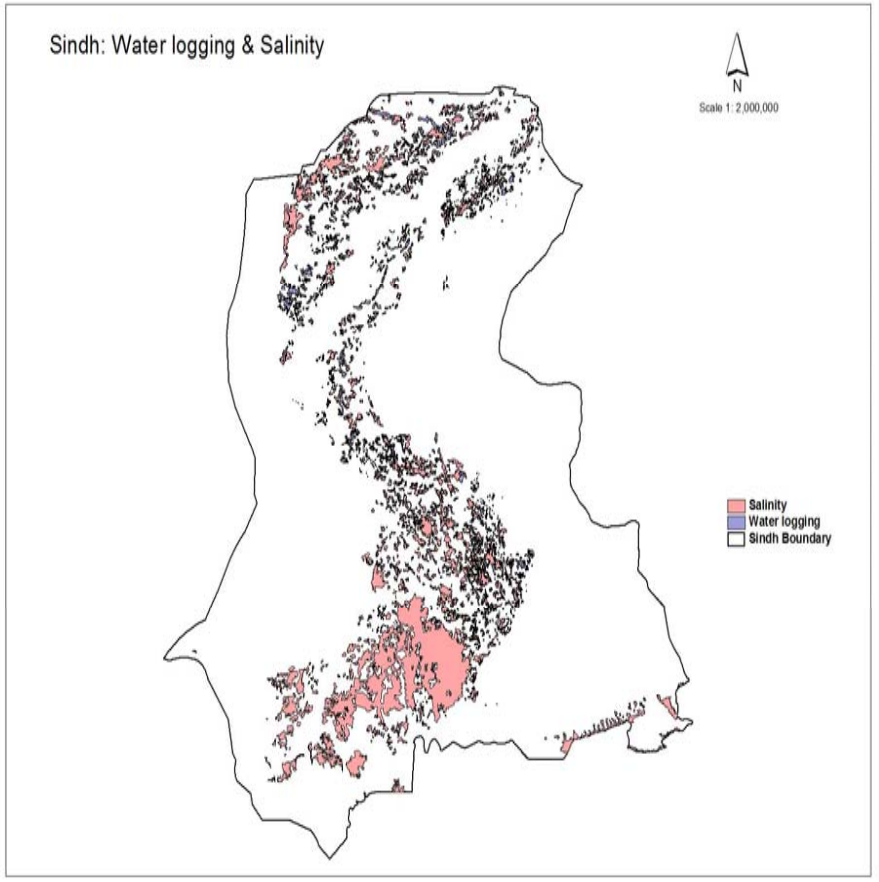


2.5. Water Logging and Salinity

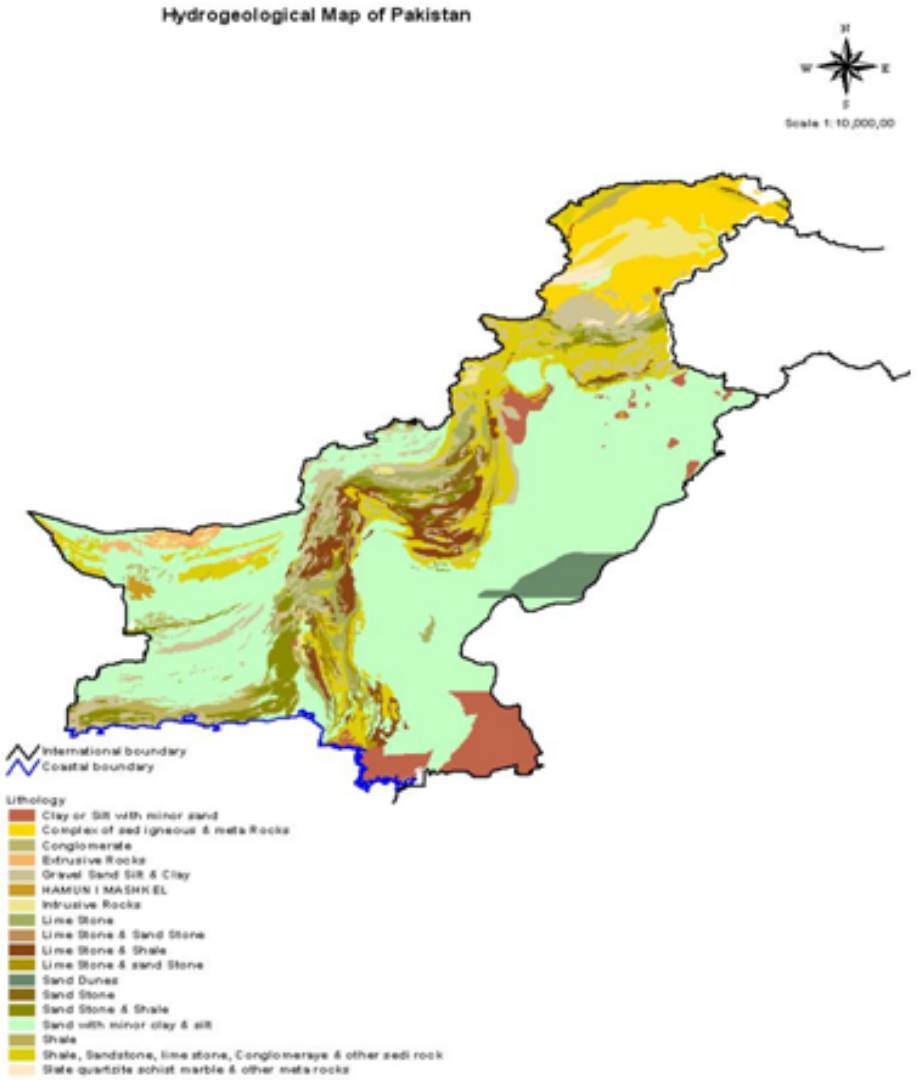
Canal irrigation in Pakistan while providing water for irrigation due to mismanagement has also resulted in twin menace of water logging and salinity. By the early years of the present century, water logging and salinity gained such intensity that remedial measures became a necessity. Since 1912, efforts have been made to tackle the problems. But it was only in 1953-54 that detailed mapping of soil and land use of the Indus plain was carried out under the Colombo Plan. Unlike inundation canals where water was available during one season, the introduction of perennial canals water has been available throughout the year. As a result, the water seeped to the subsurface all through the year from the unlined canals and irrigated fields. This constant supply of water is more than that which can be lost by evapotranspiration. Consequently, accumulation of water in the subsurface starts and the water table begins to rise. So long as the water table remains at a depth of five meters or more below the surface, there is no problem. When the water table rises to five meters from the surface, the water begins to rise to the surface by capillary action. The major part of Pakistan, being arid to semi arid, there is a considerable amount of salt in the soil. The rising water dissolves the salts and carries them to the surface evaporates and the salts are continuously added to the surface soils. The amount of salts on the surface increases as the water table rises. By the time the water table reaches 3.3 meters from the surface, salinity adversely affects the production and yields of crops.

A detailed plan was developed to combat the problem in 1959. The Indus basin was divided into 28 zones of reclamation. Tube wells and drains were to play the key role in reclamation in these various zones. Salinity Control and Reclamation projects are still working to combat the problem but they are costly. As a result, lining of canals and on farm water management is being pursued to contain the problem.


Punjab: Water logging and Salinity
N
Scale 1:2,000,000
Salinity Area
Water logged Area
Punjab Boundary


Sindh: Water logging & Salinity
N
Scale 1: 2,000,000
Salinity
Water logging
Sindh Boundary

WATER RESOURCES



3.1. Hydro geological Profile of Pakistan

Hydro geological profile of the country varies and is dependent upon the geological, physiographical, lithological and climatic conditions of the area. The main features of hydrogeology of Pakistan are shown in the accompanying hydro geological map.

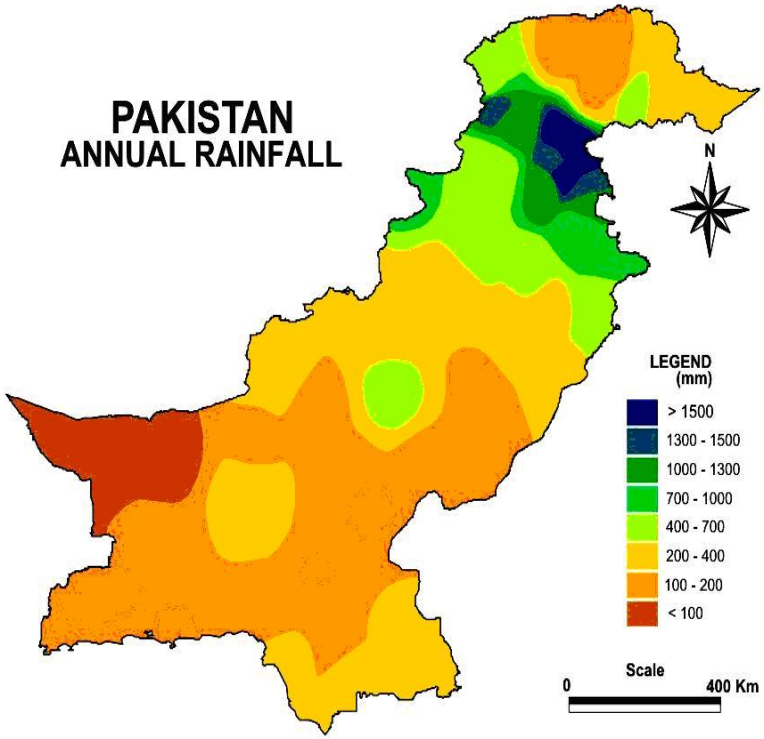
The geology of Pakistan is dominated by quaternary sediments laid over large parts of the Indus Plain and Baluchistan Basins and is often hundreds of meters thick. The terrain consists of the flat-lying Indus Plain in the east, The Himalaya, Karakoram and Hindukush ranges in the north, hilly regions with intermountain valleys of Peshawar, Bannu and D I Khan in the north-west, Potwar Plateau in the north western part of Punjab and the upland Baluchistan plateau in the west.

The climate, as stated earlier, is mostly arid to semi-arid. The main river is Indus, which has its source in the Karakoram Range and joined by several rivers including Jhelum, Chenab, Ravi and Sutlej in the Punjab and River Kabul and its tributaries Chitral, Kunar and Swat in NWFP.

Rivers in Pakistan, as elsewhere derive their flow from precipitation. But the storage of precipitation in the catchment has a great influence on the time distribution and magnitude of river flow. In Pakistan the most important storage of water is in the glaciers and in the perennial and seasonal snow packs. Thus flow in the rivers and their peaks depend on the combined availability of heat to melt the snow and of water stored in the form of snow and ice, as well on the lithology that influences the water loss within the ground. Coefficients of variation of monthly flow calculated for various rivers give an idea of the regularity and predictability of flows at gauging stations. The calculations in Pakistan show that:

• basins that are mostly dependent on snow and glacial melt, such as Shyok, Shigar, Hunza and upper Indus, have lower variability in their flows than those which depend on rainfall

• such variability is also smaller with increasing catchment size – thus Indus at Kachura has a more variable flow than the Indus at Besham.

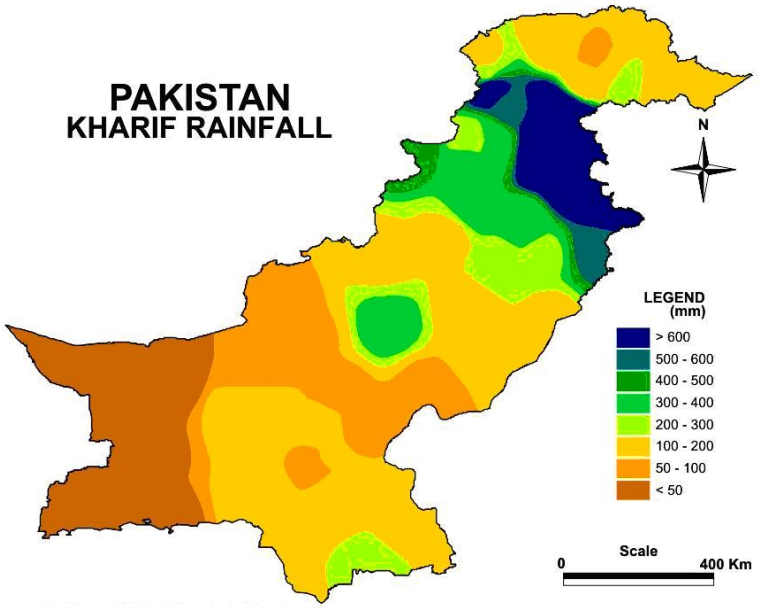


Source: Pakistan Meteorological Department (1955-2000 Data)

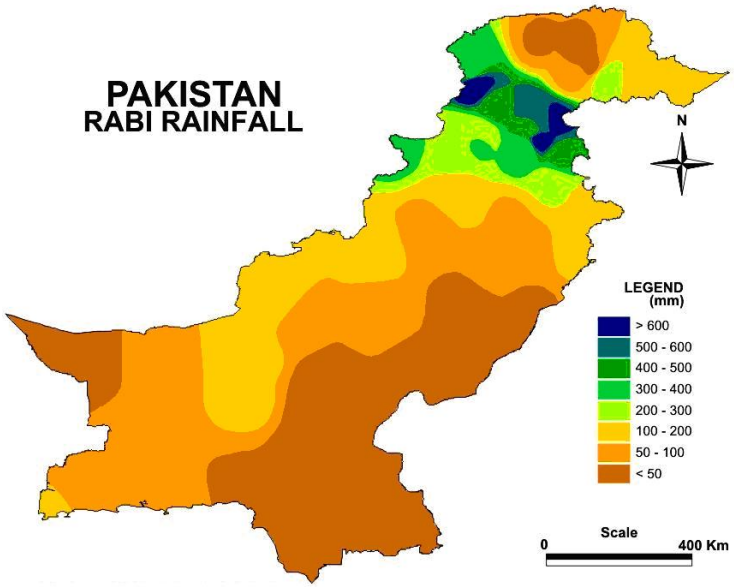
3.2. Rainfall

The major part of Pakistan is dry and humid conditions prevail only over a small area in the north, where the rainfall is above 700mm. Most of Balochistan and the major part of the Punjab south of Sahiwal, and Sindh receive rainfall less than 200 mm per year. North of Sahiwal, the rainfall gradually increases and aridity diminishes. However, the true humid conditions appear after the rainfall increases to 1000 mm per year on the plains and 700 mm per year over the highlands.

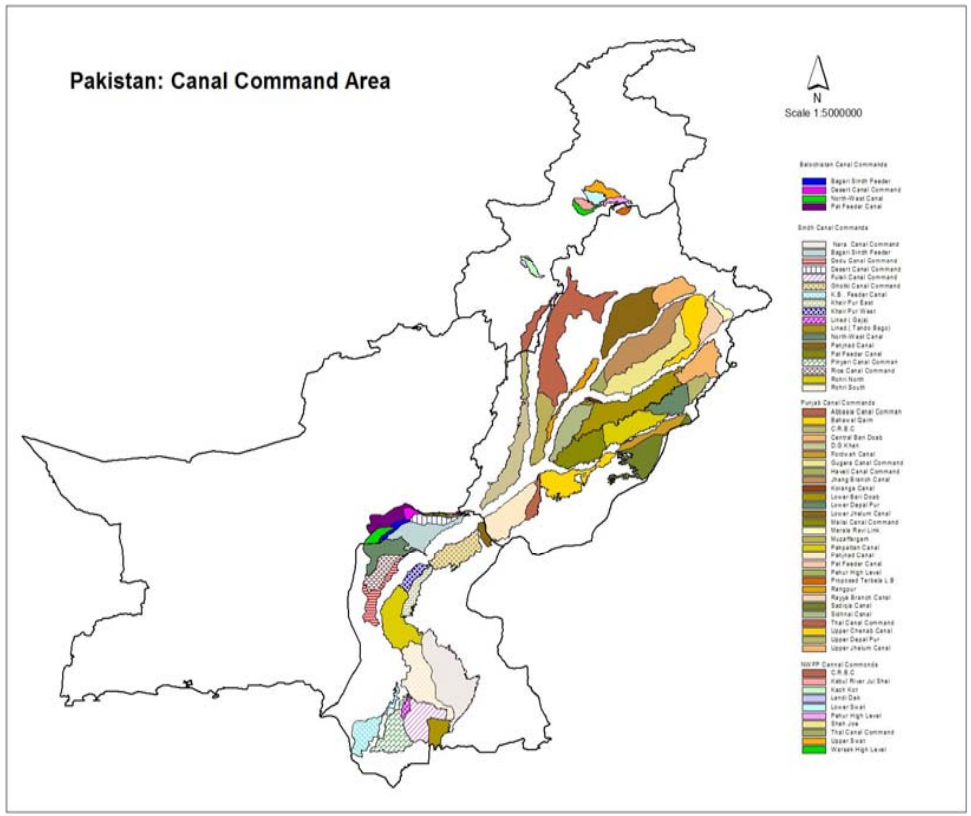
There are two sources of rainfall in Pakistan, the Monsoon and the Western Depression. The monsoon rainfall takes place from July to September (Kharif season). Since the monsoon enters from the east, the eastern part receives more rainfall from these. The western depression enter Pakistan from the west after passing over Iran and Afghanistan, losing moisture on the way, therefore they bring a small amount of rainfall to the western part of the country from December to March (Rabi season).



