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BHUVAN

GEOSPATIAL CONTENT STANDARDS

www.bhuvan.nrsc.gov.in

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15.	**Abstract (with Keywords)**	This document gives the Standards of various Geospatial Datasets hosted on Bhuvan such as Remote Sensing Data, Base and Thematic layers, Project specific thematic layers & Value added products and Applications. ***Keywords:*** *Bhuvan, NNRMS, Geospatial, Thematic, CartoDEM, Datum, Projection, Spatial extent, Resolution, Accuracy*			

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1. INTRODUCTION

Bhuvan (http://bhuvan.nrsc.gov.in) is a Geo-Platform of Indian Space Research Organisation hosting Remote sensing images from multi-sensor, multi-platform, multi-temporal domain; Multi-scale, multi-theme Base & Thematic GIS data; Value added products and Web applications & Services. Bhuvan also offers free download of remote sensing data, GIS data, Value added data & DEM for academic and research purpose. In the recent times, Bhuvan has been a standard Indian Geo-Platform for developing many national and state level operational applications in the areas of natural resource development, monitoring, infrastructure planning, disaster management etc. In order to improve the effective usability of these datasets and services by various users, the Bhuvan datasets that are being hosted/ organised need to adhere to uniform standards and data policies.

Like many areas of Information technology, Geospatial information is growing rapidly. Standards are crucial to share geospatial data accurately and uniformly across the national and international users and enable them to work together. Many countries and internal organisations have made efforts for development of standards - especially in USA (through the US-NSDI and USGS National Map); Europe (through the IGN Standards of France and Eurogi Standards for Europe); Australia (through the AUSLIG NSDI Standards), India (NNRMS Standards) and the international efforts of GSDI, ISO, OGC, CEOS, ISPRS etc.

Some of the international organisations working on geospatial standards with an objective to improve the usability of data across the users include:

- American National Standards Institute (ANSI) - (http://www.ansi.org/)
- Digital Geographic Information Working Group (DGIWG) - (http://www.dgiwg.org/digest/About2.htm)
- European Committee for Standardization (CEN) - (http://www.cen.eu/cen/)
- Federal Geographic Data Committee (FGDC) - (http://www.fgdc.gov/)
- Global Spatial Data Infrastructure (GSDI) - (http://www.gsdi.org/)
- International Hydrographic Organization (IHO) - (http://www.iho.int/)
- International Organization for Standardization (ISO) - (http://www.iso.org/)
- Location Interoperability Forum (LIF) - (http://www.cellular.co.za/technologies/location/lif.htm)
- American Society of Photogrammetry and remote sensing (ASPRS) (www.asprs.org)
- International Society for Photogrammetry and Remote Sensing (ISPRS) (www.isprs.org)
- Infrastructure for Spatial Information in the European Community(INSPIRE) (htt://inspire.ec.europa.eu)

- Natural Resources Canada – Geospatial Standards and policy for interoperability (www.nrca.gc.ca)
- UK GEMINI (GEo-spatial Metadata INteroperability INitiative) (www.agi.org.uk)
- UK Ordinance Survey –Geospatial Standards Policy (www.ordinancesurvey.co.uk)
- Open Geospatial Consortium (OGC) - (http://www.opengeospatial.org/)
- Web Services Interoperability Organization (WS-I) - (http://www.ws-i.org/)
- World Wide Web Consortium (W3C) - (http://www.w3.org/)

However, the most important concern is that, the stringent accuracy standards should not affect the specific project specifications, objectives which can significantly impact project / program implementation. Therefore, it is essential to develop/implement/adopt the standards which will meet the project needs as well as cater to the geospatial data needs of the National level programs or projects.

In 1998, the National Natural Resources Management System (NNRMS) took a major leap in defining GIS standards for the Natural Resources Information System (NRIS) and adopted the "NRIS Standards", the first GIS standardization in the country, wherein the GIS design and content standardization for the NRIS projects had been optimally defined for 1:50,000 scale (NRIS Standards, 2001). Over the years, the NRIS standards have served the requirements of GIS databases and have emerged as the de-facto national guideline standards for GIS databases. Similarly, many NNRMS projects have re-scoped the NRIS standards and adopted them for various thematic projects at 1:250,000, 1:50,000 & 1:10,000 scales and Cartographic projects at 1:4000 & 1:2000 scales. Owing to the relevance of developing uniform geospatial data standards, later National Natural Resources Management System (NNRMS) has developed the first geospatial data standards in 2005.

With the advancement of geospatial technologies in terms of data sources, processing and dissemination, as well as the introduction of New National Map Policy 2006 and Remote Sensing Data policy 2011, there is a need to revise existing standards for Bhuvan geospatial content.

2. COMPONENTS OF BHUVAN GEOSPATIAL CONTENT STANDARDS

Bhuvan Geo-Platform primarily host and publish Remote sensing image data, Base & Thematic GIS data, Topographic data, Crowd sourcing data, Mobile based geo tagged field data. The main components are given below:

Remote Sensing data Standards
This section describes the different remote sensing data, their spatial, spectral parameters, processing level and accuracies.

Spatial Reference Standards
This section gives the spatial reference systems as per the National Map Policies-2006.

GIS data standards
Bhuvan hosts GIS database/layers that are generated under various ISRO/DOS projects and user specific projects data at different scales. The geospatial content of these datasets are generated as per the NNRMS-2005 standards for each of the theme and scale. Nevertheless, the content and classification of themes are modified to meet project / user specific needs. Therefore, in additional to the NNRMS-2005 base thematic content standards, the project specific content standards are also given.

Topograhic Data Standards
Describes the specifications of Digital Elevation Model (DEM) derived from Cartosat-1 Stereo data.

Output Standards
The output standards cover the Output framework, Mode of data dissemination and Format.

Meta data Standards
Describes the basic Meta data elements of the Bhuvan Geospatial data content.

2.1 Remote Sensing Data Standards

Bhuvan hosts the various multi sensors, multi resolution (spatial /spectral) satellite datasets as permissible according to the Remote Sensing Data Policy (RSDP)-2011

Global Coverage Datasets

- **Low Resolution Satellite Data**
  1. Resourcesat AWiFS (53m)
  2. Resourcesat LISS-III(23.5m)
  3. Oceansat-2 OCM
  4. Oceansat-2 Scatterometer
  5. IMS-1 Hyperspectral Imager(HySi)

National Coverage Datasets

- **Medium Resolution Satellite Data**
  1. IRS LISS-III (23m)
  2. IRS LISS-IV MX (5.8m)
  3. RISAT-1 , C-band (Modes: HRS, FRS-1, FRS-2, MRS, CRS)
  4. Megha Tropiques (MADRAS, ScaRab, SAPHIR, ROSA)

- **High Resolution Satellite Data (Indian)**
  1. Cartosat-1 + LISS-IV MX Pan sharpened NCC (2.5m)
  2. Cartosat-2 + LISS-IV MX Pan sharpened NCC (1m)

International Satellite datasets

1. GeoEye Series (0.46m/ 0.34m PAN & 1.84m/ 1.36m Mx)
2. World view Series (0.5m/ 0.31m PAN & 1.84m/ 1.24 Mx)
3. Kompsat 2 (1m Pan, 4m MSS)
4. Kompsat 3 (0.7m PAN, 2.8 Mx)
5. Kompsat 3a (0.55m PAN, 2.2m Mx, 5.5m IR)
6. Pleiades 1A / 1B (0.5m, 2m Mx)
7. Skysat Series (0.9m / 1.1m PAN & 2m Mx)
8. SPOT – 6 & 7 (1.5m PAN, 6m Mx)
9. ALOS (2.5m PAN)

Future Indian Satellite Missions

1. GISAT (50m mx, 500m HySI(VNIR, SWIR), 1.5km Thermal)
2. Resourcesat -3 / 3A/ 3B(23.5m)
3. Cartosat 1A / 1B/1C (1.25m Stereo PAN, 2.5m Mx, 25m HySI VNIR and SWIR)
4. Cartosat 2C / 2D (0.64 m PAN / 2.5m Mx)
5. Cartosat 3 (0.25m PAN, 1m Mx, 5m MIR)

(Note: The Satellite data sets shall be hosted / published as per RSDP-2011 or according to the future Remote Sensing Data policies.)

The Table-1 gives remote sensing sensor wise standards which include processing level, spatial resolution, spectral resolution, radiometry, positional accuracy and spatial reference and other relevant parameters. The standards are defined with reference to presently available remote sensing data sets. However the standards are applicable / extendable for the future sensors data.

2.2 Spatial Reference Standards

The spatial reference frame has been defined in compliance to the National Map Policy-2006.

