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Indus FOREVER

Study of Riverine forest upstream Sukkur and downstream Kotri 2008

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JE MAINTIENDRAI

Indus for All Programme
WWF - Pakistan

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ACRONYMS

AMA	Adaptive Management Approach
CBO	Community Based Organization
CFT	Cubic Feet per Second
D/S	Down Stream
EES	Emergency Erosion Strip
EM:	Ecosystem Management
GIS	Geographical Information System
IES	Initial Erosion Strip
IUCN	International Union for conservation of Nature
LBOD	Left Bank Outfall Drain
MAF	Million Acre Feet
NCA	National Commission on Agriculture
NGO	Non Governmental Organization
NR	Natural Resources
NWFP	North West Frontier Province
U/S	Up Stream
WAPDA	Water And Power Development Authority
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

Province of Sindh, the lower part of Indus Basin is divided on climatic and ecological parameters. Climatically it is divided in upper and lower regions called Upper Sindh and Lower Sindh. The main factor distinguishing both the regions is temperature which is mild in lower part due to coastal influence. Ecologically, Sindh is distinctly divided in three regions i.e., sandy desert in the east, hilly tract in the west and alluvial plain in the centre. Indus flows almost in the middle of central alluvial plain from north to south extending over about 600 km. All these parts have ecological significance depending on various parameters. On both banks of Indus, blocks of varying sizes of forests are located within earthen embankments. These forests are designated as riverine forests. They are just not the forests but are a complex ecosystem dominated by trees and have other biotic and a-biotic components. The survival and upbringing of these forests is dependent on flow of water in Indus especially during monsoon season. Due to the diversion of Indus waters for agriculture and other uses coupled with naturally occurring drought, the required quantity of water for the riverine forests and associated biotic life has been adversely affected reducing the productivity and function of riverine ecosystem to a significant level. Other environmental, managerial and socio-economic factors have exacerbated the degradation of riverine forests and ecosystem to such a degree that they are fading away from the scene. There have been attempts to replenish the degradation through limited development activities but the initiative made, lacked in-depth study of causes of general degradation.

WWF-Pakistan under its “Indus for All Programme” has initiated a study of Riverine Ecosystem upstream Sukkur and downstream Kotri to find out the causes of degradation, their impact on riverine ecosystem and measures for its amelioration and restoration. Through consultation with Sindh Forest Department two representative sites, Keti Shah riverine forest located Upstream Sukkur and Kathore and Hayat Gaho riverine forests at Downstream Kotri were identified for the study. In order to address the key issues and to arrive at the desired outcome, the methodology was designed to collect important primary and secondary data of the selected sites by spot inspections, consultative meetings with stakeholders and various officials of the departments/organizations who have specific assignments/role along the long route of river from Guddu barrage onto downstream Kotri. All the information collected from both the sites was critically analyzed to arrive at recommendations applicable to all riverine forests of Sindh.

The focus of the study is on the comparison of ecosystems located in upstream Sukkur and that of downstream Kotri. It is felt necessary to collect and analyze related information on the biophysical environment of the entire Sindh in general and upper and lower Sindh in particular regarding, forest resources, history of management of riverine forests, water regimes, natural growth riverine forests succession, formation of vegetation, artificial regeneration and impact of social and biotic factors on these forests. Chapter 1 of the report contains the general description of Sindh and biophysical environment entailing climate, soil, surface water sources and land use patterns. Chapter 2 dwells on riverine forests and their importance as an ecosystem, history of management, ecological succession and natural and artificial/manual regeneration operations. Chapter 3 gives detailed account of Indus River water and riverine forests. Chapter 4 covers the social, economic, climatic, water related issues, biotic, edaphic factors and government policies attributing the degradation of riverine forests. Chapter 5 focuses on identified forests and entails in-depth comparison of upstream Sukkur (Keti Shah) and downstream Kotri (Kathore and Hayat Gaho) and chapter 6 analyses the factors responsible for the degradation of these forests. Recommendations to improve the existing depletion of the riverine forests pertaining to policy, management, development, participation of local communities and research are made in the final chapter. The study reveals that apart from non-availability of inundation water there are several managerial, social and economic factors responsible for degradation of riverine forest ecosystem of Sindh which can be improved with collective efforts of all the stakeholders particularly local communities.

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Introduction to Sindh's Riverine Ecosystem

2008

Indus for All Programme
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CHAPTER 1

GENERAL DESCRIPTION OF SINDH

1.1 General Description

1.1.1 Geographic Location

Sindh, the southern province of Pakistan, lies between 26^{o} – 28^{o} North latitude and 69 - 71 E longitudes. It extends to the Indian State of Rajasthan in the east, Punjab and Balochistan provinces in the north, Balochistan province in the west, and the Arabian Sea and the Runn of Kutch are in the south. The salient physiographic features of Sindh are shown in Figure 1. The total land area of the province is 14.09 million ha (34.82 million acres) which forms 17.7 per cent of the entire country. It constitutes the lower part of the Indus Valley (Basin), widely considered in the world as the cradle of civilization. The province has 3 distinct physical regions- the alluvial plain located in the center, the rocky region in west, and the sandy desert in the east. Each region is described separately as under:

Map 1: Map of Sindh

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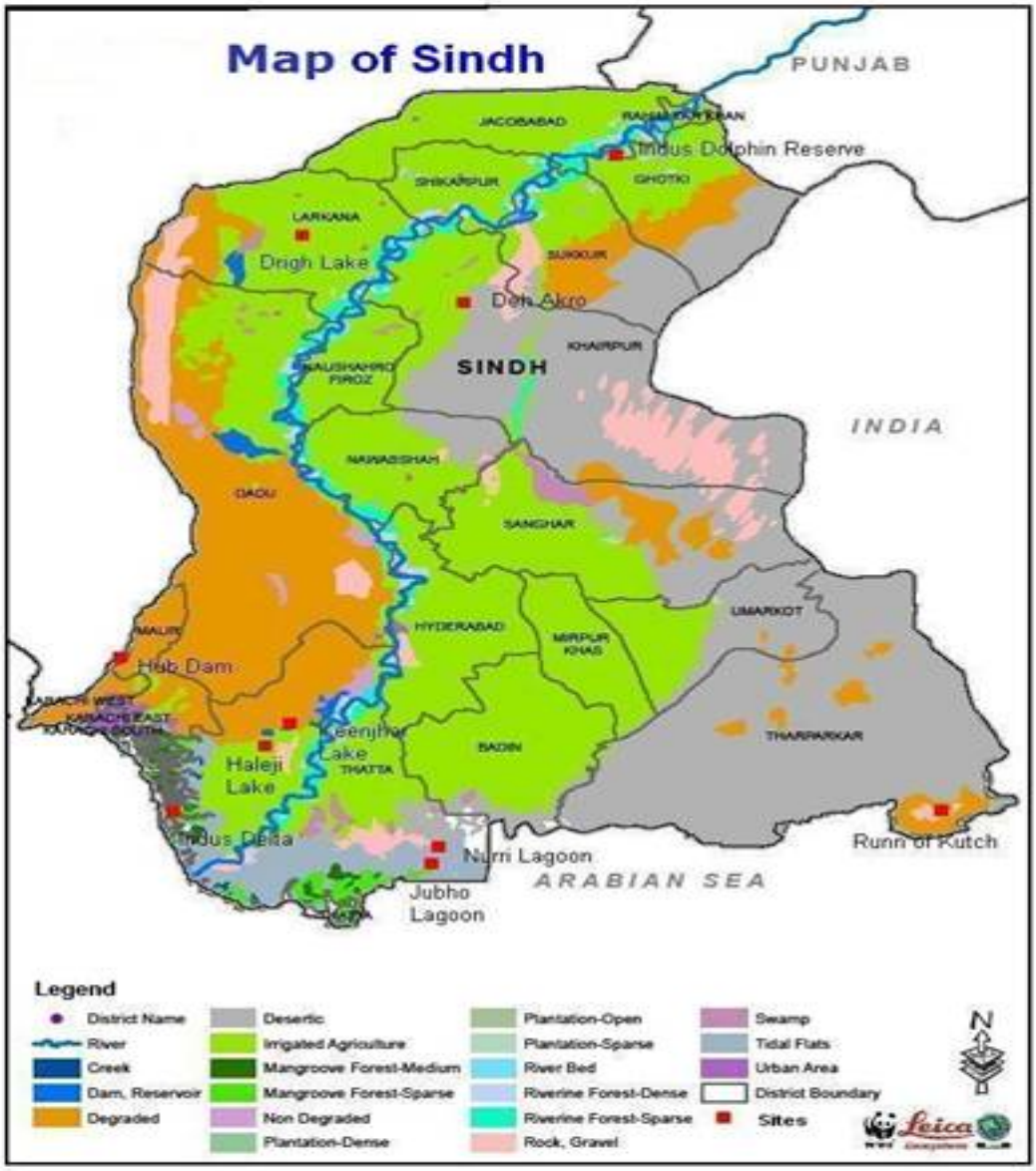


1.1.2 Central Alluvial Region

The central region is a fertile alluvial plain through which flows the Indus River. The total area of this region is 8.5 million ha that includes 0.86 million ha riverine tract (Panhwar, 2004). Three barrages have been constructed on the Indus River to divert river water for canal irrigation system emerging from these barrages. The main land use of this region is agriculture which is irrigated through one of the world's most extensive and integrated irrigation network. The topography is flat with a gradient of 12 cm per kilometer from north towards sea in the south.

Out of total area of riverine tract, about 0.24 million ha is under riverine forests, 0.41 million ha is privately owned (Kabuli) land, 0.16 million ha river bed, depressions (*dhoras*) and mud flats/sand bars and the remaining about 0.04 million ha are either under villages, graveyards or un-culturable wasteland (Panhwar, 2004). With the construction of barrages on river, the *kacho* area is divided in following three zones:

- Area between Guddu and Sukkur barrages
- Area between Sukkur and Kotri barrages
- Area between Kotri barrage to mouth of Indus river

The ecological features, biodiversity and socio-economic conditions of the above areas are dependent on water regime and make up three different sub-ecosystems with varying characteristics and distinct environments.

1.1.3 Eastern Sandy Region

All along the eastern side of the province flanking the central alluvial region, lies the sandy desert popularly known as "Thar Desert locally called *Registan*" This sandy region forms the western part of Great Indian Desert. the total area of this region is 3.39 million ha (8.38 million acres), which is further divided into Thar and Nara regions. The topography of the region is undulating with varying sizes of sand dunes. Rainfall is scanty and erratic and underground water is generally brackish. Small areas along ridges and narrow valleys are cultivated by rainwater during monsoon period. The economy of Thar Desert is pastoral and the main land use is grazing. The dry weather, brackish ground water coupled with harsh and sever climatic conditions are unfavorable for growing crops, vegetation propagation or livestock rearing.

1.1.4 Western Hilly Region

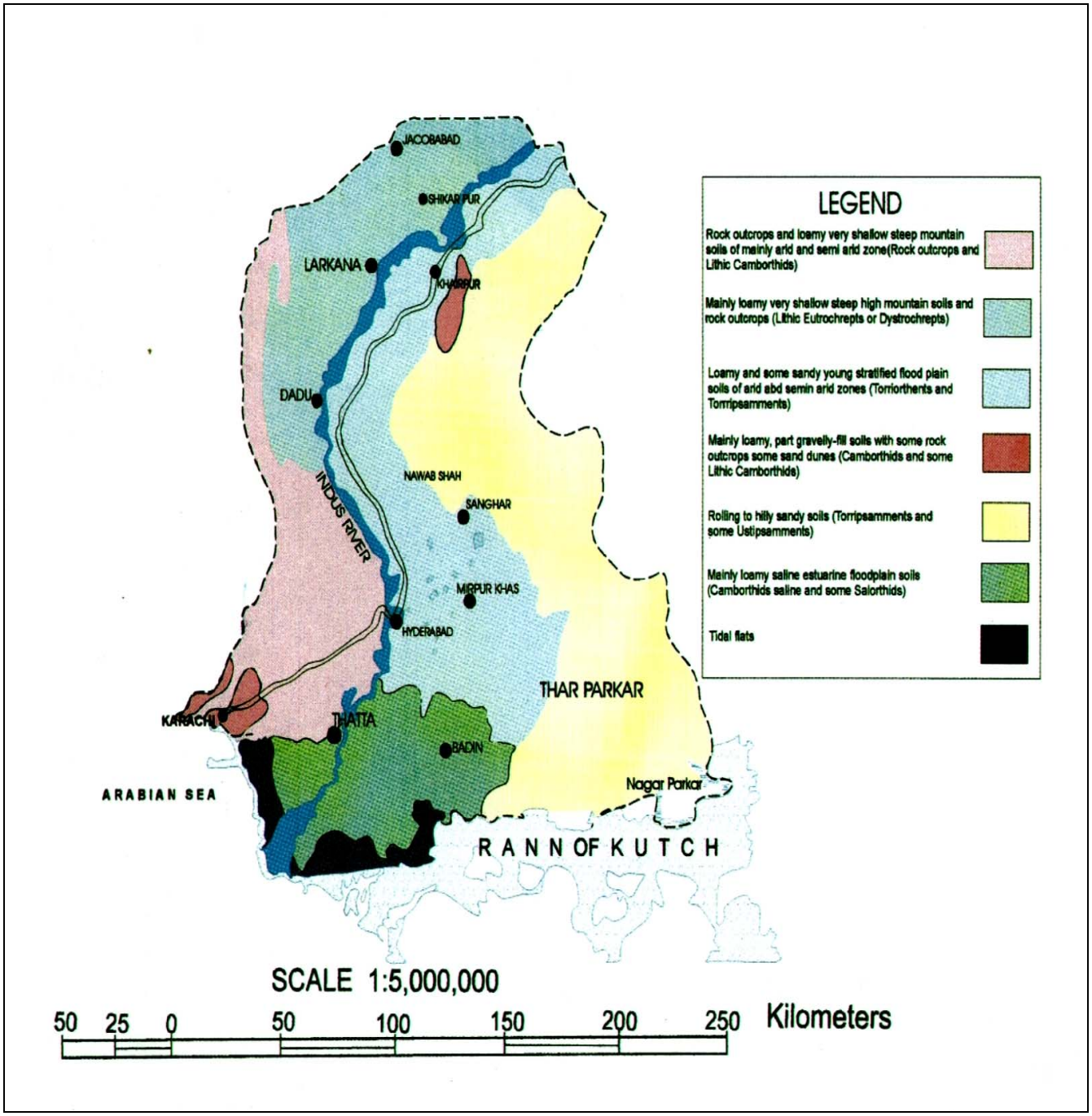
The western hilly region locally called as "Kohistan" is a part of the long Khirthar mountain range formation. This region occupies 2.30 million ha (5.44 million acres) constituting 15.6 percent of total land area of the province. Ecologically it is categorized as a tropical sub-mountainous zone. Like sandy desert region, dry conditions prevail in this area resulting in similar living conditions.

1.2 Biophysical Environment of Sindh

1.2.1 Climate

The climate of Sindh is broadly described as sub-topical continental type. It is characterized by hot summers and mild dry winters. May and June are the hottest months while the winter season normally lasts from December to February. The mean annual rainfall is about 100 mm in the northern part and gradually increases to 175 mm in the south. The rainfall mainly occurs during the months of July and August. Like-wise average temperature in northern part of Sindh is 35.6^0 C whereas it is 28.8^0C in lower Sindh. The average humidity in upper Sindh is 20.76% whereas in lower Sindh it is 54.13%. Evapo-transpiration exceeds precipitation throughout the year.

Map 2: Soil Map of Sindh



1.2.2 Soils

Sindh is located in the lower part of the Indus Plain. Its productive soils in central plains have been formed by actions of the Indus River which deposits silt cover along both sides of river banks during *Abkalani* every year since time immemorial. These alluvium soils are largely medium to fine textured generally with high ratio of silt, clay and contain equitable lime-magnesium ratio and low amounts of sodium carbonate. The overlying alluvial sediments vary in thickness from several meters near Guddu and Sukkur to less than 30 meters in the areas downstream Kotri. Due to continuous deposition of fresh sediments after flooding season, soils do not show any profile development but are stratified sand, silt, loam, and silty clays (Al-Mubarak, 1975). The soils of riverine tract in general are very fertile and the topography of the riverine belt is flat but uneven due to annual silt deposition.

1.3 Land use

The main land use of centrally located plain is agriculture followed by forestry, whereas the land use in desert and hilly regions is mainly pastoral with little rain fed (*barani*) crops.

1.3.1 Agriculture

Pakistan has one of the largest contiguous canal irrigation networks in the world which supplies irrigation water to the provinces of Punjab and Sindh and to some extent in the provinces of Balochistan and NWFP. Several barrages have been constructed on the Indus River for multifarious purposes; three such barrages are located in Sindh. Agriculture is mainly practiced in central alluvial plain on canal water and rain fed *barani* agriculture is practiced along shallow dunes and narrow valleys of desert and flat areas of hilly tract. Certain crops are also grown on residual moisture after the flood season is over in riverine areas. Of the cultivated land, 6.0 million ha is irrigated. The major crops grown, acreage wise are wheat, rice, cotton, sugarcane and oilseeds (NCA, 1988). Among the valuable fruit trees, Sindh produces varieties of mangoes, bananas, dates, chikoos, papayas, citrus, guavas, and wide range of vegetables are grown in all such areas.

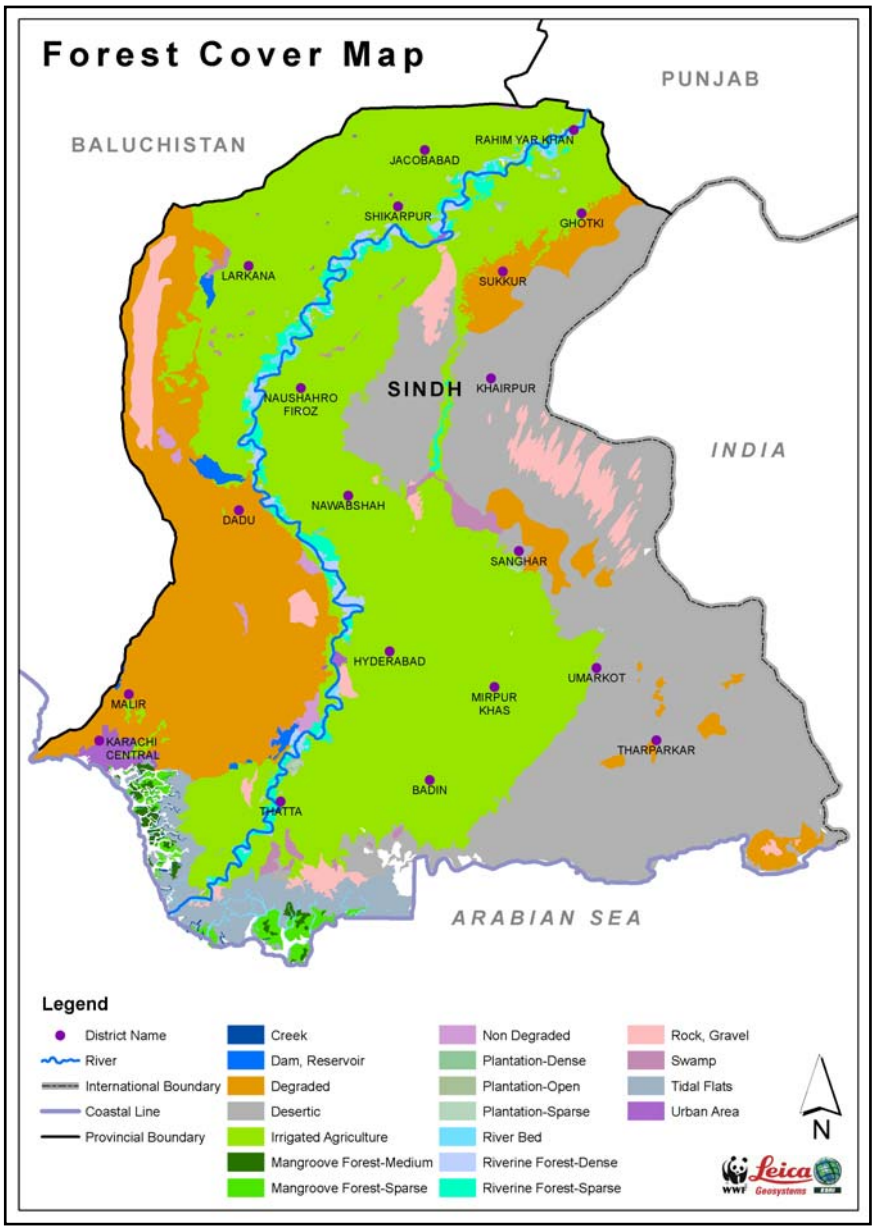
1.3.2 Forests

After agriculture, forestry is the other major land-use in centrally located plains. The Sindh Forest Department, manages 8% of the province of which only 2.3% contain productive forests. Table 1 gives the details of forest types and respective areas.

