Water Bodies Information System (WBIS)

Technical Document

Document Control Sheet

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15	Abstract			

Automated water bodies extraction algorithms were developed for Resourcesat-1 AWiFS (56m), LISS III (23m) and RISAT-1 MRS (18m) Sensor

	datasets. Spectral knowledge based hierarchical automated algorithm was developed for quick processing of satellite data and to extract water bodies information in near real time. and the water bodies layer generated is hosted as Water Bodies Information System (WBIS) on Bhuvan portal. WBIS facilitates visualization of temporal water spread and water spread analytics.
	This technical document describes briefly on input satellite data, methodologies for extraction of water bodies and publishing on web and limitations and use of datasets.

About -WBIS			
Size of water bodies for which information is provided	>2 Ha		
Water bodies reference (Pre-identified)	**>50 Ha** - 11938 No. **5-50Ha** - 122629 No. **2-5Ha** - 73447 No		
Satellite data	**Satellite Data** **Optical Sensors** Resourcesat-2 AWiFS(56m) -5 Days Resourcesat-2 LISS III(23m) -24 Days **Microwave Sensors** • RISAT-1 MRS (18m) - 24 • RISAT-1 CRS(36m)	**Size of water body** >50 Ha > 2 Ha >10 Ha > 50Ha	**Frequency of observation** Once in 5 Days Once in 24 days Once in 24 Days Available data (no systematic coverage)
Accuracy - Water spread Area	Around 95%		
Information provided	(i) Water spread boundary, area statistics (ii) Water spread analytics		
Disclaimer and conditions for Use			
Satellite derived information is only **Surface Water Spread**. Other attribute namely capacity is a derived parameter. The limitations and use of the WBIS : (i) Information is provided as captured by the satellite data. Clouds may hamper the availability of information. (ii) Accuracy depends on size, shape of water body and the spatial resolution of the sensor, efficiency of automated algorithms (built on knowledge base) (iv) WBIS highlight patterns, trends and variability in water quantity at individual, regional scales. It is suggested for field validation where ever anamoly is observed. (v) Identification and areal extent of Glacial lakes and water bodies in Himalayas, small urban water bodies are not depicted accurately in wbis.			

Water Bodies Information System (WBIS)-2.0
Technical Document

1. Introduction

Satellite sensors can capture the scenario of surface water features at frequent intervals, facilitating mapping and monitoring of surface water bodies at regular intervals. There are several water bodies in India in the form of major/ medium reservoirs, irrigation tanks, lakes, ponds, which are primarily used for agriculture and drinking water purposes. Variation in water spread occurs as a function of rainfall amounts, intensity of rainfall, etc. over season / year. Satellite data utilization for inventory, mapping and monitoring of water bodies over larger areas is a popular technique for generation of temporal database databases.

2. Satellite Data

Indian Remote Sensing (IRS) Missions like Resourcesat-2, RISAT-1 are the main source of satellite data for monitoring changes in water spread. The following are the details of the sensors utilized for the study.

Satellite –Sensor	Spatial Resolution	Repetivity
Resourcesat-2 AWiFS	56m	5 Days
Resourcesat-2-LISS III	23m	24 Days
RISAT-1 –MRS	18m	23 Days
Risat-1 – CRS	36m	As per the request

3. Satellite Data Processing

Spatio temporal water bodies' database has to be generated by processing large number of multi-temporal satellite data sets. Automated water bodies extraction algorithms were developed by NRSC for quick processing of satellite data processing in Integrated Multi Mission Ground Segment for Earth Observation (IMGEOS) IMGEOS from multi-sensor datasets. Thus, the water bodies layers derived are integrated into a common geospatial database. This information is depicted through **Water Bodies Information System (WBIS)** for spatial dynamic data visualization and analysis with respect to individual water body, and also at regional levels**.** Brief methodology for satellite data processing and development of

water bodies information system is described in this document. Satellite /sensor inputs for WBIS are provided below :

Satellites / Sensor based Inputs for WBIS

Satellite Data Optical Sensors	Size of water body	Frequency of observation
Resourcesat-2 AWiFS(56m) -5 Days	>50 Ha	Once in 5 Days
Resourcesat-2 LISS III(23m) -24 Days	> 2 Ha	Once in 24 days
Microwave Sensors		
• RISAT-1 MRS (18m) - 24	>10 Ha	Once in 24 Days
• RISAT-1 CRS(36m)	> 50Ha	Available data (no systematic coverage)

3. Automated algorithms for extraction of surface water bodies

Water bodies database has been generated with a combined use of Reourcesat-2 AWiFS, LISS III (optical data) and RISAT-1 MRS, CRS (microwave data) for which automated algorithms have been developed & made operational in IMGEOS in near real time.

