Deforestation Analysis of Riverine Forest of Sindh Using Remote Sensing Techniques

HABIBULLAH U. ABBASI*, AND MUSHTAQ AHMED BALOCH**

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ABSTRACT

During recent decades the large scale deterioration of forests and natural resources is an eye opener. The degradation of forests and other natural resources has affected the ecology, environment, health and economy. The ecological problem with living organisms such as animals and plants, environmental problems such as increase in temperature and carbon dioxide, these factors have contributed to change in regional climate, health problems such as skin, eye diseases and sunstroke and economic problems such as loss of income to rural population and resources which depend on forests such as livestock. Therefore, it was necessary to carry out land cover/use research focusing on the monitoring and management of the present and past state of forests cover and other related objects using RS (Remote Sensing) technologies. The RS is way of mapping, monitoring the changes taking place in forests cover and other objects on a continuing basis. Sukkur and Shikarpur riverine forests are vanishing quickly due to the construction of barrages /dams on upper streams to produce hydroelectricity and irrigation installations which reduce the discharge of fresh water into the downstream Indus basin. Moreover, anthropogenic activities, livestock population, increased grazing, load and illegal tree cutting have contributed to this. The riverine forests are turning into barren land and most of the land is used for agriculture. These uncontrolled changes contribute to climate change and global warming. These changes are difficult to monitor and control without using RS technology. Assessment of deforestation of the Sukkur and Shikarpur to find temporal changes in the forests cover from April, 1979 to April, 2009. The integrated classes such as water body, grass/ agriculture land, dry/barren land and forest cover maps show the temporal changes taking place in the forests cover as show in the present research for the last 30 years period. RS has been employed in the present study to assess deforestation. The results show significant changes in sub-tropical forests cover, the overall forests cover in April, 1979 was 22.67%, April, 1992 17.38%, April, 1998 12.28%, April, 2000 6.15%, April, 2006 7.51%, and April, 2009 5.97%, the overall change observed in forest area is 25.07%.

Key Words: **Analysis Deforestation; Land Use/Cover Remote Sensing; Supervised Classification Method; Maximum Likelihood Algorithm; Landsat; Riverine Forest Sindh.**

1. INTRODUCTION

Forest is a valuable resource 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, unemployment (theft due to poverty), drought and global warming, have contributed to deforestation [1].

* Ph.D. Scholar, and ** Professor,
Center for Environmental Sciences, University of Sindh, Jamshoro, Pakistan

The forests of Sindh since independence (1947) have undergone a considerable change in its resources and extents both quantitatively and qualitatively. The forests of Sindh before World War-II were totally stocked. But due to extreme wartime stress greater utilization of forest; the results were reduction of natural resources [2-3]. 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 traverse through Sindh like a mid-rib covering 865kms, from Guddu Barrage to Arabian Sea and is 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 a period of 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 [4]. This study looks into the effect of changes in riverine forests from Guddu to Sukkuer by remote sensing. Remote sensing is a powerful technique for surveying, mapping and monitoring and assessment of forests cover using temporal images MSS & TM sensor data of 1979, 1992, 1998, 2000, 2006 and 2009 [5].

2. STUDY AREA

The Sukkur and Shikarpur division's forests grow up naturally at the side of in Indus-basin of Indus. They cover an area of 493,439.873 Acres (Fig.1) fluctuating from 4-6km in width provide protection of the river against the flood in the province [6]. The Climate of the study area is sub-tropical and continental type, comprising of warm summers and waterless winters last from December to February. The yearly mean rainfall in the northern part is about hundred millimeters but in the south it is one hundred seventy five millimeters. July and August are the months of rainfall [6]. Riverine forests have 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" [7]. The most important species of plants of Riverine forests are "Acacia nilotica, Prosopis spicigera, P. juliflora, Prosopis glandulosa, Tamarix dioica, Desmastachya bipinnala, Calotropis Procera," etc.