Source: Pakistan Meteorological Department (1955-2000 Data)



Source: Pakistan Meteorological Department (1955-2000 Data)

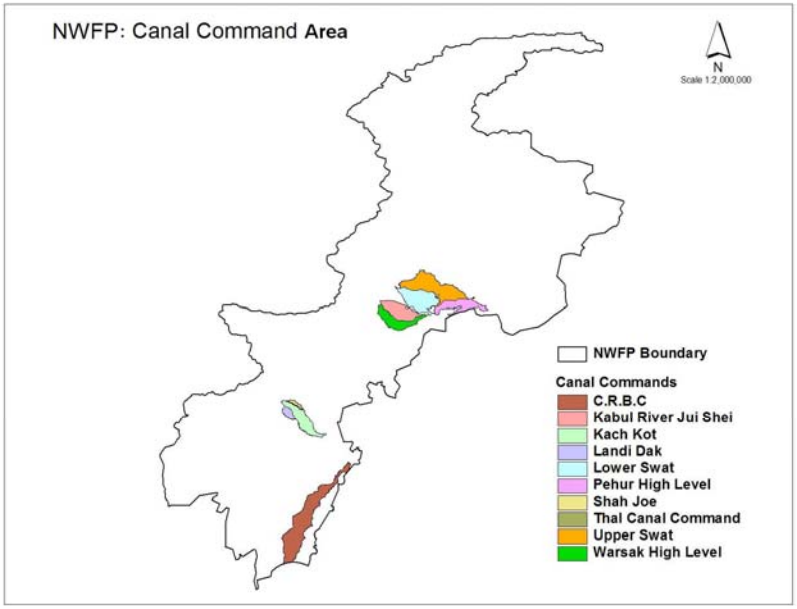


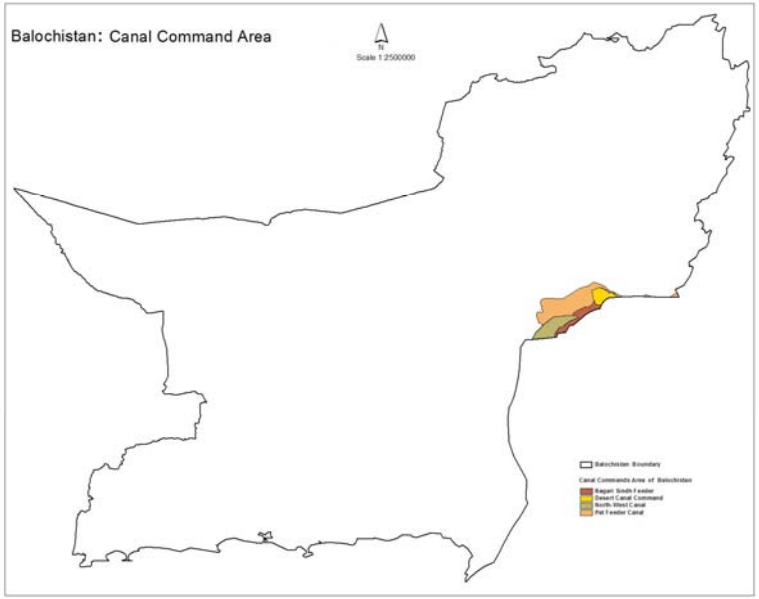
3.3. Canal Command Area

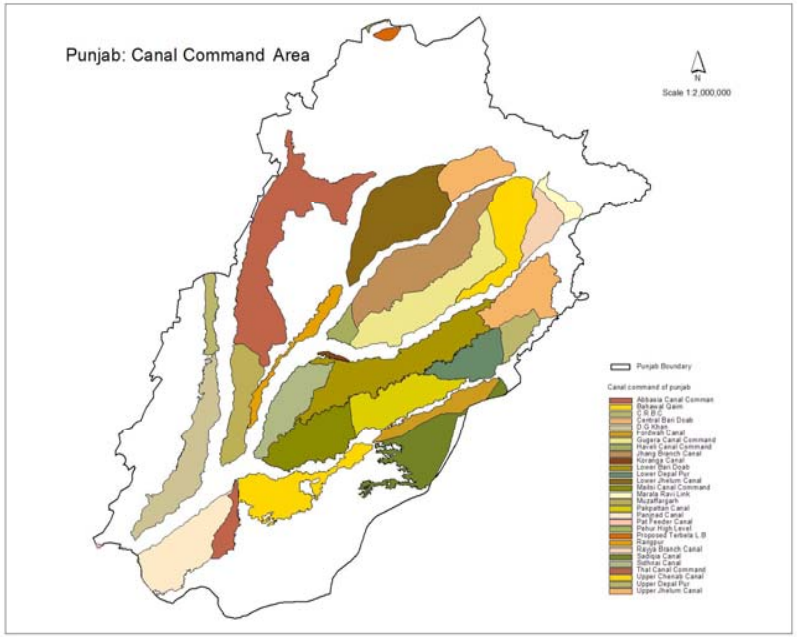
Irrigation is a very old tradition in Pakistan from simple lift irrigation, the country has developed the most intricate and complex system of canal irrigation in the world. Although irrigation channels and inundation canal were there in Pakistan since ancient times, the first perennial canal was constructed in 1639 during Mughal period from Ravi River in the Punjab to irrigate Shalimar Garden but it also irrigated some of the agricultural areas that lay in its course. The next perennial canal was taken out from Madhopur headwork in India to irrigate areas between Beas and Ravi Rivers but the headwork went to India after partition. Since then a number of Canals were constructed including Sidhnai Canal in Multan District taken out from River Ravi in 1885, Lower Chenab Canal (1887-1892), and Lower Jhelum Canal (1901). These were followed by the triple project Upper- Jhelum - Upper Chenab – Lower Bari Doab Canals (1909-1917). Until, the creation of Pakistan there was no arrangement to perennially irrigate the interfluves between Jhelum and Indus Rivers. Jinnah and Taunsa barrages were constructed and canals taken out to irrigate the area after independance.

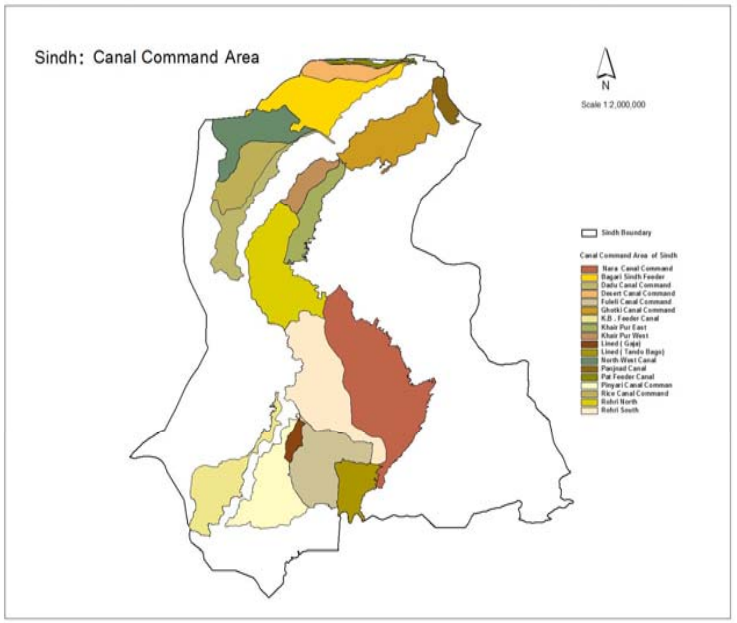
The Indus is the only major river that flows through the province of Sindh. It was in 1932 that the Sindh got its first barrage at Sukkur. Three canals take off from its right bank and four from the left bank. Two more barrages were constructed after independence at Kotri and Guddu with the irrigated areas of 1.11 and 1.16 million hectares respectively.

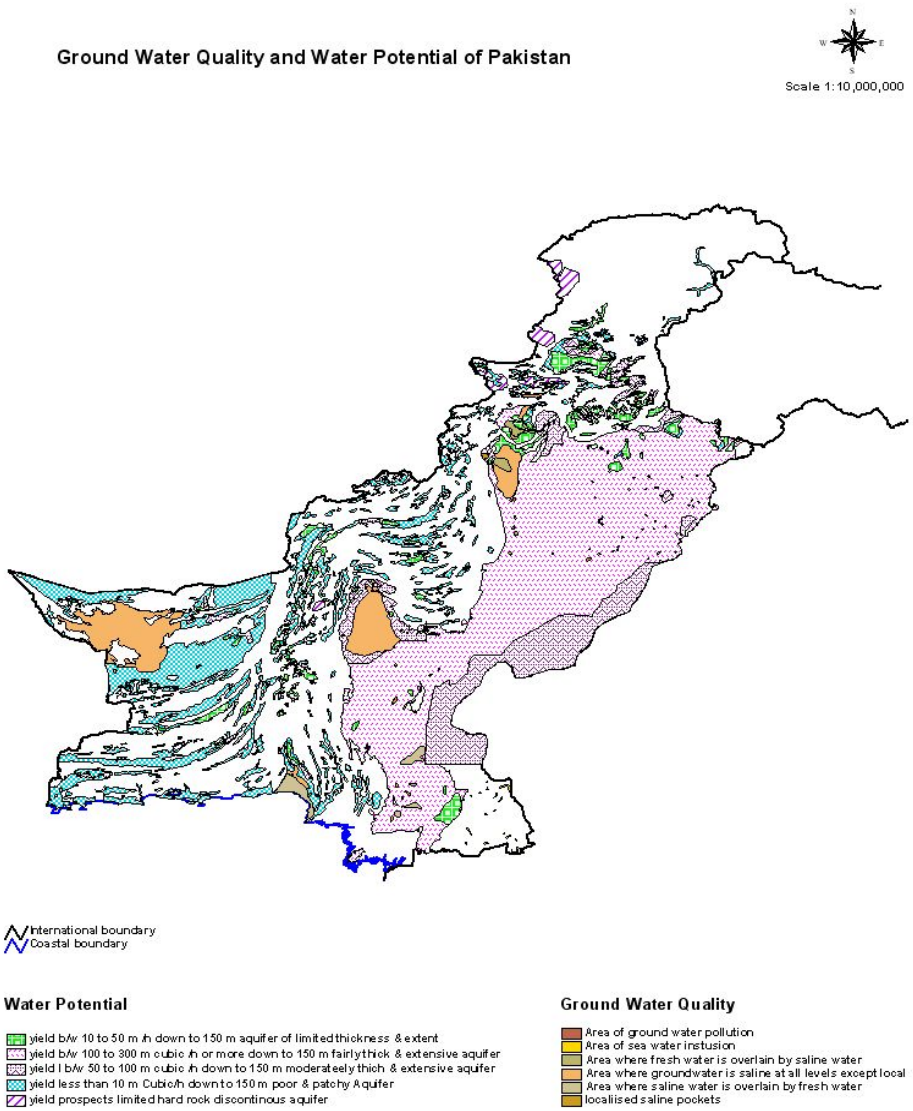
NWFP got Lower Swat Canal about a hundred years ago. Then came the Upper Swat Canal. After partition, the Warsak Dam was constructed and Kabul river canals taken out from it irrigate an extensive area in the Peshawar valley. Kurrumgarhi project and CRBC are two other important projects irrigating Bannu valley and Dera Ismail Khan. Balochistan has a small area under canal command. The irrigation in the area is mainly by extension of canals from Sindh.


NWFP: Canal Command Area
N
Scale 1:2,000,000
NWFP Boundary
Canal Commands
C.R.B.C
Kabul River Jui Shei
Kach Kot
Landi Dak
Lower Swat
Pehur High Level
Shah Joe
Thal Canal Command
Upper Swat
Warsak High Level


Balochistan: Canal Command Area
N
Scale 1:2500000


Punjab: Canal Command Area
N
Scale 1:2,000,000

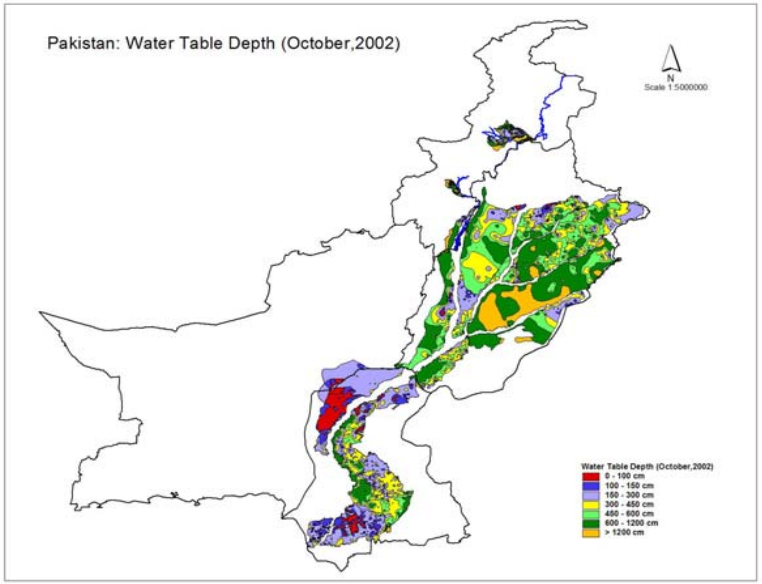

Sindh: Canal Command Area
N
Scale 1:2,000,000



3.4. Water table Depth and Potential

Ground water potential is shown in the accompanying map. The depth of ground water table in the Indus Basin canal commands exhibits an annual cycle of rise and fall. The water table is measured twice a year during pre-monsoon (April/June) and post- monsoon (October) period. It is at its lowest point in the period prior to the monsoon (April/June). Recharged through Kharif season (summer) irrigation and rains, it rises to its highest point in October, when it is closest to the land surface before declining again. High water table conditions after the monsoon, although transitory, interfere with the cultivation of Rabi (winter) crops. The water table position in April/June is, particularly, critical as it persists throughout the year and is used as an index of waterlogged area.

Zone-wise point data of depth to water table below national standard limit (NSL) for the periods June and October 2002, for all the irrigation canal commands were digitized, analyzed and the contour maps were generated through interpolation technique. The criteria for classification of water table depth categories adopted for this project are according to Soil Survey Manual Agricultural Handbook No.18 and are given in the maps and table below:.



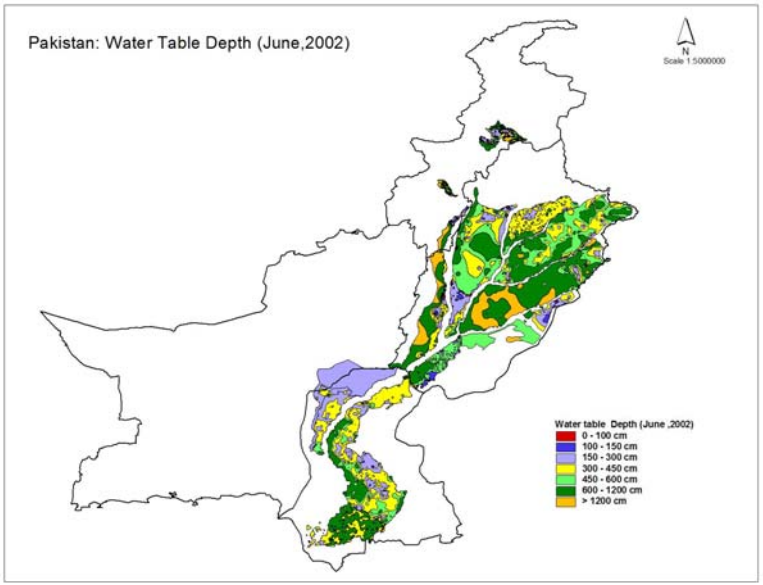
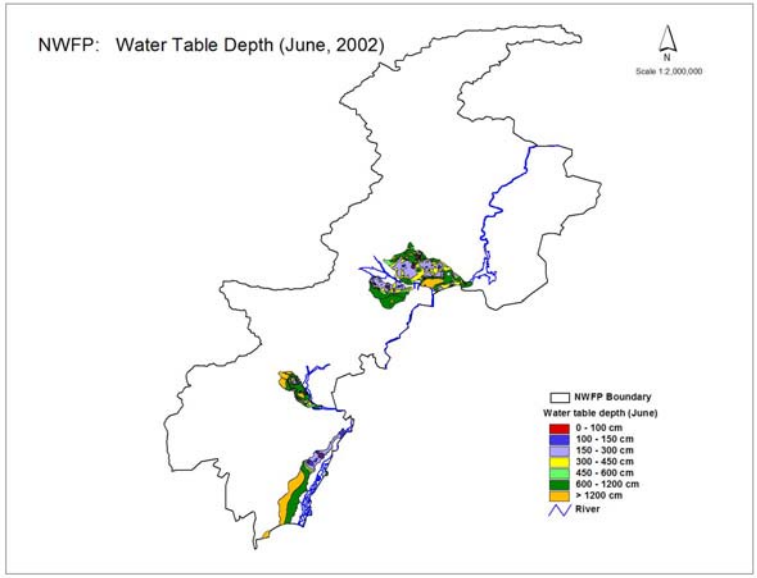


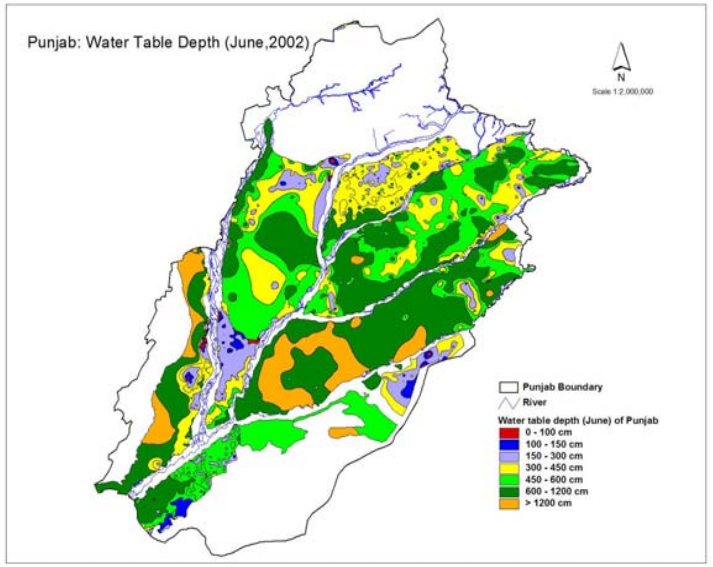
Table : Classification of Water table Depth by Drainage

