Journal of Global Resources Volume 2 January 2016 Page 127-135
ISSN: 2395-3160 (Print), 2455-2445 (Online)

17

NEEDS TO CONSERVE THE WETLAND RESOURCES FOR SUSTAINABLE DEVELOPMENT OF BELGAUM DISTRICT OF KARNATAKA: USING MULTISPECTRAL SATELLITE DATA

S. S. Hangaragi[1] and **Sunanda. I. Kittali**[2]
[1]Associate Professor, Dept. of Geography, SRN Arts and MBS Commerce College, Bagalkot, Karnataka, India
Email: sshangaragi@rediffmail.com
[2]Assistant Professor, Dept. of Geography, Rani Parvati Devi Arts and Commerce College, Tilakawadi, Belgaum, Karnataka, India
Email: sikittalibelagavi@gmail.com .

Abstract: *Wetlands support a large variety of plant and animal species adapted to fluctuating water levels, making the wetlands of critical ecological significance. Wetlands are one of the crucial natural resources. Wetlands are areas of land that are either temporarily or permanently covered by water. However, the very existence of these unique resources is under threat due to developmental activities and population pressure. In this paper attempt is made to analyze the planning for preservation and conservation of wetland resources. To find out the wetlands in the study area used the multispectral data for accurate results. In the study area numerous small and important wetlands found and prepared a map at 1:50,000 scales. The multispectral data collected two time period of IRS: LISS- III data acquired during pre and post monsoon season are used for inventory to account for wet and dry season hydrology of wetlands. The map outputs include the status of water spread, aquatic vegetation and turbidity. Ancillary layers like road/rail, habitations are also created. The results are complied for prepare wetlands map of Belgaum District. This map highlights the characteristics of the wetlands in the particular area within the district and hopes to improve our understanding of the dynamics and distribution of wetlands and their status in the study area. At present urgent need to take various conservation activities through the action plans by the concerned state government.*

Keywords: Resources, Wetlands, Diversity, Sustainable, Development.

