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BHUVAN USER HAND BOOK

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Abstract (with Keywords):

Bhuvan is the geoportal of ISRO in public domain. Bhuvan User Manual describes the Data, Products, Services and Applications offered on Bhuvan. It highlights the potential of Bhuvan platform for visualization, providing satellite and map services to any users, building governance applications, moderated Crowd sourcing and Disaster management support. It also explains Bhuvan as data clearing house and hosting government data. The guidelines for data sharing are also provided to build collaborative applications. It highlights the usage of Bhuvan platform in public

Keywords: Bhuvan, User Manual, Governance, geospatial Applications, Satellite image, map crowd sourcing, disaster management support, warnings and alerts

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Executive Summary

Bhuvan (is a Sanskrit word, meaning **Earth**) is a Geoportal of Indian Space Research Organisation (ISRO), hosted through URL http://bhuvan.nrsc.gov.in is now completing six years of successful journey and sustained growth. Bhuvan made a humble beginning in 2009 with simple display of satellite images with medium resolution (5m) satellite data and basic GIS functionality with many thematic maps on display functions. These six years have provided ample opportunity for Bhuvan to grow in all directions, it has horizontally grown in diverse areas of applications and vertically in terms of number of image and map services including high resolution satellite data. Bhuvan is the only government platform in India that is operational in public domain with PAN-India coverage of systematic geographical database. The platform allows seamless transitions from national to village level depiction of varieties of geospatial datasets that are unique to Bhuvan. The platform not only enables good base data and image display up to 1m spatial resolution, but also provides hydrological base for the country from Basin to watershed, Transport Network from National highways to city roads and rich location information, traditionally called as Points of Interest for5 million locations. Bhuvan showcases more than 3.5 million location-based information that are created through crowd sourcing mechanism, which is very active in current times. Apart from this, the Scientifically derived Digital Surface Model for entire country is another unique feature that gives excellent depiction of the country's topography on the fly. While Bhuvan hosts content for public consumption, there are hosts of applications being developed and deployed on a daily basis to enrich the usage of this platform. Bhuvan has been able to accomplish a huge user-base with millions of users taking advantage of this national platform. With all these capabilities, Bhuvan is today is reckoned one of the most unique GIS platform of the country that is freely accessible on the internet used by wide varieties of user community including school children.

The satellite data that is hosted on the Bhuvan conforms to the prevailing national data policy "Remote Sensing Data Policy-2011". Presently, satellite image data for more than 350 cities are hosted at 1 m spatial resolution that could help in various plans for town/ city development schemes of the Government. This seamless large coverage is now available for parts of Rajasthan, Gujarat and Madhya Pradesh. Soon one could use 1 m images for the entire country.

Bhuvan, as a platform, is open and being used by diverse user community. The Government agencies use this platform to share and host their data, as per their requirements, enabling specific applications of their choice. Some of the State Goverments and Departments are using Bhuvan platform for specific applications of State's requirement, such as Punjab, Karnataka, Himachal Pradesh, Odisha. These are specific joint initiatives that address specific thematic applications in Forestry, Tourism, Municipal GIS and so on. These applications have paved the way for collaborative portal development and use Bhuvan as common platform for

State's purpose while at the same time becomes a national asset. To facilitate similar such activities across the country, Bhuvan presently hosts 30 state geoportals and these have many interesting thematic layers with high resolution satellite image backdrop and is bound to further grow in terms of capabilities with collaborative efforts in the near future. Theses are typical Best-Practices on the usage of online Geoportals for developmental activities, that are bound to be replicated in large number, while facilitating online information and effective project monitoring. In addition, there are many examples of public sector, private users and NGOs who host their data and utilize the services for Bhuvan for varieties of purposes, particularly under the ENVIS program of Ministry of Environment, Forest & Climate Change, there are large number of such users who are actively using Bhuvan services.

The recent direction from the Government on the most effective use of space technology by user ministries, a number of geospatial application areas have been identified and as a result of this about 22 ministries have been integrated into Bhuvan platform for specific use related to g-Governance program. Many of the Ministries/ Departments have linked their web portals to Bhuvan for online services. Further, the Indian Meteorological Department (IMD) has also started using this platform for Thunderstorm and Fog alerts. Bhuvan has become a popular platform that hosts one of the largest repository of GIS map and services in the country. There are more than 6000 services offered by Bhuvan.

Bhuvan disaster support provides support to disaster like Cylcone, Floods, Landslides, Earthquakes, Forest Fire and Drought, which is useful for various phases of disaster including preparedness and response. Uttarakhand disaster in 2013, J&K floods and Hudhud cyclone in 2014 and Nepal Earthquake in 2015 are some of the recent examples where Bhuvan provided unique services in terms of online disaster information update, forecasts and post-disaster scenario. Yet another important forewarning solution provided by Bhuvan is in the landslide forewarning system. The rain induced landslide warning for major pilgrimage routes in Uttarakhand hills are being provided on an experimental basis for the past 2 seasons. This gives regular updates on the potential landslides alert based on rainfall and other parameters.

Bhuvan is also acting as a clearing house for satellite data and satellite data derived products. They are effectively used for scientific studies and help students, researchers and organization to take up the scientific projects for applied research. 3.5 lakh products have been downloaded by users in last 3 years and the, NRSC Open EO Data Archive, as clearing house named has become widely popular. This includes scientific products created by studying land, ocean and atmosphere under National Information System for Climate and Environmental Studies (NICES).

Chapter 1

Bhuvan as Visualization platform

1.1 Bhuvan Genesis

Bhuvan is a Geoportal platform of Indian Space Research Organisation (ISRO), hosted presently through URL http://bhuvan.nrsc.gov.in, with a host of wide ranging services that cover visualization of multi-date, multi-platform, multi-sensor satellite data, thematic map display, query and analysis, free data downloads and products, near real-time disaster services, Apps for crowd sourcing and diverse geospatial applications. The platform also supports usage on multiple languages for interactive use. Bhuvan is now available in Hindi, Tamil and Telugu apart from English and working towards expanding to all major Indian languages. Bhuvan is providing new applications and services on a daily basis, including special products, and innovative visualisation capabilities.

1.2 Bhuvan -2D

Bhuvan 2D visualization interface is designed to provide Map view, Satellite image view and Hybrid of both. In addition, Terrain view is also provided in a single integrated viewer. The interface is designed in such a way that the usershasonline access to all services and applications, there by,enabling smooth navigation to desired map / datain a simple and easily usable manner.Simple tools are provided for online measurements, user GIS data incorporation or Map services, geospatial search for place names, choice of language and so on. The linkages to Updates, Bhuvan Store & Collaborators and online help are also available on this page. The map view provides administrative(State, District, Tehsil, Village) and hydrologic base (Basin, Sub-basin, Watershed) for the entire country. Census 2011 information is also integrated at village level for the user to make necessary visual analysis. Further, a new concept of 2.5D visualisation model is enabled that enables display of man-made structures like buildings and recreational areas for about 130 towns in shaded-relief mode, road network information at all levels, settlement locations, and cities/towns, with Population >1 Lakh, as point locations layers, water bodies (Rivers, Reservoirs& Lakes)and many more.

Bhuvan2D provides visualization of ISRO Automatic Weather Stations with current and archived data/information in a graphic view and use of tabular weather data of user choice. It facilitates to find weather information of any place in India using nearest AWS stations information. It also has visualization of Ocean Services like Potential Fishing Zones, Chlorophyl and Sea Surface Temperature with other data on Ocean, such as, Agro Floats, Moored Buoys, Waverider Buoy etc.

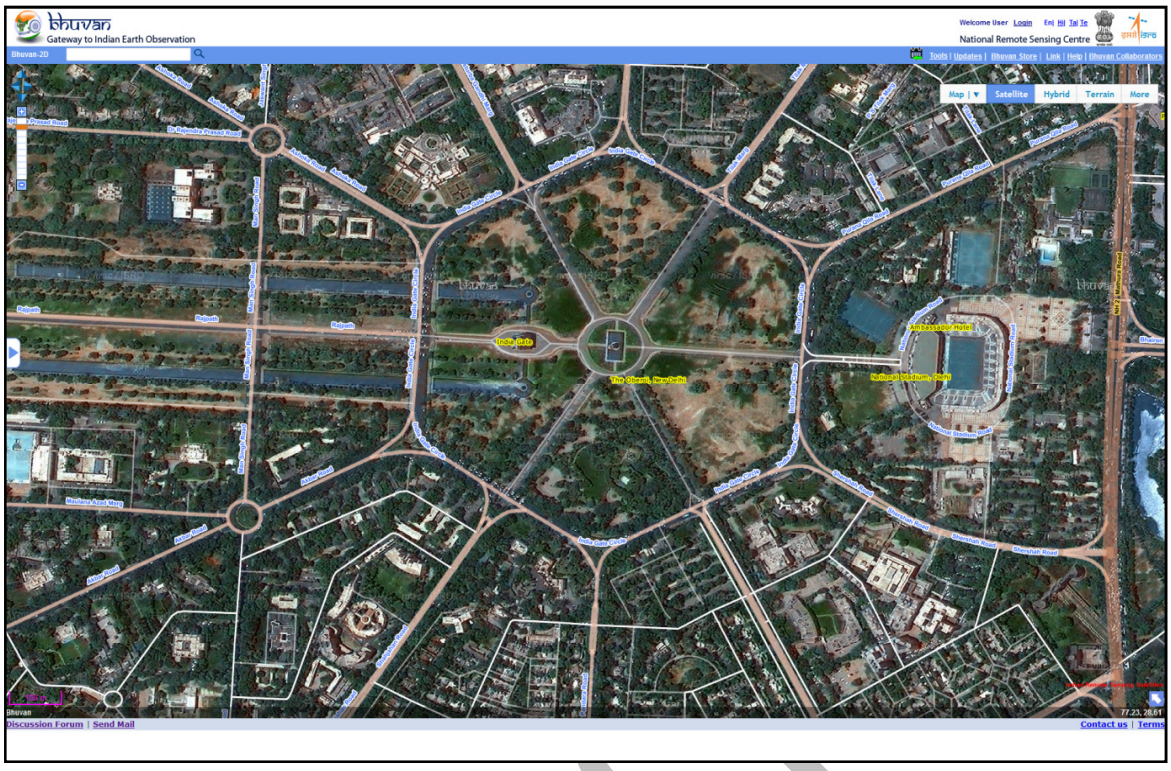

Figure 1.1: Surrounding places of India Gate circle on High Resolution Satellite imagery

Bhuvan 2D provides a special display option to view the crowd sourced data, collected in various applications by different users and public. It has facility to visualize such field data with respect to various categories (Crop, Point of Interest, Landslides and etc). In addition, it has also facility to visualize Filed -Photographs/Field info clusters

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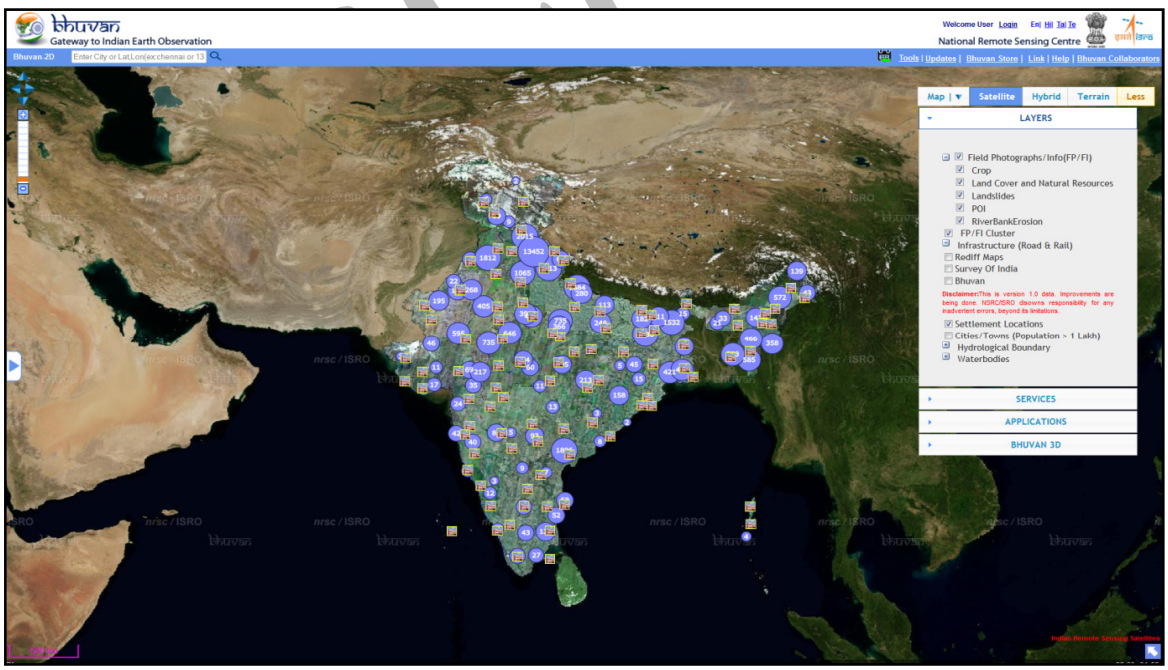


Figure 1.3 Crowd sourced data collected from application specific users and general public

Some of its functional capabilities include map navigation, map panning, Online Shape file creation utility (drawing line, point, polygon and download as shape file), and overview map, search, linear and aerial measurement. Bhuvan allows variable interactive zoom levels that enable users to go down to street level and display of map scale amongst many things. Users can embed/add Bhuvan Map/Satellite/Terrain into their web geoportal using Embed HTML option and Send Mail option for sharing with others.