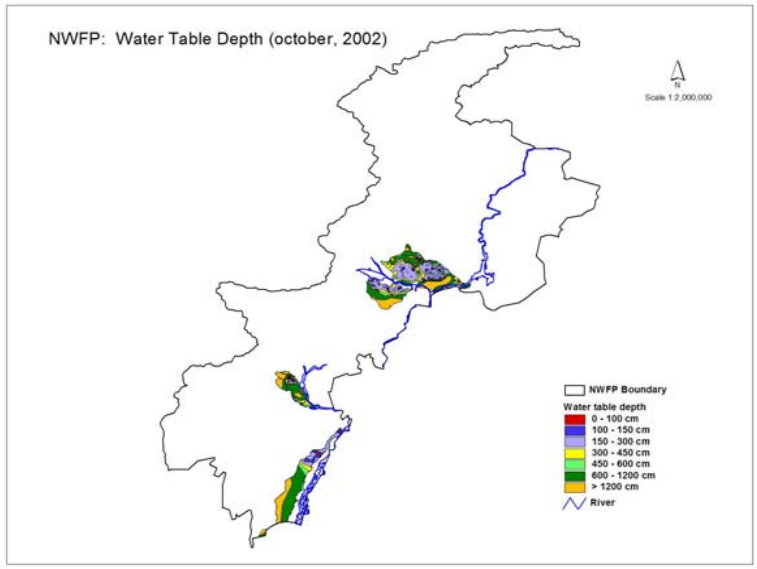
Drainage Class	Watertable Depth (cm below NSL)
Very poorly drained (Waterlogged)	< 100
Poorly drained (Waterlogged)	100-150
Moderately drained	150-300
Well drained	>300

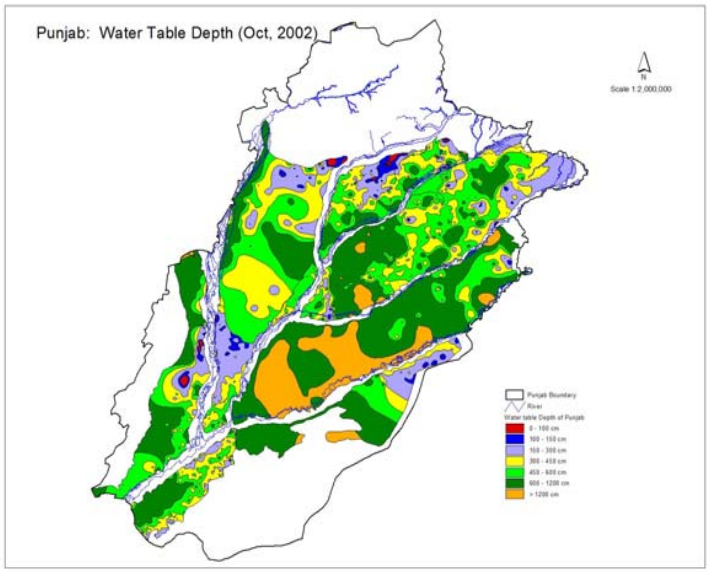
NSL indicates National Standard Limit

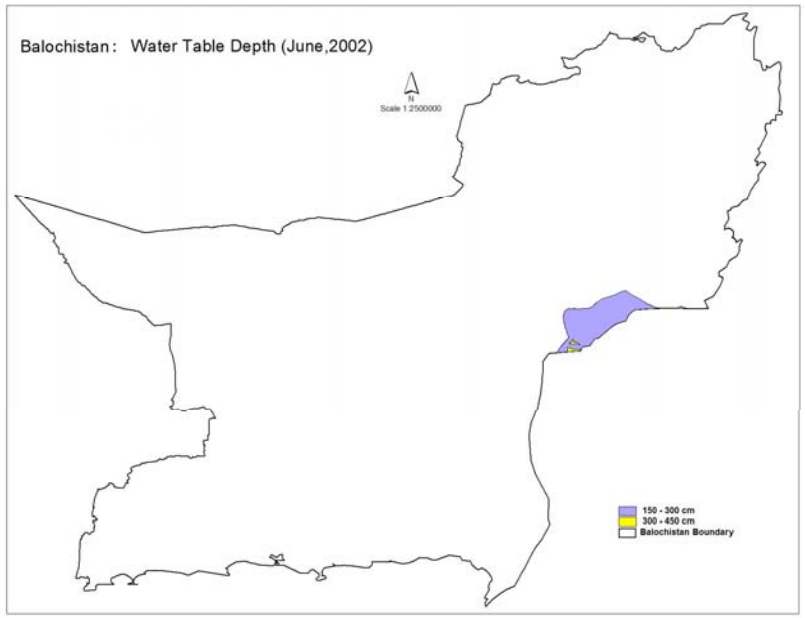
The raster maps which contain interpolated values from the point data of depth to water table in June and October, 2002 were used for calculating areas under different categories of depth to water table in ArcView software. The zone-wise depths to water table results for June and October 2002 were thus prepared and shown in the output maps.

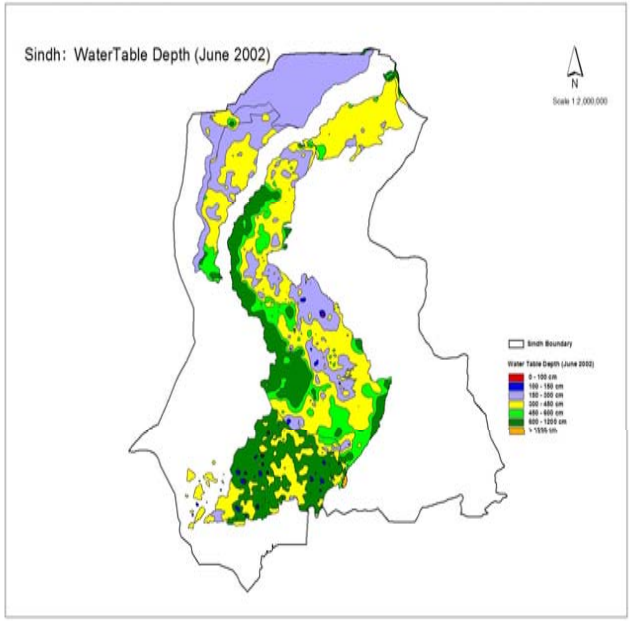

NWFP: Water Table Depth (June, 2002)
N
Scale 1:2,000,000
NWFP Boundary
Water table depth (June)
0 - 100 cm
100 - 150 cm
150 - 300 cm
300 - 450 cm
450 - 600 cm
600 - 1200 cm
> 1200 cm
River

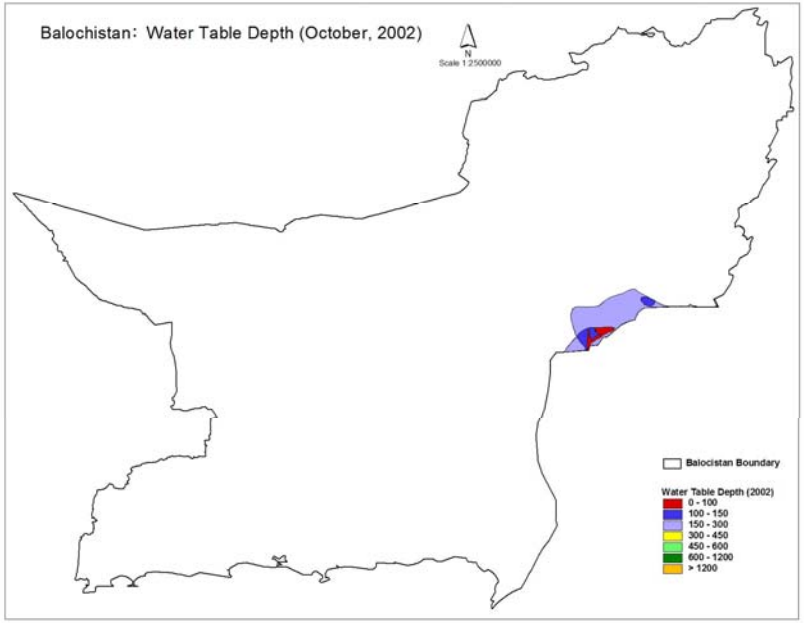

Punjab: Water Table Depth (June,2002)
N
Scale 1:2,000,000
Punjab Boundary
River
Water table depth (June) of Punjab
0 - 100 cm
100 - 150 cm
150 - 300 cm
300 - 450 cm
450 - 600 cm
600 - 1200 cm
> 1200 cm

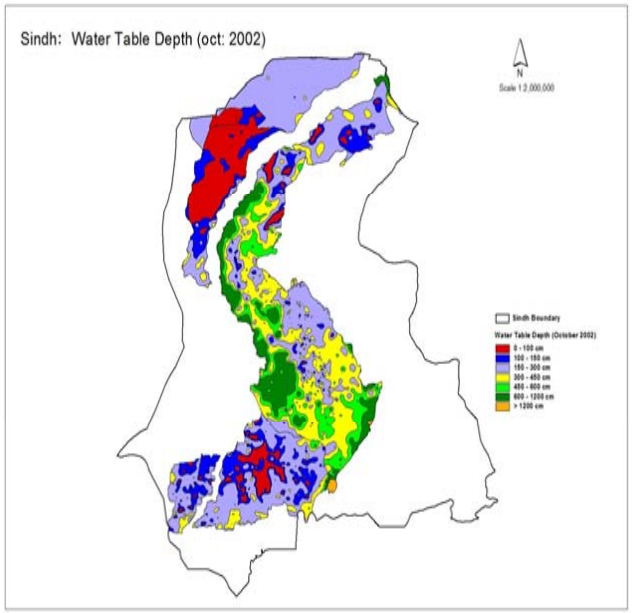

NWFP: Water Table Depth (october, 2002)
N
Scale 1:2,000,000
NWFP Boundary
Water table depth
0 - 100 cm
100 - 150 cm
150 - 300 cm
300 - 450 cm
450 - 600 cm
600 - 1200 cm
> 1200 cm
River

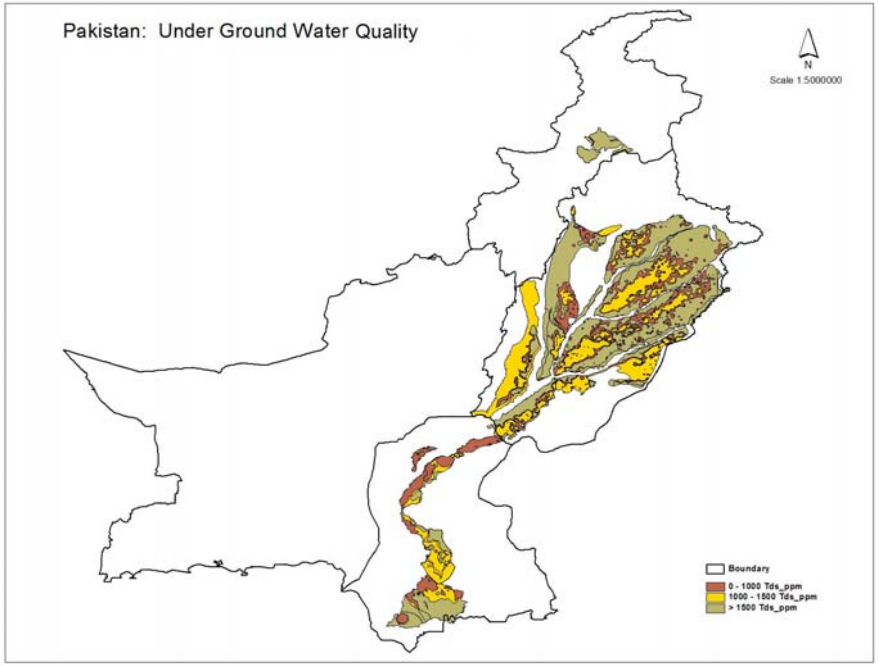

Punjab: Water Table Depth (Oct, 2002)
N
Scale 1:2,000,000


Balochistan: Water Table Depth (June,2002)
N
Scale 1:2500000
150 - 300 cm
300 - 450 cm
Balochistan Boundary


Sindh: WaterTable Depth (June 2002)
N
Scale 1:2,000,000
Sindh Boundary
Water Table Depth (June 2002)
0 - 100 cm
100 - 150 cm
150 - 300 cm
300 - 450 cm
450 - 600 cm
600 - 1200 cm
> 1200 cm


Balochistan: Water Table Depth (October, 2002)
N
Scale 1:2500000
Balocistan Boundary
Water Table Depth (2002)
0 - 100
100 - 150
150 - 300
300 - 450
450 - 600
600 - 1200
> 1200

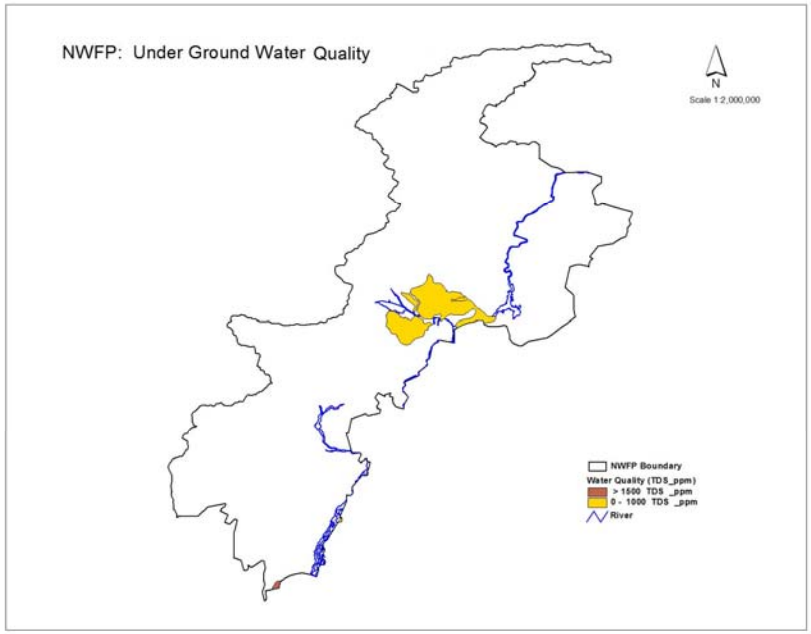

Sindh: Water Table Depth (oct: 2002)
N
Scale 1:2,000,000
Sindh Boundary
Water Table Depth (October 2002)
0 - 100 cm
100 - 150 cm
150 - 300 cm
300 - 450 cm
450 - 600 cm
600 - 1200 cm
> 1200 cm

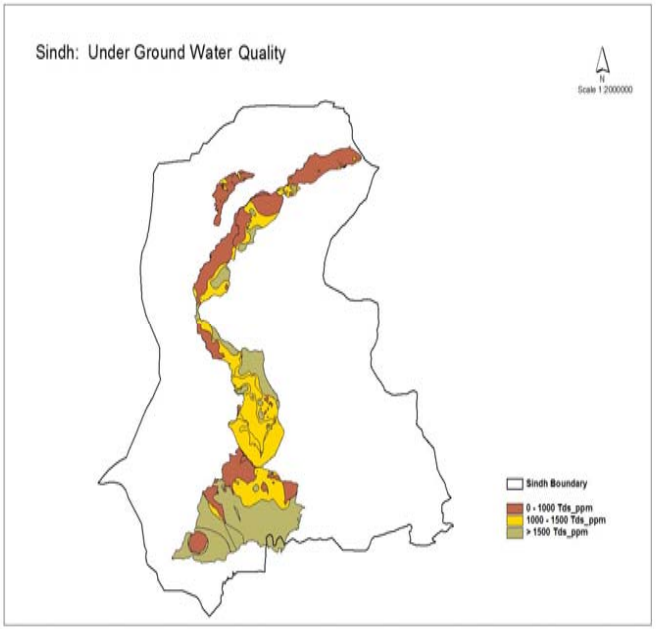


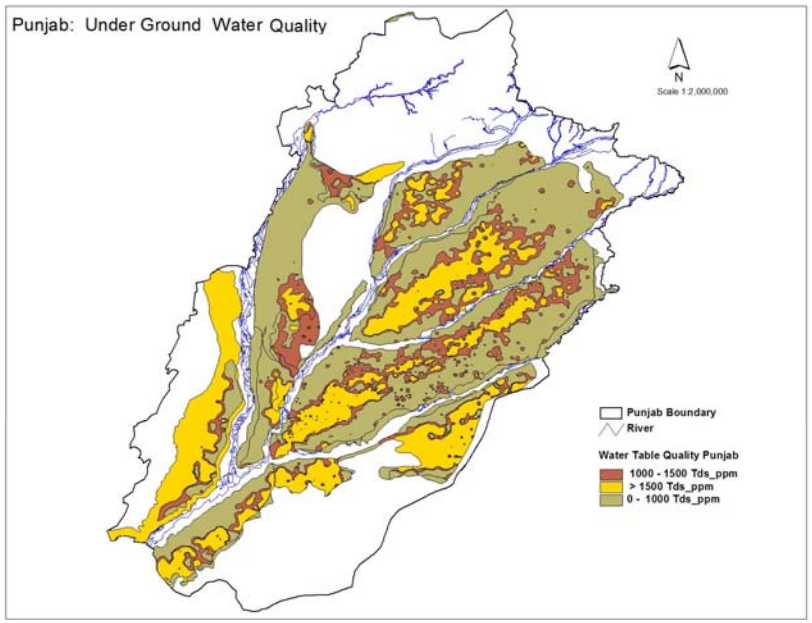
3.5. Ground water quality

Zone-wise point data of water quality (TDS) survey during 2001-2003 were digitized and analyzed. After screening of the data the contours were generated through various interpolation procedures. The raster maps of canal commands which contain interpolated values from the point data were used for calculating areas under different categories of water quality in terms of totally dissolved solids(TDS) in ArcView software. The zone-wise water quality based on TDS results for the survey during 2001-2003 are shown in the accompanying maps and the table below.

