Analysis of Riverine Forests of Nawabshah and Hyderabad Divisions Using Landsat Satellite 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%.**

Keywords: 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. Riverine Forests of Sindh province occupies the area **1, 861,571 Acres** of the lower Indus plain, the mostly used Indus basin for Agriculture, forestry and grazing land 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 (Bhatti, *et al.,* 2000 and Kimin 1987). 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 using temporal Landsat MSS and TM data 1979-1992, 1998-2000-2006-2009, December, 2009 and January 2010 (McDermid, *et al.,* 2005 and Siddiqui, *et al.,* 2004).

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 3 to 4 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 (Shah, 2000 and Fund, 2008).

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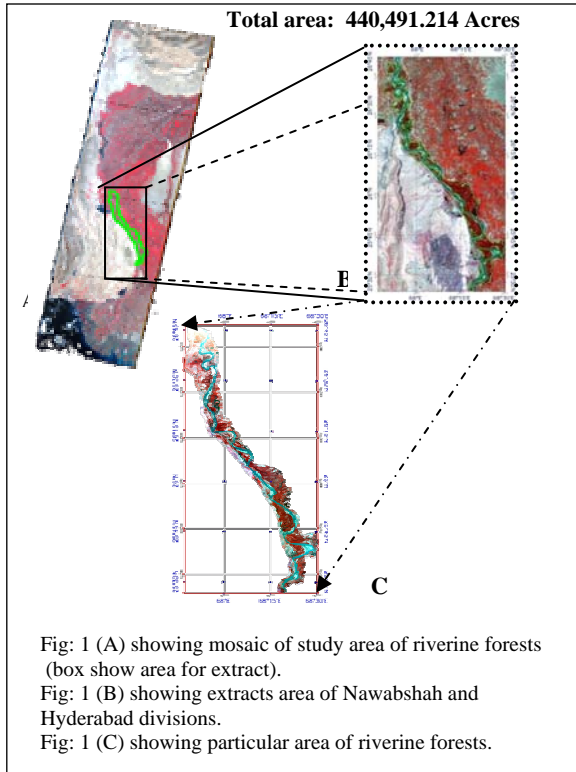
Total area: 440,491.214 Acres

Fig: 1 (A) showing mosaic of study area of riverine forests (box show area for extract).
Fig: 1 (B) showing extracts area of Nawabshah and Hyderabad divisions.
Fig: 1 (C) showing particular area of riverine forests.

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

2. RESEARCH METHODOLOGY

The study areas of Nawabshah and Hyderabad divisions are covered in three Landsat images (USGS). 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 (Richards *et al.*, 1999). 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 (Hesbon, e*t al.*, 2003). 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 Dec. and 2010 Jan. data was set as reference image and classified in the similar way. These classified maps from year 1979 April to 2010 Jan. contained information about the Nawabshah and Hyderabad division forests, water body, grass/agriculture land and dry/barren land are shown in F**ig, 3 (a, b, c), 4 (a, b, c), and 5 (a, b)** respectively.

The methodology flowchart of satellite data classification has been shown in Fig.2.

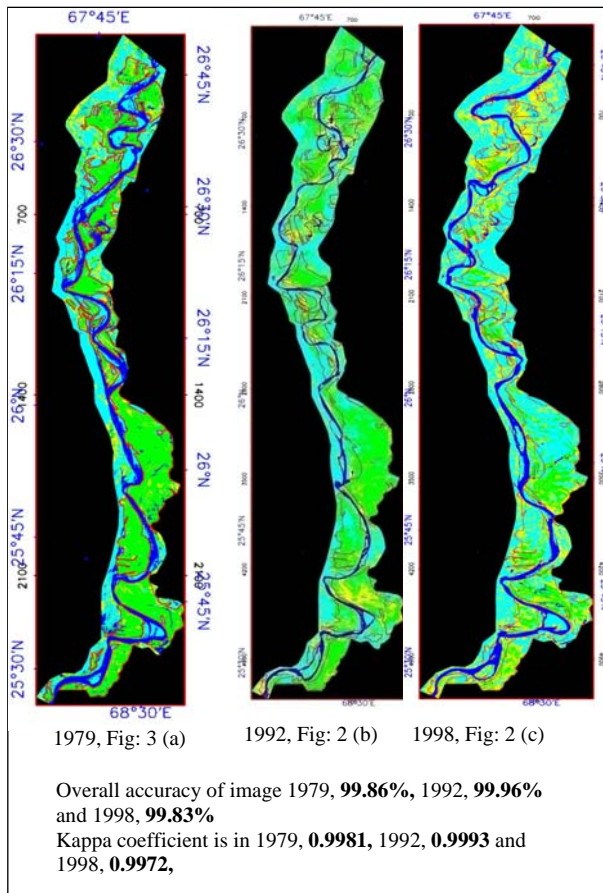**Fig. 2. Methodology for image classification**
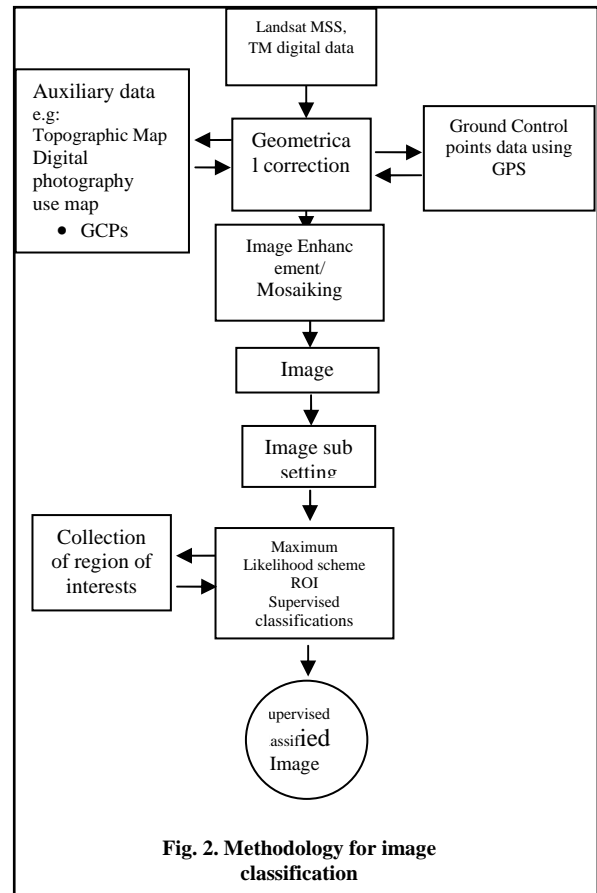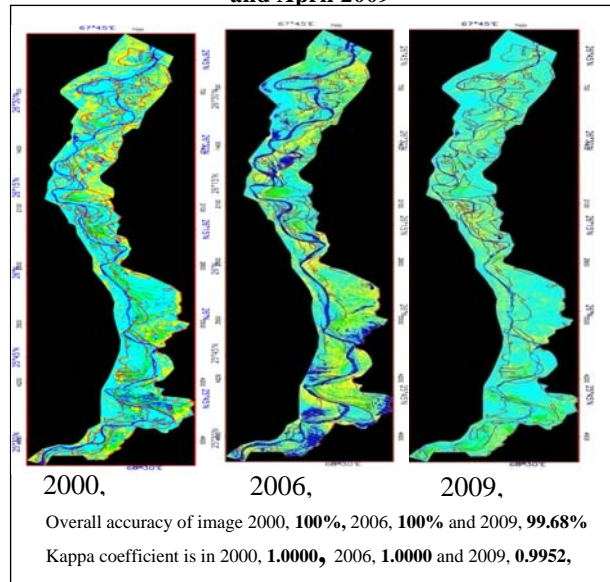
3. RESULTS AND ANALYSIS