Datum: WGS84
Projection for hosting on Bhuvan: Geographic
Output Projection: UTM

Table 1 - Remote Sensing Data Standards

Parameter	Low Resolution		Medium Resolution	High Resolution		Remarks
	AWiFS	LISS- III	Resourcesat LISS IV MX	Cartosat 1 / Cartosat 1+ LISS IV MX Pan sharpened	Cartosat 2/ Cartosat2+ LISS IV MX Pan sharpened / Other High Resolution Pan sharpened	
Procedure / Methodology for Ortho rectification	Photogrammetric Bundle block adjustment using GCPs derived from reference image (X, Y) and Z from CartoDEM.	Photogrammetric Bundle block adjustment using GCPs derived from reference image (X, Y) and Z from CartoDEM.	Photogrammetric Bundle block adjustment using GCPs derived from reference image (X, Y) and Z from CartoDEM.	Photogrammetric Bundle block adjustment using GCPs derived from reference image (X, Y) and Z CartoDEM.	Photogrammetric Bundle block adjustment using GCPs derived from reference image (X, Y) and Z from CartoDEM.	Photogrammetric Bundle Block level accuracy better than one pixel with reference to reference image or previous block. For example: T1 time Image block shall be processed with reference to T0 time Image block
DEM Source	CartoDEM or open source DEMs	CartoDEM or open source DEMs	CartoDEM or open source DEMs	CartoDEM or open source DEMs	CartoDEM or open source DEMs	DSM can be used for correcting the relief displacement.
Spatial Reference	Datum: WGS 84 Projection : Geographic	Datum: WGS 84 Projection : Geographic	Datum: WGS 84 Projection : Geographic	Datum: WGS 84 Projection : Geographic	Datum: WGS 84 Projection : Geographic	Geographic Projection is defined to maintain the seamlessness across States and Nation.
Spatial Resolution	50m	25m	5m	2.5m	1m	As per RSDP-2011 policy, up to 1m spatial resolution is permissible for public use.
Image Display	Natural Color Composite (NCC) [Optionally False Color Composite (FCC) can be enabled as per user requirement]	Natural Color Composite (NCC) [Optionally False Color Composite (FCC) can be enabled as per user requirement]	Natural Color Composite (NCC) [Optionally False Color Composite (FCC) can be enabled as per user requirement]	Natural Color Composite (NCC)	Natural Color Composite (NCC)	Thematic interpretation is best done in FCC mode from Low and medium resolution satellite images. Interpretation of optical images is better in NCC from High Resolution satellite data.
Radiometry	8 bit or 10bit	8 bit or 10bit	8 bit or 10bit	8 bit or 10bit	8 bit or 10bit	For visualisation and interpretation 8 bit is better suited.

Parameter	Low Resolution		Medium Resolution	High Resolution		Remarks
	AWiFS	LISS- III	Resourcesat LISS IV MX	Cartosat 1 / Cartosat 1+ LISS IV MX Pan sharpened	Cartosat 2/ Cartosat2+ LISS IV MX Pan sharpened / Other High Resolution Pan sharpened	
Planimetric Accuracy RMSE(Root Mean Sqaure Error), CE(Circular Error)	RMSE = better than 100m CE 90 = 240m	RMSE = better than 50m CE 90 = 120m	RMSE = better than 20m CE 90 = 48m	RMSE = better than 10m CE 90 = 24m	RMSE = better than 5m CE 90 = 12m	CE = 2.4 X RMSE
Band to band registration	0.25 pixel in m	0.25 pixel in m	0.25 pixel in m	0.25 pixel in m	0.25 pixel in m	
Resampling	Bilinear or Cubic Convolution	Bilinear or Cubic Convolution	Bilinear or Cubic Convolution	Cubic Convolution	Cubic Convolution	Online user choice
Tile to Tile Seamlessness	Geometric Error: Within one pixel Color Balance: Color Balance of adjacent scenes is recommended, if scenes fall within the same season & same year	Geometric Error: Within one pixel Color Balance: Color Balance of adjacent scenes is recommended, if scenes fall within the same season & same year	Geometric Error: Within one pixel Color Balance: Color Balance of adjacent scenes is recommended, if scenes fall within the same season & same year	Geometric Error: Within one pixel Color Balance: Color Balance of adjacent scenes is recommended, if scenes fall within the same season & same year	Geometric Error: Within one pixel Color Balance: Color Balance of adjacent scenes is recommended, if scenes fall within the same season & same year	
Time series Co-registration	One pixel accuracy	One pixel accuracy	One pixel accuracy	One pixel accuracy	One pixel accuracy (valid for the ground, excluding DSM features relief displacement)	To facilitate time series comparison and analysis.
Format	Geo-tiff	Geo-tiff	Geo-tiff	Geo-tiff	Geo-tiff	OGC standards

2.3 GIS Data Standards

Bhuvan hosts base and multi-thematic GIS databases, generated under various National User projects and ISRO/DOS projects. Numerous applications, Valued added products and Science Products are also being hosted on Bhuvan. The Base and Thematic layers are prepared at multi scales using satellite data of different spatial resolutions. The accuracy of the databases shall be ensured with respect to Projection/Datum, Planimetric Accuracy, Minimum Mappable Unit, Thematic Accuracy, Format and other parameters. Table 2 gives the standards for Base and Thematic data based on NNRMS-2005 Standards.

The Base and Thematic GIS data content includes the following layers:

Base Layers

1. Road
2. Rail
3. Water Bodies
4. Canal
5. Drainage
6. Settlements
7. Administrative boundaries
8. City/Town boundaries

Project Specific Thematic Layers

1. Land use/land Cover (250K)
2. Land use/land Cover (50K) 2005-06, 2011-12
3. Wastelands (50K) 2008-2009
4. Geomorphology (50K) 2005-2006
5. Lineament (50K)
6. Ground Water Prospects (RGNDWM) (50K)
7. Erosion (50K) 2005-2006
8. Salt Affected & Waterlogging (50K) 2005-2006
9. Land use/land Cover (10K) SIS-DP
10. Urban Land use (10k) NUIS
11. Glacial Lakes/Water Bodies
12. Agricultural Plantations

Project Specific Value Added products

1. Time series Urban Built Up
2. Disaster Services
3. Water resources Data services
4. Agricultural Drought Assessment
5. Forest Fire Alerts
6. Ocean Services
7. Climate and Environment Services

Table 3 gives the Base and Thematic Data Content as per NNRMS Standards.

Table 2 - Standards for Base and Thematic Data

Parameter	1 : 250,000	1 : 50,000	1 : 10,000	1 : 5,000	1:4000
Spatial Extent	National/Global	National/Global	National/State/ District/Local	District/Local	District/Local
Map Projection	Geographic	Geographic	Geographic/UTM	Geographic/UTM	Geographic/UTM
Datum	WGS 84	WGS 84	WGS 84	WGS 84	WGS 84
Planimetric Accuracy Thematic : 1mm of scale Topographic: 0.25mm of the scale	 250m 62.5m	 50m 12.5 m	 10m 2.5m	 NA 1.25m	 NA 1m
Minimum Mappable Unit (MMU) (3 X3 pixels of image resolution) Thematic: Topography:	 25281 sq. m NA	 4970.5 sq. m NA	 56.25 sq. m 9 sq. m	 NA 2.25 sq. m	 NA 1.44 sq. m
Thematic Accuracy of Classification/Mapping	90/90	90/90	90/90	90/90	90/90
Data Format	Shape File	Shape File	Shape File	Shape File	Shape File

Table 3 - Base and Thematic Data Content

Content Category	1 : 250,000	1 : 50,000	1 : 10,000	1 : 5,000 / 1:4000
Base Data	Road	Road	Road	Road
	Rail	Rail	Rail	Rail
	Drainage	Drainage	Drainage	Drainage
	Waterbodies	Waterbodies	Waterbodies	Waterbodies
	Admin Boundaries	Canals	Canals	Canals
		Settlement	Settlement	Settlement
		Admin Boundaries	Admin Boundaries	Admin Boundaries
		Village Boundaries	Village Boundaries	Village Boundaries
		Watershed Boundaries		City/Town boundaries (Planning area, Municipal/Corporation, Ward)
Thematic Data	Land use/Land cover	Land use/Land cover	Land use/Land cover(SIS-DP)	Urban Land use
	Soil Erosion	Wastelands	Urban Land use (LSM, NUIS)	
	Glacial Lakes	Geomorphology		
		Geological Structures		
		Lithology		
		Ground Water Prospects		
		Erosion		
		Salt Affected & Waterlogging		
		Urban Built Up		
		Snow (NRC/Glacier studies)		

2.3.1 Project Specific Thematic Layers

NUIS 1:10,000 scale Thematic Data Content

NUIS Urban Thematic Database has been prepared from Cartosat-1 and LISS IV Merged product on 1:10,000 scale for 152 towns. The Urban Land use classification content up to Level-III is given in the Table 4.

Table 4 - NUIS - Urban Land Use/ Land Cover (1:10,000)

LEVEL – I	LEVEL – II	LEVEL – III
Built Up		
	Built Up (Urban)	
		Residential
		Industrial
		Mixed Built Up area
		Recreational
		Public and Semi public
		Public Utilities &
		Commercial
		Transportation
		Reclaimed land
		Vacant land
		Vegetated Area /Trees
	Built Up (Rural)	Settlement Area
Agriculture		
	Cropland	
	Fallow land	
	Orchards	
Forest		
	Dense Forest	
	Open Forest	
	Plantations	
	Mangroves	
Grazing land		
Wastelands		
	Salt-affected	
	Gullied / Ravinous	
	Land with / without scrub	
	Barren / Rocky	
	Sandy area	
Wetlands		
	Marshy / Swampy	
	Mudflats	
	Waterlogged	
	Salt pans	
Water bodies		
	River/Streams	
	Canal	
	Lakes/ Ponds	
	Reservoirs	

LEVEL – I	LEVEL – II	LEVEL – III
	Tanks	
	Cooling Pond/ Cooling Reservoir	
	Abandoned quarries with water	
Others		
	Quarry / Brick Kilns	
	Dam / Barrage	
	Coral reef / Atoll	

SIS-DP Land use / Land cover 1:10,000 scale Thematic Data Content

Space based Information Support for Decentralized Planning (SIS-DP) aims to empower Panchayat Raj Institutions (PRIs) and stakeholders for spatial, participatory, integrated decentralized planning in the country. SIS-DP provide the 1:10,000 scale geospatial data including Land Use / Cover, Infrastructure - Road, Rail, Canal, Drainage and terrain slope covering entire country. The data sets are accessible by State/District.