Table 1: Type of Forests in Sindh

Type	Area (in million acres)	% of Total Land Area
Productive Forests		
Riverine Forests	0.6	1.7%
Irrigated Plantations	0.2	0.57%
Sub-total	**0.8**	**2.3%**
Protective Forests		
Mangrove Forests	0.85	2.45%
Rangelands	1.13	3.25%
Sub-total	**1.98**	**5.7%**
Total	**2.78**	**8%**

Figure 3: Forest Map of Sindh



1.3.2.1 Productive Forests

Riverine Forests

To protect the hinterlands from flooding, earthen embankments were erected on both sides of the River Indus 5 to 20 km apart during 1860 to 1960..They are one of the important components of riverine belt and owe their existence to the uncontrolled flooding/inundation of Indus River. Riverine forests spread over 0.6 m acres (0.24 m ha) are the mainstay of forestry in Sindh and entirely depend on the inundation waters received during monsoon season. All forestry operations are dependent on inundation supplies. The predominant species of Riverine forests are *Acacia nilotica (Babul, Prosopis cineraria (Kandi), Tamarix aphylla (Lawa), Tamarix dioca (Lai)* and *Populus euphratica (Bahan)* confined to well drain high silt containing stabilized kacho areas. Mesquite growth has invaded high lying areas which is quite useful for fuelwood and charcoal making.

Image 1: *Acacia nilotica* - Golden Tree of Sindh

Irrigated Plantations

After construction of bunds (earthen embankments) along both sides of Indus River, 81,200 ha of Riverine forest were rendered as inland forests and with the construction of three barrages on Indus River for diverting river water for agriculture, canal water was allocated for many inland forests for converting these in to Irrigated Plantations. Inland forests falling in the command of each barrage are as under:

1. Guddu Barrage command area = 0.02 million ha (0.05 million acres)
2. Sukkur Barrage command area = 0.04 million ha (0.09 million acres)
3. Kotri Barrage command area = 0.03 million ha (0.07 million acres)

Total 0.08 million ha (0.20 million acres)

The concept of irrigated forestry was introduced during the British Rule with an objective of supplying firewood to railways, steam boats and ships and fuel wood for military cantonments in the territory of Sindh then part of Bombay Presidency Species such as *Acacia nilotica (Babul), Dalbergia sissoo (Shisham), Eucalyptus camaldulensis and Salmalia malabaricum (Simal)* were planted in these plantations in varying proportions during different times under different conditions.

1.3.2.2 Protective Forests

Mangrove Forests

Sindh has a 342 km long and 50 km wide coastal belt along the coastline of the Arabian Sea covering an area of 600,000 ha. It is a complex distinct environment pre-dominated by mangrove ecosystem. Within the coastal belt an area of 73,000 ha of Indus delta is covered by mangrove forests in districts of Thatta, Badin and Karachi. They rank 6th largest contiguous fresh water mangroves worldwide (IUCN,1991). Mangroves are distinct and diverse ecosystems. They form a unique assemblage of flora and fauna providing a complex detritus-based food web for a number of marine and brackish water organisms. These forests are not productive in terms of timber and fuel wood, but their protective role is very significant. They serve as a breeding grounds for fish and shrimp, protect Karachi and Bin Qasim ports from silting and city of Karachi from tsunamis. The main tree species grown in these forests is *Avicennia marina* which is locally known as *Timer* and occupies 97 per cent of mangrove tree cover. Other species are *Rhizophora macronata, Ceriops tagal* and *Aegiceras cornicuata.*

Rangelands

Rangelands in Sindh occupy about 62% of the total land distribution and comprise of vast expand of *Thar* Desert and hilly tracts of Kohistan in Khirthar Range and are totally dependent on sporadic and scanty rainfall. The area under the control of Sindh Forest department is 1.13 m acres (0.45 m ha) located in Tharparkar, Thatta, Karachi, Jamshoro, Kambar-Shahdad Kot and Khairpur districts. The Important xerophytic and drought resistant species of trees, shrubs and grasses found in these dry arid rangelands are *Acacia senegal, Prosopis cineraria, Tecomella undulata, Acacia jacquemontii, Salvadora oleoides, Capparis decidua, Cenchrus ciliaris, Cenchrus biflorus, Panicum turgidum, Panicum antidotale*, etc. Rangelands are also habitat for variety of indigenous and migratory birds and wild mammals and reptiles.

1.4 Agroforestry

People generally grow trees on the farmlands in different combinations such as woodlots, linear plantations along boundaries, paths, water courses, and isolated trees. Babul and Eucalyptus are important tree components in agroforestry systems being practiced in Sindh which gets priority by the farmers due to its multiple use and soil improving qualities.

1.5 Babul Block Plantations (*Hurries*)

This system has a traditional and age-old historical background. The practice of raising 'Babul Hurries' on agricultural lands has been in vogue since 1858. Sir Bartley Frere, the then Commissioner of Sindh, issued a circular to allocate up to 4 ha (10 acres) of state land, free of cost to farming families for raising Hurries (woodlots) so as to meet the wood requirements of local population and ensure conservation of agricultural lands. Incentives of remission of land revenue and water rates were given to encourage the farmers. The cultivation of Babul Hurries has evolved into an agroforestry system for improvement of marginal lands while meeting fuel wood and timber needs.

Although free land grants and other concessions have stopped long ago, farmers continue growing Hurries. It suggests that Hurry growing is an economically viable system due to the following:

i) the lower water requirement, thus enabling the farmers to divert more water to agricultural crops;
ii) the improvement in soil productivity due to the nitrogen-fixing ability of Babul, and;
iii) a hedge against emergencies to supplement the income from farmlands.

The rotation of Hurries varies from 6 to 8 years. The predominant uses of the wood are mining timber (pit props) and fuel wood.

1.6 Surface Water Resources of Sindh

1.6.1 Indus River Irrigation System

Since the sub-soil water is brackish and rains are scanty, canal waters from Indus river network is the only source of irrigation water in Sindh. Irrigation system presently comprises of three barrages, 14 canals, 1200 distribution channels, and 47,400 watercourses (IUCN, 2004). Table 2 shows the barrage-wise length of canals and available water for irrigation.

Table 2: Irrigation Canals and Available Water in Sindh

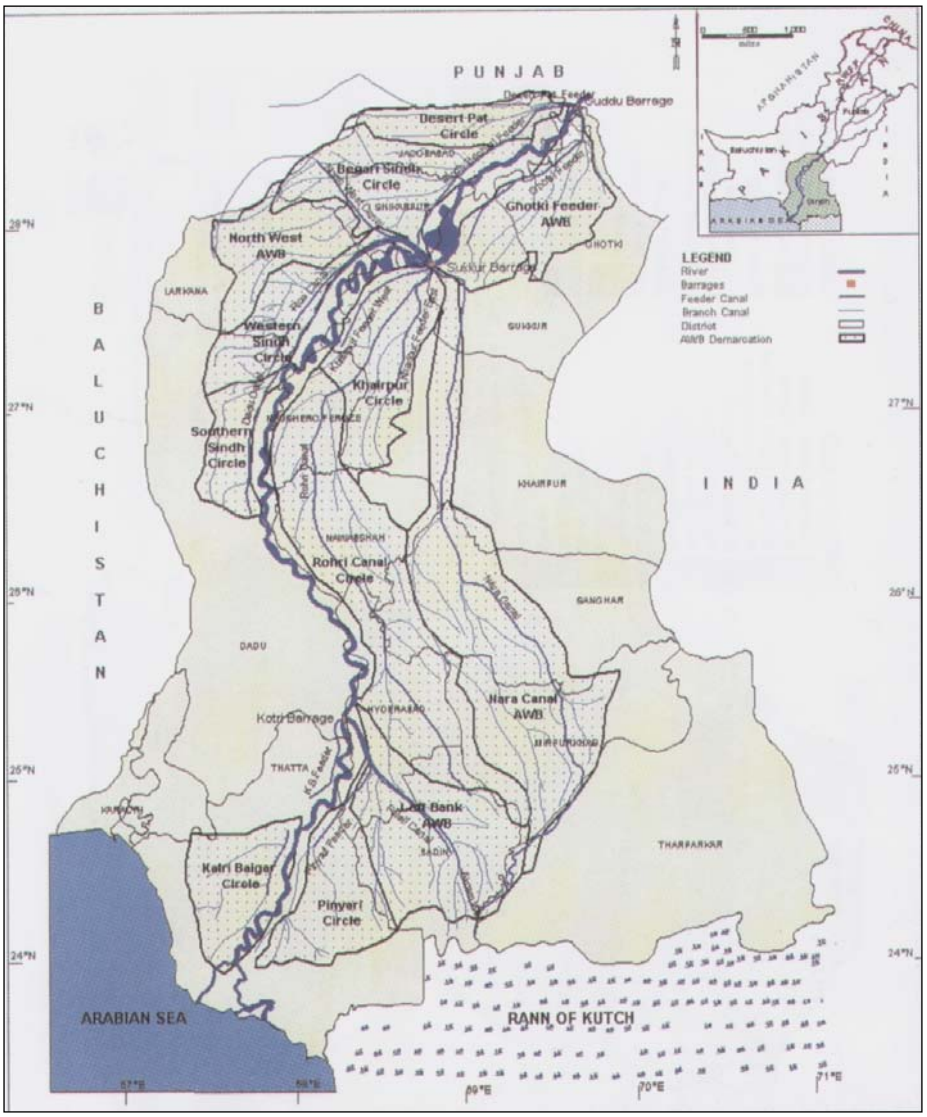
Barrage	Length of canals (Km)	Withdrawal ((MAF)
Sukkur	2,083	26.4
Guddu	992	9.1
Kotri	1,592	10.4
Total	**4,667**	**45.9**

1.7 Underground water level and quality

1.7.1 Ground water

Panhwar (1954) assessed the ground water in riverine belt of Sindh. According to his report, except for the riverine belt in Thatta district, the southern most area and the right bank of the river from cities of Sehwan and Jheruk in Dadu and Thatta districts, the rest of the area is reported to have shallow underground arable water from 15-21 m depth. This water is not copious and saline below 21m.

Map 4: Irrigation (Canals) system of Sindh



CHAPTER 2

RIVERINE FORESTS OF SINDH

2.1 History of Riverine Forests

2.1.1 Pre-Colonial Period

Prior to the British conquest of Sindh, the annual inundations were practically unchecked throughout central alluvial plain of the Province. The population and cultivation were a fraction of what these are today. The forest growth covered all the land wherever water reached. Later on people cut forests, made temporary settlements and cultivated crops wherever they chose and were thus responsible for the separation of the wooded area into the patches and blocks which to a large extent characterizes the riverine tract today. Some of the riverine forests were reserved by the Mirs for purposes of the *shikar* (hunting), strictly protected under game laws and mud walls were erected around these confined areas.

These game preserves (shikargahs) became the nucleus of the present day forests after the conquest of Sindh by British in 1843. There is no record that when *shikargahs* were demarcated as forests, but in the year 1847 Major Scott was appointed the first Forest Ranger in Sindh. He was followed by Captain Crawford, Dr. Stocks the botanist, Captain Hamilton, and Mr. Dalzell another celebrated botanist. These two rangers demarcated all the *shikargahs* by erecting boundary marks.

The occupation of Sindh by the British brought the ownership of land to the Crown. The proclamation of Imperial Monarchy in 1858 through Queen's declaration ushered in the British colonial outlook over Sindh as with other places in British India. The rich *shikargahs* and *Moharies* (Private shikargahs) were taken over for commercial exploitation for the production of firewood for flotillas.

In 1861, Mr. Fenner was made in-charge of the forests. In 1862 the Forest Department was created and forests were transferred to the Forest Department from railway companies. General application of the Indian Forest Act in 1863, defined the procedure for declaration of certain lands as legally constituted forests. The other lands were constituted as wastelands for grazing/ pasture.

During this period, demand of fuel wood increased because of establishment of railway lines between Karachi, Kotri, Dadu, Larkana, Ruk and Sibi and thereafter between Rohri and Samasata. The army cantonments established at Karachi and Quetta also needed firewood. Timbers were needed for port works at Karachi and Bombay and gun carriages and ammunition boxes in Jabalpur ordinance factory. The commercial utilization of forests for firewood and timber increased and continued increasing with changing demand and quantities, although Indus flotilla stopped functioning around 1875 and railways switched over to coal and oil in 1895.

In 1871, Dr. Schlich became the first Conservator of Forests. He organized the Department and divided the Sindh Circle into three Divisions corresponding to the Revenue Divisions. He placed each division in charge of a District Forest Officer and a Forest Guard was made responsible for about 1,400 ha each. Mr. Campbell, succeeded Dr. Schlich and obtained Government sanction in 1876 for reconstituting of the Circle into the four Forest Divisions viz. Sukkur, Naushahro, Hyderabad and Jerruck with 15 Rangers, for an area of 173,330 ha. The jurisdiction of these Divisions did not commensurate Revenue Districts, but extended over both banks of the Indus. During Colonel Mac Rae's tenure of the Conservator ship, Jacobabad Division was created in 1888, but was shortly abolished. In that year, the forest area had increased to 249,600 ha..

In 1906, the Sindh Forest Department consisted of a Deputy Conservator of Forests in charge, responsible to the Commissioner in Sindh, and 4 officers' in-charge of divisions and one Superintendent of Forest Contour Surveys. Of this four, one officer was from the Imperial Forest Service and the rest were Extra Assistant Conservators of the Provincial Branch. There were 5

Rangers and 19 Foresters in charge of Ranges, of whom only 4 Rangers and 5 Foresters were trained from Forest Schools in Poona and Dehra Dun. There were 352 Forest Guards in charge of beats and depots (Aitken. E.H. 1907).

2.1.2 Past Management of Riverine Forests

Prior to the conquest of Sindh by the British to 1860-61 nothing is known of the system under which these forests were managed, as no administration reports are available for that period. However, these woodlands were being administered by local rulers and local communities for hunting and local wood consumption.

The management from 1860 to 1895 also does not appear to have been based on any pre-conceived plan of harvesting and reproduction. Forests were exploited as convenient to meet the local demand from the population, Indus Flotilla Company, and subsequently for the state railway when railway took the place of steam boat navigation. In earlier days, the methods of disposal adopted were the royalty and share systems, which were later substituted by departmental working. Departmental working continued up to 1901, when the system of selling coupes by tender or by auction was introduced.

The first attempts at systematic management were made during the period 1875 to 1895. The main features were “rotational cutting” and “sustained yield”. Even those attempts were sporadic, as forests continued to be worked in parts within easy reach of the railway and the river. In 1891 Mr. Hexton introduced some slight change in the working system; but both these plans had no advantage to the forests as prescriptions of the plans were not followed.

The objective of introduction of systematic working was to produce fuel wood on sustained basis for Indus Flotilla Company and North Western Railway, which required a very large amount of wood fuel and to collect as much revenue as possible, without any consideration for improvement and conservation of forests.

Systematic management commenced from 1896, when Mr. Desai obtained Government sanction for preparation of working plans under Forest Code. Main features were clear felling in equal adjacent areas under a rotation of 30 years for babul and 10 years for kandi and lai. Regeneration was proposed by coppice, supplemented in places by sowings. This plan was followed up to 1900-01, when first regular plan prepared by Mr. A. C. Robinson was sanctioned and put into force.

Under Mr. Robinson’s plan, forests were mainly worked for the production of fuel wood. The method adopted was clear felling on equal adjacent areas on a rotation of 30 years. In a few forests the rotation was fixed at 20 years. For timber, babul was reserved irrespective of its girth, age or condition. Regeneration was to be by coppice, supplemented in places by sowings. This plan remained in force up to 1917-18 and revised by Mr. D.L. Nawani for 1918 to1930 which was subsequently revised/written by Mr. C.G. Abichandani for the period 1936 to 1955-56 (for Sukkur, Shikarpur and Larkana districts).

Three others plans for Hyderabad, Jherk and Naushahro were also brought into force in 1901, 1902 and 1908 respectively. Subsequently, the working plans for Lower Sindh were also re-written for the period up to 1949-50.

Since, the chief demand for wood was fuel particularly for railway, no provision was kept in the Plans for growing timbre trees, although railway had switched over coal and timber demand had arisen from the Gun Carriage Factory and expanding local market for large size babul (Gazetteer of Sindh, 1906).

Mr. Robinson’s plan was revised because it was found that:

(i) As a result of the harvest of adjacent coupes from year to year regardless of the age of the crop, over mature crop was allowed to rot in some places and immature crop came under axe in others; and also the annual yields were unequal;

(ii) The whole sale reservation of babul for timber necessitated frequent deadwood felling which were not carried out and resulted in loss of material; and,

(iii) Safeguard against fire was necessary which his plan did not provide.

In revised working, following changes were made:

(i) The sequence of felling was determined not by the order of situation but by the stage of growth and mature/over mature growth was harvested first. To protect from fire and collection of seed, cleared areas alternated with stands of wood and where ever there were large blocks of old crop, main roads, external boundary lines and compartment lines were also widened for fire control;

(ii) For production of timber, advance growth of babul up to 30 cm and all dense babul stands up to 3 feet in girth were to be reserved;

(iii) Light thinning for babul and kandi crops from the 6th year onwards was prescribed.

This plan served its main purpose that bulk of the over mature and deteriorating tree growth was removed. Its revision was considered necessary because scattered felling under the existing plan rendered exploitation expensive and execution and supervision of works difficult and the main object to be kept in view was to concentrate on economical working. Also *Populous euphratica* (Bahan) was mainly in demand in small sizes for rafters and 'Lai' became hollow after the age of 15, therefore it was desirable to provide for their working on a smaller rotation than was allowed for other species (C.G. Abichandani, 1936).

It was difficult to carry out the prescription of management plans systematically due to the annual liability of the riverine forests to erosion, and huge changes that took place in the river course. It also happened at times that several years' coupes were washed away during floods before their time for exploitation occurred. Although erosion was more or less counter balanced by the corresponding accretions, it was impossible to forecast the sequence of working or the outturn of the forests for any length of time accurately.

The harvesting of yearly coupes were estimated and sold through public auction to contractors who supplied the wood to locals, towns, factories and exported small quantities to Quetta and Persian Gulf. The chief lines of transport were the river, its backwater channels and canals which were connected with the forests by roads and temporary tracks made by the contractors. The transport used was camels and donkeys by land and boats by water. Bullock carts were also used in Sukkur Division. The cutting work was done by Chavans, Brohis and Kachhis.

2.1.3 Present Management of Riverine Forests

The object of management in these forests has been to generate/regenerate *Acacia nilotica* which is the most suitable tree species with short rotation period and high economic value. *Acacia nilotica* takes a longer time to grow or regenerate in its natural succession as it follows a growth cycle which is preceded by Tamarix (*Lai*), Saccharum *(Kana*) and *Populus euphratica (Bahan)* growth. Acacia *nilotica* regenerates when favourable conditions and new soil formation are created in the riverine tract. In order to hasten the process and grow *Acacia* in a shorter period, broadcast sowing is done in muddy waters during recession of floods each year.
Management practices have been simple and time tested. The forests areas on attaining rotation period are marked for clear felling in the form of 64 ha (one compartment) or smaller coupes for felling operations. Clear felled coupes/areas and newly stabilized *kacha* areas are regenerated after inundation recedes after peak flood season. The complete regeneration process has been dealt in this chapter in the description artificial regeneration in riverine forests.

2.2 Erosion and Accretion Process

Indus River flows on ridge once it passes through the boundaries of the province of Sindh and therefore during flood season, its water inundates the surrounding areas. Due to meandering behaviour, it keeps changing its course frequently. Wherever, the main current of the river strikes the banks, it undermines and then erodes large chunks of land and deposits the same in the frontage of the opposite bank side at some distance. A new land in the form of unstable *Kacho* emerges and gets stabilized in due course of time with annual silt depositions. While changing its course, river creates bi-rivers, depressions (*Dhands*) and leaves abandoned beds (*Dhoras*) in the riverine tract which later serve as lateral channels and spread inundation water in *kacho* tract. Some of these depressions retain water for entire year and is used for drinking; fish culture and lift irrigation to grow agricultural crops and tree plantations (Fig 3).

Image 2: River bank erosion

2.2.1 Causes of Erosion and Accretion

i) The soil of the entire Indus valley is generally friable and easily disintegrated by the river water currents or wave wash even at low velocity. This eroded land and large amount of silt in suspension, begins to settle and rapidly forms banks and shoals (sand bars) because the velocity of flowing water to transport the silt load to flow downstream falls below what it is required.

ii) In order to keep the velocity within limits that can be withheld by the banks without undergoing erosion, the river has to workout for itself a very tortuous course.

iii) The river banks are generally low and overflow during inundation season. Owing to the tortuous course of the river it frequently happens that the distance across the neck of land separating two great bends becomes relatively very short. The river may then force through this neck of land and cut off eventually takes place resulting in the shortening of the length of the river. As the banks cannot withhold this velocity, they are cut away in the endeavor to recover the normal ratio and sever erosion sets up until such time as the river gets its normal length.

