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Assessment of Deforestation of Riverine Forests of Nawabshah & Hyderabad Divisions Using Landsat Data



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Abstract

The large scale deterioration of forests and natural resources are threatening ecosystem of forests. The deforestation contributes to regional climate change and environmental and social problem such as flood, ecology, health, and economy. It was necessary to carry out land cover such as (forests cover). The scientific studies have been focusing on the past and present conditions of Nawabshah and Hyderabad divisions, to extent of forests cover and other related objects using (RS) remote sensing technologies. The Riverine forests of Nawabshah and Hyderabad divisions are disappearing very rapidly due to construction of dams/barrages on the upper streams to produce hydroelectric power and irrigation works significantly reducing the discharge of fresh water into the lower Indus basin. The anthropogenic activities and livestock population increased grazing and illegal tree cutting have been contributing to depletion process. The landsat advance data MSS and TM to analyze forest cover from 1979 to January - 2010 has been used to calculate the deforestation area of Nawabshah and Hyderabad division. The results show significant changes in sub tropical forests cover, continuously monitored from 1979 to 2010. Overall forests cover in 1979 was **42.67%**, 1992 **37.62%**, 1998 **11.74%**, 2000 **9.52%**, 2006 **10.69%**, 2009 **4.71%**, 2009-12 **2.50%**, and 2010 **0.722%**.

Key words: Analysis deforestation; Land use/Land cover remote sensing; supervised classification method; Landsat; Riverine Forests Sindh.

1. Introduction

Forests are a valuable source which contributes significantly to economy and provides environmental stability, (regional climate stability), regulate rainfall patterns, reduce sedimentation load in our rivers. The environmental pollution and climate change have become burning issues throughout the world and natural and human made disasters such as land **erosion**, flooding, agriculture, urbanization and unemployment (theft due to poverty) drought global warming, contribute to deforestation. The forests of Sindh since independence (1947) have undergone a considerable change in its resource and extent both quantitatively and qualitatively. The forests of Sindh prior to World War II were almost fully stocked. Owing to excessive wartime pressure, the over exploitation of the forests was inescapable,

necessitating deviation from prescribed management practices. This has inevitably resulted in over felling and depletion of resources. Sindh province occupies 14.09 million ha of the lower Indus plain. Agriculture, forestry and pasture are three main land uses in the province. The Indus River traverses through Sindh like a mid-rib covering 865kms, from Guddu Barrage to Arabian Sea and the only source of water for irrigation, agriculture, forestry and human consumption. Riverine tract and delta formed by River Indus occupies a special significance in economy and ecology of Sindh province. Agricultural expansion and subsequent industrial development has brought significant economic growth in the country over time. But at the same time construction of irrigation development structures at the upper streams of river Indus and its tributaries for storage and diversion of water for agricultural use and power generation has reduced intensity and frequency of floods in lower Indus basin. This study looks into the effect of deforestation changes in Nawabshah and Hyderabad division forests by remote sensing, focusing forests cover of s using temporal Landsat MSS & TM data of 1979, 1992, 1998, 2000, 2006 2009, December - 2009 and January - 2010.

Study Area

The Riverine forests of Nawabshah and Hyderabad division grow up in narrow belts along the banks of Indus. They cover an area of **440,491.214 Acres** which vary from 4 to 6 km in width and a line barrier between the river and the embankments has been formed against the flood in the country side. The Climate of the study area is sub-tropical and continental type, comprising hot summers and dry winters lasting from December to February. The annual mean rainfall in the northern part is about 100 mm whereas in the south it is 175mm. July and August are the months of rainfall. Riverine forests have been significant sanctuaries for a variety of mammals and reptiles especially Hog deer and other animals like partridges, wild boars, jackals, sand grouse, wolves, porcupines etc. The main species of plants of Riverine forests are *Acacia nilotica* *Prosopis spicigera*, *Prosopis glandulosa*, *Tamarix dioica* *Desmastachya bipinnala* *Calotropis Procera*, etc.