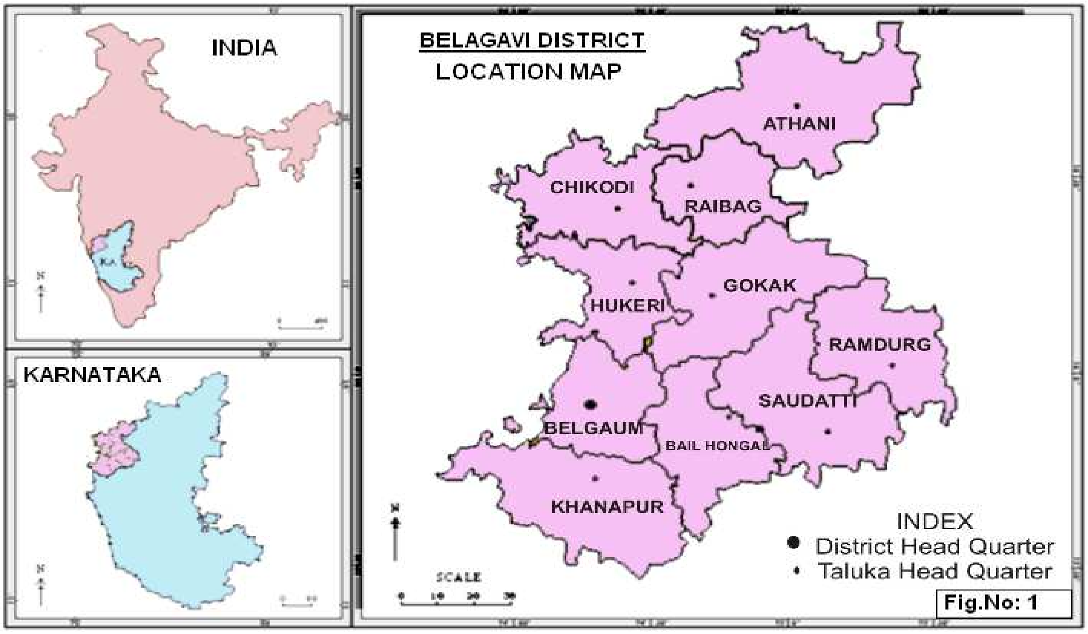
Introduction

It is increasingly realized that the planet earth is facing grave environmental problems with fast depleting natural resources and threatening the very existence of most of the ecosystems. Serious concerns are voiced among scientists, planners, geographers, sociologists, politicians and economists to conserve and preserve the natural resources of the world. One of the difficulties most frequently faced for decision making is lack of scientific data of our natural resources. Wetlands are one of the crucial natural resources. Wetlands are areas of land that are either temporarily or permanently covered by water. This means that a wetland is neither truly aquatic nor terrestrial; it is possible that wetlands can be both at the same time depending on seasonal variability. Thus, wetlands exhibit enormous diversity according to their genesis, geographical location, water regime and chemistry, dominant plants and soil or sediment characteristics. Because of their transitional nature, the boundaries of wetlands are often difficult to define. Wetlands do, however, share a few attributes common to all forms. Of these, hydrological structure (the dynamics of water supply, throughput, storage and loss) is most fundamental to the nature of a wetland system.

It is the presence of water for a significant period of time which is principally responsible for the development of a wetland. One of the first widely used classifications systems, devised by Cowardin et.al., (1979), was associated to its hydrological, ecological and geological aspects, such as: marine (coastal wetlands including rock shores and coral reefs, estuarine (including deltas, tidal marshes, and mangrove swamps), lacustarine (lakes), riverine (along rivers and streams), palustarine (marshy - marshes, swamps and bogs). Given these characteristics, wetlands support a large variety of plant and animal species adapted to fluctuating water levels, making the wetlands of critical ecological significance. Utility wise, wetlands directly and indirectly support millions of people in providing services such as food, fiber and raw materials, storm and flood control, clean water supply, scenic beauty and educational and recreational benefits. The Millennium Ecosystem Assessment estimates conservatively that wetlands cover seven percent of the earth's surface and deliver 45 percent of the world's natural productivity and ecosystem services of which the benefits are estimated at $20 trillion a year (Source : www.MAweb.org). Wetlands are the first target of human interference and are among the most threatened of all natural resources. Around 50 percent of the earth's wetlands are estimated to already have disappeared worldwide over the last hundred years through conversion to industrial, agricultural and residential developments. Even in current scenario, when the ecosystem services provided by wetlands are better understood - degradation and conversion of wetlands continues. This is largely due to the fact that the 'full value' of ecosystem functions is often ignored in policy -making, plans and corporate evaluations of development projects. One of the difficulties most frequently faced for decision making is lack of scientific data of our natural resources. Often the data are sparse or unconvincing, rarely in the form of geospatial database (map), thus open to challenges. Thus, the current thrust of researcher is to have an appropriate geospatial database of natural resources that is based on unambiguous scientific methods. The wetland areas of Belgaum District are important among the wetlands of India. In this paper made an attempt to identify important wetlands for strengthening the ecological balance.

Study Area

The area under study covers the whole geographical area of the Belgaum District, lies between 15° 23' to16°58' North latitude and 74° 05' to 75°28' East longitude, covering an area of 13,415 sq.kms. and is bounded on the west and north by Maharashtra state, on the north-east by Bijapur District, on the east by Bagalkot District, on the south-east by Gadaga District, on the south by Dharawad District and Uttara Kannada districts and on the southwest by the state of Goa (see Fig. No:1). The city of Belgaum is the district headquarters. According to the 2011 Census of India, it has a population of 4,778,439 of which 24.03 percent live in urban areas, making it the second most populous district in Karnataka (out of 30), after Bangalore. Roughly the Belgaum district population is equal to the nation of Singapore or the US state of Alabama. This gives it a ranking of 25th in India (out of a total of 640). The district has a population density of 356 inhabitants per sq. kms. (920 /sq mi). Its population growth rate over the decade 2001-2011 was 13.38 percent. Belgaum has a sex ratio of 969 females for every 1,000 males, and a literacy rate of 73.94 percent. Belgaum (Belgaum in Marathi) is the Divisional Headquarters of North Karnataka. The ancient name of the town of Belgaum was Venugrama, meaning *Bamboo Village*. It is also called as Malnad Pradesh. Belgaum district was incorporated into the newly formed Mysore state (now Karnataka) with the passage of the *States Reorganization Act* (1956), which reorganized India's states along linguistic lines since majority of the people in the district spoke Kannada, although the majority in the cities in Belgaum district spoke Marathi. Because of that linguistic disparity, Maharashtra has been claiming the district and the case is now in the Supreme Court of India.