2.3 Succession in Riverine Ecosystem

The series of vegetation changes on a single site is called plant or vegetation succession (Billings, 1970). Succession on new areas is called primary succession and the re-vegetation after disturbance is termed as secondary succession. Examples of allogenic succession can easily be observed along the banks of meandering rivers in flood plains, where succession starts on recently deposited sand and dictated by subsequent flooding and alluvial deposits (Kimmins, 1987).

The succession along the Indus River plains is the best example of allogenic succession. In the riverine ecosystem due to deposition of new soils through river action, primary succession takes

place. In areas of riverine belt, where soil has already stabilized, secondary succession/re-vegetation takes place after removal or the disappearance of the original plant formations.

Ecologically, riverine forests are classified as the Indus Inundation seral stage and inland forests as at various degradation stages of Tropical Thorn Forest type (Champion-19??). Inundation and meandering are the most important ecological factors, which are responsible for the species composition and growth of tree crops in these forests. Tree species of these forests appear in a succession according to the type of soil and water regime.

2.3.1 Succession Process

When a new kacho is formed, the soil is generally sandy and land is low lying. It gets inundation annually and for longer periods. In this process, fresh silt is deposited annually and the land level rises with enrichment of soil quality class. *Tamarix* and *Saccharum* are the pioneer species which occupy the un-stable kacho lands. In the later stage, *Populus euphratica* starts growing in kacha areas and it is the first stage of the succession. When soil stabilizes, and the duration of inundation reduces, *Acacia nilotica* occupies stabilized kacha areas and this is the second stage of succession. After several inundation floods, silt is deposited to the extent that the land is rendered high lying and hardly get inundated periodically, *Acacia nilitica* starts disappearing and is replaced by *Prosopis cineraria* which constitute third stage of succession. As the time passes and more silt depositions take place the lands become very high lying and seldom receives inundations, the *Prosopis cineraria* gives way to the hardy and thorny climax species, such as *Salvadora spp. Calotropis procera, Capparis decidua* etc. which is the fourth and final stage of succession. This stage continues till the area is eroded and the succession cycle restarts from the first stage and progression follow the pattern as before.

2.3.2 Economic Succession

Since *Acacia nilotica i*s economically valuable species suited to riverine tract, it is managed systematically from the early stages of formation of insignificant grasses and thin *Tamarix* growth on the unstable kacho areas. Broadcast sowing of *Acacia* seed is undertaken manually once kacho stabilizes after the peak floods every year in muddy waters. Forestry personnel's plan to bring more areas under babul vegetative cover for economic returns. Other tree species too have importance and economic value and *Salvadora persica (Khabar*) which once was considered inferior fuel wood is now being used in the manufacture of hard boards, etc.

2.4 Artificial Regeneration in Riverine Forests

The regeneration of Bahan (*Populus euphratica)*, Lai (*Tamarix dioca*), and Lawa (*Tamarix aphylla*) takes place in natural form whereas babul and Kandi seed is sown either through broad cast, dibbling or drilling depending on site conditions and availability of inundation water. Babul and kandi takes longer time to grow and flourish in the natural form of regeneration. (Fig.4).

Figure 3 & 4: Regeneration Operations

Image 5 & 6: Regenerated seedlings

In the riverine forests the inundation water is primarily used for artificial regeneration of babul and kandi by the foresters as a basic tool through standard management practices. The artificial regeneration is carried out in three distinct phases called *"Pre-abkalani", "Mid-abkalani"* and *"Post-abkalani"* sowings. (In local terms the word *"abkalani"* means **"**flood water**"**). The regeneration operations are generally undertaken i) prior to advent of inundation ii) during inundation i.e. while flood water is receding, but still standing in the area and iii) after the flood water has totally receded (Advani, 1943).

2.4.1 Collection of Seed

Before start of the inundation (abkalani) season, Babul and Kandi seed is collected in the months of May and June every year. The seed is collected either by threshing of pods or the pods are given in feed to goats and sheep and seed is collected after the pods have passed through the alimentary canal of goats in the form of droppings. These are then cleared by winnowing. Seed from goat dropping is far better than the seed extracted from the pods as they are viable and can not be easily attacked by the insects (Fig 5)

2.4.2 Pre-abkalani Sowings

Pre-abkalani sowings are undertaken in areas where low flooding is expected to occur for a shorter period. It is also done in those areas which are difficult to regenerate without prior soil working such as grassy areas, hard pan and or of high lying nature and composition. In such difficult areas, soil working operations mainly ploughing with country plough or tractor is done and all bushy and unwanted, stunted growth is cleared and sowing operations are undertaken by broadcasting sowing, dibbling or dibbling with babul mixed with kandi seed.

2.4.3 Mid-abkalani Sowings

This operation is carried out in the months of July and August during the recession of flood water. Before the sowing operations are started, blank regeneration coupes are earmarked on the maps and regeneration *pahis* (5' clear strips) 20-30 ft apart are laid in the coupe areas having dense growth of *Tamarix* to facilitate the workers that are employed for broadcast sowing in muddy waters. Before the start of regeneration operations, seed is transported to site and group of labourers is lined up at a distance of about 30 feet in knee-waist deep water each carrying about 10 kg of seed each on their back as one can easily throw the seed in an area of 15 feet on his both sides. Seed in boats will move with each party and constantly will be supplied to each labour for broadcasting in line. This operation is carried out at each site within 2-4 days as once flood water started receding, it does not take much time to evaporate and dry. Any technical lapse and inordinate delay in this phase will result in poor form of regeneration.

This operation is generally repeated for three years as in following years, regenerated area may either get high flood or low flood insufficient for the survival of small seedlings and in this manner proper vegetation cover of babul is endured in these regeneration coupes.

2.4.4 Post-abkalani Sowings

This operation is undertaken after the recession of flood water and in such lands which are fit for dibbling or drilling of seed in residual moisture in the months of October through December. This method is follow up of the pre-abkalani and post abkalani as leftover areas are sown by this method. Whatever, blanks are noticed; they are sown through drilling and dibbling with Babul and Kandi seeds.

After the area has been regenerated, next important thing is the protection and aftercare of regenerated coupe areas specially from grazing and browsing of animals. The area is normally fenced with brushwood till the regeneration gets established.

2.4.5 Aerial Seeding

For the first time in the history of this region, aerial seed sowing operation was undertaken in 1974, when 2,428 ha. blank riverine area was broadcasted with babul seed from specially equipped aircraft. Experience showed that this operation was highly costly and required large chunks of blank land areas. It did not give the desired results and success as the seed after each sortie generally drifted in deep water as it did not hold the ground firmly due to the speed of the aircraft. These operations were followed by the traditional methods of sowings by dibbling and drilling to regenerate the coupe areas earmarked for aerial seeding programme.

2.5 Development Initiatives

Since, the riverine areas were annually inundated and thousands of acres were regenerated at a low cost, there was little need for raising the irrigated plantations in riverine tract. But with construction of several water reservoirs and barrages and the occurrence of frequent droughts, time came for raising plantations on lift water in these depleted and degraded areas. In early eighties, few pilot projects titled: 'Afforestation of high lying areas' were undertaken in different districts, but insignificant areas were afforested due to high cost of land leveling machinery employed on land development works, high cost of lift pumps and their maintenance in subsequent years. About 3000 ha were also developed and planted under Sindh Forestry Development Project but the achievements are considerably less than the amount spent on diesel oil, land development charges, subsequent maintenance and overhead expenses. These development activities in riverine areas are not viable and practicable from an economic stand point hence not feasible.

2.6 Forest Management Plans

Forest management plans have always been a pre-requisite of the objects of forest management on scientific lines. It contains detailed descriptions of forest beats, blocks, ranges and divisions, gives clear picture of the growing stock and about the commercial timber fellings/selection fellings, pruning, cleaning, spacing / thinnings, rotation period of different tree species and regeneration of felled and new areas. It provides guidelines for all operations that are periodically required in each forest of the plan. However, the management plans of many forests have ceased to work on completion of the plan period in the last two decades. Sindh Forestry Development Project has also covered the important assignment of the preparation of management plans of all the riverine forests from the year 2001 for a period of 10 years.

2.6.1 Stocking

Prior to the independence (1947), riverine forests were densely stocked and flourished all over 80% of the total land area under vegetation. After the construction of Tarbella dam and other several barrages and link canals coupled with occasional drought seasons, the river inflows have been greatly reduced and the natural flora and fauna has greatly been affected. Forests have gradually depleted and in its place an inferior vegetation has emerged in vast riverine areas. In the decade of 1960, forest cover declined to the extent that less than 60% areas contained productive tree growth and it became less than 50% in late seventies. It is generally observed that there has

been 10 to 15 per cent depletion in the vegetative cover of riverine forest in every decade. However, last 15 years have been far too disastrous due to frequent low flooding season and formation of vast high lying areas. The other reasons have also contributed to this present situation such as encroachment of forestlands for cultivation purpose and poor law and order prevailing in these areas. Stock taking surveys were carried out in the year 2001 and these show that hardly 25% areas are under Babul and Kandi growth, another 25% under Mesquite, Lai and mixed growth and remaining 50% is either blank or under other uses.

2.6.2 Rotation

Rotation of timber and fuel wood crops is an essential component of forestry management. For the economic utilization and optimum production of timber, pre-fixation and ascertainment of species wise rotation period has to be identified/fixed. It varies considerably from specific need point. Rotation of babul has been prescribed as 8 years for the supply of pit props which is used in coal mines industry in Sindh and Balochistan, as per the management plans of Sindh Forestry Development Project. The rotation age for Babul has been prescribed as 15 years and for Kandi at 20 years for timber wood exploitation. In earlier working plans, the rotation period was higher to the extent of 25 t0 30 years respectively for Babul and Kandi for felling operations.

2.6.3 Irregular Fellings

Irregular selection felling in the riverine forests are a common practice as after every flood season the tree growth is partially or fully uprooted in fragile lands due to river action and needs to be harvested. Tree growth which is likely to be eroded and vulnerable areas that are under threat of being swept away in the ensuing flood season have also to be felled in advance as initial erosion strip (IES) or in some case emergency erosion strip (EES) laid out at the advent of flooding season when river changes its course suddenly in particular location. Dead, dying, fallen or disease/decaying trees are also felled in this manner. These fellings are accounted for in the annual possibility (Yields) of the succeeding year.

2.7 Features of Riverine Ecosystem

Riverine Forests are a landscape having the soil, climate and set of organisms that make it a typical forest ecosystem. In this complex ecosystem, plants, animals, and microbial communities dominated by trees occur naturally or with artificial management/assistance. following These forests provides variety of functions and are an assemblage of living organisms together with their non-living environment. Total environment includes the climate, physical components of the soil and the topography (the non-living, or abiotic components of environment) and all the other organisms (plants, animals, and microbes) that help or hinder them, feed them or feed on them, protect them or are protected by them.

2.7.1 Specific Features of Riverine Ecosystem

The main features of an ecosystem are: structure, function, complexity, biodiversity, interaction of components and tendency to change over time.

Both the vertical and horizontal structures of the plant community are important ecosystem characteristics. Vertical structure refers to vertical layering of different types of trees/plants in the community whereas the horizontal structure refers to canopy levels of shrubs, herbs, microbes/moss available on the forest floor. Riverine ecosystems are natural biomass factory as they produce plant biomass, animal biomass, and microbial biomass. They produce energy from foliage and also capture chemical energy from solar system. Riverine forests are complex ecosystem as they are composed of many individual structural components that interact to determine ecosystem function.

Riverine ecosystem is a pool of biodiversity of living organisms such as trees, shrubs, wildlife, insects, fish, cultivated crops, livestock etc. All its biotic and abiotic component are dependent

upon each other. Any positive or negative impact/influence upon any component of the system results in imbalances in the ecosystems function and productivity. Riverine ecosystem is not static but has a tendency to change with passage of time and natural and manmade influences creating disturbances. The ecosystem reverts back to its normalcy if external influences are minimized.

2.7.2 Source of Timber and Fuel wood

The riverine forests are the mainstay of forestry and a major source of timber and fuel wood particularly for mining timber in Sindh and Balochistan. For meeting the increasing energy demand in the country, greater emphasis has to be given to this cheap renewable energy resource. These forests in the past were extensive and very productive and been a source of fuel wood/charcoal to the Middle East countries and some towns in India besides meeting the needs of local population.

2.7.3 Habitat for Wildlife

The riverine forests have remained important habitats for wide range of mammals and reptiles notably the Hog deer (*Axis porcinus*) which has managed to survive in the shrinking riverine forests. This species is near extinction due to shrinking habitat, food scarcity, illegal hunting and expansion of agriculture in Kacho areas and needs to be protected. Besides, wild boars, partridges, Sand grouse, wolves, jackals, porcupines etc. also inhabit riverine forests.

2.7.4 Environmental Amelioration

The riverine Forests are a vital component of riverine land ecosystem that lessen the impact of diurnal temperatures, sequester CO_2, and retain soil moisture.

2.7.5 Livestock Grazing

Riverine forests were used to be the major source of livestock grazing. The Babul pods and leaves are nutritious and favourable fodder particularly for goat and sheep. Besides, abundant grasses, wild herbs, shrubs, etc. growing after floods and rainfall are source of fodder for the livestock and wild animals.

2.7.6 Minor Products

There are several *Dhands* (Natural lakes) and *Dhoras* (abandoned river beds) in riverine areas, some of which store water round the year and are the source of fish and employment. In addition, these forests produce Honey, Gum, Lac, Medicinal herbs and bark for tannin.

CHAPTER 3

WATER RESOURCES OF SINDH

3.1 The Mighty Indus River

The classic name of the river Indus is derived from Sanskrit word *Sindu* means Ocean which is equivalent to word Darya in Persian. The Indus River originates North of the Himalayas and discharges into the Arabian Sea. With summer discharges exceeding one 1.0 million cft/sec, it is among the largest rivers in Asia. Its total catchments area is about 945,346 sq km and extends to Tibet, Afghanistan, and India and covers the greater part of Pakistan. The river has specific annual flow patterns, reaching the highest level in July and August and the lowest in January and February, reflecting that most of the water is derived from snow melt and monsoon rainfall in its catchments. Its length is about 2,898 km of which, nearly a third (935 km) it traverses Sindh province.

3.1.1 The Lower Indus Basin

Major part of Lower Indus Basin comes within Sindh province, which has been created and sustained by the Indus River, without which it would have been a barren land or desert. From time immemorial, Sindh has depended for its fertility on floods. As the river started swelling in the beginning of summer, it regularly surmounts, or breaches its banks letting loose a great volume of water, which takes its own course to sea while submerging all lowlands on its way.

Due to the gentle gradient and flowing of Indus on a ridge in the province, the river has been changing its courses in order to maintain its velocity. It has been flowing in the central plain through out its width changing its course remembered with different names. Historians say that a lost river was also flowing through Sindh that started from Himalayas east of river Sutlaj, discharging down to Gulf of Cutch, passing near the town of Umerkote in Tharparkar district, where it was called Gaggar, Hakra, etc. There were several ancient natural channels and long depressions which transported their waters to sea; among which, Eastern and Western Nara, Ochto river, Fuleli, Dhoro Puran were the prominent channels. It is said that the Eastern Nara flows in the bed of lost river about which there are several theories (Sindh Gazetteer, 1907) .

3.2 History of Irrigation in Sindh

History of irrigation in Sindh is very old. Evidences from Moenjo Daro indicate that beside River Indus, the lands used to be cultivated by flood irrigation. Other evidences also give strength to this statement that lands of Sindh were irrigated artificially through canals from time immemorial. In 8th century Arab conquerors differentiated their land tax assessment between land watered from the public canals and land watered privately.

Construction of barrages made it possible to provide controlled and assured water supplies to the agricultural lands. Sukkur (Lloyd) barrage was the first barrage constructed on Indus in Sindh in 1932. This was followed by Kotri barrage in 1955 and Guddu barrage was the last barrage commissioned in 1962.

3.2.1 Barrage-wise Commanded and Irrigated Areas in Sindh

1. Guddu barrage designed for 36,000 cubic meters was constructed in 1960. This barrage serves water to three canals, two on the right and one on the left side of the Indus. These canals divert 1,090 cubic meters of water and irrigate 1.1 million ha.

2. Sukkur barrage designed for discharge of 30,000 cubic meters was constructed in 1932. From this barrage seven canals originate, 3 on left and 4 on the right side of the Indus and discharge 2,026 cubic meters of water to irrigate an area of 3.22 million ha.

3. Kotri barrage designed for discharge of 21,000 cubic meters was constructed in 1955. Four canals originate from this barrage, one on right and three on left side of the Indus to serve 1.62 million ha with 1240 cubic meters' of water.

3.3 River Indus and Forests of Sindh

The forests of Sindh are entirely dependent upon Indus River flows. The regeneration and upbringing of riverine forests depend upon the vagaries of the river that are dictated by quantity, frequency, and period of occurrence of floods from year to year. River Indus is also a source of sediments that determines the soil regime of forests and agricultural lands. The quantity of flood water received and discharged at each barrage since 1932 is shown as Appendix I. Monthly distribution of water in Indus River is shown below in Table 3.

Table 3: Average Distribution of Indus Waters During 1961-1970 at Sukkur

Month	Water Quantity (cft)	Percentage of Total Flow
January	77, 000	1.9
February	73,000	1.8
March	124,000	2.5
April	215,000	5.2
May	302,000	7.3
June	529,000	12.8
July	826,000	20.2
August	964,000	23.6
September	631,000	15.3
October	199,000	4.8
November	128,000	3.1
December	62,000	1.5

Source: Irrigation Department records

The above data indicate that about 70 per cent water arrives during the months of July, August and September. This trend of water has major impact on the regeneration practices or riverine forests in Sindh.

The data indicate that the frequency of water in the Indus has been varying from year to year and it has created problems with respect to the management of the riverine forests intensively. The forests of Sindh have been adversely affected due to the erratic nature of flood water and its frequency. The Indus River Commission has categorized the discharges of river water at Guddu for management purposes under following categories:

Table 4: Categories of Floods

Category	Discharge (cubic meters)	
	Lower	Upper
Low flood	6000	10500
Medium flood	10500	15000
High flood	15000	21000
Very High flood	21000	27000
Super flood	27000	>27000

Source: Sindh Irrigation and Power Department

3.3.1 Intensity of Floods and Inundation of Riverine Forests

According to experience and records of Forest department, 50% riverine forests becomes inundated at a peak discharge of 15,000 cubic meters, 60 per cent with 19,500 cubic meters, 75 per cent with 24,000 cubic meters and almost entire riverine tract gets inundated with a peak discharge of 30,000 cubic meters at Sukkur barrage. The data in Appendix I show that except for a few high year floods, most of the years have received inadequate water resulting in flooding of some low lying areas. The riverine area which could not get inundation water has been affected very badly with respect to growth and establishment of vegetation. Having no any other significant source of water, the riverine ecosystem has been degraded in its productivity.

The table below indicates that from the year 1940 to 1990, only 10 super and 8 high floods have been recorded. For rest of the years, the regeneration and rehabilitation operations in riverine forests could not be carried out significantly. Inadequate flooding resulted in insufficient moister availability in the soil, which in turn made it difficult to nurture the regeneration carried out during high flood years which requires 5 years to get established under normal conditions.

Table 5: Discharge in High Flood Years in Indus River at Sukkur during the last 50 years

Month	Max. discharge (cubic meters)	Type of Flood
1943	21,840	High
1948	22,830	High
1955	24,150	Super
1956	29,940	Super
1958	32,940	Super
1959	29,160	Super
1960	23,850	High
1966	19,950	High
1967	19,710	High
1969	19,740	High
1973	33,510	Super
1975	30,450	Super
1976	36,000	Super
1978	33,540	Super
1983	22,650	High
1986	35,010	Super
1988	33,570	Super
1989	23,160	High

Source: Indus River Bulletin report 1990

It is concluded from above facts that inundation water is quite essential for the growth and development of riverine forests. When it is in abundance, the riverine forests grow profusely and the regeneration operations on new and harvested sites could easily be done successfully. In low flood season, these activities are hampered to a large extent resulting in poor growth and lesser regeneration operation opportunities. Apart, the whole ecological pattern gets changed and disturbed and gives desolate look.