3.1. Processing of Resourcesat-2 AWiFS/LISS III data

Space-borne multi-spectral satellite images are analyzed using supervised/unsupervised classification techniques available in any image processing softwares. The parameters for image classification are provided manually for each of the scene and the process is repeated for all. This process is time consuming and manual interpretation is required for identification of thresholds and assigning clusters to water feature class. Automatic algorithm developed by NRSC (S. Subramaniam, A.V. Suresh Babu and P.S. Roy 2011) for quick processing of satellite data was used for generation of spatial water layers. This automated algorithm is a spectral knowledge driven hierarchical, multi-logic algorithm developed after spectral characterization and transformation to mathematical relationships viz. band ratios, band thresholds & other combination of relationships across the spectral data of four bands 0.52-0.59 μm (Green), 0.62-0.68 μm (Red), 0.77-0.86 μm (NIR) and 1.55-1.70 μm (SWIR) . The principles used for automatic water feature extraction are: Water has lower reflectance in the Visible-SWIR spectral region compared to other surface cover features; Very high contrast between Green & NIR (except turbid water pixels) and Green & SWIR due to the absorption of NIR & SWIR reflectance by water ; Reflectance of water in NIR is lower than that of Red band.

Algorithm is well tested over larger datasets across the country and is scene independent, which is operationally used for extracting water feature. A typical satellite derived water bodies layer is shown in **Figure.1.**
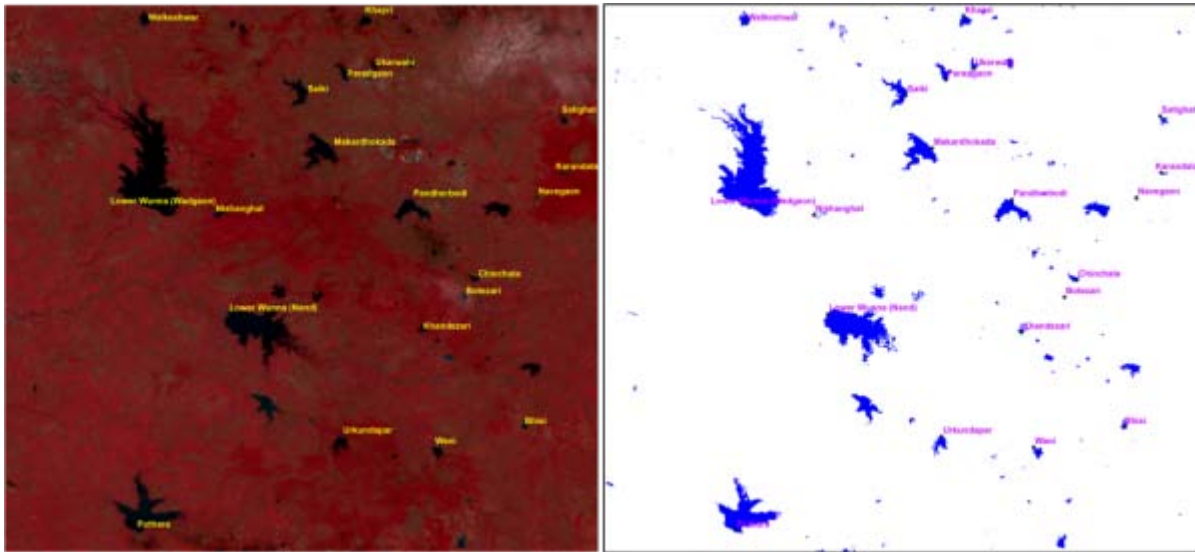

Figure.1. Example showing Resourcesat-2 AWiFS image and the corresponding water layer

3.2. Processing of RISAT-1 MRS / CRS Data

RISAT-1, a microwave satellite data has been used in addition to Resourcesat-2 AWiFS and LISSS III for taking of advantage of microwave imaging in case of cloud cover and also to have additional frequency of coverage for generation of fortnightly / monthly water layer.

RISAT-1 MRS sensor (18 m resolution and 128 km swath) has systematic coverage over India in C Band, dual polarization (HH, HV) mode. Back scatter coefficient (σ_o) was estimated for each of HH, HV images and this information was used for the generation of knowledge base, and to develop an algorithm for identifying water pixels. Methodology consists of Knowledge base creation for water and non water features and characterization of microwave response in terms of of back scatter coefficient (σ_o), identification of thresholds for back scattering coefficients to enable water pixel detection. Legacy database on water bodies was also used for improving the thematic mapping accuracy. (Ref.5). A typical satellite derived water bodies layer is shown in Figure.2.
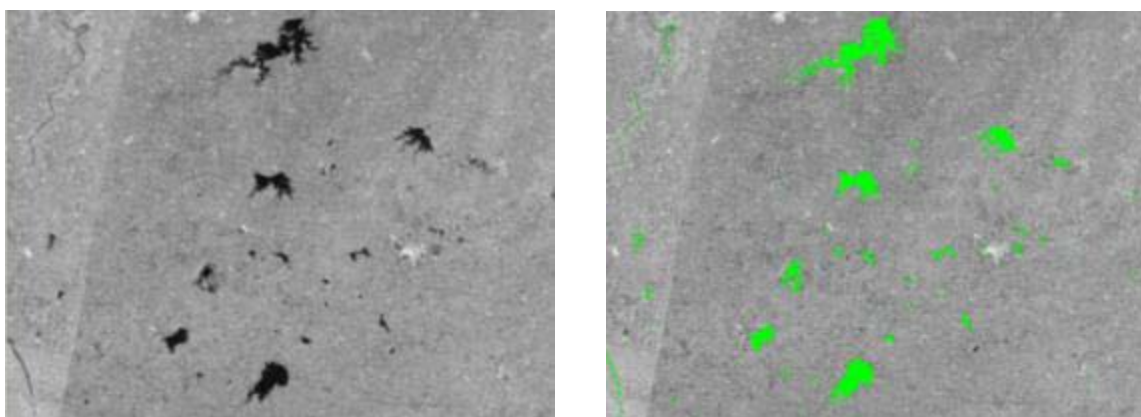
Figure.2. Example showing RISAT-1 MRS image and water layer

