SAROVAR SAURABH

ENVIS Newsletter on Wetland Ecosystem

ISSN 0972-3153

Vol. 4 No. 1 March 2008

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Editorial

The Salim Ali Centre for Ornithology and Natural History (SACON) brings out the fourth issue of SAROVAR SAURABH, an ENVIS Newsletter on wetland ecosystems, sponsored by the Ministry of Environment and Forests, Government of India. The major goal of the Newsletter is to share information about wetlands with various users and, to highlight conservation issues of relevance to wetland community of professionals, managers, environmentalists and other stakeholders.

This issue focuses on plant invasions wetland health in Jammu & Kashmir and mapping of wetlands in Warangal district of Andhra Pradesh. It is again hoped that stakeholders in wetland conservation and all other ENVIS centres can make use of these information effectively to create public awareness for further wetland conservation.

To make this effort worth while, the editorial team of SAROVAR SAURABH seeks active participation of its readers in terms of providing information, news, views, photographs and articles on issues of wetland conservation. To make the newsletter a truly effective forum for all wetland conservation related issues of the country, feedback and contributions from scientific communities and research groups are highly appreciated.

Alien plant invasions: Threat to wetland health and public wealth

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Introduction

Biological invasion occurs when a species acquires competitive advantage following the disappearance of natural obstacles to its proliferation, which allows it to spread rapidly and to conquer novel areas within recipient ecosystems (Valéry et al., 2008). Humans are noteworthy not only in their ability to alter landscapes but also in mediating introductions of species, especially to areas well outside their potential range as defined by their natural dispersal mechanisms and biogeographic barriers (Richardson and Pyšek, 2006). While majority of such introductions by most measures are benign, there is a great deal of concern regarding the detrimental ecological and socio-economic effects, including alteration of the Earth's biodiversity that certain introduced species may cause.

Wetlands, that encompass diverse and heterogeneous assemblage of habitats ranging from lakes, estuaries, river flood plains, mangroves, coral reef and other related ecosystems, seem to be particularly vulnerable to invasions. Even though 6% of the earth's land mass is wetland, 24% of world's most invasive plants are wetland species (Zedler and Kercher, 2004).

It is because wetlands are landscape sinks where nutrients are augmented by runoff or enriched groundwater, allowing invasive species to establish, spread and displace native species.

In fact, according to the United Nations' comprehensive Millennium Ecosystem Assessment, wetlands are one the most threatened ecosystems on earth. In view of the variety of deleterious impacts that alien invasive species can have (Table 1), the international theme for World Wetlands Day 2008, "Healthy Wetlands, Healthy People" seems far-fetched.

These impacts can severely constrain the provisioning (e.g., food and water), regulating (flood and disease control), cultural (e.g., spiritual, recreational), and supporting ecosystem services provided by wetlands that maintain the conditions for life on Earth (e.g., nutrient cycling). A meta-analysis of 89 wetland valuation studies (excluding climate regulation and tourism) by Schuyt and Brander (2004) indicated that the global annual value of wetlands is $70 billion, with an average annual value of $3000/ha/year and a median annual value of $150/ha/year. Thus, wetland degradation by invasion due to alien species will have substantial economic impact as well.

Economic Impacts	Reduction in agricultural productivity Reduction in livestock productivity Disruption of ecosystem services Reduction in land values Hampering of transportation
Social Impacts	Decrease in value of public amenities (tourism, recreation) Deleterious effect on public health and safety
Environmental Impacts	Ecosystem functions Impairment of water quality Alteration in nutrient cycling Change in habitat morphology Alteration in water flow Decrease in water retention Ecosystem structure Local or regional species extinctions Loss of biodiversity and reduced ecosystem stability

Table 1. Impact of invasive species on wetlands and other aquatic ecosystems

For instance, in the United States alone aquatic invasion associated damages and costs of controlling them are estimated at $9 billion annually (Pimentel, 2003). Hence the Ramsar Convention strives hard to ensure conservation, sustainable use and management of wetlands worldwide, but biotic and abiotic pressures continue to impact a number of wetlands.