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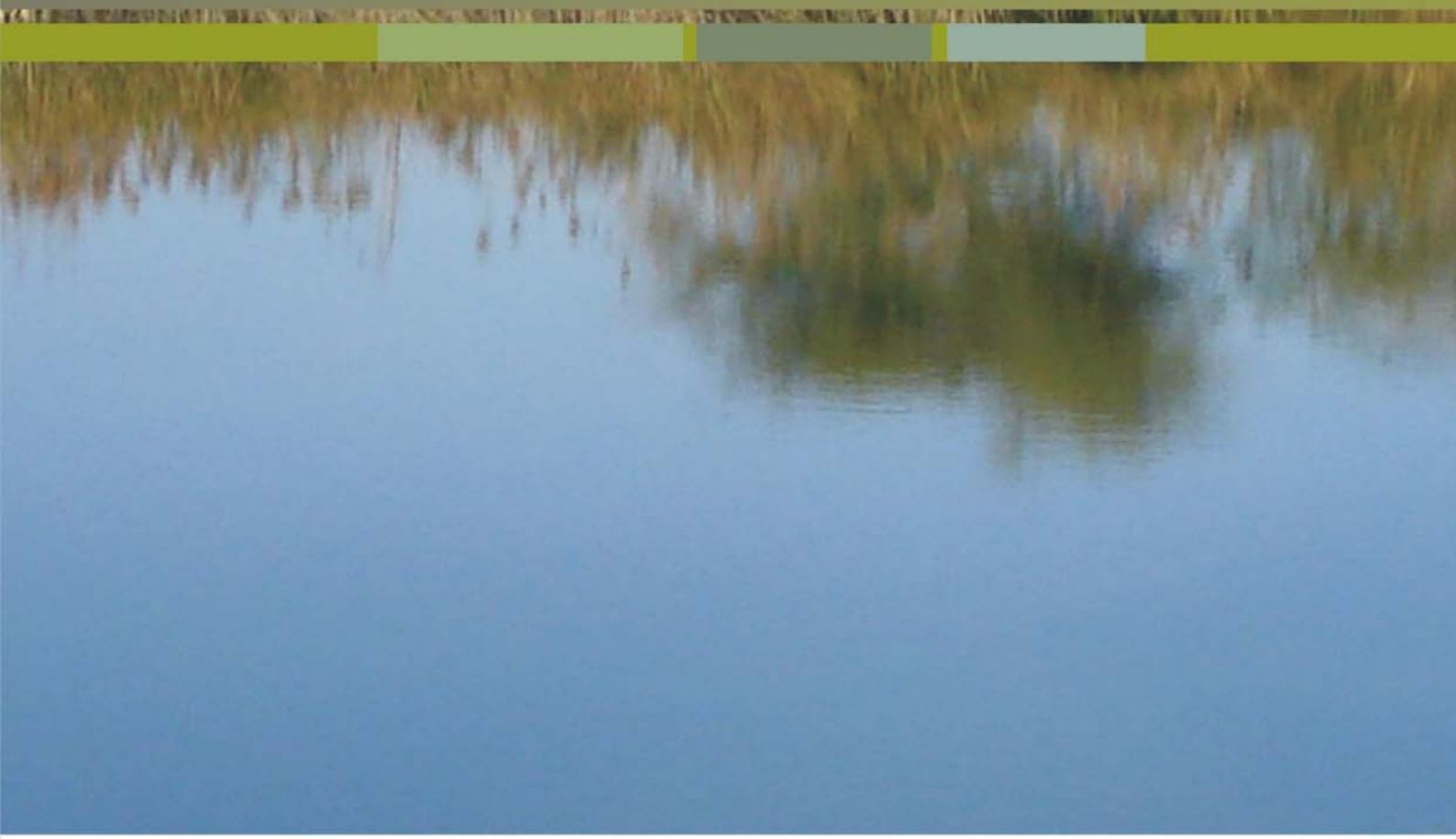
Analysis of factors responsible for degradation of Riverine ecosystem and recommendations

2008



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CHAPTER 4

FACTORS RESPONSIBLE FOR DEGRADATION OF RIVERINE FORESTS

Historically, the riverine ecosystem of Sindh was productive and economically viable, but the climatic changes, socio-economic pressures and disturbances caused by natural and anthropogenic factors have significantly depleted and degraded this ecosystem. The ecosystem functions as a web or chain where the climatic and biotic factors function as its string (Stoszek, 1991). Any natural or artificial change in any factor disturbs the whole web. Higher the disturbance, the greater the complexity of interactions within the ecosystem results in a catastrophe. In this case, the most affected components of ecosystem are the living organisms. The factors described here are both natural and manmade but their extent has been exacerbated by the intentional and un-intentional activities of human beings.

4.1 Main Degradation Factors and Consequences

4.1.1 Population

Sindh is the most populous and urbanized province of Pakistan. According to 1998 census, it accommodates 30.4 million people with a density of 135 persons per sq. km. This population is 23% of country's total population of which 48.9% resides in urban areas. With the annual growth rate of 2.8 percent, the projected population of the province will reach 43 million and 56 million in the years 2010 and 2020, respectively (IUCN, 2004). The dependence of 72% of population is upon agriculture which is mostly practices in central zone of the province. Hence, irrigated tract is thickly populated and has a direct pressure on riverine ecosystem.

Table 6: District-wise Census of Sindh

District	Population (million)			
	1961	1972	1981	1998
Jacobabad	0.580	0.813	1.103	1.426
Sukkur	0.581	0.863	1.120	0.908
Shikarpur	0.391	0.512	0.619	0.880
Larkana	0.535	0.842	1.140	1.927
Nawabshah	0.842	1.286	1.637	1.071
Khairpur	0.541	0.848	1.103	1.547
Dadu	0.649	0.810	1.074	1.689
Hyderabad	1.042	1.545	2.080	2.891
Badin	0.431	0.624	0.769	1.136
Sanghar	0.518	0.715	0.922	1.453
Tharparkar	0.860	1.221	1.501	0.914
Thatta	0.421	0.601	0.757	1.113
Karachi East	0.713	1.223	2.059	2.746
Karachi West	0.782	1.382	2.087	2.106
Karachi South	0.645	0.902	1.207	1.745
Karachi Central	Not Available	Not Available	Not Available	2.278
Karachi (Malir	Not Available	Not Available	Not Available	0.982
Mirpurkhas	Not Available	Not Available	Not Available	0.906
Umerkote	Not Available	Not Available	Not Available	0.663
Naushahro Feroz	Not Available	Not Available	Not Available	1.088
Ghotki	Not Available	Not Available	Not Available	0.971
Total	**9.531**	**14.187**	**19.178**	**30.440**

Source: National Institute of Population Studies, 2001

The census reports of 1961, 1972, 1981 and 1998 indicate that there is an increase of population to an average of 48.9, 35 and 58.7 percent. The uneven distribution of population has a tremendous impact on the natural resources particularly forests. The effect of increasing population on the growth and establishment of riverine forests is analyzed as under:

4.1.2 Population Pressure on Riverine Forests

The degradation of riverine forests has accelerated mainly due to ever increasing population. Although all the components of riverine ecosystem have been affected due to population pressure, the trees are badly affected. Since the requirement of domestic fuel wood as well as livelihood needs is met from indiscriminate tree cutting, the entire ecosystem has been disturbed. People have also encroached upon forestland for agriculture purposes. The study reveals that more than 40,000 ha of riverine forests of Sindh have been encroached. The impact of this action has emerged in the form of overall degradation of the riverine ecosystem by destruction of wildlife habitat, disappearance of associated fauna and flora, reduction in gene pool, degradation of soil; change of micro climate and over all environment of the region. This has resulted in reducing the vertical and horizontal structures of riverine ecosystem.

4.1.2.1 Upstream Sukkur

Upstream Sukkur comprises of Ghotki, Sukkur, Kashmore and Shikarpur districts. The total population of these districts is 3.1 million which forms 20% of the rural population. The riverine forests located in above 4 districts are spread over an area of 47,889.5 ha detailed below:

Table 7:Forest-wise Area of Riverine Forests Upstream Sukkur

District		Riverine Forest	Total Area (ac)	Total Area (ha)
Sukkur	01	Bindi Dhareja	7,265.0	2906
	02	Keti-abad	5,032.0	2012.8
	03	Khia Bindi	990.0	396
	04	Qadirpur	2,119.0	847.6
	05	Ding	1,644.0	657.6
	06	Keti Shah	18,445.0	7378
	07	Panwhari	503.0	201.2
	08	Azizpur	448.0	179.2
	09	Keti Shahu	11,145.0	4458
	10	Keti-abad-II	6,294.0	2517.6
	11	Changri	239.0	95.6
	12	Katha	346.0	138.4
	13	Rohri	1,774.0	709.6
	14	Sadhuja	8,804.0	3521.6
	15	Khan Belo	1,620.0	648
	16	Budh	945.0	378
	17	Wahidpur	8,450.0	3380
	18	Bahab	3,016.0	1206.4
	19	S.K.Shahu	10,752.0	4300.8
	20	Sunderani	225.0	90
	21	Old Gublo	4,912.0	1964.8
	22	Gondak	3,472.0	1388.8
	23	Rounti	6,156.0	2462.4
	24	Wasti	677.0	270.8
		Sub -Total	**104,203.0**	**41681.2**
Shikarpur	25	Muhro Mari	1,922.8	769.12
		Sub -Total	**1,922.8**	**769.12**
Kashmore	26	Gondak	2,455.8	982.32
	27	Gihalpur	480.3	192.12

	28	Gandher	873.7	349.48
	29	New Gublo-I	2,694.3	1077.72
	30	New Gublo-II	2,926.3	1170.52
	31	Makhan	628.0	251.2
	32	Daho	1,377.0	550.8
	33	Jhangan	2,062.5	825
		Sub -Total	**13,597.9**	**5439.16**
		Total	**119,723.7**	**47889.48**

4.1.2.2 Downstream Kotri

Down stream Kotri comprises of Thatta and part of Hyderabad and Jamshoro districts. The total population of these districts is 1.84 million which forms 6% of the population of the province. The riverine forests located in above districts are spread over an area of 56,011 ha detailed below:

Table 8: Area of Riverine Forests Downstream Kotri

District	Riverine Forest		Total Area(ac)	Total Area(Ha)
Thatta	01	Viran	3,963	9,792
	02	Sonda	939	2,320
	03	Ali Ganj	2,406	5,944
	04	Lallong	1,489	3,680
	05	Shah Lunko	811	2,003
	06	Baopurandas / Bijora	4,399	10,869
	07	Cut Munarki / Sadnani	2,964	7,324
	08	Hayat Gaho / Gullel / Kathore	2,425	5,991
	09	Marho Kotri	1,560	3,854
	10	Budhani	724	1,789
	11	Khirsar	2,430	6,005
	12	Surjani	3,330	8,228
	13	Ganj	607	1,501
	14	Panhwar	2,037	5,033
	15	Ali Bahar	2,709	6,695
	16	Chach Keti / Munarki / Bahadipur	5,094	12,587
	17	Pako Allah Bux	1,376	3,401
	18	Acho Marho	1,686	4,167
	19	Mulchand	2,287	5,651
	20	Khadi / Jurar	6,418	15,860
	21	Khokhar	1,282	3,168
	22	Budhaka	879	2,173
		Sub-Total	**51,815**	**128,035**
Hyderabad	23	Railo	162	399
	24	Karo Khaho	1,184	2,926
	25	Keti Mehrani	2,222	5,491
	26	Hajipur	541	1,336
	27	Dhandh Dhabo	87	215
		Sub-Total	**4,196**	**10,367**
		Total	**56,011**	**138,402**

The population living in Kacho area and adjoining towns and villages depend either directly or indirectly on the riverine forest resources. This study reveals that the people residing within riverine forests or its proximity mostly depend on riverine forests for meeting their domestic needs in the form of goods and services. As per an estimate, people residing within 5 kms of forests are

dependent on riverine forests to the extent of 50%, whereas 30% needs of the people living up to 10 kms are met from riverine forests. This dependence can be categorized as under:

4.2 Goods

Riverine forests produce and provide several goods such as wood (fuel wood and timber), fishing, agriculture, livestock grazing, fodder, seed, medicinal plants, wildlife hunting etc. for meeting the local, regional and national consumption.

4.3 Services

Services include employment opportunities through forestry operations and agriculture practiced over forestlands.

4.4 Climatic Factors

The vegetation is a function of soil, climate, parent material, topography, biota and time. Of these factors, climate is generally accepted as one of the major determinants of vegetation type (Kimmins, 1987). It influences the suitability and productivity of tree species on a particular site and it affects every aspect of forest management from regeneration to harvesting.

The main components of the climate discussed and analyzed are rainfall, temperature, wind, humidity and their interaction with respect to availability and duration of water for the growth and survival of riverine forests. All these factors have direct and or indirect influence on the occurrence and growth of different species in these forests. There has been a significant deterioration in Riverine ecosystem due to climatic factors over time.

4.4.1 Rainfall

The rainfall in Sindh is scanty and alone does not meet the moisture requirement of trees for their required growth. The rainfall data of the province indicates that its northern part receives almost half the quantity of rainfall than its southern part, which significantly influences the growth and development of riverine forests. The rainfall mostly occurs during the monsoon season i.e. from June to August. The rest of the year remains mostly dry and unfavorable for tree growth.

Predominant species in the riverine forests is *Accacia nilotica* (Babul) which requires sufficient moisture and does not grow in harshly dry conditions. In the upstream Sukkur except for the low lying areas or areas in the immediate upstream of Sukkur barrage, Babul does not grow well and xerophytic *Prosopis cineraria* takes its place as dominant species and it is more conspicuous in the sites which are high lying and out of reach of normal inundation water.

4.4.2 Temperature

After rainfall, the periodical temperatures have influence and impact on overall climate of the lower Indus plain, which ultimately influences the riverine ecosystem in that area. From the temperature point of view Sindh has two distinct portions/ parts i.e. upper Sindh and the Lower Sindh. The meteorological data indicate that there is no significant difference in mean annual temperatures between two eco-zones, but there is significant difference in hot and cold seasons.

This variation in temperature associated with other factors such as biotic, edaphic and socioeconomic considerations influence the composition, distribution, growth and establishment of flora and fauna in general and tree species in particular.

Plants and tree species in riverine tract grow well in the temperature range of 23.9^0 C to35^0 C (Troup, 1921). Hence, these areas are quite suitable for the growth and establishment of

indigenous plant species. The mean maximum and minimum temperatures during summer and winter seasons prevailing around upstream Sukkur and downstream Kotri are as follows:

Table 9: Minimum and Maximum Mean Temperature (C^o) in Sindh

Season	Upstream Sukkur		Downstream Kotri	
	Max.	Min.	Max.	Min.
Summer	43	33	37	26
Winter	13	8	20	19

There is substantial difference in the mean temperature ranges of the two regions and indicate significant temperature variations in summer and winter seasons which ultimately influence the composition and growth pattern of the vegetation. It also indicates difference in duration of hot season and mean temperatures of upstream Sukkur and downstream Kotri regions which gradually affects each component of Riverine ecosystem. The maximum temperature reaches to 50^0C upstream Sukkur, where as it seldom exceeds 40^0 C below Kotri.

Extreme temperatures for longer duration associated with low rainfall and humid conditions create dry conditions around upstream Sukkur riverine tract whereas moderate temperature, high humidity with relatively higher rainfall makes the climate moderately dry below Kotri (Keerio, 1990).

4.4.3 Effect of High Temperatures

The most common deleterious effects of high temperatures are the stimulation of the excessive respiration and the excessive loss of moisture (Kimmins, 1987). The effects of increased soil temperatures have significant influence on trees foliage of seedlings (regeneration areas) due to decreased soil moisture and the direct heat.

4.4.4 Effects of Low Temperatures

The ability of plants to withstand freezing temperature is a function of its genetic potential and environmental factors which tend to condition tissue for cold treatment (Steponkus, 1981). Babul, the predominant tree species of riverine forests is a frost tender species. Large areas of young seedlings in the newly regenerated sites in the forests and farmlands are damaged or even killed due to injuries caused by persistent frost bites. The damage is at times so severe that younger plantations of Babul die back to the ground (Sirhindi and Keerio, 1985). Late frost is also common in the upper region of Sindh. Frost is not of common occurrence below Kotri due to proximity of the Arabian Sea.

4.4.5 Humidity and Wind

Humidity and the wind are two important components of climate. Any change in the humidity ranges and wind velocity and directions, has influence over climatic pattern of that region. These two important factors also play a significant role in defining the climate of two ecological zones of Sindh. Average humidity is about 21 per cent in upstream parts of Sindh whereas it is far higher around 54% downstream Kotri.

There is also significant difference in the climate of two ecological zones due to wind direction and velocity. In lower Sindh fast humid winds blow almost all time from May to September. It is entirely insignificant as upper Sindh ecological zone is less humid and wind velocity is low and constantly normal. These two important factors of climate humidity and wind velocity and direction play significant role in the composition of flora and fauna on these two distinct ecological zones

As to their impact on tree growth and its establishment, these two aspects have great influence of their own as well as collectively and interactively. The interaction of humidity and wind with the rainfall and temperature constitute the climatic pattern of the two zones varying in every constituent aspect. There is also unmarked influence they impart on vegetation. One positive impact observed

during the study was that the trees in height are taller and in girth sizeable and straight in the upstream ecological belt than that of trees found in down stream ecological belt.

4.5 Water Distribution Issues and Impact on Riverine Forests

4.5.1 Construction of Barrages and Dams on Indus

The main source of water for the sustenance of riverine forests of Sindh is entirely dependent on summer inundations in Indus River. The extent of river water volumes, frequencies and occurrences of floods determines the water regime required for regeneration, enrichment and growth of vegetation and related components of riverine ecosystem. Riverine forests are fast deteriorating after the construction of upstream reservoirs that have significantly reduced the intensity, extent, and frequency of annual flooding. Diversions on Indus River due to the installation of canals and link canals have further worsened the on spot situation.

Due to continuous receipt of low/no floods coupled with prolong droughts since last decade, most of the riverine forests have not been inundated. With the result that most of the original forest sites are now devoid of vegetation. The existing conditions will further deteriorate when new dams and barrages will be constructed as is anticipated. It is predicted that only about 20 per cent of the original forest area will get sufficient inundations for its sustenance. At present as much as 50 per cent of the original 0.238 mil ha of riverine forests has degenerated beyond the level of economic viability (ADB. 1988). The diversion of water into canal irrigation systems for agricultural purposes, have, further exacerbated the situation in the riverine forests. Due to excessive colonization brining more land under the plough, large quantities of the water is used for agricultural purpose and it has made it impossible to achieve the original Afforestation plan objective. The future development programmes of improving the depleted riverine forests is now entirely dependent on one specific need of availability of inundation water periodically for sustaining the vegetation of degraded forestlands. Assured water supplies for the riverine forests will only suffice for future viability and tentatively of tree growth in the lower Indus Basin. A separate share of water for the lifelong need of these forests has to be earmarked and given priority to save the entire riverine ecosystem and tree growth in particular.

4.5.2 Water Accord 1991

Apportionment of Indus water among the provinces has been made amongst the provinces with the implementation of Water Accord 1991. Indus water accord lay out the share of water apportioned for the both Kharif and Rabi season as under:

Table 10: Water Apportionment

	Kharif		**Rabi**		**Sub-Total**	
Province	MAF	Mil Ha meters	MAF	Mil Ha meters	MAF	Mil Ha meters
Punjab	30.07	3.73	19.87	2.46	49.94	6.19
Sindh	33.94	4.20	14.82	1.84	48.76	6.04
NWFP	5.28	0.65	3.5	0.43	8.78	1.09
Balochistan	2.85	0.35	1.02	0.13	3.87	0.48
Total Allocation	**77.34**	**8.94**	**37.01**	**4.86**	**114.35**	**13.79**

Source: Water Accord 1991

Distribution of flood supplies and future storage in percent is as under:

Punjab	37 %
Sindh	37 %
Balochistan	12 %
NWFP	14 %
Total	**100%**

Water apportionment for Sindh is on the basis of following needs and prerequisites:

- Fair amount of quantities of water for urban and industrial uses during the year around;
- The need for other storage facilities on the Indus and other rivers was admitted and recognized (including proposed Kalabagh dam);
- The need for a certain minimum escapage to sea, below Kotri to check sea intrusion was recognized;
- Sindh's view of optimum requirement of 10 MAF was discussed and it was decided to conduct further studies to establish downstream needs;
- The system-wise allocation will be worked out on a 10 daily basis and record of actual average system used for the period 1977-82 would form the guideline basis for developing future regulation pattern;
- The requirements of LBOD will be met out of the flood supplies in accordance with the agreed sharing formula;
- Indus River System Authority would be established to implement the accord with representation from all the provinces.

This water accord has not fulfilled the requirements of water for the province of Sindh and quantity of water rather reduced every year particularly the situation worsens in drought years of low flooding (1998 to 2002). It has adversely affected the entire province particularly the riverine tract which has only chance of survival dependent on adequate water supplies. It has been recorded fact that Sindh is getting less water than the water share apportioned under water accord 1991. This can amply be ascertained from the records taken after the implementation of water accord.