Table 5 – SIS-DP Land Use / Land Cover (1:10,000)

Level-I	Level-II	Level-III
Built Up	Built Up (Urban)	Built Up (Urban)
		Core urban
		Peri-urban
	Built Up(Rural)	Built Up (Rural)
		Village
		Mixed settlement
		Hamlets & dispersed
	Mining / Industrial	Mining/Industrial
	Transportation	Transportation
Agricultural Land	Crop land	Crop land
	Agriculture plantation	Agriculture plantation
	Aquaculture /	Aquaculture / Pisciculture
Forest	Forest	Forest
	Forest plantation	Forest plantation
	Mangrove / Swamp Area	Mangrove/Swamp Area
Grassland & Grazing land	Grassland & Grazing land	Grassland & Grazing land
Wastelands	Salt affected	Salt affected
	Gullied / ravenous	Gullied / ravenous
	Waterlogged	Waterlogged
	Scrub land	Scrub land Dense
		Scrub land Open
	Sandy areas	Sandy areas
	Barren rocky	Barren rocky
Shifting cultivation	Shifting cultivation	Current
		Abandoned
Water bodies	River / Stream / Drain	River / Stream / Drain
	Canal	Canal
	Lakes / Ponds	Lakes / Ponds
	Reservoir / Tanks	Reservoir / Tanks
Snow / Glacial area	Snow / Glacial area	Snow / Glacial area

Table 6 – SIS-DP Transportation Layer (1:10,000)

Layer	Categories	Type	Status
Transportation	Road	Pucca Road	National Highway
			Express Highway
			State Highway
			District Road
			Village Road
			City Road
		Kutchha Road	Village Road
			Cart Track
			Foot Path
	Rail	Broad Guage	Government
			Captive
		Meter Guage	Government
			Captive
		Other Guage	Government
			Captive

Table 7 – SIS-DP Drainage Layer (1:10,000)

Layer	Categories
Drainage	River
	Stream
	Drain
Canal	Main Canal
	Branch Canal
	Distributory Canal

Table 8 – SIS-DP Slope Layer

Class	Range (%slope)
Level to nearly level	0-1
Very Gently sloping	1-3
Gently sloping	3-8
Moderately sloping	8-15
Moderately steeply sloping	15-30
Steeply sloping	30-50
Very steeply sloping	>50

Land use / Land cover 1:50,000 scale Thematic Data Content

Land use / Land cover 50k Database has been prepared from IRS LISS III product on 1:50,000 scale for entire country. The Land use/Land cover classification content is given in the Table 9

Table 9 - Land Use / Land Cover (1:50,000)

DESCRIPTION-1	DESCRIPTION-2
Built-up	Urban
	Rural
	Mining
Agriculture	Crop land
	Plantation
	Fallow
	Current Shifting cultivation
Forest	Evergreen / Semi evergreen
	Deciduous
	Forest Plantation
	Scrub Forest
	Swamp / Mangroves
Grass/ Grazing	Grass/ Grazing
Barren/Unculturable/Wastelands	Salt Affected Land
	Gullied / Ravinous Land
	Scrub land
	Sandy area
	Barren rocky
	Rann
Wetlands / Water Bodies	Inland Wetland
	Coastal Wetland
	River / Stream / canals
	Water bodies
Snow and Glacier	

Wastelands 1:50,000 scale Thematic Data Content

Wasteland mapping for the whole country was carried out using has been prepared from IRS LISS III product on 1:50,000 scale for entire country. The classification content is given in the Table 10

Table 10 - Wastelands (1:50,000)

CATEGORY
Gullied and/or ravinous land-Medium
Gullied and/or ravinous land-Deep/very deep ravine
Land with dense scrub
Land with open scrub
Waterlogged and Marshy land-Permanent
Waterlogged and Marshy land-Seasonal
Land affected by salinity/alkalinity-Moderate
Land affected by salinity/alkalinity-Strong
Shifting cultivation area-Current Jhum
Shifting cultivation area-Abandoned Jhum
Under utilised/degraded forest-Scrub dominated
Agricultural land inside notified forest land
Degraded pastures/grazing land
Degraded land under plantation crops
Sands- Riverine
Sands- Coastal sand

CATEGORY
Sands- Desert Sand
Sands- Semi-stabilized to stabilized (>40m) dune
Sands- Semi-stabilized to stabilized moderately high (15- 40m) dune
Mining Wastelands
Industrial wastelands
Barren rocky area
Snow cover and/or glacial area

Land use / Land cover 1:250,000 scale Thematic Data Content

LULC 250k Database has been prepared from Resourcesat-II AWifs data product on 1:250,000 scale for entire country. Till now 10 cycles have been completed starting from 2004-2005. The land use/land cover classification content is given in the Table. 11. The content accuracy is 88-92% and updation cycle is every year starting from 2004-05 to 2013-14.

Table 11 - Land use / Land cover (1:250,000)

ID	LULC CLASS
1	Built-Up
2	Kharif only
3	Rabi only
4	Zaid only
5	Double / Triple
6	Current fallow
7	Plantation / Orchard
8	Evergreen forest
9	Deciduous forest
10	Scrub / Degraded forest
11	Littoral swamp / Mangroves
12	Grassland
13	Other wasteland
14	Gullied
15	Scrub land
16	Water bodies
17	Snow covered
18	Shifting cultivation
19	Rann

CONTENT	ACCURACY	TIME SERIES (UPDATION CYCLE)
LULC 250K	88-92%	Every year. Till now 10 cycles completed and hosted on Bhuvan starting from 2004-05 to 2013-14

Soil Erosion 1:50,000 scale Thematic Data Content

Soil Erosion 50k Database has been prepared from IRS LISS III product on 1:50,000 scale for entire country. The thematic content is given in the Table 12.

Table 12 - Soil Erosion (1:50,000)

ID	LDPROCESS
1	Sheet erosion
2	Rill erosion
3	Gully

4	Ravines
5	Loss of top soil by wind
6	Stabilized dunes
7	Partially stabilized dunes
8	Unsterilized dunes

CONTENT	TIME SERIES (UPDATION CYCLE)
Soil Erosion 1:50,000	Once in 10 years

Salt affected and Waterlogged areas of India at 1:50,000 scale Thematic Data Content

Salt affected and waterlogged areas at 50k Database has been prepared from IRS LISS III product on 1:50,000 scale for entire country. The thematic content is given in the Table 13.

Table 13 - Salt affected and Waterlogged areas (1:50,000)

ID	LDPROCESS
1	Saline- slight
2	Saline- moderate
3	Saline- severe
4	Sodic- slight
5	Sodic- moderate
6	Sodic- moderate
7	Saline-sodic - slight
8	Saline-sodic - moderate
9	Saline-sodic - severe
10	Rann
11	Seasonal waterlogging
12	Seasonal waterlogging associated with Salinity/Sodicity
13	Permanent waterlogging
14	Sub-surface waterlogging

CONTENT	TIME SERIES (UPDATION CYCLE)
Salt affected and waterlogged areas 1:50,000	Once in 10 years

Agriculture

Thematic layers of Mango and Banana Plantations for Krishna and Kadapa districts using Cartosat-1 PAN and LISS-IV data, Accuracy of 85%, Updation once every 5 years.

Table 14 - Agricultural Plantations (1:5 million)

CONTENT	ACCURACY	TIME SERIES (UPDATION CYCLE)
Mango Plantations Banana Plantations	85%	Updation once every 5 years

Geomorphology

Geomorphology layers at 1:50,000 scale has been prepared using IRS LISS – III data, for the entire country, with 85% thematic accuracy and updation cycle of 10 years (Only for dynamic landforms).