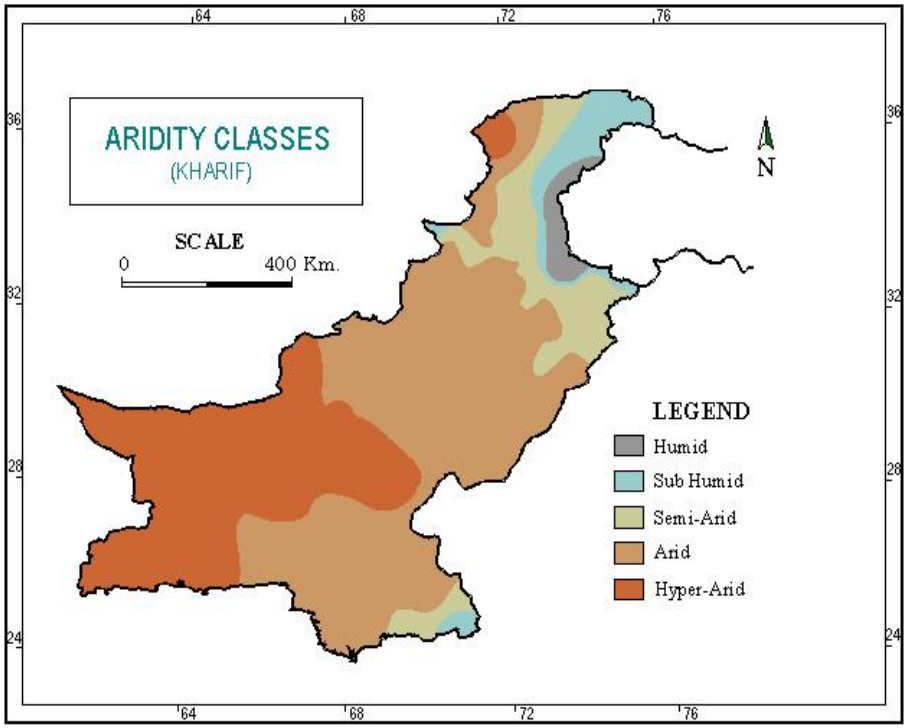
Zone Name	Area Surveyed	Shallow Water Quality Based on of TDS(ppm)					
		Usable (<1000)		Marginal (1000-1500)		Hazardous (>1500)	
		Area	%	Area	%	Area	%
NWFP							
Swat	0.715	0.715	100	0	0	0	0
Kabul River	0.273	0.265	97.07	0.008	2.93	0	0
Total	**0.988**	**0.98**	**99.19**	**0.008**	**0.81**	**0**	**0**
PUNJAB							
Thal Doab	3.977	2.627	66.05	0.567	14.26	0.783	19.69
Chaj Doab	2.474	1.624	65.64	0.49	19.81	0.36	14.55
Rechna Doab	5.729	3.245	56.64	1.095	19.11	1.389	24.25
Bari Doab	4.288	2.77	64.60	0.76	17.72	0.758	17.68
Fordwah Zone	2.534	0.718	28.33	0.336	13.26	1.48	58.41
Punjnad Zone	1.644	0.986	59.98	0.161	9.79	0.497	30.23
D.G.Khan Zone	0.957	0.37	38.66	0.214	22.36	0.373	38.98
Total	**21.603**	**12.34**	**57.12**	**3.623**	**16.77**	**5.64**	**26.11**
SINDH / BALUCHISTAN							
Guddu Left Zone	0.566	0.492	86.92	0.063	11.14	0.011	1.94
Guddu Right Zone	0.222	0.197	88.72	0.025	11.28	0	0
Sukkur Left Zone	2.81	0.784	27.90	1.497	53.27	0.529	18.83
Kotri Left Zone	2.786	0.577	20.69	0.454	16.25	1.757	63.06
Kotri Right Zone	0.717	0		0		0.717	100
Total	**7.101**	**2.05**	**20.86**	**2.039**	**28.70**	**3.014**	**42.44**

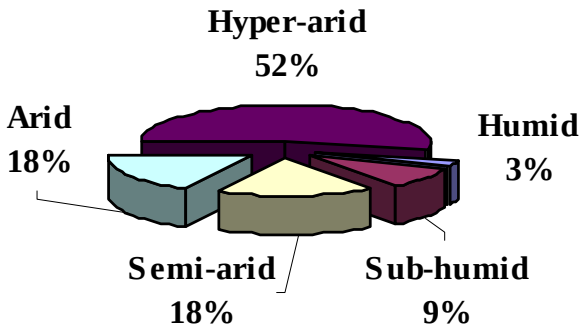

NWFP: Under Ground Water Quality
N
Scale 1:2,000,000
NWFP Boundary
Water Quality (TDS_ppm)
> 1500 TDS _ppm
0 - 1000 TDS _ppm
River


Sindh: Under Ground Water Quality
N
Scale 1:2000000
Sindh Boundary
0 - 1000 Tds_ppm
1000 - 1500 Tds_ppm
> 1500 Tds_ppm


Punjab: Under Ground Water Quality
N
Scale 1:2,000,000
Punjab Boundary
River
Water Table Quality Punjab
1000 - 1500 Tds_ppm
> 1500 Tds_ppm
0 - 1000 Tds_ppm

AGRICULTURE LAND USE & ASSOCIATED FEATURES



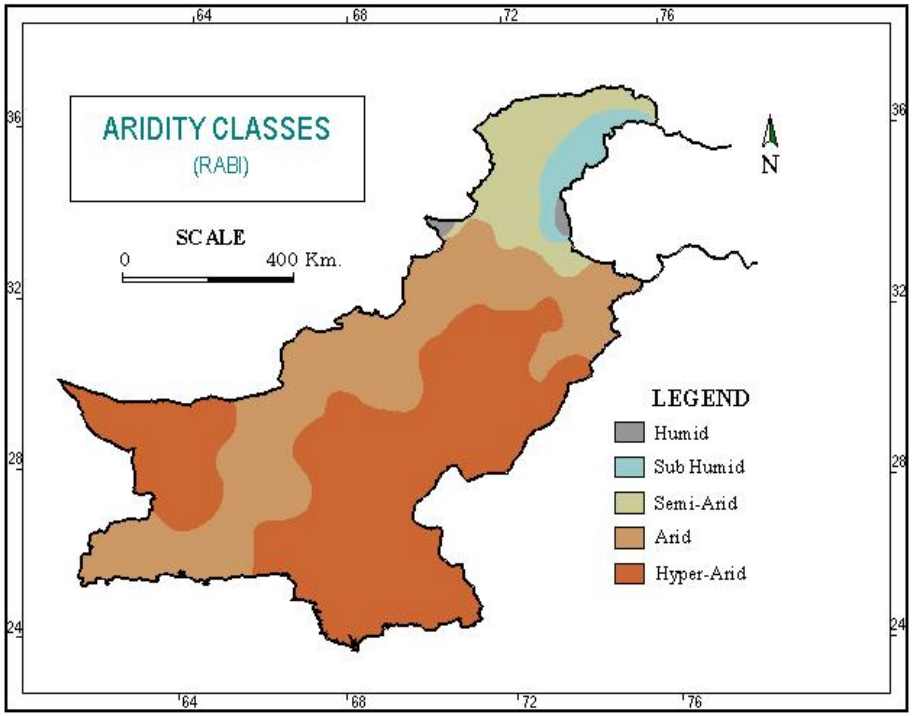


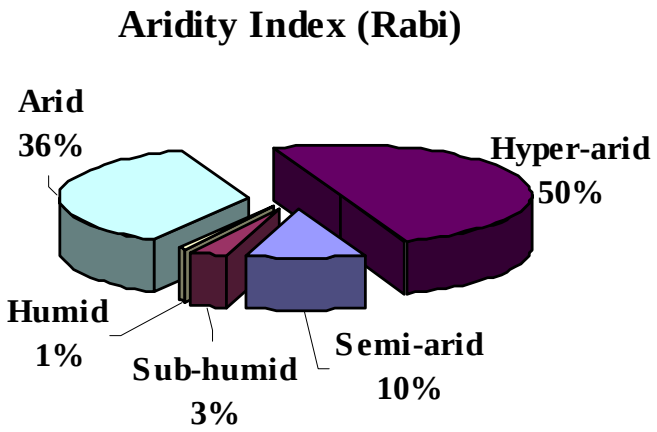
4.1. Aridity Index Kharif (summer)

The Aridity Index refers to the ratio of 50% probability of rainfall and actual crop evapo-transpiration. The aridity classes ranged from humid to hyper-arid as given in the accompanying map.

A minor area in the north eastern part of the country, covering the districts of Mansehra, Abbotabad, Rawalpindi, Islamabad, Jhelum, and Gujrat fall under the humid zone, where the aridity index is higher than 0.75. Sub-humid zone lies in the north eastern and the south eastern parts. A narrow belt along with the humid zone, including the districts of Sialkot and parts of Jhelum and Mardan, represents the north eastern sub-humid zone. The south eastern part of the sub-humid zone covers the extreme south eastern corner of the Mirpur Khas district. Similar to the sub-humid zone, the semi-arid zones are located in the northern central part of the country and south eastern part, north of the sub-humid zone. The northern semi-arid zone covers parts of the districts of Sialkot, Gujrat, Jhelum, Mardan, Gujranwala, Attock, Peshawar, Kohat, Tribal areas, Mianwali, Khushab, Sargodha, Sheikhupura, Lahore, Kasur and parts of Faisalabad, Jhang, and Zhob. The southern part of the semi-arid zone covers most of the Mirpur Khas district.

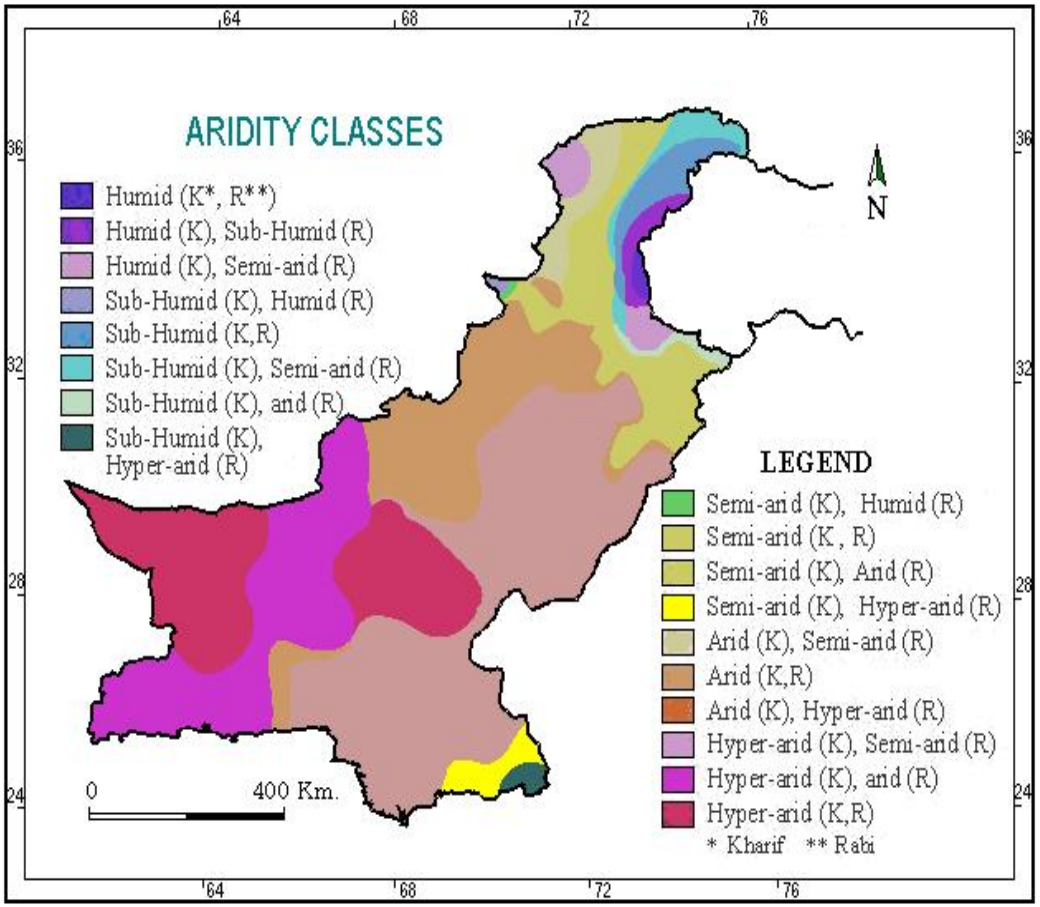
Generally the Hyper-arid zone covers more than half the area of the country (See Pie Diagram). It extends from west of Pishin, to Dadhar and Uthal in Balochistan and Larkana and Dadu in the Sindh province. The arid and semi-arid zones collectively occupy about 36% area of the country. The arid zone covers most of the Punjab, Sindh and eastern part of the Baluchistan provinces. The humid and sub-humid zones cover only 3% and 9% area respectively.





Aridity Index Rabi (winter)

The aridity index for Rabi season ranges from humid to hyper-arid as can be seen in the map. Compared to Kharif, Rabi season has higher dryness with greater fluctuations in the pattern of dryness. The humid zone in Rabi season covers only 1 percent area and is limited to the north eastern fringe of the country extending over parts of Abbotabad and Murree districts. The sub-humid zone covers 3% area of the country extending over Rawalpindi in the Punjab, Federal Capital territory of Islamabad, and Abbotabad and Mansehra districts in NWFP. The semi-arid zone covers the northern Potwar plateau in the Punjab and Peshawar and Malakand districts in NWFP. The arid and hyper arid zones cover a vast area including the whole of Baluchistan and Sindh provinces, the central and southern parts of the Punjab and south western parts of NWFP.



K* (Kharif) R (Rabi)**

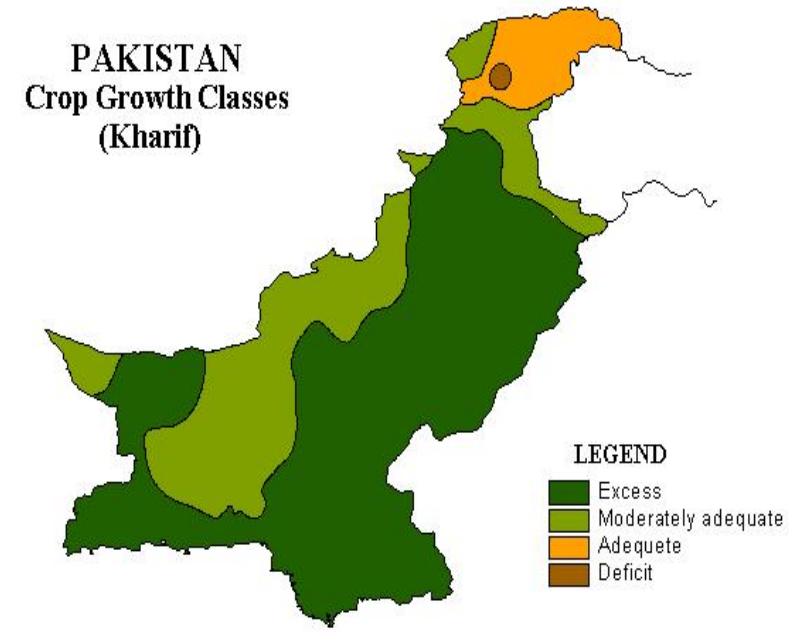
Aridity Index Annual

The seasonal aridity class maps of the Kharif and the Rabi seasons were superimposed to prepare a single map representing the average aridity classes. A total of 18 classes were identified as given in the accompanying map.

The combination shows that humid and sub-humid Kharif zones have 3 and 5 Rabi zones, respectively. The variability in Rabi season for the humid Kharif zone ranges from humid to semi-arid, whereas for the sub-humid Kharif zone it ranges from humid to hyper-arid. The semi-arid Kharif zone shows 4 combinations in the Rabi season namely humid, semi-arid, arid and hyper-arid. In the arid and hyper-arid zones in the Kharif season, the Rabi season is either arid or hyper-arid.

Table: The Share of various Aridity Zones of Pakistan

S. No.	Annual Aridity Classes	% coverage
1	Humid (K* & R**)	0.30
2	Humid (K), Sub-humid (R)	1.07
3	Humid (K), Semi-arid (R)	0.79
		2.16
4	Sub-humid (K), Humid (R)	0.15
5	Sub-humid (K&R)	2.38
6	Sub-humid (K), Semi-arid (R)	1.84
7	Sub-humid (K), Arid (R)	0.59
8	Sub-humid (K), Hyper-arid (R)	0.58
		5.54
9	Semi-arid (K), Humid (R)	0.07
10	Semi-arid (K&R)	3.95
11	Semi-arid (K), Arid (R)	5.45
12	Semi-arid (K), Hyper-arid (R)	1.53
		11.00
13	Arid (K), Semi-arid (R)	2.34
14	Arid (K&R)	14.17
15	Arid (K), Hyper-arid (R)	31.73
		48.23
16	Hyper-arid (K), Semi-arid (R)	1.00
17	Hyper-arid (K), Arid (R)	15.71
18	Hyper-arid (K&R)	16.36
		33.07

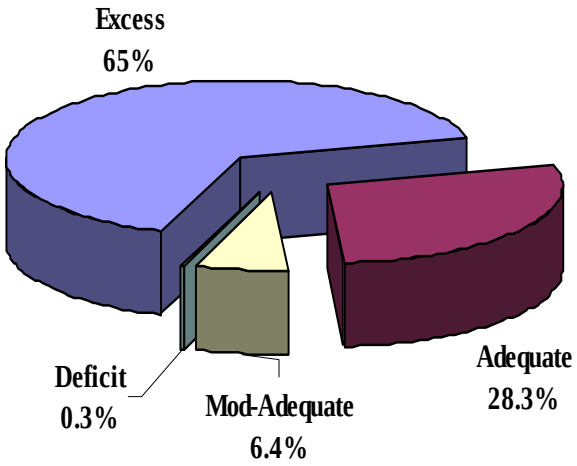


Source: Meteorological department
Developed by: RUP, WRRI/NARC

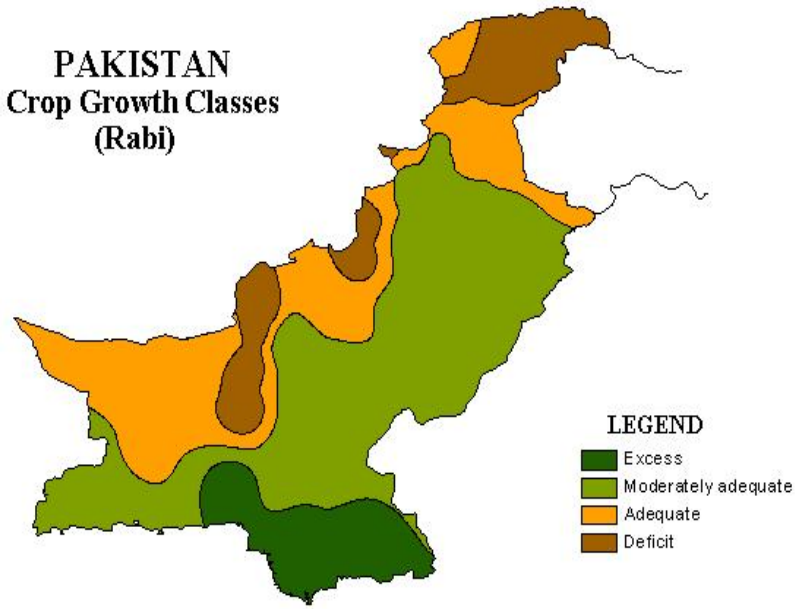
4.2. Crop Growth Index (CGI) Kharif

Crop Growth Index (CGI) reflects the temperature availability for crop growth and is estimated as a ratio of growing degree-days available to those required by a particular crop. The Crop Growth Classes defined range from deficit to excess.