The remotely sensed data used for deforestation assessment was chosen non-crop 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 and 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 Dec. and 2010 Jan.both images show that most of the area of forests (Indus basin) has been used for agriculture purpose (**Fig. 5 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 dry land/land use.

5.1 Classifieds Images: April, 1979, April, 1992 and April 1998.

1979, Fig: 3 (a)   1992, Fig: 2 (b)   1998, Fig: 2 (c)

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,**

5.2 Classifieds Images: April 2000, April 2006 and April 2009

2000,   2006,   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,**

5.3 Classifieds Images: December 2009 and January 2011.

Unclassified
Forest
Water Body
Grass/ Agriculture Land
Dry Land/ Land Use

0   11 Kilometers

2009, Fig: 4 (a)   2010Fig: 4 (b)

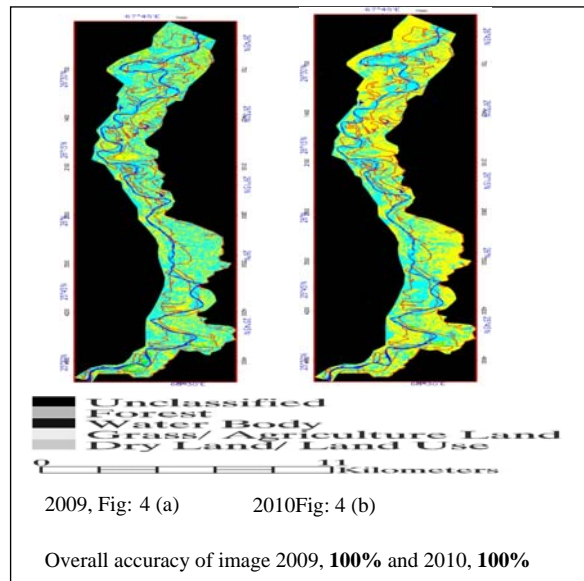Overall accuracy of image 2009, **100%** and 2010, **100%**

Table 3: Assessment of Nawabshah and Hyderabad forests areas and other objects (%) 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%

4.   CONCLUSION

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 drastic reduction observed in both regions are 89%.

Recommendations and Mitigation

•   In the present situation, there is a strong need to prepare a dynamic policy for the protection and management of Riverine forests which is most important to continue the forestry in Indus basin; these forests play essential part in environment and protection of biodiversity in Indus basin.

•   These recommendations have been made on the basis of research findings and ancillary data collected from different departments and interaction with all the stakeholders. Observations made during the field inspections, discussions with the communities and field staff to analysis of the climatic, social, political, economic and biotic factors in the Indus Eco-region.

•   Security is a vital requirement for any development and management program, therefore present study strongly suggests the maintenance of law and order in Riverine forest and to provide required force to forest staff to enforce writ of law to vacate encroachments and check wood cutting in forests and apprehend the culprits.

•   Lease policy was one of the main tools for developing and managing Riverine forests. These policies had adverse impact on Riverine forest and converted forest land into agriculture land which is the root cause of encroachment. Therefore the study suggests that leasing policy should be stopped immediately.Forest department should enhance the monitoring system to achieve departmental goals, with the collaboration of researchers, scientists and local communities. This study suggests that the forest department should develop acknowledgment database system with environmental application, remote sensing and GIS.

5.   ACKNOWLEDGEMENT

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