3. METHODOLOGY

The study areas of Sukkur and Shikarpur divisions are covered in four satellite images. MSS, TM sensor imagery data covering Indus basin from Guddu to Sukkur barrage and data analyzed on ENVI 4.0 (Environment for Visualizing Images) software system; the raster imagery were improved by distinction stretching and applied false color composite and subset study area. Geo-referencing carried out to eliminate geometric, distortion using the topographic maps and field survey GCP (Ground Control Points) to development geometrical correct images. Geometrical correct images were mosaiced by image mosaicing method and color matching scheme was applied on mosaiced imagery. The study areas and the borderline of the river forest, Indus basin was digitized and masked. The river basin was divided into four main land use/cover classes, which are forests cover, water body, grass/ agriculture land and dry/barren land. Then supervised classifications were conducted, The ROI (Regions Of Interest) were used for classification, show Table 1, latitude and longitude of sample areas of different forests and to determine the different zones (or classes) based on the spectral response. Likewise, the existing MSS sensor imagery of 1979 and TM sensor imagery of 1992 were corrected with respect to TM sensor 1998, 2000, 2006 and 2009. These analyzed images from year April, 1979 to April, 2009 contain information about the Riverine forests, water body, grass/ agriculture land and dry/barren land are shown in Figs. 2-4(a-b) respectively.

4. RESULTS

The remotely sensed data used for deforestation assessment was chosen for non-cropping season, in the month of April, with no seasonal crop production in that area, except few permanent vegetable crops were present in the area. The enhanced false colour composite of images, the grass/ agriculture land cover show in bright red and forests patches become visible in dark red tone and can easily be illustrated from extra ground features. In MSS sensor image of 1979, the analyzed large amount of forests cover was healthy in Sukkur and Shikarpur

division from Guddu to Sukkur barrage. From 1979 to 2009 drastic reduction in forest cover was observed and most of the area of Indus basin was used for agriculture purpose.

4.1 Supervised Classification

Supervised classification of satellite imagery MSS and TM: (April, 1979 and April, 1992) as shown in Fig. 2(a-b), shows that both images are classified into four classes; forest cover, Grassland/Agriculture cover, dry land/land use and water. Classification report shows that forest cover of Sukkur and Shikarpur divisions in 1979, was 22.67%, and Water body 14.60%, Grassland/Agriculture land 18.19% and Dry land/ land use 44.69%; similarly in 1992 the status of forest cover was less than in 1979 the total forest cover in both divisions 17.38%, Water body, 11.15%, Grassland/Agriculture 43.97% and Dry land/land use 27.48%.

4.2 Supervised Classification

Supervised classification of satellite imagery TM: (April, 1998 and April, 2000) as shown in Fig. 3(a-b) shows that both images are classified into four classes; forest cover, Grassland/Agriculture cover, dry land/land use and water. Classification analysis shows that forest cover of Sukkur and Shikarpur divisions in April 1998 12.28%, and Water body 12.67%, Grassland/Agriculture land 43.33% and Dry land/land use 31.70%; in April, 2000 the status of forest cover was less than in 1998 the total forest cover in 2000 6.15%, Water body, 7.97%, Grassland/Agriculture 24.57% and Dry land/land use 61.29%.