Fig: 1. showing the Area of Study, Nawabshah and Hyderabad divisions

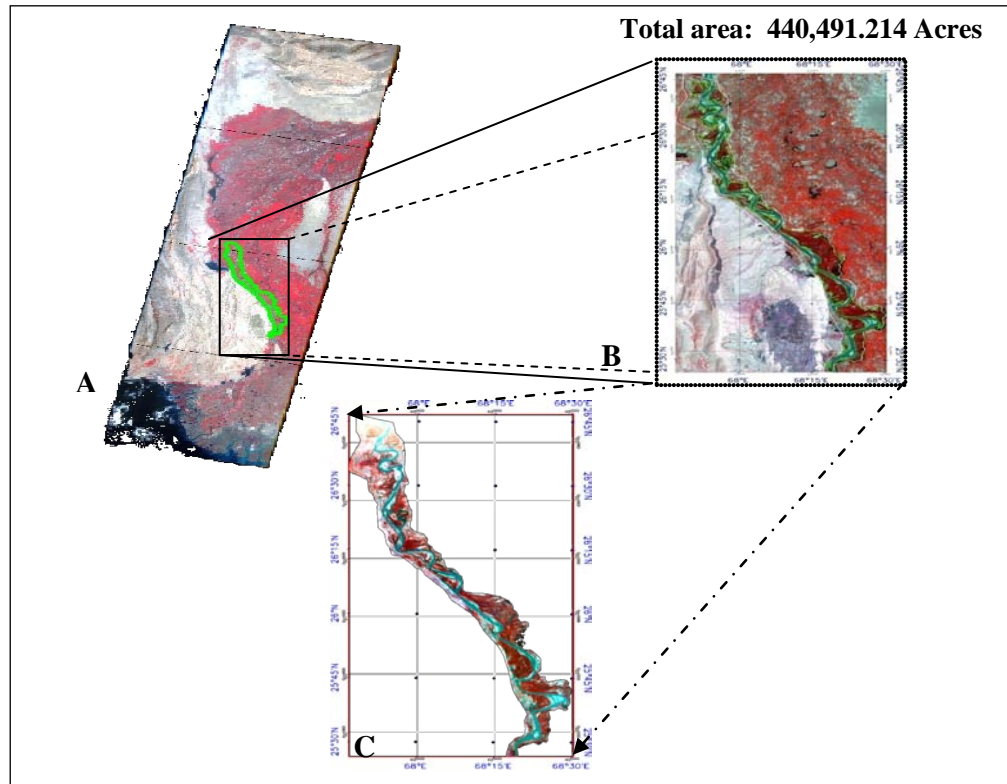


Figure: 1 (a) showing mosaic of whole study area of riverine forests (box show area for extract).

Figure: 1 (b) showing extract area of Nawabshah and Hyderabad divisions.

Figure: 1 (c) showing particular area of riverine forests.

2. Data and Material

The Landsat 4 & 5 satellites are commonly used for land cover classification. The Landsat 4 MSS - 5 TM sensors are medium-resolution and the Landsat 7 ETM+ sensor are very similar. Table 1, 2. Details regarding the capabilities of these sensors are given in Table 1. Images from these satellites were used,

Table.1: Landsat satellite characteristics.								
Landsat 5 TM			Landsat 7 ETM+			Landsat 4 MSS		
Band	Spectral Wavelength (μm)	Spatial Resolution (m)	Band	Spectral Wavelength (μm)	Spatial Resolution (m)	Band	Spectral Wavelength (μm)	Spatial Resolution (m)
1	0.45-0.52	30x30	1	0.45-0.52	30x30	4	0.5-0.6	68 x 83
2	0.52-0.60	30x30	2	0.52-0.60	30x30	5	0.6-0.7	68 x 83
3	0.63-0.69	30x30	3	0.63-0.69	30x30	6	0.7-0.8	68 x 83
4	0.76-0.90	30x30	4	0.76-0.90	30x30	7	0.8-1.1	68 x 83
5	1.55-1.75	30x30	5	1.55-1.75	30x30	8	10.41-12.6	68 x 83
6	10.4-12.5	120x120	6	10.4-12.5	60x60	---	-----	-----
7	2.08-2.35	30x30	7	2.08-2.35	30x30	---	-----	-----
-			Pan	0.52-0.90	15x15	---	-----	-----
Swath Width		185 km	185 km		185 km			
Revisit Period		16 days	16 days		18 days			

Data Acquired and Source

For the present study, Landsat satellite images of riverine forests were obtained from United States Geological Survey (USGS) Data Interface.