In fact, many wetlands declared internationally important are now on the Montreux Record of sites in need of priority action.

Alien plant invasions in the Kashmir Himalayan wetlands

The picturesque Kashmir Valley is dotted with wetlands, which play an enormous role in maintaining the hydrological regime of the entire landscape. Owing in part to lack of consensus about the definition of a wetland, besides their conversion into agricultural fields, several assessments of the extent of area under wetlands in the Kashmir Valley are available. These estimates that range from 236.50 sq. km (Space Application Centre, 1998) to 256 sq. km (National Wetland Inventory, Salim Ali Centre for Ornithology, 2001) are largely considered as underestimations.

Notwithstanding their multifarious socio-ecological roles, all wetlands of the Valley are facing degradation due to accelerated rate of siltation, faster eutrophication, encroachments leading to shrinkage of area, hydrological interventions resulting in loss of aquifers and habitat destruction leading to loss of biodiversity. These and other disturbances create opportunities for introduction, establishment and spread of alien species. Many wetland invaders that form monotypes have wreaked havoc with the health of these wetlands with attendant cascading socio-economic effect as well. This grim scenario calls for a more proactive strategy to combat the menace of alien plant invasions in wetlands and other ecosystems. As a first logical step in this direction, we undertook extensive floristic survey of wetlands, such as Shalbough, Rakhi-i-Ganderbal, and Hokersar and lakes like Dal, Wular and Manasbal in order to document and inventorize the alien flora of these aquatic ecosystems so as identify broad patterns of invasion and determinants of invasiveness (Khuroo et al., 2007).

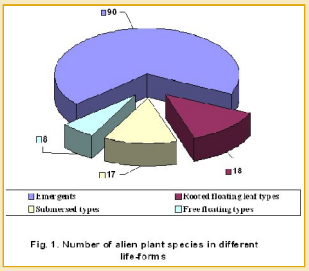

Fig. 1. Number of alien plant species in different life-forms

In all 133 plant species belonging to 66 genera and 36 families constitute the alien flora of wetlands and lakes in the Kashmir Valley. Species with emergent life forms are predominant in comparison to rooted floating leaf types and submersed types. Very few species have free-floating growth habit (Fig.1).

Highest number of species belong to Cyperaceae, Polygonaceae, Potamogetonaceae, Lamiaceae, Poaceae, Nympheaeceae, Lytheraceae, Ranunculaceae. Based on spatial spread and abundance in the surveyed freshwater ecosystems, the most common invasive plant species are *Sparganium erectum*, *Typha angustifolia* and *Phragmites australis* (rooted emergent life form), *Nymphoides peltata* and *Potamogeton nodosus* (rooted floating leaf type habit), *Potamogeton crispus* and *Myriophyllum-Ceratophyllum* complex (submersed growth habit) and *Lemna-Salvinia-Azolla* complex (free-floating life form). The explanations that have been invoked to account for the predominance of few species across different aquatic habitats are: (a) uniformity of the aquatic environments which is assumed to result in broad dominance of best-fitted, single purpose genotypes; (b) high phenotypic plasticity that allows the species to adapt to conditions prevalent in different habitats, and (c) widespread clonality which can contribute to broad distribution of aquatic plants by reducing both the risk of genotype mortality and the genetic differentiation of spatially separated populations (Table 2).