1.3 Bhuvan 3D

Bhuvan3D is yet another option for visualization that enables 3 dimensional representation of objects on Bhuvan platform. This option enables Multi sensor, Multi platform and Multi temporal data display along with the height information. There are 2 possibilities of 3D, viz., with plugin or without. The Plug-in version of Bhuvan3D provides fly over viewing capabilities with interactive manipulation of view angle, distance, elevation and motion in a 3D landscape. Users can virtually build roads, junctions and traffic lights in an urban setting and also can find terrain profile. The other option is plug-in free version. This version is completely developed using the open source solutions, which works on any platform. It lets you access, explore and visualize satellite imagery and a bundle of infrastructure information in 3D landscape and users can fly to different locations on the terrain and experience unparalleled 3D navigation. By default, the globe displays satellite imagery and user can choose to view the globe as maps instead of satellite imagery. It also provides facility to overlay Administrative boundaries, Road and Rail, Panchayat boundaries, Sub Basin, Basin and River layers.

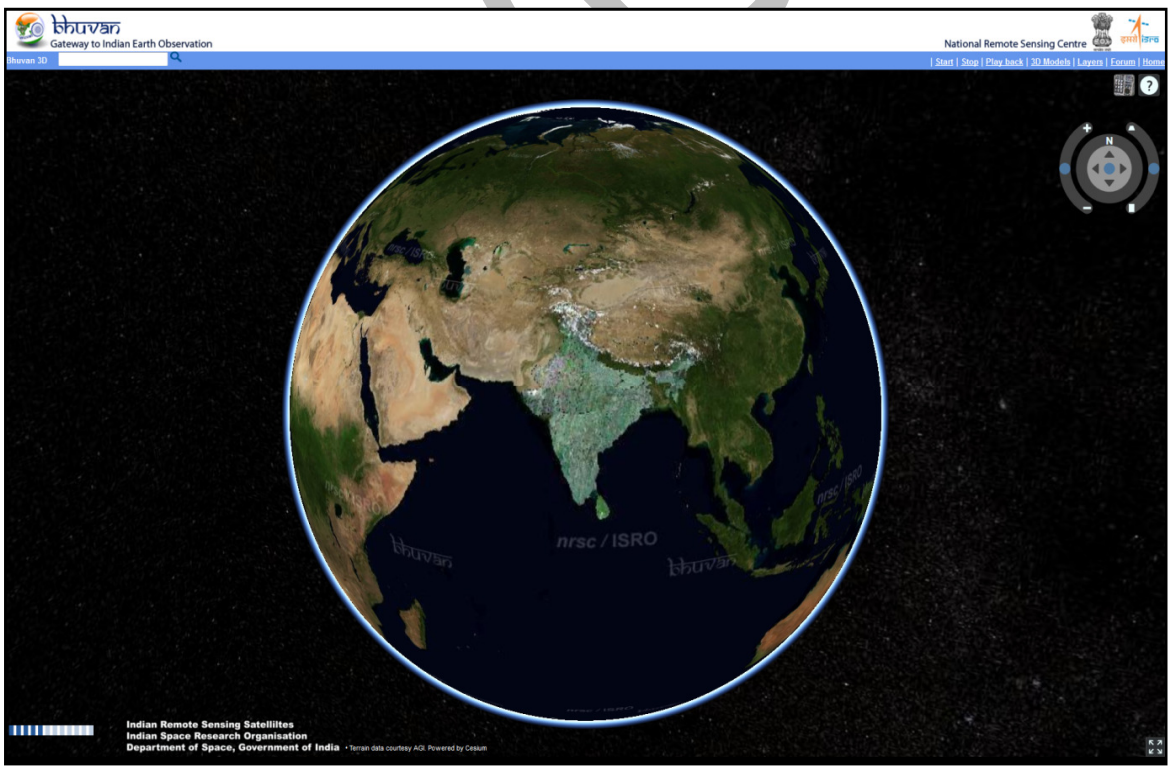


Figure 1.4: Plug-in less and Platform independent – New 3D

This new Bhuvan-3D provides visualization of 203D models for four Cities. Bhuvan facilitates to obtain the 3D models from the community. If they can share the 3D models in required format with us, after validation it will be hosted on to the public domain.

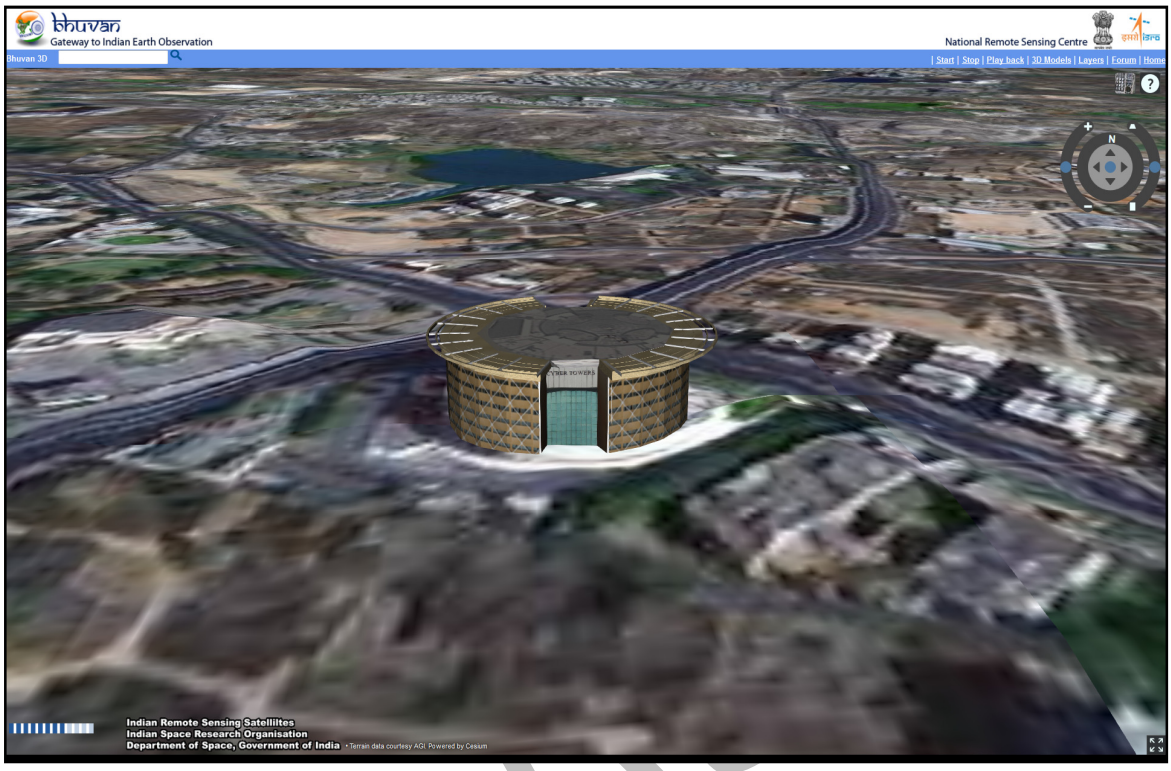


Figure 1.5: Cyber Tower 3D model on Bhuvan- 3D

New Bhuvan-3D also facilitates Recording option i.e capturing the events on globe and Play back.

1.4Add external Web Map Services

Bhuvan allows users to add Web Map Services directly on to the portal. Since it has wide range collection of data, by allowing user to add web map services to the portal, increases the analysis skills. Bhuvan web map services are OGC complaint towards Interoperability. Thus Portal doesn't limit to specific Geographic Information System(GIS) platforms and increases of different user from various GIS platform to visualize, share and overlay maps and geospatial feature data through interoperability that implement the OGC standards. Add Web Map Service (WMS) option enables users to connect and visualize external web map service along with services/data available in Bhuvan by providing layer name and layer URL.

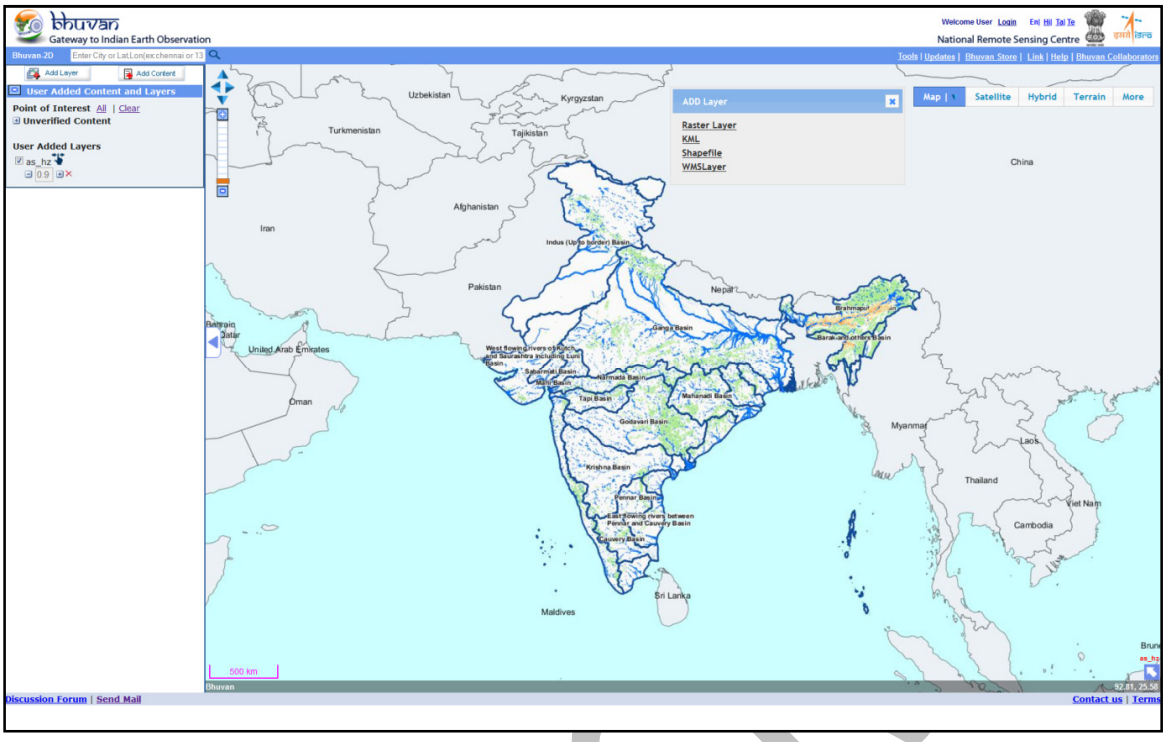


Figure 1.6: Add WMS - Consumed Assam Flood layer as WMS

Bhuvan also has WMS Manager which facilitates to connect with external web map service providers to bring all web map services and visualization, users can also submit the URL for other users to access the services. These tools facilitate users to bring diverse data which is available as web map service on internet and visualize along with rich Bhuvan satellite and thematic data.

