FORESTS & BIODIVERSITY INFORMATION/DATA REPORT

Table of Contents

List of Tables

List of Appendices

List of Maps

Forest:
A community of plants and animals dominated by woody vegetation is called a forest

Jungle
Land densely overgrown with vegetation naturally and without human intervention

Legal Definition of Forest
An area or piece of land declared by Government under law as forest is a forest

Guzara Forest
These are the forests located close to settlements to meet the needs of local communities and owned by these communities, either managed by communities or by forest departments. Communal and Shamlat are its sub categories.

Natural forests
A natural forest is a complex ecosystem, comprising of indigenous species that has evolved over millennia

Irrigated Plantation
The man made forest or a large number of trees cultivated together by man and are irrigated through artificial water channels are called as irrigated plantation.

Rangeland
Rangelands are ecosystems which carry a vegetation consisting of native and/or naturalized species of grasses and dicotyledonous herbs, trees and shrubs, used for grazing or browsing by wild and domestic animals, on which management is restricted to grazing, burning and control of woody plants

Wildlife
All non-domesticated plants, animals and other organisms

Biodiversity
Biodiversity is the variation of life forms within a given ecosystem, biome, or on the entire Earth

Desert
A region that receives an extremely low amount of precipitation, less than enough to

support the growth of most plants

FORESTS

PART-I

INFORMATION ON FORESTS

Forests

1.1 Forest Area of Pakistan and its comparison with other countries following progressive forestry practices

Pakistan is a forest poor country. Only 4.72 million hectares or 5.36 percent of its land mass is covered with forests (See map on next page). This compares unfavorably with several other countries of the region; Malaysia 65.5, Sri Lanka 42.4, India 23.7, China 17.7 and Bangladesh 15.3 percent which are following progressive forestry practices. The per captia forest area is merely 0.033 hectare compared with world average of one hectare. The primary reason for meager forest area is that most of land area (70-80%) of Pakistan falls in arid or semi arid zones where precipitation is too low to support tree growth.

Table: 1.1 Forest areas by types (1999-2000)

(000 ha)

Forest types	Total area	Percentage
Coniferous	1930	40.92
Irrigated	259	5.49
Riverain	332	7.03
Scrub	1639	34.75
Coastal	512	10.86
Mazri land	24	0.51
Linear plantation	21	0.44
Total	**4717**	**100,00**

Source: Forestry Statistics of Pakistan (2004)

Table: 1.2 Area of forests and rangelands under the control of provincial/territories forest departments by vegetation types, 1999-2000.

(000 ha)

Legal Category	NWFP	Punjab	Sindh	Balochistan	Northern Areas	AJ&K	Total
Coniferous	1,073	49	-	116	285	407	1,930
Irrigated Plantations	-	150	95	6	8	-	259
Riverain	-	58	272	2	-	-	332
Scrub	63	316	1	598	652	9	1,639
Coastal	-	-	281	231	-	-	512
Mazri lands	24	-	-	-	-	-	24
Linear Plantations	2	16	1	1	1	-	21
Rangelands	150	2,679	437	371	2104	151	5,892
Total	1,312	3,268	1,087	1,325	3,050	567	10,609

Source: Forestry Statistics of Pakistan (2004)

Table: 1.3 Area of forests and rangelands under the control of provincial/territories forest departments by legal category, 1999-2000.

(000 ha)

Legal Category	NWFP	Punjab	Sindh	Balochistan	Northern Areas	Azad Kashmir	Total
State	-	-	48	707	-	567	1,322
Reserved	106	311	228	-	-	-	645
Protected	467	2,736	795	378	67	-	4,443
Unclassed	-	103	11	-	-	-	114
Resumed	33	9	5	-	-	-	47
Guzara	248	68	-	-	-	-	316
Communal	-	-	-	-	2983	-	2,983
Section 38*	26	19	-	1	-	-	46
Cho Act**	-	1	-	-	-	-	1
Miscellaneous	432	21	-	239	-	-	692
Total	**1,312**	**3,268**	**1,087**	**1,325**	**3,050**	**567**	**10,609**

Source: Forestry Statistics of Pakistan (2004)

Table: 1.4 Extent of forest area in different province/territory 1999-2000

Province	Total land area (Million ha)	Total Population (million ha)	Forest Area (million ha)	Per capita forest area (ha)
NWFP	10.17	21.68	1.16	0.054
Punjab	20.63	77.01	0.59	0.007
Sindh	14.09	31.47	0.65	0.021
Balochistan	34.72	6.83	0.95	0.139
Northern Areas	7.04	0.84	0.95	1.131
Azad Kashmir	1.33	3.12	0.42	0.135
Total	**87.98**	**140.95**	**4.72**	**0.033**

Source: Forestry Statistics of Pakistan (2004)

Table: 1.5 Situation of natural forests after 1992

Province	Forest Cover (million ha)			% Change (1992-2001)
	1992	1997	2001	
NWFP	1.49	1.52	1.49	0.00
Punjab	0.27	0.46	0.43	5.93 (+)
Sindh	0.32	0.25	0.27	1.56 (-)
Balochistan	0.57	0.71	0.60	0.53 (+)
N.As	0.66	0.31	0.32	5.15 (-)
AJK	0.26	0.33	0.33	2.69 (+)
Total	**3.57**	**3.58**	**3.44**	**0.36 (-)**

Source: National Forest & Rangelands Resource Assessment Study, GoP, Ministry of Environment, and Pakistan Forest Institute 2004

Section 38: Areas offered by Private owners to the Forest Departments for afforestation and management
Cho Act: Areas notified under Land Reservation Act for Forestry purposes

Table: 1.6 Situation of tree cover on farmalnds after 1992

Indicators	Unit	1992	2003-04	% increase
Average number of trees	trees/ha	20.5	25.9	26
Total number of trees	million	331	554	67
Total standing stock	million M3	70	97	38.6
Total annual growth rate	million M3	0.8	1.17	46
Total area equivalent to Block Plantation	000' ha	466	781	7.5

Source: Survey to Assess Wood Vegetation and Wood Volume on Non-Forest Areas in Pakistan, 2004, Ministry of Environment, Government of Pakistan and Asianics Agro-Dev Int.

Table: 1.7 Afforestation during last ten years (2000 - 2009)

S.No.	Years	(Million) Spring	(Million) Monsoon	(Million) Total	(mill Ha) Area Planted	Change in Rate of afforestation	% Change
1	2000	94.561	55.263	149.824	0.140	-(0.13)	13 Decrease
2	2001	83.039	47.111	130.15	0.121	-(0.14)	14 Decrease
3	2002	66.752	39.705	106.457	0.099	-(0.19)	19 Decrease
4	2003	55.018	38.398	93.416	0.059	-(0.40)	40 Decrease
5	2004	63.166	58.00	121.166	0.113	+(1.91)	119 Increase
6	2005	65.799	30.654	96.453	0.090	-(0.03)	3 Decrease
7	2006	57.17	35.34	93.51	0.087	-(0.19)	19 Decrease
8	2007	61.48	37.32	95.14	0.088	+(0.01)	1 Increase
9	2008	73.31	38.12	111.43	0.104	+(0.18)	18 Increase
10	2009	55.77	35.96	91.73	0.085	-(0.19)	19 Decrease

Source: IGF office (2010) official data collected from Chief Conservators of all provinces including AJK& GB

As data indicates rate of afforestation in Pakistan is 0.018 or 1.8 % (0.085 mill ha) annual increase in existing national resource of 4.72 Mill ha

- Survival rate: 60-75 %
- General age of maturity; Conifers 85-100 years and broadleaved 20-40
- Mature trees/acre; Conifers 200-250 and broadleaved 28-108
- Estimated Timber/Fuelwood ratio; 65:35 in %

Table: 1.8 Area regenerated* 1991-92 to 1999-2000

(000 ha)

Province/Territory							
Year	**NWFP**	**Punjab**	**Sindh**	**Balochistan**	**Northern Areas**	**Azad Kashmir**	**Total**
1991-92	2.9	1.3	12.0	-	0.2	9.1	25.5
1992-93	6.3	4.6	25.3	-	0.7	8.1	45.0
1993-94	-	2.3	24.9	-	0.7	-	27.0
1994-95	1.9	4.2	27.0	0.2	0.7	-	34.0
1995-96	2.0	4.5	21.9	-	0.7	-	29.1
1996-97	2.5	3.6	20.9	0.1	0.7	-	17.2
1997-98	0.6	1.6	16.1	-	1.0	-	19.3
1998-99	0.5	1.0	18.3	-	0.8	-	20.6
1999-2000	0.5	0.6	5.9	-	0.8	-	7.8

Source: Forestry Statistics of Pakistan (2004)

2. Wood and wood based Statistics

Out-turn of timber, firewood and non-timber forest produce from state controlled forests.

2.1 Out-turn of timber from state controlled forest.

The out-turn of timber during the 1997-1999 has exhibited mixed trend. The total production of timber during 1997-98, 1998-99 and 1999-2000 was 321, 455 and 305 thousand cubic meter respectively. It reached at the highest level during 1998-99 by 455,000 m3 , and the lowest level during 1999-2000 i.e. 305,000 m3. The largest contributors to timber production were NWFP, Azad Kashmir and Northern Areas. During 1997-98, 1988-99 and 1999-2000 timber production consisted of 54.1, 75.5 and 83 percent softwoods, while rest of the timber production i.e. 45.9, 24.5 and 17 percent came from hardwood species respectively. Coniferous timber is mainly obtained from Azad Kashmir, NWFP and Northern Areas, whereas hardwood is from Punjab and Sindh. Coniferous timber is mainly used for constructional purpose, while hardwoods are used in the manufacture of furniture, sport goods, matchsticks, pit props, plywood etc.

2.2 Out-turn of fire-wood from state controlled forest.

The recorded out-turn of firewood from state controlled forests during these three years was 211.000 m^3 in 1997-98, 220,000 m^3 in 1998-99 and 237,000 m^3 in 1999-2000 it touched the highest level of production during 1999-2000 and lowest 1997-98. Punjab

Regeneration: the process by which a forest land is reseeded and renewed, naturally or artificially

and NWFP were the major firewood producers. The contribution of Punjab was 53.07 percent, NWFP 28.64 percent and other provinces 18.29 percent.

The major use of firewood is as fuel for cooking and heating purposes in the household. For this purpose hardwood is preferred. A part of fuel wood out-turn is converted into charcoal. In commercial sector, brick kiln and tobacco curing industries are the other major users of firewood.

2.3 Supply and demand of wood

Timber: On account of scarcity of wood and high prices, per captia consumption of timber is much constrained. It is estimated around 0.026 m^3 which is among the lowest in the world. For the population of 134.28, 137.69 and 140.95 million in `1997-98, 1998-99 and 1999-2000 the timber demand was 3.49, 3.58 and 3.67 million m^3 respectively, of this 9.20, 12.81 and 8.40 percent were supplied by the state controlled forests for the year 1997-98, 1998-99 and 1999-2000 respectively. The percentages for the said years were 27.17, 26.46 and 19.15 for imported timber and rest 27.22 from the farmlands. Regarding the end uses of the timber, nearly 1/3 is used in building construction. Wood based pulp and paper and panel products account for another 1/3 and remaining is used in various wood based industries.

Firewood: The per capita consumption of firewood is estimated at 0.184 m^3 per annum. For the population of 134.28, 137.69 and 140.95 million in 1997-98, 1998-99 and 1999-2000 firewood consumption was 24.71, 25.33 and 25.94 million m^3 respectively. The contribution of farmlands and wastelands was 24.50, 24.93 and 25.51 million m^3 for the year 1997-98, 1988-99 and 1999-2000 respectively, the rest was supplied from the state controlled forests in the form of recorded removals and bio-mass generated during conversion operations.

Table: 2.1 Supply and demand of wood in Pakistan, 1999-2000 (000 ha)

	Source	Quantity	Percentage
I. Timber			
	1. State controlled forests	305.6	8.34
	2. Imports of wood and wood products.	697.1	19.02
	3. Farmlands	2,662.3	72.64
Total		**3,665.0**	**100.00**
Note:	On the basis of 0.026 m^3/captia consumption (FSMP) for a population of 140.95 million in 1999-2000.		
II. Fuelwood			
	State lands.	237	0.91
	Farm lands	25,698	99.09
Total		**26,935**	**100,00**
Note:	On the basis of 0.184 m^3/captia consumption (FSMP) for a population of 140.95 million in 1999-2000.		

Source: Forestry Statistics of Pakistan (2004)

Wood: the hard, fibrous substance beneath the bark in the stems and branches of trees and shrubs
Timber: The wood having diameter with more than 9 inches and length at least 8 feet
Fuelwood: Any wood usable for fuel/wood with diameter less than 9 inches

Table: 2.2 Consumption of Wood in Pakistan (2003-04)

Province	Fuel wood	Timber	Total
NWFP	6.22	1.6	7.8
Punjab	14.8	6.7	21.5
Sindh	4.6	2.7	7.3
Balochistan	2.2	0.6	2.8
AJK	0.9	0.3	1.3
N.As	0.9	0.1	1
FATA	1.6	0	1.6
Total	31.52	12.24	43.76

Source: Supply & Demand Survey (2003), GoP, Ministry of Environment, 2004

2.4 Supply and Demand Gap/Wood Shortage Analysis

The total wood consumption for the year 2002-03 was estimated at 43.761million m^3 to which fuelwood has accounted for 31.523 million m^3 i.e 72 percent. As per FSMP studies in 1992, the forest growth (annual yield) was estimated at 14.4 million m^3. Assuming that the forest growth has remained the same since 1992, the country has faced with annual wood shortage of about 29.361million m^3. This gap is presently being met by over cutting of trees in the state and private forests and on farmlands. According to Supply and Demand Survey, the consumption of wood is expected to increase from 43.761million m^3 in 2003 to 58.377 million m^3 by the year 2018. The Supply and Demand gap for the base year 2002-03 is presented in table (K).

Table: 2.3 Timber available on State and farm Forests (2003) **(million m^3)**

Timber	Quantity	% share
State Controlled Forest	0.409	3.34
Imports of wood and wood products including Afghan timber	0.639	5.22
Farmlands	11.190	91.44
Total	**12.238**	

Source: Supply and demand survey (2003)

Note: On the basis of 0.0796 m^3/capita consumption for a population of 153.73 million in 2002-2003

Table: 2.4 Fuelwood available on State and farm Forests (2003) **(million m^3)**

Fuelwood		
Farmlands	31.462	99.80
State forests	0.061	0.20
Total	**31.523**	

Source: Supply and demand survey (2003)

Note: On the basis of 0.205 m^3/capita consumption for a population of 153.73 million in 2002-2003

Note: Pakistan imports wood mainly from Canada, New Zealand and Germany

Table:2.5 Supply and Demand gap/wood shortage in Pakistan, 2002-03

Gap Ananlysis	Million m^3	% share
Total timber consumption	12.238	28
Total fuelwood consumption	31.523	72
Grand total	43.761	
Forest Growth (FSMP, 1992)	14.400	
Gap/wood shortage	**29.361**	

Source: Supply and demand survey (2003)

The shortage of 29.361 million m^3 of wood during 2002-03 was based on the assumption that forest growth (annual yield) estimated by FSMP in 1992 have remained constant since 1992.

As stated elsewhere, the estimate of wood production is in fact reflecting poor state of affairs which is in consequence of ban on harvesting since 1992. The management of forests through working plans is inoperative since then. However, harvesting ban was lifted for one year in 2001 to clear back log of timber harvested prior to ban. As such, the shortage of wood production has widened the gap between supply and demand to the extent that the gap of 29.361 million m^3 of wood in the year 2002-03 is almost double than that of 14.4 million m^3 reported by FSMP in 1992.

Table:2.6 Total Annual Consumption of Fuelwood in Pakistan, 2003

Province	Rural				Urban				Total		
	Total Population	Av. use/ Capita	Total Consumption		Total Population	Av. use/ Capita	Total Consumption		Total Population	Total Consumption	
	`000'	mnds	`000' Tons	`000' m^3	`000'	mnds	`000' Tons	`000' m^3	`000'	`000' Tons	`000' m^3
NWFP	16767	0.872	6266.1	8145.9	3403	0.748	1090.9	1418.2	20170	7357.0	9564.1
Punjab	57204	0.614	15052.8	19568.6	26546	0.110	1251.4	1626.8	83750	16304.2	21195.5
Sindh	17548	0.591	4444.7	5778.1	16692	0.028	200.3	260.4	34240	4645.0	6038.5
Baloch	5670	0.924	2245.3	2918.9	1780	0.526	401.3	521.7	7450	2646.6	3440.6
S.Total	**97189**	**-**	**28008.9**	**36411.5**	**48421**	**-**	**2943.9**	**3827.1**	**145610**	**30952.8**	**40238.7**
AJK	2928	0.907	1138.2	1479.7	399	0.268	45.8	59.5	3327	1184.0	1539.2
NA	1100	2.503	1179.9	1533.9	-	-	-	-	1100	1179.9	1533.8
FATA	3328	1.380	1968.2	2558.6	92	1.380	54.4	70.7	3420	2022.6	2629.3
PATA	274	0.537	63.1	82.0	-	-	-	-	274	63.1	82.0
S.Total	**7630**	**-**	**4349.4**	**5654.2**	**491**	**-**	**100.2**	**130.2**	**8121**	**4449.6**	**5784.3**
Total	**104819**	**-**	**32358.3**	**42065.7**	**48912**	**-**	**3044.1**	**3957.3**	**153731**	**35402.4**	**46023.0**
%share				**91.4%**				**8.6%**			**100%**

Sources: MAANICS and IGF office (2005)

The sources of wood supply are ownlands (61%), markets (34%) and others (5%). The position is different in urban and rural areas. In rural areas majority of the population have obtained from non-forest sources (farmlands, wild lands). The wood is usually collected by family members in rural areas. The major supply sources near houses are gardens, village farms, shamlats etc. It is usually obtained by pruning of trees or cutting

shrubs. In case of urban areas, the distribution channel is short; markets (wholesaler and retailer) are reported the major source of supplies. Wood is mainly used to meet requirements of household for cooking and heating.

The household survey reveals that

- 75% of all household have used wood as a principal fuel;
- for cooking, 14% for water heating and
- 11% for room heating.
- The situation is quite different by urban/rural divide; 90% in rural areas have used fuelwood for cooking but only 10% in urban areas by slum dwellers.

The species preferred for cooking are Kikar, Phulai, Shisham, Ber, Mulberry and other because of their good burning qualities.

The major problems faced by the consumers are scarcity of wood, distance of wood talls, high price level and many more. The suggestions to improve the situation are i) expansion in irrigation facilities for forests, ii) subsidized saplings iii) grow more tree campaigns, iv) afforestation, v) credit facilities, vi) increased development funds etc.

Table:2.7 Comparative Analysis of Rural and Urban Fuelwood consumption of Pakistan (1992)

Area	Provinces				
	Balochistan	NFFP	Punjab	Sindh	Total
Rural	2490	6747	19043	8298	36578
Urban	908	660	3883	1466	6917

Sources: FSMP (1992) and Pakistan Forest Programme (2009) WWF-P

2.5 Imports of wood, product-wise and country-wise

The imports of wood and wood products almost doubled from Rs. 4.251 billion in 1992-93 to Rs. 13.716 billion in 2002-03. The annual average growth rate is much higher i.e. 6.5%. The distribution of wood products by specific items are reflected below in table 2.8.

The distribution of imports by major commodity and major countries is reflected in table 2.9.

Table 2.8: Imports of Wood and Wood Products for the year 1992-93 to 2002-03

Million Rs.

Items	1993-94	1994-95	1995-96	1999-00	2000-01	2001-02	2002-03
(a) Timber round and sawn	**322.5**	**314.4**	**346.0**	**129.7**	**539.7**	**718.3**	**1537.6 11.21%**
Saw logs & veneer logs conifer	0.4	0.05	0.5	0	0	0	74.7
Saw logs & veneer logs non-conifer	240.0	239.8	318.9	360.2	315.0	397.8	562.5

Railway Sleepers	1.1	-	0.5	0	0	0	0
Timber sawn,plained conifer	6.3	1.8	2.8	13.2	0.8	0.7	1.5
Timber sawn, plained non-conifer	65.9	59.8	1.1	94.7	205.3	311.3	857.1
Pulpwood including proadleaved	0.8	0.04	4.8	1.6	0	0	0
Poles, pilings, posts & other recind wood (pit props)	4.9	6.2	5.0	12.7	12.8	50.1	30.5
Wood simply shaped	3.1	5.7	12.4	8.9	4.2	3.4	11.3
(b) Wood and wood manufact.	**17.5**	**41.4**	**38.5**	**104.3**	**79.4**	**116.0**	**215.4 1.57%**
Veneer sheets	1.8	9.3	6.8	39.2	31.5	79.9	167.4
Plywood	11.2	3.0	8.3	24.0	11.6	10.2	28.5
Improved or reconstituted	1.6	8.6	16.9	23.1	22.6	10.2	6.2
Manuf. Of wood not (NES)	2.9	20.5	6.5	18.0	14.3	15.9	13.3
© Pulp & Paper boardd	**4449.3**	**4707.8**	**6412.3**	**7381.5**	**9061.6**	**10290.0**	**11832.7 86.27%**
Wood pulp	694.2	794.4	1175.4	1292.9	1677.1	1892.9	2217.7
Kraft paper and roll sheet	432.4	286.7	406.8	566.1	646.0	736.5	982.6
Fiber board including building board	0.4	0.6	0.7	2.8	0.8	1.8	6.0
News print paper	1097.3	1315.3	1858.4	2071.3	2260.8	2368.6	2087.1
Un-coated and writing paper	711.4	685.1	744.3	529.2	650.8	944.6	1011.4
Other paper ad paper board	1301.5	1363.0	1819.4	2173.9	2497.0	2985.8	4107.7
Article made of paper and paper board	212.1	262.7	407.3	745.3	1329.1	1359.7	1420.2
(d) Miscellaneous items	**39.0**	**34.0**	**51.1**	**66.3**	**74.7**	**87.0**	**130.3 0.95%**
Resin	3.9	2.1	0.8	0.4	0.7	1.2	43.2
Cork raw and waste	2.3	1.0	2.0	2.0	1.0	2.4	1.5
Cork manufactures	9.5	8.1	9.9	10.9	9.9	10.7	8.1
Bamboos	16.2	13.6	28.4	45.3	53.2	62.4	68.8
Cane & rattans, wood waste	7.1	9.2	10.0	7.7	9.9	11.3	8.7
Grant Total (a+b+c+d)	**4828.3**	**5096.6**	**6847.9**	**7681.7**	**9755.4**	**11211.4**	**13716.0**

Source: Federal Bureau of Statistics, Islamabad

Table 2.9: Import of Wood and Wood Products by Commodities and Countries for the Year 2000-2002

Value in 000 Rupees

S No.	Commodity	Country	Year 2001-2002		Year 2000-2001	
			Quantity	Value Rs.	Quantity	Value Rs.
1	Wood Charcoal	F.R. Germany	3000	57	0	0
2	Coniferious	Dubai	0	0	365,570	1,385
3	Sawdust, Wood waste & Scrap	Asian Countries N.S.			24,000	89
		Tanzania	25000	262	0	0
4	Pitprops (Mine Timber)	Burma	505	1,707	1,711	3,416
		Singapore	960	2,360	0	0
		Total	**1465**	**4,067**	**3,632**	**6,894**
5	Poles, Pilings, Posts etc	Burma	325	951	2,713	5,918
		Total	**325**	**951**	**2,713**	**5,918**
6	Pulpwood in Round/Quarter Spltom	Afghanistan	0	0	75	248
		Total	**0**	**0**	**75**	**248**
7	FIR LOGS, CONIFEROUS	Afghanistan	0	0	31	101
		Total	**0**	**0**	**31**	**101**
8	PINE (CHIR) Logs, coniferous	Finland	0	0	182	815