3.3. Productization in IMGEOS

IMGEOS is a ground segment infrastructure designed as a multi layer architecture having User Services, Data reception & Processing systems and Storage along with Security and Monitoring components to meet the increasing demand of varied types of satellite data products acquired from all IRS Earth Observation missions. In IMGEOS the data product generation chain is triggered by work-orders from User order processing system (UOPS). The chain comprising of dedicated processing systems controlled by Data product work-flow manager (DPWFM), generates products as per the defined processing level. The Information Product Generation System (IPGS) is a newly added work-flow in IMGEOS to automatically generate water layers from standard products of Resourcesat-2 AWIFS, LISS III, RISAT-1 MRS and CRS sensors in near real time. Every day 1-2 passes of AWIFS sensor data covering Indian region are processed in near real time to generate scene based water layers. These layers are used to generate fifteen day composite mosaic for entire country. The major elements under IPGS production chain are Product generation Initiation through Work Order generation, Information Product Generation System, Product Dissemination to FTP, Chain Monitoring and Routing through DPWFM and EMCIPGS System and Software architecture. IPGS software is a new component in IMGEOS consisting of Information Layers, Mosaic generation and Scheduler software. The layer and Mosaic generation software is developed and optimized in IMGEOS framework with standardized interfaces for automation and error handling in production chain using open source tools. The synchronization of Mosaic generation and time composition are achieved using system level daemon services. The IPGS scheduler is capable of distributed scheduling to take advantage of available processing nodes.