1.5 Add your own data

Bhuvan facilitates to import and visualize GIS data available in Shapefile, KML,CSV,Text and Geotiff. Visualizing your own data along with Bhuvan data will bring out more enriched features and information. Swipe, Opacity/transparency, layer visibility off/on, layer identification options is available for user added data.

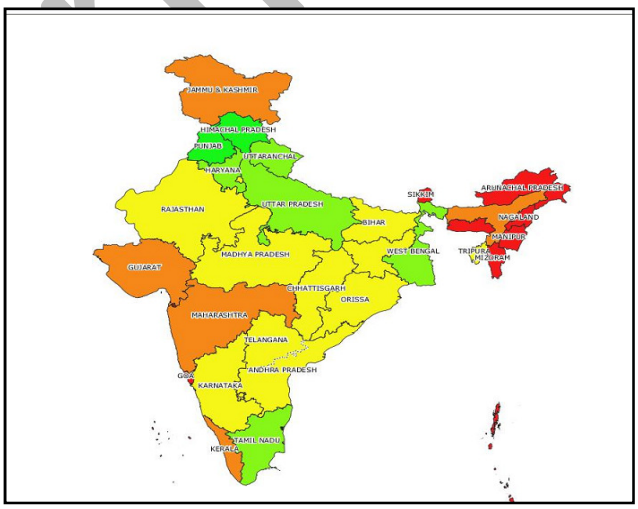


Figure 1.8: GIS VIEWER– Chloropleth map on State wise SC Percentage (Census 2011)

Visualizing textual information on Map will have a bigger impact in making the content understand, visualize and perceive things better. Towards this Bhuvan facilitate users to add csv, txt files and create maps from it. Users can generate interactive Choropleth maps based on Equal Interval classification and Unique values by providing census 2011 code or name. Point maps can be generated by providing longitude and latitude values

1.6 Add knowledge to maps

Bhuvan encourages Collaboration/Sharing/Community Participation (Crowd Sourcing) in variety of ways and creates the value addition. Add Content option available in 2D is one such option, which is a simple way to contribute the crowd sourced data for Bhuvan along photographs with minimal information. It can help you harness the crowd to increase awareness, cultivate new volunteers, gather information and add knowledge to the maps. It also has facility to visualize user's added content after the moderation; however it will be available to the users immediately who ever added the content.

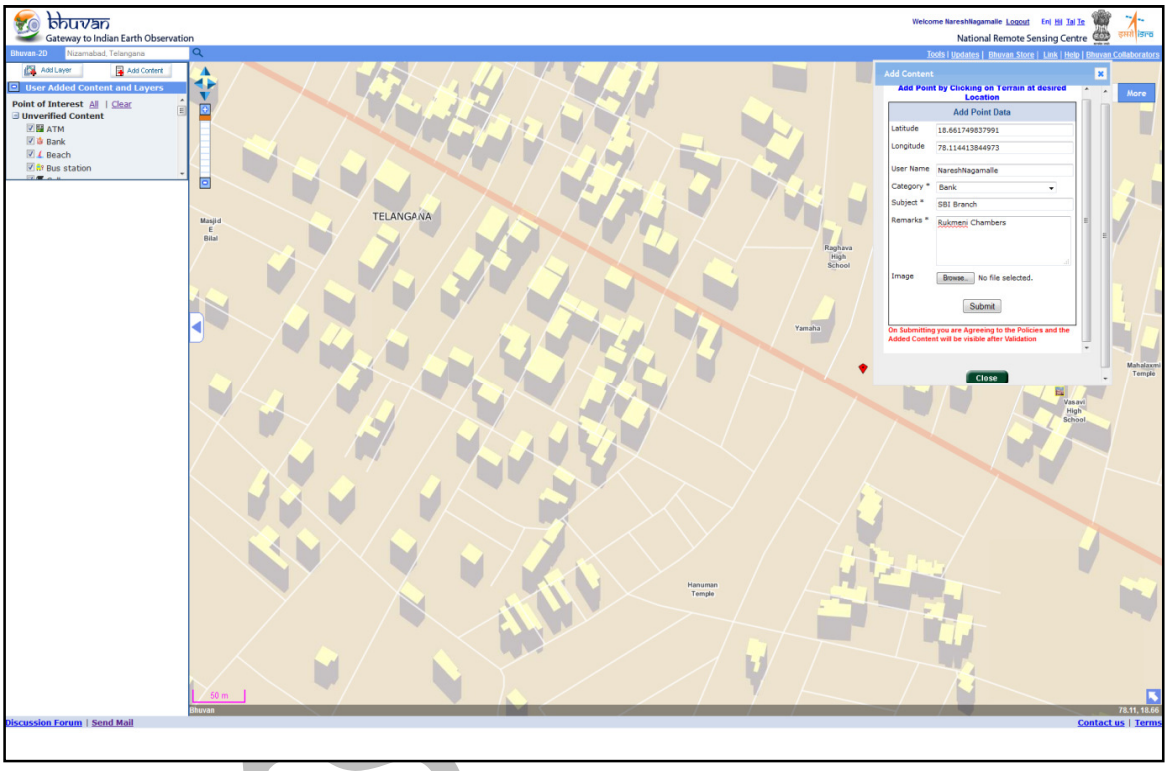


Figure1.9: Add Content – Adding the Bank details

The other two ways to add Knowledge to Maps

1. Bhuvan Mapper
2. Bhuvan POI App

1.7 Multi-date visualization and Change monitoring

Use of remote sensing in combination with geographical information system is one of the effective information technology tools for change monitoring of natural resources. Bhuvan also attempts to bring out the importance of multi-temporal data and to highlight the changes taking place to our natural resources, which will serve as a general awareness on our changing planet. Towards this Bhuvan - 2D enables multi-date view of all available high resolution data sets based on view extent and available layers/datasets along with date of pass information.

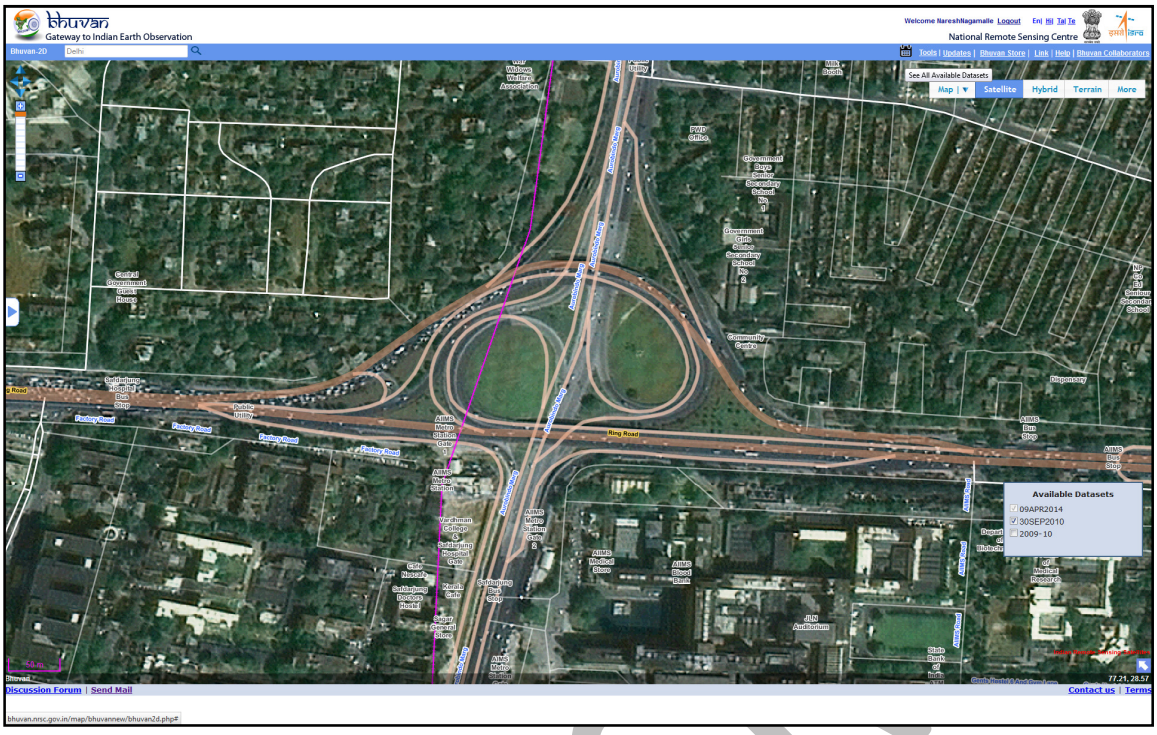


Figure1.10: High Resolution Satellite imagery of Delhi using Multi - Date Viewer

Bhuvan also enable Characterization and Monitoring of the urban growth patterns using Multi temporal and Multi spectral satellite data for 82 cities and Urban Sprawl for five states. Bhuvan also facilitates to visualize Multi temporal and Multi spectral satellite imagery used for Forest Cover monitoring and Mining Cover changes and Pre, Post satellite imagery used for monitoring of major natural disasters . Bhuvan also enables visualization of multi-date satellite imagery for Central Water Commission officials for online monitoring of Accelerated Irrigation Benefit Program funded irrigation projects and Time Series satellite& Mobile data for monitoring Integrated Watershed Management Program watersheds.. Bhuvan also provides facility to visualize Time Series Animation of the Surface Runoff, Surface Soil Moisture, Evapotranspiration products

Thus, BHUVAN is essentially envisaged as a window to ingress into different services of ISRO. The platform has been actively providing varieties of options to the users to create, visualize, share, and analyze Geospatial data products and services towards Spatial Mashups.

Chapter 2
Bhuvan - Strong Geospatial Foundation Platform for building applications

1. Introduction:

Bhuvan provides platform to create, visualize, share analyse Geospatial data products and services towards Spatial Mashups - Urban, Tourism, irrigation, Forestry, E-Governance, Crowd Sourcing, Agriculture, events, timely information on various events. The platform aims to support the State government departments in realization of Geospatial Governance with the help of spatial data at State and National level for serving better to Users and in implementing public scheme. Bhuvan with its proven platform and technical expertise providing services, application supportand value added products, using Satellite data and thematic maps, for specific requirements of the Government, Public, Private and Academia.

The collaboration with State and Central government agencies have been very fruitful with realisation of many unique applications and services by fusion of technology and expertise. Bhuvan, with its proven applications potential has become an important platform for many to build newer geospatial tools andinnovative applications to fulfillthe needs of user community. The platform provides many elements of supplementary inputs in addition to the existing thematic base for the State Government departments to enable them to create their own mashups for enabling effective monitoring mechanisms. The potential of Bhuvan is in its capability to adapt to any problem situation and provide near real-time solutions, as required by the user.

Bhuvan is a platform, not only because of rich Satellite data,the thematic maps and services, but also provides customized solutions to the users with specific utilities catering to specific project requirements. Timely delivery of data and applications has been of great support for decision making by many Government bodies, particularly in terms of Disaster management support. There are many examples of the users who have approached Bhuvan for solutions and have gone back satisfied and also continue to use the services and utilities of Bhuvan on a regular manner, hence this platform has a very good sustainable model in terms of usage by a large user community.

2. Driving Factors:

Major driving factors for making Bhuvan to be a successful Indian Geo-Platform is its adaptability to any given situation and provide quick solution. The base layers and Images are well organised as geospatial base for building rapid applications or solutions, as desired by the users. All this has been possible due to the availability of rich data assets from multiple sources, thematic maps, base layers, large-scale maps, updated attribute & infrastructure layers, robust and reliable platform. Some of the major highligts of this versatile platform and GIS applications are as follows:

a. Foundation Layers:

Base maps for the countryhave been generated with the help of permanent features, relevant reference maps, accurate ground controls and multi-resolution satellite images, including multiscale vector data of infrastructure. Further, all boundary data have been integrated into the system. Maps of administrative boundaries, selected towns/ cities etc are brought on to Bhuvan with necessary accuracy control. All the foundation layers that include basic layers, transport network, infrastructure layers etc are enabled for display that also include forest, waterbodies and settlements. Specific features like Village boundaries with census 2011 attributes are also integrated in a ready-to-use query form.