		South Africa	144	579	0	0
		Total	144	579	182	815
9	Wood, Coniferous	Afganistan	38,087	159,330	71,706	359,283
		Total	**38,546**	**160,643**	**72,394**	**363,006**
10	Sawlog, Veneerlog Nonconiferous	Cameroon	199	1,100	0	0
		China	37	190	0	0
		Malaysia	0	0	2,800	6,899
		South Africa Rep	0	0	511	1,115
		Total	**724**	**3699**	**3,311**	**8,015**
11	Teak wood, ranghly quared	Burma	2,709	16,212	4,707	29,802
		Malaysia	3,989	30,814	5,608	38,756
		Singapur	933	6,954	992	7,056
		Tanzania	0	0	207	1,624
		Total	**7,756**	**55,247**	**11,984**	**80,266**
12	Gurjan Logs, nonconiferous	Singapur	332	1,161	0	0
		Total	**332**	**1,161**	**0**	**0**
13	Oak logs nonciniferous	U.S.A	240	1436	0	0
		Total	**240**	**1436**	**0**	**0**
14	Wood nonconifeous Species NS	Burma	13,998	57,626	6,347	21,572
		Malaysia	50,335	212,720	36,304	140,066
		Singapor	6,277	28548	3,286	14,026
		Total	**79,414**	**336,301**	**60,101**	**226,813**
15	Other Railway Sleepers of wood	United Kingdom	0	0	180	405
		Total	**0**	**0**	**180**	**405**
16	Wood coniferous sp sawn, chipped ETCCM	United Kingdom	3,304	11,170	2866	8,775
		Total	**4808**	**17,482**	**2966**	**9,043**
17	Wood coniferous spe Strip cent shape	Dubai	130	380	100	286
		United Kingdom	100	313	40	92
		Total	**230**	**692**	**263**	**752**
18	Teakwood, swan, Non-coniferous	Burma	11,262	45,407	3,980	15,975
		Total	**29,345**	**138,645**	**18,148**	**90,204**
19	Wood o/TH Teak, sawn, non-coniferous	Burma	2,487,593	15,703	3682	13474
		Total	**2,515,301**	**127,699**	**36,496**	**115,083**
20	Teakwood, Block etc, Nonconiferous	Indonesia	28	203	10	64
		Total	**28**	**203**	**10**	**64**
21	Otherwood, Block etc, Non-coniferous	Theiland	250	967	220	1,088
		U.S.A	250	803	264	2,644
		Total	**1,072**	**4,278**	**753**	**4,704**
22	Waste Unbleached kraft paper	Dubai	560,870	4228	0	0
		Saudi Arabia	878,700	6,393	285,340	1,775
		Total	**1,487,510**	**10,958**	**285,340**	**1,775**
23	Waste paper bleach chen pulp	Dubai	151,030	1,083	294,910	2,312
		Saudi Arabia	180,800	1,630	76,710	486
		U.S.A	295,000	2,323	0	0
		F.R. Germany	40,300	550	20500	1,617
		United Kingdom	90,520	705	100,800	934
		Total	**785,455**	**6,492**	**506,520**	**5,493**
24	New paper old	Cypras	301,170	1,919	229,680	1,463
		Dubai	490,050	3,367	349,640	2,778
		Grecce	169,920	1,132	722,565	4,629
		Singapore	2,069,687	12,878	1,907,276	11,361
		U.S.A	877,581	5,939	515,202	3,380
		Total	**5,392,218**	**34,820**	**4,227,54,3**	**27,095**
25	Journals & printed Matther, old(kg)	Dubai	1,574,638	10,470	736,559	6,284
		Netherlands	598,465	5,194	211,840	2,212

		Singapure	1,611,905	11,832	1,861,216	14,005
		USA	3,253,575	26,702	2,842,107	23,954
		United Kingdom	1,197,686	9,365	545,680	4,682
		Total	**10,835,841**	**82,569**	**8,450,762**	**69,008**
26	Waste scrap other paper/board NS (kg).	Dubai	13,622,064	85,040	7,812,553	55,681
		Nethrlands	3,922,623	30,777	49,000	360
		Saudi Arabia	6,784,131	45,524	6,015,220	41,219
		Singapore	3,122,576	21,847	6,889,428	50,028
		USA	14,165,796	106,370	16,219,744	110,149
		Total	**51,510,250**	**367,372**	**45,948,085**	**324,700**
27	Mechanical wood pulp (kg)	Newzealand	1,958,562	38,026	1,235,512	29,225
		Sweden	3,185,998	71,918	1,969,729	54,763
		Total	**5,886,33**	**126,948**	**5,123,931**	**135,950**
28	Chem Wood Pulp, Dissolving Grad (kg)	USA	118,583	5,332	185,266	7,913
		Total	**249,483**	**10,898**	**525,689**	**54,763**
29	Chem Wood Pulp unbleached coniferous (kg)	Sweden	1,833,823	43,610	447,703	14,694
		USA	3,788,130	96,123	2,396,823	62,430
		Total	**6,150,423**	**151,953**	**4,012,617**	**119,615**
30	Chen Wood Pulp unbleached Non coniferous (kg)	Canada	395,775	9,502	286,102	9,158
		Total	**492,275**	**11,782**	**286,102**	**9,158**
31	Chem Wood Pulp Semi/Bleach coniferous (kg)	Brazil	898,435	20,901	0	0
		Singapore	1,361,946	27,923	0	0
		Canada	5,587,664	142,348	8,266,626	308,798
		Sweden	4,285,478	108,760	5,172,825	188,217
		USA	23,418,275	547,264	6,741,290	254,533
		Total	**36,585,246**	**874,163**	**21,667,644**	**798,396**
32	Chem wood pulp Bleach Non-coniferous (kg)	Thailand	199,067	5,389	107,155	3,719
		USA	502,261	12,473	147,651	5,215
		Total	**1,221,473**	**29,925**	**318,814**	**11,689**
33	Chem Wood Pulp, Sulphite, Unbleached (kg)	F.R. of Germany	23,235	1,299	51,750	2,292
		Total	**23,235**	**1,299**	**51,750**	**2,292**
34	Chem Wood Pulp, Sulphite, Bleached (kg)	F.R. of Germany	1,859,173	85,168	1,029,143	48,711
		Norway	1,052,775	44,428	1,010,700	43,903
		USA	267,967	10,871	822,200	33,908
		Total	**4,263,591**	**183,666**	**3,532,159**	**150,532**
35	Veneer Sheet for Plywood coniferouos (kg)	Malaysia	171,965	6,355	97,093	4,046
		Total	**177,937**	**6,619**	**115,756**	**4,874**
36	Sheet for Plywood Coniferous (kg)	Malaysia	15,000	508	46,212	1,650
		Total	**15,000**	**508**	**46,212**	**1,650**
37	Veneer Sheet Plywood non-coniferous (kg)	Indonesia	869,543	65,422	342,901	23,100
		Singapore	101,580	9,701	40,000	2,628
		Total	**1,040,048**	**97,701**	**471,072**	**31,474**
38	Sheet for plywood non-coniferus N.S (kg)	Indonesia	821,490	79,769	697,419	74,634
		Total	**972,544**	**94,045**	**860,423**	**89,258**
39	Densified Wood Block, Plate etc (kg)	Italy	148,772	8,406	145,971	8,456
		Total	**156,872**	**8,717**	**180,779**	**10,938**
		F.R. Germany	1,500	76	0	0
40	Beadings and Mauldings, Wooden (kg)	Italy	22,773	1,400	48,874	2,520
		Total	**24,273**	**1476**	**48,874**	**2,520**
41	Chip board of wood (kg)	Belgium	10,800	220	0	0
		China	0	0	49,440	5,023
		Total	**10,800**	**220**	**83,730**	**9,976**
42	Particle Board ligneous Materl (kg)	France	22,272	794	30,710	930
		Total	**31,132**	**1,238**	**33,730**	**1,135**
43	Plywood sheet outerply Tropical (kg)	China	6,900	181	0	0
		Sri Lunka	8,000	283	0	0

		Total	**18,078**	**731**	**1750**	**110**
44	Other plywood sheets (kg)	China	41,278	1,608	57,730	22,201
		Malaysia	81,943	2,476	14,379	480
		South Koria	56,100	2102	0	0
		Total	**259,499**	**9,440**	**298,225**	**11,506**
		Italy	12,496	716	0	0
45	Lamin board (Luminated sheets) kg	Singapore	27,700	1,347	24,479	1,285
		Total	**45,157**	**3,200**	**27,479**	**1,285**
46	Black Board (kg)	Italy	0	0	24,736	1,353
		Total	**0**	**0**	**24,736**	**1,353**
47	Other plywood veneered panel Nes (kg)	Cameroon	12,295	474	26,000	1,328
		Italy	12,295	698	15,396	821
		Total	**32,272**	**1,551**	**136,620**	**10,448**
48	Fiber board density 70.80 G/cm³ (kg)	Brazil	135,533	3,031	155,291	3,501
		Malaysia	806,287	14,474	1,237,523	21,130
		Thailand	824,203	13,343	395,824	7,006
		Total	**2,081,859**	**39,468**	**2,547,552**	**45,726**
49	Fiber board density 0.35-0.50 G(kg)	Malaysia	12,485,283	205,578	8,863,889	143,288
		Thailand	1,360,000	23,368	2,445,208	45,593
		Total	**15,584,722**	**256,688**	**15,160,725**	**256,246**
50	Fiber board density (kg)	South Korea	32,240	978	0	0
		Unite Kingdom	0	0	200,000	4,214
		Total	**32,240**	**978**	**200,000**	**4,214**
51	Fiberboard (wisulating board) kg	Brazel	0	0	12,550	238
		Canada	18,470	326	0	0
		Total	**18,470**	**326**	**12,550**	**238**
52	Fiberboard compress (Hardboard) kg	Thailand	185,360	2,868	92,220	1,438
		Total	**248,590**	**4,259**	**188,193**	**3,298**
53	Fiberboard wood/libnes matl NS (kg)	Canada	21,073	1,429	4,490	277
		Total	**21,073**	**1,429**	**21,628**	**585**
54	Split/poles, etc of wood (kg)	United Kingdom	39,500	1,937	18,000	1,070
		Total	**40,000**	**1,970**	**21,000**	**1,659**
55	Cases etc. and cable drums of wood (kg)	South Korea	15,000	471	0	0
		Total	**16,650**	**583**	**1,450**	**153**
56	Doors, Frames and Threshold (kg)	China	20,000	720	0	0
		Total	**32,500**	**2,733**	**105,878**	**10,512**
57	Flouring Panels	Sweden	0	0	8,399	718
		Total	**0**	**0**	**8,399**	**718**
58	Cellular wood panels (kg)	F.R. of Germany	0	0	450	32
		Total	**0**	**0**	**450**	**32**
59	Builder Carpentry and Joinery N.S (kg)	Italy	3,600	401	228,500	6,260
		Total	**3,600**	**401**	**258,193**	**8,330**
60	Wooden Frames for Painting etc (kg)	Singapore	1,700	98	0	0
		Total	**1,850**	**158**	**439**	**173**
61	Brass inlaid wooden material (kg)	Iran	74,826	4,858	219,511	9,285
		Total	**74,826**	**4,858**	**219,511**	**9,285**
62	Other articiles of wood N.S (kg)	Asian Countries N.S	37,124	2,060	12,370	1,108
		China	129,582	8,453	54,535	3,246
		Turkey	12,689	1,568	0	0
		United Kingdom	6,605	499	14,695	1,886
		Total	**221,602**	**15,545**	**125,182**	**14,156**
	Sub Total Wood Products (cm)	**S. Total**	**164,429**	**3,298,230**	**176,743**	**3,156,034**
	Kg converted in cm	**S. Total**	**352,278**		**345,552**	
	Pulp & Paper Board etc. (cm)	**S. Total**	**38,894**	**7,056,097**	**15,258**	**6,052,248**
	G.Total		**555,601**	**10,354,327**	**537,553**	**9,208,282**

3. Harvesting Age/Rotation Age

It is not possible to calculate average age of tree harvesting because there are thousands of tree species with different rotation ages and growth patterns. Each one spp has different rotation ages based on its purpose of harvesting e.g. timber, fuelwood etc. However, it is possible to calculate/estimate species-wise rotation age or harvesting age under given conditions. Rotation/harvesting age for some imortant commercial species of Pakistan is given below; **(for details see Appendix-D)**

1.	Kikar/Babul	*(Acacia nilotica)*	40 years
2.	Poplar	*(Populus euphratica)*	15 years
3.	Shisham	*(Dalbergia sissoo)*	60 years
4.	Chir	*(Pinus roxburghii)*	90 years
5.	Kail	*(Pinus wallichiana)*	120 years

Rates for timber and fuelwood are given in annexure-E

3.1 Economically optimum rotation age

In forestry rotation analysis, economically optimum rotation can be defined as "that age of rotation when the harvest of stumpage will generate the maximum revenue or economic yield". In an economically optimum forest rotation analysis, the decision regarding optimum rotation age is undertake by calculating the maximum net present value. It can be shown as follows:

Revenue (R) = Volume X Price
Cost (C) = Cost of harvesting + handling.
Hence, Profit = Revenue – Cost.

Since, the benefit is generated over the years; hence, it is necessary to calculate that particular age of harvesting, which will generate the maximum revenue. In order to do so, discounting for future expected benefits are undertaken and calculated, which gives the present value of revenue and costs. From this net present value (NPV) of profit is calculated. This can be done as follows:

NPV = PVR – PVC

(Where PVR = present value of revenue and PVC = present value of cost). Rotation will be undertaken where NPV is maximum. This can be further illustrated with the help of the following diagram.

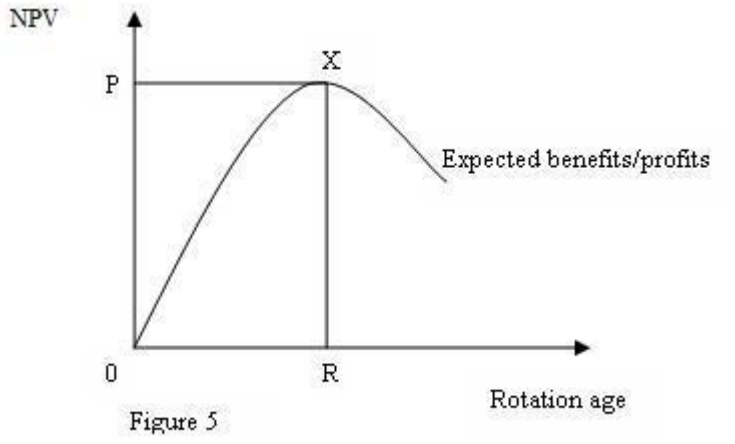
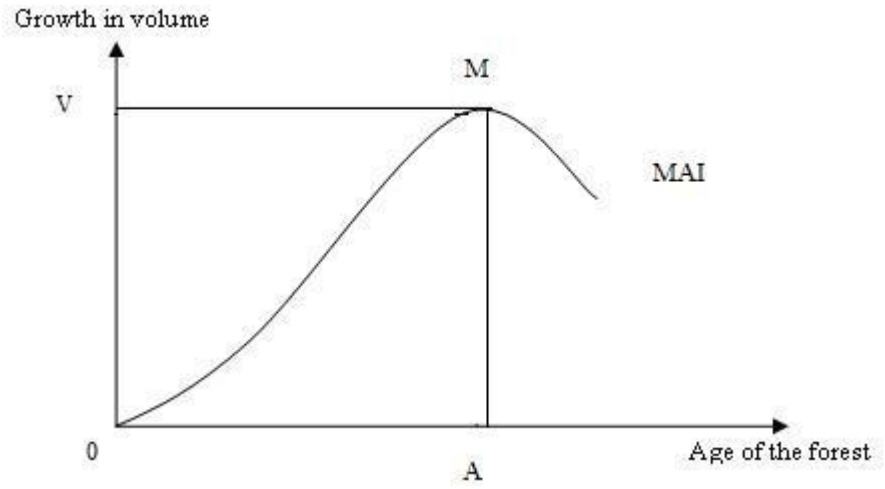


Figure 5

As can be seen in the above figure, the economically optimum rotation age is determined at point R, which gives the maximum net present value of expected benefit/profit. Rotation at any age before or after R will cause the expected benefit/profit to fall.

3.2 Biologically optimum rotation age

Biologists use the concept of maximum sustainable yield (MSY) or mean annual increment (MAI), to determine the optimal harvest age of timber. MSY can be defined as "the largest yield that can be harvested which does not deplete the resource (timber) irreparably and which leaves the resource in good shape for future uses". MIA can be defined as "the average annual increase in volume of individual trees or stands up to the specified point in time". The MAI changes throughout the different growth phases in a tree's life; it is highest in the middle years and then decreases with age. The point at which the MAI peaks is commonly used to identify the biological maturity of the tree, and its readiness for harvesting.



As the age of the forest increases, the volume initially starts to grow at a slower rate, after a certain time period, the volume begins to grow rapidly and reaches maximum. Beyond

which the growth in volume begins to decline. This is directly related with the MAI, as we find that MAI increases at a slow increasing rate, then increases at a faster increasing rate, reaches maximum (point M) during the middle years (A) and peaks where there is no increase in volume; beyond point M or after the tree reaches the age A, the MAI begins to increase, but at a decreasing rate.

Hence, optimum rotation age in biological terms is taken to be the point where MAI is equal to zero, i.e. the point where there is no increment to the volume. This is shown by point M in the figure above (fig 2), where the volume generated is V. It is interesting to note that beyond the age A, the MAI, starts to decline.

Source: "http://en.wikipedia.org/wiki/Optimal_rotation_age"

4. Climate change and tree line

The possible effects of climate change on the advance of the tree line are considered. As temperature, elevated CO_2 and nitrogen deposition co-vary, it is impossible to disentangle their impacts without performing experiments. However, it does seem very unlikely that photosynthesis per se and, by implication, factors that directly influence photosynthesis, such as elevated CO_2, will be as important as those factors which influence the capacity of the tree to use the products of photosynthesis, such as temperature. Moreover, temperature limits growth more severely than it limits photosynthesis over the temperature range 5–20 °C. If it is assumed that growth and reproduction are controlled by temperature, a rapid advance of the tree line would be predicted. Indeed, some authors have provided photographic evidence and remotely sensed data that suggest this is, in fact, occurring. In regions inhabited by grazing animals, the advance of the tree line will be curtailed, although growth of trees below the tree line will of course increase substantially.

Despite over a century of research, it is not clear how the tree line is determined by environmental variables. There is much evidence of regeneration above both the elevational and northern tree line during periods when the summers are warm, such as at the present time.

There is a strong thermal advantage of being short, which is why dwarf shrubs succeed at high elevation whilst trees do not. As seedlings grow taller, they lose this advantage, and so there may develop an extensive zone of short and stunted saplings just above the tree line, which fail to develop into tall trees.

Macrofossils and palynological evidence show that tree lines have always been dynamic. Tree lines will continue to be responsive to climate change, and large advances in tree lines, with ecological and socio-economic implications, are probable in the near future, except where prevented by human activity.

The observed migration rates of tree lines do not agree well with rates estimated from simple assumptions. Models to predict the impact of climate change on tree lines need to incorporate an understanding of energy balance, physiology and reproductive biology.

Even then, tree lines in mountains may be more influenced by the grazing of seedlings and saplings than most people have supposed.

Climate change may strongly influence species distribution and, thus, the structure and function of ecosystems. Data on predicted summer temperature changes, the current position of the tree line, and a digital elevation model were used in a study conducted in Sweden to predict the position of the tree line over a 100-year timeframe. The results show the tree line advancing upward by 233–667 m, depending on the climate scenario used and location within the mountain chain. Such changes hypothetically caused a 75–85% reduction in treeless alpine heaths, with 60–93% of the remaining areas being screed slopes and boulder fields. For this change to occur, the migration rate of the trees would be in the order of 23–221 m yr-1, which is well within published migration rates for wind-dispersed deciduous trees. The remaining alpine areas would be strongly fragmented. These drastic changes would influence all aspects of mountain ecosystems, including biodiversity conservation and human land-use patterns.

"What does that transition zone look like? Is it an abrupt change to less abundance, like you would see on alpine Rockie mountain slopes? In the end, it is imperative to quote an example of this short Spring, which withered away without shaking leaves of winter. A large no of trees have dried up in Islamabad (like of Poplar), which is an indication of expected forth coming migration of trees to higher altitude, resulting in tree line shift.

Source: Jon Moen, Karin Aune1, Lars Edenius, and Anders Angerbjörn, Swedish University of Agricultural Sciences; Stockholm University (2004)

5. Agriculture vis-à-vis forestry

Although, it's impossible to calculate financial outcomes of both businesses and then compare them, however a rationale can be given based on assumptions or available possible data. Normally, in Pakistan, agricultural lands can fetch maximum up to Rs 50,000, while Hurries in Sindh are fetching over Rs. 10,000 per year. Although, it cannot prevail throughout the country even then it can be quoted.

In addition to this review of literature has shown that a 50 inch Eastern white pine provides overall benefits of: $166 every year as calculated by National Tree Benefit Calculator of Austria. Breakdown of benefits include, storm water (50 inch pine will intercept 4,605 gallons of storm water runoff in one year.), energy (will conserve 185 Kilowatt / hours of electricity for cooling and reduce consumption of oil or natural gas by 25 therm(s).), air quality (Absorbing pollutants like ozone, nitrogen dioxide and sulfur dioxide through leaves, intercepting particulate matter like dust, ash and smoke, releasing oxygen through photosynthesis, lowering air temperatures which reduces the production of ozone, reducing energy use and subsequent pollutant emissions from power plants), natural gas and CO_2 (hey sequester ("lock up") CO2 in their roots, trunks, stems and leaves while they grow, and in wood products after they are harvested). Trees near buildings can reduce heating and air conditioning demands, thereby reducing emissions associated with power production.) as well. If we assume it a baseline to calculate cost of

one acre of pine forests, it will be worth 36188 to 54282 $ every year equivalent to 4.0 Mill to 6.0 Mill annually.

Forest provides multiple benefits to environment, people, and animals. The list of benefits is as follows

- Forest cool air temperature by release of water vapor into the air.
- At day time trees generate oxygen and store carbon dioxide, which helps to clean air.
- Forest attracts wild life and offer food and protection to them.
- Forests offer privacy, reduce light reflection, offer a sound barrier and help guide wind direction and speed.
- Trees offer artistic functions such as creating a background, framing a view, complementing architecture, and so on.
- Well managed forests supply higher quality water with less impurity than water from other resources.
- Some forests raise total water stream, but this is not true for all forests.
- Forests help in controlling the level floods.
- Forest provides different kind of wood which are used for different purposes like making of furniture, paper, and pencils and so on.
- Forest help in giving the direction of wind and its speed.
- Forest helps in keeping environment healthy and beautiful.
- Forests also minimize noise pollution.
- Forest helps the scientist to invent new medicine as forest has different kind or plants and herb.

All benefits quoted above are purely outcome of forests and cannot be derived from agriculture. If cost of these be calculated in terms of money, it will be far above the outcome/benefits of agriculture.

Source: http://www.treebenefits.com/calculator/ReturnValues.cfm?climatezone=Midwest

6. Environmental Benefits of Trees

Due to the sometimes startling loss of trees and forest cover in the civilized world, more citizens have become aware of the critical ecological role that trees play in human life. In many places worldwide, people are working to manage forest cover and reverse deforestation trends.

In Germany they have worked out the value of intangible benefits as eight times greater than the tangible value of products and services of forestry sector.

Many other “intangible” benefits are derived from the forest including oxygen production, watershed value, scenic benefits, ecosystem synergism and flow, and a variety of other values essential for human health and quality of life.

6.1 Trees and Humans

Forest cover is declining at the same time that civilizations are beginning to recognize that trees play a role in improving quality of life by contributing to natural beauty and providing an arena for recreational pursuits. But more importantly, trees play a very basic role in the complex ecological system. They clean air and water, which allows animals and humans to exist. Trees are key to maintaining human life on earth.

6.2 Forests and Water Quality

As our population grows, the demand for clean drinking water becomes more acute. Besides this, need of water for agriculture, sanitation purpose, cooking needs and other uses is imperative. In Pakistan, no one had ever thought of purchasing water 2 decades ago, but now people do purchase it, just because of depletion of forests in watersheds. Forests and plant cover are necessary to slow runoff and filter rainwater. When trees are in place, rainwater, which naturally flows downhill to the nearest stream, is slowed. Once slowed, rainwater seeps down to refill underground storage tanks or aquifers.

In addition, water may be absorbed by the roots of trees and transpired by leaves so that it can cycle back for use again as rainwater. Rain waters crops and refills drinking water supplies in reservoirs.

Forests prevent non-saline drinking-quality water from running off too quickly to mix with the salt water of oceans. Once salty, water takes much longer to re-enter the fresh water portion of the hydrological cycle, where it is most useful to humans.

6.3 Forests and Soil Quality

The roots of plants hold soil in place. Fertile soil that is needed to grow crops would otherwise be washed away in rainstorms, decreasing the amount of soil available for agriculture. Rich soil transfers nutrients to food, which contributes to human health.