Administratively Belgaum District has been divided into 10 taluks. Chikkodi taluk is the largest with an area of 1,995.70 km² and Raybag taluk is the smallest with an area of 958.8 km². The district comprises three revenue sub-divisions and six police sub-divisions. Apart from the Belgaum City Corporation, there are 17 municipalities, 20 towns, 485 gram panchayts, 1,138 habitated villages and 26 non-habitated villages.

Objectives

The main objectives of the present study are enunciated here under:

- to identify the wetlands of Belgaum District by preparing map the wetlands on 1:50,000 scale using two date (pre and post monsoon) of IRS LISS -III digital data.
- to know about the present status of wetlands at macro as well as at micro levels.
- to prepare wetland map for easily identify the major ones for planning to preserve for maintain environment balance.

Data Base

To conserve and manage wetland resources, it is important to have inventory of wetlands and their catchments. The ability to store and analyze the data is essential. Digital maps are very powerful tools to achieve this. Maps relating the feature to any given geographical location have a strong visual impact. Maps are thus essential for monitoring and quantifying change over time scale, assist in decision making. The technique used in the preparation of map started with ground survey. The Survey of India (SOI) topographic maps are the earliest true maps of India showing various land use/cover classes including wetlands. Recent years have seen advances in mapping technique to prepare maps with much more information. Of particular importance is the remote sensing and geographic information system (GIS) technique. Remote sensing is now recognized as an essential tool for viewing, analyzing, characterizing, and making decisions about land, water and atmospheric components. The Belgaum district has 10 taluks and is covered by 33 Survey of India (SOI) Topographical maps on 1:50,000 scale that form the spatial frame work for mapping (see Fig. No: 2) prepared by using 15' x 15' grid.

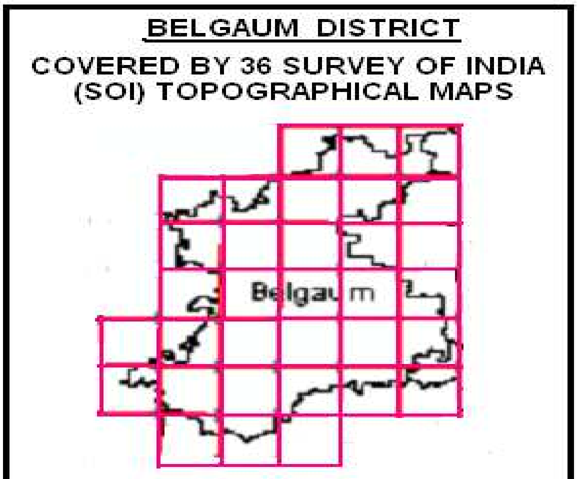


Fig.No: 2.

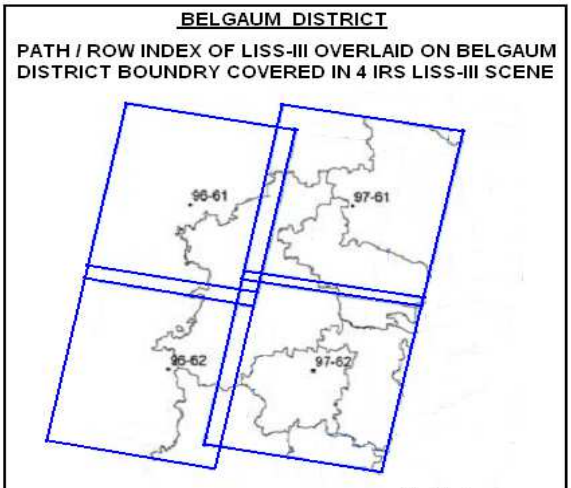


Fig.No:3.

Other Data: Survey of India (SOI) topographical maps were used for reference purpose.

Remote Sensing Data of IRS P6 LISS III data is used to prepare the Belgaum District wetland map. The IRS P6 LISS III provides data in 4 spectral bands; green, red, Near Infra Red (NIR) and Short wave Infra Red (SWIR), with 23 .5 meter spatial resolution and 24 day repeat cycle. The spatial resolution is suitable for 1:50,000 scale mapping. The Belgaum district is covered in 4 IRS LISS III scene (see Fig. No: 3 & Table No:1). Two-time data is acquired, one acquired during October/November and another during April/May were used to capture the post -monsoon and pre -monsoon hydrological variability of the wetlands respectively (see Table No: 2). The Fig. No: 6 & 6-a and Table No: 3 & 4 shows the overview of the part of Karnataka / Belgaum as seen in the LISS III FCC of post - monsoon pre-monsoon data respectively.

