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Spatio-temporal Land use/cover assessment of Sub-Tropical Forests ofThatta Division

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Abstract: The deterioration of forests has contributed to greenhouse effect on massive scale, during last four decades and related regional climatic changes and rapid disappearance of natural landscapes left unattended will cause no sign of forests in the past. The integrated remote sensing technology applied to assess forest resources cover information regarding health and related problems and depended factors such as rural population, livestock and wildlife. The main focus of this study is to quantitatively assess deforestation to evaluate forest cover change from 1979 to 2010. The employment of space borne Landsat MSS and TM sensor (multi-spectrum sensor & thematic Mapper) technology is used to analyze forests patterns and Maximum Likelihood Algorithm is applied for quantitative assessment. This study was also conducted to carry out field survey in Thatta riverine forest from Kotri barrage to Arabian Sea and three hundred samples were collected from different locations using GPS device (global positioning system) the results of remote sensing satellite imagery helped to find out significant changes in Thatta forests cover from 1979 to 2010. The forests cover in 1979 was 35.11%, 1992 29.14%, 1998 8.10%, 2000 5.56%, 2006 2.57%, 2009 1.96%, 2009-12 3.02% and 2010 2.23% the overall change observed in forests area 89.07%. The field survey revealed that the main causes of deforestation asconstruction of dams/barrages on the upper streams to produce hydroelectric power and irrigation purpose which significantly reduction in the discharge of fresh water into the lower Indus basin. The reduction in flood caused severe erosion of the Indus Delta; the sea water has been encroached the Indus basin and livestock population increased grazing load and illegal tree cutting; these main causes directly impacted on natural sub- tropical forests and also effected rural population which depended on forests produced. All these uncontrolled situations have been creating environmental, climatically, social and economical problems direct impacted on Indus region and these changes threatening Indus Eco-region system.

Keywords: Assessment; sub-tropical; Land use/Land covers; Remote sensing; Supervised classification method; Landsat; Riverine Forest Sindh;

1. INTRODUCTION

The forests play a key role in global ecological balance and are valuable natural resources of world and sinks of carbon dioxide emissions (Tan, *et al.* 2010), up to 80% of the carbon stored in the terrestrial vegetation found in forests, woodlands and natural environment suffers due to depletion of forests. Vast areas of forestlands are degraded and converted to wastelands (Tan, *et al.* 2010). The socio economic development and ecological imbalance has greatly impacted and led to depletion of forests cover(Lee and Joung 1998), (Munthali and Murayama 2011). The rapidly deterioration of physical environment of The Thatta Riverine sub-tropical forests, due to illegal tree cutting, reduced flow in Indus basin sea water encroachment of the basin area, land use for agriculture purpose and high growth rate of population. The Thatta division forests have been damaged due to mismanagement and lack of importance by government. Over 500 acres (*this is predicted figure during field survey of forests*) of forests have depleted.

The Riverine forests of Thatta expand over an area of 232,830.880 Acres mostly along the river Indus. (Siddiqui, *et al.* 2004), (Bhatti and Keerio 2000). Therefore it was considered necessary to use remote sensing technology for forest land studies to analyses past and present condition and extent of forests and to obtain valuable information. Remote sensing technology is a best tool to monitor and map the changes taking place in natural resources and environment. The analysis of remote sensing data from 1979 to 2010 and Thatta Riverine forests was monitor changes in the forests cover between 1979 and 1992, 1998, 2000, 2005, 2009, and 2010 have been reduced (Sheikh 2000), (Bharti, *et al.* 2011). The temporal changes taken place in Thatta Riverine forests in 30 years shown in the maps.

2. STUDY AREA

The Thatta River in forests from Kotri barrage to Arabian Sea grow up naturally in Indus river basin. They cover an area of 232,830.880 Acres,4 to 6km in width; provide protection against the flood in the province shown in **(Figs. 1(a-c))**(Shah 2000). The Climate of the study area is sub-tropical comprising of warm summers and waterless winters lasting from December to February. The yearly mean rainfall in the

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northern part is about hundred millimeters and in the south it is one hundred seventy five millimeters. July and August are the months of rainfall (Shah 2000), (Van *et al.* 2010). Riverine forests are important sanctuaries for a multiplicity of mammals and reptiles particularly Hog deer and other animals like "partridges, wild boars, jackals, sand grouse, wolves, porcupines etc" (Fund 2008). The most important species of plants of Riverine forests are "*Acacia nilotica Prosopisspicigera, Prosopisglandulosa, Tamarixdioica Desmastachyabipinnala Calotropis Procera,"* etc (Baloch *et al.* 2011).