6.4 Forest environmental services

Forests also provide a number of crucial ecosystem services, for example, their role in sequestering carbon from the atmosphere, protecting upstream watersheds, conserving biodiversity and gene-pools for future generations and in providing landscape beauty.

6.5 Biodiversity Conservation

Forests are one of the largest repositories of biodiversity in the world. By some estimates they contain 60-90% of all terrestrial species found on the planet. Some of these could have widespread economic or medicinal uses that are still unknown to us, for example a cure for AIDS. The conservation of these valuable genetic resources for future options that are yet undiscovered is thus a valuable service that forests provide to us.

6.6 Forests and Carbon Sequestration

Forests are both a source of carbon dioxide (CO2) when they are destroyed or degraded and a sink when conserved, managed, or planted sustainably. Forest vegetation and soils currently hold almost 40% of all carbon stored in terrestrial ecosystems. Much of this is stored in the great boreal forests of the Northern Hemisphere and in the tropical forests of South America and Africa. Further, forest re-growth in the northern hemisphere currently absorbs carbon dioxide from the atmosphere, creating a "net sink". However, in the tropics, forest clearance and degradation are together acting as a "net source" of carbon emissions. So far, in Pakistan, carbon storage in forests and plantations has not been measured. Ministry of Environment is however supporting almost 22 projects of carbon sequestration which will be a first step towards carbon accounting in Pakistan.

6.7 Economic Value of Forest Resources

Direct use values of forest ecosystem have been recognized apparently due to its easy and convenient assessment, while indirect use values are usually neglected because they are not easy to be recognized by the public. For a nature reserve with forest ecosystem, the most important economic values are the indirect use values, which provide beneficial services through ecological processes and functions. A study conducted in Turkey has assessed six aspects of ecological functions which are soil protection, water conservation, CO2 fixation, nutrient cycling, pollutant decomposition and disease and pest control. These ecological functions provide an economic value of US$10.37×106 per year, which is 25 times higher than the opportunity cost for regular timber production. This study can contribute to the monetary assessment of indirect use values of forest biodiversity and to the conservation and sustainable use of nature reserves.

Sources: http://reforestation.suite101.com/article.cfm/environmental_benefits_of_trees and IUCN

7. Sustainable Forest Management

7.1 Evolution of Forest Management in Pakistan

Before the British came to the subcontinent, the natural resource base was so vast that there was little need for forest science. However, it was soon realised in the third quarter of the 19th century, that unless forests were protected and managed properly, they would soon diminish. In this regard, German forest scientists like Brandis and Schlich were engaged for the scientific management of forest resources.

Accordingly, silvicultural systems for all forest types were developed with clear management objectives. To fulfil the fuel wood requirements of the railways, irrigated plantations like Changa Manga were established. It was due to the hard work of the pioneer foresters of the sub-continent who selected the right species from amongst the Indian native trees for large scale plantation forests. They also standardized the irrigation system that the forest related needs of the communities were accomplished. After independence (1947), some useful irrigated plantations based on the old English system were developed. In fact, a century of management (started in the end of the 19th century) in the hill forests has resulted in forests being exactly as desired by the management system. Resultantly there are hardly any primary forests left. Forests in Pakistan have the potential of being the harbingers of ecosystem diversity. Most of the landscape of the

country has been modified. Living space for the components of forest biodiversity and for the natural processes of succession is only available in the areas declared as reserves under the Forest Act of 1927.
The effects on nature by forest management in all the ecosystem types of Pakistan, as well as the dynamics of the effects of the delicate ecosystems to human interference is discussed in the following section.

7.2 Status of Sustainable Forestry in Pakistan

There is need to develop a strategy aiming at sustainable forestry development by adopting holistic and integrated resource management principles through active community participation. This will require a change in the role of the managers, the active participation of communities and other stakeholders; capacity building; and the sharing of benefits on an equitable basis. Sustainable forest development also demands consistent policies and strategies for achieving both short and long-term goals, in addition to a clear-cut vision, and strong political will to realise the objectives of the policies in true spirit. Decentralisation and devolution also play a crucial role in sustainable forest management. In some provinces, the Forest Department has already started these processes, but donor assistance plays a major role in this process. It is not known that whether these changes will continue once donor support is discontinued.
Indicators are ways to measure or describe criteria and provide a common framework for describing, monitoring, and evaluating progress towards sustainable forest management. This concept is a relatively new initiative in sustainable forest management, and is considered a very useful tool for adjusting forest policy and adopting other measures to sustain forestry. Globally, more than 150 countries are currently participating in international processes aimed at the development and implementation of national level criteria and indicators for sustainable forest management.

8. Mangroves of Pakistan

Mangroves forest ecosystem consists of the intertidal flora and fauna found in the tropics and subtropics and dominated by evergreen broad leaved trees with silt roots or pneumatophores and viviparous seedlings. People in the tropical coastal region have used mangroves resources for centuries without upsetting the ecological balance in the area. This was because of the population involved was small. Later, over exploitation and destruction of the mangrove areas became a consequence of population pressures compounded by unwise political decisions on mangroves allocation made in various Asian countries in the last 60 years or so. Moreover, colonial exploiters never took the mangroves very kindly, branding them as stinking, penetratable , mosquito-infested dirty areas. There was virtually no official realization in reclaiming mangroves land since realization of its ecological importance only surfaced during the 1960s. Even in developed countries like Australia, USA etc, mangroves used to be considered as a wasteland ripe for development.

The coast of Pakistan is essentially a subtropical desert with an average rainfall of 10-20 cm, but the rainfall is extremely sporadic and inter annual variation is high. Covering an area of about 600,000 hectares, the mangroves forests are the most prominent feature of Pakistan's coastline. Not all this area is under the mangroves forest, there are large

numbers of creeks, extensive mud flats and over 86000 hectares are growing along the coast of Pakistan (Table-1). They occur mainly in the Indus delta swamps in the province of Sindh along the Arabian seacoast in the south. Small pockets exist also in the deltaic swamps of small seasonal rivers in Miani Hor, Kalmat Hor and Gwater Bay in the province of Balochistan.

Table:8.1 The area summary of mangroves forests along the coast of Pakistan based on SPOTXS data of 2005

#	Region	Area in hectares	Area in acres	%
1	Karachi Harbour area	985.50	2435.00	1.14
2	Indus Delta region	81684.00	201841.00	94.18
3	Miani Hor	3431.36	8479.00	3.96
4	Kalmat Hor	194.00	479.00	0.22
5	Jiwani	433.00	1070.00	0.50
	Total	86727.86	214304.00	100.00

Sources: SPOTXS data of 2005 (IUCN)

The mangroves ecosystem flourished richly in the past when flushing with fresh Indus River water was natural and normal. The rhythms of the saline tidal water in general remain the same in Indus deltaic swamps, the estuary and the sea shores, but the frequency and extent of the discharge of fresh water from the Indus have been noticeably reduced de to diversion of river water to agricultural lands. Apart from this long-term threats to survival of Indus delta mangroves, there are immediate pressure from overgrazing and over-lopping for fuel wood and fodder which result in stunted trees in some areas. Within the vicinity of Karachi there is the pressure that results from the steady growth of a major industrial city of over 16 million people. Apart from untreated domestic waste which flows into the seasonal river, streams and creeks, there are significant industrial discharges from the major industries. Tanneries perhaps represent the most urgent source of pollution, since waste has a high heavy metal content and comes from different sources which are less easy to control.

Realizing the economic potential of mangroves for livelihood of the local communities and their role in combating the natural disaster, IUCN in collaboration with concerned governmental and non governmental organizations has been actively involved in the conservation and management of mangroves from 1997. So far over 6.5 million seedling and saplings have been transplanted in mangroves plantation all along the coast of Pakistan. Some mangroves species (Rhizophora mucronata, Ceriops tagal, Aegiceras corniculatum) along with Avicennia marina have been re-introduced to bring genetic variation and vibrant sustainability of plants and larger ecosystem. Some virgin estuarine areas along Balochistan coast have been brought under mangrove plantation successfully and these plantations have created new world record for high growth rates of these mangroves.

The concept of social forestry has also been introduced in coastal communities and mangroves are being planted along road sites / street, school/health centre as well. Efforts are underway to rehabilitate and regenerate mangroves forests all along the coast of Pakistan under various ongoing projects funded by ADB, RNE, etc.

Source: Muhammad Tahir Qureshi-2010 (Senior Advisor, IUCN Pakistan)

9. Riverine Forests and their status

The riverine forests in the province of Sindh occur along both banks of the Indus River. In Punjab they exist along the river banks and somewhere on the beds of rivers Chenab and Jehlum. They rely on inundation by the River for irrigation and therefore their existence is heavily dependent on the intensity, duration and frequency

The newly deposited soils support the growth of species like Saccharum bengalense, Saccharum spontaneum, Tamarix dioica, Tamarix indica and Populus euphratica. As the land becomes stable vegetation comprises of species like Acacia nilotica, Prosopis cineraria and Cynodon dactylon. Under arid conditions vegetation is comprised of species like Prosopis cineraria,Salvadora persica, S. oleoides, Capparis decidua, Acacia senegal, A. jacquemontii, Rivereine forests are the mainstay of forestry in Sindh. Besides providing a source of livelihood for thousands of people, these forests provide fuel wood, timber, fodder, honey and tannin. Moreover, they serve as carbon sinks and also protect the surrounding areas from the severity of floods.

In recent times, only 50 percent of the gross area of riverine forests is inundated even in high floods. As a result, the riverine forest area is shrinking alarmingly while less salt tolerant species have almost disappeared. The existing condition is likely to further deteriorate with the construction of new dams and barrages, enabling only 20 percent of the original forest area to get inundated. The inundation water which was a the only source of irrigation for these types of forests and the ecology has suddenly reduced. Trees being the most visible of this ecosystem suffered the most and so was the food chain and local communities. The consequence was that a vast riverine area ceased to receive the vital water supply resulting in steady deterioration of forest crops minimizing the productive as well as environmental protection function of these valueable forests.

Management:

The history of the management plans of riverine forests goes back almost 50 years. These plans are designed to convert the primary bhan (Populus euphratica) forest into irrigated plantations of shisham (Dalbergia sissoo) and mulberry (Morus alba). Neither the need of the local people, nor the habitat and foraging requirements of the wild animals that were dependent on these riverine ecosystems were considered in these management plans. Initial, success was achieved in raising valuable shisham and kiker (Acacia nilotica), but this system demands expensive input like weeding and irrigation. Huge development works such as engineering structures for flood control and water reservoirs were constructed. Therefore, these riverine forests are not receiving the vital flushing floods necessary to sustain the forests. Installing diesel-operated pumps was considered a solution as opposed to bringing the management plans in harmony with nature and the demands of the local peoples. This artificial irrigation technique is not giving the desired results. Particular example is that of Ghazi Ghat Forest near the famous Ghazi Ghat Bridge (district Dera Ghazi Khan- Southern Punjab). Foresters have not come up with any viable technique to regenerate shisham after the felling of the mature crop in areas that no longer receive floodwater. Irrigation engineers have blocked the creeks of the

mighty Indus and not a single drop of floodwater now reaches this forest. A similar situation exists in almost all the riverine forests in the country. Bhan was the traditional tree of the primary riverine system in Pakistan. This is of tremendous economic value to traditional artisans. The lacquered traditional furniture made of bhan not only has local market value, but also has export potential.

Table:9.1 The province wise area distribution of Riverine Forests

#	Province	Area in hectares	Area in acres	%
1	Sindh	241,217	595,806	81
2	Punjab	45078	111343	19
3	Balochistan	-	-	-
4	Khyber Pukhtonkhaw	-	-	-
5	GB/AJ&K/FATA	-	-	-
	Total	286,295	707,149	100.00

Sources: Official source of concerned departments (2010)

10. Top ten most forested districts of Pakistan (Based on FSMP 1992)

This information (Table-N) has been collected from the Director General WWF-Pakistan. Assessment has been made by WWF-P on the base of data provided in Forestry Sector Master Plan-1992.

Table:10.1 Top ten forested districts of Pakistan (2010)

S. #	Name of District	Province	Forest Cover (%)
1	Shangla	Khyber Pukhtunkhwa	86
2	Upper Dir	Khyber Pukhtunkhwa	58
3	Swat	Khyber Pukhtunkhwa	46
4	Batagram	Khyber Pukhtunkhwa	41
5	Muzaffarabad	Azad Jammu & Kashmir	41
6	Ziarat	Balochistan	39
7	Kohistan	Khyber Pukhtunkhwa	39
8	Baltistan	Gilgit Baltistan	35
9	Buner	Khyber Pukhtunkhwa	25
10	Mansehra	Khyber Pukhtunkhwa	25

Source: WWF-Pakistan 2010

11. Deforestation in Pakistan

Deforestation rate in Pakistan, estimated at 0.2 per cent to 0.5 per cent annually, is the highest in the world, which accounts for a 4-6 per cent decline in its wood biomass per annum. The total natural forest cover has reduced from 3.59 million hectares to 3.32 million hectares at an average rate of 27,000 hectares annually. The decline in natural forests is attributed greatly to the dependence of a major proportion of rural population for fuel and construction on wood. The natural resource is decreasing at such an alarming speed that all the forest area will be consumed within the next 15 years.

Three sectors consume wood in Pakistan ie domestic rural use, industrial sector and commercial establishments. In this regard, the household sector has emerged as the largest consumer with 81.8 percent followed by industrial entrepreneurs 14.9 percent and the commercial sector 3.3 percent. The annual wood consumption in Pakistan is 43.761 million meters against the annual forest growth of 14.4 million cubic meters. So, it has to suffer a loss of 29.361million cubic meters per annum.

The unchecked cutting of trees has resulted in rapid deforestation and now the forest cover is less than 5 per cent. With one of the highest rates of deforestation in the world, Pakistan's forests are in urgent need of protection and conservation. The major threat to Pakistan's forests is uncontrolled and unsustainable cutting for living purposes and timber products. There is dire need to find out alternate and sustainable livelihood methods to ease pressures on this precious natural resource.

Source: http://rainforests.mongabay.com/deforestation/2000/Pakistan.ht

12. Medicinal Plants

Medicinal plants are a major source of drugs for the treatment of various health disorders. Pakistan has around 6000 species of wild plants (Stewart 1972) out of which about 700 are considered to be medicinally important.

12.1 Ecological regions of medicinal plants

i) Medicinal Plants of Alpine and High Altitude Areas

Most plants of these areas are slow-growing perennials, which require several years of vegetative growth for reproduction by seed. Most of these are classified as threatened or vulnerable. Endangered plant species of this area include *Podophyllum hexandrum, Saussaurea costus, Picrorrhiza kurrooa, Aconitum heterphyllum,* and *Corydalis* spp.

ii) Medicinal Plants of Temperate Montane Forest

Common medicinal plants of these areas are *Atropa acuminata, Angelica glauca, Paeonia emodi, Geranium wallichianum, Artemisia* spp., *Glycyrrhiza glabra,* and *Ephedra* spp.

iii) Medicinal Plants of Sub-Tropical Foothill Forests

Species found here include *Terminalia* spp., *Mallotus philippensis, Phylanthus embilica, Butea monosperma*, etc.

iv) Medicinal Plants of Arid and Semi-Arid Areas

Some important species of medicinal plants of commercial importance like *Artemisia* spp., *Ephedra gerardiana, E. procera, Bunium persicum*, etc. are found in cold arid habitats. In warm arid areas, species like *Commiphora wightii* are known to be present.

Table:12.1 Endangered Medicinal Plants of Pakistan (2008)

Plant	Local name	Annual Consumption (Tons) approx.	Ecological Region
Commiphora wightii	Guggul	25-50	Deserts
Picrorrhiza kurrooa	Katki	10-15	Alpine Himalayas
Podophyllum hexandrum	Bankakri	30-40	Temperate Himalayas
Dioscorea deltoidea	Kanis	30-60	Temperate Himalayas
Paeonia emodi	Mamekh	10-20	Temperate Himalayas
Onosma echiodes	Ratanjot	5-10	Cold dry mountain
Polygonum amplexicaule	Anjabar	15-20	Temperate Himalayas
Valeriana wallichii	Mushkbala	30-50	Temperate Himalayas
Aconitum heterophyllum	Atees	4-5	Temperate Himalayas
Rheum emodi	Revand-chini	30-40	Temperate Himalayas, Hindukush
Saussurea costus	Kuth	5-8	Alpine Himalayas
Atropa acuminata	Angoor-shafa	15	Temperate Himalayas

Source: Rizwan Irshad, Biodiversity of Pakistan (2008)

12.2 Status of the distribution of medicinal plants

According to the National Institute of Health (NIH), approximately 400 plant species are used extensively in traditional medicines. The *Tibbi Pharmacopoeia of Pakistan* (a pharmacopoeia of traditional drugs compiled by the Tibbi Board) has listed around 900 single drugs and about 500 compound preparations made of medicinal plants. The Drugs Control and Traditional Medicines Division of National Institute of Health in collaboration of Hamdard University and World Health Organization has published Monographs of Unani Medicines, Vol-1, which contains more than 300 monographs of single medicinal plants. There are about 30 large herbal and around 100 manufacturing companies in Pakistan, which produce *Unani* and Homoeopathic medicines on a commercial scale. The number of herbal and Homoeopathic medicine manufacturers in the non-organised sector runs into the hundreds. The annual sale of Herbal medicines was around 6 billion rupees. The annual turnover of some large herbal manufacturers is comparable to multinational companies in Pakistan. Traditional healers (around 100,000 in numbers, including hakims and homeopaths and around 300 vaids) serve about 60% of the population, especially those living in the rural areas.

12.3 Threatened Medicinal and Aromatic Plants of Pakistan

A few preliminary attempts have been made to draw up national lists of threatened species, including a list of more than 700 plant species believed to be nationally rare or

threatened, no comprehensive and systematic list of species of national concern has been compiled for Pakistan.

Tabl:12.2 Vulnerable Medicinal Plants of Pakistan (2008)

Plant	Local name	Consumption/Yr. (Tons) approx.	Ecological Region
Plantago ovata	Isabagol	30-40	Cold arid Hills
Pistacia integerrima	Kakar Singhi	2-3	Sub-tropical Himalayas
Ziziphus sativa	Unab	50-100	Sub-tropical Himalayas
Glycyrriza glabra	Mulathi	200	Hindukush, Karakorum
Artemisia spp.	Afsantin	100-15-	Hindukush, Himalayas
Adiantum capilus-veneris	Parsiyawshan	80-100	Temperate Himalayas
Acorus calamus	Warch or gorbach	20-30	Temperate Himalayas
Mallotus Philippinensis	Kamila	5-10	Sub-tropical Himalayas
Berberis lycium	Dardald	300-400	Hindukush, Himalayas
Colchicum luteum	Suranjan Talkh	5-8	Sub-tropical Himalayas
Citrullus coloynthis	Tumba/Hanzil	40-50	Deserts
Bergenia ciliata	Zakhme-e-Hayat	15-20	Temperate Himalayas

Source: Dr. Rizwan Irshad, Biodiversity of Pakistan (2008)

13. Economic share of Forestry and Forestry Education

13.1 Growth Performance of Forestry in Gross National Product

(% Growth at Constant Factor Cost)

Table: 13.1 Yearly performance of forestry in GNP (2007-08)

Forestry	1980's	1990's	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
	6.4	-5.2	11.1	-3.2	-32.4	-1.1	-5.1	-11.5	-15.7

Source: Economic Survey of Pakistan (2008-09)

Forestry accounts for 0.2 percent of GDP and value addition contracted by 15.7 percent compared to a contraction of 11.5 percent last year. The forestry sector is depicting negative growth for the sixth year in a row. Forests are a key component of our environment, degradation of which can pose severe socio-economic challenges for the generations to come.

13.2 Forestry Share in Gross Domestic Product (GDP)

(At Constant Factor Cost) (In %)

Table: 13.2 Yearly performance of forestry in GDP (2007-08)

Forestry	1969-70	2004-05	2005-06	2006-07	2007-08	2008-09
	0.1	0.4	0.4	0.3	0.3	0.2

Source: Economic Survey of Pakistan (2008-09)

Figures show that GDP expanded in 2004 and 2005 but from year 2006 it's again contacting negatively, which poses a serious threat to coming generations for environment and wood-based local needs.

13.3 Resource Allocation/ODA

Traditionally the financial resources are much short of the optimum requirement for maintaining and development of forest and range resources. Whatever funds are received, are too much delayed resulting in degradation of the resources due to season specific nature of forestry operations. The capacity and timely receipt of the budget are crucial issues requiring due attention. An exercise to assess optimum / minimum requirement of funds for maintenance and development of forests and rangelands in various provinces reveals in table below.

Table 13.3: Estimated Annual Financial Resource Allocation and Requirement of Provinces (2005)

S. No.	Province / Territory	Funding Scenario of Forestry Sector in million rupees			
		Current Average Allocation	Minimum Funds for Maintenance	Funds for Development	Total
1	AJK	150	200	200	400
2	Baluchistan	50	100	100	200
3	ICT	100	200	200	400
4	NA	50	75	75	150
5	NWFP	700	1000	1000	2000
6	Punjab	500	1000	1000	2000
7	Sindh	400	750	750	*1500*
Total		**1950**	**3325**	**3325**	**6650**

Source: Land Ownership Pattern and Tenural Arrangements in Forests and Rangelands (Ministry of Environment 2005)

Note: In addition to this MoE has allocated Rs. 12 Bill for MDG targets to be achieved till 2015.

13.4 Forestry Education and Research

Forestry sector formal education has been monopolized at Pakistan Forest Institution Peshawar for graduate and post graduate programmes and Forestry Schools for technician level diploma and certificate for pre-service education is the responsibility of the provinces. It has very strong practical field education component comprising of working plans, field survey, visits to various ecosystems to familiarize the students with management regimes and its imperatives, stem and stump analysis and improvised field engineering training at Military Engineering Academy Risalpur. Recently many new parameters like social and farm forestry have been added. There is need for specialization in various disciplines during the final semester. Training for the serving mid-level and senior professionals is part of continuing education at Pakistan Forest Institute Peshawar but funding is neither reflected in the budget of PFI nor in budget of the provinces. Consequently the provincial Forestry Departments have to arrange for the cost of such education and training, often under various development projects. In the absence of projects funding is not available for in-service training.

Note: Data provided above is from latest possible published source/document

BIODIVERSITY

PART-II

INFORMATION ON BIODIVERSITY

BIODIVERSITY

Biological diversity or "biodiversity" has been defined as:

> "the variability among living organisms from all sources including *inter-alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems". (CBD 1992).

14. ECOLOGICAL ZONES OF PAKISTAN

Major ecological zones of Pakistan and their break down into more discrete units characterized by the association of particular species of plants and mammals are given below. Such units cannot be grouped into continuous ecological zones, but split up the whole region into a mosaic of areas of similar ecological constitution.

A. PERMANET SNOW AND COLD DESERT

1. **Permanent Snowfields and Cold Desert.** In the northern –most regions and highest altitudes as typified by the Karakoram Mountains and Hunza and northernChitral, the vegetation is often more xerophytic than in those alpine zones associated with smaller mountain masses. Plants: *Salix denticulate, Juniperus communis, Mertensia tibetica, Potentilla desertorum.* **Mammals:** On the periphery of this zone will be found the Himalayan Ibex (*Capra ibex sibirica*), Altai Weasel (*Mustela altacia*), Golden Marmot (*Marmota caudata aurea*), Bharal (*Pseudois nayaur*), Lynx (*Felis lynx*), and Snow Leopard (*Panthera uncia*).

B. ALPINE ZONE

2. **Alpine Meadows.** Northern Hazara District and Gilgit, Chitral and Swat Kohistan and also in all regions where mountains extend above coniferous forest treeline, **Plant:** Many annual grasses of *Poa pratensis*, and *Drada trinervia, Polygonum affine. Saxifragra sibirica*. **Mammal:** Snow Leopard (*Panthera uncial*). Himalayan Ibex *Capra ibex sibirica*). Red Bear (*Ursus arctos*), g-tailed Marmot (*Marmota caudate*). Lesser Striped Shrew (Sorex thibetanus), Royle's High Mountain vole (Alticola roylei), Ermine (Mustela erminera). The Chinese Birch Mouse (Sicista concolor).