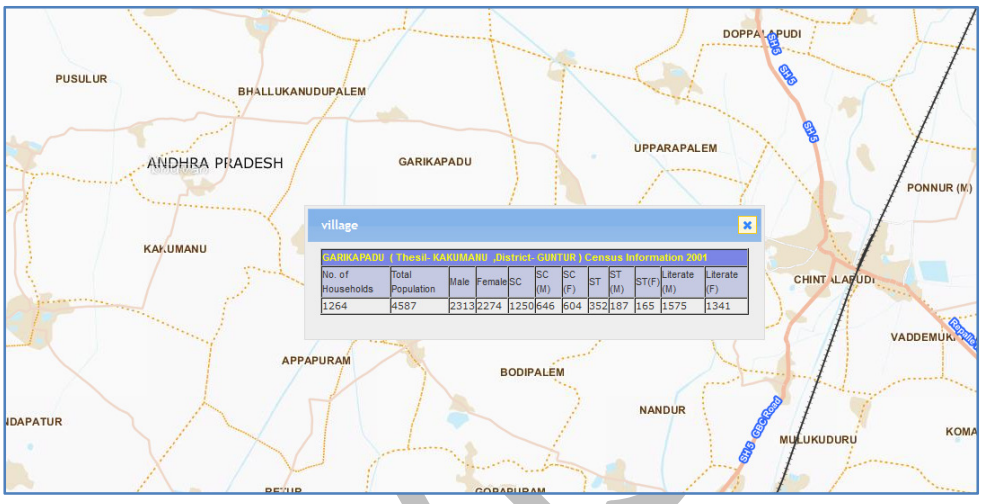


Figure 2.1: Village boundaries integrated with Census information

b. Hydrological Layers:

These layers are of prime importance for any of the applications related to Agriculture, Water, and Forestry & Environment etc The datasets like Basin, SubBasin, Watershed Boundary, River network, Reservoirs and Lakes, Drainage Network (1:50,000, 1:10,000) are available as base layers served through Bhuvan for visualization. water layer etc.

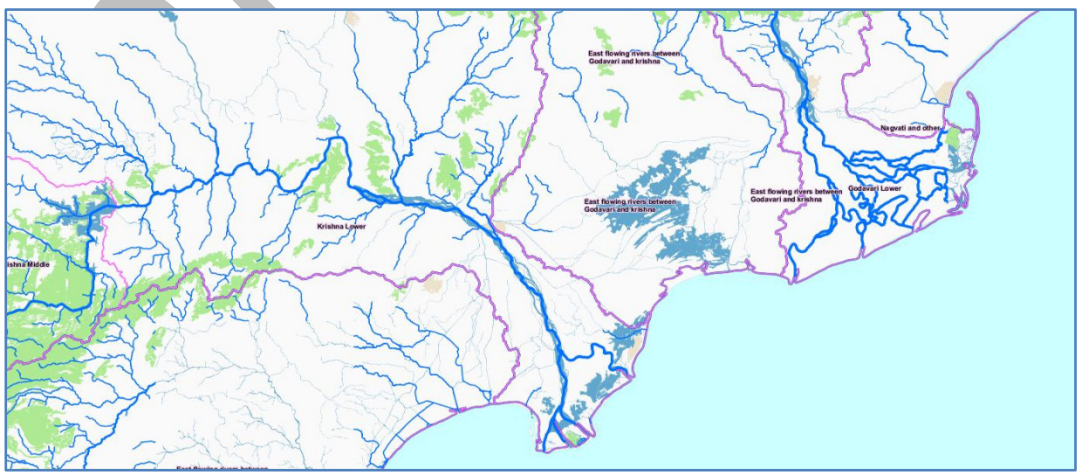


Figure 2.2: Drainage Network along with Sub-basin boundaries

c. Physiographical Base

Terrain view is available in Bhuvan 2D for visualization. Digital Surface Model generated from Cartosat Stereo images are made available with 30m placement for entire country which are downloadable through Open Data Archive. Four versions of CartoDEM are available for download. These datasets are provisioned as 1deg x 1deg tiles.

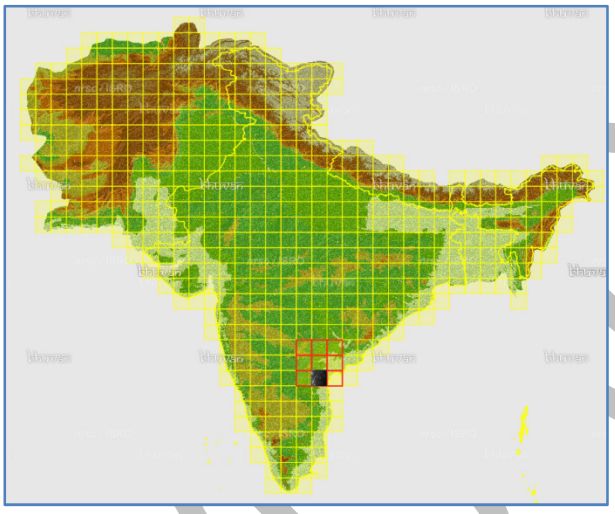


Figure 2.3: CartoDEM Version 3 availability as 1degX1deg Tiles

d. Transportation Base Layers:

Rail network, Road network data from National Highways up to Street level is available for display through multi-level geospatial visualisation mechanism. Infrastructure layers consist of National, State, District highways up to Street level information. This information is of prime interest for any of the GIS application and mainly for the urban sector applications. The Rail Network database also contains details on Station locations and other assets. Scale based rendering of the Administrative and Infrastructure layers with required styling and annotations are enabled for ease of interpretation.

Figure 2.4: Road Network data with detailed street level information

e. Large Scale City Maps:

In the present day requirements, large scale images and maps are most sought after data set for many appllications. Accordingly, planning inputs for towns and citis are enabled through a detailed GIS database for 152 towns in the countrythat has been created and hosted on Bhuvan to meet the requirements of Urban Ministry. The database is primarily useful for Master Plan / Development Plan preparation, Planning and Monitoring. For these cities and towns, a detailed base maps, administrative and infrastructure data is also available at 1:10K scale. The Bhuvan 2.5D depiction of buildings further helps in better visualisation of such large scale maps of towns & cities.

Bhuvan also supports special geoportals for 30 States, which have rich spatial data for respective states facilitating for G-Governance. These portals are good examplesof Bhuvan to support as a platform for all State Remote Sensing Application Centers in the country. This also facilitates sharing of data and making them available through a generic framework covering the entire country. A good example is the kind of applications realised for Punjab state geoportal that supports Municipal GIS requirements, Tourism GIS solutions, including village information system at scales better than 10K.

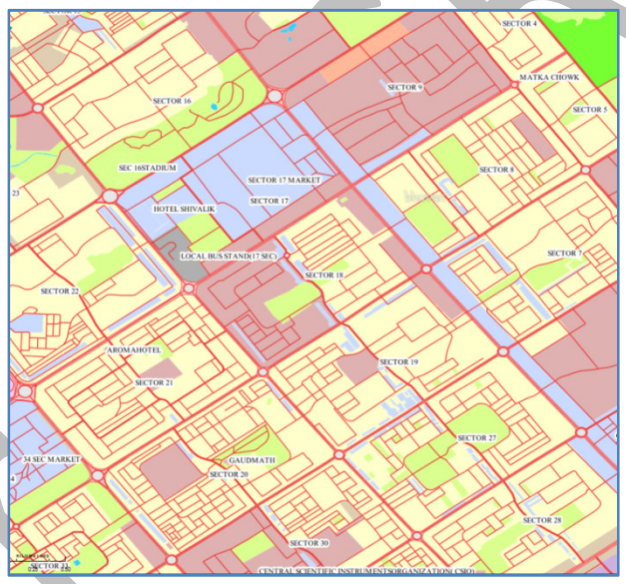


Figure 2.5: Detailed Towns map of 1:10K

f. High Resolution images of Urban and Rural areas:

The major component for enriching any of the GIS based applications for better decision making and value adding is the support of multi-resolution high quality satellite data. Bhuvan started with a vision of supporting visualization and showcasing of multi sensor and multi temporal satellite imagery of IRS satellites. Bhuvan has already positioned a satellite base at 2.5m spatial resolution for the entire country, along with this it also has enabled 1m datasets for more than 300 Cities and Towns. For supporting many of the Governance applications and better user experience, enriching its satellite base with 1m data for the entire country is one of the endevours that Bhuvan platform.

Satellite data is available for visualization through Bhuvan applications and also provisioned as part of OGC services for spatial mashups and collaborative applications.

Also through Embedded HTML option, rich data is integrated into user application that address both urban and rural areas for varieties of value added products and services.

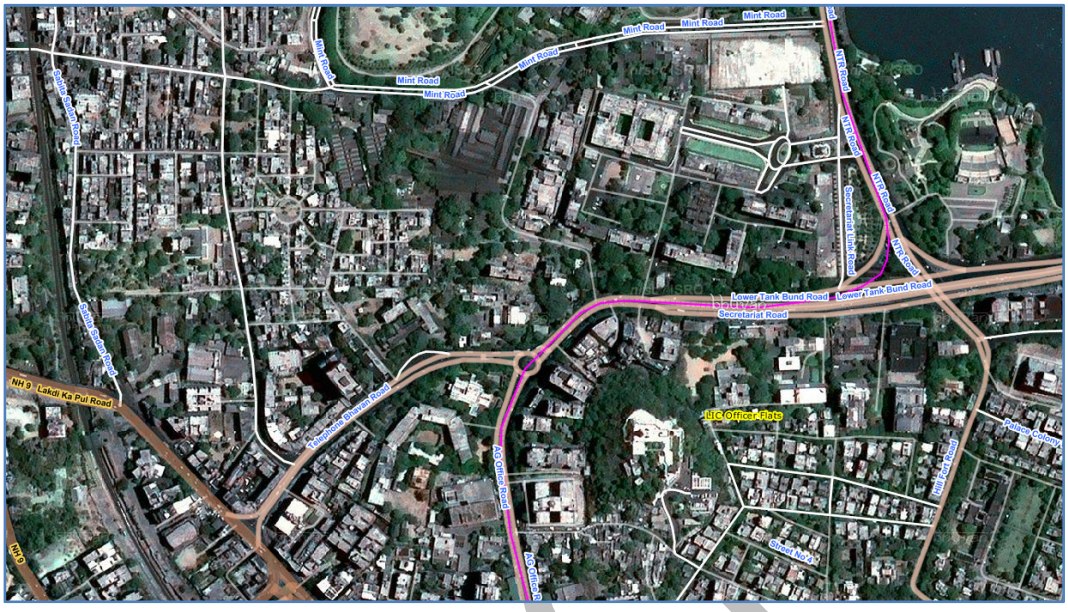


Figure 2.6: High Resolution Satellite imagery of spatial resolution 1m for Cities

g. Multi-date Satellite Images:

Applications mainly built for decision making, monitoring and evaluation need Temporal Satellite data for change detection and change monitoring. For many of the Applications built for monitoring, they need to precisely identify the features for monitoring the progress over a period of time. Such examples are available, live on Bhuvan, through Irrigation monitoring, Watershed monitoring, Oil Pipeline monitoring and so on.These applications need continous multi-temporal datasets along with the software tools to Swipe, Overlay and analyse changes which are supported effectively on bhuvan. Satellite data sets are processed regularly, based on the project requirements and are made available for these applications through a well orchestrated mechanism.