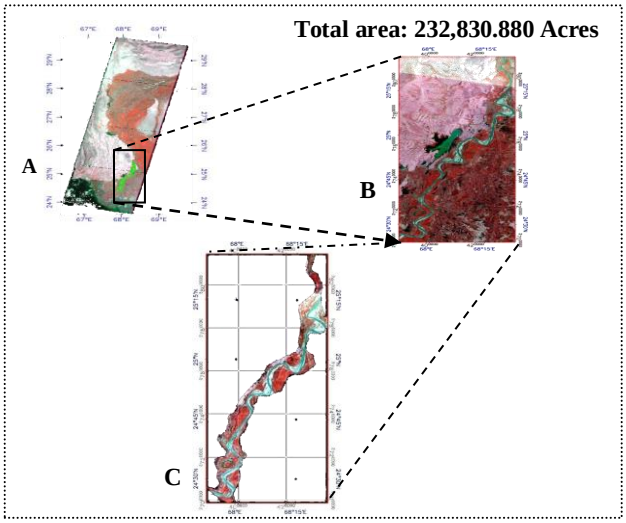

Fig. 1, showing the Area of Study, Thatta divisions
Fig: 1 (a) showing mosaic of study area of riverine forest.
Fig: 1 (b) showing extracts area of Thatta division.
Fig: 1(c) showing particular area of riverine forest.

3. METHODOLOGY

Study areas of Thatta division wereenclosed in threesatellite data imagery Landsat Multi-spectral scanner, Thematic Map-per digital images data coved Indus river basinstarting Kotri barrage to Arabian sea & landsat dataprocessed by "Earth Resources Data Analysis System" (ERDAS IMAGINE 9.1), and "Environment for Visualizing Images (*ENVI* 4.0)" through image processing method. In first step enhanced the images, then raster images were stretching, step two to eliminate geometric errors via the "Pakistan Survey maps and survey of field and Ground control points (GCP)"(Appendix) to develop the imageriesfor trueearth coordinate. Step three resolveimagery were mosaic by mosaic scheme and color matchinghas employed on mosaic imagery;separation/ masked area ofresearch andthenfused false color imagerybehind that grass/ agriculture area become visible in bright red and forest coverterritorymaterialize in dark red tendency and can simply be notable from other landskin texture. TheIndus river basin wereassess into two major classes such as landuse/landcover (Memon *et al.* 2015), which are Riverine forests, water body, grass/ agriculture land and dry/ barren land. Step four maximum likelihoodclassifications method were performed and"the regions of interest (ROI) (See Appendix ROI coordinates and area cover)"were used for analysis and assessing the dissimilarregion (or classes) support on the spectral reaction. These analysis imagery from year 1979- April and 2010- January were holdrecord regarding the Riverine forests, water body, grass/agriculture land and dry/ barren land are shown in **(Figs, 2(a, b) - 5(a, b)** respectively.

No.	Name of Forests	Sea level (ft)	GPS L/L	Information
1.	KhirSar	70	27^{O} 44635 ^{O}N 40^{O} 6355 ^{O}E	Barren land
	KhirSar	63	27^{O} 44631 ^{O}N 40^{O} 6342 ^{O}E	Land Cover With *Prosopisjuliflora*
	KhirSar	69	27^{O} 44632 ^{O}N 40^{O} 6344 ^{O}E	Land Cover With *Prosopisjuliflora*
2.	Panwhari	54	27^{O} 30225 ^{O}N 39^{O} 7551 ^{O}E	Land Cover*CalotropisProcera*
	Panwhari	52	27^{O} 29861 ^{O}N 39^{O} 8431 ^{O}E	Land Cover With *Prosopisjuliflora*
	Panwhari	51	27^{O} 30155 ^{O}N 39^{O} 7524 ^{O}E	Land Cover With Indus Water