Ground Truth Data: Remote sensing techniques require certain amount of field observation called "ground truth" in order to deduce meaningful information. Such work involves visiting a number of test sites, usually taking the satellite data. The location of the features is recorded using the GPS. The standard Performa as per the NWIA manual was used to record the field data. Field photographs are also taken to record the water quality (qualitative), status of aquatic vegetation and water spread. All field data collection work has been done during October and November 20010.

Table 1: Information of Satellite Data Used in the Present Study

#	Resources at LISS III Path Row	Post-monsoon	Pre-monsoon
1	97-61	December 02,2010	April 25,2010
2	97-62	December 02,2010	April 25,2010
3	96-61	December 07,2010	April 30,2010
4	96-62	December 07, 2010	April 30,2010

Source: The data received from National Remote Sensing Agency, Hyderabad.

Methodology

The methodology to create the state level atlas of wetlands is adhered to NWIA technical guidelines and procedure manual (Garg and Patel, 2007). The work was carried out using Arc/Info and Arc-gis software's. The overview of the steps used is shown. Salient features of methodology given as under:

- Generation of spatial framework in GIS environment for database creation and organization.
- Geo -referencing of satellite data
- Identification of wetland classes as per the classification system given in NWIA manual and mapping of the classes using a knowledge based digital classification and on -screen interpretation
- Generation of base layers (rail, road network, settlements, drainage, administrative boundaries) from satellite image and ancillary data.
- Mosaicing/edge matching to create district and state level database.
- Coding of the wetlands following the standard classification system and codification as per NWIA manual.

Creation of Spatial Framework: This is the most important task as the state forms a part of the national frame work and is covered in multiple map sheets. To create NWIA database, NNRMS/NRDB standards are followed and four corners of the 1:50,000 (15' x 15') grids are taken as the tics or registration points to create each map taking master grid as the reference. Spatial framework details are given in NWIA manual (Garg and Patel 2007).

Geo-Referencing of Satellite Data: In this step the raw satellite images were converted to specific map projection using geometric correction. This is done using archived geometrically corrected LISS III data (ISRO-NRC-land use / land cover project). Standard image processing software was used for geo -referencing. First one date data was registered with the archived image. The second date data was then registered with the first date data.

Mapping of Wetlands: The delineation of wetlands through image analysis forms the foundation for deriving all wetland classes and results. Consequently, a great deal of emphasis has been placed on the quality of the image Interpretation. In the present study, the mapping of wetlands was done following digital classification and on-screen visual interpretation. Wetlands were identified based on vegetation, visible hydrology and geography. There are various methods for extraction of water information from remote sensing imagery, which according to the number of bands used, are generally divided into two categories, i.e. Single-band and multi -band methods. Single -band method usually involves choosing a band from multi -spectral image to distinguish water from land by subjective threshold values. It may lead to over - or under -estimation of open water area. Multi-band method takes advantage of reflective differences of each band. In this paper, five indices known in literature that enhances various wetland characteristics were used as given below:

i) Normalized Difference Water Index (NDWI) = (Green-NIR) / (Green + NIR).
ii) Modified Normalized Difference Water Index (MNDWI) = (Green-MIR)/ (Green + MIR)
iii) Normalized Difference Vegetation Index (NDVI) = (NIR-Red) / (NIR + Red)
iv) Normalized Difference Pond Index (NDPI) = (MIR-Green / MIR + Green)
v) Normalized Difference Turbidity Index (NDTI) = (Red -Green) / (Red + Green)

The indices were generated using standard image processing software, stacked as layers. Various combinations of the indices/spectral bands were used to identify the wetland features as shown in Fig. No: 8. The following indices were used for various layer extractions:

- **Extraction of wetland extent:** MNDWI, NDPI and NDVI image was used to extract the wetland boundary through suitable hierarchical thresholds.
- **Extraction of open water:** MNDWI was used within the wetland mask to delineate the water and no -water areas.
- **Extraction of wetland vegetation:** NDPI and NDVI image was used to delineate the vegetation areas within a wetland using a suitable threshold.
- **Turbidity information extraction:** MNDWI image was used to generate qualitative turbidity level (high, moderate and low) based on signature statistics and standard deviations. In the False Colour Composite (FCC) these generally appear in different hues (Table No. 2).