4.5.3 Impacts of Reduced Water on the Natural Resources of Sindh

If less than optimum water supplies and frequent drought conditions remain intact, IUCN -P (2004) have observed and reported as follows:

- Due to scarcity of freshwater the riverine forests, irrigated plantations, mangrove forests and wildlife have been adversely impacted.
- Biodiversity has been lost which has reached at the verge of extinction of some flora and fauna Such as *Populous uephratica, Tamarix aphylla,* Hog deer, Pala fish, etc.
- The farming community located at the tail of irrigation network is becoming significantly impoverished due to water scarcity.
- Migration is in process due to perpetual shortage and irregularity of water supply.
- Widespread environmental degradation has taken place both In terrestrial and aquatic ecosystems resulting in decline in resources on which people are dependent for their livelihood.

4.5.4 Reduced Floods

Prior to 1932, Province of Sindh used to receive/gain additional land area by silting process in delta and formulation of deltaic land pushing Arabian Sea backwards. After construction of Sukkur barrage, gaining of additional area almost ceased as relatively less water reached the sea due to sprawl of flood water in Kacho area and its diversion into canals. After construction of water reservoirs and several other barrages, frequency of water was greatly hampered towards the deltaic region and it started taking back the reclaimed land through sea intrusion.

Climate changes also were brought in the Indus Basin and country experienced more droughts, than before. Population explosion, law and order situation, tribal feuds, un-employment and political disorder exacerbated the illegal tree cutting and encroachment of forestlands by influential local people and unscrupulous persons.

Indus Delta has been significantly affected due to freshwater shortages below Kotri, reduction in flows during flood period and reduction in silt and nutrient flows. The primary effects of reduced water supplies cause salt water intrusion, changes in geomorphology of the delta and changes in nutrient balance of the ecosystem (IUCN, 1991).

4.5.5 Droughts

Dry and wet yearly cycles are a common feature of the climate but the province of Sindh has experienced severe drought conditions from the year 1997 to 2003. The main factor responsible for this situation was no floods occurrence due to low precipitation in catchments areas. The flood occurrence at Guddu, Sukkur and Kotri and extent of inundation in Riverine tract during the drought period are shown as under:

Table 11: Extent of Inundations and Occurrences (1997-2004)

Category	Extent of Inundation	No of Occurrences at		
		Guddu	Sukkur	Kotri
Normal	Only low lying areas above Sukkur	7	6	1
Low	20%	3	2	0
Medium	40%	2	1	0
High	75%	0	0	0
Super	Above 75%	0	0	0

This data reveals that in last seven years, the Indus flow never exceeded beyond medium flood except at Guddu, whereas, there were no medium floods at Sukkur. At Kotri even low and medium floods did not occur and water never spilled out of river banks during these seven years.

Impacts

A study was carried by Sindh Forest department to assess the damage caused by this long persistent drought in Riverine forests. The parameters of the study were existing stock and annual regeneration stocks. The extent of damage upstream Sukkur and down stream Kotri was recorded to the extent shown below:

Table 12: Extent of Damage to Existing Growth of Riverine Forests

Severity of Damage	Upstream Sukkur	Downstream Kotri
Total Area	48,452 ha	56,011 ha
Area under tree cover	26,825 ha	7,805 ha
Severe damage	51%	29%
Partial damage	34%	58%

4.5.6 Setback in the Execution of Regeneration Operations

The long persistent drought conditions also accounted for failure to undertake regeneration/reforestation programs as per management plans in the riverine forest areas as under:

Table 13: Area Regenerated and Survival During Drought Period (1997-2004)

Area	Upstream Sukkur	Downstream Kotri
Area planned for regeneration	24,932 ha	15,635 ha
Area regenerated	13,200 ha	571 ha
Survival %	39%	10%

This whole scenario reveals that during the long drought period, there was a significant damage to the existing tree growth and failure to achieve annual regeneration plan targets. It was extremely alarming position in the forests downstream Kotri, where only one normal flood was received in seven years and large area was damaged and only 10 percent of regenerated area survived.

4.5.7 Government Policies

The Riverine Forests have also suffered immensely on account of the policies of the incumbent government and at the altar of these policies; great losses were caused to the principles which regulate the scientific management of the riverine forests.

4.5.8 Illegal Allotments by the Revenue Department

Revenue department has made several allotments of forest areas to local people under land grant policy. Recently, expert allotments of forest lands have been made by the Revenue Department to local people. Even such lands have been allotted which were in possession of the Forest Department for decades where well established growth existed and from where Forest Department has harvested its tree growth for more than two rotation cycles of 25 years each. This illegal action of the Revenue Department has encouraged many private parties to occupy the forest lands and has provided a tremendous setback to the riverine ecosystem. As reported by Sindh Forest department, more than 10,000 ha of forestland have been allotted to the local people by the Revenue Department.

4.5.9 Reorganization of Forest Department

In the year 1973-74, the administrative set up of the Forest Department was reorganized from territorial to functional and two separate wings were created. The sale of standing tree growth to the forest contractors for regular felling operations were abolished and the department itself started functioning by carrying the regular felling operations in order to check the high handedness and illegal cutting of the forests by the unscrupulous contractors. All operations required before and after harvesting were assigned to the officials working in functional group after reorganization of department. Forest material after cutting into required sizes was transported to depot through

labor, where it was stacked and sold in open auction to the purchasers instead of auction of standing trees to the contractors.

The Department was thus bifurcated into two different wings i.e. Afforestation and utilization wings. The existing divisions were reorganized and areas increased largely to two fold, only to be managed by the same field staff with of course lesser responsibilities. The department suffered adversely as the protection of the vast number of forests by almost the same staff of original division resulted in poor performance and inadequate protection of the forest areas.

After the ostensible success for initial couple of years, the very objective of departmental felling was defeated as the quantities of harvested material rarely exceeded from the estimated volume after the stock enumeration of felling coupes. In the initial 2-3 years, easily accessible areas with quality class timber whose yield were 20-25% higher were extracted without following proper working plan or approved felling programme of the department.

4.5.9.1 Adverse or Negative Impact of Re-organization on Riverine Forests

In order to justify new system of departmental working of harvesting the trees, large areas were proposed for exploitation to achieve increases in the annual revenue targets without any consideration to the working plan prescriptions and scientific management. The areas with better Babul growth, and easily accessible were cut in order to show large gains and prove usefulness of the new system. Due to these actions vast blank areas were created due to large scale harvesting. Because of inadequate and erratic flooding and non availability of funds the regeneration programmes could not keep pace with the excessive harvestings resulted in creation of large blank chunks inside the riverine forests.

This was the time when the local people generally and politician particularly raised voices against the working of the department and proposed that the vast blank areas inside the forests be brought under food crops and agriculture in order to meet the ever increasing demands of rising population.

The policy of the Forest Department to change over to work on a functional basis created several problems and brought criticisms from all over (where). This problem was not foreseen in proper perspective while taking decisions and it emerges as one of the main causes of degeneration of riverine ecosystem and the forestry cover in Sindh. Babul and Kandi, which are the dominant tree species have been adversely affected beyond repairs after the departmental working on functional basis continued for several years without any considerations of annual possibilities of forests and other working plan prescriptions.

4.5.9.2 Supply of Babul Timber for Railway Sleepers to Pakistan Railways and Cross Arms to WAPDA

During this organizational setup, Sindh Forest Department took another decision of supplying railway sleepers and cross arms to Pakistan Railways and WAPDA, respectively. In order to meet their demand large size specially selected Babul trees were felled from the riverine forests without following the working plan prescriptions. This decision of the department produced negative impact on the riverine forests of Sindh particularly such areas that were near the towns and accessible through roads.

Impact

The ultimate negative impact on the riverine ecosystem took place where large size trees were selectively cut leaving behind sparse and inferior tree growth. This action was although for a brief period but it shook the structure of the riverine ecosystem.

4.5.9.3 Self Financing System in Forest Department

Self financing system was actually a follow up action of the reorganization of the department. The case was vigorously moved by the Forest Department and was approved by the legislature of Sindh (date). The main objectives of this system were to provide freedom of investment in forestry business on commercial lines, help expand the utilization of forest lands to their full productivity, follow the prescription of working plans, and implement afforestation plans by the forest department without looking for funds to the other agencies. The whole idea was to plough back the earnings for forestry development.

In order to implement this system Rs. 5.45 million as an interest free loan, repayable within one year, was obtained from the Finance Department of Government of Sindh with a working capital of Rs. 15.77 million as under:

i.	Government loan	Rs. 5.45 million
ii.	Outstanding (recoverable revenues)	Rs. 8.89 million
iii.	Inventory stock (felled timber)	Rs. 1.44 million

The system functioned well and the Forest Department repaid the loan to the Finance Department from its first year's proceeds. The Finance Department earmarked another loan of Rs. 1.36 million and Rs. 4.34 million for the years 1980 and 1981, but the Forest department did not draw these loans, because it was able to manage its finances from first year's savings. By working on these lines for five years the forestry department had built up a cash reserve of Rs. 72.065 million. During this period of time the department prepared plans for re-ploughing these funds for reforestation and development of forestry resource. But unfortunately these plans were not cleared by the provincial Planning & Development Department and Finance Departments as it reduced their authority and remitted the savings of Forest Department in government treasury. Hence the trouble started.

Impact

Originally it was envisaged that the Forest Department will be given free hand by the Finance Department to recycle the revenue for expanding forestry base in the province. But due to Finance Department's non-cooperation, the cash reserves built up by the Forest Department were held up. Hence, the Forest Department was facing same problems of deficit funding and involvement of other agencies at every step. Therefore, the desired results could not be achieved.

The failure of this system also added to the degradation of forestry resource in different ways such as over exploitation, inadequate funding for reforestation, non recruitment of additional staff for utilization wing, increase in blank areas, etc. It was a great setback to the growth and development of riverine forests.

4.6 Mismanagement of NR during Coalition and Weak Governments

Mismanagement of forests including illicit cutting, encroachments etc. have been rampant during coalition government rule that followed Army control of the government. This has been significant from the years 1985 to 1988 and from 2000 to this day. Forests in general and riverine forests in particular have been put to great set back during this period.

4.6.1 Forest Lease Policies

Another setback received by the forestry resource, was that of changing polices regarding leases for agricultural purposes in the forest areas. This has become a political problem rather than an administrative. Due to land hunger for agricultural purposes and the fertile forest lands, there has been pressure from influential people for cultivation of agricultural crops on much relaxed terms

during the last two decades. There have been many changes in the government policies on forest leases for cultivation dictated by the influential persons and politicians. How these changes have affected the tree resources in Sindh forests and what changes in policies from time to time have been brought about in the system is analyzed below:

4.6.1.1 Policy prior to 1975

Prior to 1975, the problematic forest areas (high lying and undulating) were leased out for a period of 3-5 years for development and cultivation purposes to local small farmers who abided with terms and conditions of the agreement. Blank and problematic forest lands were leased out on the lines of *Taungya system*, where the purpose of leasing was to develop forestlands for raising forests without any financial burden on the exchequer. The lease holder had to develop the forestland, arrange irrigation water and raise seasonal crops during lease period. The farmer was obliged to raise and nurture Babul tree line at a spacing of 33' on completion of one year of lease period. He was also obliged by the agreement to pay the lease money to the Forest Department. Concerned Forest Officers were supposed to inspect the lease area and verify that lease holder had raised and protected tree lines, had not made excess cultivation or damaged adjoining tree growth, paid annual lease money and not breached any clause of agreement. They were penalized heavily and sometimes their leases were terminated in addition to imposition of penalties and fines and forfeiture of the standing crops.

Impact

This system was viable and profitable for the department as many difficult areas were regenerated through this system without any expenses on land development. With passage of time, the increasing costs of land development and fuel for lifting water coupled with land hunger, small lease holders were unable to perform the development works and in their place influential people with ulterior motives misused the system and the department had to move the government of the day to put a ban on forestland leases.

4.6.1.2 1979 Policy

Looking to the benefits derived from the lease policy and ban on leasing, Forest Department introduced a new system with the nomenclature of Co-Worker system. In this system, the term of agreement was just and well suited for the benefit of the co-workers. Coworkers were the partners in inputs as well as the share of the produce instead of paying of lease money. He had to develop the land and cultivate crops with tree lines. The inputs on seed, fertilizer and pesticides were initially arranged by the coworker, which were later on shared by the department from sell proceeds after harvesting the crops. After deduction of expenditure, the profit was shared by the co-worker and the department on 70-30, bases respectively. On expiry of the lease the land was available to the forest department for raising tree crops with its own expenses as most of the coworker did not grow the tree lines as per agreement. This system was altogether different than the original system of forest leases and was in favour of the co-worker. The Forest Department was looser in a sense that the land was given for only agriculture rather improving the forestry resource.

Impact

The department did not gain much from this system, but got lands reclaimed and developed in few forest areas besides earning small in revenues.

4.6.1.3 1983 Policy

According to this policy, the forestland was to be allotted to the lessee for at least 6 years. For the first two yeas, the lessee was to develop the land and cultivate without giving any share of the produce or lease money to the Forest Department. From the third year and onwards, he was

supposed to pay Rs. 150 per acre per year to the department. Under this system the lessee was not bound to raise trees lines. This system was purely designed for the benefit of the people and Forest Department had no effective control on the lessee. Fortunately this policy did not continue for longer than 3 years as such the adverse affects were insignificant.

4.6.1.4 Lease Policy 1991

Under this policy, forestlands were granted to the lease holders for raising agriculture crops only from the approved lease-areas schedule in the riverine forests and irrigated plantations. There was no consideration of raising any forest trees in this policy. The lease holders were generally influential and land grabbers and did not fulfill the lease conditions and applied political influence got the lease of their choice outside approved schedule. These areas were in fact required by the Forest Department for their phased developing works to improve the productivity of the respective areas. This policy did not last long and Sindh Forest Department approached the Government of the day for imposition ban on leases of forestland. All these leases granted outside approved schedule were cancelled and ban was imposed for further leasing of land even from the approved schedule of lease of forestlands.

Impact

Lessees went into litigation by filing civil suits and completed their lease period without giving any lease money. The impact of this policy on the overall development in the riverine forests was detrimental and further degraded the riverine ecosystem.

4.6.1.5 Agroforestry Lease Policy - 2004

Immediately after termination of the government, several unscrupulous people started encroaching upon forestlands in the province. All the encroachments were retrieved and regained during army rule from 1999 to 2001, but it did not last long and any one with little influence could cut the trees, and cultivate the land by installing tube wells without paying any compensation or lease money. Easily accessible forested areas were cut and brought under cultivation illegally by forceful land grabbers.

To regularize these forcible encroachments, the government of the time notified a new policy titled “Agroforestry Policy 2004”. The salient features of this policy are as under:

The Government earmarked an area of 53,200 ha for leasing and approved an “Agroforestry Schedule 2004”. Under this policy, the land is granted for a period of five years extendable for another 5 years in the riverine and irrigated forest areas with a condition that lease holder shall bring 25% of the leased land under block plantation within first 12 months of the lease. On the rest of the leased area the lease holder is allowed to raise any agricultural crop. All the expenditure on land development, irrigation, rising of agricultural and forest crops and their maintenance is to be borne by the lease holder. The maximum land for a lease to a person is fixed as 16 ha..

Impact

Although it is quite early to comment on the success of this lease policy but there are clear indications of its failure that after two years of implementation of this policy, only 16,000 ha could be leased out. The remaining encroached area is still in the adverse possession of the land grabber and none of the lease holder has so far raised block plantation in leased area.

It is apprehended that like the previous policies, this policy instead of improving the tree growth in the riverine forests will aggravate the existing degraded action of ecosystem with further loss of productivity. The influential people will get extension of their lease period and will not vacate forestlands under any circumstance.

4.7 Edaphic Factors and Their Impact on Riverine Forests

Fire

Tree growth is not a fire-resistant and is often burnt by fire. Forest fires are common in areas which have luxuriant growth of grasses. It is sometimes started by villagers to promote fresh grasses which sprout when dry and coarse grass is burnt. Fires are also caused by people collecting honey (Sheikh, 1989). Since the adjoining lands have been converted into agricultural fields, the grazing pressure on remaining forestlands has increased

Soil

Another factor affecting the growth and establishment of trees in riverine forests is the degradation of soil. Due to climatic and socio economic factors the productive capacity of some of the soils has been degenerated gradually affecting the reforestation and management practices in the riverine forests.

4.7.1 Socioeconomic Factors and their Impact on Riverine Forests

The people of Sindh adopted traditional way of life which have mixed approaches with good or bad habit and peculiar notions on the use and management of natural resources. People can join together and play positive role in unity to safeguard the existing natural resources including forests and vegetation cover but due to ever increasing population, need for cultivating lands for food crops, firewood, grasses and other socioeconomic obligations do not allow the people to play the proper role and protect and preserve the forestlands for better future and favourable environment. Forestry resource has significantly been affected due to the above mentioned socioeconomic needs and related problems. Socioeconomic factors have direct influence on the growth and establishment of forest resource. It is further elaborated in the next part of this treatise.

4.7.1.1 Population Growth and Distribution

Disproportionate population growth and distribution is the root cause of these social problems. It affects the natural resources directly as well as indirectly. The data presented in chapter 4 indicate that the province of Sindh is the most thickly populated province of Pakistan with an average of 135 people per sq. km as compared to 106 of the whole country. The increase in population growth is 2.8 to 3 per cent per year. For the increasing population the demand for meeting the immediate daily requirements of food, water, shelter, etc. is also increasing rapidly as the time passes. On the other hand the resources to meet the increasing demands are either static or decreasing resulting in widening of the gap between demand and supply.

After agriculture, the forestry is the resource which has been greatly affected either directly or indirectly by the increasing population in Sindh (Anon, 1987). People's immediate demand for constructional timber, fuel wood, and other forest-based products are increasing with increase in population but the area under tree growth and the productivity of the lands producing trees is decreasing fast (Sirhindi and Keerio, 1985) hence, there is tremendous pressure on the existing meager tree resource.

It is not only the increase in population but also its distribution in the region that adversely affects the tree resource. Data indicate that the central plain where riverine forests are located is thickly populated. This distribution of population exerts a lot of pressure on the tree resource for fuel wood and other demands.

In the riverine tract upstream Sukkur there are several villages and towns of which only 20 percent are electrified so far and less than 5 percent use fossil fuels for cooking and heating. The rest of the villages depend upon fuel wood for cooking and heating. Hence, the forest areas are under pressure for collection of fuel wood and timber for domestic use. The damage is caused to the

trees by cutting, lopping, and girdling. Babul and Kandi are the species which are most affected by these activities of increasing population.

4.7.2 Land Hunger

This factor is also an outcome of the population pressure in a given area. For the increasing population there is increasing requirement of food security. The food producing areas are not only static but are lost further to urbanization and shortage of irrigation supplies and moisture. Besides, its productivity is also decreasing due to overall degradation of the ecosystem and interaction of several factors. This situation has resulted in land hunger for agricultural purposes in the shape of encroachments on the tree producing areas particularly forests and wastelands. Riverine lands are fertile and virgin and are suitable for crop production. According to an estimate, over 16,000 ha of forest lands are under encroachments which are equivalent to 15% of the productive forestlands. Besides, an area of 10,000 ha which forms 10 percent of the productive forestland has been illegally allotted by the Sindh Revenue department and is under litigation and civil suits are pending for the decision of title of the lands.

Impact

The above mentioned alarming situation has adverse impact on the growth and development of riverine forests. If this trend continues, the situation will aggravate to such limits that mitigation efforts of any magnitude will not bring back the productivity and reforestation of the highly degraded forest ecosystem beyond repairs.

4.7.3 Grazing Pressure on Riverine Forests

In the riverine forests the main occupation of the population is livestock rearing. People rear livestock to obtain milk, meat, wool and other products. Cattle also provide draught power for ploughing the fields and transportation of produce from farms to the markets. People of Sindh are fond of rearing these livestock animals. It is hard to find a household in riverine areas without at least 5-25 livestock. All the wooded areas are heavily surrounded by livestock populations viz. goats, cows, sheep, buffaloes, and camels. Babul and Kandi being a favourite fodder for browse animals specially goats and camel, it remains always under excessive use injurious for forest growth.

Table 14: Livestock Population of Sindh (in millions)

Animal Species	1984	1996
Cattle	4.088	5.404
Buffaloes	3.194	5.615
Sheep	3.068	3.710
Goats	7.196	9.734
Camel	0.224	0.225

Source: Livestock Census 1984 and 1996

It indicates that there has been sizeable increase in livestock numbers in the province. The goat and sheep are notoriously known to stunt growth and cause severe damage to the vegetation cover and are considered the enemies of any form of vegetation. The forestlands are surrounded by the domestic animals and exert much pressure on trees and seedlings growing in the newly regenerated sites. In the vicinity of forests people are dependent on the livestock that mainly graze in these forests.

Due to arid conditions the carrying capacity of the designated rangelands of Sindh is very low. Therefore, the people and livestock flocks from these areas migrate from arid rangelands and desert to wooded and cultivated areas in famine conditions. They exert further pressures on the Babul crop, especially young seedlings in the newly regenerated areas which are badly trampled and their growing terminal shoot is either torn or eaten away while grazing in the forestlands.