Apart from these project specific requirements there is a provision available in Bhuvan 2D for multi date viewer, through which multiple imagery covering any specific area can be analysed on the fly throughmultiple datasets as per user choice. Hence, Bhuvan has this important challenge fulfilled that needs multi-temporal data sets and software tools on the fly for analysis, which are most important for project monitoring.

h. Over 8 million Point of Interest Locations (POI):

For building any applications catering to Urban, Tourism, Location based Service applications, Disaster specific rich Point of Interest data is the prime requirement. Bhuvan with its base of more than 8 million POI location information for visualization and rich place name search can help building these applications. These POIsare diversified in

nature ranging from place names, localities, municipal, tourism information and information derived from various projects on diversified themes.

Figure 2.7: Rich Point of Interest data along with Road network data

i. Over 3.8 Million Crowd-sourced data:

Through Bhuvan various tools and applications are brought for the Crowdsourcing data from the community. Exclusive Mapper application for creating detailed maps, Add Content option to contribute POI data, customized Android applications for Field data collection. Primary challenge for the Crowdsourced data is community participation, robust architecture to handle large volumes of data received, moderation. Bhuvan with its proven platform and architecture could already obtain more than 3.8 million crowdsourced data.

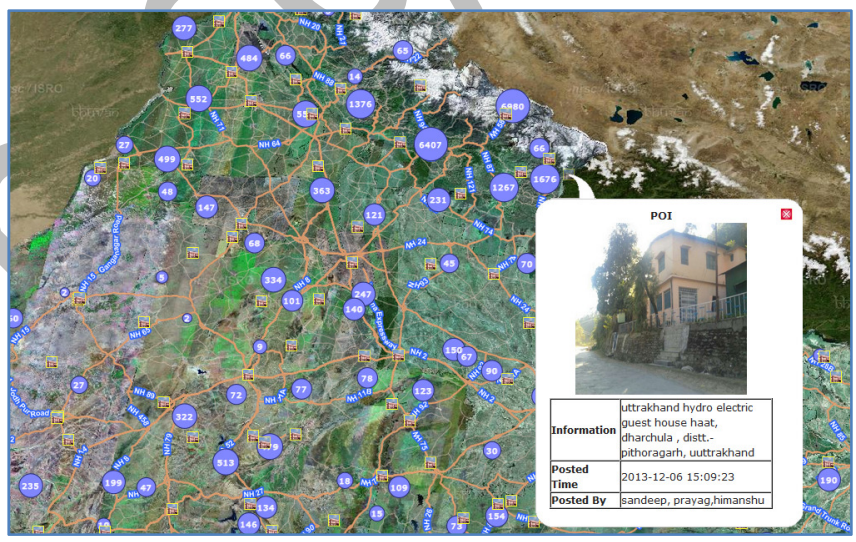


Figure 2.8: Clusters depicting Crowdsourced data across the country

Applications with the requirement of Asset Mapping and Field data collection need these Crowdsourced tools and concurrent users participating in these applications will be more. Typical examples are house tagging for Andhrapradesh, Mapping of neighbourhoods in

Uttarakhand disaster affected areas, field data for crop mapping and many more.Theamount of data gathered through customized android applications for Asset mapping are quite large due to wide usage of mobile tools that are supported from Bhuvan platform.Community participation plays a vital role during disaster management, crisis management and for such events like Phailin and Hudhud cyclones, Uttrakhand and J&K disasters, Nepal Earthquake etc. The crowdsourced applications are built for the community participationthrough mobile apps and Bhuvan is successful in engaging community participation through the use of mobile apps effectively. A special portal for AP Housing corporation Ltd has been done on Bhuvan that has been successfully used for geo-tagging of houses constructed by the Andhra Pradesh State Housing Corporation, which hosts more than 3.8 million geo-tagged houses in just a few months duration, clearly establishing the power of technology usage.

Quality of the crowd sourced data is always a concern, it is addressed on Bhuvan by authenticating the participant and also adding a level of moderation by an identified group of people. The crowdsourced data added by the general public is moderated by Bhuvan Administrators, while the project specific data moderation is assigned to the concerned project administrator. For example for Asset Mapping of A.P.State Housing Corporation Moderation is done by the concerned officials based on their hierarchical structure like district, division and subdivison levels.

After moderation only the data is available for visualization to the general public as unverified content. The content is named as unverified as thought eh moderation is done but content is not verified by doing field visit.

Chapter 3: Bhuvan as a clearing house

3. Bhuvan as a data product clearing house

Bhuvan is used as a data and product clearing house for supporting scientific and Remote Sensing based projects. The data and products can be downloaded from NRSC/ISRO Open data and product archive. Requirement of users to carry out remote sensing based projects specially by universities, researchers and departments is fulfilled by providing free satellite data and products through NRSC Open Data Archives. Complete list of products available for download is given in Table 3.1. Bhuvan has crossed free data download of ~ 3.8 lakhs as on July, 2015.

Table 3.1 List of all products available under Open Data Archive along with the coverage

S.No.	Product	Resolution	Availability	Coverage: Tile Extent/Spatial Extent
1	**Cartosat-1:DEM - Version-1**	1 arc Sec (~ 32 m)	2006-08	India: 1°X1°
2	**Cartosat-1:DEM - Version 1.1R1**	1 arc Sec (~ 32 m)	2008-12	India: 1°X1°
3	**IMS-1:Hyper spectral Imager**	Spectral Binned Data(17 bands)	2008-12	India: Scene Based
4	**Resourcesat-1:AWiFS Ortho**	56 m	2008, 2009 (2 seasons), 2010 (2 seasons)	India: 1°X1°
5	**Resourcesat -1:LISS III Ortho**	24 m	2008-09, 2011, 2012	India: 15'X15'
6	**Derived Tropospheric Ozone**	1° x 1°	2010 – 2013	Daily
7	**Daily Ocean Heat Content of 700m Layer**	0.25°	2002 - 2015	North Indian Ocean (30S – 30N; 30-120E)
8	**Daily Tropical Cyclone Heat Potential**	0.25°	1998 – 2015	North Indian Ocean (30S – 30N; 30-120E)
9	**Model Derived Depth of 26°C Isotherm**	0.5° x 0.5°	2013 - 2015	30° S - 30° N; 30° E - 120° E
10	**Model Derived TCHP**	0.5° x 0.5°	2013 - 2015	30° S - 30° N; 30° E - 120° E

S.No.	Product	Resolution	Availability	Coverage: Tile Extent/Spatial Extent
11	**Ocean Wind Curl**	0.5° x 0.5°	2012 – 2014 (Feb)	30° S - 30° N; 30° E - 120° E
12	**Ocean Wind Stress**	0.5° x 0.5°	2012 – 2014 (Feb)	30° S - 30° N; 30° E - 120° E
13	**Ocean Wind Velocity**	0.5° x 0.5°	2012 – 2014 (Feb)	30° S - 30° N; 30° E - 120° E
14	**AWiFS: Water Bodies Fraction**	3' X 3' Grid	2004 – 2013, 2014-2015	India
15	**Mesoscale compatible inputs for: MM5**	30 sec, 2, 5 mins	2004-05 to 12-13 (9 Cycles)	90° S - 90° N; 180° W - 180° E
16	**Mesoscale compatible inputs for: WRF**	30 sec, 2, 5 mins	2004-05 to 12-13 (9 Cycles)	Indian Region
17	**OCM2: Albedo**	1 Km	2013 – 2014	India
18	**OCM2: NDVI - Global Coverage**	8 Km	2013	Global
19	**OCM2: NDVI - Local Coverage**	1 Km	2011, 2012-2014	India
20	**OCM2: Vegetation Fraction**	1 Km	2011, 2012-2014	India
21	**Snow Melt and Freeze**	2.225 Km	2009 – 2013	Himalayan Region
22	**Surface Soil Moisture - 2 Day**	0.25° x 0.25°	2012 – 2014	India
23	**Daily Ocean Mean Temperature & Heat Content of Different Layers**	0.25° x 0.25°	1998-2015	0° - 30° N; 40° E - 120° E

These datasets are being used by a wide variety of user community. Following are few illustrations -

1. Evaluation of FOSS GIS Tools in Drainage Network Extraction and Classification using Cartosat Digital Elevation Model [1].
2. Bhuvan services used for Spatial Mashup Technology and real time data integration in geo-web application using open source GIS – a case study for disaster management [2].
3. Cartosat Digital Elevation Model use for - Water Conservation using Remote Sensing and GIS: A Case Study from a DevasugurNala Watershed in Middle Krishna Basin in Raichur District, Karnataka [3].
4. Cartosat Digital Elevation Model use for - Morphometric analysis of Upper Tons basin from Northern Foreland of Peninsular India [4].

5. Usage of field data collection for - 'Use of Remote Sensing in Crop Forecasting and Assessment of Impact of Natural Disasters: Operational Approaches in India'[5].
6. Oil Spill Map for Indian Sea Region based on Bhuvan- Geographic Information System using Satellite Images [6].
7. Bhuvan Satellite Imagery use for ' Geomorphic Evolution of Chambal River Origin in Madhya Pradesh using Remote Sensing and GIS' [7].
8. Identification of Potential Zones for Groundwater Recharge in Kosigi Mandal, Kurnool District, by digitization using Bhuvan data-sets [8].
9. Bhuvan use case in Slum Mapping for Rajiv Awas Yojana used by Ministry of Housing and Urban Poverty Alleviation in 2010

References of technical publications by users of Bhuvan data-

[1] Singhai A and Saxena A. (2012) An Evaluation of FOSS GIS Tools in Drainage Network Extraction and Classification using Cartosat DEM. International Journal Of Advanced Scientific Research And Technology (2)433-441.

[2] Karnatak, H. C., Shukla, R., Sharma, V. K., Murthy, Y. V. S., & Bhanumurthy, V. (2012). Spatial mashup technology and real time data integration in geo-web application using open source GIS–a case study for disaster management.Geocarto International, 27(6), 499-514.

[3] Sahebagoud N Patil, B. MaheshwaraBabu and G.V. Srinivasa Reddy, Water Conservation using Remote Sensing and GIS: A Case Study from a DevasugurNala Watershed in Middle Krishna Basin in Raichur District, Karnataka, User Interaction Meet (Jan 20-21, 2014), NRSC, ISRO.

[4] Yadav, S. K., Singh, S. K., Gupta, M., & Srivastava, P. K. (2014). Morphometric analysis of Upper Tons basin from Northern Foreland of Peninsular India using CARTOSAT satellite and GIS. Geocarto International,29(8), 895-914.

[5] Shibendu Shankar Ray, Neetu, S. Mamatha and Sanjeev Gupta, Use of Remote Sensing in Crop Forecasting and Assessment of Impact of Natural Disasters: Operational Approaches in India, MNCFC, 2014

[6] Kishore, J. K., Kesava Rao, P., Annadurai, M., Dutt, C. B. S., Hanumantha Rao, K., Sasamal, S. K., ... & Shenoy, H. P. (2014). Oil Spill Map for Indian Sea Region based on Bhuvan-Geographic Information System using Satellite Images. ISPRS-International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 1, 1085-1090.

[7] Kaushik, P., & Ghosh, P. (2015). Geomorphic Evolution of Chambal River Origin in Madhya Pradesh using Remote Sensing and GIS. International Journal of Advanced Remote Sensing and GIS, 4(1), pp-1130.

[8] PalakaA, R., & SankarḂ, G. J. (2015). Identification of Potential Zones for Groundwater Recharge in Kosigi Mandal, Kurnool District, using Remote Sensing and GIS.

Chapter 4

Bhuvan as support for Disaster Management

4.1 INTRODUCTION

India has been traditionally vulnerable to natural disasters on account of its geo-climatic conditions. Floods, droughts, cyclones, earthquakes and landslides have been recurrent phenomena. About 60% of the landmass is prone to earthquakes of various intensities; over 40 million hectares is prone to floods; close to 5,700 km long coastline out of the 7,516 km, is prone to cyclones; about 68% of the cultivable area is susceptible to drought. The Andaman & Nicobar Islands, the East and part of West coast are vulnerable to Tsunami. The deciduous/ dry-deciduous forests in different parts of the country experience forest fires. The Himalayan region and the Western Ghats are prone to landslides.