Table 15 - Geomorphology (1:50,000)

LEVEL 1	LEVEL 2	LEVEL 3
Structural origin	Highly Dissected Hills and Valleys	Same as Level2
		Hogback
		Cuesta
		Strike Ridge
		Strike Valley
		Homocline
		Monocline
		Antiformal Hill
		Antiformal Valley
		Synformal Hill
		Synformal Valley
		Intermontane Valley
		Rift Valley
		Strath Terrace
		Ridge
		Hill
		Valley
		Dyke / Sill Ridge
		Dome
		Basin
		Scarp
		Gorge
	Moderately Dissected Hills and Valleys	Same as Level2
		Hogback
		Cuesta
		Strike Ridge
		Strike Valley
		Homocline
		Monocline
		Antiformal Hill
		Antiformal Valley
		Synformal Hill
		Synformal Valley
		Intermontane Valley
		Rift Valley
		Strath Terrace
		Ridge
		Hill

LEVEL 1	LEVEL 2	LEVEL 3
		Valley
		Dyke / Sill Ridge
		Dome
		Basin
		Scarp
		Gorge
	Low Dissected Hills and Valleys	Same as Level2
		Hogback
		Cuesta
		Strike Ridge
		Strike Valley
		Homocline
		Monocline
		Antiformal Hill
		Antiformal Valley
		Synformal Hill
		Synformal Valley
		Intermontane Valley
		Rift Valley
		Strath Terrace
		Ridge
		Hill
		Valley
		Dyke / Sill Ridge
		Dome
		Basin
		Scarp
		Gorge
	Highly Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley

LEVEL 1	LEVEL 2	LEVEL 3
		Bench
	Moderately Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
	Low Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
Denudational origin	Highly Dissected Hills and Valleys	Same as Level2
		Residual Hill
		Hill
		Dome
		Scarp
		Valley
	Moderately Dissected Hills and Valleys	Same as Level2
		Residual Hill
		Hill
		Dome

LEVEL 1	LEVEL 2	LEVEL 3
		Scarp
		Valley
	Low Dissected Hills and Valleys	Same as Level2
		Residual Hill
		Hill
		Dome
		Scarp
		Valley
	Highly Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Residual Capping
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Residual Capping
	Moderately Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Residual Capping
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench

LEVEL 1	LEVEL 2	LEVEL 3
		Residual Capping
	Low Dissected Upper Plateau	Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Residual Capping
		Same as Level2
		Plateau Top
		Plateau Remnant
		Mesa
		Butte
		Scarp
		Valley
		Bench
		Residual Capping
	Piedmont Slope	Same as Level2
		Colluvial Fan
		Talus / Scree
	Mass Wasting Products	Same as Level2
		Landslide
		Talus / Scree
	Pediment-Pediplain Complex	Same as Level2
		Residual Mound
		Inselberg
		Monadnock
		Bornhardt
		Tor
		Pediment
		Pediment-Corestone-Tor Composite
		Pediplain
		Rolling Plain
		Wash Plain
		Valley Fill
		Gullied Land
		Badland
		Plain (Lateritic)
		Upland (Lateritic)
Fluvial origin	Older Alluvial Plain	Same as Level2

LEVEL 1	LEVEL 2	LEVEL 3
		Palaeo channel
		Abandoned Channel
		Palaeolevee
		Oxbow Lake
		Cut-off Meander
		Meander Scar
		Terrace
		Gullied Tract
		Valley Fill
		Ridge
		Marsh
	Younger Alluvial plain	Same as Level2
		Palaeo channel
		Abandoned Channel
		Natural Levee
		Oxbow Lake
		Cut-off Meander
		Meander Scar
		Terrace
		Gullied Tract
		Valley Fill
		Ridge
		Marsh
	Older Flood plain	Same as Level2
		Palaeo channel
		Abandoned Channel
		Palaeolevee
		Oxbow Lake
		Cut-off Meander
		Meander scar
		Terrace
		Point Bar
		Gullied Tract
		Valley Fill
		Ridge
		Marsh
		Back Swamp
	Active Flood plain	Same as Level2
		Palaeo channel
		Abandoned Channel
		Natural Levee
		Oxbow Lake
		Cut-off Meander

LEVEL 1	LEVEL 2	LEVEL 3
		Meander scar
		Crevasse Splay
		Point Bar
		Braid Bar
		Lateral Bar
		Channel Bar
		Channel Island
		Valley Fill
		Back Swamp
		Flood Basin
	Piedmont Alluvial Plain	Same as Level2
		Alluvial Fan
		Dissected Alluvial Fan
		Palaeo channel
		Abandoned Channel
		Oxbow Lake
		Cut-off Meander
		Meander scar
		Marsh
		Gullied Tract
	Bajada	Same as Level2
		Alluvial Fan
		Gullied Tract
Coastal origin	Older Deltaic Plain	Same as Level2
		Palaeo Distributary
		Intra-Meander belt shallow depression
		Aggraded palaeo channel
		Swamp
		Marsh
	Younger Deltaic Plain	Same as Level2
		Inter-distributary Marsh
		Aggraded palaeo channel
		Active Distributary
		Swamp
		Marsh
	Older Coastal Plain	Same as Level2
		Beach Ridge
		Swale
		Beach Ridge-Swale Complex
		Aggraded palaeo channel
		Tidal Flat
		Mud Flat

LEVEL 1	LEVEL 2	LEVEL 3
		Tidal Lake
		Creek Network
		Rann
		Swamp
		Marsh
	Younger Coastal Plain	Same as Level2
		Beach
		Beach Ridge
		Swale
		Beach Ridge-Swale Complex
		Tidal Flat
		Inter Tidal Flat
		Mud Flat
		Tidal Inlet
		Marine Terrace
		Wave cut Terrace
		Sea Cliff
		Spit
		Longitudinal Bar
		Barrier Bar
		Offshore Bar
		Lagoon
		Mangrove swamp
		Tidal Lake
		Creek Network
		Back Water
		Estuarine Island
		Swamp
		Marsh
	Offshore Island	Same as Level2
		Beach
		Beach Ridge
		Swale
		Beach Ridge-Swale Complex
		Tidal Flat
		Inter Tidal Flat
		Mud Flat
		Tidal Inlet
		Spit
		Longitudinal Bar
		Barrier Bar
		Offshore Bar
		Lagoon

LEVEL 1	LEVEL 2	LEVEL 3
		Mangrove Swamp
		Tidal Lake
		Back Water
		Swamp
		Marsh
	Coral Reef	Same as Level2
		Fringing Reef
		Barrier Reef
		Atoll
	Sea-stacks	Same as Level2
Aeolian origin	Aeolian Plain	Same as Level2
		Wadi
		Sand Dune
		Sand Sheet
		Parabolic Dune
		Linear Dune
		Longitudinal Dune
		Transverse Dune
		Barchan
		Seif Dune
		Star Dune
		Dune Complex
		Interdunal Depression
		Playa
		Dissected Dune Complex
		Desert Pavement
		Deflation Plain
		Hamada
		Loess
		Stabilised Dune
		Ridge
Glacial origin	Glacial Terrain	Same as Level2
		Outwash Plain
		Terminal Moraine
		Lateral Moraine
		Medial Moraine
		Kame Terrace
		Esker
		Lake
		Ice Pavement
		Cirque
		Arete
		Hanging Valley

LEVEL 1	LEVEL 2	LEVEL 3
		Valley
		Valley Glacier
		Horn
		Nunatak
		Avalanche Chute
		Crevasse
		Same as Level2
Karst Origin	Karst Terrain	Same as Level2
		Sink Hole
		Doline
		Uvala
		Lapies
Volcanic Origin	Volcanic Terrain	Same as Level2
		Crater
		Volcanic cone
		Shield Volcano
		Strato Volcano
		Lava flow
		Lava Channel
Impact Origin	Impact Crater	Same as Level2
		Crater Basin
Lacustrine Origin	Lacustrine Terrain	Same as Level2
		Plain
		Lake Island
		Swamp
		Marsh
		Delta
Anthropogenic Origin	Anthropogenic Terrain	Same as Level2
		Mine Dump
		Active Quarry
		Abandoned Quarry
		Road cutting
		Embankment
		Dam and Reservoir
		Archaeological Excavation
		Dike
		Salt Pan
Water Bodies	River	Same as Level2
	Pond	Same as Level2
	Lake	Same as Level2
	Others	Same as Level2

Rajiv Gandhi Drinking Water Mission

The properties that are important for ground water study are primarily the porosity and permeability, or in other words, the texture of a geological material, the conduciveness of a landform with respect to recharge and discharge and the source of water for the recharge, etc. Under Rajiv Gandhi Drinking Water Mission (RGNDWM), the Rock types, Geological structures, Geomorphic units and recharge conditions based on the hydrogeological properties considering various terrain provinces have been classified using IRS LISS-III data at 1:50,000 scale. The classification content of Rock Types / Lithologic Units, Geological Structures, Geomorphic Units / Landforms and recharge conditions are given in the following Tables 16, 17, 18 & 19.