Sub-alpine Scrub and Birch Forest. Though widespread this always comprises a very limited or snow zone confined often to small ravines on upper zones throughout higher mountain ranges of the Himalayas, including the north-eastern corner of Hazara District, Gilgit and Swat Kohistan. **Plants:** *Betul*a *utilis*. *Rhododendron hypenanthemum, Juniperus communis, Sorbus tianshanica, Alopecurus Praten, Poa* grasses with many *Primula, Ranunculaceae Anemone*, spp. **Mammals:** Royle's High mountain Vole (*Alticola roylei*). True's vole *Hyperacrius fertilis*), Chinese Birch Mouse (*Sicista concolor*), Musk Deer (*Moschus chrysogaster*), Snow leopard (*Panthera uncia*), and Markhor (*Capra falconeri*).

C. MONTANE TEMPERATE FOREST

4. **Dry Temperate Coniferous Forest.** Usually found the in the inner ranges of the Himalayas with less monsoon influence and confined to the more sheltered lower slopes. Typified by upper reaches of Kaghan Valley, Jabba Valley in Swat, Gabrial, Dir, Chilas and Naltar Valley in Gilgit. **Plants:** Spruce (*Picea smithiana),* Kail (*Pinus wallichiana),* deodar (*Cedrus deodara),* with under shrubs of indigofera (*Indigofera gerardiana),* elderberry *Sambucus ebulus*. **Mammals:** Royle's Pika (*Ochotona roylei*), Small Kashmir Flying Squirrel (*Hylopetes fimbriatus*), Himalayan Black Bear (*Ursus thibetanus*), Yellow-throated Merten (*Martes flavigula*), Long-tailed Field house (*Apodemus rusiges*/Syn: sylvaticus), and Turkestan Rat (*Rattus turkestanicus*).

5. **Himalayan Moist Temperate Forest.** Typical of the Galis, Lower Kaghan Valley, Shogran, Neelum Valley in Azad Kashmir, having mixed deciduous and coniferous forest and high rainfall during monsoon season. **Plants:** Quercus (*Quercus dilatata),* Acer (*Acer caesium),* Poplar (*Populus ciliate),* Taxus (*Taxus baccata),* Kail (*Pinus wallichiana)* with under shrubs as Berberis (*Berberis lyceum),* Honeysuckle (*Lonicera alpigena),* Viburnum (*Viburnum nervosum),* Nazar Panra *(Skimmia laureola), Fragaria, Viola* and *Impatiens* species. **Mammals:** Yellow-throated Marten (*Martes flavigula*), Giant Red Flying Squirrel *Petaurista petaurista*), Small Kashmir Flying Squirrel *Hylopetes fimbriatus*), Leopard Cat (*Prionailurus bergalensis*). Grey Langur (*Semnopithecus entellus*, Rhesus Macaque (*Macaca mulatta*). Himalayan Black Bear (*Ursus thibetanus*), Porcupine (*Hystrix indica*). Murree Vole (*Hyperacrius wynnei*). Turkestan Rat (*Rattus turkestanicus*), Long-tailed Field Mouse *Apodemus rusiges*/Syn: *sylvaticus*). Whiskered Bat (*Myotis muricola*) and Grey Long-eared Bat *Plecotus austriacus*).

6. **Sub-tropical Pine Forest.** A fairly narrow zone confined between about 3000ft and 6500ft. Typified by Batrasi Pass. Buner in Swat, Gora Gali and Tret. **Plants:** Chir (*Pinus roxburghii).* Quercus (*Quercus incana)* with undershrubs of Berberis (*Berberis heteropoda), Berberis lyceum*. Clematis gouriana, Carissa spp. Cotoneaster spp. and clumps of grasses such as *Apluda aristata*. *Themeda anathera* and *Aristida cyanantha*. **Mammals:** Grey Goral (*Naemorhedus goral*). Panther (*Panthera paradus* Cape or Tibetan Hare (*Lepus capensis*). Yellow-throated Marten (*Martes flavigula*) and Himalayan Palm Civet (*Pagum alarvata*).

D. TROPICAL DECIDUOUS FOREST

7. **Tropical Deciduous Forest.** This habitat is very restricted in area within Pakistan and is largely associated with the Jhelum Valley, the Rawalpindi foothills and outer Margalla Hills. It is nevertheless of great ecological interest, as it has deciduous tree species of Indo-Malayan origin as well as some truly Oriental mammal and bird species. It is typified by Kahuta, Lehtrar and Nurpur Shahan. On the dryer ridges the forest is dry sclerophyllus and it is only in the shadier ravines that some association of typical tropical deciduous species builds up. Early summer and spring are hot and dry but there is much rain in late summer: upto (40mm (37 in.) in the year. **Plant:** Phulai (*Acacia modesta).* Kachnar (*Bauhinia variegate).* Amaltas (*Cassia fistula).* Anjeer (*Ficus carica).*Shorea (*Shorea robusta).* Simal (*Salmalia malabarica).* *Sterculia villosa*. Anar (*Punica granatum)* and *Lannea coromandelica* with an understorey of Snatha (*Dodonea viscose).*

Woodfordia fruiticosa, *Carissa spin arum*. *Adhtoda vesica* and Ber (*Zizyphus mauritiana)*. **Mammals:** Barking Deer (*Muntiacus muntjak*). Wild Pig (Sus *scrofa*). Nilgai (*Boselaphus tragocamelus*) in Azad Kashmir only. Yellow-throated Marten (*Martes flavigula*), Leopard (*panthera pardus*), and False Vampire Bat (*Megaderma lyra*).

E. ALPINE DRY STEPPE

8. **Steppic Forest in Northern Latitudes.** Typified by side valleys of Lower Chitral, parts of Gilgit, Kohistan and Dir, **Plants:** Juniper (*Juniperus macropoda), Juniperus polycarpos*, kakar singhi *(Pistacia integerrima), Quercus ilex*, Chilghoza pine (*Pinus gerardiana)* and *P. wallichiana*, *Plectranthus rugosus*, *Artemisia maritima*, *Hippophaes rhamnoides* (in valleys), *Enneapogon persicum*, *Ephedra intermedia* and *Berberis species*. **Mammals:** Markhor (*Capra falconeri*), Royle's Pika (*Ochotona roylei*), Forest Dormouse (*Dryomys nitedula*), Migratory Hamster (*Cricetulus migratorius*), Stone Marten (*Martes foina*), and Field Mouse (*Apodemus rusiges*/Syn: *sylvaticus*).

9. **Steppic Forest in Intermediate Latitudes.** Typified by Takht-i-Suleiman, Toba Kakkar Range, Fort Sandeman (now Zhob), western border of Waziristan, parts of Safed Koh, Malakand and Swat. **Plants:** *Juniperus macropoda, Fraxinus xanthoxyloides, Pinus gerardiana, Artemisia maritima, Rheum emodi, Ephedra nebrodensis, Rosa webbiana, Pennisetum orientalis, Pistacia mutica, Thym*us *serpyllum*, *Eremurus aurantiacus*. **Mammals:** Markhor – (*Capra falconeri*), Collared Pika (*Ochotona rufescens*), Migratory Hamster (*Cricetulus migratorius*), Stone Marten (*Martes foina*), Forest Dormouse (*Dryomys nitedula*), Persian Jird (*Meriones perscius*) and Mouse-like Hamster (*Calomyscus bailwardi*).

10. **Steppic Forest in Southern Latitudes.** Typified by the higher mountain ranges of northern Kalat (Harboi and Gishk), Chiltan, Takhatu, Zarghun and Kaliphat Mountain ranges, also the higher parts of the Suleiman Hills. **Plants:** stunted *Juniperous macropada, Shnai (Pistacia khinjik), berberis balochistanica, Prunus eburnean, Rosa wbbiana, Tulipa spp, Iris spp, Ermurus stenophylus, Artemisia scoparia*and grasses such as *Stipa pennata, Pennisitum orientale* and *Ephedra nebrodensis.* **Mammals:** in the extreme south there is the Persian Wild Goat *(Capra aegagrus),* further north, the Straight Horned Markhor *(capra falconeri jerdoni)* elsewhere Stone Marten *(martes foina),* Persian Jirds *(Meriones persicus)* Collard Pikas *(Ochotona rufescens),* Migratory Hamsters *(Cricetulus migratorius)*, Mouse-like Hamster *(Calomyscus bailwardi)*, and Afghan Hedgehog *(Hemiechinus auritus megalotis).*

F. ARID SUB-TROPICAL HABITAT

(Characterized by rocky and hilly country between sea level and about 3000 ft elevation)

11 **Monsoon-influenced Arid Sub-tropical.** With humid summers, mild but dry winters. Typified by Karachi environs, Malir, Lakhi Hills, Sindh Kohistan, Kirthar, Lasbela. **Plants:** *Euphorbia caducifolia*, *Ziziphus nummularia*, Kikar (*Acacia Senegal), Commiphora mukul*, and in valley bottoms Mazri (*Nannorrhops ritchieana), Capparis*

deciduas, *Caragana ambigua*, *Haloxylon salicornicum*. **Mammals:** Indian Fox (*Vulpes bengalensis*), Desert Cat (*Felis silvestris ornata*), Chinkara (*Gazella bennettii*), *Pangolin* (*Manis crassicaudata*), Hyaena (*Hyaena hyaena*), Ratel (*Mellivora capensis*), Sindh Wild Goat (*Capra aegagrus*), Porcupine (*Hystric indica*), Bush Rat ((*Golunda ellioti*), Spiny Mouse (*Acomys cahirinus*), Grey Spiny Mouse (*Mus saxicola*), Balochistan Gerbil (*Gerbillus nanus*), Trident Leaf-nosed Bat (*Asellia tridens*), Indian Hedgehog (*Paraechinus micropus*).

12. **Less Pronounced Monsoon Influence.** Some winter showers with frost regularly occurring and rather dry hot summers, more akin to Mediterranean climate. Typified by salt Range, Kala Chitta Hills and the eastern or outer hills of Waziristan. Most of these regions are heavily over-grazed showing only degraded vegetation. **Plants:** *Acacia modesta*, *Olea cuspidata*, occasionally *Tecomella undulate*, and on dryer's slopes *Dodonea viscosa*, *Monotheca buxifolia*, *Eryngium billardieri*, *Adhatoda vasica*, *Witbania coagulans*. **Mammals:** Urial (*Ovis vignei*), Chinkara (*Gazella bennettii*), Panther (*Panthera paradus*), Desert Fox (*Vulpes vulpes pusilla*); Desert Hare (*Lepus nigricollis dayanus*), Porcupine (*Hystrix indica*), Hyaena (*Hyaena hyaena*), Pangolin (*Manis crassicaudata*), Larger Rat-tailed Bat (*Rhinopoma microphyllum*), Bi-coloured Leaf-nosed Bat (*Hipposideros fulvus*), Caracal (*Felis caracal*), Soft-furred Field Rat (*Millardia meltada*), Brandt's Hedgehog (*Paraechinus hypomelas*).

13. **Balochistan Desert Scrub.** Usually associated with higher hills, stony plateaus or peneplains. Very cold winters and no monsoon influence but occasional winter and spring showers. Typified by Northern Kalat, the lower parts of the Suleiman Hills, most of the Balochistan valleys, the Kurram valley and most of Waziristan and the North West Frontier Province. All these regions tend to be heavily overgrazed and felled and with vegetation degraded. **Plants:** *Reptonia buxifolia*. *Haloxylon ammodendron*, *Pistacia integerrima*, *Olea cuspidata*, *Nannorrhops ritchieana*, *Bromus molle*, *Bromus tectorum* and other *Bromus* spp. In Waziristan's inner hill ranges the dominant species are *Quercus ilex, Olea cuspidata*, *Sophora mollis* and especially *Monotheca buxifolia*. In ravines and valleys *Adhatoda vasica* and *Withania coagulans*. **Mammals:** Hill Fox (*Vuples vulpes griffithi*), Balochistan race of Black Bear (*Ursus thibetanus gedrosianus*), Hyaena (*Hyaena hyaena*), Marbled Pole Cat (*Vormela peregusna*), Leopard (*Panthera pardus*), Caracal Cat (*Felis caracal*), Urial (*Ovis vignei*), Goitred Gazelle (*Gazella subgutturosa*), Cape or Tibetan Hare (*Lepus capensis*), Porcupine (*Hystrix indica*), Libyan Jird (*Meriones libycus*), Sundevall's Jird (*Meriones libycus*), Sundevall's Jird (*Meriones crassus*), Balochistan Gerbil (*Gerbillus nanus*), Migratory Hamster (*Cricetulus migratorius*), Brandt's Hedgehog (*Paraechinus hypomelas*), Greater Horse-shoe Bat (*Rhinolophus ferrumequinum*).

G. TROPICAL THORN FOREST

14. **Indus Plains.** Principal edaphic feature is deep soil. Most of this region has been cleared for cultivation and last remnants of forest are heavily degraded due to over-grazing and felling by charcoal burners. Limited areas of small sandhills are usually interspersed with flat 'patts' and some of these areas are highly saline. Typical areas may be found between Jhang and Shorkot Road, around Kasur on the border of India and in Sindh on the right bank of the Indus around Kashmore. **Plants:** *Prosopis spicigera*, *Tamarix aphylla*, *Capparis decidua*and *Salvadora oleoides* with understorey of *Suada*

fruticosa and *Chenopodium album*. In the South *Salvadora oleoides* with understorey of *Suaeda fruticosa* and *Chenopodium album*. In the south *Salvadora oleoides* is replaced by *Salvadora persica*. **Mammals:** Jungle Cat (*Felis chaus*), Wild Pig (*Suss crofa*), Desert Wolf (*Canis lupus pallipes*), Common Grey Mongoose (*Herpestes edwardsi*), Long-eared Hedgehog (*Hemiechinus collaris*), Desert Jird (*Meriones hurrianae*), Yellow-bellied Scotophil Bat (*Scotophilus heathii*), Kuhl's Pipistrelle (*Pepistrellus kuhlii).*

15. **Sand-dunes.** Extensive areas of undulating sand dunes often associated with absence of cultivation and extensive semi-desert---typified by Thal Desert, Cholistan and Thar Desert. **Plants:** *Calligonum polygonoides*, *Alhagi camelorum*, *Acacia jacquemontii*, *Prosopis spicigera*, *Pennisetum dichotomum*, *Leptadaenia spartium*, *Capparis decidua*, *Tamarix articulate* and *Eragrostis* tef. In the sand-dune areas of Nushki and Chagai, instead of *Calligonum polygonoides* binding the sandhills together the dominant bush is *Haloxylon polygonoides*. **Mammals:** Desert Fox (*Vulpes vulpes pusilla*), Small Indian Civet (*Viverricula indica*), Caracal Cat (*Felis caracal*), Hairy-footed Gerbil (*Gerbillus gleadowi*), Cheesman's Gerbil (*Gerbillus cheesmani*), Common Indian Gerbil (*Tatera indica*), Chinkara (*Gazella bennettii*), Kutch Sheath-tailed Bat (*Taphozous nudiventris). Desert Hare (Lepus nigricollis dayanus).*

H. RIVERAIN PLAIN OR INDUS BASIN

16. **Inundation Zones, Seepage Zones, Jheels and Swamps.** These include areas subject to summer flooding but which often become dry by April or May. There are very few areas of permanent swamp in Pakistan. Typical examples are around the East Nara and Sanghar, Ghauspur in Jacobabad District and Manchar in Dadu District-all in Sindh, Trimmu and Balloki Headworks in the Punjab, and Lal Suhanran near Bahawalpur. **Plants:** *Saccharum spontaneum*, *Phrangmites communis*, *Tamarix dioica*, *Typha elephantina*, *Typha angustata*, *Arundo donax*, *Paspalum ditichum*, *Erianthus* spp. **Mammals:** Wild Pig (*Sus scrofa*), Hog Deer (*Axis porcinus*). Smooth-coated Indian Otter (*Lutrogale perspicillata*). Fishing Cat (*Prionailurus viverrinus*), Yellow-bellied Scotophil Bat (*Scotophilus healthii*).

17. **Riverain Tract.** The immediate vicinity of the Indus River and its tributaries up to the base of the foothills in the north. **Plants:** *Tamarix dioica*, *Tamarix aphylla*, *Saccharum spontaneum*, *Populus euphratica*, *Acacia Arabica*. **Mammals:** Smooth-coated Indian Otter (*Lutrogale perspicillata*), Hog Deer (*Axis porcinus*), Wild Pig (*Sus scrofa*), Small Indian Civet (*Viverricula indica*), Short-tailed Mole Rat (*Nesokia indica*), Jungle Cat (*Felis chaus*), Jackal (*Canis aureus*), Desert Hare (*Lepus nigricollis dayanus*).

18. **Littoral or Inter-tidal Zone.** Typified by Indus mouth and Sonmiani and other bays along the Mekran Coast, being characterized by mangroves. **Plants:** *Avicennia officinalis*, *Rhizophora conjugata*, *Ceriops tagal* and *Salsola foetida*. **Mammals:** Lesser Bandicoot Rat (*Bandicota bengalensis*), Hog Deer (*Axis porcinus*), Smooth-coated Indian Otter (*Lutrogale perspicillata*), Fishing Cat (*Prionailurus viverrinus*), Plumbeous Dolphin (*Sousa plumbea*), and Finless Black Porpoise (*Neophocaena hocaenoides*).

Source: T.J.Roberts, The Mammals of Pakistan (1997)

15. PROTECTED AREAS OF PAKISTAN

A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN)

15.1 National Parks:

National parks in Pakistan have apparently been established primarily for wildlife and not necessarily for their historic or scenic features. The provincial wildlife departments handle their administration. The first national park, Lal Suhanra, was formally declared in the Bahawalpur district of Punjab in 1972. The park consists of irrigated forest plantations (20,974 acres), desert branch pond (4780 acres) and Cholistan Desert (51726 acres) for a total of 77480 acres.
So far, 23 national parks have been declared as follows:

Table:15.1 National Parks of Pakistan (2010)

S/No	Name	Province/Territory	Area (Ha)
1.	Margalla Hills	Capital Territory	17,386
2.	Lal Sohanra	Punjab	51588
3.	Chinji	Punjab	6070
4.	Kala Chitta	Punjab	
5.	Murre Kahuta Kotli Sattian	Punjab	
6.	Kirthar	Sindh	308,733
7.	Chiltan Hazarganji	Balochistan	15,555
8.	Hingol	Balochistan	619043
9.	Ayubia	NWFP	1,684
10	Chitral Gol	NWFP	7750
11	Sheikh Buddin	NWFP	15540
12	Lake Saif-ul-Maluk	NWFP	4867
13	Lake Lulu Sar	NWFP	30375
14	Khunjerab	Northern Areas	226,913
15	Deosai Plains	Northern Areas	3,58,400
16	Handrap Shandhoor	Northern Areas	51,200
17	Central Karakorum	Northern Areas	13,90,100
18	Machiara	AJK	13593
19	Ghamot	AJK	27394
20	Toli Pir	AJK	5045
21	Pir Lasura	AJK	5625
22	Musk Deer NP Gurez	AJK	52816
23	Deva Vatala NP	AJK	2993

Source: NCCW/MoE official data 2010

In addition to the above mentioned 23 national parks, the provincial governments have listed;

- 99 wildlife sanctuaries (Punjab - 37, Sindh - 35, Northwest Frontier - 6, Balochistan 14, Northern Areas – 5, federal territory 1)
- In addition, 97 areas have been designated as game reserves. These govern an additional 4407 square miles of terrain, (Punjab - 19 areas, Sindh - 14 areas, Northwest Frontier - 38 areas, Balochistan - 8 areas, Northern Areas - 9 sites and AJK - 8 sites, federal territory - 1).

Table 15.2: Summary of Protected Areas in Pakistan (based on NCCW data 2010)

Region/ Province	National Parks	Wildlife Sanctuaries	Game Reserves	Un Classified	Total PAs	Total Area Conserved (ha)	% of Total Land Area Protected
Azad Jammu Kashmir	6	0	8	0	14	151,871	11.41
Balochistan	2	15	7	7	31	1,837,704	5.29
Punjab	4	37	19	0	60	3,315,803	16.14*
NWFP	5	6	38	5	54	521,457	6.97
Sindh	1	35	14	4	54	1,307,575	9.27
Federal Territory	1	1	1	0	3	94,186	100
Northern Areas	4	5	9	0	18	2,092,180	2.97
Totals	**23**	**99**	**96**	**16**	**234**	**9,320,776***	**10.91***

a. One of the Wildlife Sanctuary in Balochistan has been redesignated as Game Reserve in 1998.
b. Two of the Wildlife Sancturies in Northern Areas have been redesignated as Controlled Hunting Areas in October 1998
* The area of three new National Parks of Punjab is missing; rest of table has been updated by writer of report

15.2 IUCN PROTECTED AREAS CLASSIFICATION

I. Strict Nature Reserve/Wilderness Area: Areas of land and/or sea possessing outstanding or representative ecosystems, geological physiological features and/or species, available primarily for scientific research and/or environmental monitoring; or large areas of unmodified or slightly modified land, and/or sea, retaining their natural character and influence, without permanent or significant habitation, which are protected and managed so as to preserve their natural condition.

II. National Park: Protected Areas Managed Mainly for Ecosystem Conservation and Recreation. Natural areas of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for this and future generations, (b) exclude exploitation or occupation inimical to the purposes of

designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

III. **Natural Monument: Protected Areas Managed Mainly for Conservation of Special Features.** Areas containing one or more specific natural or natural/ cultural features which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.

IV. **Habitat/Species Management Area: Protected Areas Managed Mainly for Conservation through Management Intervention.** Areas of land and/ or sea subject to active intervention for management purposes to ensure the maintenance of habitats and/ or to meet the requirements of specific species.

V. **Protected Landscape / Seascape: Protected Areas Managed Mainly for Landscape/ Seascape conservation and recreation.** Areas of land, with coast and sea as appropriate, where the impact of people and nature over time has produced an area of distinct character with significant aesthetic, cultural and/ or ecological value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.

VI. **Managed Resource Protected Area / Protected Areas Managed Mainly for the Sustainable Use of Natural Ecosystems.** Areas containing predominantly unmodified natural systems managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Source: IUCN, 1994. Guidelines for Protected Area Management Categories

15.3 Species of Special Concern

Only four species of mammals are endemic to Pakistan. Two species i.e. Woolly Flying Squirrel (Eupetaurus cinereus) and Indus Dolphin (Platanista minor) were declared as an Endangered (EN) at the recent attempt on mammalian red listing for Pakistan. Two endemic sub-species are the Balochistan Black Bear (Ursus thibetanus gedrosianus) declared as Critically Endangered (CR) and the Punjab Urial (Ovis vignei punjabensis) as Endangered.

15.3.1 Extinct Species

At least four mammal species are known to have disappeared from Pakistan within the last 400 years: tiger (Panthera tigris); swamp deer (Cervus duvauceli); lion (Panthera leo); and the Indian one-horned rhinoceros (Rhinoceros unicornis). A further two species have probably gone extinct in recent decades: cheetah (Acinonyx jubatus); and hangul (Cervus elaphus hanglu). The blackbuck (Antelope cervicapra) has been listed as locally extinct but has now been bred in captivity while the Asiatic wild ass (Equushemionus) is believed to be threatened with extinction in Pakistan (Ahmad 1997).

15.3.2 Internationally Threatened Species

The IUCN Red List of Threatened Animals (IUCN 1996)/ (**Appendix-A**) lists 37 species and 14 sub-species of internationally threatened or near- threatened mammals as occurring in Pakistan. Of these, two are critically endangered, nine endangered, 11 vulnerable, 24 near- threatened, five data deficient and one conservation dependent. The critically endangered mammals are Balochistan black bear (Ursus thibetanus gedrosianus) and Chiltan goat (Capra aegagrus chiltanensis). Endangered mammals include snow leopard (Uncia uncia), Indus river dolphin (Platanista minor), markhor (Capra falconeri), Urial (Ovis vignei), and woolly flying squirre (Eupetaurus cinereus). Internationally threatened bird (**Appendix-B**) species in Pakistan include 25 internationally threatened (one critically endangered, two endangered, 22 vulnerable) and 17 internationally near- threatened bird species (IUCN 1996). The critically endangered bird is the lesser florican (Eupodotis indica), while the Siberian crane (Grus leucogeranus) and great Indian bustard (Ardeotis nigriceps) are listed as endangered. Ten internationally threatened reptiles occur in Pakistan (three endangered, three vulnerable, three near-threatened and one data deficient), but there are no internationally threatened amphibians.