Table 2: Qualitative Turbidity Ratings

#	Qualitative Turbidity	Conditional criteria	Hue on FCC
1	Low	> +1σ	Dark blue/blackish
2	Moderate	> -1σ to <= +1σ	Medium blue
3	High/Bottom reflectance	<= μ - 1σ	Light blue / whitish blue

Source: The data calculated by researcher based on NRSA Data.

Conversion of the raster (indices) into a vector layer: The information on wetland extent, open water extent, vegetation extent and turbidity information was converted into vector layers using region growing properties or on-screen digitization.

Generation of reference layers: Base layers like major rail, road network, settlements, drainage are interpreted from the current image or taken from other project database. The administrative boundaries (district, state) are taken from the known reference data.

Coding and attribute scheme: Feature codification scheme for every input element has been worked out keeping in view the nationwide administrative as well as natural hierarchy (State -district -taluka) within the feature class for each of the theme. All data elements are given a unique name/code, which are self explanatory with short forms.

Map composition and output: Map composition for atlas has been done at district and state level. A standard color scheme has been used for the wetland classes and other layers. The digital files are made at 1:50,000 scale.

Accuracy Assessment

A comprehensive accuracy assessment protocol has been followed for determining the quality of information derived from remotely sensed data. Accuracy assessment involves determination of thematic (classification) as well as location al accuracy. In addition, GIS database(s) contents have been also evaluated for accuracy. To ensure the reliability of wetland status data, the project adhered to established quality assurance and quality control measures for data collection, analysis, verification and reporting.

Table 3: Wetland Area of Belgaum District compare to Karnataka State: 2010

#	Name	Area of (Sq.Kms)	Wetland area (hectares)	Percentage of total wetland area	Percentage of district area	Open water extent (hectares)		Seasonal change (in percent)
						Post-monsoon	Pre-monsoon	
1	Belgaum	13,415	33,412	5.2	0.2	22,090	13,639	-38
2	Karnataka	1,91,791	6,43,576	100.00	3.40	4,27,921	2,62,991	- 39

Source: The data of Belgaum district calculated by researcher based on satellite FCC imaginary and Karnataka State data extracted from NIC Data.

The Belgaum district has a total geographical area of 13,415 sq. km. (see Table No: 3). The whole district is drained by East flowing rivers namely, Malaprabha, Markandeya, Dudganga, Krishna, Mahadai and Ghataprabha. In the district Hidkal, Renuka Sagar reservoir/Barrages and Rakaskoppa tanks are the major wetlands. Famous falls like Gokak, Vajrapoha, Godachina malki and Ghataprabha Bird century are located in this district, which enriches the wetlands. The district comprises of 288 wetlands, which were mapped besides 431 small wetlan ds (< 2.25 hectares). These wetlands account for 33,412 hectares. Three wetland types (see Table No: 4) are Reservoir/Barrages, (19,213 hectares) followed by River/ Stream (13,639 hectares) and Tanks/Ponds (3,832 hectares) exists in the district. Aquatic vegetation has an increase from 4,190 hectares in post -monsoon to 5,402 hectares in pre-monsoon. Analysis of wetland status in terms of open water the district has recorded 22,090 hectares and 13,639 hectares of during post -monsoon and pre-monsoon respectively out of 32,981 hectares (excluding wetlands <2.25 hectares) . Qualitative turbidity of the open water dominated by moderate (20,625 hectares) followed by high turbidity (1,465 hectares) while low turbidity has not been observed in post-monsoon. During pre -monsoon the turbidity was dominated by moderate (8,491 hectares) followed by low (4,282 hectares) and high (866 hectares).