3.	Hayat Gaho	33	27^{O} 06500 ^{O}N 39^{O} 2925 ^{O}E	Land Use For Agriculture
	Hayat Gaho	38	27^{O}06885 ^{O}N 39^{O}3019 ^{O}E	Land Cover With *Prosopisjuliflora*
	Hayat Gaho	31	27^{O} 06862 ^{O}N 39^{O} 3189 ^{O}E	Land Use For Agriculture
4.	Kathore	48	27^{O} 04699 ^{O}N 38^{O} 9807 ^{O}E	Land Cover With *Prosopisjuliflora*
	Kathore	58	27^{O} 04607 ^{O}N 39^{O} 0094 ^{O}E	Land Use For Agriculture
	Kathore	52	27^{O}04607 ^{O}N 39^{O}0078^{O}E	Land Used For Agriculture
5.	Gulail	67	27^{O} 08549 ^{O}N 36^{O} 3397 ^{O}E	Land Cover *TamarixDioica*
	Gulail	63	27^{O} 09230 ^{O}N 39^{O} 4181 ^{O}E	Barren Land
	Gulail	58	27^{O}09228 ^{O}N 39^{O}4187 ^{O}E	Land Cover With Indus Water
6.	MarhoKotri	37	26^{O} 96403 ^{O}N 38^{O} 0326 ^{O}E	Land Cover With Water
	MarhoKotri	33	26^{O} 97001 ^{O}N 38^{O} 0566 ^{O}E	Land Use For Agriculture
	MarhoKotri	39	26^{O}50422 ^{O}N 38^{O}0099^{O}E	Land use With village
7.	Hudarani	49	27^{O} 42122 ^{O}N 40^{O} 6637 ^{O}E	Land Use For Agriculture
	Hudarani	65	27^{O} 42131 ^{O}N 40^{O} 6620 ^{O}E	Land Use For Agriculture
	Hudarani	40	27^{O}42121 ^{O}N 40^{O}6641^{O}E	Land Use For Agriculture
8.	BahadiPur	50	27^{O} 03124 ^{O}N 39^{O} 7067 ^{O}E	Land Cover With *Prosopisjuliflora*
	BahadiPur	56	27^{O} 029340 ^{O}N 39^{O} 6204 ^{O}E	Land Cover With Indus Water
	BahadiPur	58	27^{O}02823 ^{O}N 39^{O}6355 ^{O}E	Land Use For Agriculture
9.	Budani	30	26^{O} 94897 ^{O}N 38^{O} 1002 ^{O}E	Land Cover *TamarixDioica*
	Budani	31	26^{O} 94824 ^{O}N 38^{O} 1024 ^{O}E	Land Cover *TamarixDioica*
	Budani	33	26^{O}94905 ^{O}N 38^{O}1004^{O}E	Land Cover with Indus Water

The Methodology flowchart of satellite data classification has been shown in **(Fig.2)**.