4. Water Bodies Information System (WBIS)

Water Bodies Information System (WBIS) is developed using web technologies like Vue JS, Leaflet and eCharts for data visualization and map elements. Raster data is automatically pooled from time-series water layers into a PostGIS enabled Postgres database. Java script and REST APIs are provided using node.js. and Cassandra for generating the statistics of a individual water body, regional (River Basin, River Sub-basin, State, District) Mapnik was used as rendering Engine.
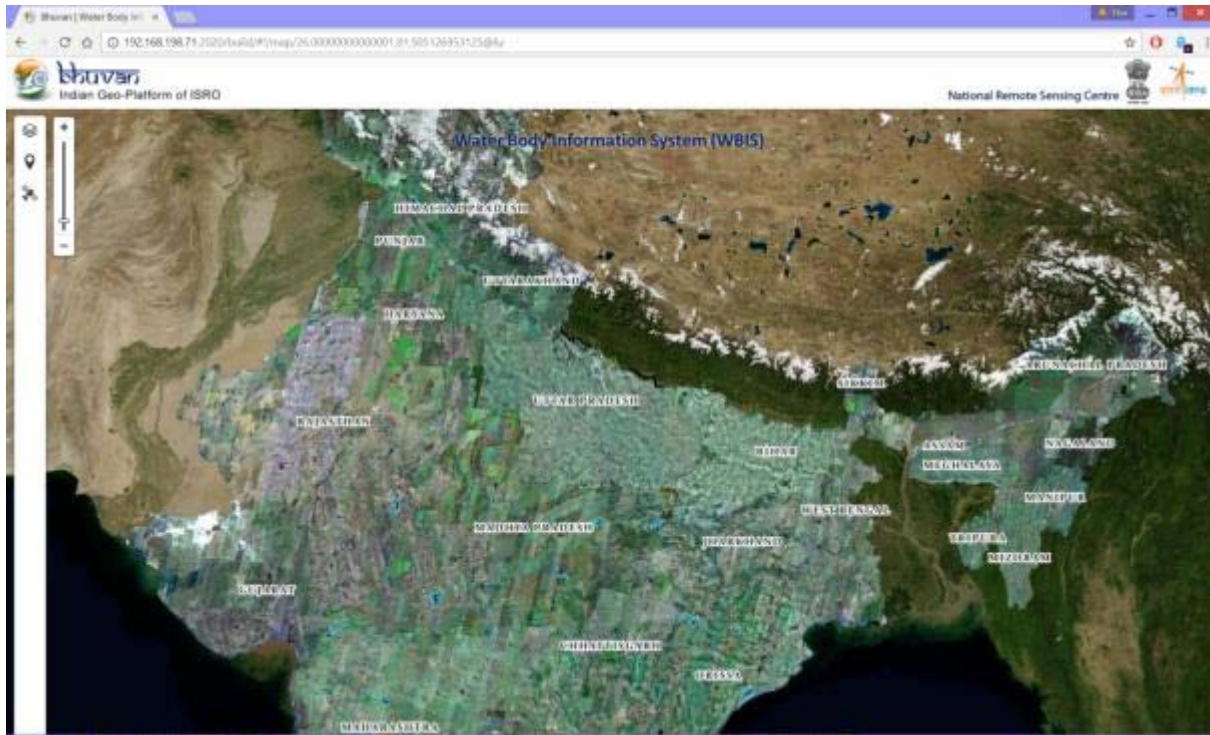
Process flowchart of WBIS are shown in figure below
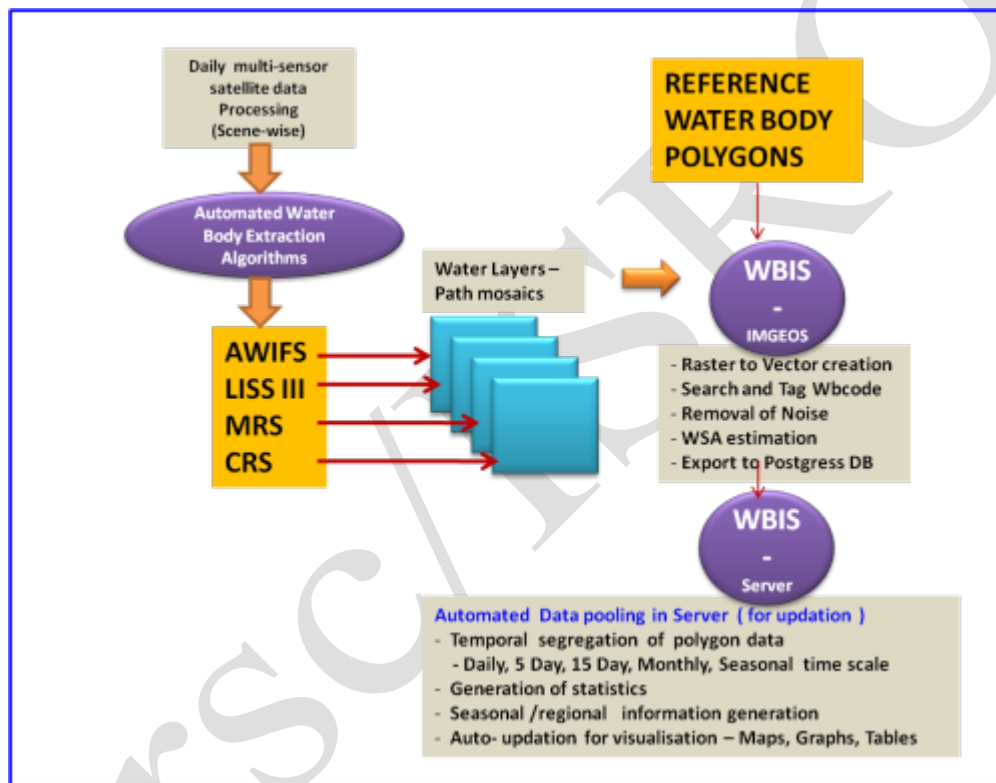
Process flow chart of Water Bodies Information System (WBIS)
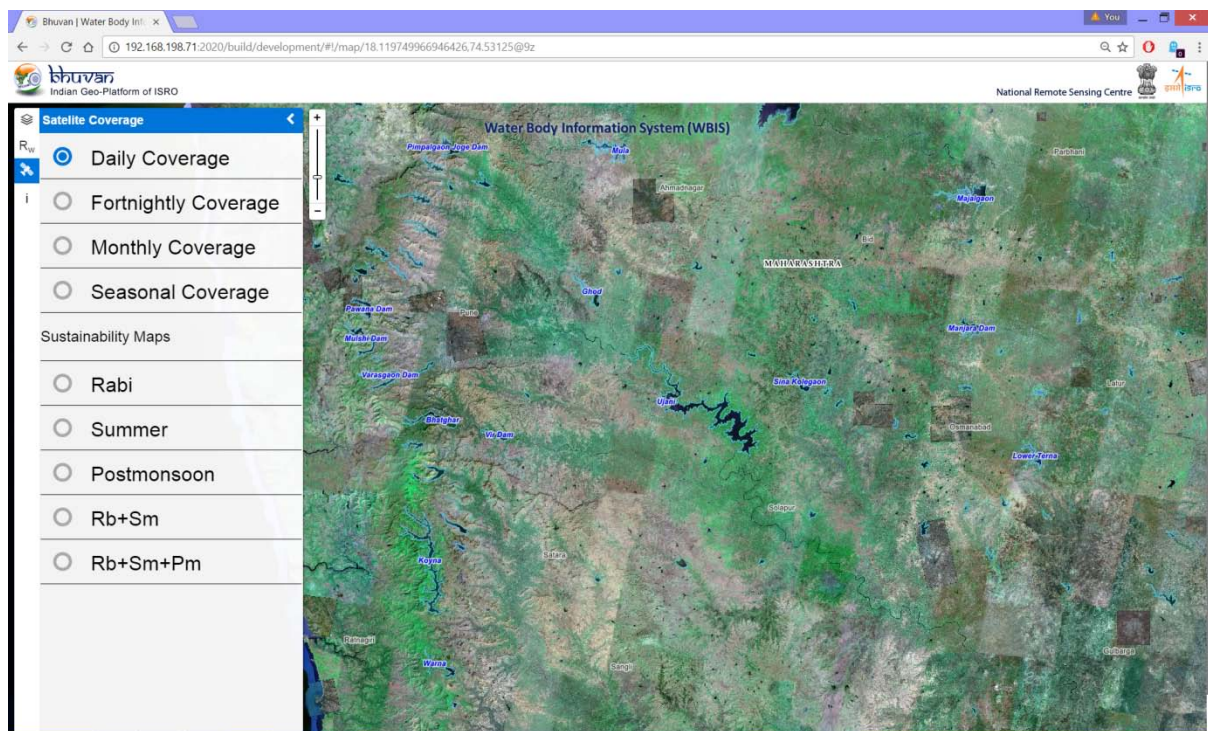
4.1. Data Visualization in WBIS

