Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 7, Issue, 01, pp.11434-11439, January, 2015

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

USE OF GIS AND REMOTE SENSING TOOLS FOR ASSESSING POINT AND NON-POINT SOURCES OF POLLUTION TO KOLLERU LAKE IDENTIFICATION BASED ON LAND USE AND LAND COVER ASSESSMENT OF THE CATCHMENT AREA – AN APPROACH

***Raghuveer Naidu, K. and Atchim Naidu, M.**

Environment Protection Training and Research Institute, Hyderabad, India

ARTICLE INFO

Article History:
Received 25th October, 2014
Received in revised form
19th November, 2014
Accepted 14th December, 2014
Published online 23rd January, 2015

Key words:

GIS, Remote Sensing, Land use and Land Cover, Ground truthing, Geo-referencing, Classification system, Point source pollution, Non-point source pollution.

ABSTRACT

Nonpoint source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. Given the agriculture intensive economy in India, agricultural storm water discharges and return flows from irrigated agriculture are predominate sources under this category. The Point source means any discernible, confined and discrete conveyance and predominant contributors are Urban agglomerations and Industries. To carry out the assessment of pollutant load in macro level and in mirco level depending on the spatial scale, the land use and land cover assessment facilitates to quantify the total load into the lake system. The paper describes the methodologies adopted for carrying out such assessment for Kolleru Lake thereby to review the appropriate mitigation methods.

INTRODUCTION

Kolleru Lake, a wetland, supports a host of migratory birds and aquatic life, as well as the livelihood of many thousands of fishermen. This is the largest fresh water shallow lake in India, lies between the Godavari and Krishna river basins in Andhra Pradesh. An area covering 308.5 Sq.km. was declared as Kolleru Wild Life sanctuary by Government of Andhra Pradesh under Wildlife (Protection) Act, 1972 considering its renowned abundance and rich population of bird species namely pelicans, storks, ducks, herons, various waders etc. This lake with its multi-faceted eco-system and grandeur has been inviting the attention of national and international tourists for centuries. The Kolleru lake has a multi-catchment from various rivulets and has both inflow and outflow channels. The Kolleru lake area is affected with severe floods due to heavy discharge (1,10,000 cusecs) into the lake where as the capacity outlet is not even more than 15,000 cusecs. The water quality of Kolleru Lake has deteriorated considerably in the last few decades. The main environmental issues are excessive weed growth, reduction in water clarity, enrichment of waters and high microbial activity. The contaminants enter the lake through direct point sources, diffuse agricultural and aqua cultural sources and diffuse urban sources.

****Corresponding author: Raghuveer Naidu, K.***
Environment Protection Training and Research Institute, Hyderabad, India.

Study area

The study area is located in between 16°17'00" and 16°59'00" N latitudes and 80°50'00" and 81°39'00" E longitudes, covering in and around Kolleru lake region (Fig. 1) and the study area covers East Godavari and Krishna districts of Andhra Pradesh and a small portion of Khammam district of newly formed Telangan State. Water source to this lake is form its tributaries-Budameru, Tammileru and Ramileru, originating from the Eastern Ghats.

RESULTS AND DISCUSSION

Role of Non Point Source Pollution

Just as the name implies, nonpoint source pollution cannot be attributed to any one source. This type of polluted runoff is caused predominantly by rainfall runoff moving over and through the ground. As the runoff moves over the land, it picks up and carries away natural and man-made pollutants, eventually depositing them in lakes, rivers, wetlands, coastal waters and even our groundwater supplies. Researchers have determined that polluted runoff is not one source of runoff that causes all the problems, but a combination of different sources. Nutrients and eroded soil are the most common pollutants causing degradation of water resources. There are several categories of pollutants that regularly result from common land use practices. Each type of pollutant can impact our water resources.