Generally the crop growth index (CGI) in Kharif season is in excess in Punjab, Sindh, southern half of Baluchistan and NWFP. Northern fringes of Punjab province fall in the zone where it is moderately adequate while in the Federally Administered Northern Area of the country, it is adequate (See map).The area where CGI is in excess constitute 65% area of the country. In contrast, in Kharif the area that has temperature deficit or limitation is only 0.3% as can be seen in the figure below.



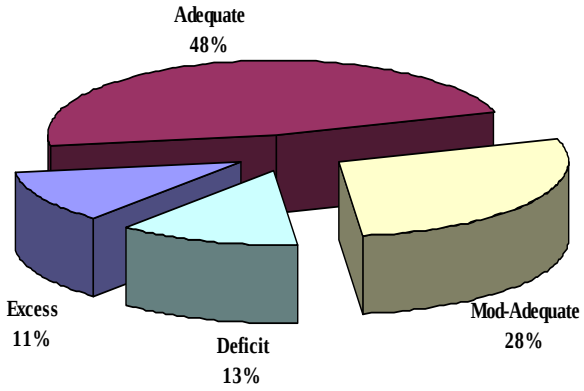
Share of Crop Growth Classes in Kharif



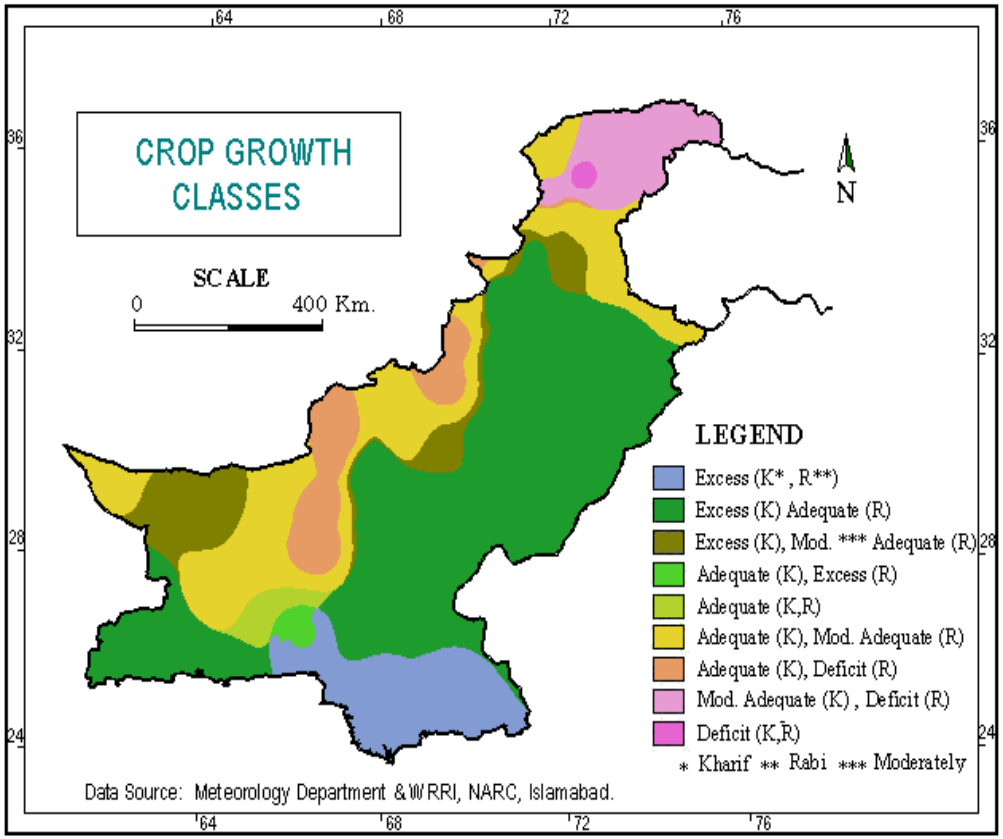
Source: Meteorological department
Developed by: RUP, WRRI/NARC

Crop Growth Index (CGI) Rabi

In Rabi season, the coastal area covering parts of Thatta and whole of Badin in Sindh and Gawadar, Pasni and parts of Turbat and Uthal in Balochistan fall in a zone where the CGI is in excess(See map). The southern half of Balochistan, most of Punjab and a big part of Sindh fall in the moderately adequate zone. The deficit zone lies in the north of Mansehra and Saidu in the northern parts and Quetta, Zhob and Loralai in Balochistan. Almost 11% of the country falls in zone where CGI is excess in even Rabi season (Figure below) whereas 13% area has temperature limitations or deficit. Generally 76% area falls in zone having either adequate or moderately adequate CGI.



Share of Crop Growth Classes for Rabi



Crop Growth Index (CGI) Annual

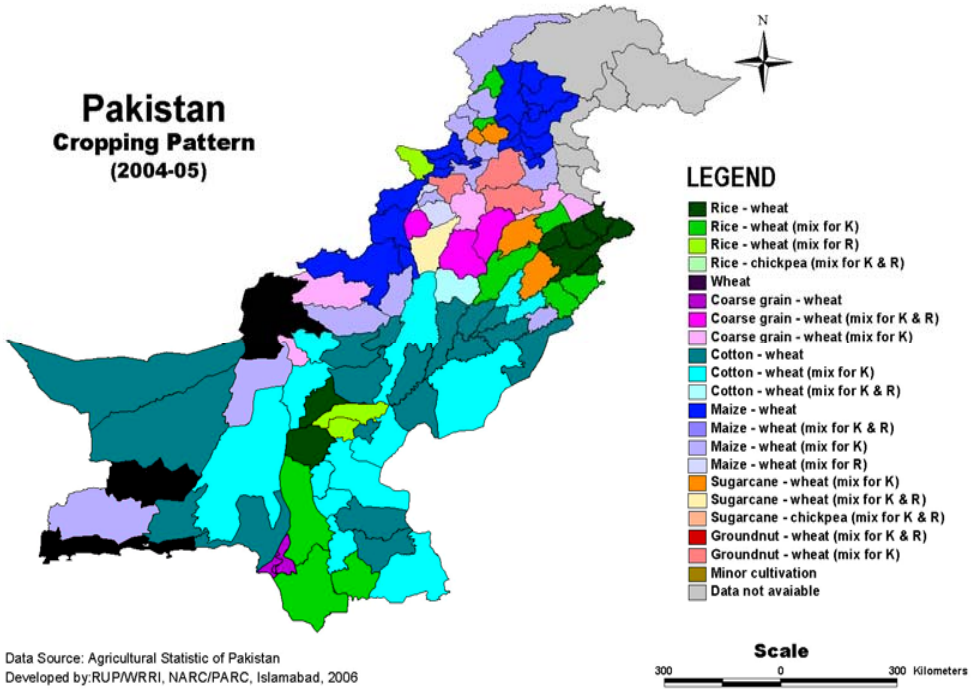
The annual crop growth zones were defined by superimposing the seasonal maps. A total of 9 zones were delineated on the accompanying map.

The crop growth index in both Kharif and Rabi seasons ranges from excess to deficit. In Kharif season, it ranges from normally adequate to excess, whereas in Rabi season from adequate to deficit. The combined 9 zones indicate a considerable variability in the availability of temperature for crop growth. The areas under each class and their percentage share are given in the table below.

Table: The share of CGI classes in Pakistan

S. No.	Classes	Area (Mha)	Area %
1	Excess (K, R)	8.27	10.45
2	Excess(K), Adequate(R)	36.41	46.00
3	Excess(K), Mod.Adequate(R)	6.50	8.21
		51.18	**64.67**
4	Adequate(K), Excess(R)	0.65	0.82
5	Adequate (K, R)	1.26	1.60
6	Adequate(K), Mod.Adequate(R)	15.83	20.00
7	Adequate(K), Deficit(R)	4.89	6.18
		22.63	**28.60**
8	Mod-Adequate(K), Deficit(R)	5.08	6.42
9	Deficit (K, R)	0.24	0.31
Total		**79.13**	**100.00**

Data Source: Pakistan Meteorological Department & WRRI, NARC



4.3. Cropping Pattern

The analysis of cropping pattern using agricultural statistics (2004-05) was completed and the map given here was developed presenting the cropping sequence at national scale under each cropping zone. The areas under each zone are presented in the table below. There are 6 major cropping zones including Cotton-wheat, Maize-wheat, Rice-wheat, Sugarcane- wheat, Coarse grain-wheat and Groundnut-wheat. There are all sorts of variability in these major cropping sequences i.e., either cropping mix for Rabi or Kharif seasons or mix of another major crop of the season. The predominant cropping sequence is Cotton-wheat covering an area of about 49%. It is stretched over lower Punjab, eastern Sindh and western Baluchistan The predominant Cotton-wheat area covers 55% whereas Cotton-wheat mix for Kharif is 43%. On minor area (about 2%) in this zone, the wheat in Rabi season is mixed with Chickpea.

The next predominant cropping sequence is Maize-wheat stretching over about 17% of the total area of the country. For this cropping sequence there are four sub-classes i.e., either it is predominant Maize-wheat system or is mixed with Kharif, Rabi or both Kharif or Rabi crops. This cropping sequence is practiced in the northern Punjab and Baluchistan and NWFP. The maximum extent is of Maize-wheat (46%) followed by this sequence mixed with other Kharif crops (36%). For this cropping sequence on 14% of the area the predominant Kharif crop is Rice. The mix for Rabi crop is limited and account for only 3% of this cropping sequence.

The Rice crop is predominantly rotated with wheat crop in Kharif season and this major cropping pattern accounts for more than 14% of the total area. The area stretches over eastern Punjab and western Sindh. This cropping pattern mixed with Sugarcane stretches over 38% of the zone whereas pure Rice-wheat system is practiced over 24% of the area. Another 20% is the area where Rice is mixed with other Rabi crops and on 12% area wheat is mixed with other Rabi crops. Rice and Maize are the dominant Kharif crops on 5% of this zone. There is

Table: Area under major cropping zones of Pakistan

S.No.	LEGEND	Area (km^2)	Area %
1.1	Cotton - Wheat	218394	26.88
1.2	Cotton - Wheat (mix for K)	171286	21.08
1.3	Cotton - Wheat (mix for K & R)	6534	0.80
		396214	**48.76**
2.1	Maize - Wheat	63057	7.76
2.2	Maize - Wheat (mix for K)	49754	6.12
2.3	Maize-Rice - Wheat	19676	2.42
2.4	Maize - Wheat (mix for R)	4216	0.52
		136703	**16.82**
3.1	Rice-Sugarcane - Wheat	43941	5.41
3.2	Rice - Wheat	28247	3.48
3.3	Rice - Wheat (mix for K)	23702	2.92
3.4	Rice - Wheat (mix for R)	14518	1.79
3.5	Rice-Maize - Wheat	5784	0.71
		116192	**14.31**
4.1	Sugarcane - Chickpea (mix for K & R)	8454	1.04
4.2	Sugarcane - Wheat (mix for K and R)	7413	0.91
4.3	Sugarcane - Wheat (mix for K)	6098	0.75
4.4	Sugarcane-Maize - Wheat	3043	0.37
4.5	Sugarcane-Rice - Wheat	6127	0.75
		31135	**3.82**
5.1	Coarse grain-Rice - Wheat	25686	3.16
5.2	Coarse grain - Wheat	10622	1.31
5.3	Coarse grain - Wheat (mix for K)	13167	1.62
5.4	Coarse grain - Wheat (mix for K and R)	3110	0.38
5.5	Coarse grain - chickpea (mix for K)	6797	0.84
		59382	**7.31**
6.1	Groundnut - Wheat (mix for K)	14031	1.73
6.2	Groundnut - Wheat (mix for K & R)	3475	0.43
		17506	**9.47**
7.0	Wheat	**42481**	**5.23**
	Not Grown	12945	1.59
Total		**812558**	**100.00**

another predominant cropping sequence in variable combinations with Sugarcane that covers 3.83% area.

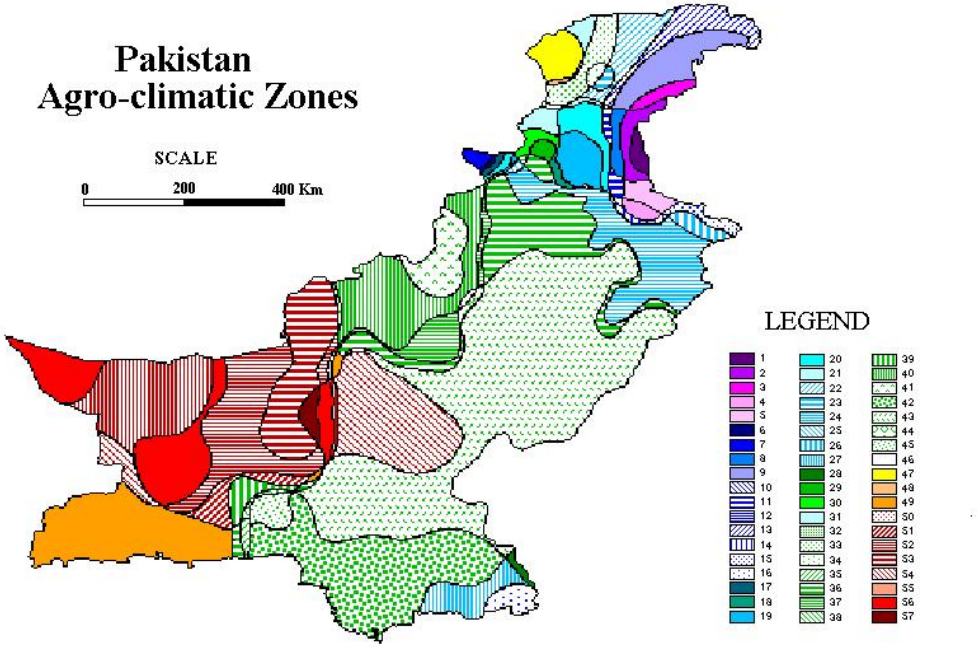
The Sugarcane-chickpea covers 27% of Sugarcane dominated area whereas Sugarcane-wheat mixed with both Rabi and Kharif crops account for 24% area. Another 20% of the area is under Sugarcane-wheat mixed with Kharif only. On another 30% of this cropping zone in Kharif the Sugarcane is either mixed with Rice or Maize.

The Coarse grain- Wheat zone stretches over 7.3% of the total area of the country. Out of this over 43% area is Coarse grain-Rice – wheat, 22% Coarse grain - Wheat (mix for K), 18% Coarse grain – Wheat and 5% Coarse grain - Wheat (mix for K and R). On 11% of this zone Coarse-grain is mixed with Chickpea.

Over about 2% of the country, the Groundnut is grown in combination with wheat. About 80% of this cropping sequence is mixed with other crops in Kharif season.

4.4. Agro-Climatic Zones

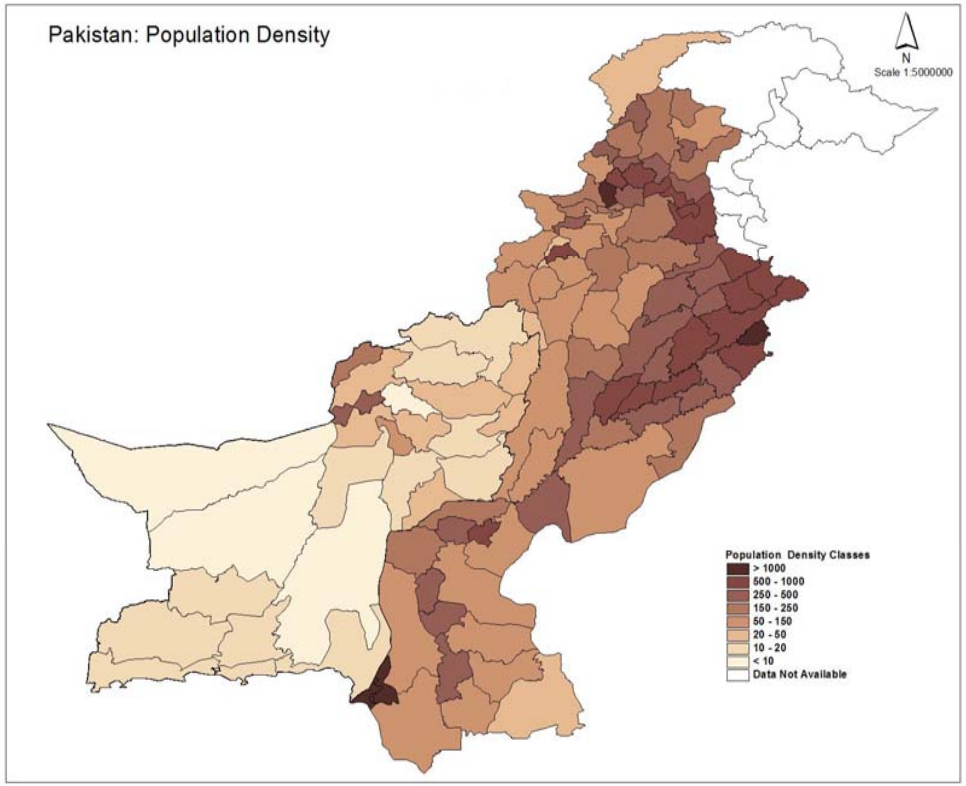
The agro-climatic zones were delineated by superimposing the 18 aridity and 9 crop growth zones, representing both Kharif and Rabi seasons. A total of 57 agro-climatic zones were classified out of which 8 zones are relatively small in size. Each zone shows variability in terms of aridity and crop growth for both the Kharif and the Rabi seasons as below



Data Source: WRRI-NARC/Pakistan Meteorology Department.