Table 16 - Rock Types / Lithologic Units (1:50,000)

Rock Group	Rock Type / Lithologic Unit
UNCONSOLIDATED SEDIMENTS	Alluvium – sand/silt dominant
	Alluvium – clay dominant
	Alluvium – sand/silt & clay alternating beds
	Colluvium – clay/silt dominant
	Colluvium – pebble/cobble dominant
	Eolian sand / silt
	Loess
	Alluvium – Gravel dominant
RESIDUAL CAPPINGS	Laterite (ferricrete)
	Bauxite (alecrete)
	Kankar (calcrete)
	Chert (silcrete)
	Detrital laterite / bauxite
DECCAN TRAPS & INTERTRAPPEANS	Inter-/Infra-trappean sand / clay beds
	Tuffacious basalt
	Vesicular basalt
	Amygdaloidal basalt
	Massive basalt
	Columnar basalt
	Red / green bole
	Unclassified basalt
OTHER VOLCANICS & METAVOLCANICS	Basalt / meta basalt
	Rhyolite / meta rhyolite
	Dacite / meta dacite
	Andesite / meta andesite
	Undifferentiated meta basics
	Ophiolite / Ophiolite melange
SEMI-CONSOLIDATED SEDIMENTS	Sandstone / pebble bed / conglomerate
	Shaly sandstone
	Sandstone with shale / coal bands
	Sandy shale
	Shale with sandstone / limestone bands
	Shale / coal / lignite
	Limestone / shell limestone
	Limestone with shale bands
	Cemented assorted mixture of gravel, sand, silt & clay
CONSOLIDATED SEDIMENTS	Thin bedded / flaggy sandstone / quartzite
	Thick bedded / massive sandstone/ quartzite
	Thin bedded / flaggy limestone / dolomite
	Thick bedded / massive limestone/ dolomite
	Shaly limestone
	Shale with limestone/sandstone bands/ lenses

Rock Group	Rock Type / Lithologic Unit
	Shale
	Conglomerate
	Cavernous limestone
PLUTONIC ROCKS	Alkaline rocks
	Basic rocks
	Ultrabasic / ultramafic rocks
GNEISS-GRANITOID COMPLEX / CHARNOKITE KHONDALITE COMPLEX / MIGMATITE COMPLEX	Granites / Acidic rocks
	Migmatite / migmatite complex
	Granitoid gneiss / gneissic granitoid / granitoid complex
	Charnockite
	Khondalite
	Charnockite-Khondalite complex
METAMORPHIC ROCKS	Gneiss
	Schist
	Phyllite
	Slate
	Quartzite
	Calc-gneiss / calc-schist
	Marble / crystalline limestone
	Undifferentiated meta sedimentaries
	Undifferentiated Metamorphics
INTRUSIVES	Quartz reef
	Pegmatite / aplite vein
	Basic dyke
	Basic sill

Table 17 - Geological Structures (1:50,000)

Structure	Category
Bedding	Horizontal to sub-horizontal (0-10 dip)
	Gentle (< 10 dip)
	Moderate (10-45 dip)
	Steep (45-80 dip)
	Vertical to sub-vertical (> 80 dip)
Schistosity / Foliation	Horizontal to sub-horizontal (0-10 dip)
	Gentle (< 10 dip)
	Moderate (10-45 dip)
	Steep (45-80 dip)
	Vertical to sub-vertical (> 80 dip)
Fault	Minor (< 3 km length)
	Major (> 3 km length)
Fracture / Lineament	Minor (< 3 km length)
	Major (> 3 km length)
Fracture / Lineament (inferred)	Minor (< 3 km length)
	Major (> 3 km length)
Thrust	Thrust
	Thrust (inferred)
Folds	Anticline/Antiform – non plunging
	Anticline/antiform – plunging
	Anticline/antiform – doubly plunging
	Syncline/synform – non plunging
	Syncline/synform – plunging
	Syncline/synform – doubly plunging
Shear zone	Minor (< 3 km length)

Structure	Category
	Major (> 3 km length)
Trend line	

Table 18 - Geomorphic Units / Landforms (1:50,000)

Physiography	Geomorphic Unit / Landform			
I. Hills & Plateau				
	Hills			
		Structural Hills		
			Less dissected	
			Less dissected-Concave slopes	
			Moderately dissected	
			Moderately dissected-Concave slopes	
			Highly Dissected	
			Highly dissected-Concave slopes	
		Denudational Hills		
			Less dissected	
			Less dissected-Concave slopes	
			Moderately dissected	
			Moderately dissected-Concave slopes	
			Highly Dissected	
			Highly dissected-Concave slopes	
		Residual Hills		
		Inselberg		
	Plateaus			
		Upper Plateau		
			Undissected	
			Moderately Dissected	
			Highly Dissected	
			Weathered	
			Weathered-Canal command	
		Middle Plateau		
			Undissected	
			Moderately Dissected	
			Highly Dissected	
			Weathered	
			Weathered-Canal command	
		Lower Plateau		
			Undissected	
			Moderately Dissected	
			Highly Dissected	
			Weathered	
			Weathered-Canal command	
		Plateau (in case of Deccan traps)		
			Undissected	
			Slightly Dissected	
			Moderately Dissected	
			Highly Dissected	
			Weathered	
			Weathered-Canal command	
	Other landforms common to Hills & Plateaus			
				Linear/curvilinear ridge
				Cuesta
				Hogback
				Mesa

Physiography		Geomorphic Unit / Landform		
				Butte
				Inselberg
				Sheet rock
				Residual mound
				Hill top-weathered
				Outer Fringe of Plateau
				Escarpment slope
				Hill Slope/Denudational Slope
				Fracture/Fault Line Valley
				Intermountain Valley
				Valley
				Deglaciated Valley
				Hanging Valley
				Valley slope
				Valley flat
				Valley Fill – Shallow
				Valley Fill–Moderate
				Valley Fill – Deep
				Old Slided Mass
				Resent Slided Mass
				Moraine Complex
				Sink Hole
II. Piedmont Zone				
	Piedmont Slope			
	Pediment			
	Pediment-Inselberg-Complex			
	Piedmont Alluvium			
		Shallow		
		Moderate		
		Deep		
		Gullied		
		Ravinous		
		Dissected		
	Bazada			
		Shallow		
		Moderate		
		Deep		
		Gullied		
		Ravinous		
		Dissected		
				Linear / Curvilinear Ridge
				Cuesta
				Hogback
				Mesa
				Butte
				Inselberg
				Talus Cone
				Alluvial Fan
				Alluvial Fan-Upper/Proximal
				Alluvial Fan-Lower/Distal
				Fracture/Fault Line Valley
				Valley
				Valley Fill-Shallow
				Valley Fill-Moderate
				Valley Fill-Deep
III. Plains				

Physiography	Geomorphic Unit / Landform		
	Pediplain		
		Weathered Pediplain	
			Shallow
			Moderate
			Deep
			Gullied
			Ravinous
			Dissected
			Under Canal Command
		Buried Pediplain	
			Shallow
			Moderate
			Deep
			Gullied
			Ravinous
			Dissected
			Under Canal Command
	Striped Plain		
		Shallow Basement	
		Moderate Basement	
		Deep Basement	
		Gullied	
		Ravinous	
		Dissected	
		Under Canal Command	
	Lateritic Plain		
		Shallow Basement	
		Moderate Basement	
		Deep Basement	
		Gullied	
		Ravinous	
		Dissected	
		Under Canal Command	
	Other landforms common to Pedi plain & Stripped plain		
			Linear/Curvilinear Ridge
			Cuesta
			Hogback
			Mesa
			Butte
			Inselberg
			Residual mound
			Sheet rock
			Fracture/Fault Line Valley
			Valley
			Valley Fill – Shallow
			Valley Fill–Moderate
			Valley Fill – Deep
	Alluvial Plain		
			Shallow
			Moderate
			Deep
			Gullied
			Ravinous
			Dissected
			Under Canl Command
		Alluvial Plain - Older / Upper	

Physiography		Geomorphic Unit / Landform		
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
		Alluvial Plain Younger / Lower		
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
	Flood Plain			
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
	Deltaic Plain			
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
	Other landforms common to Alluvial plain, Flood plain & Deltaic plain			
				Channel Bar
				Point Bar
				Natural Levee
				River Terrace
				RiverTerrace-Younger/Upper
				River Terrace-Intermediate
				River Terrace-Older/Lower
				Back swamp
				Cut-off Meander
				Oxbow/Serpentine Lake
				Meander Scar
				Palaeo channel
				Abandoned channel
				Buried Channel
				Migrated River course
	Coastal Plain			
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
		Coastal Plain – Older		

Physiography		Geomorphic Unit / Landform		
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
		Coastal Plain – Younger		
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
				Beach
				Beach Ridge
				Palaeo Beach Ridge
				Beach Ridge & Swale Complex
				Palaeo Beach Ridge & Swale Complex
				Swale
				Offshore bar
				Spit
				Mud Flat
				Mud Flat Older
				Mud Flat Younger
				Tidal Flat
				Salt flat
				Lagoon
				Channel Island
				Offshore island
				Reef island
				Palaeo channel
				Buried Channel
	Eolian Plain			
			Shallow	
			Moderate	
			Deep	
			Gullied	
			Ravinous	
			Dissected	
			Under Canal Command	
				Sand Dune
				Stabilised Dune
				Dune Complex
				Interdunal Depression
				Interdunal Flat
				Playa
				Desert Pavement
				Loess Plain
				Palaeo channel
				Buried Channel

Table 19 - Classification of Recharge Conditions

Category	Recharge condition
Excellent	Recharge from continuously irrigated canal commands, permanent water bodies, perennial rivers / streams, etc., (continuous recharge throughout the year - shallow water table conditions)
Very good	Recharge from temporarily / seasonally irrigated canal commands, seasonal / ephemeral water bodies / streams (recharge for part of the year).
Good	Having large recharge area with high rainfall and favourable Lithological – structural – landform conditions for sufficient recharge.
Moderate	Limited recharge area and moderate rainfall or seepage from other sources or limited by unfavourable Lithological – structural – landform conditions
Limited	High relief areas occupying large areas with heavy runoff, very limited recharge only along narrow valleys.
Poor	Very limited recharge area / poor rainfall / shadowed by ground water barriers like linear ridges, dolerite dykes etc.
Nil	No recharge from any source

2.3.2 Project Specific Value Added Products

Various Value Added products have been generated under different user specific projects and R&D projects. The following enumerates the value added products hosted on Bhuvan**.**

Time series Urban Built Up

The time series built up area extent of Class-I cities are being generated using medium resolution satellite data compatible to 1:50,000 scale.