Water Bodies Information System is provided with the visualization of spatio-temporal layers at fortnightly/ monthly/seasonally every year since 2012. The snapshots of important features are shown here
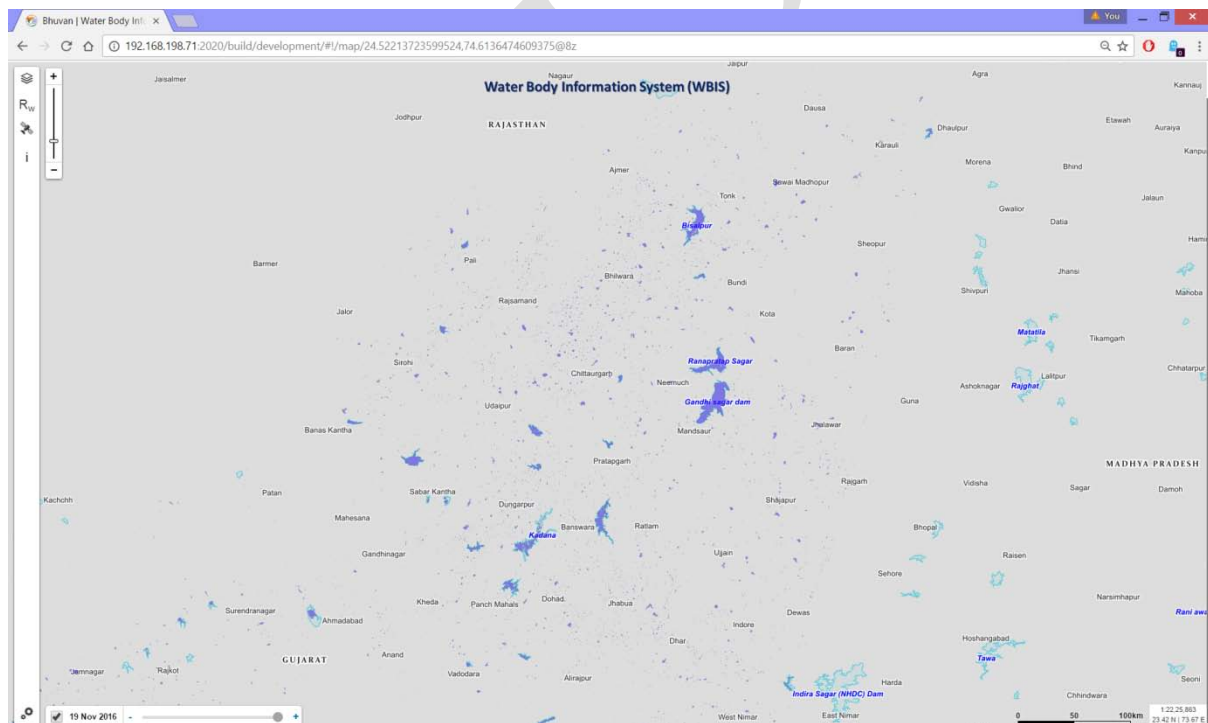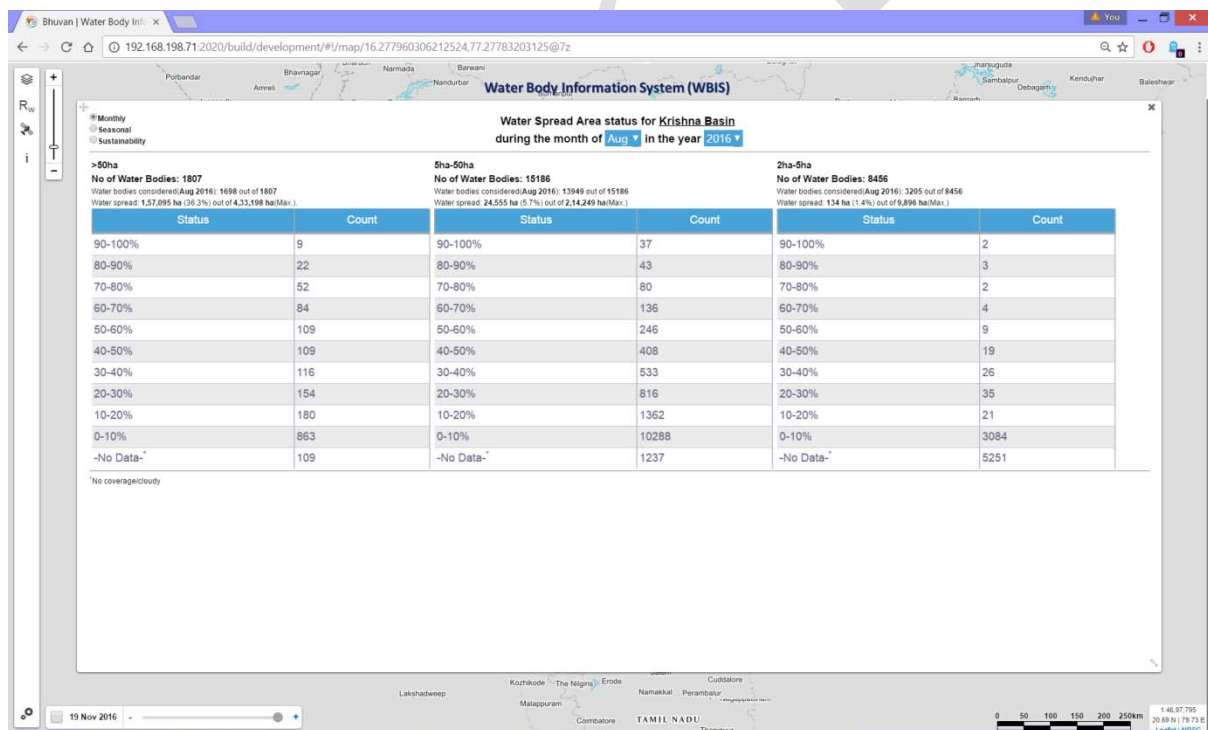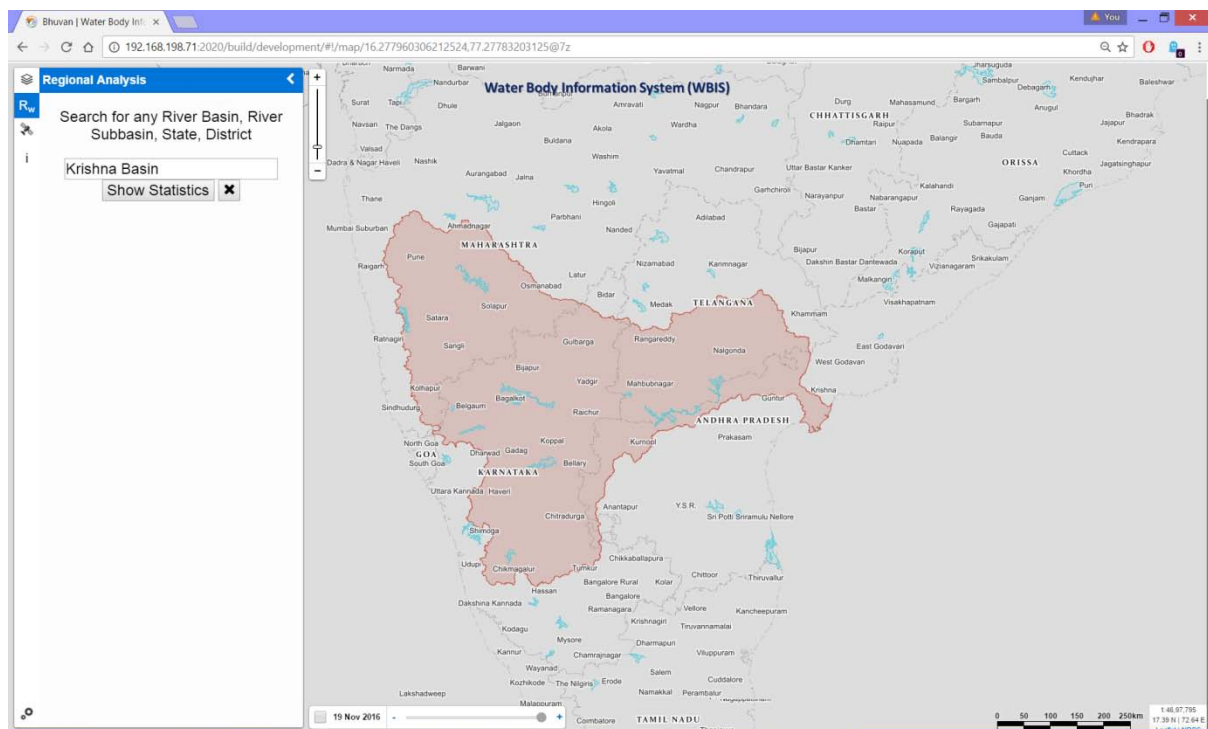
Main web page : WBIS
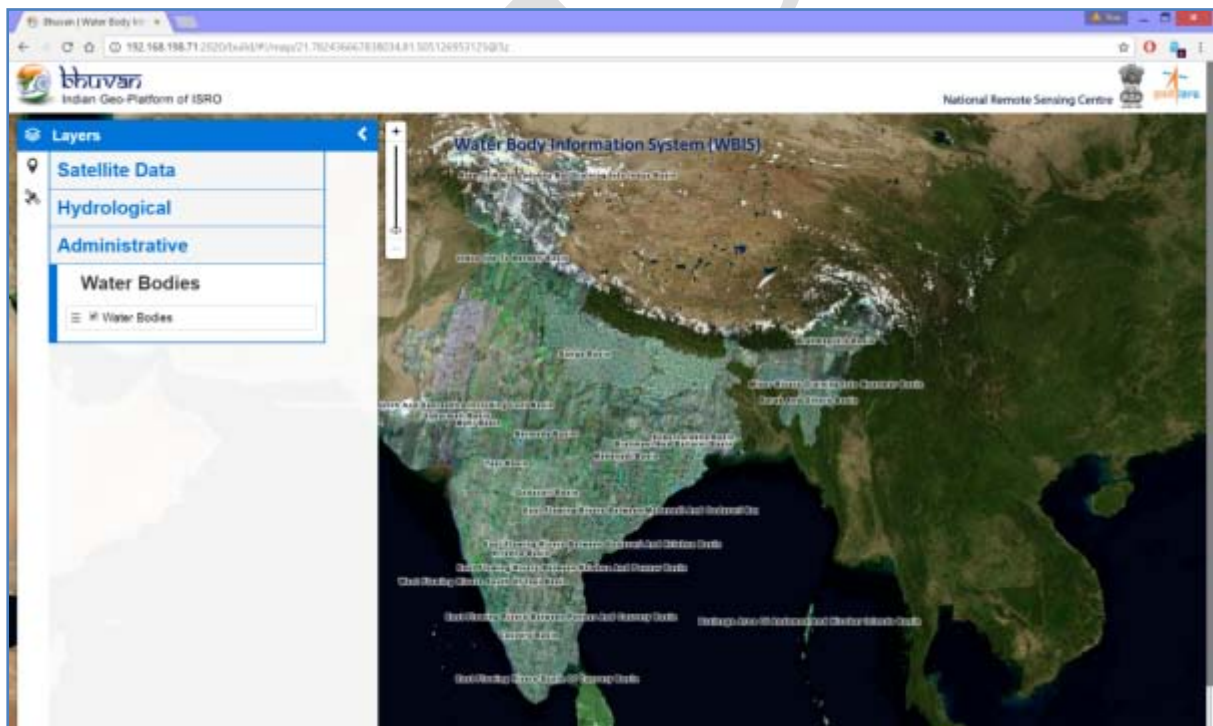