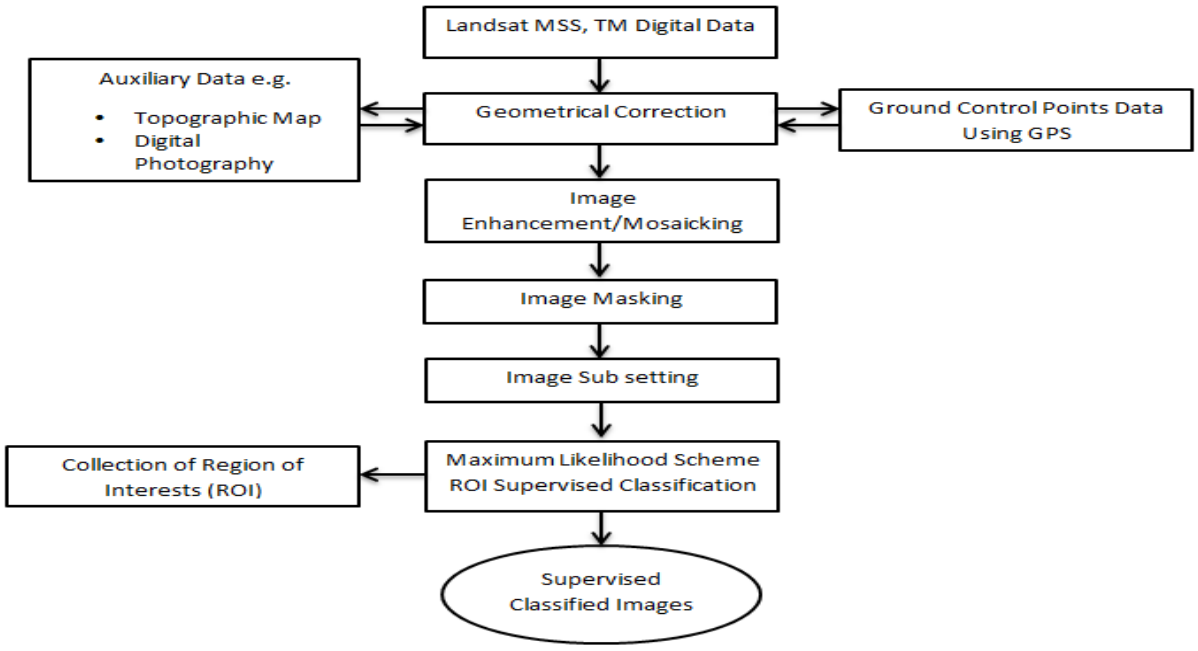

Fig. 2. Methodology of Image Classification

4. RESULTS

The satellite sensed information used for deforestation analysis and werepreferred non-cropping period, in April, there was no seasonal crop in that district, merelya fewstable vegetable crops were present in river basin. The images of December- 2009 - & January 2010 were selected with seasonal crops to analyses the agriculture area in the Indus basin. The result of Landsat MSS and TM images of 1979 and 1992 in

4.1 Classification: April - 1979 - 1992 and 1998

(Fig. 3(a,b), show greater amount of thick and in good physical shape forests cover in the area of river basin, from Kotri barrage to Arabian Sea and from 1998 to 2010 drastic reduction in forests cover was observed as shown in **(Fig. 3(c)–4(a, b, c))**.The last two cropping seasonal imageryconfirm that the largest part of the area of river basin was used for cultivation used **(Fig.5(a, b)**.Consolidated record of forests cover, agriculture and other objects are shown in Table: 1.