- Satellite Data
  - Spatial resolution - 20 to 30m
  - Spectral resolution – Multispectral (R,G,B,NIR,SWIR)
- Temporal – every five years
- Method – Automated / Semi-automated
- Thematic Accuracy - 75 %

Disaster Services

The various spatial layers pertaining to Floods being made available on Bhuvan are:

1. Inundation Layers
2. Historic Flood layers
3. Flood Annual Layers
4. Flood Hazard Zones
5. Aggregated Flood

Water Resources Data Services - The details are given in the Table 20

Table 20 - Water Resources Spatial Layers and Applications

APPLICATION	LAYERS AVAILABLE	SPATIAL / TIME DOMAIN	SCALE	ACCURACY	SOURCE
AIBP Phase I & II (For Public Access)	(1)Canal Network (Name & Type), (2)Structures on Canals,(3)Project boundaries	one time: 2007-08 or 2010-11	5000	+/- 2.5m & +/- 50m or 1% of canal length (cartographic & Thematic)	Ortho-rectified mosaic of project area

APPLICATION	LAYERS AVAILABLE	SPATIAL / TIME DOMAIN	SCALE	ACCURACY	SOURCE
AIBP Phase III & IV (for Online Monitoring and private access to CWC and MoWR)	(1)Canal Network (Name of canal, parent canal , Type of canal, off-take chainage, satellite derived chainage, proposed length, satellite derived length, balance length, no. of gaps, progress in %, CCA, ICA, proposed I.P, remarks), (2)Structures on Canals,(3)Project boundaries (4) Mobile App field data: location (lat/long), photograph (canal / structure), status	once a year during Nov-Dec (post monsoon) CWC (proposed)from 2015-16 till completion of the project	5000	+/- 2.5m & +/- 50m or 1% of canal length (cartographic & Thematic)	Ortho-rectified mosaic of project area
Hydrological Science Products	Available: (1)Surface Runoff, (2)Soil moisture, (3) Evapo-transpiration To be provided : (1)Forecast Surface Runoff for d+5 days (2) Standardized Precipitation Index (3) Standardized Runoff Index (4) River hydrograph at selected discharge location (5) Basin wise Mean WBC and its comparison with historic data	Jan 2014 to till date, Updation Cycle: Daily time step,	9' X 9'	Surface Runoff - 70-75 ; Soil Moisture (Under evaluation); Evapotranspiration (Under evaluation)	ISRO
Bhuvan (OPEN Data Archive)	(1)Water Body Fraction (from Resourcesat-1/ Resourcesat-2 AWiFS)	2004 to 2013 (May, Feb, Oct in each Year) 2014 to 2015 (Every Fortnight upto June)	3' X 3' Grid		ISRO
	(2)Snow Cover Fraction(from Resourcesat-1/ Resourcesat-2 AwiFS	2014 to 2015 (15 Day interval upto June 2015)	3' X 3' Grid		ISRO
Bhuvan Thematic Services	(1)Glacier Lakes/Water Bodies (from Resourcesat-1 AWiFS)	Indian Himalayas	250K		MoWR
	(2)Water Body (from Resourcesat-1 / Resourcesat-2 AWiFS)	2004 to 2013 (May, Feb, Oct in each Year);2014 to 2015 (15 Day interval upto June 2015)			ISRO
Bhuvan Ganga	Main River, watersheds, power house, lift irrigation, canal network, salt				As per India-WRIS & NRC data specifications.

APPLICATION	LAYERS AVAILABLE	SPATIAL / TIME DOMAIN	SCALE	ACCURACY	SOURCE
	affected area, water logged areas and other bhuvan layers				Field data updation is proposed from NMCG programmatic activities regarding water quality
Flood Forecasting – Godavari basin	Flood inundation layers	R & D results will be hosted on experimental basis during 2015 flood	25K		ISRO

Agricultural Drought Assessment

Under National Agricultural Drought Monitoring and Assessment System (NADAMS) which has been in place for over two and half decade, some of the important parameters which has not been used previously, has been taken into account. These parameters are the number of dry days, number of consecutive dry days from the rainfall analysis, the Moisture Adequacy Index (MAI) derived from evapotranspiration, which will present the status of drought during June and July 2015 and produce a drought assessment map.

a. Product Name - Number of Dry Days

Using the daily CPC rainfall, the maximum number of dry days in a dekad is derived by summing the number of dry days during the 10-day period, where a "dry day" is defined as a day in which the rainfall amount was less than 2.5 mm within a CPC rainfall product grid cell. The 10 days rainfall products from CPC were analysed and number of days which received less than 2.5 mm was counted and depicted as a dekadal product.

Scale : 1: 5 million (input data 0.1°x0.1°)
Attribute : Number of Dry Days
Accuracy : -NA-
Time Series (updation cycle): on every 5th, 15th and 25th – 10 day cycle

b. Number of Consecutive Dry Days

The maximum number of consecutive dry days is calculated by summing the maximum number of consecutive dry days during each 10-days period during June, where a "dry day" is defined as a day in which the rainfall amount was less than 2.5 millimeter within a CPC rainfall grid cell. The number of consecutive dry days gives an idea on the dry spell the country is experiencing during the 10 days periods.

Scale : 1: 5 million (input data 0.1°x0.1°)
Attribute : Number of Consecutive Dry Days
Accuracy : -NA-
Time Series (updation cycle): on every 5th, 15th and 25th – 10 day cycle

c. Moisture Adequacy Index

Moisture Adequacy Index (MAI) is the ratio of Actual Evapo-Transpiration (AET) to the Potential Evapo-Transpiration (PET).

MAI = AET/PET x 100

Where AET - Actual Evapo-Transpiration,

PET - Potential Evapo-Transpiration

The daily global potential evapotranspiration (PET) from National Oceanic and Atmospheric Administration (NOAA), Global Data Assimilation System (GDAS) analysis fields is used in this analysis. The daily PET is calculated on a spatial basis using the Penman-Monteith equation. These equations were standardized in accordance with the FAO publication 56 for the 6-hourly calculations. The AET is derived using the water balance calculation taking into account the soil characteristics, antecedent soil moisture condition (soil water evaporation coefficient) and crop growth (crop coefficients).

Scale : 1: 5 million (input data 1°x1°)
Attribute : Moisture Adequacy Index
Accuracy : -NA-
Time Series (updation cycle): on every 5th, 15th and 25th – 10 day cycle

d. Soil Moisture Index (Modelled)

The Soil Moisture Index (SMI) derived is defined as the proportion of the difference between the current soil moisture and the permanent wilting point to the field capacity and the permanent wilting point. The index values range from 0 to 100 with 0 indicating dry condition and 100 wet conditions. The SMI is derive for 5 cm, 15 cm and 30 cm soil depth on a daily basis.

Scale : 1: 5 million (input data 0.1°x 0.1°)
Attribute : Soil Moisture Index
Accuracy : -NA-
Time Series (updation cycle) : on every 5th, 15th and 25th – 10 day cycle

e. Vegetation Condition Index (VCI)

The Vegetation Condition Index (VCI) compares the current NDVI to the range of values observed in the same period in previous historic years. The VCI is expressed in % and gives an idea where the observed value is situated between the extreme values (minimum and maximum) in the previous years. Lower and higher values indicate bad and good vegetation state conditions, respectively. In this study the current years (2015) NDVI is compared with previous 13 years (2002-2014) NDVI. Vegetation Condition Index is defined as

$$VCI = \frac{NDVIi - NDVImin}{NDVImax - NDVImin}$$

Where NDVIi - Current NDVI
NDVI max- Maximum NDVI
NDVI min- Maximum NDVI

Scale : 1: 5 million (input data 0.01°x 0.01°)
Attribute : Vegetation Condition Index
Accuracy : -NA-
Time Series (updation cycle)—on every fortnight

Table 21 - Agricultural Drought Monitoring Assessment (1:5 million)

Parameter	Time Series (updation cycle)
Rainfall Number of Dry Days Number of Consecutive Dry days	on every 5th, 15th and 25th – 10 day cycle
Moisture Adequacy Index	on every 5th, 15th and 25th – 10 day cycle
Soil Moisture Index (5 cm, 15 cm & 30 cm)	on every 5th, 15th and 25th – 10 day cycle
Vegetation Condition Index	on every fortnight

Forest Fire Alerts

Fire alerts are produced using 1 km MODIS data. The location of the fire alert is derived from the centre of the pixel flagged as fire. It may represent multiple fire fronts in the same pixel. Attributes relevant to the users are Latitude, Longitude, fire detection confidence, acquisition date, acquisition time and platform. The updation is done in pass wise manner, daily. In fire season, night time fires information is also observed.

Monitoring and Evaluation of IWMP Watersheds using Geospatial technologies (Bhuvan - IWMP)

This project for the Department of Land Resources (DoLR), Ministry of Rural Development, is facilitated through Bhuvan GeoICT tools and currently covers 10 states of the country and 50 districts under the special PMO monitoring. The package facilitates Decision makers at National and State level to monitor program implementation at different levels, including at the local level on the Geo-Platform, while State Level Nodal Agencies (SLNA) and the District level Watershed Cell cum Development Centres (WCDC) are facilitated with necessary tools (Uploading, editing, Mapper tool for action plan preparation) on the package to provide specific inputs on implementation of the program at micro-watershed level. Project-wise micro-watershed boundaries which follow standards as defined by the Department of Land Resources are made available on the portal.