Table.2: Landsat scene acquisitions			
Sensor	Path / Row	Acquisition Date (dd/mm/yy)	Source
MSS	151-152 / 40-44	26/04/1979	USGS
TM	151-152 / 40-44	23/04/1992	USGS
TM	151-152 / 40-44	03/04/1998	USGS
TM	151-152 / 40-44	13/04/2000	USGS
TM	151-152 / 40-44	17/04/2006	USGS
TM	151-152 / 40-44	25/04/2009	USGS
TM	151-152 / 40-44	27/12/2009	USGS
TM	151-152 / 40-44	22/01/2010	USGS

Software Used

ENVI 4.0 (Environment for Visualizing Images) –used for displaying and enhancement, subset, flip data, layer-stacking map study area, masking, select region of inters (ROI) and supervised classification of riverine area.

Topography: Topographic sheet of Riverine forests used for guidance

Digital Camera / Movie: used during field survey to take pictures and prepare movies of land covers/use.

GPS: For ground data collection, (Field survey). Simple handset GPS receiver (GM – 100) used, the accuracy of GPS receiver is +/- 1 – 3 meters, it moved 0.1m per/s

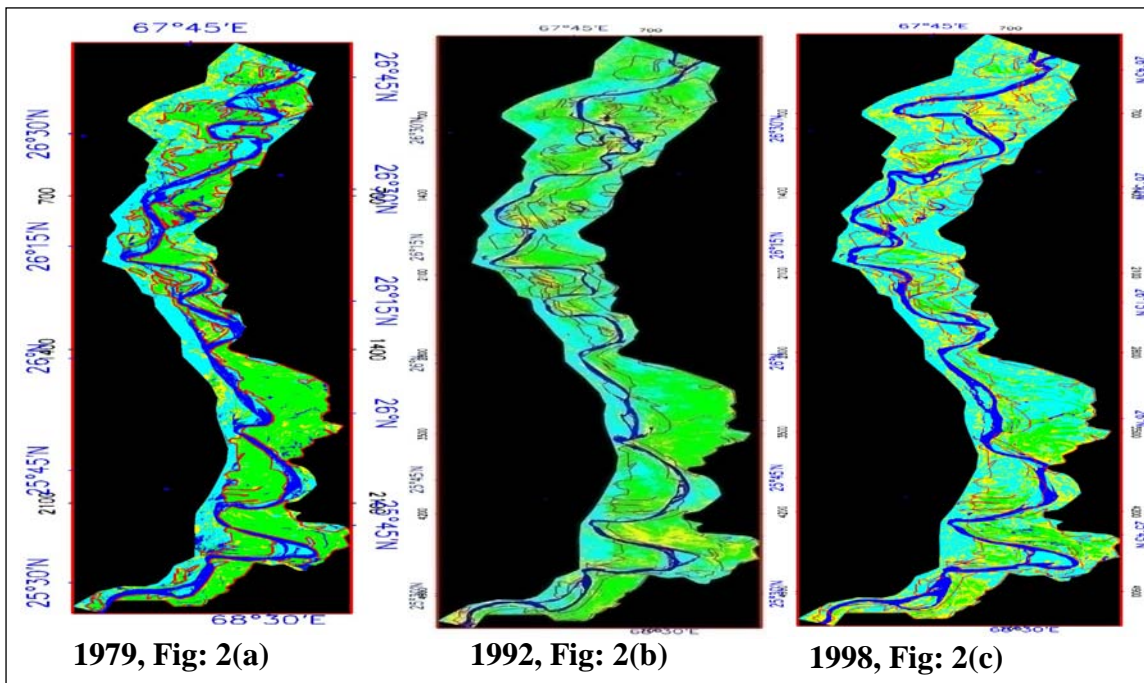
3. Research Methodology

The study areas of Nawabshah and Hyderabad divisions are covered in three Landsat images. Landsat MSS, TM digital data covering river Indus plains from Sukkur barrage to Kotri barrage and analyzed on *ENVI 4.0* (Environment for Visualizing Images) based image processing system. The raster images were enhanced by contrast stretching and displayed in false color composite images and subset. Geo-referencing was then carried out to remove geometric errors using the survey of Pakistan maps and field survey ground control points (GCP) to project the images to real world coordinate systems. Rectified images were mosaiced by image mosaicing method and color balancing was applied on mosaiced images. In order to use the required area of the mosaic, the outside area, i.e., the borderline of the river plain were digitized and masked. The Indus basin was classified into four main landuse/landcover classes, which are, forests, water body, grass/ agriculture land and dry/ barren land and then supervised classifications were conducted, The regions of interest were used for classification and determined the different zones (or classes) based on the spectral response. Similarly, the available Landsat MSS data of 1979 and Landsat TM data of 1992 were rectified with respect to Landsat TM 1998, 2000, 2006, 2009, 2009- December and 2010 January data was set as reference image and classified in the similar way. These classified maps from year 1979- April to 2010- January contained information about the Nawabshah and Hyderabad division forests, water body, grass/ agriculture land and dry/ barren land are shown in fig, 2(a, b, c), 3(a, b, c), and 4(a, b) respectively.