Invasion of Wular lake (Ramsar site) by *Trapa natans*


Manasbal lake over-run by multiple invaders


Tropical water-fern *Azolla* now a menace in lakes of Kashmir

Invasive plant species	Native region	Habit	Mode(s) of multiplication		Mode of dispersal
			Asexual	Sexual	
Emergents					
Phragmites australis	South America	Perennial	Rhizomes, stolons	Seeds	Birds, winds
Sparganium ramosum	Europe	Perennial	Rhizomes	Seeds	Water, water birds, boating
Typha angustifolia	Europe; North America	Perennial	Rhizomes	Seeds	Wind
Rooted floating types					
Nymphoides peltatum	Asia, Europe	Annual	Stem fragments	Seeds	Water, waterfowl
Potamogeton nodosus	North America	Perennial	Vegetative fragments, turions	Absent	Water/flowing debris
Trapa natans	Europe	Annual or Perennial	Rhizomes	Seeds	Water and wind
Submersed types					
Ceratophyllum demersum	North America	Perennial	Stem fragments, turions	Absent	Water, aquarium trade etc.
Hydrilla verticillata	Asia	Perennial	Turions, tubers, fragments	Seeds	Water, boating etc.
Myriophyllum spicatum	North America	Annual or Perennial	Stolons and vegetative fragments	Seeds	Boats, aquarium trade, etc.
Potamogeton crispus	Europe; South America	Perennial	Turions, rhizomes, stem fragments	Seeds	Machinery translocation, Boating
Free-floating types					
Azolla sp.	—	Perennial	Rhizomes	Spores	Water, aquatic animals
Lema minor	Asia; Africa	Perennial	Auto-fragments	Occasional seeds	Water, wastewater treatment
Salvinia natans	Africa; Europe	Annual or Perennial	Auto-fragments, ramets	Spores (rarely produced)	Aquarium trade, waterfowl, water animals and humans.

Table 2. Attributes of the most common invasive species of the wetlands and lakes of the Kashmir Valley

Management Strategies

Recognizing the importance of wetland ecosystems, the National Environment Policy (NEP), 2006, contains an unambiguous assertion of the need for a holistic view of wetlands, which looks at each identified wetland in terms of its causal linkages with other natural entities, human needs, and its own attributes. The NEP's six-fold 'Action Plan' in this direction comprises, among others, formulation of a regulatory framework, linkage with poverty alleviation, and programmes for employment generation. Under the National Programme for Conservation and Management of Wetlands, ninety-four wetlands have been identified for conservation and management and so far 24 States have been covered; the remaining States are expected to the covered in the Eleventh Five-Year Plan. These initiatives, though commendable and exemplary, yet fall short of taking strong note of alien invasive species that impinge upon the structural organization and functional integrity of these fragile ecosystems. Thus, to reduce the associated economic, social and environmental costs it is important to integrate following steps and initiatives into overall wetland resource management objectives and plans.

- AWARENESS—of the issues and the seriousness of wetland invasion and their consequences to wetlands, people and biodiversity.
- INFORMATION AND TRAINING—specialized expertise and training for documentation of priority and potential invasive species.
- RESEARCH and MONITORING—for identifying the underlying mechanisms responsible for invasiveness and invasibility.
- PREDICTION and QUARANTINE—development of a predictive framework for potential invaders in order to prevent and limit their spread.
- POLICIES AND LEGISLATION—their development and implementation for management of biological invasions.
- COOPERATION—among agencies and organizations involved in global, national, and regional efforts to understand and manage invasive species in wetlands, such as Global Initiative on Invasive Species, The Global Invasive Species Programme and the Regional Invasive Species Programmes. Fortunately, the issue of invasive species is an area identified for cooperative action in the Joint Work Plan between the Convention on Biological Diversity (CBD) and the Ramsar Convention.

The management strategies, based on above initiatives, will be most effective when long-term, ecosystem-wide approach is employed rather than a tactical approach focused on battling individual invaders. Alternatively, failure to address the issue of plant invasions could result in wholesale loss of wetland resources, disruption of ecological processes and ecosystem services they provide and the creation of homogeneous, impoverished landscape units in place of diverse communities.

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Upcoming Events

- Wetlands 2008: Wetlands and Global Climate Change, 16-18 September 2008, Portland, Oregon
  Organized by: Association of State Wetland Managers
  Contact: http://www.aswm.org/
- The 11th International Conference on Wetland Systems For Water Pollution Control 2008 - India, 1-7 November 2008, Vikram University, Indore
  Organized by: International Water Association
  Contact: http://www.wetland2008.org/SaveWater/

Mapping Wetlands of Warangal District, Andhra Pradesh, India using IRS P6 LISS III data

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Introduction

Sustainable use and development of natural resources has become a key issue for our own survival. Water is one of the most important natural resources. There has been a serious threat to the wetland ecosystem by human interference and unscientific exploitation. Therefore, there is an urgent need to conserve the wetland *in situ* before it lost forever. Remote Sensing (RS) and Geographical Information System (GIS) have been highly useful in natural resources mapping. This gives the present scenario of the resources and changes that have occurred over a period of time.