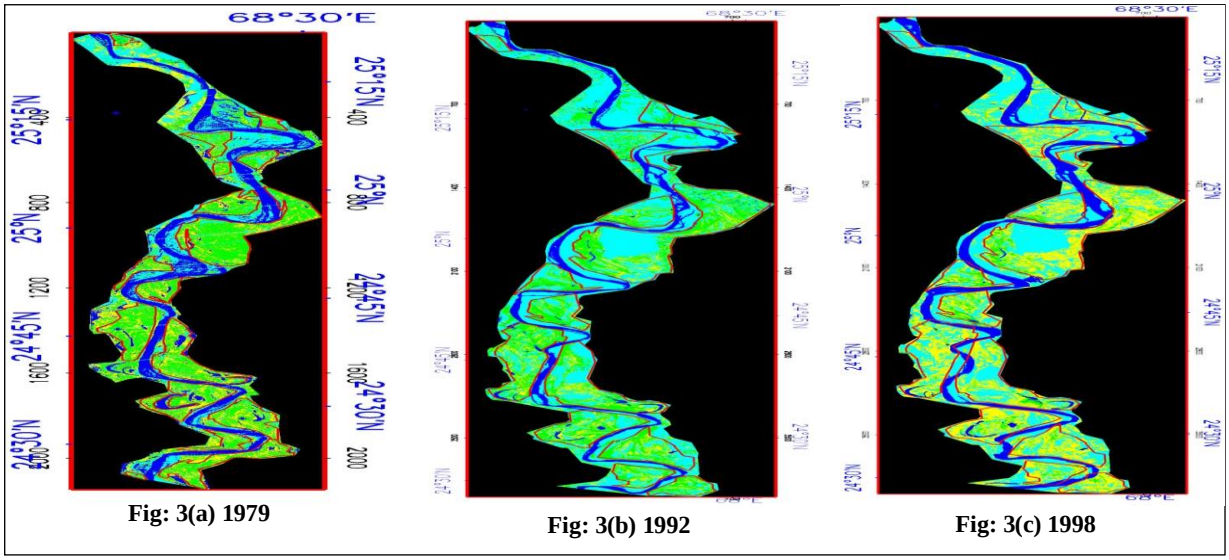

Fig: 3(a) 1979 **Fig: 3(b) 1992** **Fig: 3(c) 1998**

Overall accuracy of image **1979** - 93.46%, **1992**- 99.18% and **1998** - 99.91%
Kappa coefficient is **1979** - 0.9094, **1992** - 0.9886, and **1998** - 0.9986,

4.2 Classification: April - 2000- 2006 and 2009.

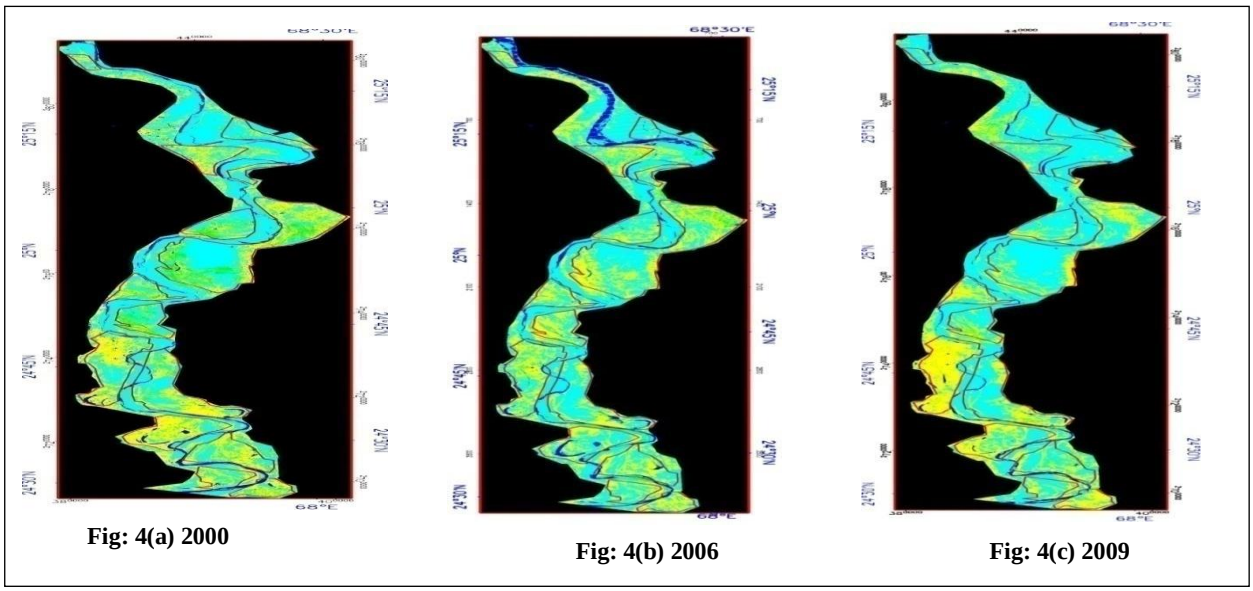

Fig: 4(a) 2000 **Fig: 4(b) 2006** **Fig: 4(c) 2009**

Overall accuracy of image **2000** - 99.79%, **2006** - 100% and **2009** - 100%
Kappa coefficient is 2000 - 0.9966, 2006 - 1.0000, and 2010, 1.0000.