S.No	Classes	Area	%
1	Humid(K), Humid(R), Adequate(K), Mod-Adequate(R)	0.24	0.30
2	Humid(K), Sub-humid(R), Mod-Adequate(K), Deficit(R)	0.32	0.41
3	Humid(K), Sub-humid(R), Adequate(K), Mod-Adequate(R)	0.52	0.66
4	Humid(K), Semi-arid(R), Adequate(K), Mod-Adequate(R)	0.41	0.52
5	Humid(K), Semi-arid(R), Excess(K), Adequate(R)	0.21	0.27
6	Sub-humid(K), Humid(R), Adequate(K), Deficit(R)	0.08	0.11
7	Sub-humid(K), Humid(R), Adequate(K), Mod-Adequate(R)	0.03	0.04
8	Sub-humid(K), Sub-humid(R), Mod-Adequate(K), Deficit(R)	1.59	2.01
9	Sub-humid(K), Sub-humid(R), Adequate(K), Mod-Adequate(R)	0.30	0.37
10	Sub-humid(K), Semi-arid(R), Mod-Adequate(K), Deficit(R)	1.16	1.47
11	Sub-humid(K), Semi-arid(R), Adequate(K), Deficit(R)	0.01	0.01
12	Sub-humid(K), Semi-arid(R), Adequate(K), Mod-Adequate(R)	0.26	0.33
13	Sub-humid(K), Semi-arid(R), Excess(K), Adequate(R)	0.02	0.03
14	Sub-humid(K), Arid(R), Adequate(K), Mod-Adequate(R)	0.32	0.40
15	Sub-humid(K), Arid(R), Excess(K), Adequate(R)	0.15	0.19
16	Sub-humid(K), Hyper-arid(R), Excess(K), Excess(R)	0.46	0.58
17	Semi-arid(K), Humid(R), Adequate(K), Mod-Adequate(R)	0.06	0.07
18	Semi-arid(K), Semi-arid(R), Deficit(K), Deficit(R)	0.12	0.15
19	Semi-arid(K), Semi-arid(R), Mod-Adequate(K), Deficit(R)	1.06	1.34
20	Semi-arid(K), Semi-arid(R), Adequate(K), Deficit(R)	0.07	0.09
21	Semi-arid(K), Semi-arid(R), Adequate(K), Mod-Adequate(R)	0.83	1.05
22	Semi-arid(K), Semi-arid(R), Excess(K), Mod-Adequate(R)	0.92	1.16
23	Semi-arid(K), Semi-arid(R), Excess(K), Adequate(R)	0.12	0.16
24	Semi-arid(K), Arid(R), Adequate(K), Mod-Adequate(R)	0.35	0.44
25	Semi-arid(K), Arid(R), Excess(K), Mod-Adequate(R)	0.08	0.10
26	Semi-arid(K), Arid(R), Excess(K), Adequate(R)	3.89	4.92
27	Semi-arid(K), Hyper-arid(R), Excess(K), Adequate(R)	0.12	0.15
28	Semi-arid(K), Hyper-arid(R), Excess(K), Excess(R)	1.10	1.38
29	Arid(K), Semi-arid(R), Deficit(K), Deficit(R)	0.12	0.16
30	Arid(K), Semi-arid(R), Mod-Adequate(K), Deficit(R)	0.88	1.11
31	Arid(K), Semi-arid(R), Adequate(K), Deficit(R)	0.03	0.03
32	Arid(K), Semi-arid(R), Adequate(K), Mod-Adequate(R)	0.46	0.58
33	Arid(K), Semi-arid(R), Excess(K), Mod-Adequate(R)	0.18	0.23
34	Arid(K), Semi-arid(R), Excess(K), Adequate(R)	0.18	0.22
35	Arid(K), Arid(R), Adequate(K), Deficit(R)	1.30	1.65
36	Arid(K), Arid(R), Adequate(K), Mod-Adequate(R)	3.50	4.42
37	Arid(K), Arid(R), Adequate(K), Adequate(R)	0.49	0.62
38	Arid(K), Arid(R), Adequate(K), Excess(R)	0.11	0.14
39	Arid(K), Arid(R), Excess(K), Mod-Adequate(R)	1.25	1.58
40	Arid(K), Arid(R), Excess(K), Adequate(R)	4.42	5.58
41	Arid(K), Arid(R), Excess(K), Excess(R)	0.14	0.18
42	Arid(K), Hyper-arid(R), Adequate(K), Mod-Adequate(R)	0.05	0.07
43	Arid(K), Hyper-arid(R), Adequate(K), Excess(R)	0.54	0.68
44	Arid(K), Hyper-arid(R), Excess(K), Mod-Adequate(R)	0.12	0.15
45	Arid(K), Hyper-arid(R), Excess(K), Adequate(R)	17.82	22.52
46	Arid(K), Hyper-arid(R), Excess(K), Excess(R)	6.58	8.31
47	Hyper-arid(K), Semi-arid(R), Mod-Adequate(K), Deficit(R)	0.06	0.07
48	Hyper-arid(K), Semi-arid(R), Adequate(K), Mod-Adequate(R)	0.73	0.93
49	Hyper-arid(K), Arid(R), Adequate(K), Deficit(R)	3.09	3.91
50	Hyper-arid(K), Arid(R), Adequate(K), Mod-Adequate(R)	3.92	4.95
51	Hyper-arid(K), Arid(R), Adequate(K), Adequate(R)	0.77	0.98
52	Hyper-arid(K), Arid(R), Excess(K), Mod-Adequate(R)	0.05	0.06
53	Hyper-arid(K), Arid(R), Excess(K), Adequate(R)	4.59	5.80
54	Hyper-arid(K), Hyper-arid(R), Adequate(K), Deficit(R)	0.31	0.39
55	Hyper-arid(K), Hyper-arid(R), Adequate(K), Mod-Adequate(R)	3.85	4.87
56	Hyper-arid(K), Hyper-arid(R), Excess(K), Mod-Adequate(R)	3.90	4.93
57	Hyper-arid(K), Hyper-arid(R), Excess(K), Adequate(R)	4.89	6.18
Total		**79.14**	**100**

HUMAN SETTLEMENTS & ASSOCIATED FEATURES



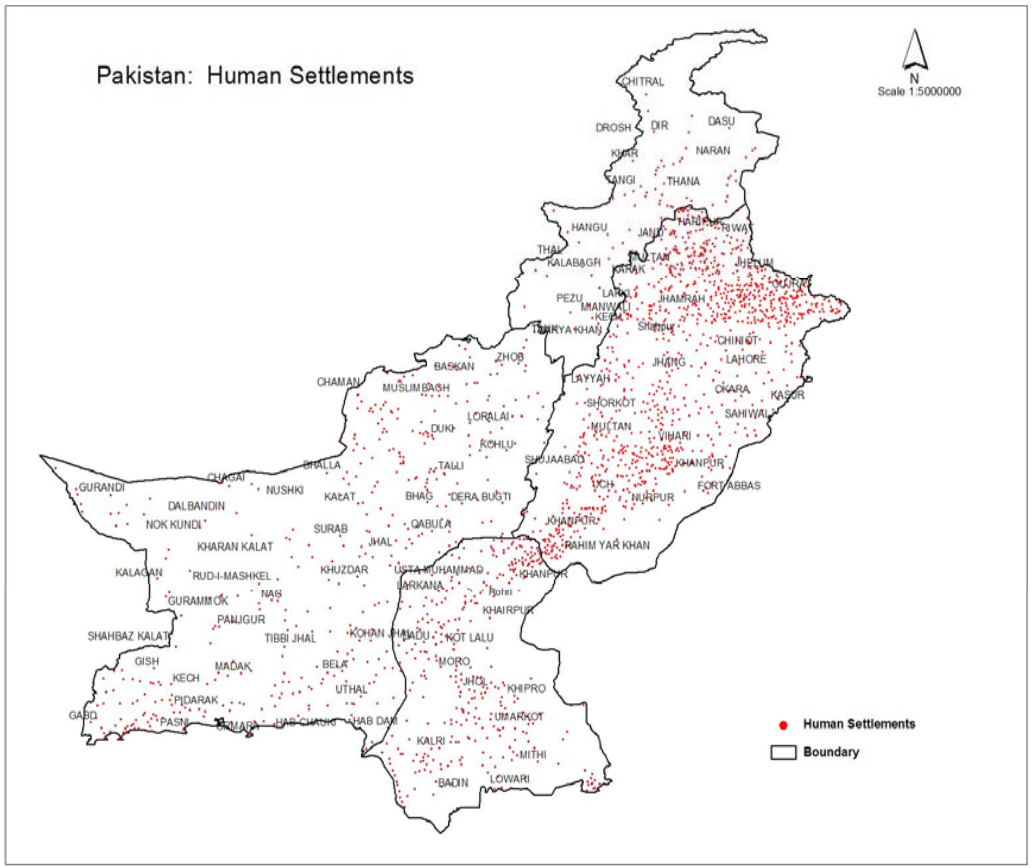
5.1. Population and Human Settlements

Land use planning and population are very closely interrelated. With increasing population per capita share in land has decreased in Pakistan. In spite of the fact that cultivated area in the country has increased, the per capita cultivated area has decreased substantially.

Pakistan's estimated population in July 2009 is around 17.5 million. During 1950-2008, Pakistan's urban population expanded over sevenfold, while the total population increased by over fourfold. By the end of this decade the population is expected to be nearly 180 million. In the past, the country's population had a relatively high growth rate that has, however, been moderated by declining fertility and birth rates.

Historical Populations		
Census	**Population**	**Urban**
1951	33,816,000	17.80%
1961	42,978,000	22.46%
1972	65,321,000	25.40%
1981	84,254,000	28.28%
1998	130,580,000	32.51%
2008	172,800,000	32.34%

In terms of human settlements, the number of towns in Pakistan increased from 238 in 1951 to 515 in 2005. The number of cities with population of over 100,000 increased from 10 to 59 and the number of cities with population of over 500,000 increased from 2 to 12. Dramatic social changes have led to rapid urbanization and the emergence of megacities. During 1990-2003, Pakistan sustained its historical lead as the most urbanized nation in South Asia; with city dwellers making up 34% of its population.The growth of the cities have had notable environmental impacts particularly in terms of encroachment on prime agricultural land, and in terms of degradation of land and ambient environment through solid waste disposal and enhanced environmental pollution.


Pakistan: Human Settlements
N
Scale 1:5000000
CHITRAL
DROSH
DIR
DASU
KUNR
NARAN
ANGI
THANA
HANGU
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TIWA
THAL
KALABAGH
KARAK
JHELUM
PEZU
LAKKI
MANWALI
JHAMRAH
KERA
SHAKAR
TOWRYA KHAN
CHINIOT
ZHOB
JHANG
LAHORE
BASKAN
CHAMAN
MUSLIM BAGH
LAYYAH
OKARA
KASUR
SHORKOT
SAHIWAL
LORALAI
MULTAN
DUKI
VEHARI
KOHLU
SHUJAABAD
KHANPUR
BHALLA
TAULI
CHAGAI
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FORT ABBAS
GURANDI
NUSHKI
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DERA BUGTI
NURPUR
DALBANDIN
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JHANPOR
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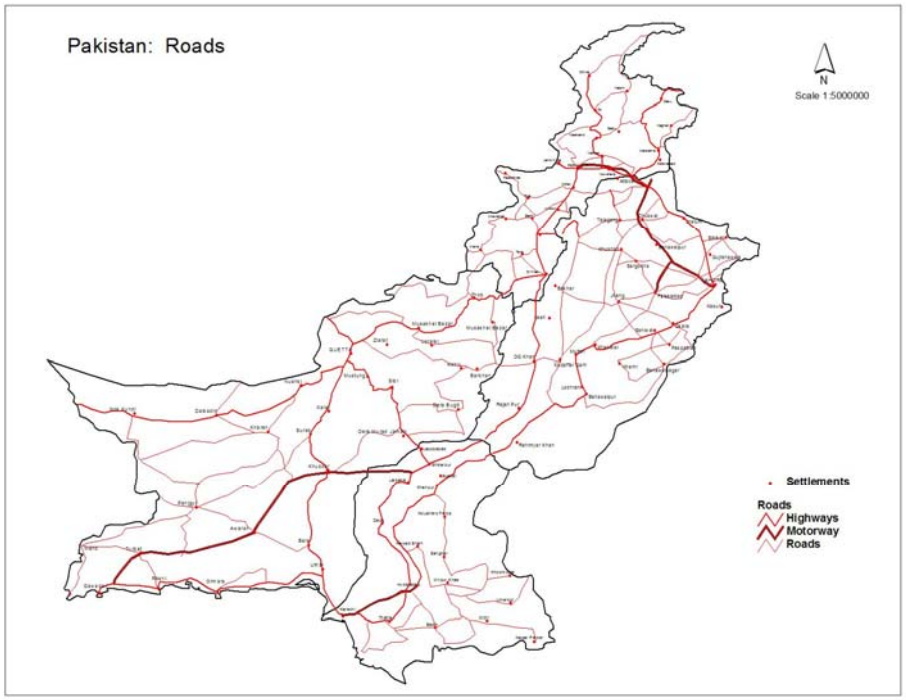
KHARAN KALAT
JHAL
RAHIM YAR KHAN
KALAGAN
RUD-I-MASHKEL
KHUZDAR
USTA MUHAMMAD
KHANPUR
JARKANA
NAG
GURAMMOK
KHAIRPUR
PANJGUR
SHAHBAZ KALAT
TIBBI JHAL
KOHAN
KOT LALU
GISH
MADAK
BELA
MORO
KECH
JHOL
KHIPRO
PIDARAK
UTHAL
GABD
PASNI
HAB CHAUKI
HAB DAM
UMARKOT
KALRI
MITHI
BADIN
LOWARI
Human Settlements
Boundary



5.2. Roads

Roads play an important role in the land use development and modification. At the time of independence roads in Pakistan served more as feeders to the railways. Today however, they are competitor of railways both in the carriage of goods and passengers. The road network in the country has a total road length of 257,683 kms, of which 152,033 are paved and 105,650 are unpaved. It includes four national highways as well as three important motorways as follows:

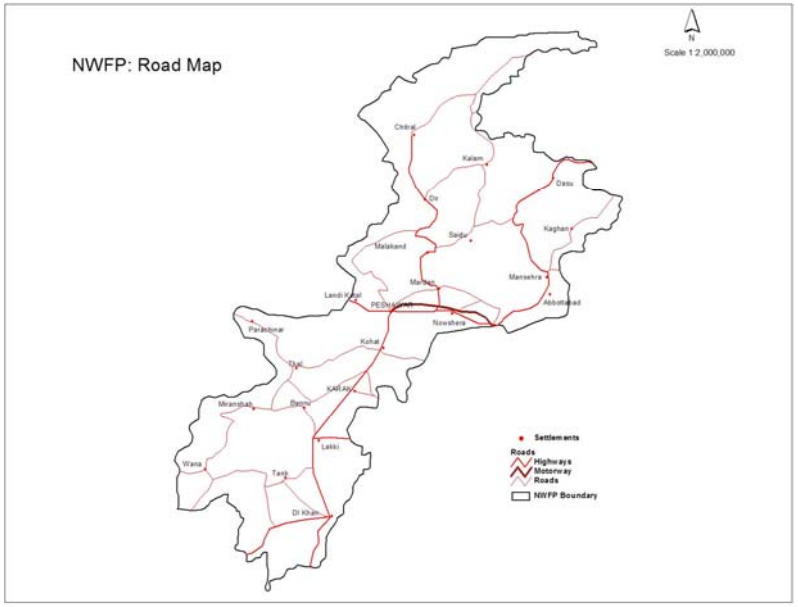
The Makran Coastal Highway follows the coast of Sindh and Balochistan provinces, linking Karachi and Gwadar. The highway was built as part of an overall plan to improve transport facilities in southern Balochistan.

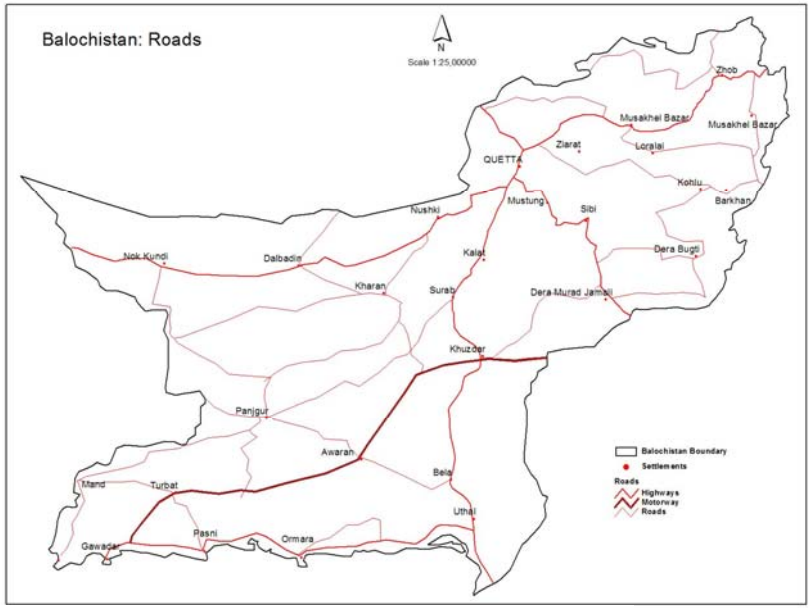
The Karakoram Highway is the highest paved international road in the world. It connects China and Pakistan across the Karakoram mountain range, through the Khunjerab Pass.