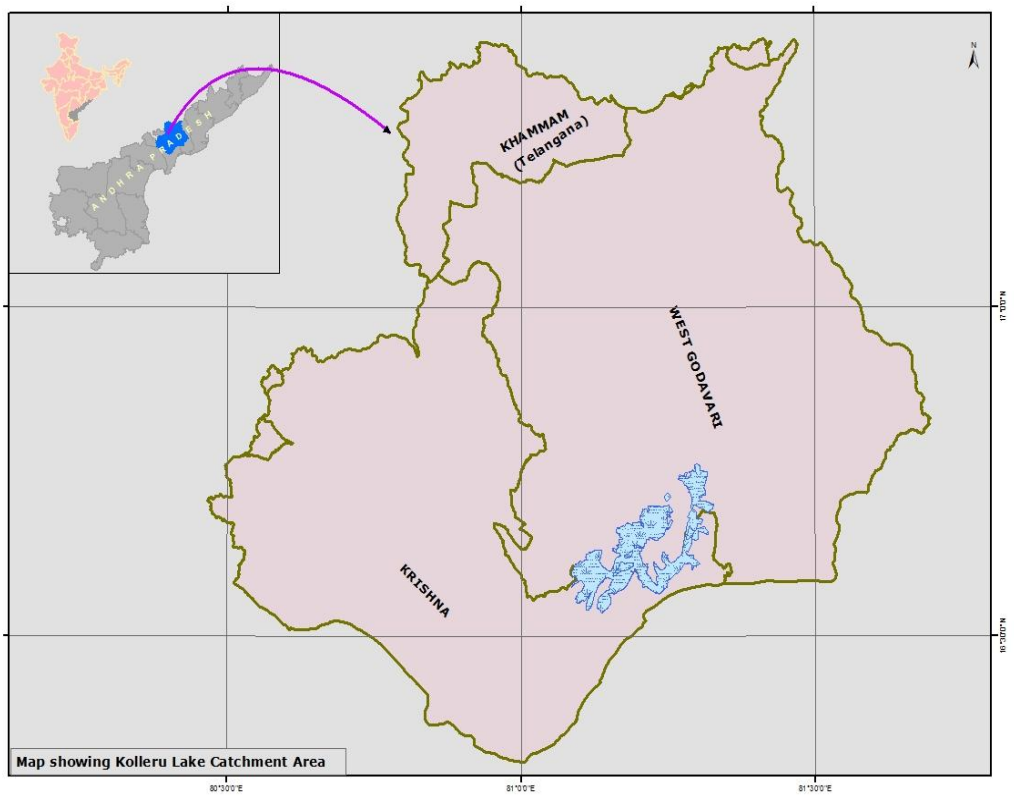


Fig.1. Location Map of the Study Area

Table 1. Classes of non-point source pollution

(Source: International Joint Commission, 1974, and other sources)

Activities	Pollution sources	Pollutants
Agriculture activities - Irrigation Cultivation, Pastures, Agriculture Plantations, Dairy farming, Orchards, Aquaculture	Runoff from all categories of agriculture leading to surface and groundwater pollution. Growth of aquaculture is becoming a major polluting activity in many States. Irrigation return flows carry salts, nutrients and pesticides. Tile drainage rapidly carries leachates such as nitrogen to surface waters.	Phosphorus, nitrogen, metals, pathogens, sediment, pesticides, salt, BOD1, trace elements (e.g. selenium).
Forestry	Increased runoff from disturbed land. Most damaging is forest clearing for urbanization and mono culture plantations.	Sediment, pesticides.
Liquid waste disposal	Disposal of liquid wastes from municipal wastewater effluents, sewage sludge, industrial effluents and sludges, wastewater from home septic systems; especially disposal on agricultural land, and legal or illegal dumping in watercourses.	Pathogens, metals, organic compounds.
Residential Commercial Industrial	Urban runoff from roofs, streets, parking lots, etc. leading to overloading of sewage plants from combined sewers, or polluted runoff routed directly to receiving waters; local industries and businesses may discharge wastes to street gutters and storm drains; street cleaning contributes to surface and groundwater pollution.	Fertilizers, greases and oils, faecal matter and pathogens, organic contaminants (e.g. PAHs2 and PCBs3), heavy metals, pesticides, nutrients, sediment, salts, BOD, COD4, etc.
Rural sewage systems	Overloading and malfunction of septic systems leading to surface runoff and/or direct infiltration to groundwater.	Phosphorus, nitrogen, pathogens (faecal matter).
Transportation	Roads, railways, pipelines, hydro-electric corridors, etc.	Nutrients, sediment, metals, organic contaminants, pesticides (especially herbicides).
Mineral extraction	Runoff from mines and mine wastes, quarries, well sites	Sediment, acids, metals, oils, organic contaminants, salts (brine).
Recreational land use	Large variety of recreational land uses, including ski resorts, boating and marinas, camp grounds, parks; waste and "grey" water from recreational boats is a major pollutant, especially in small lakes and rivers	Nutrients, pesticides, sediment, pathogens, heavy metals.
Solid waste disposal	Contamination of surface and groundwater by leachates and gases. Hazardous wastes may be disposed of through underground disposal.	Nutrients, metals, pathogens, organic contaminants.
Dredging	Dispersion of contaminated sediments, leakage from containment areas.	Metals, organic contaminants.
Atmospheric deposition	Long-range transport of atmospheric pollutants (LRTAP) and deposition on land and water surfaces	Nutrients, metals, organic contaminants.