Table: 15.3 Species Richness and Endemics for Major Plant and Animal Groups in Pakistan. (1999)

	Total Reported in Pakistan	Endemics	Threatened
Mammals	174	6	20
Birds	668	?	25
Reptiles	177	13	6
Amphibians	22	9	1
Fish (freshwater)	198	29	1
Fish (marine)	788	-	5
Echinoderms	25	-	2
Molluscs (Marine)	769	-	8
Crustaceans (Marine)	287	-	6
Annelids (Marine)	101	-	1
Insects	>5000	-	-
Angiosperms	5700	380	?
Gymnosperms	21	-	?
Pteridophytes	189	-	?
Algae	775	20	?
Fungi	>4500	2	?

Source: Biodiversity Action Plan Pakistan (1999)

Note: Data provided is from latest possible source

16. Invasive and Alien Species

"Alien species" (non-native, non-indigenous, foreign, exotic) means a species, subspecies, or lower taxon occurring outside of its natural range and dispersal potential (outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans). This term includes any part, gametes, or propagules of such species that might survive and subsequently reproduce.

"Invasive species" means an alien species which has become established in natural or semi-natural ecosystems or habitats, is an agent of change that threatens native or biological diversity.

Table: 16.1 Invasive and Alien Species (2010)

S.#	Name of Species	Area of Origin
1	Eucalyptus (Eucalyptues spp)	Australia
2	Mesquite (Prosopis juliflora)	Mexico
3	Paper mulberry (Broussonetia papyrifera)	China
4	Parthenium (Parthenium hysterophorus)	North Central America
5	Ailanthus (Ailanthus altissima)	China
6	Robinia (Robinia pseudoacacia)	North America
7	Lantana (Lantana camara)	America and Africa

Source: Rizwan, Biodiversity of Pakistan (2008)

16.1 Introduced Eucalyptus Species

Eucalyptus is native to Australia and was introduced in Pakistan almost one hundred years ago. There are more than 600 species of eucalyptus. Four namely: *Eucalyptus camaldulensis*, *E. citriodora*, *E. territicornis* and *E. microtheca*, have adapted to local conditions. However, only *E. camaldulensis* is widely grown on farmlands for commercial purposes. Eucalyptus belongs to family Myrtaceae and is now widespread in the problem soils of Pakistan.

It is found in areas such as marginal and sub-marginal farmlands, scrub forests, Pabbi Hills, Salt Range, Thar and Cholistan Desert, piedmont tract of the Salt Range and the Sulaiman Range. Additionally, it is found in the plains of Punjab, Sindh, NWFP and Balochistan. Eucalyptus can be seen growing and contributing to conservation, good air, and the production of honey and soil environment. This is done because eucalyptus firewood now sells, thereby mitigating the pressure on the local firewood species. However, contrary to the claims of the anti-eucalyptus campaigners, birds roost and nest on this tree, and honey bees flock to collect its nectar.

This species is also found in the linear land strips, village surroundings and grazing lands. Most of the man-made irrigated plantations have sizeable areas under *Eucalyptus camaldulensis*. At least 7.7 million cubic feet of eucalyptus biomass was estimated in 1992 (FSMP, 1992). The Sindh province alone has 6,000 ha of land under this species.

There is lot of controversy surrounding the monoculture of *Eucalyptus camaldulensis.* For example, in Malakand, lower Swat Valley, and Siren Valley, natural vegetation has been totally replaced by eucalyptus plantations. Natural vegetation can not grow under eucalyptus. Consequently, the natural habitat will be totally degraded, and wildlife normally seen around indigenous plant species in the area will disappear.

Eucalyptus camaldulensis has fully adapted to the edapho-climatic conditions of Pakistan. Even in piedmont soils like the one prevailing in the Jauharabad Plantation, regeneration from seed has been observed. It has an excellent coppicing power and ratoon cropping can be practised for pulp and small timber.

Allelopathic Affects

Experiments at Punjab Forestry Research Institute (PFRI) Faisalabad have confirmed that *Eucalyptus camaldulensis* has no adverse allelopathic affect on wheat crop. However, it competes for moisture, nutrients and light and must be properly planted in farmlands.

Ecological Impact

Eucalyptus is believed to compete with local flora for nutrients and outpaces all other in drawing water from deeper soils, resulting in the drying up of the subsoil water table. Still, more scientific data is required on this issue.

16.2 Invasive Mesquite

The mesquite *Prosopis juliflora* locally called *valayati jand* or *Kabuli kiker* is indigenous to the west tropical and sub-tropical North and South America (N.P. Mohan Punjab Forest Records 1940). It is well adapted in its native habitat to low rainfall and arid conditions. In Jamaica it is described as an admirable tree often attaining a height of 40 to 60 feet, growing in gravel soil and in situations where it does not rain for months. This species was introduced to Hawaii in 1828 and since then has spread from the seacoast up to an elevation of 2000 feet. It has also been successfully introduced in Australia and South Africa.

Available records show that the mesquite was introduced initially in the Indo-Pak subcontinent in Sindh to act as a sand binder in 1878. It has reproduced naturally over the Miani plain near Hyderabad through seed distribution by goats. It did well in Balochistan, the Pabbi Hills in the Punjab and near Peshawar in the early years of its introduction. In the canal irrigated areas the mesquite has assumed the role of an invader, particularly in the irrigated plantations of Punjab and Sindh. It grows naturally in the Pabbi hills, the Salt Range, the piedmont area, the mining wastes, plains, riverine forest area, waste agricultural lands, saline and waterlogged areas, the desert, the Sulaiman Range. It is found on almost all the linear land strips like highways, canals, and railway tracks. Sizeable areas of the Makran coast of Balochistan are home to the mesquite. The poor rural masses enjoy its free harvest for their domestic energy needs, is considered as a weed. The forestry departments spend huge amounts on mesquite eradication whenever new plantations are established.

Two species of mesquite (*Prosopis juliflora* and *P. glandilosa*), as well as five varieties were introduced in the country in the last century. These were the arid country form; the Mexican tree form introduced in 1912, the Australian form introduced in 1915, the Peruvian form introduced in 1915 and the Argentine form introduced in 1916. However,

the majority of the varieties now encountered in the country are bushy forms. The PFI, Peshawar, has been successful in identifying and raising tree varieties of mesquite. This variety promises good quick green cover in the arid country.

Environmental Impact

Mesquite has occupied a niche by replacing the local flora. Some wildlife is known to prefer mesquite plantations for refuge. The unprecedented increase in the population of the wild boar after 1947 was partly attributed to the mesquite. Ecological studies on its effects on the local flora that it has replaced and its effects on the ecosystem have not been detailed, also research on its ecological and social impacts has not been conducted, yet there is a general view that it has helped the rural poor by providing a cheap source of fuel and livelihood for small traders in fuel wood and in charcoal kilns.

16.3 Invasive Paper Mulberry

Paper mulberry (*Broussonetia papyrifera)*is a fast growing Southeast Asian species that has naturalised widely in the country. Records show that it was introduced in northern India (Saharanpur) in 1880. Parker in his *Forest flora for the Punjab*, *1915*, feared it would become common in the sub-Himalayan tract and the irrigated plantations. He also reports its spread in Lahore and Shahdara Plantation in the first quarter of the twentieth century. Today it is one of the major weeds of all the irrigated plantations and neglected spots and is suppressing the growth of trees (Khan and Rizwanullah, 1981), even in areas not reported earlier (Khan and Adil, 1994). It was planted on a large scale in the new capital Islamabad in the sixties but today is a menace. Allergies and choking of sewerage lines in the urban set-up are attributed to the paper mulberry. The strategy of regeneration, both vegetative and by seeds plays an important role in its invasion. Birds disperse its fruit (which ripens in June). Additionally, it also sends root suckers, thus forming layers around the mother plant.

16.4 Parthenium:

Parthenium (*Parthenium hysterophorus*) is a native of North Central America was probably introduced into the plains of Pakistan in late nineties through India where it was reported much earlier. The species has replaced the native vegetation and shows vigorous growth by forming thick continuous mats along the roadsides in many cities of the country where the climatic conditions are favourable. It is also one of the major weeds of the disturbed areas causing allergy.

16.5 Ailanthus:

A native of China, ailanthus (*Ailanthus altissima*) was introduced in early 1970s. At present, it is growing along the roads and other naturally disturbed habitats of northern Pakistan. Ailanthus has already created a lot of problems in North America as invasive species because it produces abundant root sprouts that can develop into extensive thickets and displace native vegetation. In Pakistan, its impact as non-native species is yet to be evaluated.

16.6 Robinia:

A native of North America Robinia (*Robinia pseudoacacia*) introduced in early 1990s in the hilly areas of northern Pakistan mainly along the road-sides and stream bottoms. It is feared by some experts that its rapidly growing stands may displace native vegetation particularly pine forests. Its assessment as an invasive tree is needed to be done at the earliest.

16.7. Lantana:

One among the world's worst 100 invasive weed, Lantana (*Lantana camara*) has extensively invaded the countryside by forming pure continuous thickets. It not only replaces the native vegetation but also repels the associated fauna by its strong odour. Lantana has entirely changed the vegetation picture of certain areas in Punjab and the Federal Capital.

16.8 Fauji Khagga as an Invasive Species

Bagarius bagarius locally called Fauji Khagga is a kind of catfish, often called the 'freshwater shark' due to its voracious habits and ugly shape. It inhabits the freshwaters of South Asian countries like Pakistan, Nepal, India, Bangladesh, China, Thailand, Malaysia and Indonesia.

The records of Chashma Barrage landings and arrivals in the fish markets of the Punjab show that the population of this fish has increased significantly during 1990-1996. The catchers from all the rivers, especially at the Chashma Barrage, contained very big fish ranging from 40 – 65 kg in weight. The autopsy of the fish stomach showed that each fish had preyed upon several dozens of fish of all kinds, inflicting heavy losses to other fish populations. During the years 1997-98 and 1998-99, the fish population of the Khagga was greatly reduced at Chashma due to the reduction in water supply and the draining of the water from the barrage reservoir for repair purposes.

16.9 Introduced Cats in Islands of the Arabian Sea

As one sails south of the small Balochi coastal town of Pasni, after about three hours an island with serene blue seas all around becomes visible. The island is locally known as Haptalar and is located some 16 miles from the town of Pasni.

Though the island is not easily accessible and is uninhabited, fishermen from nearby coastal towns like Shah Bandar in Sindh, visit the island seasonally to catch fish, lobsters and oysters.

Table:16.2 Exotic Fish in Pakistan (2008)

Common Name	Scientific Name
Brown trout	*Salmo trutta fario* (Walbaum)
Rainbow trout	*Oncorhynchus mykiss* (Linnaeus)
Grass carp	*Ctenopharyngodon idellus* (C. and V.)
Silver carp	*Hypophthalmichthys molitrix*
Bighead carp	*Aristichthys nobilis* (C. and V.)
Common carp	*Cyprinus carpio* Linnaeus
Tilapia	*Oreochromis aureus* (Steind.)
Tilapia	*Oreochromis niloticus* (Linnaeus)
Tilapia	*Oreochromis mossambicus* (Peters)
Gold fish	*Carassius auratus* (Linnaeus)
Guppy	*Poecilia reticulata* (Peters)
Gambusia fish	*Gambusia affinis* (Baird and Girard)
Black Mollie	*Poecilia latipinna* (Le Sever)
Swordtail	*Xiphophorus helleri* (Heckel)
Swordtail	*Xiphophorus variatus* (Heckel)

Source: Dr. Nazir Bhatti, former Director General, Fisheries, Government of Punjab and Rizwan Irshad 2008

17. Ramsar Wetland sites in Pakistan

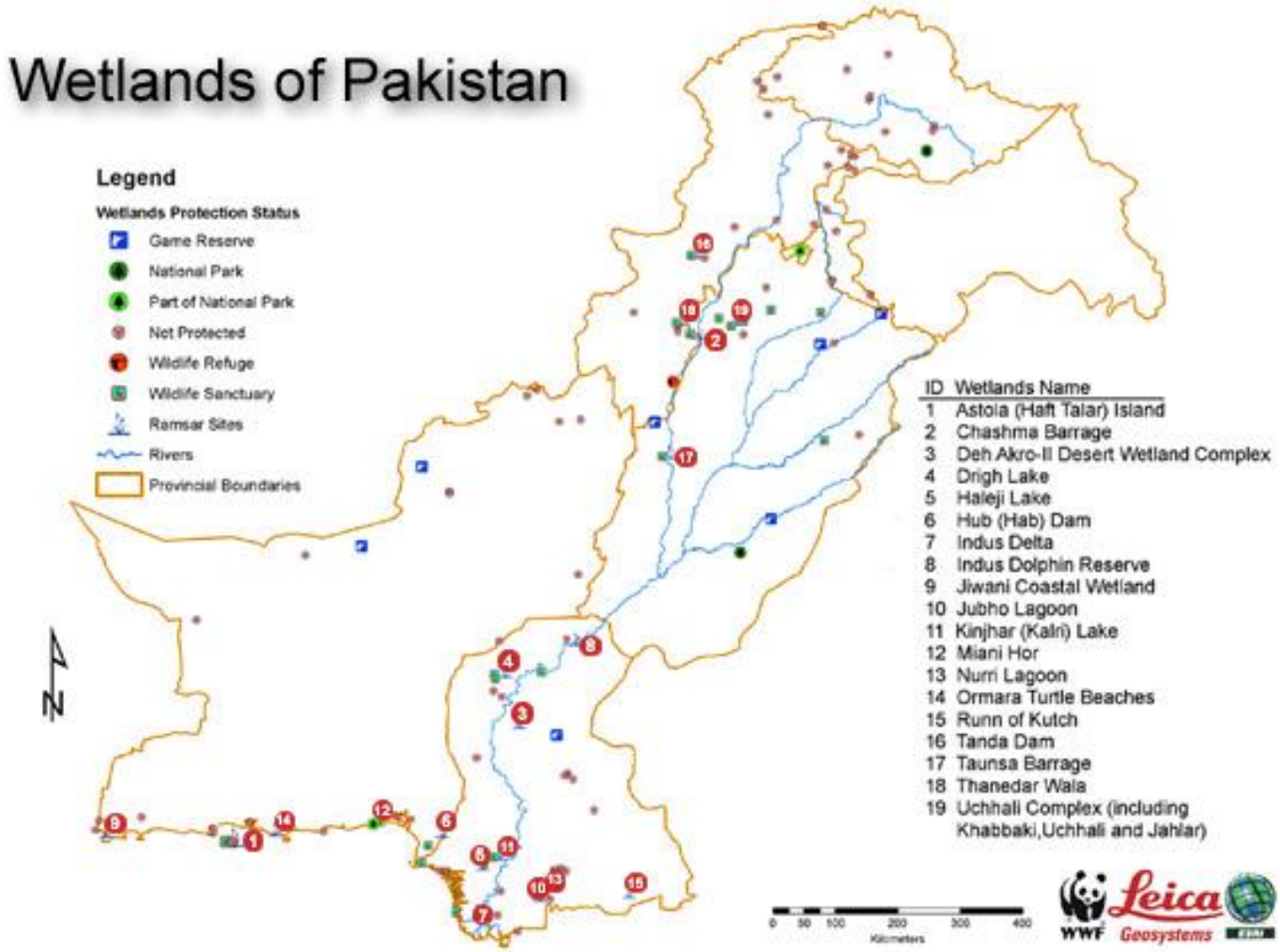
The Convention on Wetlands came into force for Pakistan on 23 November 1976. Pakistan presently has 19 sites designated as Wetlands of International Importance, with a surface area of 1,343,627 hectares.

Table: 17.1 List of Ramsar Wetland sites in Pakistan (2010)

S. #	Site Code	Site name	District	Province
1	2PK009	Astola (Haft Talar) Island	Makran	Balochistan
2	2PK002	Chashma Barrage	Mianwali District	Punjab
3	2PK017	Deh Akro-II Desert Wetland Complex	Nawabshah	Sindh
4	2PK007	Drigh Lake	Larkana	Sindh
5	2PK008	Haleji Lake	Thatta	Sindh
6	2PK010	Hub Dam	Karachi & Lasbella	Sindh, Balochistan
7	2PK018	Indus Delta	Thatta	Sindh
8	2PK011	Indus Dolphin Reserve	Sukkar & Kashmore	Sindh
9	2PK012	Jiwani Coastal Wetland	Makran	Balochistan
10	2PK013	Jubho Lagoon	Badin District	Sindh
11	2PK006	Kinjhar (Kalri) Lake	Thatta District	Sindh
12	2PK014	Miani Hor	Lasbella	Balochistan
13	2PK015	Nurri Lagoon	Badin District	Sindh
14	2PK016	Ormara Turtle Beaches	Makran	Balochistan
15	2PK019	Runn of Kutch	Tharparkar	Sindh
16	2PK004	Tanda Dam	Kohat District	Khyber Pukhtonkhaw
17	2PK003	Taunsa Barrage	Muzaffargarh District	Punjab
18	2PK001	Thanedar Wala	Bannu District	Khyber Pukhtonkhaw
19	2PK005	Uchhali Complex	Khushab District	Punjab

Sources: NCCW/Pakistan Wetlands Programme, MoE, Islamabad (2010)

(See Map on next page for location)


Wetlands of Pakistan
Legend
Wetlands Protection Status
Game Reserve
National Park
Part of National Park
Not Protected
Wildlife Refuge
Wildlife Sanctuary
Ramsar Sites
Rivers
Provincial Boundaries
ID Wetlands Name
1 Astola (Haft Talar) Island
2 Chashma Barrage
3 Deh Akro-II Desert Wetland Complex
4 Drigh Lake
5 Haleji Lake
6 Hub (Hab) Dam
7 Indus Delta
8 Indus Dolphin Reserve
9 Jiwani Coastal Wetland
10 Jubho Lagoon
11 Kinjhar (Kalri) Lake
12 Miani Hor
13 Nurri Lagoon
14 Ormara Turtle Beaches
15 Runn of Kutch
16 Tanda Dam
17 Taunsa Barrage
18 Thanedar Wala
19 Uchhali Complex (including Khabbaki,Uchhali and Jahlar)
0 50 100 200 300 400
Kilometers
WWF
Leica Geosystems

Astola (Haft Talar) Island.

- Date of designation; *10/05/01*.
- Balochistan. 5,000 ha. 25°07'N 063°52'E.
- Ramsar site no. 1063.

A uninhabited island about six km in length, some 25 km south of the desert coast of Balochistan. It is the only significant offshore island along the north coast of the Arabian Sea, and as such maintains the genetic and ecological diversity of the area. The endangered Green turtle (*Chelonia mydas*) and possibly the Hawksbill turtle (*Eretmochelys imbracata*) nest on the beach at the foot of cliffs, and it is a very important area for endemic reptiles such as the viper *Echis carinatus astoli*. The island is said to have an aura of mystery and is venerated by Hindus; there are architectural remains of an ancient temple to the Hindu goddess Kali Devi, as well as a prayer yard constructed for a Muslim saint associated with oceans. It serves as a base for fishermen between September and May, but is unfrequented during the period of rough seas and high tides. Feral cats originally introduced by fishermen to control the endemic rodent population pose an increasing threat to birds' nesting and breeding sites.

Chashma Barrage.

- Date of designation;*22/03/96;*
- Punjab; 34,099 ha; 32º25'N 071º22'E.
- Ramsar site no. 816.

Wildlife Sanctuary. A storage reservoir on the Indus River supporting various aquatic plants. Up to 200,000 waterbirds of numerous species use the site for staging and wintering. An especially important staging area in spring and autumn for cranes. Over 50 species of birds, some of which are globally endangered, use the site for breeding. The site is used as storage for irrigation water, electricity generation, livestock grazing, reed harvesting, and fishing. Planned dam construction upstream would affect the water regime, limiting the site's use for water storage.

Deh Akro-II Desert Wetland Complex.

- Date of designation;*05/11/02*;
- Sindh; 20,500 ha; 26°50'N 068°20'E.
- Ramsar site no. 1283.

Wildlife Sanctuary. A complex of four major habitats, desert, wetland, marsh, and agricultural, 330km northeast of Karachi, representing an example of a natural inland wetland ecosystem comprising 36 lakes and unique desert habitat, which supports a variety of rare and endangered wildlife species. Based in a typical stable sand desert covered with 5m-10m dunes lying in an east-west orientation, the flat-bottomed valleys between them contain lakes, mostly brackish but five freshwater, recharged by seepage from the Nara and Jamrau irrigation canals and by rainwater. The complex plays host to a considerable number of fauna that are rare (e.g., Desert cat *Felis libyca*, Darter *Anhinga melanogaster pennant*, Garganey *Anas querquedula,* Black Ibis *Pseudibis papillosa*) and *endangered (e.g., Marsh crocodile crocodylus palustris, Hog deer Axis porcinus, White-eyed pochard* Anthya nyroca), and it supports many indigenous fish species - though commercial fishing is prohibited, subsistence fishing by local people is permitted. Water

scarcity during a current long dry spell is considered to be a threat. WWF-Pakistan assisted in preparations for the designation of the site.

Drigh Lake.

- Date of designation;*23/07/76;*
- Sindh; 164 ha; 27º34'N 068º06'E.
- Ramsar site no. 100.

Wildlife Sanctuary. A small, slightly brackish lake with extensive reed marshes and rich aquatic vegetation situated in the Indus floodplain. An important breeding and wintering area for a wide variety of waterbirds, regularly supporting over 20,000 birds, mostly Anatidae (ducks, geese, swans, etc.), but including 5,000 roosting Black-crowned Night Heron. The surrounding plains are cultivated for rice production.

Haleji Lake.

- Date of designation;*23/07/76;*
- Sindh; 1,704 ha; 24º47'N 067º46'E.
- Ramsar site no. 101.

Wildlife Sanctuary. An artificial freshwater lake with fluctuating water levels, fringed by brackish seepage lagoons and supporting abundant aquatic vegetation. One of the most important breeding, staging and wintering areas for waterbirds in southern Pakistan, supporting between 50,000 and 100,000 birds annually, including Dalmatian Pelican, European Wigeon and Black Coot. Thousands of Black-crowned Night Heron roost in the area.

Hub (Hab) Dam.

- Date of designation;*10/05/01*.
- Sindh, Balochistan. 27,000 ha. 25°15'N 067°07'E.
- Ramsar site no. 1064.

A large water storage reservoir constructed in 1981 on the Hub River on the arid plains north of Karachi. The reservoir supplies water for irrigation in Lasbella District and domestic and drinking water for the city of Karachi. It is an important staging and wintering area for an appreciable number of waterbirds and contains a variety of fish species which increase in abundance during periods of high water. The Mahseer (*Tor putitora*), an indigenous riverine fish found in the Hub River, grows up to 2m in length and provides for excellent angling. Recent consecutive years of low summer rainfall have reduced the water level. WWF launched a wetland visitors' centre on World Wetlands Day 1999.

Indus Delta.

- Date of designation;*05/11/02*;
- Sindh; ~472,800 ha; 24°06'N 067°42'E.
- Ramsar site no. 1284.

Includes wildlife sanctuaries. The fifth largest delta in the world, formed under largely arid climatic conditions and characterized by high river discharge, moderate tides, and evidently the highest wave energy of any river in the world. The fan-shaped delta consists of creeks, estuaries, mud, sand, salt flats, mangrove habitat, marshes, sea bays, and straits and rocky shores. Its 129,000 ha. of mangrove, mostly Avicenna marina, comprises 97% of the total mangrove area in the country and is said to be the 7th largest mangrove forest in the world. A large number of species are supported, of birds (including the threatened Dalmatian pelican), of fish and shrimps, and of dolphins (Plumbeous dolphin, Finless porpoise, and Bottlenose dolphin), humpback whale, and reptiles. The area is rich in archaeological and religious heritage. Some 40 settlements in the area, with about one million people, find livelihoods largely from fishing.

Indus Dolphin Reserve.

- Date of designation;*10/05/01;*
- Sindh; 125,000 ha; 28°01'N, 069°15'E.
- Ramsar site no. 1065.

A 170 km stretch of the River Indus between the Sukkar and Guddu barrages, providing a home for the 500 remaining individuals of the formerly common Indus dolphin *Platanista minor* (or *P. indi*), a blind cetacean endemic to this river. Originally sea creatures, the Indus dolphins adapted to river life as the Indian subcontinent rose. The site is considered essential for the survival of this CITES Appendix I and IUCN Red List species endemic to Pakistan. The area is also home to the historical Sadhu bella Hindu shrine and Satinjo Astan Muslim graveyard.

Jiwani Coastal Wetland.

- Date of designation;*10/05/01;*
- Balochistan; 4,600 ha; 25°05'N 061°48'E.
- Ramsar site no. 1066.