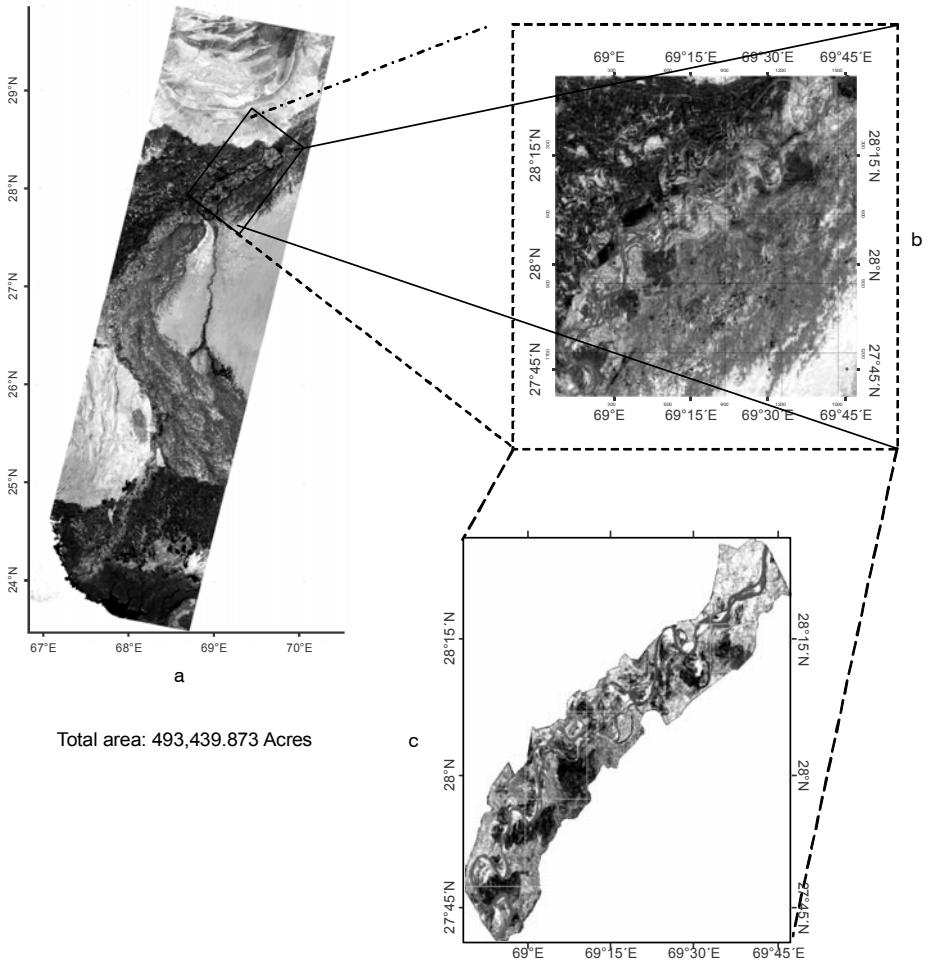

FIG. 1(A). SHOWING MOSAIC OF SINDH PROVINCE PAKISTAN (B). SHOWING EXTRACT AREA OF SUKKUR AND SHIKARPUR DIVISIONS (C). SHOWING PARTICULAR AREA OF RIVERINE FOREST

TABLE 1. GLOBAL POSITION SYSTEM, COORDINATES OF TRAINING AREAS OF FORESTS, SELECT COORDINATES USED FOR ROIS, FOR SUPERVISED CLASSIFICATION

No.	Name of Location	Sea Level (ft)	GPS L/L/A	Information
1.	Daho Forest	252	31° 15739 °N 52° 2394 °E	Land Cover With The Kandi (Prosopis Cineraria),
2.	New Gublo Forest	237	31° 19479 °N 52° 8046°E	Land Cover With The Forest
3.	Rounti Forest	236	31° 18054 °N 55° 5153 °E	Punjab Boundary
4.	Gondak Forest	240	31° 20732 °N 55° 8035 °E	Land Cover With The Forest
5.	Old Gublo	228	31° 18923 °N 54° 5144 °E	Land Cover With The Agriculture
6.	Mohromari Forest	206	31° 04920 °N 50° 0816 °E	Land Cover With The Lai (Tamarix Dioica)
7.	Sundrani Forest	285	31° 11479 °N 53° 7078 °E	Land Cover With The Agriculture
8.	Bind Dharoja Forest	220	30° 68378 °N 48° 9443 °E	Land Cover With The Forest
9.	Kadra Pur Forest	207	30° 71127 °N 48° 4951 °E	Land Cover With The Lai (Tamarix Dioica)
10.	Andal Dal Forest	177	30° 73227 °N 46° 36255 °E	Land Cover With Forest