In Indian scenario, agricultural activity is the major source for non point source pollution. With agriculture being the major economic activity, the pressure to produce has had an impact on agricultural practices. This pressure has resulted in expansion into marginal lands and is usually associated with subsistence farming. Further with augmented canal irrigation system, it has steadily increased the use of fertilizers and pesticides to achieve higher yields. The various classes of non-point pollution are tabulated in Table 1.

Considering the need for assessment of the pollutant load from various sources in the catchment, the land use and land cover facilitates to understand and quantify the possible contribution from each sectoral activity. Keeping view, an assessment is carried out to delineate the land use in the Kolleru Lake catchment area.

Role of point source pollution

Point source pollution can be attributed to one source. This type of polluted runoff is caused predominantly by industries and major outfalls of sewers of the major urban settlements. The delineation of these features explicitly identifiable and delineated from the satellite data.

METHODOLOGY

The methodology adopted in carrying out the assessment is presented in Figure 1. The drainage pattern covering the whole region is brought into GIS platform using available topographic maps. Considering the orders of the streams that flows into the lake, the watersheds are delineated. Keeping the watershed of each rivulet that drains into the Kolluru Lake, the catchment area of the lake is identified. For the analysis of land use land cover in the study area i.e the catchment area of Kolleru lake, satellite data of RESOURCESAT 1 IRS P6 LISS-1V of 5.8m resolution has been used. Cartosat Satellite data of 2.5 m resolution has been used to know the extents of the bunds of the fishponds.

The satellite data is geometrically corrected after collecting DGPS points from the field at various locations for each satellite scene. To carry out this exercise, the locations of ground control points (GCPs) have been identified using SOI Top sheets. The coefficients for co-ordinate transformation equations were completed based on polynomial regression between GCPs collected on the ground and satellite.