Ramsar Convention (1971) has defined wetlands as areas of marsh, fern, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters". A wide variety of wetlands like marshes, swamps, open water bodies, mangroves and tidal flats and salt marshes etc. exist in our country. Realizing the importance of wetlands in India, Ministry of Environment and Forests, Government of India, has published a directory of wetlands (1990) based on the survey carried out during 1972. However, the survey is not comprehensive and many inland wetlands and most of the coastal wetlands have not been included in the compilation. The multi-spectral data obtained from remote sensing satellites like Landsat, IRS, SPOT, IKONOS have been used to study land cover features either by visual interpretation or by processing digital data using digital computers. Space Application Centre (1997) has mapped the wetlands of Andhra Pradesh at 1:250,000 scale using coarse resolution satellite data. In this only wetlands of 56.25 ha and above in size could be mapped. It is known that a vast majority of wetlands often in number, extent and conservation importance is below 56 ha in size.

The present study was undertaken as part of national project on "biodiversity characterization at landscape level using Remote sensing and GIS" for inventory and creation of a database for conservation using IRS P6 (ResourceSat-1) LISS III data. IRS-P6 LISS-III multi-spectral scanner with 23.5m resolution enables discrimination of different land cover on 1:50,000 scale.

The present communication deals about mapping of wetlands in Warangal District, Andhra Pradesh.

Study Area

The Warangal District of Andhra Pradesh, India lies between 17^0 19' and 18^0 13' north latitudes and 78^0 49' and 80^0 43' east longitudes, under Deccan Plateau physiographic zone. It is bounded on the north by Karimnagar district and Chhattisgarh state, on the west by Medak district, on the south by Nalgonda district, on the east and north east by Khammam district. The total geographical area of the district is 12,846 km² and the forest cover is 3,132 km² (Reddy *et al.* 2008).

The district receives southwest and northeast monsoon rains and summer showers. The district exhibits clear rainfall zonation from west east (764 mm) to north east (1096 mm). There is no remarkable difference in the temperature, as the district on the whole tends to be dry. The maximum and minimum temperatures have been recorded as 42.9°C and 16.2° C respectively.Warangal is predominantly an agricultural district with a large number of lakes and the river Godavari.

The common plant species that are found in ponds and lakes of Warangal are *Hydrilla, Potamogeton, Vallisneria, Utricularia, Ceratophyllum* (submerged plants), *Azolla, Lemna, Spirodela* and *Wolffia* (free – floating plants), *Nymphaea* spp., *Nelumbo, Eicchornia* and *Marsilea quadrifolia* (floating plants rooted in the mud), *Typha, Sagittaria, Phragmitis* and *Schoenoplectus* (amphibious plants). *Cleome chelidonii* var. *pallai* is an endemic, rare species found in margins of Pakhal lake (Reddy & Raju, 2001).

Methodology

IRS-P6 LISS-III data acquired on 23rd December, 2003 and 7th January 2004 have been used in the study (path / row 100 / 61, 101 / 61). The ortho-rectified Landsat ETM+ data (http: / / glcf.umiacs.umd.edu /) was used as reference for geo-rectification using ERDAS IMAGINE. The extracted False Color Composite (FCC) image of study area is shown in Figure 1.