Under the DMS programme, the services emanating from aerospace infrastructure, set up by ISRO, are optimally synthesized to provide data and information required for efficient management of natural disasters in the country. The Geostationary satellites (Communication and Meteorological), Low Earth Orbiting Earth Observation satellites, aerial survey systems together with ground infrastructure form the core element of the observation Systems for disaster management.

The Decision Support Centre established at National Remote Sensing Centre (NRSC) of

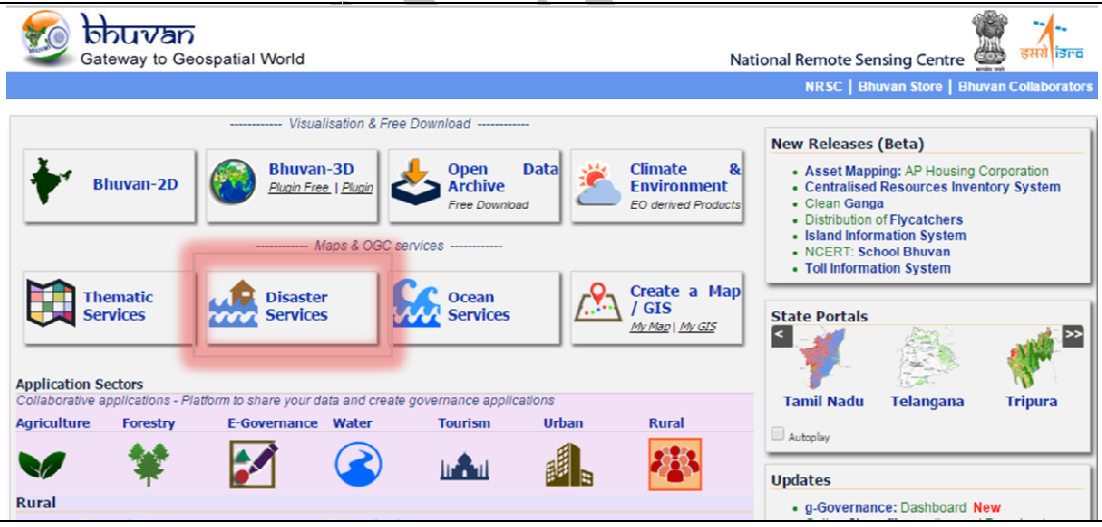


Figure 4.1: Disaster Services under Bhuvan Portal

ISRO is engaged in monitoring natural disasters such as flood, cyclone, agricultural drought, landslides, earthquakes and forest fires at operational level. The information generated from aero-space systems are disseminated to the concerned in near real time for aiding in decision making. The value added products generated using satellite imagery helps in addressing the information needs covering all the phases of disaster

management such as, preparedness, early warning, response, relief, rehabilitation, recovery and mitigation.

All the information derived from satellite data and other sources is disseminated to the concerned organisations in the form of maps (jpg) and documents (pdf). Apart from this, the information is also incorporated in ISRO-Bhuvan portal for better visualisation and with basic GIS functions (Figure 4.1).

4.2 FLOODS

India is one of the most flood prone countries in the world. Floods occur in almost all major rivers basins in India. Twenty-three of the 35 states and union territories in the country are subject to floods and 40 million hectares of land, approximately, one-eighth of the country's geographical area, is prone to floods. Satellite data provides synoptic views of the flood affected regions. In case of severe cloud conditions, data from microwave satellites is very useful in deriving flood inundated areas of the region.Flood related information is organised in Bhuvan as Recent Floods, Historic Flood, Flood Annual Layers, Flood Hazard Zones,Aggregated Flood

4.2.1 Recent Floods

In order to understand the flood situation, it is necessary to know which areas are

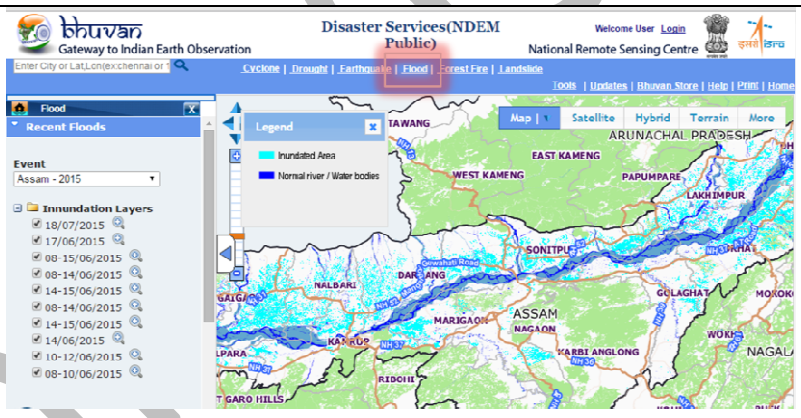


Figure 4.2: Flood inundation observed in Assam State during 2015

inundated. Satellite data provides such information very quickly and accurately. The satellite is planned based on rainfall forecasts / persistent clouds / other information, in advance, to map the extents for flood inundation at regular intervals.

This helps the users to understand the flood severity, potential damages to the infrastructure and enable them in better decision making with respect to relief management. Information on current flood situation is updated typically within 4-6 hrs, after acquiring the satellite data.

Bhuvan provides such facility to visualise the flood information. Figure 4.2 provides the information on the flood situation in Assam State during June-July, 2015.

4.2.2 Historical Floods

State-wise flood inundation information is organised for the reference of decision makers to understand the earlier flood scenarios. Typically, this information is organised from 2006-2014.

4.2.3 Flood Annual Layers

After the flood season, flood managers look for cumulative information on the floods for understanding and for preparing for the next flood season.

Accordingly, Bhuvan presents annual layers of floods for selected States (Figure 4.3) by integrating the flood inundation derived from multiple satellites during the year.

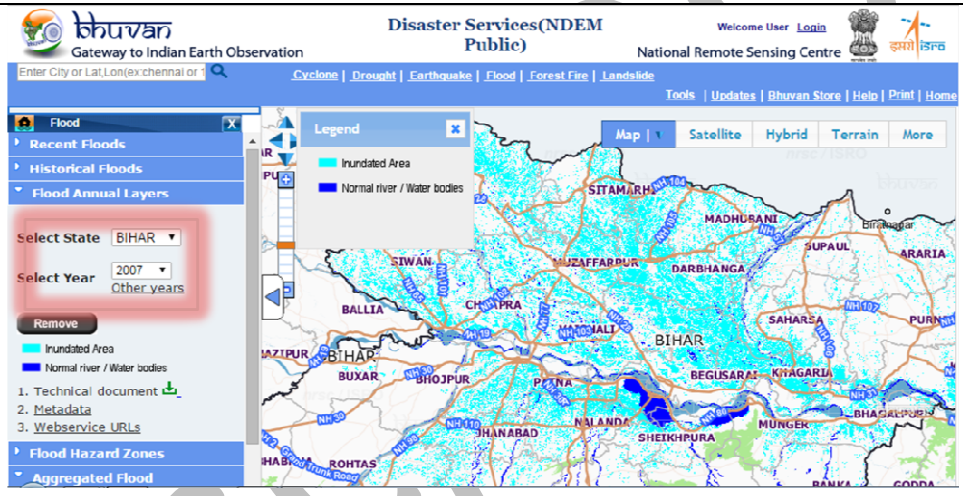


Figure 4.3: Annual Flood inundation observed in Bihar State during 2007

4.2.4 Flood Hazard Zones

Information is required on flood history of the region, to mitigate the floods. Satellites provide such historical observations on flood inundations during major events also.

Using historical satellite data of floods affecting different areas flood hazard zonation is carried out State-wise flood hazard maps are prepared for the first time in India, for selected States. Information on flood hazard, derived from satellite data of 10-15 years is made available through Bhuvan for Assam, Bihar, Odisha and Uttar Pradesh (Figure 4.4).

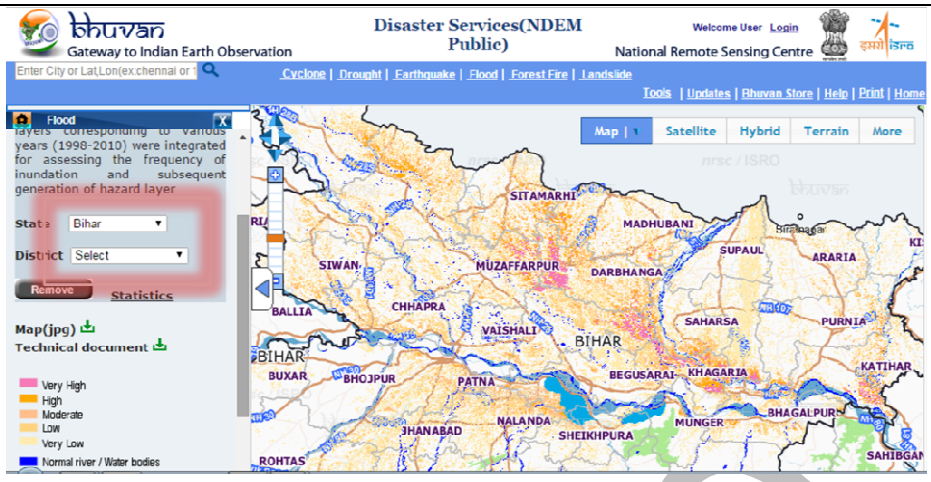


Figure 4.4: Flood Hazard Zones in Bihar derived from satellite data of 1998- 2010

4.2.5 Aggregated Flood

The flood prone area in India, generally referred official documents, is based on the information aggregation of the information provided by State Governments.

NRSC has initiated a study to scientifically assess the flood prone area. As a first step, available historical satellite datasets acquire during the flood season (more than 100 historical satellite datasets) from Indian Remote Sensing Satellites (IRS) and foreign satellites have been analysed for generating the aggregated extent of flood inundated area. Only those datasets corresponding to either high flood situation or unprecedented floods were used in this study.

Figure 4.5 shows the flood inundation observed during major floods, cyclones and tsunami in India.

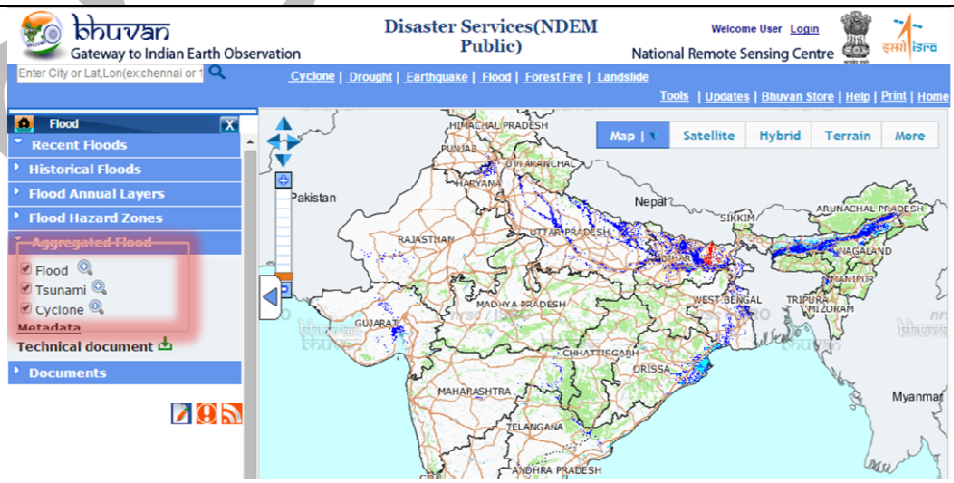


Figure 4.5: Aggregated Flood Zone of India from satellite data of 2003 - 2013

4.3 CYCLONES

Cyclones are wind-systems of relatively low pressure which spiral inwards towards a centre in the lowest atmospheric levels and cause immense destruction and loss of life when they strike coastal areas. Our country's vast coastline of 7500 Km is exposed to tropical cyclones arising in the Bay of Bengal and Arabian Sea. The average annual losses due to cyclone damage are Rs.200 crore, which at times exceeds Rs.400 crores. Satellite communications provide an effective mechanism for real-time dissemination of information and early warning besides establishing communication link after cyclone hit. INSAT system provides half-hourly observation of cyclone movement and its associated parameters for warning and prediction of landfall.