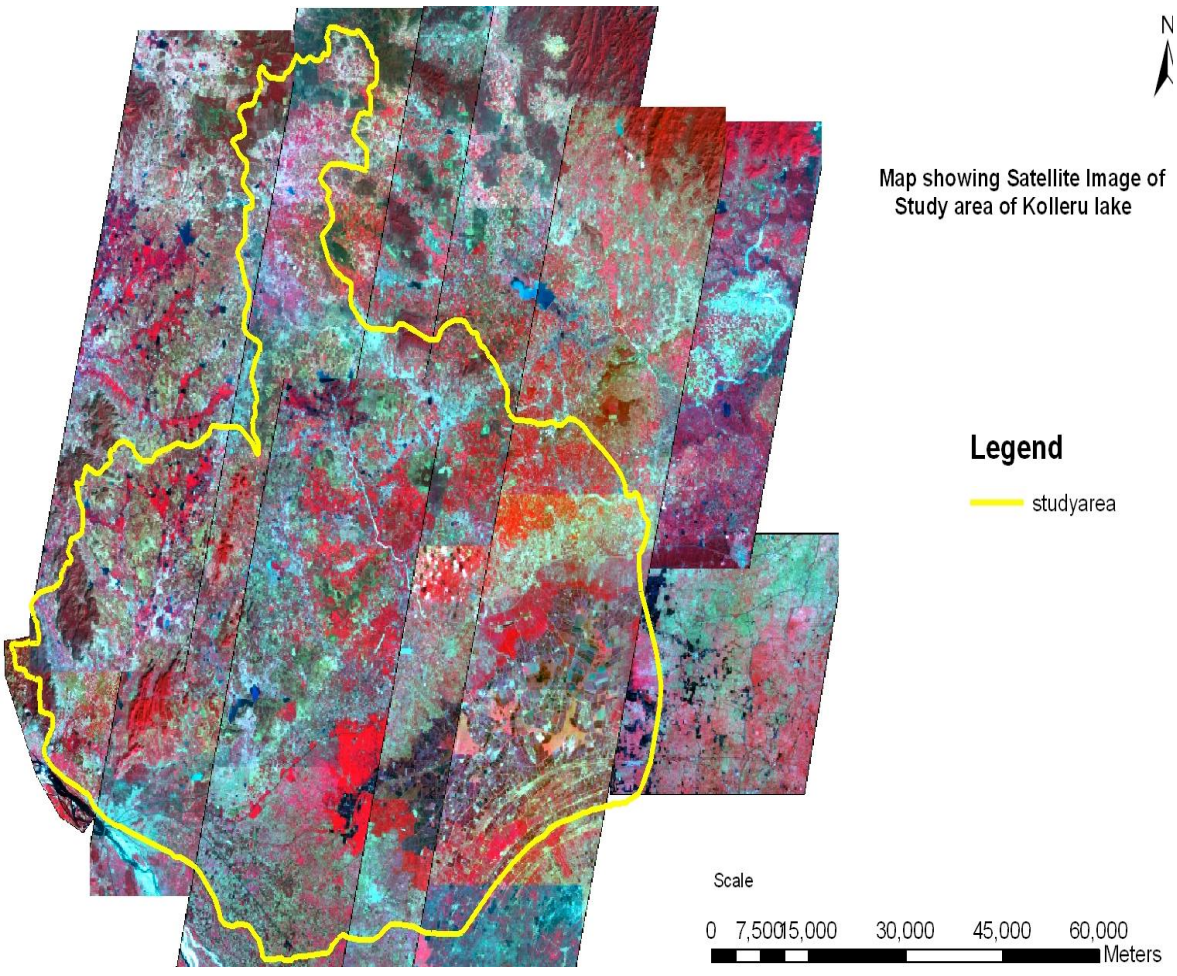
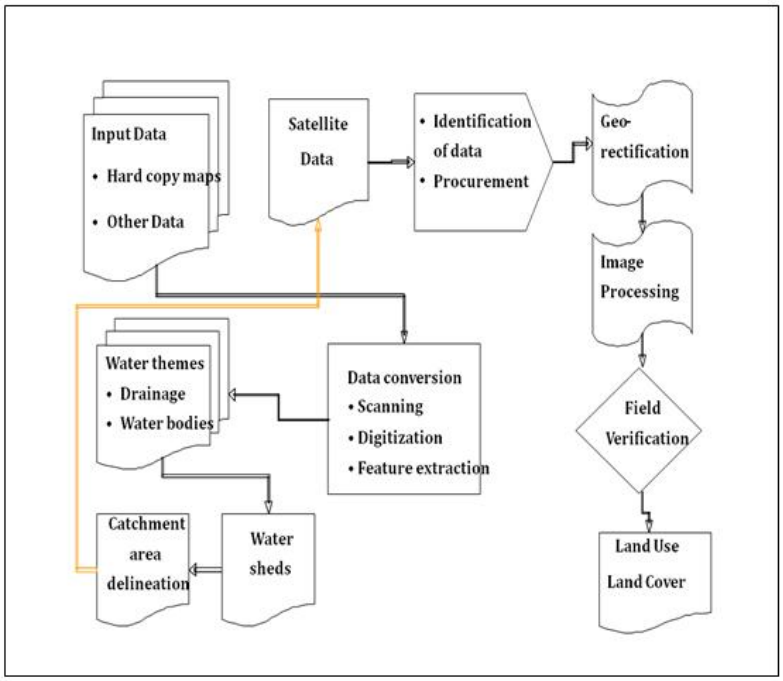


Fig. 2. Resoursesat LISS IV MX satellite image covering catchment area of Kolleru Lake