Layer	Source	Scale
Micro-watershed boundaries	State Watershed Depts.	1:50000/ 1:10000 scale

Table 22 - Micro-watershed layer information

Fields
Micro-watershed code
Project Name
State Name
District Name
Block Name
Period ('Batch')
Sanctioned Area to be treated (in Hectares)
Area treated till now (in Hectares)
Progress (Prep/Work/Cons)
Project Executing Body
Are Data Available (i.e., all layers sought by NRSC)?
DPR Uplinked?
Base Line Data (Road/Rail/Socio-economic)

The project involves the monitoring of the IWMP watersheds of the country using satellite data on a yearly basis from 2013-14 to 2017-18 and will provide a common platform for monitoring the developmental activity and also the field based inventories in the watersheds through the web based interface.

Ocean Services

a. Ocean Heat Content

Ocean Heat Content up to 700m depth (OHC700) is an important climatic parameter required for atmospheric and oceanic studies like cyclone and monsoon prediction and ocean heat transport estimations. This parameter is estimated on a daily basis from 2002 to present with a one week time delay. The data used to estimate this parameter are (a) sea surface height anomaly (SSHA) from the available altimeters, (b) sea surface temperature (SST) from Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) and the climatological values of OHC700. The artificial neural network techniques, similar to the one used by Ali et al. (2012: IEEE GRSL) for the estimation of Tropical Cyclone Heat Potential, is also followed in the estimation of OHC700.
Coverage: Indian Ocean: 30^0E-120^0E Longitude and 20^0 S to 30^0 N Latitude.
Frequency: Daily, Spatial scale: 0.25 degree.
Availability: January 1998 to 6th April 2015(one week delay).

b. Tropical Cyclone Heat Potential

Tropical Cyclone Heat Potential (TCHP), an important ocean parameter influencing cyclones and hurricanes, is defined as the energy available for cyclones and is calculated by summing the heat content in a column where sea

surface temperature is above 26° C isotherm. This parameter, by definition, is estimated from the in situ temperature profiles. In view of the limitations of temperature profiles, methods have been evolved to estimate this parameter from satellite altimeter derived sea surface height anomalies (SSHA). Using ANN techniques, TCHP has been computed on daily basis from the available altimeter observations of SSHA, sea surface temperature using Tropical Rainfall Measuring Mission Microwave Imager (TMI) and climatological depth of 26° C isotherm.
Coverage: Indian Ocean: 30^0E-120^0E Longitude and 20^0 S to 30^0 N Latitude.
Frequency: Daily. Spatial scale: 0.25 degree.
Availability: January 1998 to 6th April 2015(one week delay).

c. Ocean Surface Winds

Surface winds over oceans are required for several operational, oceanographic, atmospheric and climatological studies. Global gridded daily and two day Wind Composites have been generated using Oceansat-2 Scatterometer. For this ascending and descending passes of OSCAT version 1.4 have been used. Variance inverse method model (DIVA) is used by interpolating OSCAT level-2B wind fields for generation of gridded winds. Currently due to non-availability of OSCAT global quality winds has been generated from the period 2010-2013. Gridded daily and tow day composite data is validated using in-situ buoys over the global oceans and ASCT also been used. Comparison has been carried for different scenarios like locations, different wind speeds and seasons. Gridded two day is of good quality. Best match is found between 3-10m/. Comparison also shows that OSCAT gridded products compares well with annual and at seasonal scales. These products have their utility in daily weather and modeling activities.

Coverage : Global 0.0^0E-160^0 W Longitude and 80^0 S to 80^0 N Latitude

Period : Jan 2010-Dec 2013,

Frequency: Daily and two day composite at 0.50^0 degree.

d. Wind Stress and wind stress curl

Wind stress is defined as the tangential (drag) force per unit area exerted on the surface of the ocean by the adjacent layer of moving air. Wind Stress Curl is the measure of the rotation of the wind stress (or ocean surface circulation**).** OSCAT daily Wind Stress and wind stress curl composites have been generated using DIVA generated daily wind field composites. For wind stress computation, Large and Pond (1981) drag coefficients, modified by Trenberth et al. 1990, are used. While wind stress curl has been estimated using cross directional differential of wind stress. For this MATLAB tools are used to compute and map in standard formats with 50 km resolution. The curl of wind stress is helpful in identifying areas of cyclogenesis and their propagation.

Coverage : Indian Ocean 30.0^0E to 120^0 E Longitude and 30^0 S to 30^0 N Latitude

Period : Jan 2010-Dec 2013. Daily composite at 0.50^0 degree

e. Ocean Surface Currents

The Ocean surface currents of the north Indian Ocean are estimated combining Ekman Surface Current (ESC) and Surface Geostrophic Current (SGC). Application of the product will be used for the studies of dispersion analysis of marine pollutants, algal blooms, coastal sediments, oil spills and debris. These products are available on daily basis for the period of availability of data from both the satellites concurrently.

The ESC is derived from the ocean surface wind fields of Oceansat-2 Scatterometer data products. The path wise observations of OSCAT wind vector are used after removing high frequency variations with data Interpolating Variation Analysis (DIVA). These winds are converted to wind stress components of Zonal and meridional direction. These components are used for the estimation of Ekman surface current adopting well established methods of Lagerlof et al (1999). Similarly SGC component of the current is estimated using Saral-AltiKa Sea Surface Height (SSH) products. Towards the geostrophic current, along track data are interpolated to a quarter (0.25) degree maps on daily basis. The gridded maps are used in the estimation of SGC of the Indian Ocean with reference to local Coriolis force. The Coriolis amplifies its influence in the equatorial region within 5 degree on either side of the equator; a double differential method of surface slope is adopted to estimate SGC. Further SGC and ESC are used to estimate the Ocean surface current. This is restricted to North Indian Ocean only.

Comparisons were carried with moored current observations along the Indian coast in the Bay of Bengal and shown a positive relationship with R values of 0.55- 0.64 and negative bias of -4.0 cm/s in the zonal and -2.0 cm/s in meridional components.

Coverage: Indian Ocean 30.0^0E to 120^0 E Longitude and 30^0 S to 30^0 N Latitude

Period : Jan 2010-Dec 2013. Daily composite (running mean of 15 days) at 0.25^0 degree.

f. Potential Fishing Zones

Information on Potential fishing zones are provided by INCOIS. A live link established between INCOIS Site and Bhuvan to provide the above information.

Climate and Environment Services (NICES)

a. Surface soil moisture (Satellite based)

Two days merged surface soil moisture (0-2 cm) products for Indian subcontinent at 0.25 X 0.25 degree grid spacing are provided.

These products are generated using Level 3 brightness temperature data from Advanced Microwave Scanning Radiometer 2 (AMSR2) aboard the Global Change Observation Mission 1st-Water "SHIZUKU" (GCOM-W1). The retrievals are made with a Land Parameter Retrieval Model (LPRM) that uses a radiative transfer model to solve for surface soil moisture.

The soil moisture product has been validated with in-situ data from ground station of International Soil Moisture Network (ISMN) located at IIT Kanpur Airstrip. The overall accuracy is 96% with Pearson's correlation coefficient of 0.79. Quality tags are attached to each grid.

The retrieved datasets of surface soil moisture have been written and stored in Network Common Data Format (NetCDF). The products are available from July 2012 to June 2015.

b. Land use/land cover for MM-5 & WRF

Global products with annual cycle Landuse/Landcover (LU/LC) details of Indian region are provided at 5, 2 minute & 30 second grid resolutions.

The 25 categories (including no data class) USGS global LU/LC product has been used as base onto which, Indian region data is replaced with AWiFS derived 19 categories data re-aggregated/regrouped to USGS class and made compatible to MM5 & WRF models. Thus, the resultant product is a global USGS LU/LC data with the Indian region replaced by the basic 56 m resolution AWiFS based LU/LC data adopted for MM5 & WRF mesoscale model.

National LU/LC mapping project was taken up during 2004-05 (cycle 1) with an objective to undertake "Rapid assessment of national LU/LC on 1: 250,000 scale using multi-temporal IRS-P6 AWiFS datasets". The accuracy of the thematic classified layer is 750m X 750m.

The USGS LU/LC global data are assumed to be valid at the centre of a grid box. Hence there are 360X180 data points for 1 degree data; (360X12) X (180X12) for 5 minute data; (360X30) X (180X30) for 2 minute data and (360x120) X (180X120) data points for the 30 second data.
For the 30 seconds MM5 compatible data creation, majority classes are calculated based on a new fixed grid accommodating 17X17 AWiFS pixels and then replacing the Indian region of global USGS LU/LC data (of 24 classes) by AWiFS derived data. In the similar way, 30 second AWiFS majority filtered data has used to replace USGS global WRF tiles of Indian region covering 16 numbers of tiles.

For coarse resolution data of 2 and 5 minutes, grids are created respectively accommodating 66 and 165 number of AWiFS pixels. Frequency of occurrence of each of the LU/LC cover classes in IRS-P6 AWiFS data at different resolutions mentioned above is calculated. USGS global LU/LC (2,5minute) of Indian region is then replaced with AWiFS LU/LC 2 minute frequency data to create MM5 compatible output (2,5minute).Similarly for WRF compatible 9 tiles each for 2 & 5 minutes are created.