Odisha Super Cyclone of 1999 is a typical example of severe devastation in the recent years. Recent examples include cyclone PHAILIN (2013) and cyclone HUDHUD (2014).

Bhuvan provides information on cyclone track, inundation, ground information integrated through mobile apps (crowd sourcing), etc.

With the availability of Indian RISAT-1 and other satellites, information on cyclone inundation was derived on daily basis for PHAILIN hit Odisha area. Even 12-hourly information was also derived for severely affected areas (Figure 4.6).

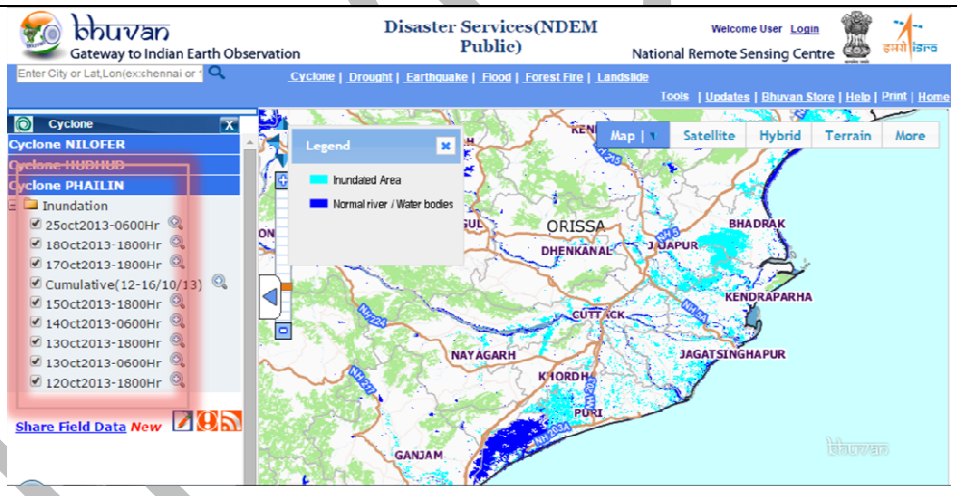


Figure 4.6: Inundation in Odisha State due to Cyclone PHAILIN

During Cyclone HUDHUD, information on following is provided through Bhuvan.

a. Cyclone Track
b. Experimental Surface Run-off
c. Cyclone Inundation
d. Detailed Damages (using Mobile application)

4.3.1 Cyclone Track

Information on cyclone track obtained from India Meteorological Department (IMD), Joint Typhoon Warning Centre (JTWC) are regularly updated through Bhuvan (Figure 4.7a & 4.7b)

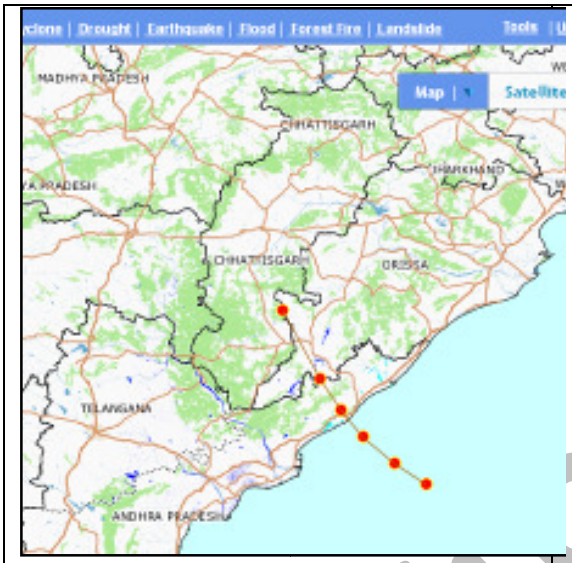


Figure 4.7a: Cyclone Track from IMD

Figure 4.7b: Cyclone Track from JTWC

4.3.2 Experimental Surface Run-off

Experimental surface run-off estimation was attempted using Global Ensemble Forecast System Reforecast (GEFS/R) data of 9/10/2014 at 9min grid level for 10-12 Oct, 2014. (Ref-ftp://ftp.cdc.noaa.gov/Projects/Reforecast2)

The outputs are experimental and derived using VIC-3L hydrological model framework at 9min (~16.5km spatial resolution) grid level at 24hr time-step. Runoff depth (mm/day) are shown increasing from light to dark blue.

This indicates the potential inundation (Figure 4.8) due to heavy rains.

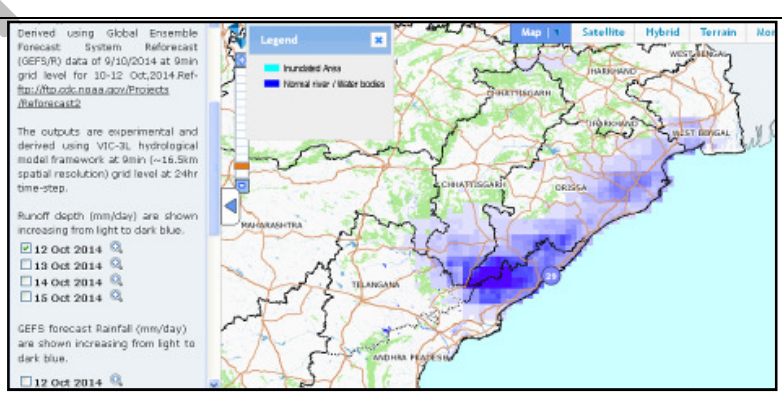


Figure 4.8: Cyclone HUDHUD Track

Further hydrological simulations are also carried out for typical rivers in order to estimate the discharge.

4.3.3 Cyclone Inundation

Using Indian and foreign satellites information on inundation is provided to the concerned departments (Figure 4.9).

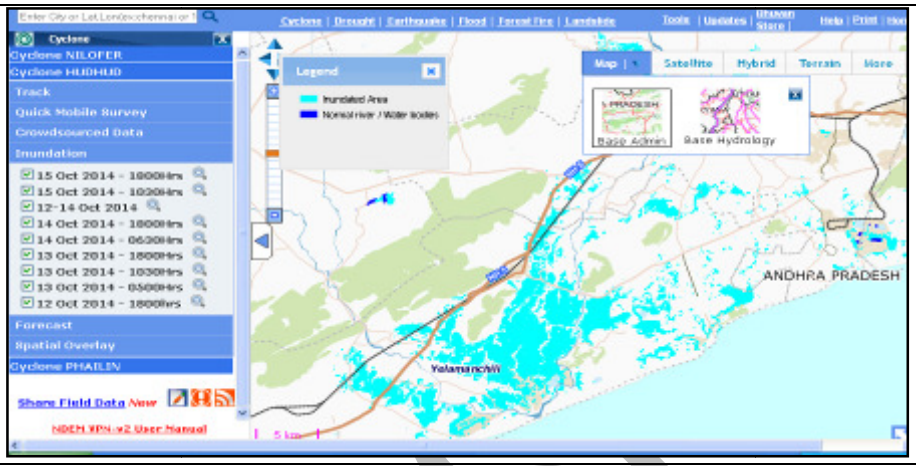


Figure 4.9: Inundation due to cyclone HUDHUD

4.3.4 Detailed Damages (using Mobile application)

A customized mobile app is developed to obtain additional ground data on damages (Figure-4.10a & 4.10b).

Figure 4.10a: Crop Damage data in Cyclone HUDHUD

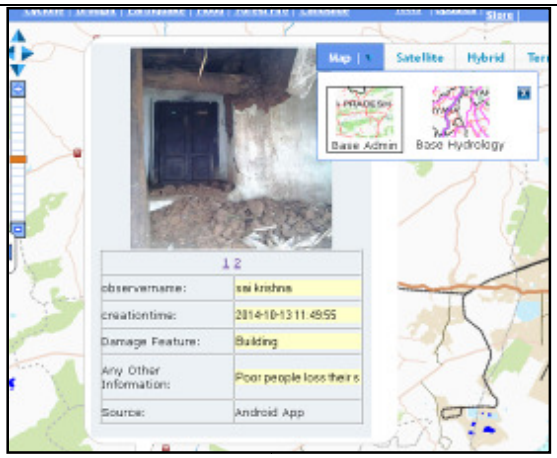


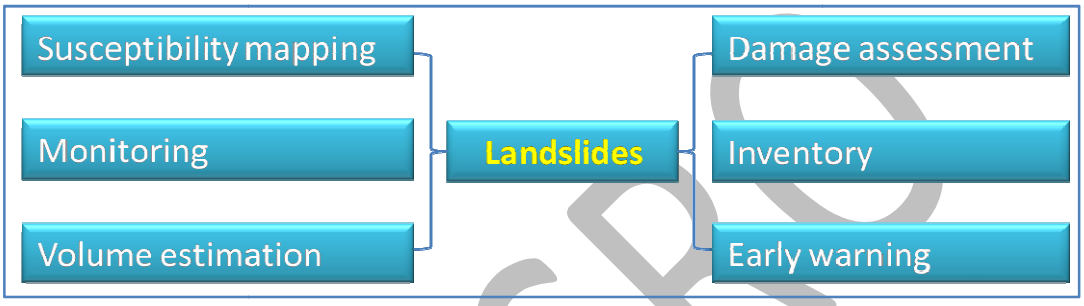
Figure 4.10b: Damage to buildings due to Cyclone HUDHUD.

4.4 LANDSLIDES

Most of the Himalayan region, eastern and western ghats are typically prone to landslides in India.

Necessary support to the decision makers is provided through Bhuvan for understanding and mitigating the landslides.

This includes susceptibility mapping, monitoring, volume estimation, damage assessment, inventory and early warning.



Proactive support for landslide disaster includes preparation of maps concerning to landslide activities as shown in the following figure depending upon the scale and extent of the disaster. Landslide hazard zonation maps for following routes in the states of Uttarakhand and Himachal Pradesh are available in Bhuvan.

i. Rishikesh-Uttarkashi-Gangotri-Gaumukh
ii. Rudraprayag-Okhimath-Kedarnath
iii. Rishikesh-Rudraprayag-Chamili-Badrinath
iv. Pithoragarh-Khela-Malpa
v. Chamoli-Usara-Okhimath
vi. Dalhousie-Chamba-Brahmaur
vii. Shimla-Rampur-Sarhan-Sumdo
viii. Shimla-Bilaspur-Kulu-Manali

Post disaster support for landslide includes preparation of damage assessment maps and landslide inventory maps after the occurrence of landslides within 24 hours of the receipt of the cloud free optical satellite data. Landslide inventory map prepared for major disasters such as Uttarakhand 2013 (6585 landslides), Okhimath 2012 (451 landslides), J&K 2014 (1071 landslides) gives a comprehensive quantification of the magnitude and extent of the damage. Figure 4.11 shows the landslide inventory map of the Uttarakhand 2013 disaster. Figure 4.12 shows the Phuktal river landslide in J&K.