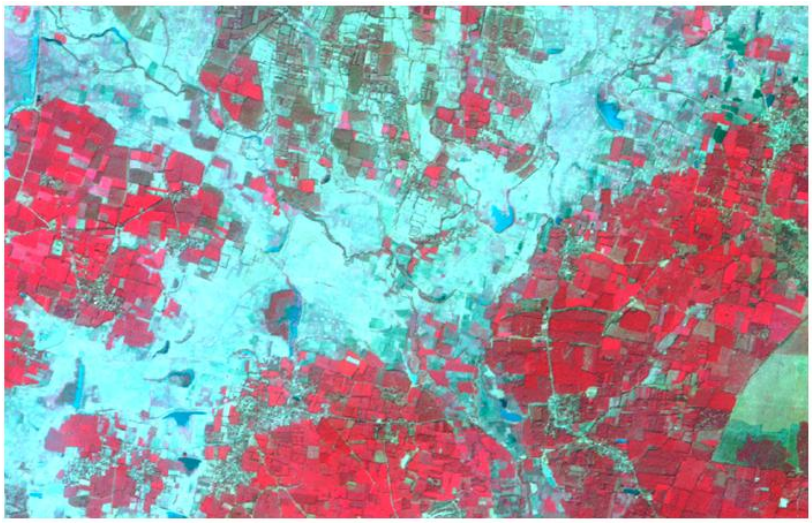


Fig. 3. LISS-IV Satellite imagery of a portion of the Kolleru Lake catchment showing sheet erosion

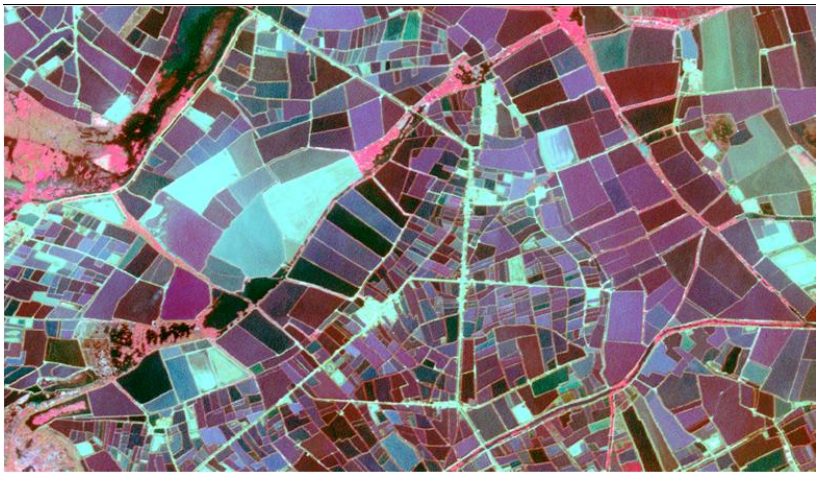


Fig.4 LISS-IV Satellite imagery of a portion of the Kolleru Lake showing Aqua culture ponds