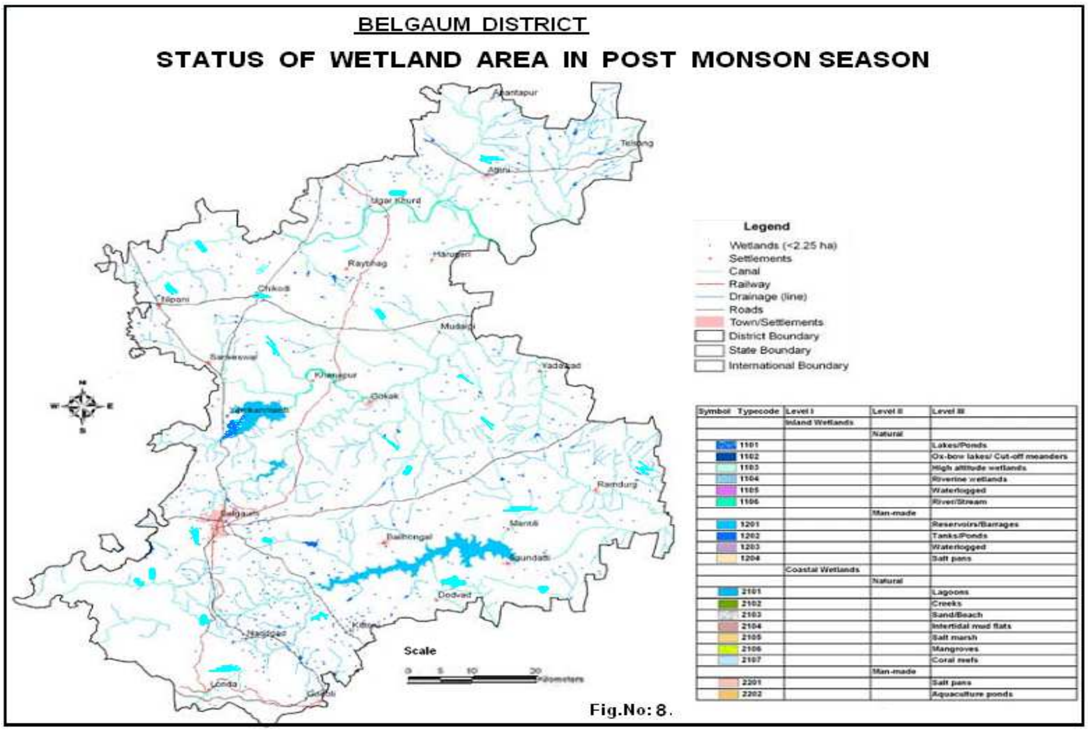


Fig.No: 8.