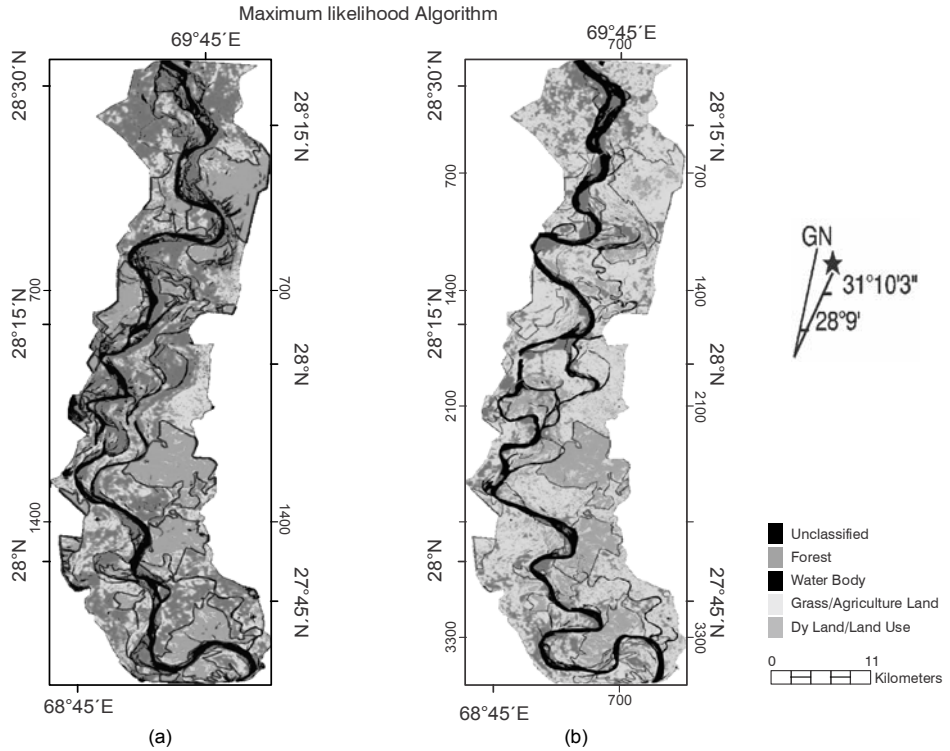

FIG. 2. (A) OVERALL ACCURACY OF IMAGE 1979, 99.96% AND KAPPA COEFFICIENT IS 0.9995 (B) OVERALL ACCURACY OF IMAGE 1992, 99.9% AND KAPPA COEFFICIENT IS 0.9996

4.3 Supervised Classification

Supervised classification of satellite imagery TM (April, 2006 and April, 2009) as shown in Fig. 4(a-b) shows that both images are classified into four classes; forest cover, Grassland/Agriculture cover, dry land/land use and water. Classification analysis shows that forest cover of Sukkur and Shikarpur divisions in April, 2006 7.51%, and Water body 9.58%, Grassland/Agriculture land 23.56%and Dry land/land use 56.33%; in April, 2009 the status of forest cover was less than in April, 2006 the total forest cover in April, 2009 5.97%, Water body, 8.34%Grassland/Agriculture 21.22% and Dry land/land use 64.45%.

The Riverine forests mapping based on remotely sensed data, were evaluated with the forest topographic maps prepared by Sindh Forest Department in 1974. These maps were prepared using conventional methods of survey. Riverine forests mapping from Guddu to Sukkur barrage show huge changes in the riverine forests covered area and water body; grass/agriculture and dry/barren land. The main causes of deforestation of Sukkur and Shikarpur are scarcity of fresh water, floods and illegal cutting for fuel wood and most of land for agricultural purpose. The annual ratio of depletion of forests is 9.0% (approximately). Result shows that the deforestation from 1979-2009 was about 85% (Table 2).