Located along Gawater Bay around the delta of the Dasht River, a very significant area of mangrove forests extending westward to the Iranian frontier, contiguous with Iran's Govater Bay and Hur-e-Bahu Ramsar site. The site is a particularly important nesting ground for endangered Olive Ridley and Green turtles, especially at four moderately wide and gently sloping sandy beaches in the eastern part of the site. Fishing is the most important human activity, practiced by clans that have migrated from Iran and from farther east in Pakistan as well as descendants of traders and soldiers from North and East Africa and the Gulf. Provincial plans to grant fishing concessions to a US industrial fishing firm and offshore drilling rights to a foreign oil company are viewed with concern by conservation authorities.

Jubho Lagoon.

- Date of designation;*10/05/01*;
- Sindh; 706 ha; 24°20'N 068°40'E.
- Ramsar site no. 1067.

A large shallow brackish lagoon with associated mudflats and marshes, important for wintering waterbirds (particularly Greater and Lesser Flamingos and Dalmatian Pelicans)

and for commercial fisheries. The site is privately owned by local inhabitants, who practice fishing and livestock grazing. WWF launched a wetland visitors' centre on World Wetlands Day 1999.

Kinjhar (Kalri) Lake.

- Date of designation;*23/07/76;*
- Sindh; 13,468 ha; 24º56'N 068º03'E.
- Ramsar site no. 99.

Wildlife Sanctuary. The largest freshwater lake in Pakistan, supporting extensive reedbeds and rich submerged and floating vegetation. An internationally important area for breeding, staging and wintering waterbirds, supporting as many as 140,000 birds, including European Wigeon, Black Coot and Common Pochard. The lake is a major source of drinking water for Karachi and supports an important fishery.

Miani Hor.

- Date of designation;*10/05/01*.
- Balochistan. 55,000 ha. 25°24'N 066°06'E.
- Ramsar site no. 1068.

A large shallow sea bay and estuarine system with several low-lying islands and extensive mangrove swamps and intertidal mud flats, separated from the adjacent Sonmiani Bay in the Arabian Sea by a broad peninsula of sand dunes. The site is the only area of Pakistan's coast where three species of mangroves (*Avicennia marina*, *Rhizophora mucronata*, and *Ceriops tagal*) occur naturally. The Hor receives freshwater input from a number of seasonal streams rising in the hills of eastern Balochistan to the north. The site is important for large concentrations of waterbirds. Smaller fish, shrimp, and crabs are abundant and are both consumed locally and brought to market. The area is archaeologically interesting: Balakot, 16 km to the northeast, was once home to a thriving civilization which flourished around 2000 BC. Domestic waste disposal and accumulated solid waste debris (plastic bags and bottles, etc.) are growing problems. Both IUCN-Pakistan and WWF-Pakistan are very active in the region, in collaboration with local communities, and WWF launched a wetland visitors' centre on World Wetlands Day 1999.

Nurri Lagoon.

- Date of designation;*10/05/01*.
- Sindh. 2,540 ha. 24°30'N 068°47'E.
- Ramsar site no. 1069.

A very shallow brackish lagoon with barren mudflats on the northern side. The site has consistently recorded very large concentrations of migratory waterbirds on a seasonal basis. Salinity and sedimentation are increasing due to the intrustion of the sea in this area. The privately-owned land provides livelihood to about 3,000-4,000 people in surrounding villages, chiefly through fisheries. Invasive species, such as *Typha* and occasionally *Tamarix*, are seen to be hindering the growth and diversity of native flora, and population pressures, including accelerating agricultural and industrial pollution, offer challenges.

Ormara Turtle Beaches.

- Date of designation;*10/05/01*.
- Balochistan. 2,400 ha. 25°13’N 064°28’E.
- Ramsar site no. 1070.

A sandy beach extending about 10 km along the shores of the Arabian Sea. The site supports a considerable number of marine turtles, particularly the endangered Olive Ridley and Green turtles and possibly the Hawksbill turtle as well. Because the area falls in the subduction zone of the Indian Ocean tectonic plate moving northward, clusters of mud volcanos have developed along the shore, where gas-charged water escapes to the surface. The vegetation is composed of salt-tolerant and arid area plants which grow in very harsh, freshwater-scarce conditions. Migratory waterbirds visit the site but not in significant numbers. Subsistence and commercial fishing is the primary economic, social, and cultural activity of the local communities, and drying of fish is an important source of employment. Accumulations of plastic debris along the coast cause significant problems, as does the capture of turtles for export.

Runn of Kutch.

- Date of designation;*05/11/02;*
- Sindh; 566,375 ha; 24°23'N 070°05'E.
- Ramsar site no. 1285.

Wildlife Sanctuary. Part of the great Thar desert and comprising stablized sand dunes, some more than 170m in height, with broad inter-dunal valleys of alluvial soil, integral with the large Rann of Kutch across the frontier with India, which includes permanent saline marshes, coastal brackish lagoons, tidal mudflats, and estuarine habitats. The site supports many locally and globally threatened species, including the Great Indian bustard (*Choriotis nigriceps*), Houbara bustard (*Chlamydotis undulata*), Sarus crane (*Grus antigone*), and hyena (*Hyeana hyaena*) and supports more than 1% of the biogeographical population of flamingos *Phoenicopterus ruber* and *P. minor*. Some 500,000 agro-pastoralists live in 330 villages/hamlets in the site area, and rich archaelogical remains include three giant temples dating from 1375-1449. Scarcity of water remains the potential threat to the ecosystem. WWF-Pakistan and Sindh authorities have carried out work with GEF funding and a management plan is in preparation.

Tanda Dam.

- Date of designation;*23/07/76;*
- North West Frontier Province; 405 ha; 33º35’N 071º22’E.
- Ramsar site no. 98.

Wildlife Reserve. A small water-storage reservoir supporting irrigated agriculture and a small fishery. The site is a wintering area for Anatidae (ducks, geese, swans, etc.) and serves as a staging area for various waterbirds. Bird numbers seldom exceed 500 in mid-winter and 2,000 during migration periods.

Taunsa Barrage.

- Date of designation;*22/03/96;*
- Punjab; 6,576 ha; 30º42'N 070º50'E.
- Ramsar site no. 817.

Wildlife Sanctuary. A large reservoir on the Indus River, constructed for irrigation purposes. Vegetation includes riverine forest and numerous species of aquatic plants. A very important wintering area for waterfowl, notably Anatidae (ducks, geese, swans, etc.) which breed in the area, and a staging area for some species of cranes and shorebirds. Human activities include commercial fishing, irrigation, reed harvesting, recreation, and in adjacent areas agriculture, livestock grazing, and forestry.

Thanedar Wala.

- Date of designation;*23/07/76;*
- North West Frontier Province; 4,047 ha; 32º37'N 071º05'E.
- Ramsar site no. 97.

Game Reserve. A stretch of the Kurram River and associated floodplain, consisting of braided river channels and seasonally flooded islands. Reeds and sedges occur, along with extensive thickets of *Tamarix*. An important route for migratory birds, the site supports small numbers of various species of breeding and wintering waterbirds. Hunting is the main human activity.

Uchhali Complex (including Khabbaki, Uchhali and Jahlar Lakes).

- Date of designation;*22/03/96;*
- Punjab; 1,243 ha; 32º37'N 072º00'E.
- Ramsar site no. 818.

Game Reserve; Wildlife Sanctuary. Three separate brackish to saline lakes of fluctuating levels, surrounded by agricultural fields, located in the heart of the Salt Range. An important wintering area for the rare or vulnerable White-headed Duck, Ferruginous Duck, Greylag Goose, and flamingos. Villagers depend on the wetland for their domestic water supply. Human activities include fishing, livestock grazing, recreation, and illegal hunting.

Source:http://www.ramsar.org/cda/en/ramsar-pubs-annolist-annotated-ramsar 16123/main/ramsar/1-30-168%5E16123_4000_0__

Note: Ownership of wetlands is difficult to establish. Wetland ecosystems often do not have clear natural boundaries and, even when natural boundaries can be defined, they may not correspond with an administrative boundary.

18. Pakistan's Compliance with International Treaties and Conventions

The Government of Pakistan is a Party to a number of international treaties/conventions related to nature conservation. These conventions and focal points in Pakistan are as under:

Table:18.1 Various Multilateral Environmental Agreements Signed by Pakistan (2008)

S. #	Particulars of Multilateral Environmental Agreements	Date of Signing	Date of Ratification
1	RAMSAR Convention on Wetlands	1971	January 1976
2	Convention on Migratory Species (CMS)	1971	December 1987
3	Convention on International Trade in Endangered Species (CITES)	1973	April 1976
4	Convention on Biological Diversity (CBD)	June 1992	June 1994
5	United Nations Convention to Combat Desertification (UNCCD)	October 1994	February 1997
6	Basel Convention on the Control of Trans-boundary Movements of Hazardous Waste	May 1992	October 1994
7	Montreal Protocol on Substances that Deplete the Ozone Layer.	January 1989	December 1992
8	Vienna Convention on Substances that Deplete the Ozone Layer		December 1992
9	United Nations Framework Convention on Climate Change (UNFCCC)	June 1992	June 1994
10	Kyoto Protocol to UNFCCC	December 1997	Ratified January 2005
11	Stockholm Convention on Persistent Organic Pollution (POPs)	December 2001	Ratification in process
12	Rotterdam Convention on Prior Informed Consent (PIC) for certain hazardous chemicals and pesticides	1999	August 2005
13	Cartagena Protocol on Bio-safety to the CBD	June 2001	Ratification in process

Source: Dr. Rizwan Irshad, Biodiversity of Pakistan (2008)

19. Biodiversity and Climate Change

The world's climate patterns have always been highly dynamic. However, recent decades, reveal new patterns, indicating more rapid changes than has been seen for thousands of years. These changes have been linked to equally rapid changes in atmospheric concentration of gases, and the release of "greenhouse gases" by human activities. These gases include oxides of carbon, methane, nitrous oxides and oxides of sulfur. These gases are dealt under the UNFCCC, while other proven gases that deplete the ozone like Chloro-Floro-Carbons (CFCs), bromides and other halogens are covered under the Montreal Protocol for Substances that deplete ozone. While a lot of progress has been made in eliminating the Ozone Depleting Substances (ODS), efforts are under way to limit the use of the gases covered under the UNFCCC.

Impacts on Biodiversity

Climate change is likely to have considerable impacts on most or all ecosystems. The distribution patterns of many species and communities are determined to a large part by climatic parameters, globally there is a consensus that the predicted climate changes will effect the whole distribution and dynamics of biodiversity at many levels. It may be possible for species to migrate in response to changing conditions. Vegetation zones may move towards higher latitudes or higher altitudes following shifts in average temperatures. Rainfall and drought will also be of critical importance. Extreme flooding will have implications for large areas, especially riverine and valley ecosystems. Changes in seasons are already being noticed in many temperate regions. Many birds are being reported earlier and spring flowers are emerging when it was once winter. In agricultural landscapes changes in the length of growing seasons may improve productivity in mid-latitudes and increase the potential for arable crops at high latitudes.

Negative impacts may include increased ranges of insect pests and diseases, and failure of crops in some regions from drought or flooding. Rising sea temperatures will further affect the distribution and survival of particular marine resources. Corals have already shown an extremely high sensitivity to minor increases in temperature. In addition to causing a warming effect, increased concentrations of atmospheric carbon dioxide is known to increase the rate of photosynthesis in many plants. In this way the climate changes may increase growth rates in some natural and agricultural communities. International efforts are being focused towards reducing the amounts of gas emissions, however climate change has already begun, and the impacts will increase considerably over coming decades.

Global biodiversity is under particular risk: habitat loss, pollution and over-exploitation, species and natural systems are now faced with the need to adapt to new regimes of temperature, precipitation and other climatic extremes. Nature conservation has difficult challenges to face that are increasing day by day.

Source: Dr. Rizwan Irshad, Biodiversity of Pakistan (2008)

20. Genetically Modified Organisms in Pakistan

In Pakistan, 89 cases of GMOs have been received and processed by National Biosaftey Centre of Pakistan Environmental Protection Agency under the umbrella of Ministry of Environment. Details in brief on GMOs are contained in table given below.

Table: 20.1 Names of Genetically Modified Organisms in Pakistan (2010)

S. #	Name of Organism	Category
1	Cotton	Plant
2	Sugarcane	Plant
3	Potato	Plant
4	Wheat	Plant
5	Maize	Plant
6	Corn	Plant
7	Tobacco	Plant
8	Rice	Plant
9	Spider	Insect
10	Gene of Mouse-ear cress	Plant
11	Tomato	Plant
12	Indian Mustard (Roya)	Plant

Source: National Biosafety Centre, PEPA, MoE, Islamabad (2010)

Further, details of all cases is given in **Appendix-C** at the end of the report

21 Critically Threatened Ecosystems

Given the widespread historic conversion of natural ecosystems to agriculture in Pakistan, the already highly advanced and rapidly accelerating depletion of habitats, and the continuing depletion of species and populations, almost all remaining natural or modified ecosystems in Pakistan are now critically threatened.

No systematic and comprehensive assessment has yet been made with the aim of objectively ranking the biodiversity importance of Pakistan's remaining natural

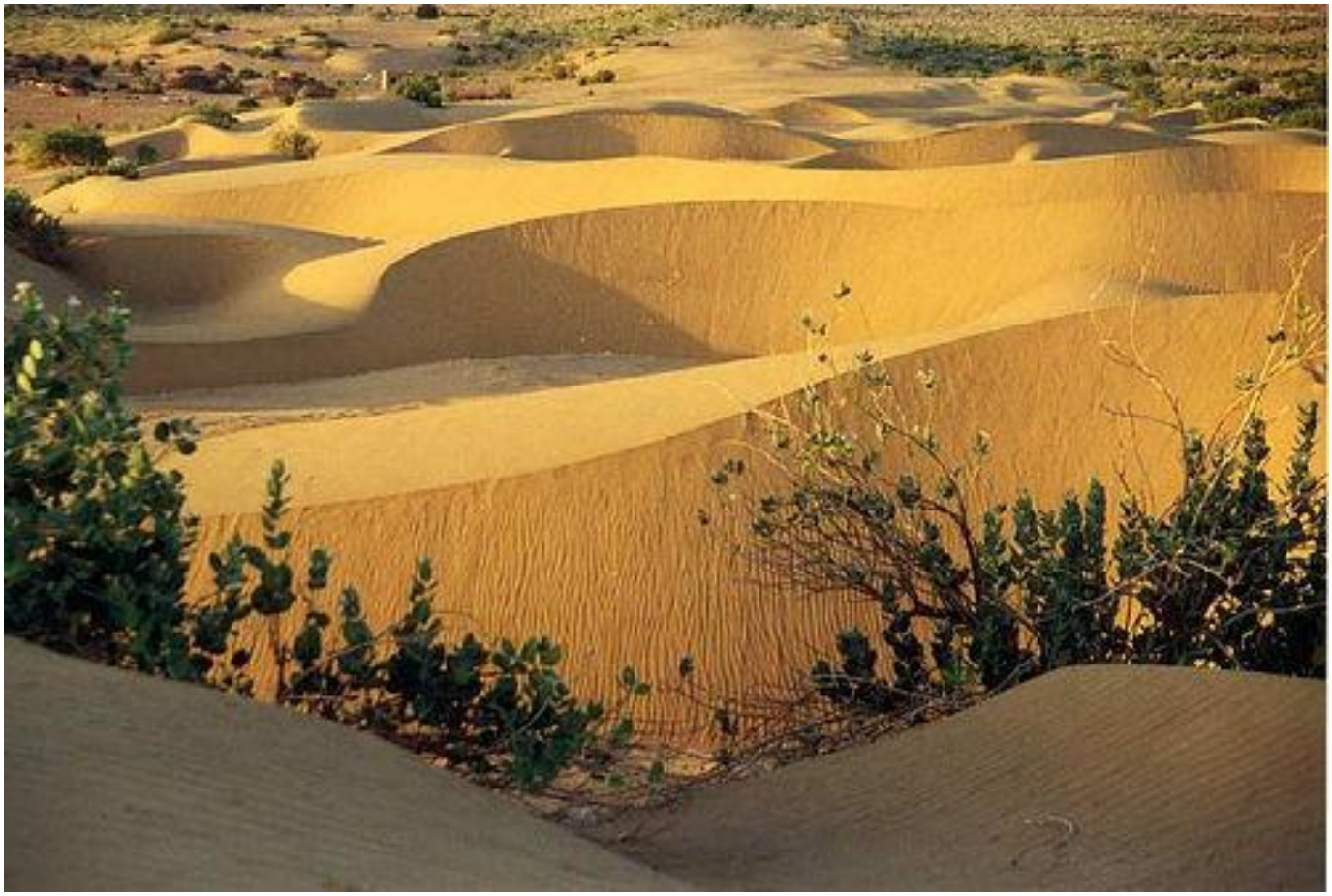
ecosystems and habitats. However, based on various reports (e.g. Mallon 1991, ICBP 1992) and the opinions of recognised authorities (e.g. Roberts, pers. comm., R. Rafiq, pers. comm.), at least ten ecosystems of particular value for their species-richness and/or unique communities of flora and fauna are threatened with habitat loss and degradation

Table 21.1: Critically Threatened Ecosystems in Pakistan (BAP-1999/IUCN)

	ECOSYSTEM	CHARACTERISTICS	SIGNIFICANCE	THREATS
1	**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
2	**Indus river and wetlands**	Extensive wetlands	Migratory flyway of global importance Habitat for Indus river dolphin	Water diversion/drainage Agricultural intensification Toxic pollutants
3	**Chagai desert**	A desert of great antiquity	Many endemic and unique species	Proposed mining Hunting parties from the Gulf
4	**Balochistan juniper forest**	Huge and ancient junipers	Largest remaining juniper forest in the world Unique flora and fauna	Fuelwood cutting & overgrazing Habitat fragmentation
5	**Chilghoza forest (Suleiman Range)**	Rock outcrops with shallow mountain soils	Important wildlife habitat for several species at risk	Fuelwood cutting & overgrazing Illegal hunting
6	**Balochistan subtropical forests**	Mid-altitude forests with sparse canopy but rich associated flora	Very few areas now remain Important wildlife habitat	Fuelwood cutting & overgrazing
7	**Balochistan rivers**	Not connected with the Indus River System	Unique aquatic fauna and flora with high levels of endemism	Water diversion/drainage Overfishing
8	**Tropical deciduous forests (Himalayan foothills)**	Extend from the Margalla Hills NP east to Azad Kashmir	Perhaps the most floristically rich ecosystems of Pakistan	Fuelwood cutting & overgrazing
9	**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 & overgrazing
10	**Trans-Himalayan alps and plateaux**	Spectacular mountain scenery	Unique flora and fauna; center of endemism	Fuelwood cutting & overgrazing Illegal hunting Unregulated tourism Habitat fragmentation

Source: (BAP-1999/IUCN) it is latest possible source of authentic data

DESERTS AND RANGES

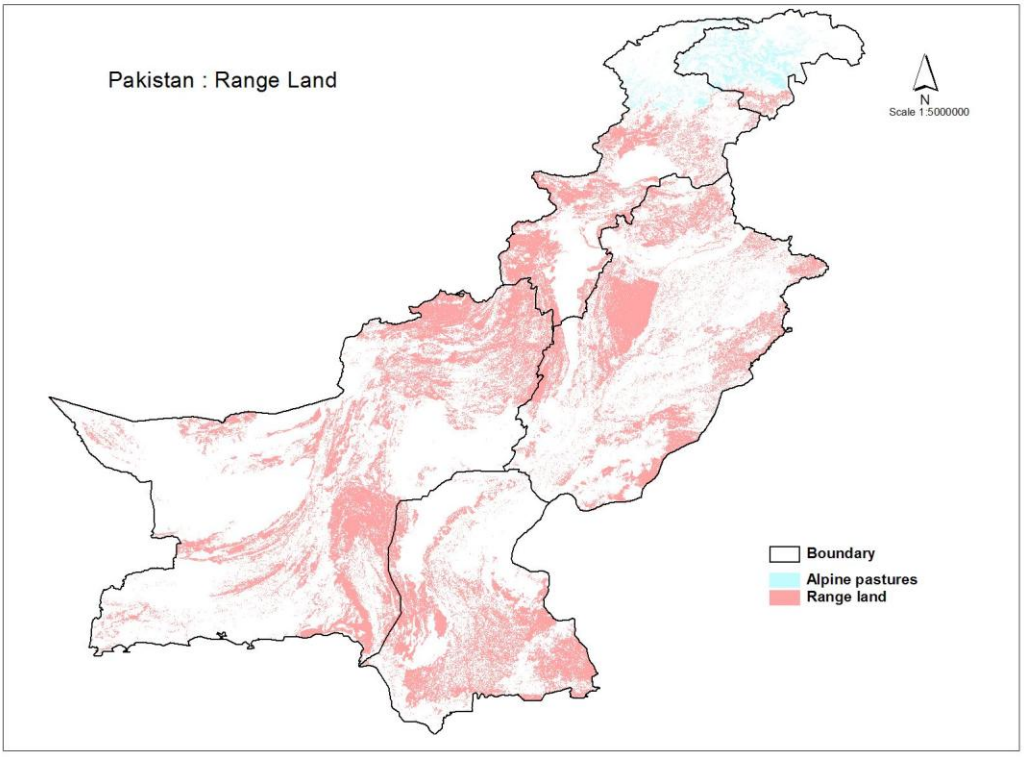


PART-III

Range Resources and Deserts of Pakistan

22. RANGE RESOURCES

The Range resources cover more than 60% of the total area of the country (See map given below). It has a vast spread starting from the northern part of the country and extends to temperate and Mediterranean ranges in the western mountains. This also covers a considerable part of the Indus plain. The climatic conditions vary across the whole length of the country from south to north. The main contributing factors for these variations are the altitude, and extent of the winter and monsoon rains. The elevation ranges from sea level to around 7500 meters in north. The northern part receives more than 1500 mm rainfall, while it gradually decreases and reaches to the minimum in the south upto less than 100 mm. The northern parts falling mostly under dry and moist temperate area; where in the moist temperate zone there is more rainfall and less snow, while in the dry temperate areas, there is more snow and less rainfall. The vegetation also developed in response to the climatic conditions. The pastures and rangelands in the northern parts are more productive than those in the central, western and central parts of the country. The following map shows the various ecological zones of Pakistan



The total geographical area of Pakistan including Azad Jamu and Kashmir and Gilgit-Baltistan is 88 million hectares. Major portion of the total land falls under the rangeland category. These are the areas which by physical limitations such as altitude, temperature are unfit for agriculture. Over 52.2 million hectares is classified as rangelands. Out of this 18.5 million ha is considered to be productive.

The total pasture area in different parts of Pakistan is presented in Table. Due to misuse and centuries of overgrazing, the productivity of rangelands has been adversely affected. FAO (1987) has reported a critical stocking rate of 16 ha/animal unit for low potential ranges. At present, rangelands are producing only 10 to 15 % of their potential. This low

productivity can be improved by adopting various management practices such as periodic closures, re-seeding, and improved grazing management etc.

Table 22.1: Area of Rangelands in Pakistan (million hectares)

Province	Total area	Rangeland	Percentage of provincial area
Balochistan	34.7	27.4	79
Sind	14.1	7.8	55
Punjab	20.6	8.2	40
NWFP	10.2	6.1	60
Northern Areas	7.0	2.1	30
Azad Kashmir	1.3	0.6	45
Total	88.0	52.2	51

Pakistan has diverse climatic conditions, which lead to various ecological zones. There is considerable variation in altitude, temperature and rainfall. In the southern and western parts of the country the elevation is low resulting in a high temperature and low rainfall. These conditions result in arid and semi-arid ecology. While in the northern part of the country the temperature sometimes touches the freezing point, and the rainfall reaches more than 1500 mm compared to the temperature range of 45^0 C and rainfall around 100 mm.

Ecologically, there are five types of rangelands including Alpine pastures, semi-alpine pastures, temperate rangelands, and arid rangelands. The alpine pastures are mainly located in the northern part of the country. These pastures fall between 3500 and 5200 meters elevation. The sub-alpine pastures lie below the alpine pastures at an elevation of 2500 to 3000 meters.

The temperate ranges, unlike the alpine pastures are located within the forests. The temperate ranges occur between 1300 to 3500 meters. These rangelands have been created mainly due to the deforestation mainly in the moist and dry temperate forests of the country. The fourth category of the rangeland is the foothill ranges situated below 1300 meters. Due to the close vicinity to the habitation, and hunger for agricultural land due to the increased human population, majority of these rangelands have been encroached for cultivation. The last category of the rangeland is the arid rangelands covering a vast geographical areas including, southern part of NWFP, Balochistan, Sind, Punjab and some parts of Northern areas.