4.3 Classification: December - 2009 - & January 2010

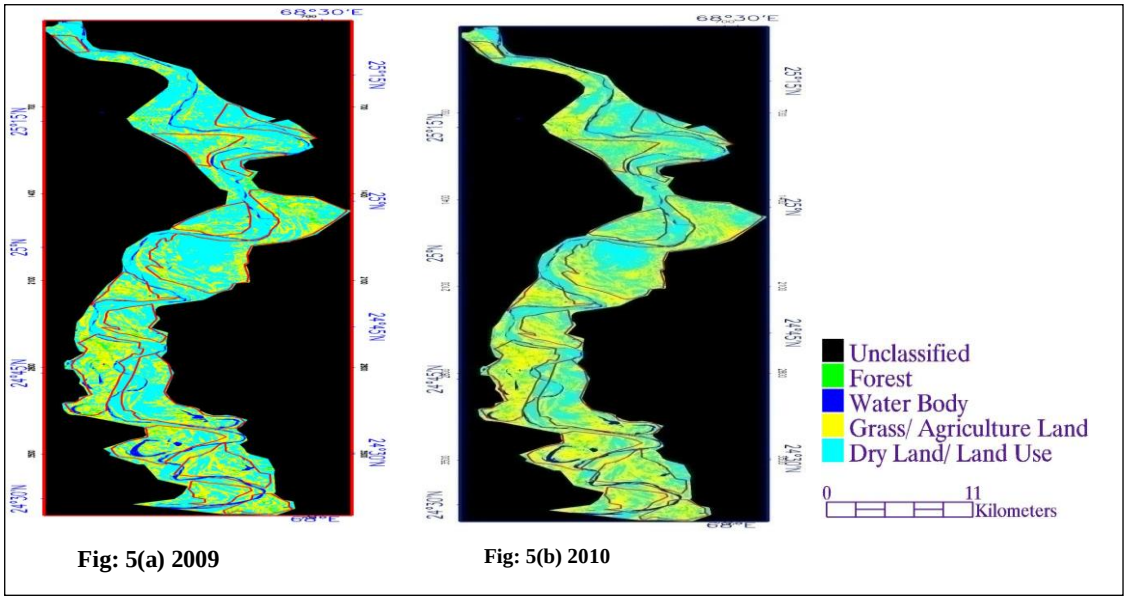

Fig: 5(a) 2009 **Fig: 5(b) 2010**

Overall accuracy of image 2009, **100%** and 2010, **99.00%**
Kappa coefficient is 2009 - 1.0000 **and 2010 - 0.9825**

Table 1 Evaluation ... different years and other objects in (%) from 1979 to 2010- January.

Year	landsatMSS Data sat1979	landsat TM data sat 1992	landsat TM Data sat1998	landsat TM Data sat 2000	landsat TM Data sat 2006	landsat TM Data sat 2009	landsat TM Data sat 2009-12	landsat TM Data sat 2010 -01
Forest cover	35.11%	29.14%	8.10%	5.56%	2.57%	1.96%	3.025%	2.237%
Water body	23.66%	12.21%	16.64%	4.87%	6.17%	2.87%	3.468%	3.782%
G/agriculture land	22.36%	10.12%	33.16%	33.63%	32.24%	32.413	2.53%	46.53%
Dry/ barren land	18.84%	48.51%	42.08%	55.91%	59.2%	62.74%	60.97%	47.45%

5. CONCLUSION

The results reveal that forests cover have disappeared from the basin and most of the area has been usedfor agriculture purpose. Irrigation water is obtained from outside the boundaries of Indus River.The local communities have broken the boundaries of Indus River illegally with the connivance of forest department and local government; as a result of this the forest cove has been replaced by the agriculture.The result during flood most of the urban areas are inundated by the flood water. The study of Thatta forests cover has been analyzed and valuable suggestion for the government anddecision makersfor sustainable management and planning to avoid future damages of forests and toprotecturban areas of Thatta division.

ACKNOWLEDGEMENT

The author is thankful to the University of Sindh, Jamshoro, Sindh Pakistan for financial support for the research project**.**

Appendix:

Table 2: Ground control points (GCP)" of the Study Area using GPS and the digital camera