1. Results and Analysis

The remotely sensed data used for deforestation assessment was chosen for non-cropping season, in the month of April, when there was no seasonal crop in that area, only some permanent vegetable crops were present in the Indus basin (these two images December 2009 & January 2010, use for grass/ agriculture cover assessment in the forests area). The enhanced false colour composite of images, the grass/ agriculture land appear in bright red and forests patches appear in dark red tone and can easily be distinguished from other ground features. In Landsat MSS image of 1979, it was observed that there were large numbers of dense and healthy forests in the upper Indus river basin, from Sukkur barrage to Kotri barrage. From 1979 to 2009 drastic reduction in forests cover was observed. From 2009- December and 2010- January both images show that most of the area of forests (Indus basin) has been used for agriculture purpose fig: 4(a, b). These satellite imageries from 1979 to 2010 are classified into four classes, Green legend for the forests cover, yellow for Grassland / agriculture cover and aqua for dry land/ land use.

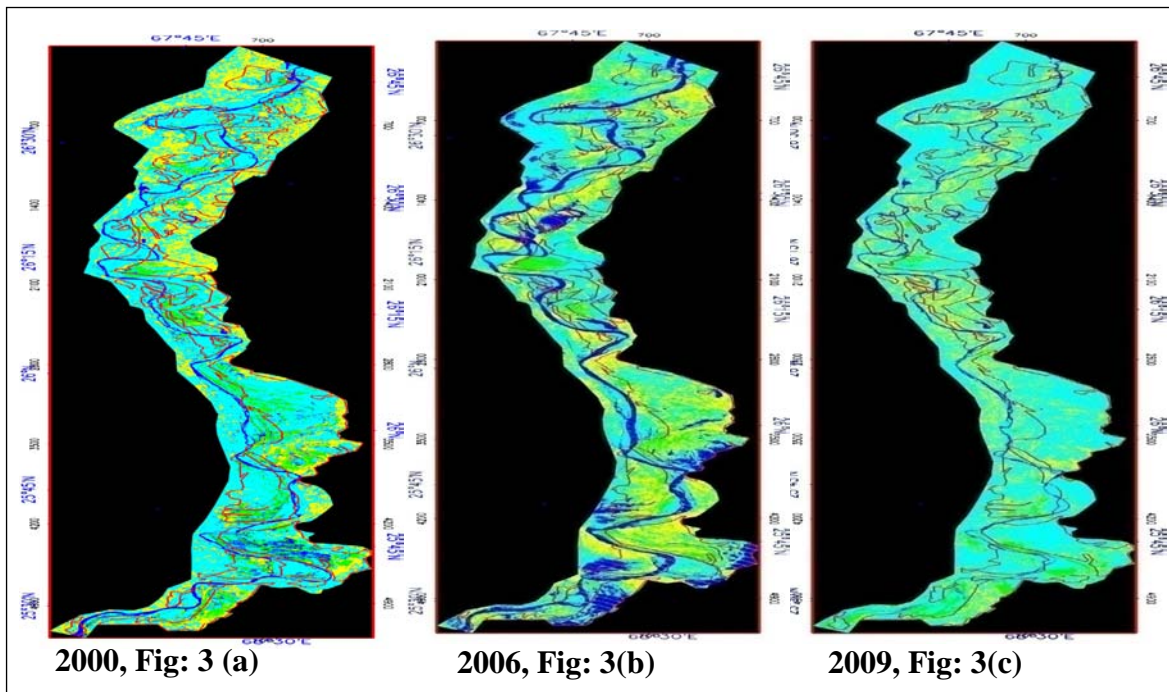
Classified Images: April – 1979, April – 1992 & April - 1998



Overall accuracy of image 1979, **99.86%**, 1992, **99.96%** and 1998, **99.83%**