In NWFP, these are known as Sulainman mountain ranges covering an area of 1.50 million hectares. In Balochistan there are three categories of the arid rangelands including central, western and eastern ranges. Collectively covering 31.5 million hectares, however, the western range is covering more than 18.5 million hectares. In Punjab, the arid Ranges are mainly located in Cholistan belt, while in Sind these cover Thal and Kohistan Ranges. Noor (1989) classified the rangelands into 10 classes on ecological basis. These include; Alpine pastures; Trans-Himalayan grazing lands, Himalayan forest grazing lands, Pothwar scrub ranges, Desert range lands, Kohistan ranges, central Balochistan ranges, eastern Balochistan ranges, western Balochistan ranges, and Sulaiman mountain ranges.

According to the Forestry Master Plan Report(1991),the province-wise distribution of rangelands (in thousands hectares) is 600, 2100, 27400, 6100, 8200,7800,for AJK,

Northern Areas, Balochistan, NWFP, Punjab and Sindh, respectively. In order to better understand the whole profile of the range ecosystem, the various types of ranges, falling in various ecological zones are described in the following section.

Alpine pastures

The alpine pastures lie above 3500-meter elevation, and are located in Hindu-Kush-Himalayan area. These pastures are characterized by short, cool growing season and long winter, receiving heavy snow. The vegetation mainly consists of perennial, herbaceous and shrubby plants with few scattered bushy type trees as well. Khan (1971) divided the vegetation of alpine and sub-alpine zone into seven distinct classes including meadows, shrub meadows, shrub, kail/fir forest range, birch range, shrub grassland, and pure grasslands. The productivity of the meadows, shrub-grasslands, and grasslands was estimated to be 1240, 2300, and 2300 kg/ha respectively. The highest productivity of 2660 kg/ha was recorded for shrub-meadows.

Similarly, Hussain (1968) estimated pasture condition including average plant cover, cumulative cover, and soil protection percentage in the range of 90.82, 119.25, and 97.79 respectively in Kaghan valley. In similar survey in Khunjerab National Park the productivity was estimated at 380, 470, 585, and 370 kg/ha recorded at an altitude of 3500, 4000, and 4500 meters respectively. In the upper Hunza valley, an average production of 600 kg/ha, and the foliar cover was 73 %. In Chaprot, 500 to 700 kg/ha average production was recorded. In Dir-Kohistan, the average production in the alpine pasture was in the range of 1500 kg/ha (Bari 2003).

Trans-Himalayan grazing lands: These rangelands are located in Giligit, Chilas, Skurdu, Chitral, Swat and Dir valleys. The climate is that of mountain, characterized by severe cold winter and hot dry summer. The areas from 2300 to 3300 meters fall in dry temperate climate and received sufficient snow during winter. Most of the areas fall beyond the monsoon rains, and therefore receive an average annual rainfall of 100-300 mm. The rainfall is mainly received in winter and early spring. Vegetation of this tract is divided into four distinct zones including; alpine pastures, valley depression grazing lands, dry temperate ranges and foothills ranges. The current forage productivity varies from 300 kg/ha to 1200 kg/ha. (Bari, 2003).

Himalayan forest grazing lands: These rangelands are situated in Kaghan, Siran, Galiat of NWFP and Neelam and Jehlum valleys of AJK. The area receives more than 1000 mm during the monsoon. Besides the heavy rainfall, these areas also receive heavy snow as well. The winter is very cold, while the summer is less severe. Khan (1971) indicated six types of ranges/zones, including sub-tropical sub-humid zone, temperate humid zone, sub-alpine zone, alpine zone and glaciers or snowfields. Depending upon the vegetation type, the productivity ranges from 200 to 3000 kg/ha.

Pothwar Scrub Ranges: These scrub ranges are located between Indus and Jehlum rivers in Attock, Jehlum, Chakwal and Rawalpindi districts including Islamabad. The altitude varies from 300 to 1500 meters. Ecologically, these ranges fall in sub-tropical and semiarid to sub-humid zone. The climate is thus temperate in nature in the north-east to sub-tropical semiarid in the southern part of the salt range. Annual rainfall varies from 250 mm to 1500 mm. The temperature also varies a lot, and in winter it reaches below

freezing point (January), while in summer (June) it touches 45^0 C. The vegetation type is basically sub-tropical thorn mixed forests. *Acacia modesta* is the predominant species, besides *Olea cuspidate* and *Dodonea viscosa*. The productivity of these range lands varies from 1500 kg/ha to 2000 kg/ha.

Desert Rangelands: These rangelands cover Thal, D.G.Khan of Punjab province and Tharparker of Sind province. Thal ranges cover an area of 2.6 million hectares. Its boundaries touch the salt range in the north, the Indus river flood plains in west and Jehlum and Chenab river flood plains in the east. Ecologically this tract falls in the tropical plains (sandy). The climate is arid and hot ranging from 0^0 C to a maximum of 44^0 C. The rainfall is ranging from 133 to 300 mm. Thal rangelands basically consist of four types including; Dunes, Slopes and foot of dunes, flats, and kanker sites.

D.G.Khan Rangelands: These ranges cover an area of 0.5 million hectares, and also situated between the Sulaiman range and Indus river. Ecologically it is tropical plains non-sandy).The summers are very hot and the winter are very clod. The temperature varies from 0 to 42^0 C. Average annual rainfall varies from 75 to 162 mm. In order to get the advantage of periodic favorable conditions, most of the annual plants start growing in early spring and complete their growth cycle within two to three months. The productivity is in the range of 400-500 kg/ha.

Cholistan Desert Ranges: These rangelands are located in Bahawalpur, Bahawalnagar, and Rahim Yar Khan districts of the Punjab province. This covers a total area of 2.7 million hectares. Ecologically these ranges fall in tropical arid sandy desert. The rainfall is in the range of 100 to 200 mm, and the mean minimum and maximum temperatures are 20^0 to 40^0 C, respectively. The drinking water for both the human and livestock is a major problem. Over the last one decade, the drought is a common phenomenon, which has both negative impacts on the ecology as well as on the animal production. Cholistan has xerophytic vegetation including the following;

Tharparkar Desert Ranges: This desert is situated in Tarparkar, Sangar, and Mirpur Khas districts of Sind, and spread over an area of 2.65 million hectares. This tract basically falls in tropical thorn desert. Hussain (1966) classified the area into four distinct zones; including sand dunes, valleys between two parallel sand dunes, flat alluvial plains, and rocky hill known as Krunjar near Nagarparkar. The climate is arid; rainfall is erratic and generally received in monsoon. Rainfall varies from 150 to 400 mm. The temperature varies from 5-45^0 C. The ground water is 200 to 300 meter deep, and is saline and brackish.

Rangelands in Tarparkar desert are in poor condition. Due to continuous drought and desertification the desirable grasses have disappeared. However, the shrubs provide good feed for browsing animals. These ranges are only used in spring, summer and autumn, but are not grazed during winter as the fodder production is mainly linked with the rains, which are received in monsoon only.

Kohistan Ranges: These ranges are situated in Karachi, Thatta, Dadu and parts of Lasbela districts. Total area is around 2.38 million hectares. Ecologically the tract lies in tropical arid thorn sub- mountainous zone. FAO (1975) distinguished the following three land systems, Kirthar range, Central Kohistan, and south-eastern shield. The temperature in winter is around 3^0 C and reaches even upto 45^0 C in summer. Mean annual rainfall varies from 150 to 200 mm.

Balochistan Ranges; Area-wise Balochistan is the largest province of the country, with a total area of 34.73 million hectares. Due to arid nature of the climate, about 93% of the total area has been classified as rangelands. About 10 million hectares are un-productive, and 12 million hectares have limited capacity to support livestock grazing, besides being in-accessible for grazing. Thus range management can be practiced only on 9-10 million hectares (FAO, 1983). The climate is arid to semiarid with annual rainfall from 50 mm in the west to 400 mm in the east. The rainfall is mainly received in winter. The temperature varies from 3 –50^0 C. Range lands in Balochistan can be further divided into three main types; Central Balochistan Ranges, Western Balochsitan Ranges, and Eastern Balochistan Ranges. A short description of each of these types is provided below;

Central Balochistan Ranges
These ranges are located in Quetta and Kalat civil divisions. The climate is basically Mediterranean in nature. Annual rainfall varies from 100 to 400 mm, received in winter till early spring. The altitude ranges from 1000 to 3000 meters.

Western Balochistan Ranges: These ranges are located in Chagai, Kharan, Panjgur, Makran, Turbat, Gawadar and Lasbela districts. This area receives very little rainfall (50-200mm).Due to the sporadic and scare rainfall, and frequent drought spells, the fodder availability is low and so is the carrying capacity.

Eastern Balochistan Ranges: These ranges are situated in Zhob and Lora Lai districts of Balochistan. These ranges have the high potential for livestock production. These are mainly used by the Afghan nomads. The vegetation is similar to that of the adjacent Sulainman ranges.

Sulaiman Mountain Ranges: This category covers a total area of 1.5 million hectares. It mainly touches Afghanistan border. Altitude varies from 1540 to 3400 meters. The climate of this area is mountainous sub-tropical continental. Annual rainfall is 200-250 mm. Major portion of the rainfall is received in monsoon period. Mean maximum temperature is around 400 C. The productive capacity is around 1500 kg/hectares.

Sources: Baseline study report on rangeland resources of Pakistan for the formulation of national range land policy (Ministry of Environment 2010)

23. Deserts of Pakistan

The deserts in Pakistan and India fall in the category of the Monsoon Deserts. "Monsoon," derived from an Arabic word for "season," refers to a wind system with pronounced seasonal reversal. Monsoons develop in response to temperature variations between continents and oceans. The southeast trade winds of the Indian Ocean, for example, provide heavy summer rains in India as they move onshore. As the monsoon crosses India, it loses moisture on the eastern slopes of the Aravalli Range. The Thar Desert of Pakistan is part of a monsoon desert region west of the range.

23.1 The Cholistan Desert

The Cholistan desert extends over an area of 26,000 sq. km., in the southern part of the

Punjab, Pakistan. From the viewpoint of agriculture it is a highly fascinating wildness possessing a tremendous potential as a range-land provided it is managed and exploited resourcefully. On the basis of its topography i.e., parent material, soil and vegetation; it is divided into two geomorphic regions. The northern region (Lesser Cholistan) bordering the canal-irrigated areas cover about 7770 km2 while the southern region (Greater Cholistan) comprises 18130 km2. The Lesser Cholistan consists of large saline, hard and compact areas (locally called 'Dahars') alternating with low sandy ridges. Sand dunes are stabilized, semi-stabilized or shifting, while the valleys are mostly covered with sand. The soils are classified as either saline or saline sodic, with pH ranging from 8.2 to 8.4 and 8.8 to 9.6, respectively. The Greater Cholistan is a wind sorted sandy desert and comprises river terraces, large sand ridges and less interdunal plain areas.

The vegetation of Cholistan desert is a typical of arid regions and comprises of xerophytic species, adapted to extreme seasonal temperature, moisture fluctuation and a wide variety of edaphic conditions. Vegetation cover is comparatively better in eastern region (200 mm rainfall zone) than the hyper arid southern region (100 mm rainfall zone). The soil topography and chemical composition is playing an important role in plant distribution in the area. The association of certain plant species to certain soils at different places is very common. The compact saline 'dahars' without any soil cover are dominated by *Haloxylon recurvum, Haloxylon salicornicum* and *Suaeda fruticosa,* whereas *Salsola baryosma, Sporobolus ioclados, Aeluropus lagopoides, Capparis decidua, Cymbopogon jwarancusa, Ochthochloa compressa* and *Prosopis cineraria* are specific to the 'dahars' having some sandy cover. Similarly, the sand dunes are dominated by *Calligonum polygonoides, Aerva javanica, Panicum turgidum* and *Lasiurus scindicus.*

Source: Edaphic factors and distribution of vegetation in the Cholistan desert, Pakistan (Mohammad Arshad et.al 2008)

23.2 The Thar Desert

The arid Thar Desert is the world's seventh largest desert with a size of 92,200 square miles (238,700 square kilometers) However, 4,000 to 5,000 years ago this area supported what is considered to be one of the world's oldest civilizations, the Mohenjo Daro and Harappa.

This large ecoregion lies to the west of the Aravalli Mountain Range in northwestern India and includes the deserts that cover portions of the Indian states of Gujarat, Rajasthan, and Punjab, as well as the Punjab and Sind in Pakistan.

The climate is extreme: annual temperatures can range from near-freezing in the winter to more than 50(C during the summer. All rainfall is associated with the short July-September southwest monsoon that brings a mere 100-500 mm of precipitation (Hawkins 1986). About 10 percent of this ecoregion is composed of sand dunes, and the other 90 percent of craggy rock forms, compacted salt-lake bottoms, and interdunal and fixed dune areas (Grewal 1992).

The habitat is greatly influenced by the extreme climate. The sparse vegetation consists of xerophilious grasslands of *Eragrostis* spp. *Aristida adscensionis, Cenchrus biflorus, Cympogon* spp., *Cyperus* spp., *Eleusine* spp., *Panicum* spp., *Lasiurus scindicus, Aeluropus lagopoides,* and *Sporobolus* spp. (Mares 1999). Scrub vegetation consists of low trees such as *Acacia nilotica, Prosopis cineraria, P. juliflora, Tamrix aphylla, Zizyphus mauritiana, Capparis decidua,* and shrubs such as *Calligonum polygonoides,*

Calotropis spp., *Aerva* spp., *Crotalaria* spp., and *Haloxylon salicornicum. Haloxylon recurvum* is also present (Puri et al. 1989; Mares 1999).
Despite the climate, several species have evolved to survive the extreme conditions here. Among the mammal fauna, the blackbuck (*Antilope cervicapra*), chinkara (*Gazella bennettii*), caracal (*Felis caracal*), and desert fox (*Vulpes bengalensis*) inhabit the open plains, grasslands, and saline depressions known as *chappar* or *rann* in the core area of the desert (Grewal 1992; Rodgers and Panwar 1988). The overall mammal fauna consists of forty-one species. None are endemic to the ecoregion, but the blackbuck is a threatened species (IUCN 2000) whose populations take refuge in this harsh environment.
Among the 141 birds known in this ecoregion, the great Indian bustard (*Chirotis nigricaps*) is a globally threatened species (IUCN 2000) whose populations in this ecoregion have rebounded in recent years. A migration flyway used by cranes (*Grus grus, Anthropoides virgo*) and flamingos (*Phoenicopterus* spp.) on their way to the Rann of Kutch (Grewal 1992) further south crosses this ecoregion.

Source: http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im1304_full.html (WWF-2001)

23.3 The Indus Valley Desert

The Indus Valley Desert, like the larger Thar Desert, is one of the most inhospitable ecoregions in the Indo-Pacific region. Biodiversity conservation should focus on the large mammals and birds of the region.
This arid ecoregion is located in Pakistan's Indus Valley. The foothills of the Glaiman Range and the Chenab River define its western and eastern limits, respectively. The size of desert is 7,500 square miles (19,500 square kilometers) about the size of New Jersey
The extreme annual temperature variations can range from near-freezing in the winter to highs of more than 45(C during the summer. Annual rainfall averages from 640 to 760 mm (Grewal 1992), which is slightly more than in the Thar Desert.
The vegetation is greatly influenced by the extreme climatic regime. The desert thorn scrub vegetation is characterized by isolated clumps of *Prosopis* spp., *Salvadora oleoides* and *Caparis* spp., and taller thorn-scrub forests of *Acacia* spp., *Tamarix* spp., *Albizzia lebbek,* and *Morus alba* (Grewal 1992). This desert ecoregion is not high in richness or endemism, but it does harbor a few large vertebrates that can serve as focal species for conservation. These include the wolf (*Canis lupus*), hyena (*Hyaena hyaena*), caracal (*Felis caracal*), leopard (*Panthera pardus*), and Punjab urial (*Ovis orientalis punjabensis*). The overall mammal fauna consists of thirty-two species, but none are endemic to the ecoregion.

Source: http://www.worldwildlife.org/wildworld/profiles/terrestrial/im/im1304_full.html (WWF-2001)

23.4 The Kharan Desert

The Kharan Desert, also known locally as the "Sandy Desert", is located in northwest Balochistan. The Kharan Basin is known as a closed basin because the entire basin's catchment water is used for agriculture and domestic requirements. The Kharan Desert area consists of shifting sand dunes with an underlying pebble-conglomerate floor. The

moving dunes reach heights of between 15 and 30 meters. Level areas between the dunes are a hard-topped pan when dry and a treacherous, sandy-clay mush when wet. The barren wastes that occupy almost half of Iran, with its continuation into Kharan in Pakistan, form a continuous stretch of absolute barrenness from the alluvial fans of the Alborz mountains in the north to the edge of the plateau in Balochistan, more than 1,200 kilometres to the southeast. In altitude these central deserts slope from about 1,000 m in the north to about 250 m on in the southwest. Average annual rainfall throughout these deserts is well under 100 mm. The desert includes areas of inland drainage and dry lakes (*hamuns*). The Gowd-e Zereh (lake basin) in Iran, which occasionally receives excess drainage, is separated from Kharan in Pakistan by the low Chaghai hills, which, with the highlands around the extinct volcano Koh-e Tafta'n, cause the Mashkel river to form a lake. The surface of the Hamun-i-Mashkhel, which is some 85 kilometers long and 35 kilometers wide, is littered with sun-cracked clay, oxidized pebbles, salty marshes and crescent-shaped moving sand dunes. The area is known particularly for its constant mirage and sudden severe sand-storms.

The most dominant species on the basis of importance value were *Zygophyllum eurypterum* and *Rhazya stricta*, which grows in graval sand, sandy clay and sandy streambeds. *Pennisetum divisum* and *Convolvulus spinosus* were also wide spread species found in sandy clay and sandy streambeds. The other common species of Nag were *Otostegia aucheri*, *Astrogalus stocksii*, *Cymbopogon jwarancusa*, *Haloxylon ammodenderon*, *Haloxylon griffithi*, *Fagonia indica* and *Peganum harmala*. Two new species *Douepia tortuosa* and *Cynomorium songaricum* were also recorded from Nag area.

Sources: http://www.pakistanpaedia.com/land/GEO_6.html (Pakistan Paedia 2009)
Muhammad Sajid Nadeem (2003) Ecology of Houbara Bustard Chlamydotis Undulate Macoqeenii in Punjab, Balochistan (Nag Valley and Uzbekistan)

23.5 The Thal desert

The Thal desert is a vast area lying in Indus plain south of Salt Range between the Jhelum and Indus rivers. Its total length from north to south is 304 km, and its maximum breadth is 112 km. It extends over the districts of Bhakkar, Khushab, Mianwali, Jhang, Layyah, and Muzaffargarh. The climate of Thal is arid, summers are very hot and the average annual rainfall varies from 185 mm to 300 mm. The terrain consists of sand dunes interspersed with flat chunks of land. Agriculture and livestock rearing are currently the main sources of livelihoods. The area is rainfed & resource deficit, land is of marginal quality and poverty is inherent in local population. Windstorms are normal features which cause severe soil erosion. The ecology of the area is fragile because of low resilience of the desert. The sand dunes, when disturbed by over grazing,
removal of vegetation or ploughing for cultivation of gram, get destabilized and start moving due to wind action. The natural vegetation is sparse and consists of xerophytic trees, bushes / shrubs, forbs and grasses.

The main crop of Thal desert is gram (channa) and its cultivation has been inappropriately extended even to sand dunes. Some area of Thal desert is also suffering from water logging at certain places due to seepage from Greater Thal Canal emanating from river Indus.

The main problems of Thal tract include aridity, desertification by wind erosion all over the desert area and water logging in a specific smaller area. The land degradation is

taking place due to changes in land use from pasturing to cultivation of gram, the resultant over grazing by livestock due to shrinkage of grazing area and clearance of vegetative cover which is causing severe shortage of fuel wood. People therefore burn cow dung for cooking purposes instead of using it as organic manure.

The Thal desert is not very rich in biodiversity due to harsh ecological factors. The plant species include trees like Jand *(Prosopis cineraria)*, Wan *(Salvadora oleoides)*, Karir *(Capparis aphylla)*, Farash *(Tamarix aphylla)* Ber *(Zizyphus mauritiana)*, bushes and shrubs like Phog *(Caligonum polygonoidies)*, Ak *(Calotropis procera)*, and various forbs and grasses. Gazelle antelope (Chinkara) thrived in Thal desert till 1970s and now it is extinct. Other animal and bird species include fox, jackal, hare, grey partridge, black partridge, pigeon, dove, warbler, courser, babbler and some migratory birds like houbara bustard, sand grouse, quail, rain quail, falcon etc. A variety of reptile population also exists. The conservation of native plants and animals can be achieved through reversing the process of desertification.