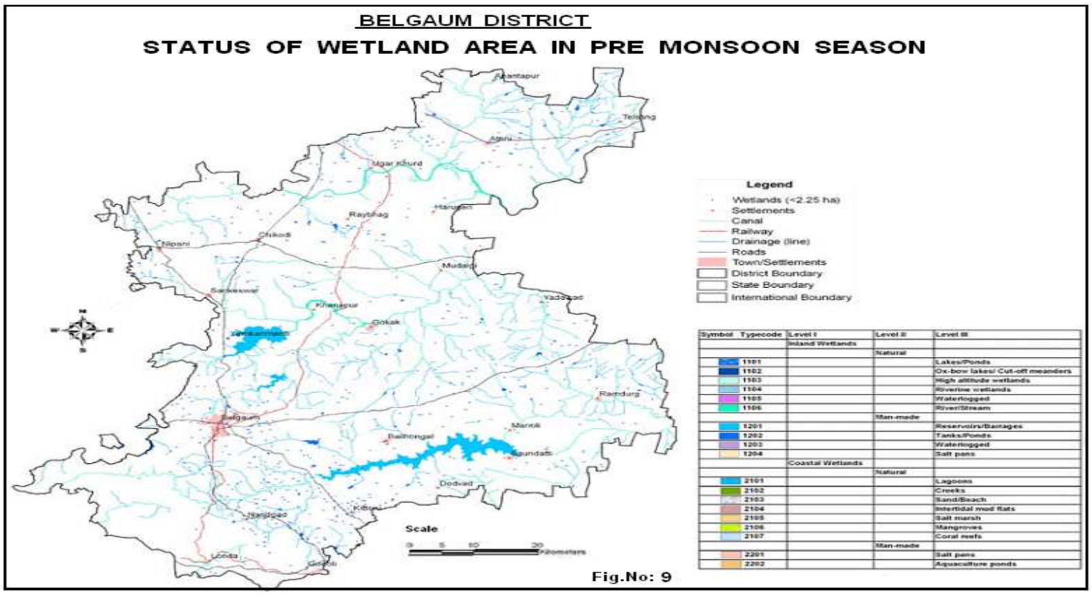


Table 4: Estimated Area under Wetlands in Belgaum District

#.	Wet land Code	Wetland Category	Number of Wetlands	Total Wetland area (hectares)	Percentage of total wetland	Open water extent (hectares)	
						Post-monsoon	Pre-monsoon
	1100	**Inland Wetlands - Natural**					
1	1101	Lakes/Ponds	-	-	-	-	-
2	1102	Ox-bow lakes/ Cut -off meanders	-	-	-	-	-
3	1103	High altitude wetlands	-	-	-	-	-
4	1104	Riverine wetlands	-	-	-	-	-
5	1105	Waterlogged	-	-	-	-	-
6	1106	River/Stream	35	9,336	29.74	8,333	6,619
	1200	**Inland Wetlands -Man made**					
7	1201	Reservoirs/Barrages	3	19,213	57.50	11,190	5,393
8	1202	Tanks/Ponds	255	3,832	11.47	2,567	1,627
9	1203	Waterlogged	-	-	-	-	-
10	1204	Salt pans	-	-	-	-	-
		Total - Inland	**288**	**32,981**	**98.71**	**22,090**	**13,639**
		Wetlands (< 2.25 hectares), mainly Tanks	431	431	1.29		
		Total	**719**	**33,412**	**100.00**	**22,090**	**13,639**
		Area under Aquatic Vegetation	-	-	-	4,190	5402
		Area under Turbidity Levels					
		Low				-	4,282
		Moderate				20,625	8,491
		High				1,465	866

Source: The data calculated by researcher based on satellite FCC imaginary with the help of GIS technology processed through Arc GIS software.

Conclusion

The above study has revealed that satellite data has the unique capability to detect the accurate place of each wetland and changes its characteristics. In some taluks of Belgaum district, due to over irrigation the land use and land cover area is changed drastically specially in Jamkhandi, Mudhol, Badami and Bilagi taluks. For the purpose of conceptual planning need to maintain the slow changes in land use and land cover area for sustainable development of biodiversity in wetland on one hand. In other hand, need to control the areal extension of wetland areas of the study area for the better agriculture output. For fulfilling all these, need to implement the specific area planning in near future. This will help in maintaining the ecological balance and improving micro-environment of the study region.

Reference

1. Anon. (2005) NNRMS Standards. A National Standards for EO images, thematic & cartographic maps, GIS databases and spatial outputs. ISRO: NNRMS: R: 112:2005. A Committee Report: National Natural Resources Management System, Bangalore.
2. Garg, J.K., Singh, T.S. and Murthy, T.V.R. (1998) Wetlands of India. Project Report: RSAM/sac/resa/pr/01/98, June 1998, 240 p. Space Applications Centre, Ahmadabad,
3. Garg J.K. and Patel J. G., (2007) National Wetland Inventory and Assessment, Technical Guidelines and Procedure Manual, Technical Report, SAC/EOAM/AFEG/NWIA/TR/01/2007, June 2007, Space Applications Centre, Ahmadabad,
4. Jensen, J.R. (1986) Introductory Digital Image Processing: A Remote Sensing Perspective, Prentice Hall, Englewoods Cliff, NJ.
5. Lillesand, T.M. and Keifer, R.W. (1987) Remote Sensing and Image Interpretation. John Wliey and Sons, New York.
6. McGraw - Hill (1974) Encyclopedia of Environmental Science, (Ed. Sybil P. Parkar), McGraw -Hill Book Company, New York.
7. McFeeters, S.K. (1996) The use of Normalized Difference Water Index (NDWI) in the delineation of open water features. International Journal of remote Sensing, Vol: 7, pp.1425 -1432.
8. Navalgund, R.R., Nayak, S.R., Sudarshana, R., Nagaraja, R. and Ravindran, S. (2002) Proceedings of the ISPRS Commission VII. Symposium on Resource and Environmental Monitoring, IAPRS & SIS, Vol: 35, Part -7, NRSA, Hyderabad.
9. Patel J.G., Singh T.S., Garg J.K. et al, (2003) Wetland Information System, West Bengal, SAC/RSAM/RESA/FLPG/WIS/01/2003, A Technical report: Space Applications Centre, Ahmedabad