Kappa coefficient is in 1979, **0.9981**, 1992, **0.9993** and 1998, **0.9972**,

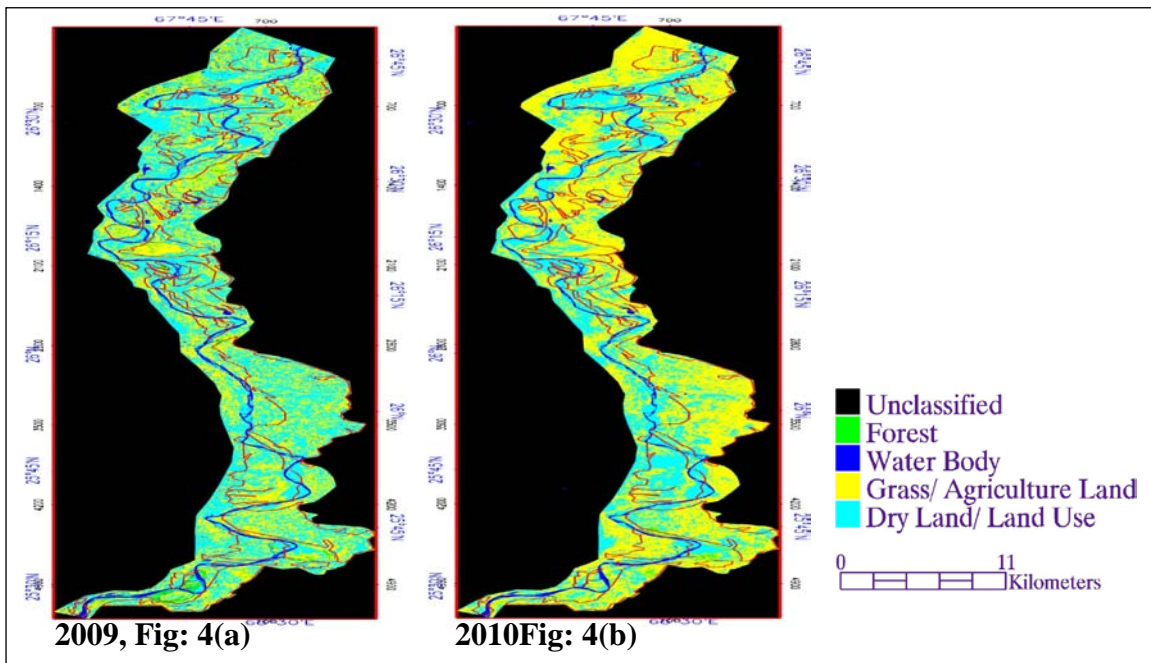
Classifieds Images: April -2000, April – 2006 & April 2009



Overall accuracy of image 2000, **100%**, 2006, **100%** and 2009, **99.68%**

Kappa coefficient is in 2000, **1.0000**, 2006, **1.0000** and 2009, **0.9952**,

Classifieds Images: December - 2009 - & January 2010



Overall accuracy of image 2009, **100%** and 2010, **100%**

Kappa coefficient in 2009 **1.0000** and 2010, **1.0000**,

Table 3: Assessment of Nawabshah and Hyderabad forests areas and other objects (in percentage) based on remote sensing data of eight different years from 1979 to 2010- January.

Year	landsat MSS	landsat TM	landsat TM	landsat TM	landsat TM	landsat TM	landsat TM	landsat TM
	Data sat1979	data sat 1992	Data sat1998	Data sat 2000	Data sat 2006	Data sat 2009	Data sat 2009-12	Data sat 2010 -01
Forests cover	42.67%	37.62%	11.74%	9.52%	10.69%	4.71%	2.50%	0.722%
Water body	18.3%	8.69%	12.59%	9.48%	15.34%	3.07%	6.64%	3.85%
G/agriculture land	10.54%	17.11%	27.27%	23.41%	26.74%	19.87%	39.16%	58.23%
Dry/ barren land	28.39%	36.56%	48.38%	57.55%	47.22%	72.32%	51.67%	37.18%

5. Conclusions

Landsat 4 and landsat 5, remotely sensed data of Nawabshah and Hyderabad division forests has been processed and interpreted to extract accurate information of deforestation and to find out the precise and accurate boundaries of Indus basin by developing digital images record from 1979 to 2010. Our research has revealed the alarming changes in the Nawabshah and Hyderabad divisions. The overall forests cover in 1979 was 42.67%, 1992 37.62%, 1998 11.74%, 2000 9.52%, 2006 10.69%, 2009 4.71%, 2009-12 2.50%, and 2010 0.722%; respectively overall drastic reduction observed in both region in forests area.

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