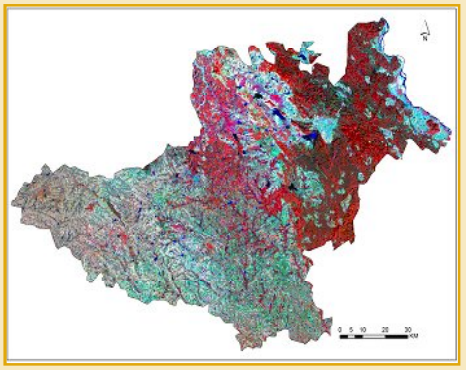

Fig 1. IRS P6 LISS III False Color Composite image of Warangal District

Wetlands are digitized using on-screen visual interpretation method. Standard weed tolerance, snap tolerance and grain tolerance set followed as per NNRMS standards. Specifications for minimum mappable unit (MMU) are also followed as per the standards. Wetland areas were categorized into 11 classes as <50 ha, 50- <100 ha, 100 -< 150 ha, 150 - < 200 ha, 200 - < 250 ha, 250 -< 300 ha, 300 -< 350 ha, 350 - < 400 ha, 400 - < 450 ha, 450 -< 500 ha and > 500 ha.

Results and Discussion

In the present study, there are 1,307 number of wetlands more than 2.2 ha size has been delineated. The total extent of wetlands for the Warangal District as a whole is estimated to be 441.4 km². Wetlands occupy 3.4% of geographical area of the district. The classified wetland map was shown in Figure 2. Wetland area statistics pertaining to different wetland categories of study area is given in Table 1. The distribution of wetland area is given in Figure 3.

Maximum number of wetlands (1149) are belongs to the class of <50 ha area. Interestingly, wetland area class >500 ha occupies higher proportion, second to <50 ha class. Among all the rivers, the river Godavari comprises maximum area (19.1%) under wetlands (occupancy 8,449.1 ha) primarily due to the fact that the district has longest river course. It is followed by big artificial lakes like Laknavaram (1030.9 ha), Pakhal (982.8 ha), Ramappa (837.8 ha) and Ghanapur (522.6 ha) (Figures 4 & 5).

There are 148 wetlands composed of area in between 51-500 ha accounts for 35.3% of total area. The prominent lakes near by Warangal city, viz.Waddepally lake and Bhadrakali lake contributes 162 ha and 128 ha wetland area respectively.

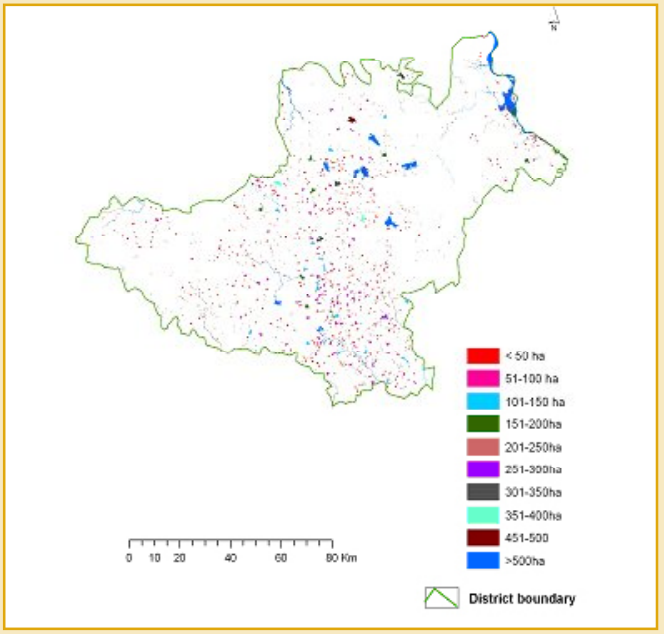

Fig 2. Classified map of Wetlands of Warangal District

Sl. no.	Class	No. of Wetlands	Area (Ha)	% of Area
1	<50	1149	16757.0	38.0
2	51-100	100	7018.8	15.9
3	101-150	26	3185.3	7.2
4	151-200	13	2311.0	5.2
5	201-250	1	235.4	0.5
6	251-300	1	270.3	0.6
7	301-350	4	1299.8	2.9
8	351-400	2	755.6	1.7
9	401-450	0	0.0	0.0
10	451-500	1	487.0	1.1
11	>500	10	11823.3	26.8
	Grand Total	1307	44143.4	100