Layers arrangement : Hydrological, Administrative and Reference Satellite Data
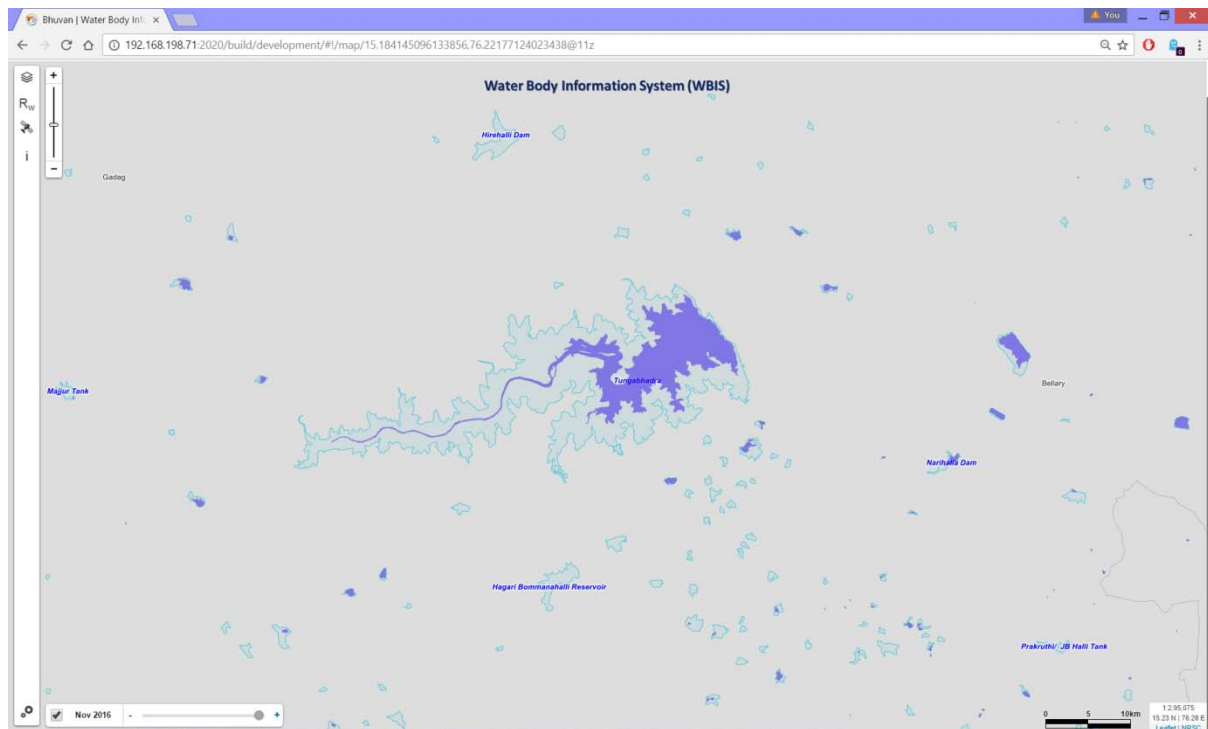
Status of Seasonal information and waterspread sustainability data visualization