Impact

Grazing and browsing pressures on regeneration areas cause retardation of the growth of young seedlings when trampled and uprooted or the leading terminal shoot is chewed by the livestock movements. Indiscriminate lopping of *Babul* and *Kandi* cause deformation of trees and affects their growth process. Trampling of soil during livestock movements delays or stop seed to germinate despite the favourable conditions. Such seedlings hardly penetrate their tender roots in hard soil. Hence, grazing and browsing by the livestock in general and goat and camel in particular adversely affect and hinder the growth process and development of the principal tree species in riverine belts.

4.7.4 Population and Livestock Census of Keti Shah Riverine Forest

The village-wise data regarding number of households, their inhabitants and livestock number collected during the study is shown in the table below.

Table 15: Villages, Household and Human/Cattle Population Living in and around Keti Shah Forest

No	Name of Village	Total Houses	Total Population	Cattle Type		
				Buffalos	Cows	Goats
1	Bindi Khaderi	13	100	60	40	130
2	Khadheri	20	220	120	85	90
3	Jam Mahar	5	30	40	165	70
4	Sadh Mahar	25	160	-	60	-
5	Saaharo Indher	20	200	100	78	150
6	Mian Muhammad Indher	50	300	56	60	130
7	Madan Indher	20	150	50	130	-
8	Loung Malik	10	60	10	30	40
9	Budho Mahar	8	40	30	60	40
10	Illahi Bux Indhar	10	20	40	50	45
11	Meeran Indher	40	300	45	60	30
12	Khadim Mahar	5	50	50	60	30
13	Hussain Brohi	150	700	200	400	300
14	Idrees Indher	10	70	60	100	60
15	Iqbal Indher	20	100	200	60	130
16	Muhammad Issa Jatoi	1	20	40	10	125
17	Jaffar Jatoi	1	18	20	25	-
18	Sultan Jatoi	1	10	5	-	-
19	Jiand Jatoi	5	21	50	25	105
20	Ghulam Mahar	3	20	20	70	65
21	Ali Hassan Kalhoro	1	10	-	20	33
22	Jumo Mahar	2	20	20	35	55
23	Sajan Mangi	3	20	-	15	25
24	Hayat Mahar	2	17	-	25	38
25	Haji Fakir Mohd. Jatoi	1	100	50	65	56
26	Attaullah urf Kachi Jatoi	4	40	80	60	20
27	Muhammad Nawaz Jatoi	6	62	135	70	60
28	Abdul Majid Jatoi	3	35	150	100	60
29	Sher Jatoi	2	35	35	200	30
30	Ghaffar Jatoi	3	33	33	115	60
31	Sahwan Jatoi	5	60	130	103	25
32	Amir Bux Jatoi	3	53	55	103	120
33	Muhammad Jatoi	3	75	90	95	35
34	Mansoor Bux Jatoi	6	75	40	165	105
35	Sukhwan Jatoi	3	88	43	153	30
36	Muhammad Usman Jatoi	5	71	140	123	-

37	Laloo Khan Jatoi	4	35	163	200	120
38	Riaz Bhatting	50	500	135	100	250
39	Suleman Dodo	30	200	20	150	30
40	Amir Bux Dodo	10	100	35	160	-
41	Beg Daryoon	3	20	25	50	-
42	Shah Jatoi	5	60	130	125	75
43	Laiq Mangi	5	40	25	60	-
	Total	**576**	**4338**	**2730**	**3860**	**2,757**

4.7.5 Population and Livestock Census of Kathore Riverine Forest

The village-wise data of household number, population and livestock census collected during study is given as under:

Table 16: Villages, Household and Human/Cattle Population Downstream Kotri

No.	Name of Village	Total Houses	Total Population	Kind of Cattle		
				Buffalos	Cows	Goats
1	Darwesh Goth	225	1500	500	700	50
2	Shabu Khaskheli	12	95	30	65	15
3	Gaho Goth	30	250	10	15	7
4	Baran Goth	25	200	25	40	15
5	Abdullah Goth	6	50	4	6	-
6	Ladho Goth	20	145	12	20	8
7	Achar Jakhro	30	250	20	35	15
	Total	**348**	**2440**	**601**	**881**	**110**

From table 10 and 11 it is inferred that the most of the villages in Ketishah forest are small and comprising less than 10 house holds. They are temporary and are scattered within forest area, whereas, no village is located inside Kathore forest but are situated on its periphery and are comparatively large in size. The above data further reveals that the people per household in both the areas is almost the same (7 persons/household). In Keti Shah forest, the density of people, buffaloes, cows and goat is 0.6, 0.4, 0.5 and 0.4 per ha, whereas, in Kathore forest the density is 1.0, 0.2, 0.4 and 0.04 per ha respectively. This indicates that the density of human population is more in Kathore forest than in Keti Shah forest, where as the density of cattle and goat is thin in Kathore forest. The critical factors responsible for the degradation of Kathore forest are low/no inundation and human population. Easy accessibility and proximity to urban markets is also an important factor responsible for the degradation of this forest. The reason of less goat population in Kathore forest are cultural variations, intensive agriculture, and less bushy/browse area which is preferred by the goat.

4.7.6 Law and Order Situation in Riverine Forests

Wooded lands, especially the riverine forests have remained hideouts for the dacoits for decades. But this activity has gained momentum in the last decade to such an extent that not only the dacoits are using the wooded areas as their hideouts from the law enforcing agencies, but also abduction of innocent people for ransom has become a common practice. Even Forest Department personnel are not safe to move and perform duties freely in many areas. The situation is quite alarming in upper Sindh than that of lower Sindh. It has created several problems for the functionaries of the Forest Department and other departments concerning with law and order maintenance. The management operations in the riverine forests have been hampered to great extent. On the other hand due to the ineffectiveness of the forest personnel in some forests, the cases of unauthorized encroachments, cutting of trees and theft of wood have become common and uncontrollable which has played havoc with the protection of wooded area of riverine forests.

Impact

Since protection personnel are unable to visit and safeguard riverine forests, trees are being ruthlessly cut and forestlands are cleared for cultivations. In such circumstances it is difficult to maintain and protect the forestlands of riverine ecosystem.

4.7.7 Illiteracy

The literacy rate in Sindh province above the age of 10 years is 45% which is low and it is mainly the root cause of several social and economic evils. Literacy rate in the areas under study upstream Sukkur and downstream Kotri is almost of same standard/level. This factor has many direct and indirect effects on the existing wooded areas and their future developments. Due to illiteracy people do not understand the importance of trees and commit offences of cutting, grazing, encroachments etc. for their meager monetary benefits. Other effects of illiteracy on the trees are as follows:

- People are unable to understand the new technologies and modern techniques regarding selection, site preparation, planting, aftercare and marketing of trees. Hence, illiteracy is a barrier in implementing the forestry extension programs.

- Due to language barriers in understanding new technologies, the people's participation in tree planting activities is minimal.

- People cannot read, write, understand and practice the extension material, Hence their turn out in training programs is minimum.

- Due to cultural resistance and rigid religious beliefs, the people do not normally allow their women to participate in agroforestry practices and other tree planting activities with the result that a local labor force can not be fully employed on forestry related works (Keerio 1990).

4.7.8 Socio CulturalTaboos

People of Sindh have strong beliefs in local customs concerning marriages, ceremonies, cultural fares near spiritual places, sports and other social gatherings and traditions which are integral part of their life. Children are regarded as blessings of God. Marriages are celebrated with great fanfare and birth of a son is regarded an occasion of great festivity. In times of better conditions erstwhile ago and when population was sparse, resources were plenty; people were congenial and law abiding and were more disciplined. All these traditions, customs and events of joy and sorrow were inexpensive and had no bearing on the natural resources and that was the time when viability of the riverine ecosystem was at its best. But things started getting bad to worse when population pressure coupled with range of poverty increased tremendously and essential commodity prices soar beyond the reach of common man.

Impact

These social factors have adverse effects on the growth and establishment of trees in riverine forests. The rising population pressure is the root cause of most of social evils affecting tree growth in riverine areas.

4.7.9 Other Miscellaneous Factors

4.7.9.1 Weeds

Due to the favourable moisture conditions in irrigated plantations and riverine forests, there is always dense growth of weeds. These weeds compete with the upcoming tree species for light,

water, nutrients, growing space, etc. Weeds are also a cause of fires in the riverine and irrigated forests.

4.7.9.2 Livestock

Livestock and domestic animals cause damage to the Babul trees while camels and goats cause serious damages. The goats climb right on the tops of smaller trees and destroy the crown and certain regeneration areas. Light grazing by sheep and cows has been beneficial for the removal of competing grasses (Sheikh. 1989).

4.7.9.3 Insects

Acacia nilotica has several inset enemies which attack its leaves and bore into the stems and roots. More important that are found in the study area are as follows:

4.7.9.4 Defoliators

Two major pests, *Euproctis lunata* and *E. subnotata* and minor pest *Tephrina disputaria* occur in the Babul forest areas of upper and lower Sindh respectively (Sheikh, 1989). These pests cause occasional defoliation in the forests. Hamid (1966) recorded bagworm (*Clania crameri*) feeding on Babul trees in Karachi district. *Diacrisia oblique* was found for first time feeding on the Babul trees. Hamid (1966) also reported beetles of *Sternocera chrysis, S. leavigata* and *S. orientalis* feeding on the foliage in the study area.

4.7.9.5 Borers

Sibixylon anale and *Lyctus africanus* are important sapwood borers known as powder post beetles. They attack logs, branch wood and stumps of felled trees in the forest and reduce the sapwood into powder. The adult beetles sometimes bore in to green shoots and twigs for feeding or hibernation, making axial tunnels, and as a result the leading shoots of seedlings and young saplings are girdled or killed (Beeson, 1941).

Celosterna scabrator is a notorious pest of Babul. Its grubs bore into the roots and beetles gnaw the bark of young branches. *Sphenoptera beesoniana* feeds on dead shoots and roots of young plants.

4.7.9.6 Suckers

Ahmad (1970 recorded leaf hopper, *E. garhiensis* on Babul in northern areas of Sindh. Beeson (1941) found *Anomalocuscus indicus,* a dome shaped insect and *Oxyrachis tarandus***,** a tree hopper sucking cell sap from leaves, buds and soft twigs.

4.7.9.7 Diseases

Several fungi cause damage to leaves, trunks and roots of riverine species.

The discussion of the biotic factors reveals that except man and livestock, all the other factors have very little impact on the tree growth and survival.

CHAPTER 5

COMPARISON OF FORESTS SELECTED IN UPSTREAM SUKKUR AND DOWNSTREAM KOTRI RIVERINE ECOSYSTEMS

Underlying objective of this study is to undertake comparison of two representatively selected forests one each located in upstream Sukkur and downstream Kotri ecosystems. Keti Shah represents a model forest site in the upper Sindh, whereas Kathore forest in lower Sindh. Indus River traverses hundreds of miles from Keti Shah to Kathore forest. The choice of selection is based on in depth scrutiny of the causes of degeneration and various factors responsible along the long stretch of riverine tract. The consultants have designed this study after collecting important data and details about different characteristics and features including climate, availability of water, demographic descriptions, etc. Detailed site inspections and personal interviews with all the stakeholders and workshops on important forestry and ecological aspects were also conducted. Ways and means were discussed about the restoration of the depleting riverine forests and other natural resources. Detailed consultations were also held with forestry department's functionaries from higher level to field staff and persons who have experience of living in the vicinity of forests.

5.1 Keti Shah Riverine Forest

5.1.1 Location and Extent of Area

Keti Shah riverine forest also commonly known as Shahbelo extends over an area of 7,257 ha . It is located near the twin towns of Sukkur and Rohri in north-west direction. It was declared as a reserved forest vide Gazette Notification dated 13.8.1912 and 17.7.1913 during the British rule when Sindh was a distant part of Bombay Presidency.

5.1.2 Topographic and Physical Features

Keti Shah Forest has been bifurcated a long time ago by the Indus River which now flows through this forest. There is a by-river and ten depressions locally known as *dhoras/dhands* and these get inundated during the flood season. Due to meandering nature of river, erosion and accretion take place during or after the floods and vulnerable areas are eaten up and eroded from one side and deposited on opposite side. The soil of newly established kacho is sandy which turns loamy when kacho stabilizes. The riverine area is generally grouped in to three category areas low-lying category comprise such low areas which get fully inundated during normal flood season whereas, medium category area get fair amount of water in normal 'abkalani' periods. Areas which are high lying get little or no inundation supplies from the river spell during floods.

5.1.3 Accessibility

There is no direct road access to this forest without crossing main river, by-river or *dhoras*. These peculiar features of the forest have made its accessibility difficult and time consuming. Since there is no regular direct path or way of reaching Keti Shah Forest, number of routes are used by the people to reach the forest.

i) From Rohri town sailing on boat against river current crossing main and by-river

ii) From Sukkur to Panhwary village situated in North of Keti Shah forest and then by crossing the by-river.

iii) From Sukkur to Bindi Dhareja forest while traveling on earthen flood protection embankment and then by crossing the main river.

iv) By traveling on flood protection earthen embankment from Sukkur to Kadrapur riverine forest and then crossing two depressions by boat (from December to April the depressions are devoid of water and one can reach by land route).

5.1.4 Composition and Density of Vegetation

Approximately, 25% area of the forest contains no growth and is either under sand bars or water bodies (river, by-river and depression in about 520 ha). The remaining ¾th forest area, is under tree cover of different ages and densities.

Since Keti Shah Forest receives frequent inundations, it largely contains tree growth of *Acacia nilotica*. In depressions and low lying areas having better moisture regime, *Tamarix dioca* and variety of shrubs, grasses and small growth is found. In high lying areas, *Prosopis cineraria* and on much higher areas, xerophytic species such as *Salvodora oleodis, Salvadora persica,* and *Capparis ∅ eciduas* are found. Old working plans of earlier part of the last century contain information that riverine forests of upper Sindh beyond Nawabshah were dominated by *Prosopis cineraria*. Due to severe frosts, *Acacia nilotica* was found along river course and depression. However, due to climatic change, frosts occurrence are no more common in upper Sindh and *Acacia nilotica* grows in all such areas along the river where moisture is available substantially.

5.1.5 Inundation Status

Keti Shah riverine forest is located 5 km upstream Sukkur Barrage. The structure of the Barrage causes obstruction while diverting required water to canals; upstream riverine forests up to about 48 km are inundated to varying depths even in medium inundation. As Keti Shah forest is located near Sukkur barrage, it is inundated to the extent of 30% with the availability of 9,000 cubic meter of water, 80% at 15,000 cubic meter of water and almost 100% at 21,000 cubic meter water upstream Sukkur. In medium and high floods, it remains under water for 3 months. During high floods, the people, livestock and wildlife shift to higher locations. Some of the inhabitants have raised their living huts with tractors and other means where they shift along with their cattle in times of super floods (water discharge below Sukkur barrage is 1.0 million cusec.)

Image 7 & 8: Riverine Forest Inundations

5.1.6 Adjoining Forests

Keti shah forest is surrounded by Ding, Bindi Dhareja, Qadrapur and Panhwari riverine forests spread over 665, 2,905, 848, and 201 ha respectively. They form a single ecosystem of about 30, 000 acres conjointly.

5.1.7 Habitations, Villages and Tribes

There are no permanent villages within Keti Shah Forest, but there are several scattered temporary hutments where graziers and squatters reside. In the outskirt of this forest, permanent

villages of Deda-Damia, Eddan Bhattar, Hussain Belli, Sadh, Khadwari, Bhara and Gulu Indhar are located. People living within Keti Shah Forest mostly belong to Jatoi and its sub-tribes, whereas tribes living in permanent villages are Bhara, Deeda, Damia, Indher, Machi, Dhareja and Mahar.

5.1.8 Illegal Cultivations / Encroachments

There are no major illegal cultivations found in this forest. However, inhabitants grow wheat, gram and peas on residual moisture after receding of floods over small patches of about 2.0 ha around their hutments. Total area under these scattered cultivations has been noted less than 120 ha. The main reasons for limited cultivations are sparse population, difficult transport facilities and market accessibility, worst law and order situation, tribal feuds, frequent inundations comparatively for longer period and less availability of land for cultivation.

5.1.9 Illegal Wood Cutting

Like illegal cultivations, Illegal tree cutting is not a cause of concern in Keti Shah Forest mainly due to difficult access, adverse law and order situation and thin population. However, people residing in and around the forest meet their domestic needs of fuel wood and thatching material from this forest. Boats used for communication also collect fuel wood as and when needed by the fisherman/boatman.

5.1.10 Law and Order Situation

Keti Shah Forest used to be a peaceful area until 2000. Problems emerged due to migration of dacoits from other areas after being chased by the law enforcing agencies. Keti Shah Forest being an ideal hideout for criminals due to difficult access, thick vegetation and peculiar physical features became a hub of the criminals. A large scale operation by law enforcing agencies was carried out in the year 2004. To locate the dacoits, force was applied, use of ammunition was undertaken, forest areas were burnt and fresh growth was cleared. These operations disturbed the overall ecosystem of this forest.

5.2.1 Management and Objectives

The standard management unit of the riverine forest is a compartment which measures 64 ha (0.8 sq km). Keti Shah Forest is divided into 105 compartments whose number and area keep changing due to erosion and accretion. This forest comes in the jurisdiction of Sukkur civil district and is in the charge of Divisional Forest Officer Afforestation Division, Sukkur,

For administrative purposes, management, protection and overall supervision. Range Forest Officer Rohri assists the DFO for these purposes. As against the sanction strength of two Foresters and 4 Forest Guards, only two forest guards are looking after the protection and other duties in this forest.

Since its declaration as reserved forest, Keti Shah Forest is managed for wood production as per prescription of management plans. It is one of the most productive forests of the province mainly due to, better protection, difficult access and better moisture contents in the whole tract and adequate water regime which gives ample chance to the forest staff working here to undertake regeneration of babul alone and mixed with *Prosopis cineraria* in high lying portions of forest.

5.2.1 Ecological Degradation of Keti Shah Forest

There is no significant ecological degradation of Keti Shah Forest, as this forest receives regular inundation except during long drought period of 1997 to 2005. In 1973, Sindh province experienced a devastating super flood, when Indus River changed its course and deposited huge quantity of sand over an area of 1200 ha in this forest, which became high lying and does not receive regular and proper flooding for regeneration and soil improvement.

The land-use of Keti Shah is for raising of forests and there is no threat of encroachments for agriculture or permanent settlement due to regular flooding. One species that is missing is *Populus euphratica* where it not found in sufficient area although the process of formation of new soil (kacho) an ideal habitat for its growth is still continuing. This can be attributed to long spell of drought from 1997 to 2005. Local grazers reside in temporary thatched hutments locally called *Bhans* and keep shifting in forest for feeding grass to their cattle.

5.2.2 Inefficient Management

Inefficiency on the part of the field staff and the supervisors is quite evident from the fact that the low density stocking of tree crop is seen on the fertile and ideal lands of Keti Shah Forest which generally gets proper inundation during flood every year. Instead of large wooded area it contains smaller growth of thin stocking and wide blanks with mat of grasses due to frequent trampling by the cattle. Since 1994, no harvesting of wood has been carried out in this forest which adversely affected the viability and management of the forest. The mismanagement and inefficient protection and control of forest are mainly due to understaffing of Forest Guards and block in-charge Foresters. The development and production of fishery in this forest remains under worked / utilized and there is great potential for its improvement.

5.2.3 Biodiversity

Keti Shah Forest is still rich from biodiversity perspective as all the components of biotic life such as trees, shrubs, herbs, wildlife, fish, Indus dolphin and livestock are found in this forest. However, drought conditions and various socioeconomic pressures have affected the biodiversity.

5.3 Kathore Riverine Forest

5.3.1 Location and Extent of Area

Kathore Riverine forest is located 140 km downstream Kotri Barrage and 45 km from Thatta town on right bank of the river. It is divided in 23 compartments and is spread over an area of 1973.8 ha.

5.3.2 Topographic and Physical Features

The Indus River flows through Thatta district from North to South and joins the Arabian Sea in Keti Bunder and Shah Bunder talukas. Kathore Riverine forest is situated on the right bank of the Indus River. Since Thatta district is located at the tail end of the Indus Basin, more silt is deposited in this part due to reduced velocity of river flow. Therefore, the Riverine tract of Thatta district has become too high lying and its riverine forests are seldom inundated. The physical features of most of this forest have been changed by leveling of its lands for cultivation purposes.

5.3.3 Accessibility

Kathore forest is located inside flood protection earthen bund; a metallic road passes all along it. Almost all compartment roads are accessible and can be reached at any place with transport facilities.

5.3.4 Composition and Density of Vegetation

Presently, the entire forest is almost blank and there is no tree growth existing in the forest. In the recent past, *Acacia nilotica* used to grow and flourish in this forest. Small growth of Acacia nilotica were harvested in the year 1994 when only 1.14 stacks of wood were sold in open auction. Thin mesquite of un-exploitable size grows in small patches (Fig.8).