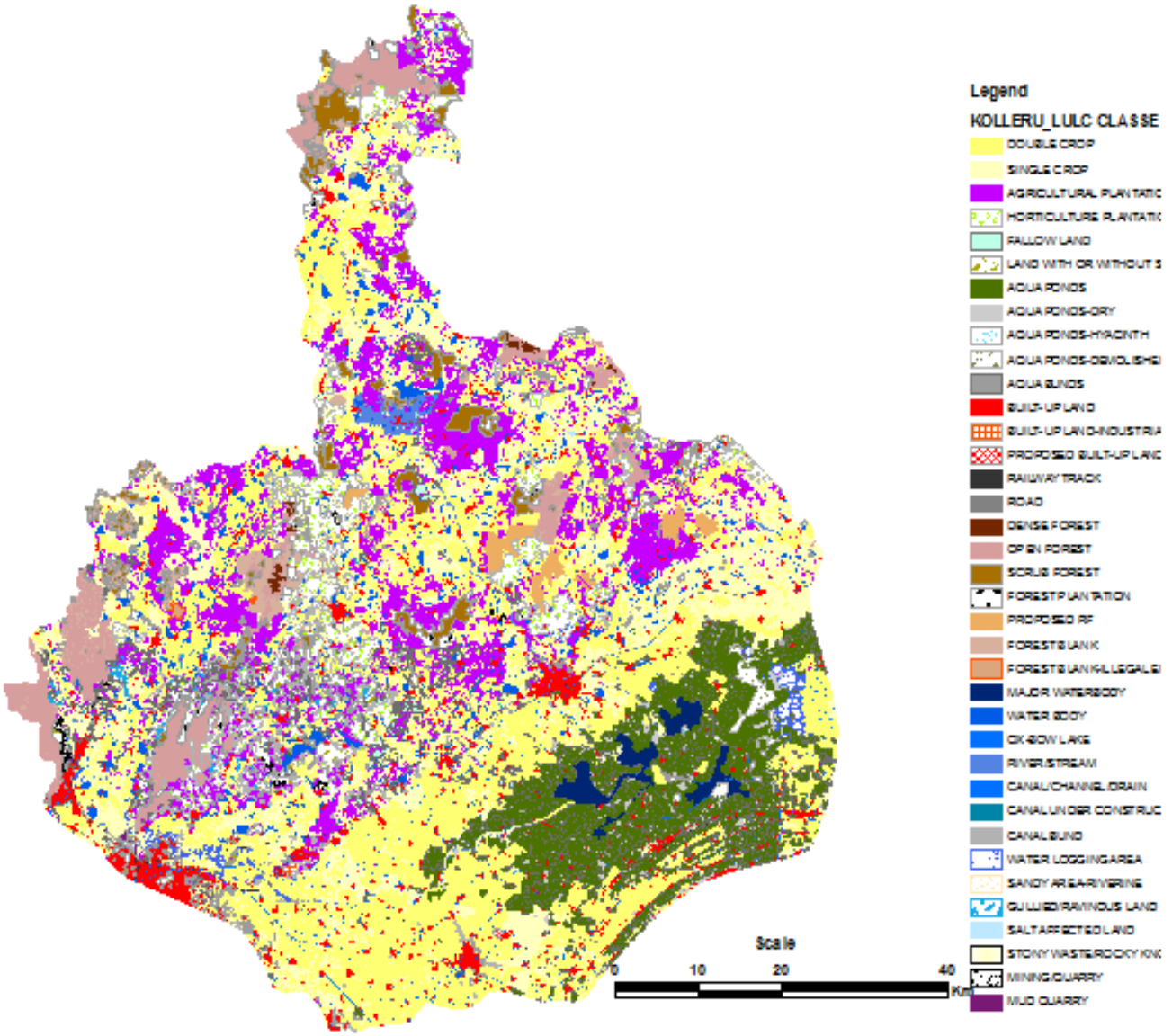


Fig. 5. Land Use and Land Cover Classification of the Kolleru Lake Study Area

Table 2. Land use and Land Cover area extents under each class

Name of the Class	Area in Hectares	Area in Percent (%)	Name of the Class	Area in Hectares	Area in Percent (%)
Double crop	170431.27	28.32	Forest plantation	4342.49	0.72
Single crop	113120.78	18.80	Proposed reserved forest	4658.26	0.77
Agricultural plantation	72064.84	11.97	Forest blank	7557.52	1.26
Horticulture plantation	35015.00	5.82	Forest blank-illegal encroachment	243.25	0.04
Fallow land	6902.50	1.15	Major water body	6243.42	1.04
Land with or without scrub	14595.76	2.43	Water body	17869.75	2.97
Aqua ponds	46028.59	7.65	Ox-bow lake	10.95	0.00
Aqua ponds-dry	3833.47	0.64	River/stream	4674.27	0.78
Aqua ponds-hyacinth	540.93	0.09	Canal/Channel/Drain	3443.87	0.57
Aqua ponds-demolished	2318.44	0.39	Canal under construction	93.29	0.02
Aqua bunds	12173.55	2.02	Canal bunds	4.85	0.001
Built-up land	26364.55	4.38	Water logging area	2497.28	0.41
Built-up land-industrial	870.35	0.14	Sandy area-riverine	23.53	0.004
Proposed built-up land	1732.77	0.29	Gullied/Ravinous land	455.17	0.08
Railway track	788.30	0.13	Salt affected land	325.80	0.05
Roads	1093.64	0.18	Stony waste	273.75	0.05
Dense forest	828.10	0.14	Mining/Quarry	269.13	0.04
Open forest	26084.63	4.33	Mud quarry	183.84	0.03
Scrub forest	13894.88	2.31	Total	601852.76	100.00

Image processing and Land use /land cover classification

Based on the scale and the satellite resolution land use and land cover classification has been made. Since the satellite data is of Resource sat LISS-1V, Level 3 classification is carried out. Both digital image processing and visual interpretation methods are used to carried out to delineate various land use and land cover categories viz. Built up land such as residential and industrial, crop areas such as double crop and single crop, plantation such as agriculture and horticulture plantation, Aqua culture, fallow land, waste lands such as scrub land, gullied or ravenous land, salt affected land and stony waste, forest land such as dense forest, open forest, scrub forest, forest blanks and forest plantations, and water bodies.