View of Daily water layer integration in web service (eg. 19.11.2016)

Water Spread Area status for Krishna Basin during the month of Aug in the year 2016

Monthly / Seasonal / Sustainability

>50ha
No of Water Bodies: 1807
Water bodies considered(Aug 2016): 1698 out of 1807
Water spread: 1,57,095 ha (36.3%) out of 4,33,198 ha(Max.)

5ha-50ha
No of Water Bodies: 15186
Water bodies considered(Aug 2016): 13949 out of 15186
Water spread: 24,555 ha (5.7%) out of 2,14,249 ha(Max.)

2ha-5ha
No of Water Bodies: 8456
Water bodies considered(Aug 2016): 3205 out of 8456
Water spread: 134 ha (1.4%) out of 9,896 ha(Max.)

Status	Count	Status	Count	Status	Count
90-100%	9	90-100%	37	90-100%	2
80-90%	22	80-90%	43	80-90%	3
70-80%	52	70-80%	80	70-80%	2
60-70%	84	60-70%	136	60-70%	4
50-60%	109	50-60%	246	50-60%	9
40-50%	109	40-50%	408	40-50%	19
30-40%	116	30-40%	533	30-40%	26
20-30%	154	20-30%	816	20-30%	35
10-20%	180	10-20%	1362	10-20%	21
0-10%	863	0-10%	10288	0-10%	3084
-No Data-*	109	-No Data-*	1237	-No Data-*	5251

*No coverage/cloudy

Regional statistics on status of water spread

Visualization of Individual reservoir / water body

5. Data use and disclaimer conditions

5.1. Possible use of Water bodies information in various monitoring projects

- o Studies on Water spread dynamics – hydrological drought assessment (for National Hydrology Project)
- o Seasonal Water bodies information -Sustainability analysis (fisheries)
- o Volume estimation (for State/Central Irrigation departments)
- o Visualisation of water spread dynamics
- o Input to hydrological models, climate /weather studies

5.2. Disclaimer and Conditions of Use

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7. References

[1] S. Subramaniam, A.V. Suresh Babu and P.S. Roy, "Automated Water Spread Mapping Using ResourceSat-1 AWiFS Data for Water Bodies Information System". *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing,* vol.4, pp. 205 – 215, 2011.

[2] IPGS Design Document,NRSC-DPSD&DBS-RS2-Aug2013.

[3] IMGEOS Design document : NRSC-DPS-IMGEOS-Sept'10-TR187.

[4] NRSC Document. Satellite derived Information on Water Bodies (WBA) and Water Bodies Fraction (WBF). NRSC – SDAPSA-RSAA-Feb 2014-TR-580.

[5] NRSC Document. Near Real Time Extraction of Water bodies through Automated Algorithm from RISAT-1 MRS Datasets in IMGEOSNRSC – RSA /SDAPSA –Jun 2014.

Acronyms

IMGEOS - Integrated Multi-mission Ground Segment for Earth Observation Satellites

RISAT-1 –Radar Imaging SATellite -1

MRS – Medium Resolution Sensor

IPGS-Information Product Generation System

UOPS – User order Processing System

SAN – Storage Area Network

SWFM – Station Work Flow Manager

EMC – Enterprise Monitor and Controller

DPGS – Data Product Generation System

SWFM   – Station Work Flow Manager