Presently MM5 & WRF model compatible AWiFS LU/LC data are available in 30 second, 2 and 5 minutes resolutions (1-9 Cycle) for modelers through National Remote Sensing Centre/ISRO site (www.nrsc.gov.in) under Bhuvan/NICES geospatial portal.

c. Atmospheric stratospheric & tropospheric ozone

Daily Stratospheric Columnar Ozone (SCO) and Tropospheric Ozone (TO) concentration products of Indian region are generated at 1 degree resolution.

TO and SCO concentrations are obtained from the estimated total columnar atmospheric ozone (TCO) concentrations using satellite sensors from Ozone monitoring instrument (OMI), Microwave Limb Sounder (MLS) both of Aura and Total Ozone Monitoring Spectrometer (TOMS) of NASA.

The derived Tropospheric Columnar Ozone is compared using Ozonesonde data archived at Southern Hemisphere Additional Ozonesondes. The quality flag (mean±1σ) has been applied to TO data of Ozonesonde fortnightly observations at Vietnam and Kuala Lumpur stations for six year period from 2007 to 2012. R^2 values of 0.56 for Vietnam and 0.61 for Kuala Lumpur are obtained, respectively.

The Indian region (0° - 40°N; 60°E - 100°E) SCO and TO daily products in Net CDF format are available for the period 2007-2013.

d. Gridded atmospheric profiles (from GPSRO data)

Seasonal gridded atmospheric profile products of pressure, temperature and humidity fields for the Indian Sub-Continent (0° - 40°N; 60°E - 100°E) are generated at spatial resolution of 1° x1° and vertical resolution of 1 km.

GPSRO satellites based on radio occultation technique exploits the ray bending angle for the retrieval of atmospheric profiles using the refractivity values. COSMIC level 2 data has been used for generating gridded product at 1^0x1^0 resolutions, and then it is averaged to give seasonal value for the entire country. The products are available for the period April 2006-December 2012.

e. Snow melt and freeze in Indian Himalayas

Every two days snow melt and freeze condition raster products are generated for Indian Himalayas at 2.225 km resolution.
Every alternate day OSCAT 2 backscatter coefficients (σ0) along with temperature variations are used to identify onset of melt and freeze conditions. A significant drop in the backscatter (σ0) coefficient associated with above/below threshold temperature, caused due to the presence of liquid water content in the snow is the basis for detection of snow melt/freeze. DN values of 0, 1, 5 and 6 are assigned to pixels to denote non snow, snow in melt, and snow in freeze and no data areas. The products in geo-tiff format are available for the period Nov. 2009 - December 2013.

f. Antarctica Snow melt and freeze*(to be made available on Bhuvan)*

Daily products of snow melt duration and melt onset are generated for Amery ice shelf region of Antarctica at 2.225 km resolution. OSCAT 2 backscatter coefficients (σ0) along with temperature variations are used to identify onset of melt conditions. A dynamic threshold which is based on mean and standard deviation of austral winter backscatter coefficient is used for detection of melt/freeze. The products are available for the years from 2009 to 2014.

g. Sea Ice extent in Antarctica*(to be made available on Bhuvan)*

Time series of daily sea ice extent in Antarctica using OSCAT 2 enhanced resolution data at 2.225 km will be uploaded soon for a period of December 2009 to February 2014.

2.4 Topographic Data Standards

CartoDEM free download specifications are given in Table 23

Table 23 – Topographic Data (CartoDEM) Standards

Parameter	Value	Remarks
DEM Type	DSM	Generated by automated image matching technique from Cartosat-1 Stereo data
Horizontal Datum	WGS 84	
Vertical Datum	WGS 84	
Positional Accuracy	15 m	
Height Accuracy	8 m	
Sampling Distance (Posting)	30 m	

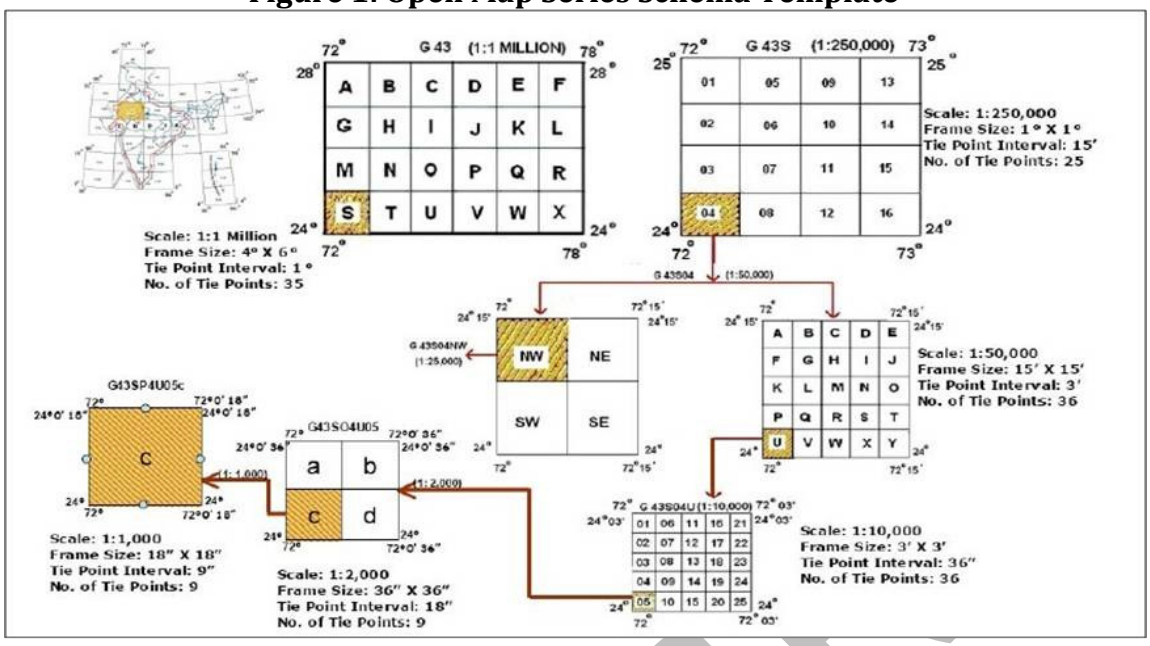
2.5 Output Standards

The output map format has defined as per the Open Series Map as per the National map Policy-2006. Figure 1 shows the OSM schema template.

Table 24 - Output Standards

Parameter	1 : 250,000	1 : 50,000	1 : 10,000	1 : 5,000/1 : 4,000
Framework	Admin Units – State, District, Taluk Natural Regions User defined region polygon Spatial Framework Grid- 1 X 1 degree	Admin Units – State, District, Taluk Cadastre reference Natural Regions User defined region polygon Spatial Framework Grid- 15 X 15 minutes	Admin Units – State, District, Taluk, Town/City Cadastre reference Natural Regions User defined region polygon Spatial Framework Grid- 3 X 3 minutes	Admin Units – Town/City Cadastre reference Natural Regions User defined region polygon
Media	Online Download	Online Download	Online Download	Online Download
Symbology	Source Project Specific	Source Project Specific	Source Project Specific	Source Project Specific
Format	PDF	PDF	PDF	PDF

Figure 1: Open Map Series Schema Template



2.6 Metadata Standards

Meta data describes data characteristics of content, quality, access, format, scale, when, who, where, how data generated and availability of the data. Meta data standard is required to enable the users to be aware of method, accuracy, exchange of data and limitations of the data for the intended purpose. NSDI ver 2.0 Metadata standards are proposed to be adopted. The following are main Metadata Elements as per OGC compliance standard.

I. Data Identification Information

S.No	NAME OF THE ELEMENT	VALUE
1	Name of the Dataset	Text
2	Theme	Text
3	Keywords	Text
4	Access Constraints	Text
5	Use Constraints	Text
6	Purpose of creating data	Text
7	Data Type	Text
8	Edition	Text
9	Status	Text

II. Contact Information

S.No	NAME OF THE ELEMENT	VALUE
1	Contact Person	Text
2	Organisation	Text
3	Mailing Address	Text
4	City/Locality	Text
5	Country	Text

6	Contact Telephone	Text
7	Contact Fax	Text
8	Contact Email	Text

III. Geographic Location

S.No	NAME OF THE ELEMENT	VALUE
1	Datum	Text

IV. Coverage

S.No	NAME OF THE ELEMENT	VALUE
1	Upper left	Float
2	Upper right	Float
3	Lower right	Float
4	Lower left	Float

V. Citation

S.No	NAME OF THE ELEMENT	VALUE
1	Data Prepared by	Text
2	Original Source	Text
3	Source Date	Text
4	Lineage State Area of Interest (Sq.Km): Scale	 Text Float Text
5	Corporate Name (Partner Institution)	Text

VI. Metadata Stamp

S.No	NAME OF THE ELEMENT	VALUE
1	Metadata Date Stamp	Date (DD/MM/YYYY)

VII. Dataset Topic Category

S.No	NAME OF THE ELEMENT	VALUE
1	Data Identification topic category	Text

VIII. Language

S.No	NAME OF THE ELEMENT	VALUE
1	Language ISO 0639-2Bsh	Text

IX. Abstract describing the data

S.No	NAME OF THE ELEMENT	VALUE
1	Data Identification abstract	Text

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