Necessary training sets have been identified based on tone, texture, size, shape, pattern and location information. Extensive field survey has been done for identifying the training sets for digital image processing. The interpreted thematic information/map has been verified on ground at limited appropriate points and final land use land cover map has been prepared. The land use and land cover map is presented in Figure 5 and the extent of each class in tabulated in Table 2.

Nearly 66% of lakes catchment area covered with agriculture activities in which around 17% area covered with plantations. Since most of crop land is of paddy, there would be need for intense irrigation, fertilizers and Pesticides. Runoff of salts leading to Stalinization of surface waters: runoff of fertilizers and pesticides to the lake deteriorate lake water and damage Lake Ecosystem. Resulting from polluted with pesticides, fertilizers, sewage and industrial waste, there is an excessive growth of weeds and hyacinth. Around 11% of the lakes catchment area covered with Aqua culture and most of it is encroached form the lake area. Release of pesticides and high level of nutrients to lake waters is leading to eutrophication.

Conclusion

i. The Illegal encroachments of aquaculture into lake needs to be controlled.
ii. Awareness has to be created among the surrounding farmers about cropping pattern and cropping methods to avoid agriculture pollution which helps to save the lake environment.
iii. An effective and comprehensive rehabilitation and management system should be evolved by irrigation engineers and planners for regular monitoring of lake.
iv. An effective watershed prioritization needs to be worked out.
v. To avoid environmental degradation desilting and deweeding of the lake should be carried out on regular basis.
vi. To ensure sustainable development of the lake and environs as well as its recreational value, the growth of uncontrolled natural vegetation (aquatic weeds) should be addressed
vii. The water reservoir capacity of the lake has been considerably reduced. Therefore, large scale dredging should be carried out to retain its original position
viii. Water quality monitoring should be done with greater frequency and result should be made public.
ix. Periodic monitoring of Lake and its surroundings needs to be monitored frequently by using Remote sensing techniques like satellite data.
x. Constitute a lake development committee for the development of sustainable plan to conserve and maintain ecosystem and environment of the lake.

REFERENCES

Alagarswami, K. 1994. Annex II-5 INDIA, Annex II Country Reports, Report on a Regional Study and Workshop on the Environmental Assessment and Management of Aquaculture Development, FAO, ROME

Andhra Pradesh Fisheries, 2007. Eleventh Five Year Plan (2007 to 2012), Fisheries in Andhra Pradesh.

Dhruba Pant Sabita Thapa Ashok Singh Madhusudhan Bhattarai and David Molden: Integrated Management of Water, Forest and Land Resources in Nepal: Opportunities for Improved Livelihood: International Water Management Institute University of Leeds Water Energy Commission Secretariat, HMG/Nepal

http://bhuvan.nrsc.gov.in

http://india-wris.nrsc.gov.in

http://irrigation.cgg.gov.in

http://www.apfdgis.com

Marappan, J., Peter Nila Rekha, Natarajan Kavitha and Pitchaiyappan Ravichandran, 2006. Assessment of impact of aquaculture on Kolleru Lake (India) using remote sensing and Geographical information system, *Aquaculture Research,* Vol.37, P: 1617-1627.

Marko Keskinen, 2008. Water Resources Development and Impact Assessment in the Mekong Basin: Which Way to Go?: Royal Swedish Academy of Sciences.

Nagaraja, R. and Vithal Reddy, K. 1988. Impact of changes in human resources on land use and environmental impact – A case study. Paper presented in Nat. Sem. On Huma Res. Dev. In India: Retropect and Prospect. Osmania University, Hyderabad.

NRDC: WATER FACTS Climate Change and Water Resource Management

Rao, A. S. 2005. Environmental Degradation of Kolleru Lake, Allied Publishers Pvt. Ltd., Hyderabad.

U.S. EPA. 2009. National Water Program Strategy – Response to Climate Change

UNICEF, FAO and SaciWATERs,2013. Water in India: Situation and Prospects.

Veena U. Joshi and Vikas Nagare, 2010. Temporal Changes in the Land-Use/Land-Cover for the last one Decade along the Paravara River Basin, *Journal of the Institute of Indian Geographers*, Vol.32, No.2, Pp.183-192.

www. isro.gov.in

www.apdes.gov.in

www.nrsc.gov.in

****