Table 1. Distribution of different wetland classes

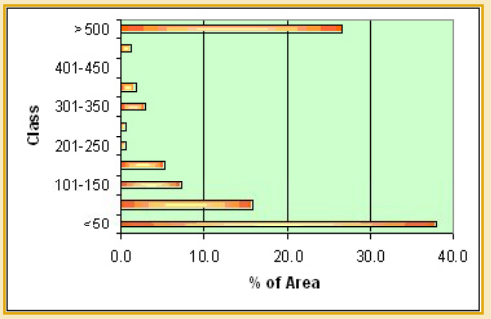

Fig 3. Distribution pattern of Wetlands

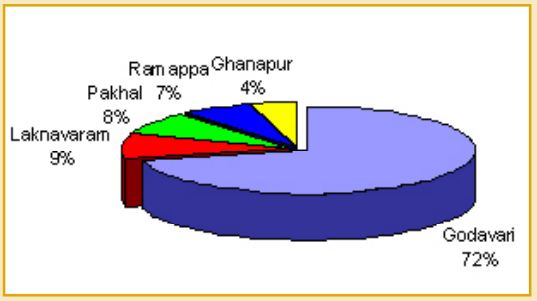

Fig 4. Pie Chart showing proportional distribution of major wetlands (>500 ha) of Warangal District

Fig 5. A view of Ramappa Lake

Conclusions

The study provides scenario of wetlands of Warangal District. One time inventory gives information of the wetlands at that time only which is of limited use. For continuous planning and management, it is necessary to assess the changes which take place in the water bodies from time to time.

Remote sensing and GIS techniques allow natural resource inventories to be completed in a timely manner with greater accuracy and provide a database for storing, manipulating, and displaying spatial data often missing in traditional inventories.

Acknowledgements

We are thankful to Dr. M.S.R. Murthy, Head, Forestry & Ecology Division, National Remote Sensing Agency for suggestions and encouragement.

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Recognisation of SACON's Work

Wetlands and climate change

Climate change poses a threat to all ecosystems. In the case of the wetland ecosystem, not only will the water bodies and their economic benefits be lost; they could directly contribute to climate change by releasing a large amount of trapped greenhouse gases. That assessment from scientists taking part in the Eighth Wetlands Conference held in Brazil by INTECOL, the International Association for Ecology, will hopefully stir governments into action. The volume of greenhouse gases sequestered by wetlands is immense. Although they occupy only six per cent of the land area worldwide, and have suffered sharp declines over the past hundred years, scientific estimates say marshes, river floodplains, lagoons, swamps, and other water bodies store almost the equivalent of the current atmospheric carbon levels within water and slow-decaying vegetation. Moreover, freshwater wetlands are a repository of biodiversity, upon which many external species depend. The developing world, unlike the west, has managed to retain many vast historic wetlands. But most countries, including India, have failed to preserve their integrity. The effort to curb industrial pollution, fertilizer and pesticide run-off from intensive agriculture, encroachment, and the dumping of municipal waste has been too feeble to make any visible change.

The conservation of India's wetlands requires a strategy and action plan that will restore their health over the next decade. An exhaustive study by the Salim Ali Centre for Ornithology and Natural History in 2004 identified 655 inland wetlands worthy of priority conservation action. Their importance cannot be overstated, now that their role as carbon sinks is evident. Preserving them is a low-cost mitigation option compared with extensive future restoration. Far-sighted action can save the country the costs that the developed world incurs on restoring and creating artificial wetlands. There is an urgent need to protect wetlands using stronger land use laws. State and local governments must enforce the laws unflinchingly. There is also a case for the mandatory creation of water bodies as a part of large real estate projects. Such measures will ensure not just aesthetic and recreational values for people but well-known ecosystem services such as flood control, water security, nutrient recycling, and preservation of biodiversity. It is increasingly clear that wetlands have a key role to play in slowing down climate change. Now is the time for serious action to protect them.

(Courtesy: The Hindu Editorial, 31st July 2008)

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Sponsored by: ENVIS, Ministry of Environment & Forests, Goverment of India, New Delhi.

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