In this forest, banana crop has been cultivated over more than 240 ha in the interspaces of coconut plantation raised under a development project titled “Establishment of Coconut and Palm oil

plantations in Coastal Zone of Sindh". As per provisions of the project, Forest Department has developed its project lands and invited the local people as a coworkers to arrange water and cultivate agricultural crops preferably banana and sugarcane crops in the interspaces of coconut/palm oil tree lines planted at a spacing of 15.0 m from row to row and 8.0 m from plant to plant. The annual water requirement of coconut, palm oil and sugarcane is almost equal to banana crop (9.7 ha meter or 80.0 acre inches). In addition, coworkers pay Rs. 2500/ha as an annual rent/lease money and after three years, their banana crop will be sold in open auction. Hence, under this arrangement, coworker arranges irrigation water, applies fertilizer, pays annual rent and nurtures the palm plantations in lieu of raising his crop in the interspaces of plantations. Forest Department will face a problem mainly of irrigation water, when coworkers will withdraw from this arrangement due to increasing competition for light and nutrients of palm trees with their crop. Forest department shall try to continue this arrangement until trees start fruiting when it shall also lease out the fruiting palm trees with banana crop to increase palm oil production in the province/country.

Image 9 & 10: Land use of Kathore Forest

5.3.5 Inundation Frequencies

Like all riverine forests downstream Kotri Barrage, Kathore Riverine forest is also a high lying forest and gets inundated rarely. In near past, Kathore forest got inundation during super floods of 1973, 1976 and 1986 to the extent of 70-80%. In high floods, its low lying areas are inundated.

Image 11: Kathore Riverine Forest

5.3.6 Adjoining Forests

It has common boundaries with two small forest units of Hayat Gaho and Gulel measuring 334.6 and 88 ha respectively and forms together a small block of 5991 acres of Kathore block. Chach Keti riverine forest is located in front of this forest across the river.

5.3.7 Habitations, Villages and Tribes

There are no temporary dwellings inside Kathore forest and there are three sizeable villages namely Darvesh, Gaho-Goth, baran Goth and Khaskheli-Goth in its surroundings outside flood protection bund, where people of Khushak, Gaho, Khaskheli and other tribes reside.

5.3.8 Socio-economic Status

In the olden days, when economy of the area was pastoral, local population entirely depended on these forests for grazing, fuel and wood for making houses, agricultural implements, etc. After the construction of Kotri barrage and upstream diversion of water and with the disappearance of tree growth from these forests, the herds of cattle has also immensely reduced and people have changed their livelihood from cattle rearing to growing of crops and other activities akin to agriculture and employment elsewhere. The land use of this forest has changed from tree growing to crop cultivations particularly banana and coconut where irrigation water lifted from different sources.

In the recent past, huge old stumps of *Acacia nilotica* were seen all over this forest which have also been extracted and sold by local people due to extreme poverty and unemployment. Thin mesquite stacks were seen lying on protection bunds and nearby villages which was cut and transported by the local people from wastelands and is sold for Rs. 20/- per 40 Kg. Local people also extract mesquite stumps and sell these for Rs.15/- per 40 Kg. All the thin wood is transported and sold at Karachi. Mesquite is not allowed to grow and flourish only due to local pressure of wood cutting and related nuisance in the forest.

5.4 Population and Livestock Needs

Livestock rearing is no more practiced in or around Kathore forest and cattle and goats are kept for milk, meat and other usages in many house holds. Cattle of local people graze in this forest which has not much to offer after complete depletion of the vegetation and palatable grass cover.

5.4.1 Needs of Local Population and Livestock

There are no unauthorized cultivations seen in the forest due to non availability of water. Coconut plantation over about 240 has has been established by Forest department under a development scheme, titled: Establishment of Coconut and Oil palm Plantations in Coastal Zone of Sindh since the year 2002. The coworkers have arranged their own water and have raised banana crop in interspaces between coconut tree lines. The coastal zone of Sindh is suitable for both these crops and grows well in combination. The water requirement of both the crops is same and nutrients applied to banana crop by the coworker are also consumed by coconut plants. Seasonal agricultural crops are also raised by local people on residual moisture after the recession of flood water received during high floods.

5.4.2 Illegal Wood Cutting

Since there is no exploitable wood growth left in this forest, no illegal wood cutting is done in Kathore block. However, mesquite is repeatedly cut for fuel wood and transported to sale points by local poor people who don't have any alternate employment opportunities. The degradation of forest has been the same as elsewhere with the addition that people have no chance of cutting trees and cultivating the lands in this forest.

5.5 Management and Objectives

Like all riverine forests of Sindh, the standard management unit is a compartment which measures 64 ha . Kathore Forest is divided into 23 compartments and falls in taluka Ghorabari, of Thatta district. It is a part of Thatta Afforestation Division and its administrative charge is with Divisional

Forest Officer Thatta. Range Forest Officer Ghorabari assists in the performance of management objectives. The principal objective of management of the forest of wood production has been changed to horticulture crop raising on lift water.

5.6 Ecological Degradation of Kathore Forest

Inundation has almost ceased to reach this forest except during super floods. In recent times a portion of this forest was inundated in the years 1973, 1976 and 1986. Ecologically, Kathore Riverine forest has completely degraded and important dominant species of Riverine ecosystem are now extinct in this forest.

5.6.1 Land Use

Land use of the Riverine forest has also changed and raising of forest plantations on lift water has become too expensive and un-economic in comparison of growing cash crops like coconut and banana due to ever increasing cost of diesel, electricity and machinery for lifting water.

5.6.2 Biodiversity

The biodiversity below Kotri particularly Kathore forest has almost degraded. No wildlife, fish and plant species of Riverine ecosystem are presently found in this forest. However, some livestock do graze in the forest.

5.7 Fishery Contracts

There is no depressions /Dhoras in Kathore forest where fish contracts could be awarded. However, there are several depressions in Keti Shah Forest which are annually auctioned for fish catch sells. Year-wise details of fishery contract for the year from 1997-98 to 2006-07 are as under:-

Table 17: Value of Fishery Contracts in Keti Shah and Kathore Forests

YEAR	AMOUNT (RS)	
	Keti Shah Forest	**Kathore Forest**
1997-1998	280,100	Nil
1998-1999	213,000	
1999-2000	245,000	
2000-2001	150,000	
2001-2002	250,000	
2002-2003	175,000	
2003-2004	230,000	
2004-2005	250,000	
2005-2006	280,000	
2006-2007	275,000	
Total	**2,348,100**	

5.8 Regeneration Operations

Although, Keti Shah Forest is extended over extensive area and frequently inundated during flood season, a small area is regenerated annually due to no harvesting and other management problems. On the contrary, Kathore Forest is seldom inundated and area regenerated does not survive due to any flood in subsequent years. Year-wise details of regeneration works carried out during last ten years in Keti Shah and Kathore forests are as under:-

Table 18: Area Regenerated in Keti Shah and Kathore Forests

YEAR	Area Regeneration (in acres)	
	Keti Shah Forest	Kathore Forest
1997-1998	1500	Nil
1998-1999	1000	Nil
1999-2000	300	Nil
2000-2001	800	Nil
2001-2002	300	Nil
2002-2003	1000	Nil
2003-2004	640	200
2004-2005	150	Nil
2005-2006	1570	1000
2006-2007	1390	220
Total:-	**8650**	**1420**

5.9 Auction of Wood Material

Year-wise details of auctioned of wood material of Keti Shah forest from 1970-71 to 1996-97 and of Kathore Forest from 1985-86 1994-95 are as under:-

Table 19: Yearly Sale of Wood in Keti Shah and Kathore Forests

Year	Quantity (stacks)		Value (Rs)	
	Keti Shah	Kathore	Keti Shah	Kathore
1970-71	651.14	Nil	352,200	Nil
1971-72	546.51	Nil	390,100	Nil
1972-73	69.9	Nil	107,000	Nil
1973-74	290.68	Nil	760,500	Nil
1975-76	101.9	Nil	272,300	Nil
1977-78	400.33	Nil	1,323,000	Nil
1978-79	293.19	Nil	1,122,000	Nil
1979-80	631.29	Nil	2,466,000	Nil
1980-81	898.91	Nil	3,118,000	Nil
1981-82	310.94	Nil	1,390,000	Nil
1982-83	473.27	Nil	1,519,600	Nil
1983-84	292.09	Nil	816,000	Nil
1984-85	475.77	Nil	1,438,000	Nil
1985-86	611.94	173.33	2,400,500	773,000
1986-87	1281.38	Nil	4,337,000	Nil
1987-88	65.734	Nil	401,000	Nil
1988-89	474.87	Nil	2,893,000	Nil
1989-90	664.31	66.94	2,933,200	243,000
1990-91	394.75	58.91	2,480,000	420,000
1991-92	434.64	41.13	2,939,000	361,000
1992-93	527.46	Nil	4,528,000	Nil
1993-94	83.13	Nil	956,000	Nil
1994-95	Nil	4.41	Nil	38,000
1996-97	8.238		70,000	
	Total:-	**344.72**	**39,012,400**	**1,835,000**

The above table reveals that no harvesting is being done in Keti Shah Forest since 1997-98 and no exploitable growth of any species is left in Kathore forest for harvesting.

5.10 Causes of Degradation of Riverine Forests Down Stream Kotri

In Sindh, Thatta is the unique district which is situated on both sides of the River Indus over a distance of more than 100 km. Its riverine forests are located on both banks of the river almost in a continuous block and some of the *dehs* are entirely declared as reserved forests. Prior to the construction of barrages and reservoirs, these forests were inundated regularly and provided a rich habitat to wildlife and grazing animals. The main occupation of the local people was cattle rearing and agriculture was practiced either along natural canals (Wah) taking off directly from Indus river in flood season and in kacho area after receding of floods on residual moisture. From canals water was mostly lifted through water mills by bullocks. Since area below Kotri is part of Lower Indus Basin, all its surplus water passed through this area submerging all the depressions, where water remained for most of the part of the year. Hence fishing was also one of the main professions of local people. Due to mild climate and low frost, dense forests of *Acacia nilotica* were growing down Kotri.

After construction of barrages and water storage reservoirs, more and more water was diverted for agricultural purposes to meet the growing food needs of ever increasing human population. Since velocity of river water reduces at its tail end, most of the silt settled in this deltaic region and made these lands high lying which could inundate only in high floods. Easy accessibility, proximity to urban centre and mild climate, there were more attraction for producing cash crops such as banana and vegetables for Karachi. With the reduction of floods, Acacia nilotica also started disappearance and fertile lands were infested with deep rooted xerophytic mesquite species and the dependence of cattle on riverine forests was drastically reduced. The communities, who depended on cattle, now started cutting forests for supplying fuelwood to Karachi. Hence reduced floods, mild climate, prolong droughts, increased pressure of human and cattle population, illegal cutting of forests, easy access, proximity to urban centre for supply of fuelwood and agricultural produce, better law and order situation, availability of canal water and host of other factors were responsible for the disappearance of once vast dense riverine forests down stream Kotri.

The factors narrated above are the same responsible for the degradation of Kathore forest. All factors individually and collectively have caused negative impact on riverine ecosystem of all the forests, right up to downstream kotri, including Kathore forest. The degradation of riverine ecosystem follows various upheavals in the socioeconomic traditions such as lesser dependence on grazing by communities on riverine forests, encroachments on forestlands, change of land use from forestry to agriculture and use of canal water for un-commanded riverine lands.

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CHAPTER 6

ANALYSIS OF FACTORS RESPONSIBLE FOR DEGRADATION OF RIVERINE ECOSYSTEM

In Chapter 4 of this report the factors responsible for the degradation of riverine forests of Sindh in general and riverine forests of up stream Sukkur and down stream Kotri in particular have been discussed. All factors such as climatic, biotic, water-related and the general policies of the government have been analyzed and their impacts on the riverine forests highlighted and recorded. In Chapter 5 of this report, Keti Shah riverine forest located in up stream Sukkur and Kathore/Hayat Gaho riverine forest located in down stream Kotri have been compared on the basis of primary and secondary data collected during the study both from the field and concerned department. This chapter of the report syntheses the impacts of key factors on the riverine ecosystem in general and Keti Shah and Kathore/Hayat Gaho riverine forests in particular.

6.1 Water

Water received in Indus River during the 'abkalani' season is the key factor responsible for survival and growth of riverine forest ecosystem. The components of riverine ecosystem includes trees and associated vegetation, wildlife and its habitat, livestock, fish, micro climate and over all products of riverine ecosystem. Inundation has been declining in the riverine areas of Sindh gradually but prominently after 1970. It was worse during the drought period from 1997 to 2004 resulting in devastating impacts on the riverine ecosystem. The position in the forests located in upstream Sukkur and down stream Kotri has been quite significant in both the areas. Keti Shah riverine forest due to its location in upstream Sukkur barrage, has been comparatively better as it received flood waters in even low floods and mostly inundated. Therefore, the ecosystem and its components were intact and less affected by reduction in inundation. Where as, the position below Kotri has been worst as Kathore/Hayat Gaho forest was seldom inundated during this period, resulting in degradation of riverine ecosystem more down stream Kotri as compared to upstream Sukkur. All the components of riverine ecosystem and their productivity downstream Kotri have been degraded which has altogether changed the land use from forestry to agricultural.

6.2 Human and Livestock Population

Population of the province of Sindh has been increasing at the annual growth rate of 2.8%. As per population census reports the human population in from 1961 to 1998 is reported as under:

Year	**Population** (million)
1961	9.531
1972	14.187
1981	19.178
1998	30.440

The projected population in 2007 is about 35 million. This increasing trend has affected the natural resources particularly riverine ecosystem as the population is constantly increasing within and around this ecosystem.

Data collected during the survey revealed that in and around Keti Shah riverine forest there are 43 villages, 576 houses holds, inhabiting 4338 people. They also have 2730 buffalos, 3800 cows and about 2800 goats. This human and livestock population has exerted tremendous pressure on Keti Shah riverine ecosystem in the form of collection of fuel wood, small timber, grazing, trampling, fishing, cultivation of agricultural crops, encroachments, illegal logging, etc. During the consultations with the people during survey, it was narrated that people and their cattle are entirely dependent on Keti Shah riverine forest. This pressure has negative impact on the forest resulting in degradation of forest but is not alarming and significant due to over all hygiene of ecosystem.

In Kathore/Hayat Gaho riverine forest of below Kotri there are six villages having 2,440 human population, 1,482 livestock and several other pressures on this forest. The entire cattle do not depend upon this forest but in rainy season and after floods if its low lying areas get inundated, cattle do graze over there. This forest is also located along a protection bund and is connected by a metal road, where irrigation water from inland irrigation network is available. These factors individually and collectively have exerted pressures on this forest in the form of illegal logging, cultivations, and grazing to the extent that now there is no tree growth but either the forest is under agricultural/fruit crops or is totally blank. These pressures have been exacerbated by continuous non-availability of inundation water and have resulted in disappearance of riverine ecosystem and its components from this forest.

6.3 People's Occupational Pattern

This factor plays an important role on the management and richness of the ecosystems. The communities residing in and around are the main stakeholders whose socio-economic conditions, poverty level, employment status and dependence on the ecosystems have direct impacts on the productivity and management activities of ecosystems. This is particularly significant in the forest ecosystems where the livelihood of communities is more dependent on forest products and services. Comparison of the above data collected during survey indicated that the occupational pattern of communities living in and around Keti Shah Forest is different than Kathore/Hayat Gaho riverine forests. Communities in Keti Shah Forest are dependent on the forest related livelihoods and they have strong sense to protect this resource from outside forces. Their literacy rate is very low, they are helpful to forest department's officials, live in harmony with natural resources, protect the components of ecosystem and also keep an eye on the activities which are harmful to forests and its ecosystem. This is why the rate of degradation of Keti Shah Forest is minimal as compared to Kathore/Hayat Gaho riverine forest.

The bio-physical environment and socio-economic conditions determining the occupational patterns of Kathore/Hayat Gaho riverine forest are altogether different. Although, it is a riverine forest but being located along the river protection bund and connected with road network having easy accessibility, occupied by outsiders and influential persons having no interest with ecosystem and its components but only economic interests. Like Keti Shah Forest, communities are not living within the forest. Only influential persons and their tenants who cultivate forestlands live in this forest. All these activities and natural conditions have exerted tremendous pressure and completely degradation the riverine ecosystem down Kotri.

It is concluded from the analysis of the above discussed factors that although the main factor responsible for degradation of riverine forest ecosystem is the reduction/non-availability of inundation water in both the riverine ecosystems located upstream Sukkur and down stream Kotri, but the socio-economic factors also play a critical role in their degradation and/or upbringing. Comparison of factors responsible for degradation of riverine ecosystems reveals that Keti Shah riverine forest ecosystem is still rich in biodiversity and other components but the Kathore/Hayat Gaho riverine ecosystem is completely degraded. If the inundation status improves and other pressures are positively managed this is still a potential site for development of riverine ecosystem.

Table 20: Comparison of socio-economic variables in two forests

Area/Forest	No. of villages	No of house hold	Total human population	Total livestock population		Dependence of communities on Natural resources
				Buffaloes/ Cows	Goats	
Keti Shah	43	576	4338	6,590	2,7 67	75%

Kathore	7	348	2440	1482	110	25%

Table 21: Assessment of different factors on the degradation of riverine forests at upstream Sukkur and Down Stream Kotri.

Severity of Different Factors on Degeneration of Riverine forests	Keti Shah Forest upstream Sukkur	Kathore Forest Downstream Kotri
Inundation of River water	4	1
Accessibility	1	5
Pressure of Local Population for Fuel wood and Timber	4	2
Pressure of Urban Population for Fuel wood and Timber	5	1
Grazing of Livestock	2	4
Suitability for agriculture	2	5
Encroachment of Forestland	5	3
Under staffing by Forest Department	2	2
Poor Forest Policies	1	1
Political Influence	4	1
Law and order situation	1	5
Wrong Management Approach Wood v/s Ecosystem	1	1
In-adequate Funding	2	4
Wildlife	4	1

Note: Assessment has been based on a score from 1 to 5, one being the worst and five being least.

CHAPTER - 7

RECOMMENDATIONS

In the present circumstances, there is a strong need to formulate a dynamic policy for the preservation and management of riverine forests which is the main stay of forestry in the province of Sindh. In addition, these forests play a vital role in the improvement of environment and preservation of biodiversity in Indus Ecoregion. The recommendations have been made on the basis of all available data from different records and sources collected during this case study, interaction with all the stakeholders, observations made during the field inspections, group discussions with the communities and field staff, analysis of the climatic, social, political, economic, edaphic, and biotic factors in the Indus Eco-region and references taken from literature on forestry. Specific appropriate recommendations have been made on policy, legislation of the suitable laws, management and research aspects of riverine ecosystem.

7.1 Policy Recommendation

Most of the existing policies and legislation are the continuation of colonial period in which forests were managed and controlled through punitive measures. In that time, neither there was a need nor a provision of working with the local communities who were the main stakeholders and lived in a harmony with forests. In those days, due to favorable bio-physical environment and sparse population, the forest resource was in abundance, whereas, the conditions have altogether altered during last 6 decades resulting in significant degradation of the forest resource. The objective of policy and management of forests was the generation of revenue without considering the needs of local communities who had dependence on natural resource as well.

In order to check the degradation and preserve/ improve the biodiversity of riverine forest, there is a dire need to adopt such policies and approaches that shall involve the participation of local communities in management and development of forest resource in Indus Ecoregion. In other words, instead of top down approach, bottom up/participatory approach shall be introduced and such policies are adopted by enactment of appropriate legislation and writ of government.

7.1.1 Policy Actions

With the adoption of participatory approach, the people shall be the subjects of the development process instead of objects. Presently, there is no such provision in the Forest Act to involve the communities in planning, management, protection and benefit sharing of forest resource. Therefore, shift in existing legislation and policy is prerequisite to involve the communities in planning, execution and benefit sharing stages. Community forestry is a model that has been proven successful in many developing countries of the region. In the community forestry approach, the local communities are involved in decision-making by giving authority to protect and manage riverine forest ‘by and for’ them. Communities through their organizations such as CBO’s and NGOs’ are involved in designing and implementing strategies for riverine forest development. Forest Department should adopt policies and enact laws that provide opportunities to local communities to develop their management capability and incentives for long-term sustainable management of riverine forests. The communities should be mobilized, organized, empowered and trained in human ecology and conservation so that they may be partners in protection, production and economic benefits at mutually agreed parameters. It is also imperative that the training of foresters and communities should be expanded for conservation, production and utilization aspects of forest resource. Communities may also be empowered to manage and use forest products other than the timber wood for their genuine demands and economic benefits.

The object of management shall have to be redrawn and recast keeping in view the environmental, biological and social aspects of forest resource in changed scenario of the riverine forests. Rightful demands and genuine needs of confide communities have to be ensured and made obligatory component of the management of riverine forests in turn these communities living nearby these forests will have to abide the ways and means laid down for the fulfillment of their needs.