5. CONCLUSION

Assessment of forests by Landsat satellite images by remotely sensed data of Sukkur and Shikarpur forests was analyzed and the process was used to obtain correct classes' information to develop digital image record from 1979-2009. Present study would be supportive for decision makers to develop an effective management system and dynamic policies for riverine forests resources. Deforestation directly affects the ecology, and threatens socioeconomic condition and creates environmental problems in Indus Eco region.

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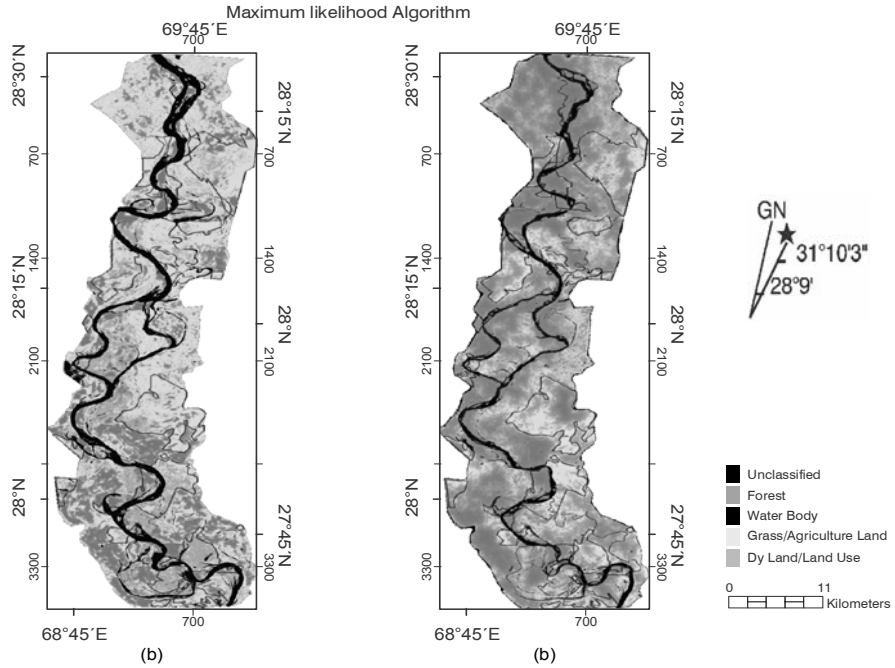

FIG. 3. (A) OVERALL ACCURACY OF IMAGE 1998, 99.53% AND KAPPA COEFFICIENT IS 0.9935 (B) OVERALL ACCURACY OF IMAGE 2000, 99.96% AND KAPPA COEFFICIENT IS 0.9994