No.	Name of Forests	Sea level (ft)	GPS L/L	Information
1.	KhirSar	70	27^{O} 44635 ^{O}N 40^{O} 6355 ^{O}E	Barren land
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			40 O 6344 O E	
2.	Panwhari	54	27 O 30225 O N 39 O 7551 O E	Land Cover*CalotropisProcera*
	Panwhari	52	27 O 29861 O N 39 O 8431 O E	Land Cover With *Prosopisjuliflora*
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3.	Hayat Gaho	33	27 O 06500 O N 39 O 2925 O E	Land Use For Agriculture
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5.	Gulail	67	27 O 08549 O N 36 O 3397 O E	Land Cover *TamarixDioica*
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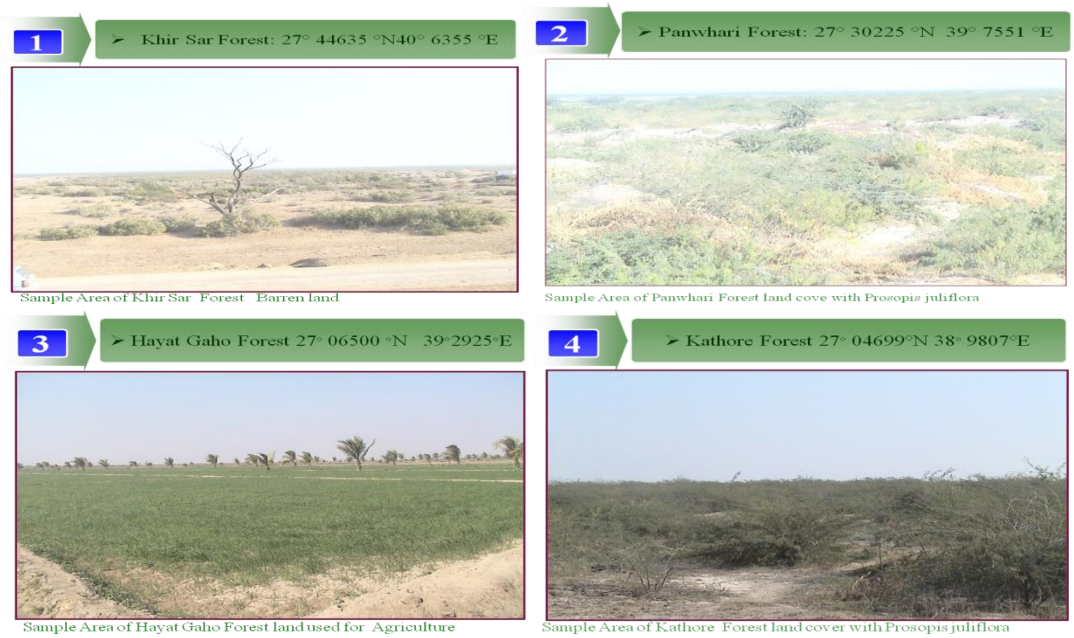
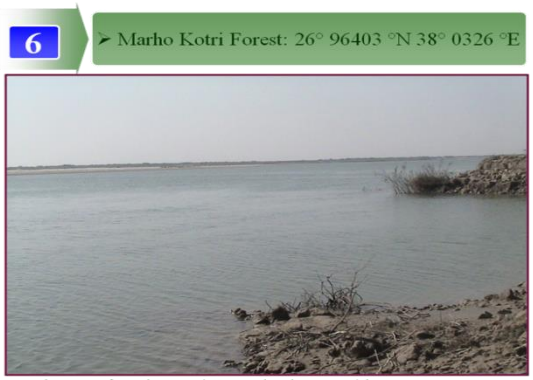
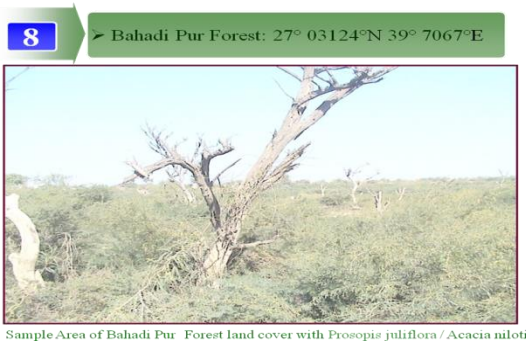


Sample Area of Gulail Forest land Cover with Calotropis Procera



Sample Area of Marho Kotri Forest land cover with Sea Water

Sample Area of Hudarani Forest land used for Agriculture



Sample Area of Bahadi Pur Forest land cover with Prosopis juliflora / Acacia nilotic

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