Source: Raja Ataullah Khan (2009) Raising of shelterbelts & tree groves for checking soil erosion & poverty reduction in Thal tract

Note: Province wise area under deserts is given above in table-0

APPENDICES

Appendix A: Internationally Threatened Animals in Pakistan

MAMMALIA

- CHIROPTERA
  - RHINOLOPHIDAE
    - *Rhinolophus blasii* **L/nt**
  - VESPERTILIONIDAE
    - *Eptesicus nasutus* **V/A2c**
    - *Nyctalus leisleri* **L/nt**
    - *Nyctalus montanus* **L/nt**
- PRIMATES
  - CERCOPITHECIDAE
    - Rhesus Macaque *Macaca mulatta* **L/nt**
    - Kashmir Grey Langur *Semnopithecus entellus* **L/nt**
- CARNIVORA
  - CANIDAE
    - Bengal Fox *Vulpes bengalensis* **DD**
    - Indian Wolf **EN C 2a (i); D**
    - Blandford's Fox *Vulpes cana* **DD**
    - Corsac Fox *Vulpes corsac* **DD**
  - FELIDAE
    - Cheetah *Acinonyx jubatus* **V/A1d+2d, C1**
    - Pakistan Sand Cat *Felis margarita scheffeli* **L/nt**
    - Red Manul *Otocolobus manul ferrugineous* **L/nt**
    - Fishing Cat *Prionailurus viverrinus* **L/nt**
    - Snow Leopard *Uncia uncia* **E/C2a**
  - MUSTELIDAE
    - Smooth-coated Otter (Smooth Otter) *Lutra perspicillata* **V/A2cd**
  - URSIDAE
    - Asiatic Black Bear *Ursus thibetanus* **V/A1cd**
    - Balochistan Bear *Ursus thibetanus gedrosianus* **CE/B1+ 2abc, C2a**
- CETACEA
  - DELPHINIDAE
    - Indo-Pacific Hump-backed Dolphin *Sousa chinensis* **DD**
  - PHOCOENIDAE
    - Finless Porpoise *Neophocaena phocaenoides* **DD**
  - PLATANISTIDAE
    - Indus River Dolphin *Platanista minor* **E/A1acd, B1+2abcde**
- ARTIODACTYLA
  - MOSCHIDAE
    - Musk deer *Moschus chrysogaster* **L/nt**
    - Himalayan Musk deer *Moschus chrysogaster leucogaster* **L/nt**
  - CERVIDAE
    - Hog Deer *Axis porcinus porcinus* **L/nt**
  - BOVIDAE
    - Blackbuck *Antilope cervicapra* **V/A1c**
    - Nilgai *Boselaphus tragocamelus* **L/cd**
    - Wild Goat *Capra aegagrus* **V/A2cde**
    - Sindh Ibex *Capra aegagrus blythi* **V/A2cde**
    - Chiltan Goat *Capra aegagrus chiltanensis* **CE/C2b**
    - Markhor *Capra falconeri* **E/A2cde**
    - Flare-horned Markhor *Capra falconeri falconeri* **E/C2a**
    - Straight-horned Markhor *Capra falconeri megaceros* **E/C2a**
    - Chinkara *Gazella bennetti* **L/cd**
    - Goitred Gazelle *Gazella subguttorosa* **L/nt**
    - Himalayan Goral *Naemorhedus goral* **L/nt**
    - Western Himalayan Goral *Naemorhedus goral bedfordi* **L/nt**
    - Argali *Ovis ammon* **V/A2cde**

Marco Polo Argali *Ovis ammon polii* **V/A2de, C1**
Afghan Urial *Ovis vignei cycloceros* **V/C1**
Punjab Urial *Ovis vignei punjabensis* **E/A1cde, C1+2a**
Ladakh Urial *Ovis orientalis vignei* **E/A2cde, C1+2a**
Blue Sheep *Pseudois nayaur* **L/nt**
Pseudois nayaur nayaur **L/nt**

PHOLIDOTA
MANIDAE
Indian Pangolin *Manis crassicaudata* **L/nt**

RODENTIA
SCIURUDAE
Small Kashmir Flying Squirrel *Eoglaucomys fimbriatus* **L/nt**
Woolly Flying Squirrel *Eupetaurus cinereus* **E/A2ce, B1+2cd, C2a**
Long-tailed Marmot *Marmota caudata* **L/nt**
MURIDAE
Alticola albicauda **L/nt**
Calomyschus hotsoni **E/B1+2c**
Grey Hamster *Cricetulus migratorius* **L/nt**
MYOXIDAE
Forest Dormouse *Dryomys nitedula* **L/nt**

AVES

PELICANIFORMES
PELICANIDAE
Dalmatian Pelican *Pelicabus crispus* **V/C2a**
ANHINGIDAE
Oriental Darter *Anhinga melanogaster* **L/nt**

CICONIFORMES
CICONIIDAE
Asian Openbill *Anastomus oscitans* **L/nt**
Painted Stork *Mycteria leucocephala* **L/nt**
THRESKIORNITHIDAE
Red-naped Ibis *Pseudibis papillosa* **L/nt**
Black-naped Ibis *Threskiornis melanocephalus* **L/nt**
PHOENICOPTERIDAE
Lesser Flamingo *Phoenicopterus minor* **L/nt**

ANSERIFORMES
ANATIDAE
Lesser White-fronted Goose *Anser erythropus* **V/A1acd**
Ferruginous Duck *Aythya nyroca* **V/A1acd**
Marbled Teal *Marmaronetta angustirostris* **V/A2c**
White-headed Duck *Oxyura leucocephala* **V/A2e**

FALCONIFORMES
ACCIPITRIDAE
Cinereous Vulture *Aegypius monachus* **L/nt**
Greater Spotted Eagle *Aquila clanga* **V/C2a**
Imperial Eagle *Aquila heliaca* **V/C2a**
Pallid Harrier *Circus macrourus* **L/nt**
White-rumped Vulture *Gyps bengalensis* **L/nt**
White-tailed Eagle *Haliaeetus albicilla* **L/nt**
Pallas's Sea-eagle *Haliaeetus leucoryphus* **V/C1+2b**
Red-Headed Vulture *Sarcogyps calvus* **L/nt**
FALCONIDAE
Red-necked Falcon *Falco chicquera* **L/nt**
Lesser Kestrel *Falco naumanni* **V/A1ace**

GALLIFORMES
PHASIANIDAE
Cheer Pheasant *Catreus wallichii* **V/C2a**
Western Tragopan *Tragopan melanocephalus* **V/C1+2a**

GRUIFORMES
GRUIDAE
Siberian Crane *Grus leucogeranus* **E/A2cd**
OTIDIDAE
Great Indian Bustard *Ardeotis nigriceps* **E/C2b**
Lesser Florican *Eupodotis indica* **CE/A1a**

Little bustard *Tetrax tetrax* **L/nt**

CHARADRIIFORMES

CHARADRIIDAE

Sociable Lapwing *Vanellus gregarius* **V/A1ac, C1+2a**

SCOLOPACIDAE

Wood Snipe *Gallinago nemoricola* **V/C2a**

LARIDAE

Black-bellied Tern *Sterna acuticauda* **V/C1**

RHYNCOPIDAE

Indian Skimmer *Rhynchops albicollis* **V/C1+2a**

COLUMBIFORMES

COLUMBIDAE

Pale-backed Pigeon *Columba eversmanni* **V/A1a**

PICIFORMES

INDICATORIDAE

Yellow-rumped Honey guide *Indicator xanthnotus* **L/nt**

PASSERIFORMES

MUSCICAPIDAE

Long-billed Bush Warbler *Bradypterus major* **V/C2a**
Bristled Grass-Warbler *Chaetornis striatus* **V/A1c, C1+2a**
Jerdon's Babbler *Chrysomma altirostre* **V/A1c**
Kashmir Flycatcher *Ficedula subrubra* **V/B1+2c**
Tytler's Leaf-warbler *Phylloscopus tytleri* **L/nt**
Rufous-vented Prinia *Prinia burnesii* **V/A1c**
White-browed Bushchat *Saxicola macrorhyncha* **V/A1ac, C1+2a**

AEGITHALIDAE

White-throated Tit *Aegithalos niveogularis* **L/nt**

FRINGILLIDAE

Orange Bullfinch *Pyrrhula aurantiaca* **L/nt**

REPTILIA

CROCODYLIA

CROCODYLIDAE

Mugger *Crocodylus palustris* **V/A1a, C2a**

GAVIALIDAE

Gharial *Gavialis gangeticus* **E/C2a**

SERPENTES

BOIDAE

Indian Python *Python molurus* **L/nt**

ELAPHIDAE

Central Asian Cobra *Naja oxiana* **DD**

TESTUDINES

CHELONIIDAE

Green Turtle *Chelonia mydas* **E/A1abd**
Olive Ridley Turtle *Lepidochelys olivacea* **E/A1abd**

EMYDIDAE

Spotted Pond Turtle *Geoclemys hamiltonii* **L/nt**
Crowned River Turtle *Hardella thurjii* **L/nt**

TESTUDINIDAE

Central Asian Tortoise *Testudo horsefieldii*

TRONYCHIDAE

Narrow-headed Softshell Turtle *Chitra indica* **V/A1cd**

ACTINOPTERYGII

SYNBRANCHIFORMES

MASTACEMBELIDAE

Spiny Eel *Macrognathus aral* **DD**

INSECTA

LEPIDOPTERA

SPHINGIDAE

Hyles hippophaes **DD**

Appendix B Internationally Threatened Birds in Pakistan

	Status (breeding/non-breeding)	Habitat codes	Threat codes	IUCN threat status codes
Endangered				
Siberian Crane *Grus leucogeranus*	**N**	**W**	**12**	**A2b,c; C1; D2**
Vulnerable				
Dalmatian pelican *Pelecanus crispus*	**N**	**W**	**1235**	**C2a**
White-headed duck *Oxyura leuocephala*	**N**	**W**	**1256**	**A2d**
Lesser White-fronted Goose *Anser erythropus*	**N**	**SWA**	**012**	**A1a,b,c**
Marbled Teal *marmoronetta angustirostris*	**B**	**W**	**125**	**A2b**
Ferruginous Duck *Aythya nyroca*	**N**	**W**	**12**	**A1a,b,c**
Pallas's Sea-eagle *Haliaeetus leucoryphus*	**B**	**GW**	**135**	**C1;C2b**
Greater Spotted Eagle *Aquila clanga*	**B**	**FW**	**13**	**C2a**
Imperial Eagle *Aquila heliaca*	**N**	**FG**	**12357**	**C2a**
Lesser Kestrel *Falco naumanni*	**N**	**FSVGA**	**15**	**Ala,b,d**
Western Tragopan *Tragopan melanocephalus*	**B**	**F**	**1**	**C1;C2a**
Cheer Pheasant *Catreus wallichii*	**B**	**FSG**	**12**	**C2a**
Sociable Lapwing *Vanellus gregarius*	**N**	**GW**	**158**	**Ala,b;C1;C2a**
Black-bellied Tern *Sterna acuticauda*	**B**	**W**	**128**	**C1**
Indian Skimmer *Rhynchops albicollis*	**B**	**W**	**1**	**C1;C2a**
Pale-backed Pigeon *Columba eversmanni*	**N**	**GDA**	**0**	**Ala**
White-browed Bushchat *Saxicola macrorhyncha*	**B**	**SD**	**1**	**Ala,b;C1;C2a**
Jerdon's Babbler *Chrysomma altirostre*	**B**	**GW**	**1**	**Alb**
Rufous-vented Prinia *Prinia burnesii*	**B**	**SGW**	**1**	**Alb**
Long-billed Bush-warbler *Bradypterus major*	**B**	**FSA**	**1**	**C2a**
Bristled Grass-warbler *Chaetornis striatus*	**B**	**SGWA**	**1**	**A1b;C1;C2a**
Kashmir flycatcher *Ficedula subrubra*	**B**	**F**	**1**	**B1+2c**

Source; Dr. Aleem Chaudhry, Director General, Wildlife, Lahore

Habitat codes

F = All forest and woodland types; S = scrub; G = grassland; W = wetlands including littoral habitats; D = desert; A = agricultural areas

Threat codes

0 = unknown; 1 = loss or alteration of habitat; 2 = hunting, persecution, egg-collecting (subsistence); 3 = disturbance (by humans, stock); 5 = pollution, pesticides, poisoning (accidental); 6 = introduced; 7 = trade, egg-collecting (commercial); 8 = natural causes (exacerbated by other influences)

IUCN status codes: http://www.iucnredlist.org/info/categories_criteria2001

Appendix-C: Genetically Modified Organisms in Pakistan

Complete List & status of Project Proposals Received and processed at NBC

Sr. No.	Project Title	Status of the Projects in NBC/TAC
1.	BT Cotton	Approval granted in 2nd NBC meeting
2.	Insect Resistance (IR) Cotton	Case was closed on the request of the applicant
3.	Sugarcane Biotechnology	Approval granted in 3rd NBC meeting
4.	Work of Sugarcane	Approval granted in 3rd NBC meeting
5.	Improvement of Cotton Fiber through Transgenic Technology	Approval granted in 3rd NBC meeting
6.	Development of Board-spectrum Resistance against three Important Virus in Potato through RNAI Technology	Approval granted in 3rd NBC meeting
7.	Genetic Engineering of Tobacco and Cotton for Developing Resistance against Cotton Leaf Curl Disease (CLCud)	Approval granted in 3rd NBC meeting
8.	Engineering resistance against chilli leaf curl disease complex in plants	Approval granted in 4th NBC meeting
9.	Molecular characterization of synthetic spider (Hadronyche versuta) toxin (Hvt) gene for the development of insect resistant plants	Approval granted in 4th NBC meeting
10.	Evaluation of transgenic cotton for resistance to cotton leaf curl disease complex	Approval granted in 4th NBC meeting
11.	Development of synthetic Bt cry 1 AC gene, its molecular and physiological characterization in tobacco and cotton to determine its potential for makig insect rsistant crops.	Approval granted in 4th NBC meeting
12.	Development of transgenic basmati rice to bacterial leaf blight	Approval granted in 5th NBC meeting
13.	Cloning and Characterization of AtNHX1 gene from Arabidopsis thaliana and its homologous from other plants for developing of salt tolerant plants	Approval granted in 5th NBC meeting
14.	Identification of mutations related to change in colony morphology and hyper production of tylosin after UV and gamma irradiation mutagenesis of Streptomyces fradiae NRRL-2702	Approval granted in 5th NBC meeting
15.	Gene mining studies on extremophiles by using integron specific probes	Proposal withdrawn by the applicant
16.	Biodesulfurization of Indigenous Fossil Fuels	Proposal withdrawn by applicant
17.	Import of Bollgard ® cotton varieties from India	Approval granted in 5th NBC meeting
18.	Import of Bt cotton seeds from China	Approval granted in principal in 5th NBC meeting
19.	Field trials of Bt seeds	Field trials conducted in 2007 without approval of NBC (TAC did not recommend)
20.	Commercial release of CEMB-01 MNH-93 and CEMB -02 CIM-482 Bt cotton	TAC had not recommended for approval and requested for more Biosafety information
21.	Development of Cotton Varieties related to biotech and abiotech stresses	TAC had not recommended for approval and requested for more Biosafety information
22.	Application for permission to import plant products	TAC disapproved the application
23.	Development of RNAi AC 123 transgenic tomato plants for resistance against tomato leaf curl New Delhi virus	
24.	Cloning of components of banana bunchy top virus and development of mRep RNAi transgenic banana resistance to banana to banana bunchy top disease (BBTD)	Approval granted in 6th NBC meeting

25.	Development of overlapping AC 1/2/3 RNAi transgenic tobacco and cotton resistant to cotton leaf curl disease (CLCuD)	Approval granted in 6th NBC meeting
26.	Development of beta C1 RNAi transgenic cotton plants for resistance against CLCuD	Approval granted in 6th NBC meeting
27.	Development of antisense AV2 transgenic tobacco plants for resistance against tomato leaf curl New Delhi Virus	Approval granted in 6th NBC meeting
28.	Cloning and expression of four drought related genes in wheat (Triticum aestivum)	Approval granted in 6th NBC meeting
29.	Containment field testing of Pioneer hybrid maize with insect protection Herculex (HX1)	Approval granted in 6th NBC meeting
30.	Application for import of YieldGard® VT PRO/RR2 (Stack of MON89034xNK603) corn hybrid from USA	Approval granted in 6th NBC meeting
31.	Multi Location Research Trials (MLRT) of transgenic hybrid corn containing events MON89034 & NK603	Approval granted in 6th NBC meeting
32.	Development of High yielding, early maturing, and Insect Resistant cotton variety Ali Akbar-802 (un-notified variety with known gene)	Approval granted in 6th NBC meeting
33.	Development of High yielding, early maturing, and Insect Resistant cotton variety Ali Akbar-703 (in corporation of Bt Gene in CIM-482 notified commercial variety).	Approval granted in 6th NBC meeting
34.	Import of Bt cotton Seed from India	Approval granted in 6th NBC meeting
35.	Development of High Yielding Insect Resistant Cotton Lines-1	Approval granted in 6th NBC meeting
36.	Development of Bt cotton Variety MG 6	Approval granted in 6th NBC meeting
37.	Development of Bt Cotton Variety Neelam 121	Approval granted in 6th NBC meeting
38.	Development of High Yielding and Insect Resistant Cotton Variety Sitara 008	Approval granted in 6th NBC meeting
39.	Application for import of Bollgard II ® Cotton Seed	Approval granted in 6th NBC meeting
40.	Application for Field Trials of Bolgard II® Cotton Seed	Approval granted in 6th NBC meeting
41.	Application for import of Bollgard II® X Roundup Ready Flex® Cotton Seed	Approval granted in 6th NBC meeting
42.	Application for Field Trials of Bollgard II® X Roundup Ready Flex® Cotton Seed	Approval granted in 6th NBC meeting
43.	Import Zea mays L. (Maize) hybrid maize seed with Herculex gene and with NK603 gene from USA	Approval granted in 6th NBC meeting
44.	Containment field testing of Pioneer hybrid maize with insect protection Herculex1 (HX1) and NK603	Approval granted in 6th NBC meeting
45.	Development of High Yielding, CLCV tolerant and Insect Resistant Cotton Variety Sitara-009	Approval granted in 7th NBC meeting
46.	Development of High Yielding, Early Maturing, Insect Resistant Cotton Varieties having tolerance CLCV	Approval granted in 7th NBC meeting
47.	Application for import of 5 new Bt cotton hybrids BG2 (Bollgard MON-15985) (Gossypium hirsutum)	Approval granted in 7th NBC meeting
48.	Agronomic performance and bioefficacy trials of 5 new Bt cotton hybrids BG2 (Bollgard MON-15985) (Gossypium hirsutum) in cotton growing areas of Pakistan	Approval granted in 7th NBC meeting
49.	Field testing of Insect Resistant (IR)-NIBGE-3701	Approval granted in 7th NBC meeting
50.	Field testing of Insect Resistant (IR)-NIBGE-1524 (IR-NIBGE-2)	Approval granted in 7th NBC meeting
51.	Proposal for approval of exempt status to conduct filed trials of insect resistant (IR) NIAB-824	Approval granted in 7th NBC meeting
52.	Expression of single stranded (ssDNA) binding protein in transgenic plants for engineering broad spectrum resistance against gemniviruses	Approval granted in 7th NBC meeting
53.	Understanding the molecular basis of cotton leaf curl disease resistance in cotton germplasm	Approval granted in 7th NBC meeting
54.	Genetic engineering of wheat for developing resistance against barley yellow dwarf virus	Approval granted in 7th NBC meeting
55.	Application for commercial Release of CEMB-01 and CEMB- 02 and Data of National Coordinated Bt trial, 2008-09	Approval granted in 7th NBC meeting
56.	Application for Commercial release of IR-1524 (IR-NIBGE-2)	Approval granted in 8th NBC meeting
57.	Application for Commercial release of IR-NIBGE-3701	Approval granted in 8th NBC meeting
58.	Commercialization of Bt Cotton Variety Sitara-008	Approval granted in 8th NBC meeting
59.	Commercialization of cotton variety Neelum-121	Approval granted in 8th NBC meeting

60.	Commercialization of Bt cotton variety MG-06	Approval granted in 8th NBC meeting
61.	Commercialization of Bt cotton variety FH-113	Approval granted in 8th NBC meeting
62.	Commercialization of Bt cotton variety Ali Akbar-703	Approval granted in 8th NBC meeting
63.	Commercialization of Bt cotton variety Ali Akbar-802	Approval granted in 8th NBC meeting
64.	Commercialization of Insect Resistant (IR)-NIBGE-3701	Approval granted in 8th NBC meeting
65.	Commercialization of Insect Resistant (IR)-NIBGE-1524 (IR-NIBGE-2)	Approval granted in 8th NBC meeting
66.	Development of High Yielding Insect Resistant cotton Lines-II {Bt cotton hybrid GN-2085	Approval granted in 8th NBC meeting
67.	Import and transport of 04 corn hybrids having NK603 event (roundup Ready Corn 2) from Monsanto USA	Approval granted in 8th NBC meeting
68.	Field Trials of NK603 (herbicide tolerant) maize hybrid seed	Approval granted in 8th NBC meeting
69.	Import of MON 15985 (Bollgar II® cotton hybrid seed from Monsanto, India	Approval granted in 8th NBC meeting
70.	Large Scale Trials (LST) of MON 15985 (also known as Bollgard II ®) Hybrid cotton in Kharif 2010	Approval granted in 8th NBC meeting
71.	Import and transport 01 transgenic autumn corn hybrid containing events MON 89034 and Nk603 from Monsanto USA	Approval granted in 8th NBC meeting
72.	2nd year field trials of transgenic corn hybrid containing events MON89034 and Nk603 in autumn 2010	Approval granted in 8th NBC meeting
73.	Import for containment field testing of Pioneer hybrid maize with insect protection HX1 x MON810 x Nk603 traits.	Approval granted in 8th NBC meeting
74.	Containment field testing of Pioneer hybrid maize with insect protection HX1 x MON810 x NK603 traits	Approval granted in 8th NBC meeting
75.	Import and transport of corn hybrid with insect protection Herculex1 (HX1) and NK603 from USA	Approval granted in 8th NBC meeting
76.	Containment field testing of Pioneer hybrid maize with insect protection Herculex1 (HX1) and K603	Approval granted in 8th NBC meeting
77.	Import of Bt Cotton Hybrids from India	Approval granted in 8th NBC meeting
78.	Introduction / Development of Bt and CLCV resistant cotton variety	Approval granted in 8th NBC meeting
79.	Development of High Yielding and Insect Resistant Cotton variety IB-09	Under Process at the Centre
80.	Development of High Yielding long staple, and Insect Resistant Cotton variety Tarzan-3 (un-nitified variety with known Gene.)	Under Process at the Centre
81.	Development of Insect Resistant, Short stature, short duration maturity cotton variety Tarzan-2 suitable for planting on high density plant population	Under Process at the Centre
82.	Development of High yielding, early maturing, and Insect Resistant cotton variety Tarzan-1 (un-notified variety with known Gene).	Under Process at the Centre
83.	Development of Bt Cotton variety Neelum 141	Under Process at the Centre
84.	Development of Bt Cotton variety Neelum 131	Under Process at the Centre
85.	Application of Genetic Engineering to Improve Oil Quality in Roya	Under Process at the Centre
86.	Application of Genetic Engineering to Improve Harvest Index in Roya (Brassica juncea)	Under Process at the Centre
87.	Development of High yielding and Insect Resistant Cotton variety Allah din One (A-One)	Under Process at the Centre
88.	Development of Insect Resistant and high Ginning out turn cotton variety CIM-595	Under Process at the Centre
89.	Development of Insect Resistant and high Ginning out turn cotton variety CIM-598	Under Process at the Centre

Appendix-D: Rotation periods for most of the important species growing in the Pakistan

Rotation period

Following rotation periods are proposed for most of the important species growing in the Pakistan, AJK and Northern Area. The information is based on field observations, official forestry records and study of relevant technical literature.

S. No	Species	Proposed Rotation
1	Acacia nilotica (kikar/babul):	5-6 yrs for pit props 20 yrs for firewood 40 yrs for timber
2	Abies pindrow (fir):	120-150 yrs for timber
3	Ailanthus altissima (ailanthus):	20-25 yrs
4	Albizzia lebbek (black siris):	20 yrs; quite fast growing
5	Albizzia procera (white siris):	30 yrs; fast growing but not as fast as black Siris
6	Alnus nitida (sharol):	20-25 yrs for timber
7	Azadirachta indica (neem):	20 yrs; has high growth rate
8	Bombax malabaricum or cieba (simal):	25 yrs; a fast growing species
9	Cassia fistula (Amaltas):	50-60 yrs; a very slow growing species
10	Cedrus deodora (deodar):	120-150 yrs for timber production, growth slow
11	Cedrela toona (tun):	25-30 yrs; will grow to a girth of 2.5 feet
12	Dalbergia Sissoo (shisnam):	20 yrs for firewood and agricultural implements 50-60 yrs for timber
13	Eucalyptus camaldulensis (sufeda):	6-8 yrs; growth very fast
14	Eucalyptus citriodora	8 yrs; growth very fast (sufeda/ lemon scented)
15	Eucalyptus teriticornus (sufeda):	15 yrs for pulp, fiber board making, growth very fast
16	Gmelina arborea (gumhar):	8-10 yrs; a relatively fast growing tree
17	Grevillea robusta (silver oak):	20 yrs; a fast growing
18	Juglans regia (akhrot):	60 yrs; for timber and furniture making
19	Leucaena leucocephala (ipil):	10 yrs; fast growing and highly productive
20	Mangifera indica (aam):	60 yrs;

21	Melia azedarach (bakain):	8-10 yrs; for firewood 20 yrs; for veneer and plywood
22	Morus alba (tut):	20-25 yrs; grows very fast attaining a diameter of 60 cm at this age
23	Pinus roxburghii (chir-pine):	80-100 yrs; for timber production
24	Pinus wallichiana (kail):	120-150 yrs; for timber
25	Platanus orientalis (chinar):	25-30 yrs; a tree expected to be about 50-60 cm in diameter at this age
26	Populus euphratica (bhan):	15-20 yrs; grows fast
27	Populus euramericana (hybrid poplar):	5-8 yrs; diameter of 15-20 cm is quite common to see
28	Prosopis juliflora (mesquite):	10 yrs for firewood
29	Robinia pseudoacacia (robinia):	20-30 yrs; growth is quite rapid
30	Salix babilonica (baid-e-majnu):	10 yrs; relatively fast growing, for paper pulp and match sticks
31	Salix tetrasperma (common willow):	10 yrs;
32	Sapindus mukorossi (ritha):	5-8 yrs;
33	Sesbania sesban (jantar):	1 yr; yields a good amount of firewood biomass
34	Syzygum cumini (jaman):	20 yrs; yield of about 10-12 m3/ha/yr can be obtained at this age
35	Tamarix aphylla (frash):	12-15 yrs;
36	Zizyphus mauritiana (bar):	15 yrs; for fuelwood and charcoal production

Sources: Survey to Assess Wood Vegetation and Wood Volume on Non-Forest Areas in Pakistan (Ministry of Environment 2005)

Appendix-E: Wood Rates in Rs. per cubic foot during 2009-10.

Timber Rates of broadleaved trees in Rs. per cubic foot during 2009-10.

Species	Class I	IR	IIR	IIIR	Under size
Shisham	1502	1000	684	510	308
Kikar		219	202	172	135
Eucalyptus		165	165	137	115
Mulberry				146	80
Poplar		185	135	104	46
Simal		132	111	101	74
Frash		206	150	133	94

Timber Rates of Pine trees in Rs. per cubic foot during 2009-10.

Species	Selected	class I	Class II	Class III
Deodar				921
Kail scants		874	694	628
Chir scants		321	369	310
Fir/ spruce				471

Firewood Rs/ Cft

Species	Rate/cft (Rs)
Shisham	37
Kikar	25
Eucalyptus	28
Others	29

Source: Director marketing Punjab Forest Department Lahore.