The Grand Trunk Road (commonly abbreviated to GT Road) is one of South Asia's oldest and longest major roads. For several centuries, it has linked the eastern and western regions of the Indian subcontinent, running from Bengal, across north India, to Peshawar in Pakistan.

The Silk Road is an extensive interconnected network of trade routes across the Asian continent connecting East, South, and Western Asia with the Mediterranean world, including North Africa and Europe. It passes through the mid section of Pakistan through cities of Peshawar, Taxila and Multan.

The construction of motorways began in the early 1990s with the idea of building a world class road network and to reduce the load off the heavily used national highways throughout the country. The M2 was the first motorway completed in 1998, linking the cities of Islamabad and Lahore. In the past few years, two new motorways have opened up including the M1connecting Peshawar and Islamabad, and M3 linking Faisalabad with M2 motorway.


NWFP: Road Map
N
Scale 1:2,000,000
Chitral
Kalam
Dir
Swat
Malakand
Kaghan
Mansehra
Abbottabad
Mardan
Landi Kotal
PESHAWAR
Nowshera
Parachinar
Kohat
OAK
KARAK
Miranshah
Bannu
Lakki
Wana
Tank
DI Khan
Settlements
Roads
Highways
Motorway
Roads
NWFP Boundary


Balochistan: Roads
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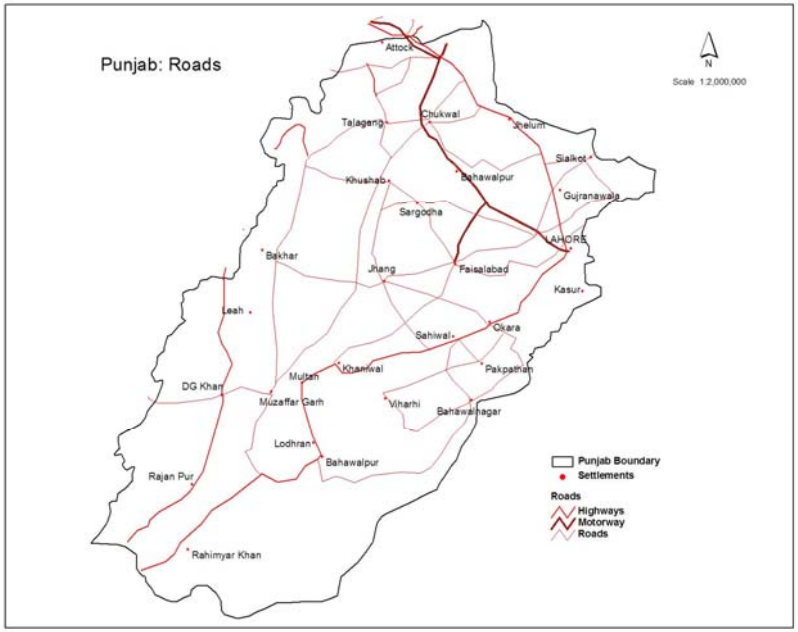
Zhob
Musakhel Bazar
Musakhel Bazar
Ziarat
Loralai
QUETTA
Kohlu
Barkhan
Nushki
Mustung
Sibi
Nok Kundi
Dalbadin
Kalat
Dera Bugti
Kharan
Surab
Dera Murad Jamali
Khuzdar
Panjgur
Awaran
Mand
Turbat
Bela
Uthal
Pasni
Gawadar
Ormara
Balochistan Boundary
Settlements
Roads
Highways
Motorway
Roads


Punjab: Roads
N
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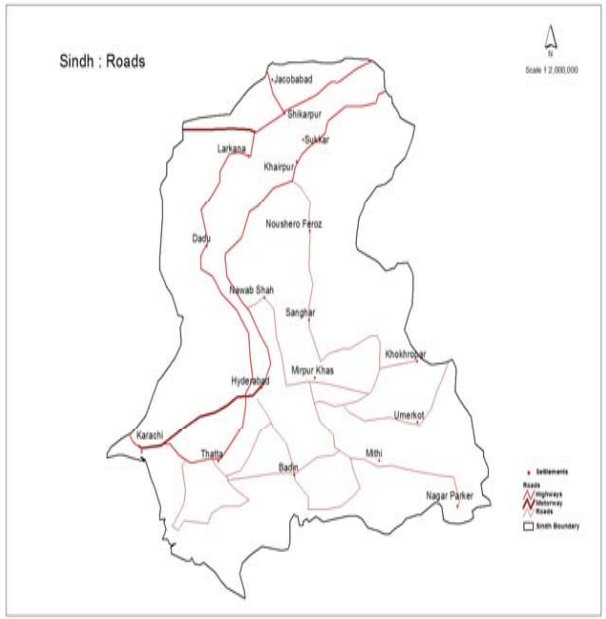
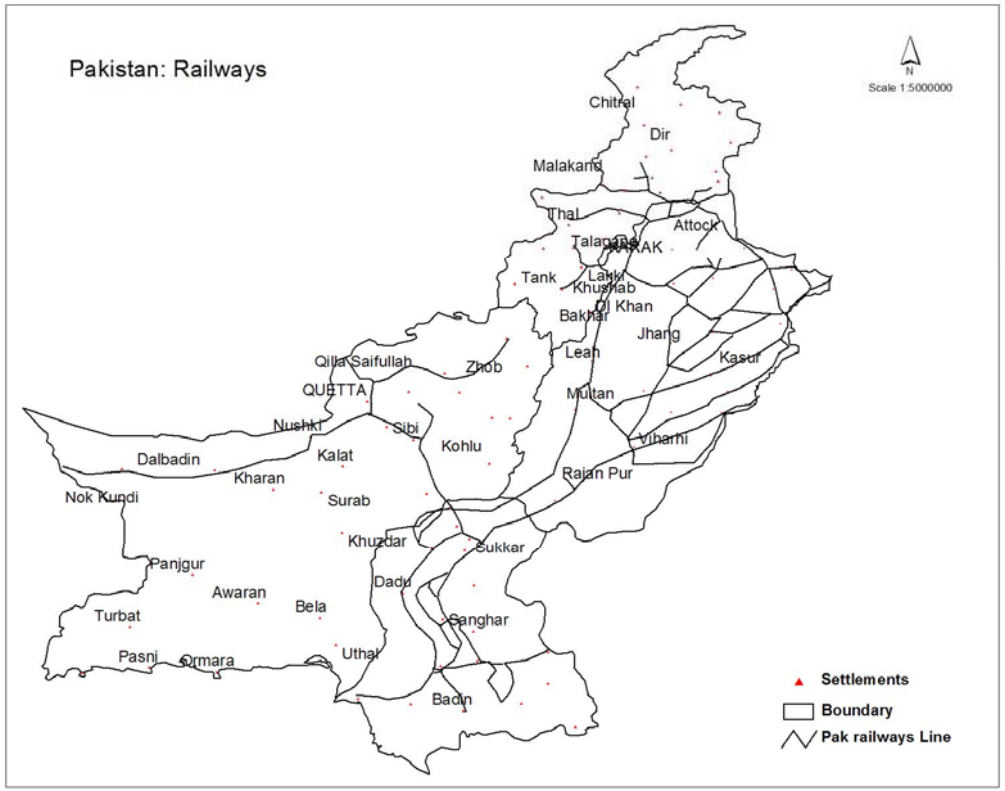
Attock
Talagang
Chukwal
Jhelum
Sialkot
Khushab
Bahawalpur
Gujranawala
Sargodha
LAHORE
Bakhar
Jhang
Faisalabad
Kasur
Leah
Okara
Sahiwal
Khanwal
Pakpattan
Multan
DG Khan
Muzaffar Garh
Viharhi
Bahawalnagar
Lodhran
Bahawalpur
Rajan Pur
Rahimyar Khan
Punjab Boundary
Settlements
Roads
Highways
Motorway
Roads

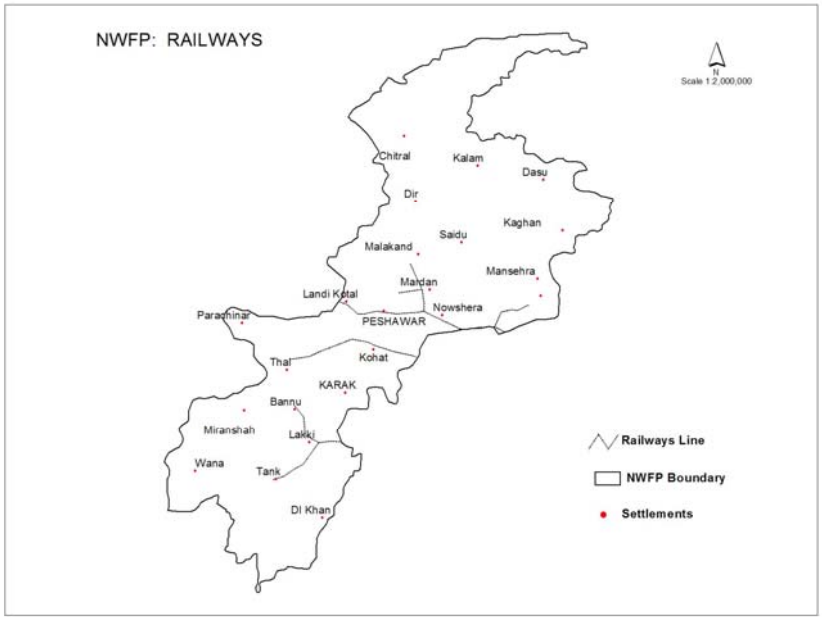

Sindh ; Roads
N
Scale 1:2,000,000
Jacobabad
Shikarpur
Larkana
Sukkar
Khairpur
Noushero Feroz
Dadu
Newab Shah
Sanghar
Khokhropar
Mirpur Khas
Hyderabad
Umerkot
Karachi
Thatta
Mithi
Badin
Nagar Parker
Settlements
Roads
Highways
Motorway
Roads
Sindh Boundary

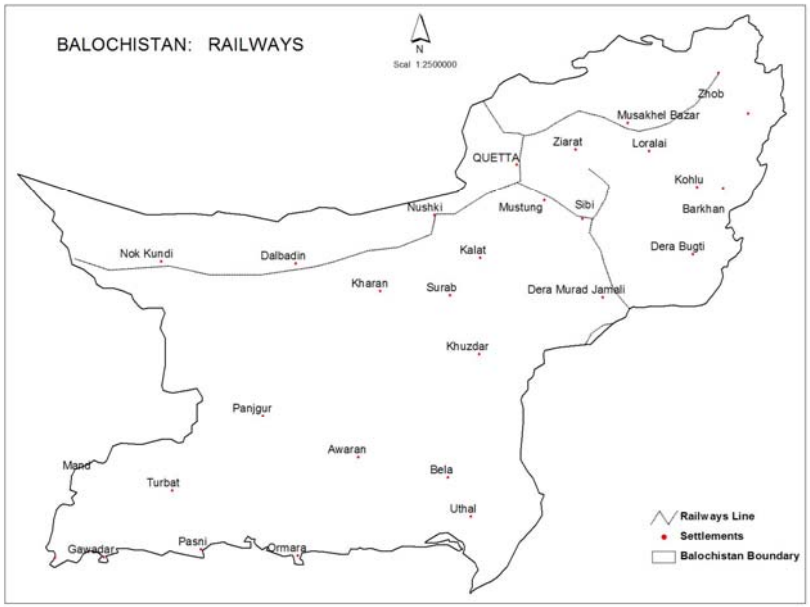


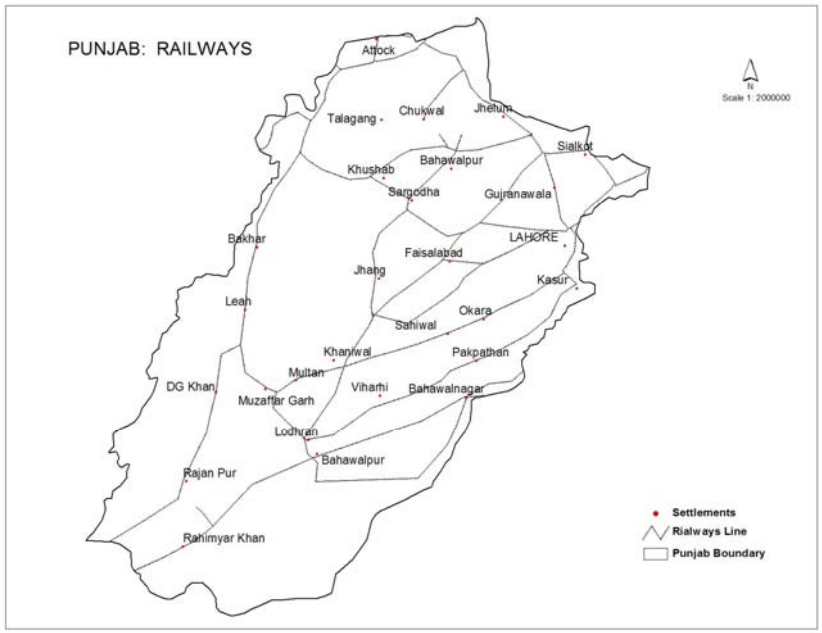
5.3. Railways

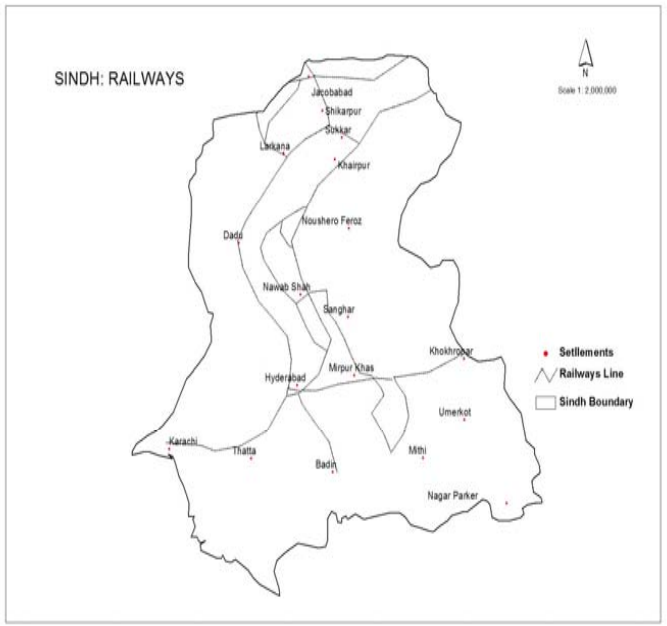
Railways, like roads also play significant role in land use development and modification. Rail services are provided by the state-run Pakistan Railways, under the supervision of the Ministry of Railways. Pakistan Railways provides an important mode of transportation, catering to the large-scale movement of people and freight. The railway network comprises 8,163 km of which broad gauge (1.676-m) forms 7,718 km including 293 km of electrified track. Narrow gauge (1-metre) tracks form the remaining 445 km. Passenger earnings comprise 50% of the total revenue. Pakistan Railways carry 65 million passengers annually and daily operates 228 mail, express and passenger trains. Pakistan Railways also operate special trains for various occasions. The Freight Business Unit with 12000 personnel operates over 200 freight stations on the railway network. The FBU serves the Port of Karachi and Port Qasim as well as in various other stations along the network and generates revenue from the movement of agricultural, industrial and imported products such as wheat, coal, fertilizer, cement, and sugar.

Internationally, a broad gauge railway line runs from Zahedan to Quetta, and a standard gauge line is being built from Zahedan to Kerman in central Iran, to link it with the rest of the Iranian rail network. Rail link with India is via Lahore in the Punjab and via Khokhrapar in Sindh.