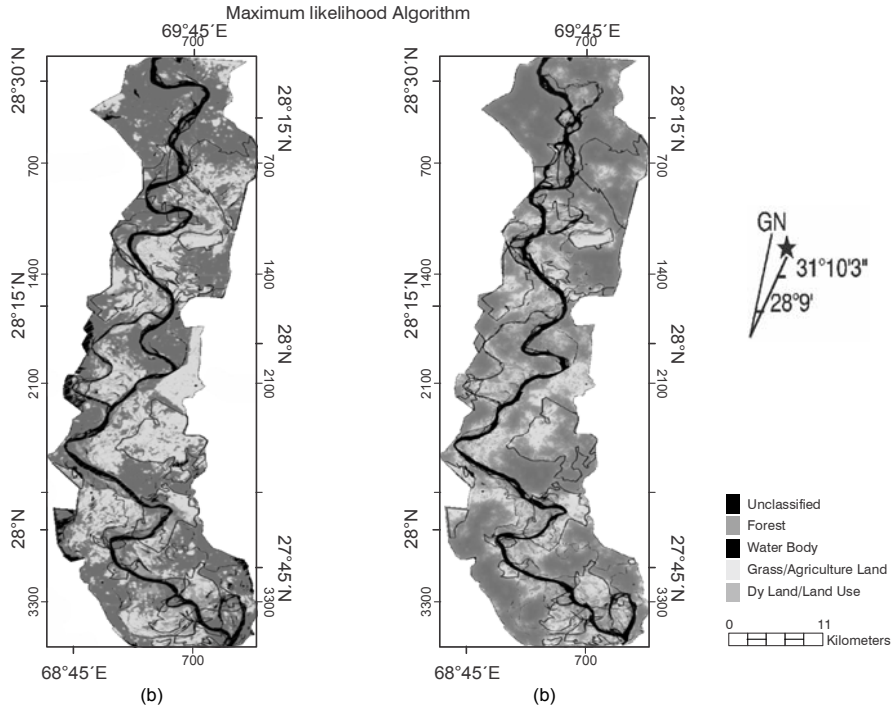

FIG. 4. (A) OVERALL ACCURACY OF IMAGE 2006, 99.93% AND KAPPA COEFFICIENT IS 0.9985 (B) OVERALL ACCURACY OF IMAGE 2009, 99.68% AND KAPPA COEFFICIENT IS 0.9945,

TABLE 2. EVALUATION OF RIVERINE FOREST AREAS OF SINDH PROVINCE BASED ON SATELLITE REMOTE SENSING DATA OF EIGHT DIFFERENT YEARS AND DIFFERENCE IN FORESTS AREA AND OTHER OBJECTS (%) FROM 1979-2009

Year	Landsat MSS Data Sat1979 (%)	Landsat MSS Data Sat 1992 (%)	Landsat MSS Data Sat1998 (%)	Landsat MSS Data Sat 2000 (%)	Landsat MSS Data Sat 2006 (%)	Landsat MSS Data Sat 2009 (%) (%)
Forest Cover	22.67	17.38	12.28	6.15	7.51	5.97
Water Body	14.60	11.15	12.67	7.97	9.58	8.34
Grassland/ Agriculture Land	18.19	43.97	43..33	24.57	23.56	21.22
Dry/Barren Land	44.69	27.48	31.70	61.29	56.33	64.45

REFERENCES

[1] Lee, K.S., and Joung, M.R, "determination of Land Use Change Categories Using Classification of Multitemporal Satellite Image Data", GIS Development, Poster Section 3, pp. 1-2Korea, 1998.

[2] Bhatti, A.M., and Keerio, G.R., "Trend of Forestry Research in Sindh Using 50, Years in Sindh", Proceeding of National Seminar on Perspectives of Forestry in Millennium, Volume 3, pp. 94, Karachi, Pakistan, April, 2000.

[3] Sheikh, G.M., "An Overview of Forestry in Sindh", Proceeding of National Seminar on Perspectives of Forestry in Millennium, Volume 3, pp, 11, Karachi, Pakistan, April, 2000.

[4] Shah, G.Q, "Change Ecology of Riverine Ecosystem in Sindh", Proceeding of National Seminar on Perspectives of Forestry in Millennium, Volume 3, pp. 148, Karachi, Pakistan, April, 2000.

[5] Wolvelaer, J.V., Gonzáles, C.S., López, A.G., and Maria, A., "Urban Atlas Updating by Semi-Automatic Change Mapping", Proceeding of 30th EARSeL Symposium, pp. 145,147, Paris, France, June, 2010.

[6] Siddiqui , N.M., Jamil , Z., and Afsar, J., "Monitoring Changes in Riverine Forests of Sindh-Pakistan Using Remote Sensing and GIS Techniques", Advances in Space Research, Volume 33, pp. 334, March, 2004.

[7] Fund, W.W., "Study of Riverine Forest Upstream Sukkur and Downstream Kotri", Report, pp. 3-18, Karachi, Sindh, Pakistan, 2008.