Riverine forests are managed on the principles of ecosystem management instead of timber production. Under the ecosystem management, due care should be taken for all components of ecosystem and their interdependence so as to complement and supplement each other for a healthy and productive ecosystem. For a certain period of time, the economic activity particularly the harvesting activities be suspended and the ecosystem be allowed to develop naturally with minimum interference. In order to execute this system, the forest department shall change its current approach/strategy and involve/mobilize the communities for their participation in the development, protection and management of riverine ecosystem.

7.1.2 Land Use Classification of Riverine Forests According to Inundation Levels

Presently, most of the riverine forests are without any tree growth and forestlands unutilized. As reported by field staff, moro than 90% riverine forests are inundated when water discharge downstream Sukkur and Kotri is 1.0 million and 0.7 million cusec respectively. The river flow data in Appendix-I indicates that during last 12 years, water downstream Kotri has not flown more than 0.3 million cusec. In the years 2000, 2001 and 2002, its flow was less than 0.08 million cusec and in 2004 it was just 0.02 million cusec. During this period, most of the tree growth died away and dry trees were either cut departmentally or removed illegally by local people for cultivations. As reported by Sindh Forest Department, more than 40,000 ha forest lands were encroached, of which about 15,000 ha were leased out after approval of Agroforestry Policy, 2005 and almost equal area was still under illegal possession. In changed climatic, there are remote chances that sizeable area of riverine forests will be regenerated through floods as riverine forests can not be grown on such a low and unpredictable flood waters. Therefore, alternate strategies are to be developed for the management of vast tract of fertile riverine forestland as in present scenario, department has neither the resources nor potential to plant entire riverine forestlands by lifting the water. On the contrary, land hunger for cultivations is increasing due to high population growth and rural poverty. Hence, appropriate land use policy is essential for the conservation of natural resource and to meet the genuine needs of people on a sustained basis. Proper use of land avoids degradation but unfortunately this subject has never received priority by our planners. It is therefore proposed that the Land use policy for the riverine forestlands shall be formulated on the consideration of inundation levels based upon previous record and experience as under:

7.1.2.1 Low-lying Areas:

All potential low-lying forestlands along river banks and depressions, which are frequently inundated in low-medium floods, should be earmarked and managed as riverine forests by the Sindh Forest Depart. No other activity except establishment of forests is permitted in these areas and all possible measures are taken so that this area receives flood water frequently.

7.1.2.2 Medium lying Areas:

Riverine forestlands which are Medium-lying and are inundated in high floods shall be earmarked for raising of short rotation irrigated plantations with and without the participation of communities. Government has to bear all the expenses of land development, arranging irrigation water and establishment of plantations. Individual coworker may be allowed to raise their crops in the interspaces of the plantations on the payment of nominal land rent / lease money to provide employment to local people.

7.1.2.3 High lying Areas:

Riverine forestlands which are high-lying and are occasionally inundated only during super floods should be earmarked and managed through the participation of local communities or entrepreneurs by leasing out the forestland without changing the status of forestlands. These arrangement shall be long term and on sustained basis. In case of communities, Government shall initially invest on the development of land and arranging irrigation water not for profit but just to facilitate the local communities in providing their livelihood. The communities will manage these lands in participation of departmental functionaries, will raise contiguous blocks of plantations on 10-15% of the total

land and will share part of the net profit with the government. The communities shall be involved right from the planning to harvesting and department will provide technical guidance and monitor planned activities.

Since large investments are required for the development of undulating riverine lands and for arranging irrigation water, entrepreneurs/corporations shall be encouraged to raise agronomic crops and forest plantations in contiguous blocks on 10-20% of leased out land on agreed terms and conditions for reviving/reestablishing the riverine forest ecosystem.

Options, other than traditional forestry shall also be explored to utilize these fertile lands and to provide livelihood to local people who depend upon this natural resource. Growing of xerophytic *Acacia* and *Prosopis* tree species and shrub species such as castor oil, *Jujuba jujube*, *Commiphora mukul* (Gugral), grafted *Zizyphus jujuba*, etc. that require less water shall be introduced in these high lying riverine areas. To economize the irrigation water which is the most precious input in riverine plantations and to avoid the leveling/ development of undulating riverine lands which is the second most costly input, drip irrigation shall be introduced for raising irrigated plantations. Wildlife lovers / conservationists can also be encouraged for developing wildlife reserves/ commercial hunting grounds in these lands.

7.1.3 Enhancement of Community Development

Forest policy has also to be revised and laws modified to improve the capabilities of the communities through training, extension and education for maintaining the sustainable management of the forests. Local organizations can contribute to enhance the local participatory role of the communities in managing the natural resources.

7.2 Management Recommendations

The study has revealed that reduced floods, land hunger and mismanagement of areas receiving inundation coupled with natural and anthropogenic factors are the main causes of degradation of riverine ecosystem. With passage of time, riverine forests particularly downstream Kotri have become high lying due to settling of silt in the river waters. Rains are scanty and sporadic to sustain tree growth and sub-soil water is saline in most part of the province. At places this water is useable, but the cost of lift pumps, diesel and electricity, has become too expensive to undertake any planting work on the basis of cost benefit ratio.

The population of the province has increased about six times during last 60 years but the area under agriculture has increased insignificantly. Almost half of the population directly depends upon agriculture and an increasing population requires more land to cultivate. On the contrary, most of the fertile riverine forest lands are blank and there is no law of rule over there. Therefore, influential and criminals are tempted to encroach and grab forestlands easily.

In order to reverse the situation, the present management strategies and policies are required to be modified / changed so as to expand management responsibilities of forestry personnel to include human ecology and conservation. Following approaches/initiatives based on the principles of ecosystem management are proposed to manage the riverine ecosystems:

7.2.1 Participatory Approach

7.2.1.1 Adaptive Management Approach (AMA)

AMA engages local communities to accept new approaches to technical, administrative and social issues which can be developed and tested. Under this approach, relatively larger areas are selected for development and testing technical and social approaches for integrating and achieving desired ecological, economic and, social objectives with overarching objective of knowledge improvement of the communities on ecosystem management. Under AMA the supporting agencies are expected to pursue a variety of approaches in achieving the conservation objectives. This

approach can be applied on selective riverine forests which are stretched over greater areas (more than 4,000 ha) on pilot basis for activities other than pure forestry.

7.2.1.2 Ecosystem Management Approach

Ecosystem Management (EM) is a concept of natural resources management wherein the forest activities are considered within the context of economic, ecological and social dimensions within a defined area or region over both short and long terms. EM is not a goal itself; but a means to an end. It is therefore not depicted as a product but rather as an approach that guides the managers to do their jobs. Principles of application of EM are public involvement; partnership, embracing modern ecological approaches, including i) independencies of natural resources and human actions; ii) the dynamic nature of ecosystems, iii) the delineation of ecosystems ecological processes; and iv) the occurrence of ecosystems at multiple scales. Under this approach it is recommended that the riverine forests shall not only be managed for economic purposes but also for other functions of ecosystem.

7.2.1.3 Bio-social Approach

The main principle of this approach is managing a framework to organize society-environment systems relationships for the management of natural resource. The biosocial model is a simplified representation of mutual adjustments that take place between a society and its physical environment. This model is composed of four parts; the management sub-system (a society), the ecological subsystem (its physical environment) and the inputs and outputs that tie them together.

Resource management takes place in an environment of continuous social and ecological change. Managers must adjust to these changes and guide them, where possible, to meet the needs of society and physical environment from which resources are derived. The resource manager acts as a mediator between society and the physical environment from which the resources are derived. To perform this mediating role more effectively, resource managers urgently need a new framework to organize relationships between people and their environment.

7.2.2 Traditional Forestry Approach

7.2.2.1 Management of Low-lying Riverine Forests

i Serious efforts are needed to regenerate all harvested and blank forestlands through pre, mid and post ‘abkalani’ according to the prescription of management plans.

ii Regeneration areas shall be protected from grazing, browsing and trampling and silvicultural operations such as re-stocking, weeding, cleaning, pruning, thinning, etc carried out for better tree form, good growth and optimum wood production.

iii Areas which possess sparse trees, bushes or mat of grass shall be harvested; soil worked up and regenerated with babul and kandi seed for full stocking.

iv All the sand bars and obstructions hindering flood water in inundating riverine areas including riverine forests shall be removed to spread flood water over maximum areas.

v. Existing inundation channels/Wahores shall be de-silted and new channels excavated for flooding and filling distant low-lying forestlands and depressions. This action will not only benefit the forestlands but assist local people to cultivate their lands on residual flood water moisture and by lifting water from depressions.

7.2.2.2 Management Plans

After a lapse of two decades, Forest Department prepared management plans for all its forests in 2001 for 10 years. As per prescription of the plans, several thousand new and harvested areas were to be planted in plan period. It was observed during the study that most of the areas have been harvested with planting of same and other new areas due to non-availability of flood water and other social problems. Hence, these plans need immediate revision to reassess the stocking and prepare new strategy.

7.3 Development Recommendations

7.3.1 Establishment of Irrigated Plantations over Riverine Forestlands

The major expenditure required for the establishment of irrigated plantations in Riverine tract is lifting of irrigation water and development / leveling of land. Therefore, propagation of forests through inundation is the most economic method for establishing forests in Riverine areas. The floods not only bring sweet water in abundance but also juvenile the soils by depositing the mineral rich silt on regular basis.

Since the intensity and extent of inundations have reduced in recent years, it is therefore proposed that all the easily accessible medium level areas where sweet water through lifting is available and receive floods at an interval of 3-4 years shall be developed and managed as short rotation irrigated plantations. If these plantations receive inundation two times in the rotation of 6 years, substantial cost for lifting water is saved and land once developed will require less cost for subsequent plantings. To economize water in initial two years, planting shall be done on trench irrigation system instead of flood irrigation layout system.

7.3.2 Development of Wood lots on Forest Margins/rims

The principle of development in riverine forests should be to combine conservation with development. In order to decrease the pressure on riverine forests and restore their productivity, the farm forestry and participatory forestry should be popularized on the margins/boundaries of riverine forests to meet their domestic needs. Incentives shall be provided by the government to promote farm forestry on private lands and community based woodlots on state arable lands to meet their fuel wood needs.

7.3.3 Participatory Extension Service

Prior to devolution the extension/social forestry service was with the forest department wherein the social forestry wing was created to popularize forestry on the farmlands. At present extension service of the department has been devolved to local government where only raising of saplings in the nurseries is being done without any approach to the farming community or other target groups to grow trees in the agricultural systems. Both the above stated approaches were without integration of principles of natural and social dimensions in the forestry development. Hence, Forestry extension services be strengthened and reorganized in order to provide technical and material assistance to the farmers for the promotion of tree growth in riverine tract, marginal and wastelands through people's participation.

7.4 Research Recommendation

Management based on sound research is always sustainable. Developing the foundation for ecosystem management will require not only sound research but the updated knowledge and understanding of how major ecosystems function; how they can support and tolerate human use, how policies and management decisions affect resource use is imperative.

Research is also an essential part of development activity as it guides the managers to amend/change management strategies and if necessary policies to manage the resource. During the course of this study it has been revealed that no research on any aspect of riverine forest resource/ecosystem has been carried out. Research on technical, biological, socio-economic and policy aspects is necessitated in order to raise the productivity of riverine species for meeting basic rural needs. Some recommendations are proposed as under:

- In riverine forest ecosystems the research should emphasize on studies, especially those that identify and analyze the causes of success and failure in forest development. Case studies are particularly needed in areas of community management, production, forest dependency, sustainable utilization, equity and benefit sharing in marketing aspects of forest resources. There is also need to develop case studies that describe and analyze the marketing channels from collectors/producers to consumers.

- Research should also be carried out on the impacts of water shortage on the forest resource particularly on biodiversity; ecosystem functions, and suggests measures to make the ecosystem functional and productive.

- Research on supply and demand of main forest products and non-wood forest resources currently and in the future is also required.

- Research on appropriate technologies for non-wood forest products their harvest, use and processing is also recommended.

- Surveys and analyses of the degree and extent of the subsistence and local use of forest products, marketing, comprehensive inventories and assessments should be conducted.

- Research is required to find out the economic rotation of all species of riverine forests particularly management of mesquite which is encroaching vast riverine areas and is the main source of woodfuel.

- Research trials for growing of suitable xerophytic species are conducted in riverine areas.

7.5 Management Decisions

7.5.1 Political Will

No policy can be implemented until and unless there is a political will in the country. Hence, sound planning and policies can bring no result unless they are implemented in its true spirit. The cause of degeneration in recent past was that there was no political will to bring any change for the betterment of natural resource.

7.5.2 Data Base

There is dearth of database pertaining to different factors affecting riverine forests such as ecological, social, economic, technical, biotic and edaphic in the region. Hence, for the future development a data bank should be created in the Forestry Department.

7.5.3 Monitoring and Evaluation

Organizational effectiveness through enhancing the monitoring and evaluation efforts to achieve departmental goals including ecosystem health and sustainability by expanding collaboration among researchers, scientists and practitioners is needed. Moreover, forest cover shall regularly be monitored using GIS.

7.5.4 Execution of Agroforestry Policy

Agroforestry lease policy which is one of the main tools for developing and managing riverine forests shall be Proper implementation of implemented in its real perspective in wherein, lease holders shall raise and maintain block plantation on required area and hand over the same to the department as per terms of the agreement.

7.5.5 Industrial Plantations

Forest Department shall earmark some of its high-lying areas for long term leasing to Industrialists for raising plantations to produce raw material for wood based industries.

7.5.6 Law & Order Situation

Security and free movement are the basic requirement for any development and management. It is, therefore, essential to improve and maintain law and order situation and provide required assistance to Forest staff to enforce writ of law in vacating encroachments, implementing Agroforestry policy and check wood cutting in forests.

7.5.7 Seed Bank

Presently there is no seed bank in Forest Department. In years, when high inundations are received or in bad seed years, sufficient seed is not available to meet the seed requirement for meeting planting targets. It is, therefore, essential that a seed bank should be developed where large quantity of quality seeds is stored for planting, sowing and supply to farmers.

7.5.8 Conservation Areas

Prior to the construction of barrages and reservoirs, there were several contiguous blocks of luxuriant riverine forests all along Indus River. In present scenario very few such scattered patches could be found only upstream Sukkur. Hence it is proposed that some conservation areas be developed for research, study and to evaluate the effects of human use and habitation on the sustainability of ecosystems. Besides, areas under the most intense environmental and social pressures needing protection should be determined and bilateral and multilateral assistance for strengthening forestry sector planning and management should be coordinated. Areas under the most intense environmental and social pressures needing protection should be determined and bilateral and multilateral assistance for strengthening forestry sector planning and management should be coordinated.

7.5.9 Wilderness / Recreation

Riverine ecosystem provides multiple benefits in the form of water, wood, wildlife, recreation, minerals, etc. If law and order situation is improved and security is provided to the civil society, riverine areas can be developed as fascinating recreation places for urban population that afford and need to get out of concrete jungles for some time.

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GLOSSARY

Abkalani: Annual inundation in River Indus during rainy season.

Bhans: Places near grazing points, where graziers live and keep their cattle temporarily in Kacho /riverine areas

Bunds: Earthen embankments erected on 7both sides of River Indus for protecting the hinterlands from inundation during flood season.

Kohistan: Hilly tract of S

Dhandh: Lakes

Dhoras: Depressions/lakes in rivrine areas formed by river action

Hurries: Short rotation, close spacing *Acacia nilotica* plantations established for the production of pit props used in coal mining.

Moharies: Private Shikargahas

Pahis: Narrow strip of land cleared from its growth for demarcation of erosion strips or as a path for broadcasting babul seed on both sides during regeneration operations

Registan: Sandy desert area

Shikar: Hunting

Shikargah: Hunting area

Taungya: An agroforestry system under which harvested forest areas were given for cultivations for few seasons and then regenerated with forestry crop, practiced during British Rule in Burma and India.

Annexures

APPENDIX-I

Yearly Maximum U/S and D/S Discharge at Sukkur, Guddu and Kotri Barrages

(0.03 cubic meter/second =1.0 cubic feet/second or 1.0 cusec)

Year	Discharge with drain (Cubic feet per second cusec)						
	Sukkur Barrage			Guddu Barrage		Kotri Barrage	
	U/S	D/S	W/D	U/S	D/S	U/S	D/S
1932	571986	541458	30528	Nil	Nil	Nil	Nil
1933	627454	616679	10775	Nil	Nil	Nil	Nil
1934	584954	542735	42219	Nil	Nil	Nil	Nil
1935	672901	632203	40698	Nil	Nil	Nil	Nil
1936	499621	459781	39840	Nil	Nil	Nil	Nil
1937	434664	400341	34323	Nil	Nil	Nil	Nil
1938	519092	477852	41240	Nil	Nil	Nil	Nil
1939	485187	440120	45067	Nil	Nil	Nil	Nil
1940	437539	425024	12515	Nil	Nil	Nil	Nil
1941	407207	367605	39602	Nil	Nil	Nil	Nil
1942	573569	533615	39954	Nil	Nil	Nil	Nil
1943	727919	695593	32326	Nil	Nil	Nil	Nil
1944	-	-	-	Nil	Nil	Nil	Nil
1945	663178	622621	40557	Nil	Nil	Nil	Nil
1946	503580	465781	37799	Nil	Nil	Nil	Nil
1947	358578	329768	28810	Nil	Nil	Nil	Nil
1948	760397	737228	23169	Nil	Nil	Nil	Nil
1949	655237	638493	16744	Nil	Nil	Nil	Nil
1950	775522	738000	37522	Nil	Nil	Nil	Nil
1951	483202	441659	41543	Nil	Nil	Nil	Nil
1952	594279	574966	19313	Nil	Nil	Nil	Nil
1953	607592	570637	36955	Nil	Nil	Nil	Nil
1954	426185	377903	48282	Nil	Nil	Nil	Nil
1955	804760	765270	39490	-	-	804536	791221
1956	998152	979777	18375	-	-	982771	980529
1957	707260	661230	46030	-	-	561488	542156
1958	1097624	1050329	47295	-	-	764094	743749
1959	972122	928925	43197	-	-	679391	658268
1960	795218	735523	59695	-	-	502258	483171
1961	828169	786197	41972	-	-	446097	441554
1962	439687	397655	42032	-	-	300908	276792
1963	522552	478902	43650	547938	501535	322341	299982
1964	710010	682793	27217	-	701700	536278	524349
1965	564573	515166	49407	660894	571444	410012	381315
1966	665029	618240	46789	613158	559136	619373	587145
1967	656945	610382	46563	677657	650949	519884	505238
1968	585896	537215	48681	651447	626197	561604	554969
1969	652781	606963	45818	683212	653416	553247	529145
1970	329275	288311	40964	349292	325237	260448	255495
1971	581600	527372	54228	613242	584513	294915	266502
1972	374971	320685	54286	407586	375561	210988	186346
1973	1117246	1065712	51534	1083742	1062954	811648	785829
1974	296126	241210	54916	324271	294768	164262	133472

1975	1051316	1024882	26434	1002496	987943	490468	476436
1976	1200574	1160984	39590	1199290	1176450	791992	765392
1977	575826	523892	51934	541400	519800	349532	323107
1978	1116430	1092770	23660	1155873	1138272	722139	710739
1979	501334	458766	42568	523719	503423	301078	293562
1980	615778	560301	55477	652045	622958	283037	253857
1981	631359	582995	48364	729122	693524	316246	302172
1982	449931	399788	50143	486119	463561	249260	219661
1983	760621	708387	52234	758655	736248	493163	47431
1984	608883	560069	48814	647753	625512	371171	384895
1985	390380	336533	53847	425835	393724	186019	156489
1986	1166574	1122874	43700	1173292	1172010	502940	471369
1987	316245	263771	52474	343067	315711	152790	122639
1988	1118850	1068920	49930	1162653	1138676	660618	649594
1989	872134	828639	43495	944888	914485	309088	282615
1990	551867	498791	53076	589430	555544	307818	274840
1991	517200	458825	58375	606211	567612	300766	270917
1992	1068072	1025937	42135	709838	700148	555965	549972
1993	569160	515500	53660	626412	590421	420417	389477
1994	575481	738481	19000	773300	739901	800381	793522
1995	986003	939978	46025	988410	970156	799435	771365
1996	757340	697520	59820	588461	553842	412917	384462
1997	801170	747690	53480	786612	763093	321180	301979
1998	628755	572530	56225	667493	631585	295986	263998
1999	390020	334030	55990	418975	390225	220680	189294
2000	170715	117675	53040	208090	171635	66471	47845
2001	222021	168935	53086	253215	219803	95205	61670
2002	242690	186440	56250	284241	255102	105972	78648
2003	335933	297663	38270	366194	365355	240907	231417
2004	126130	64780	61350	146506	116524	30648	23188
2005	508937	447407	61530	548147	515870	310495	274283
2006	554088	511898	42190	596390	569431	371870	356516

Source: Irrigation Department Records