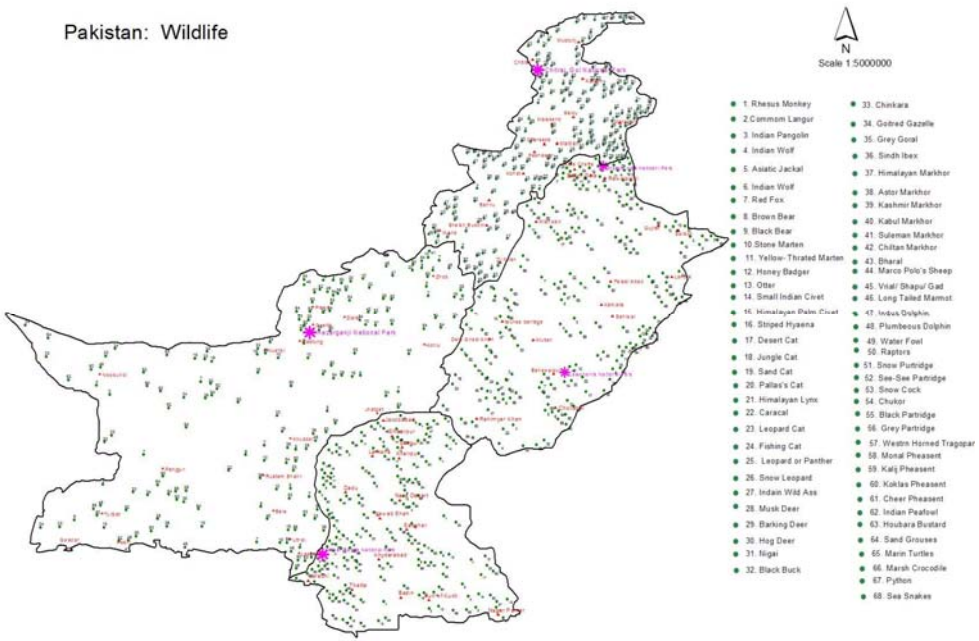

NWFP: RAILWAYS
N
Scale 1:2,000,000
Chitral
Kalam
Dasu
Dir
Kaghan
Saidu
Malakand
Mansehra
Mardan
Landi Kotal
Nowshera
Paraachinar
PESHAWAR
Thal
Kohat
KARAK
Bannu
Miranshah
Lakki
Wana
Tank
DI Khan
Railways Line
NWFP Boundary
Settlements


BALOCHISTAN: RAILWAYS
N
Scal 1:2500000
Zhob
Musakhel Bazar
Ziarat
Loralai
QUETTA
Kohlu
Nushki
Mustung
Sibi
Barkhan
Nok Kundi
Dalbadin
Kalat
Dera Bugti
Kharan
Surab
Dera Murad Jamali
Khuzdar
Panjgur
Awaran
Mand
Turbat
Bela
Uthal
Gawadar
Pasni
Ormara
Railways Line
Settlements
Balochistan Boundary


PUNJAB: RAILWAYS
N
Scale 1: 2000000
Attock
Talagang
Chukwal
Jhelum
Sialkot
Khushab
Bahawalpur
Sargodha
Gujranawala
Bakhar
LAHORE
Faisalabad
Jhang
Kasur
Leah
Okara
Sahiwal
Khanwal
Pakpattan
Multan
DG Khan
Muzaffar Garh
Vihari
Bahawalnagar
Lodhran
Bahawalpur
Rajan Pur
Rahimyar Khan
Settlements
Rialways Line
Punjab Boundary


SINDH: RAILWAYS
N
Scale 1: 2,000,000
Jacobabad
Shikarpur
Sukkar
Larkana
Khairpur
Noushero Feroz
Dadu
Nawab Shah
Sanghar
Khokhropar
Mirpur Khas
Hyderabad
Umerkot
Karachi
Thatta
Mithi
Badin
Nagar Parker
Settlements
Railways Line
Sindh Boundary

WILDLIFE & ASSOCIATED FEATURES



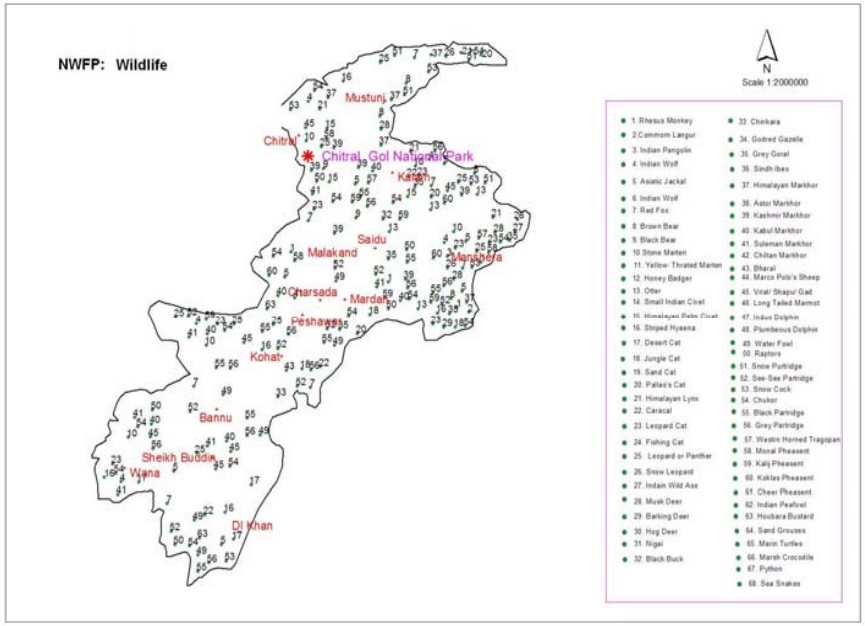
Wildlife

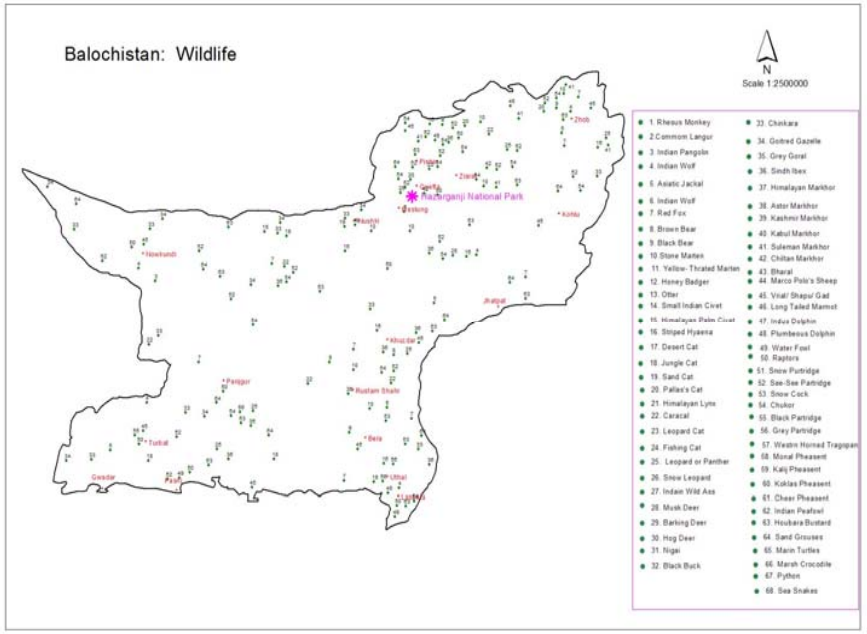
The accompanying maps of Pakistan and provinces give the distribution of wildlife. Given the widespread change of land use particularly widespread conversion of natural ecosystems to agriculture, the already highly advanced and rapidly degradation of habitats, and the continuing depletion of wildlife population, almost all remaining natural or modified ecosystems are now critically threatened.

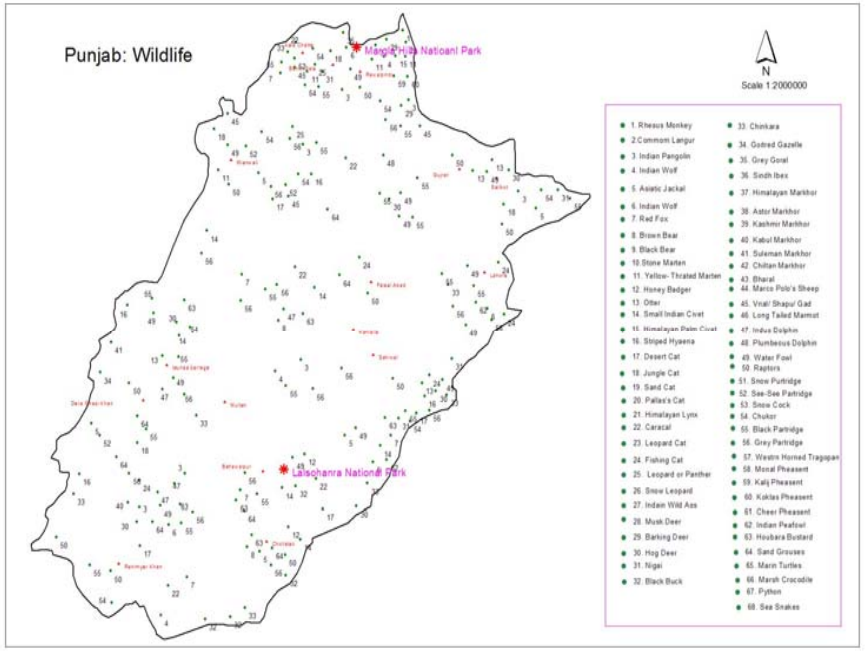
Protected areas are created to safeguard representative ecosystems. However, majority of Pakistan's protected areas were created in the 1970s with insufficient attention paid to ecological criteria and the requirement of wildlife communities. According to Biodiversity Action Plan (BAP), the protected areas are too small and isolated to be effective. Moreover, most ecological zones are not adequately represented within the network of protected areas including a majority of critically threatened ecosystems identified in BAP as shown in the table below:

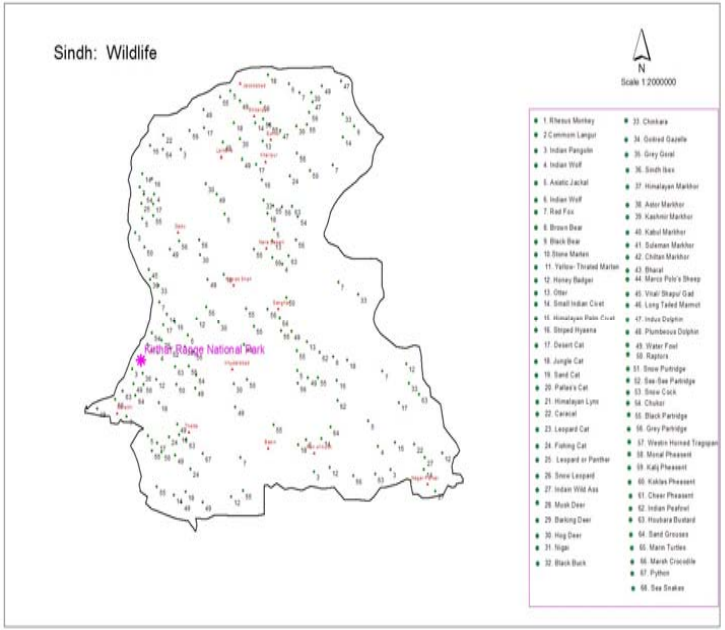
Table Critically Threatened Ecosystems in Pakistan

ECOSYSTEM	CHARACTERISTICS	SIGNIFICANCE	THREATS
Indus delta and coastal wetlands	Extensive mangroves and mudflats Inadequate protected area coverage	Rich avian and marine fauna Diverse mangrove habitat Marine turtle habitat	Reduced freshwater flow from diversions upstream Cutting mangroves for fuelwood Drainage of coastal wetlands
Indus river and wetlands	Extensive wetlands	Migratory flyway of global importance Habitat for Indus river dolphin	Water diversion/drainage Agricultural intensification Toxic pollutants
Chagai desert	A desert of great antiquity	Many endemic and unique species	Proposed mining Hunting parties from the Gulf
Balochistan juniper forest	Huge and ancient junipers	Largest remaining juniper forest in the world Unique flora and fauna	Fuelwood cutting and overgrazing Habitat fragmentation
Chilghoza forest (Sulaiman Range)	Rock outcrops with shallow mountain soils	Important wildlife habitat for several species at risk	Fuelwood cutting and overgrazing Illegal hunting
Balochistan sub-tropical forests	Mid-altitude forests with sparse canopy but rich associated flora	Very few areas now remain Important wildlife habitat	Fuelwood cutting and overgrazing
Balochistan rivers	Not connected with the Indus river system	Unique aquatic fauna and flora with high levels of endemism	Water diversion/drainage Overfishing
Tropical deciduous forests (Himalayan foothills)	Extend from the Margalla Hills National Park east to Azad Kashmir	Perhaps the most floristically rich ecosystem of Pakistan	Fuelwood cutting and overgrazing
Moist and dry temperate Himalayan forests	Important forest tracts now becoming increasingly fragmented	Global hotspot for avian diversity; important wildlife habitat	Commercial logging Fuelwood cutting and overgrazing
Trans-Himalayan alps and plateaux	Spectacular mountain scenery	Unique flora and fauna; center of endemism	Fuelwood cutting and overgrazing Illegal hunting Unregulated tourism Habitat fragmentation


NWFP: Wildlife
N
Scale 1:2000000
Mustuni
Chitral
Chitral Gol National Park
Kamoy
Saidu
Malakand
Mansehra
Charsada
Mardan
Peshawar
Kohat
Bannu
Sheikh Buddin
Wana
DI Khan
1. Rhesus Monkey
2.Commom Langur
3. Indian Pangolin
4. Indian Wolf
5. Asiatic Jackal
6. Indian Wolf
7. Red Fox
8. Brown Bear
9. Black Bear
10.Stone Marten
11. Yellow- Thrated Marten
12. Honey Badger
13. Otter
14. Small Indian Civet
15. Himalayan Palm Civet
16. Striped Hyaena
17. Desert Cat
18. Jungle Cat
19. Sand Cat
20. Pallas's Cat
21. Himalayan Lynx
22. Caracal
23. Leopard Cat
24. Fishing Cat
25. Leopard or Panther
26. Snow Leopard
27. Indain Wild Ass
28. Musk Deer
29. Barking Deer
30. Hog Deer
31. Nigai
32. Black Buck
33. Chinkara
34. Gotred Gazelle
35. Grey Goral
36. Sindh Ibex
37. Himalayan Markhor
38. Astor Markhor
39. Kashmir Markhor
40. Kabul Markhor
41. Suleman Markhor
42. Chiltan Markhor
43. Bharal
44. Marco Polo's Sheep
45. Vrial/ Shapu/ Gad
46. Long Tailed Marmot
47. Indus Dolphin
48. Plumbeous Dolphin
49. Water Fowl
50. Raptors
51. Snow Partridge
52. See-See Partridge
53. Snow Cock
54. Chukor
55. Black Partridge
56. Grey Partridge
57. Westrn Horned Tragopan
58. Monal Pheasent
59. Kalij Pheasent
60. Koklas Pheasent
61. Cheer Pheasent
62. Indian Peafowl
63. Houbara Bustard
64. Sand Grouses
65. Marin Turtles
66. Marsh Crocodile
67. Python
68. Sea Snakes


Balochistan: Wildlife
N
Scale 1:2500000
Razzarganji National Park
1. Rhesus Monkey
2.Commom Langur
3. Indian Pangolin
4. Indian Wolf
5. Asiatic Jackal
6. Indian Wolf
7. Red Fox
8. Brown Bear
9. Black Bear
10.Stone Marten
11. Yellow- Thrated Marten
12. Honey Badger
13. Otter
14. Small Indian Civet
15. Himalayan Palm Civet
16. Striped Hyaena
17. Desert Cat
18. Jungle Cat
19. Sand Cat
20. Pallas's Cat
21. Himalayan Lynx
22. Caracal
23. Leopard Cat
24. Fishing Cat
25. Leopard or Panther
26. Snow Leopard
27. Indain Wild Ass
28. Musk Deer
29. Barking Deer
30. Hog Deer
31. Nigai
32. Black Buck
33. Chinkara
34. Gotred Gazelle
35. Grey Goral
36. Sindh Ibex
37. Himalayan Markhor
38. Astor Markhor
39. Kashmir Markhor
40. Kabul Markhor
41. Suleman Markhor
42. Chiltan Markhor
43. Bharal
44. Marco Polo's Sheep
45. Vrial/ Shapu/ Gad
46. Long Tailed Marmot
47. Indus Dolphin
48. Plumbeous Dolphin
49. Water Fowl
50. Raptors
51. Snow Partridge
52. See-See Partridge
53. Snow Cock
54. Chukor
55. Black Partridge
56. Grey Partridge
57. Westrn Horned Tragopan
58. Monal Pheasent
59. Kalij Pheasent
60. Koklas Pheasent
61. Cheer Pheasent
62. Indian Peafowl
63. Houbara Bustard
64. Sand Grouses
65. Marin Turtles
66. Marsh Crocodile
67. Python
68. Sea Snakes


Punjab: Wildlife
N
Scale 1:2000000
Margalla Hills Natioanl Park
Lalsohanra National Park
1. Rhesus Monkey
2.Commom Langur
3. Indian Pangolin
4. Indian Wolf
5. Asiatic Jackal
6. Indian Wolf
7. Red Fox
8. Brown Bear
9. Black Bear
10.Stone Marten
11. Yellow- Thrated Marten
12. Honey Badger
13. Otter
14. Small Indian Civet
15. Himalayan Palm Civet
16. Striped Hyaena
17. Desert Cat
18. Jungle Cat
19. Sand Cat
20. Pallas's Cat
21. Himalayan Lynx
22. Caracal
23. Leopard Cat
24. Fishing Cat
25. Leopard or Panther
26. Snow Leopard
27. Indain Wild Ass
28. Musk Deer
29. Barking Deer
30. Hog Deer
31. Nigai
32. Black Buck
33. Chinkara
34. Gotred Gazelle
35. Grey Goral
36. Sindh Ibex
37. Himalayan Markhor
38. Astor Markhor
39. Kashmir Markhor
40. Kabul Markhor
41. Suleman Markhor
42. Chiltan Markhor
43. Bharal
44. Marco Polo's Sheep
45. Vrial/ Shapu/ Gad
46. Long Tailed Marmot
47. Indus Dolphin
48. Plumbeous Dolphin
49. Water Fowl
50. Raptors
51. Snow Partridge
52. See-See Partridge
53. Snow Cock
54. Chukor
55. Black Partridge
56. Grey Partridge
57. Westrn Horned Tragopan
58. Monal Pheasent
59. Kalij Pheasent
60. Koklas Pheasent
61. Cheer Pheasent
62. Indian Peafowl
63. Houbara Bustard
64. Sand Grouses
65. Marin Turtles
66. Marsh Crocodile
67. Python
68. Sea Snakes


Sindh: Wildlife
N
Scale 1:2000000
Kerthir Range National Park
1. Rhesus Monkey
2.Commom Langur
3. Indian Pangolin
4. Indian Wolf
5. Asiatic Jackal
6. Indian Wolf
7. Red Fox
8. Brown Bear
9. Black Bear
10.Stone Marten
11. Yellow- Thrated Marten
12. Honey Badger
13. Otter
14. Small Indian Civet
15. Himalayan Palm Civet
16. Striped Hyaena
17. Desert Cat
18. Jungle Cat
19. Sand Cat
20. Pallas's Cat
21. Himalayan Lynx
22. Caracal
23. Leopard Cat
24. Fishing Cat
25. Leopard or Panther
26. Snow Leopard
27. Indain Wild Ass
28. Musk Deer
29. Barking Deer
30. Hog Deer
31. Nigai
32. Black Buck
33. Chinkara
34. Gotred Gazelle
35. Grey Goral
36. Sindh Ibex
37. Himalayan Markhor
38. Astor Markhor
39. Kashmir Markhor
40. Kabul Markhor
41. Suleman Markhor
42. Chiltan Markhor
43. Bharal
44. Marco Polo's Sheep
45. Vrial/ Shapu/ Gad
46. Long Tailed Marmot
47. Indus Dolphin
48. Plumbeous Dolphin
49. Water Fowl
50. Raptors
51. Snow Partridge
52. See-See Partridge
53. Snow Cock
54. Chukor
55. Black Partridge
56. Grey Partridge
57. Westrn Horned Tragopan
58. Monal Pheasent
59. Kalij Pheasent
60. Koklas Pheasent
61. Cheer Pheasent
62. Indian Peafowl
63. Houbara Bustard
64. Sand Grouses
65. Marin Turtles
66. Marsh Crocodile
67. Python
68. Sea Snakes