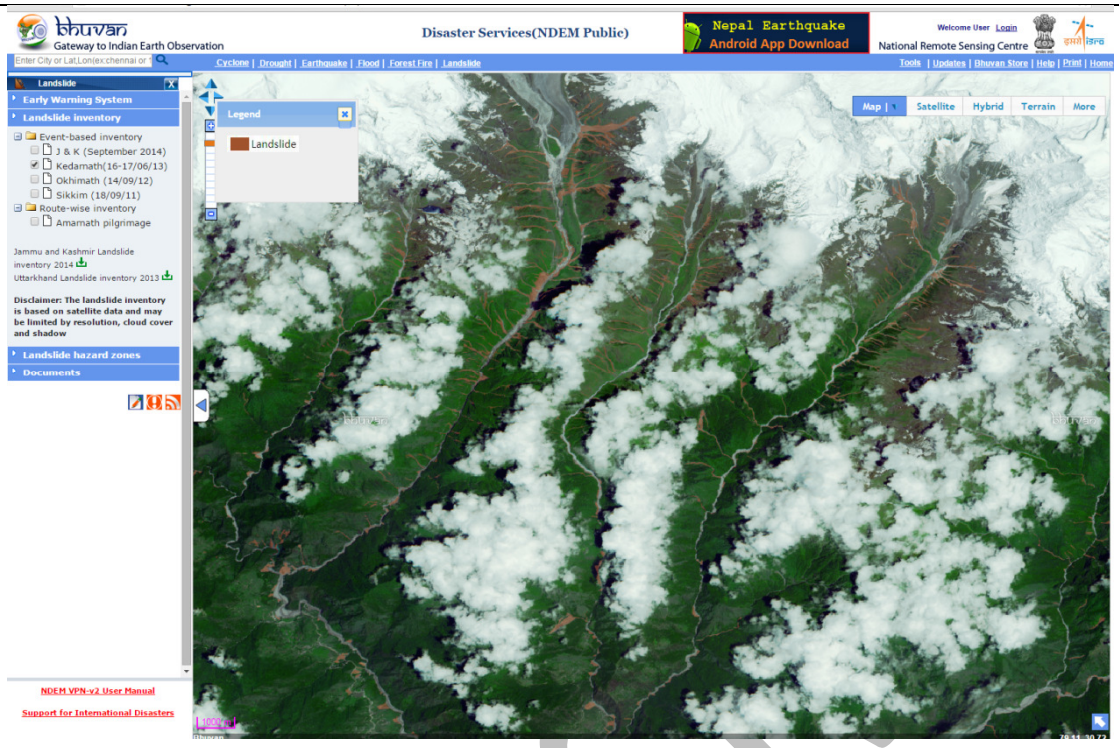


Figure 4.11: Landslide inventory map of the Uttarakhand 2013 disaster

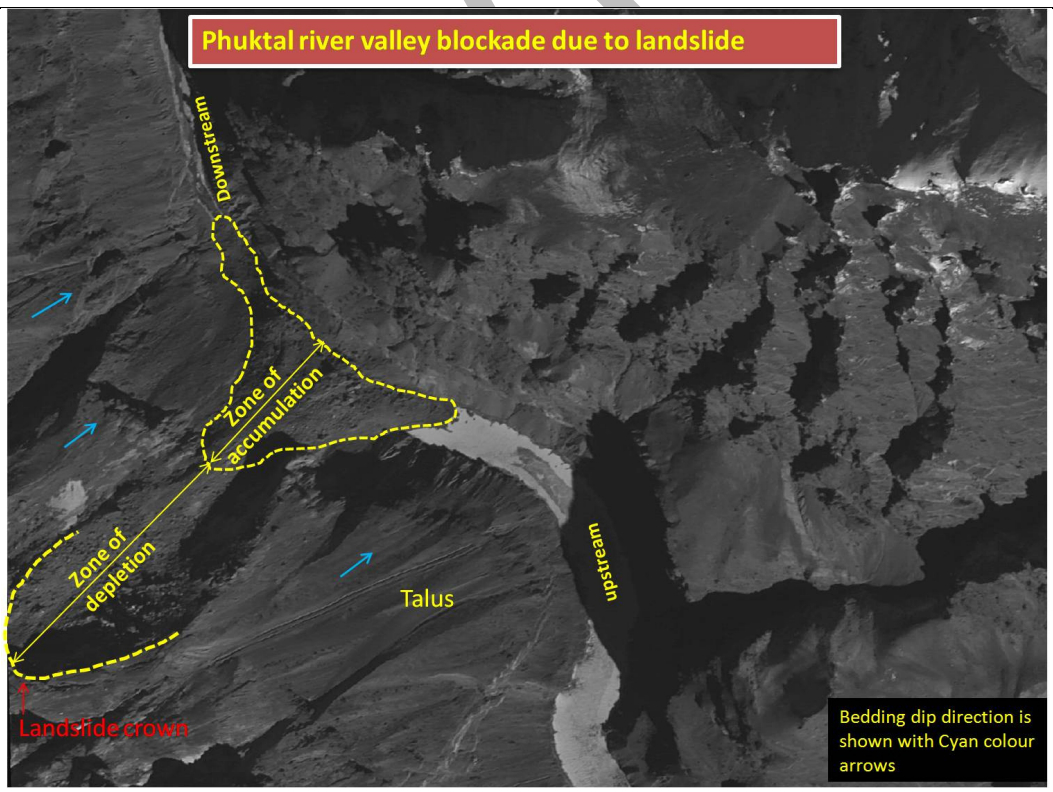


Figure 4.12: Phuktal river landslide in J&K

The historical landslide inventory database, landslide early warning and the landslide hazard zonation maps available in Bhuvan can help in disaster preparedness. Historical landslides of Amarnathyatra routes available in Bhuvan will give firsthand information of the landslide proneness of the area. Figure 4.13 shows the landslide inventory map for Amarnath pilgrimage route in J&K.

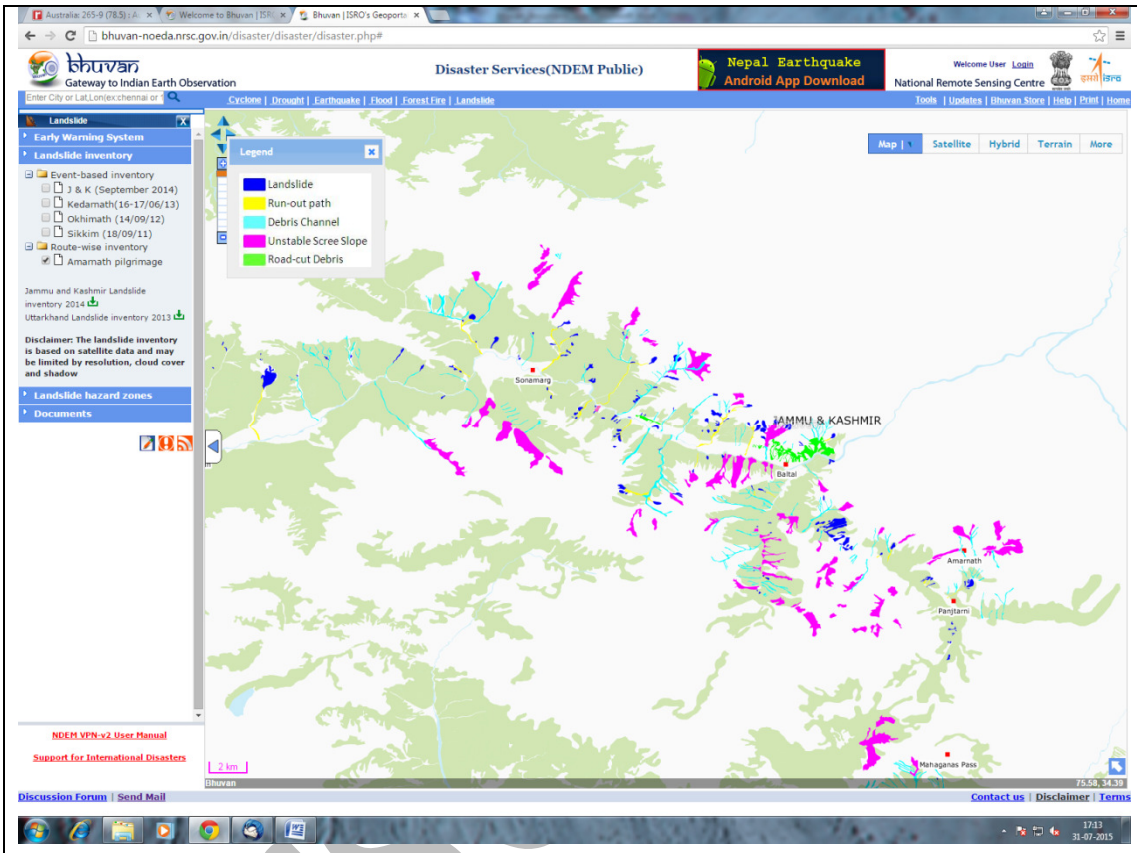


Figure 4.13: Landslide inventory map for Amarnath pilgrimage route in J&K

Towards the identification of areas that are vulnerable for occurrence of future landslides, landslide hazard/susceptibility maps have been prepared by integrating geological and topographic factors such as lithology, structure, landform, slope etc. These maps indicate unstable and stable areas. Figure 4.14 shows the landslide hazard zonation maps of Shimla to Manali route in Himachal Pradesh.

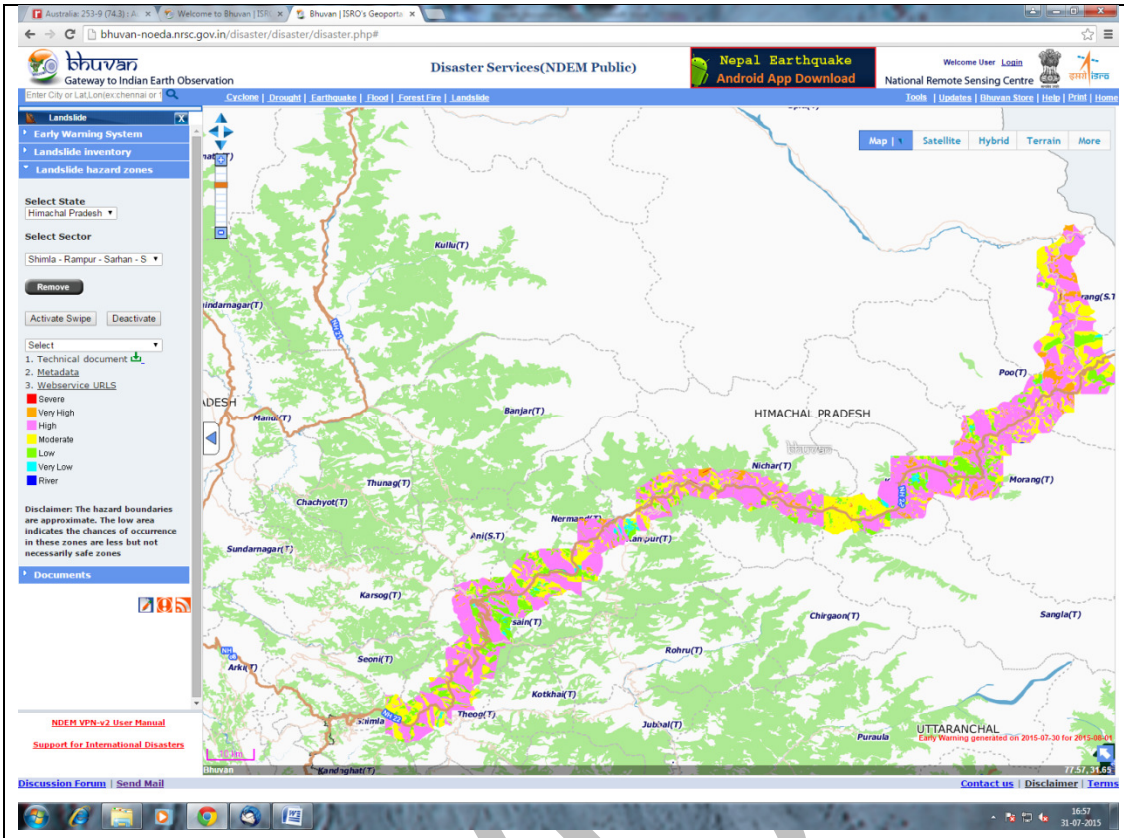


Figure 4.14: Landslide hazard zonation maps of Shimla to Manali route in Himachal Pradesh

4.4.1 Reconstruction and Rehabilitation: Landslide susceptibility/hazard zonation maps will help to identify safe place for construction of settlements and roads. The new landslide inventory maps will also help to identify areas that can be avoided in the aftermath of an landslide event.

4.4.2 Early warning for rainfall-induced landslides

Early warning for rainfall-induced landslides has been launched in Bhuvan as proactive support towards disaster mitigation. During monsoon, 72Hr forecast is generated daily for road corridors leading to Gangotri, Badrinath, Kedarnath and along the Pithoragarh-Malpa route in Uttarakhand. Figure 4.15a Early warning map for rainfall induced landslides for Uttarkashi. Figure 4.15b Early warning map for rainfall induced landslides for Rishikesh-Badrinath-Rudraprayag-Kedarnath-Chamoli-Okimath area.

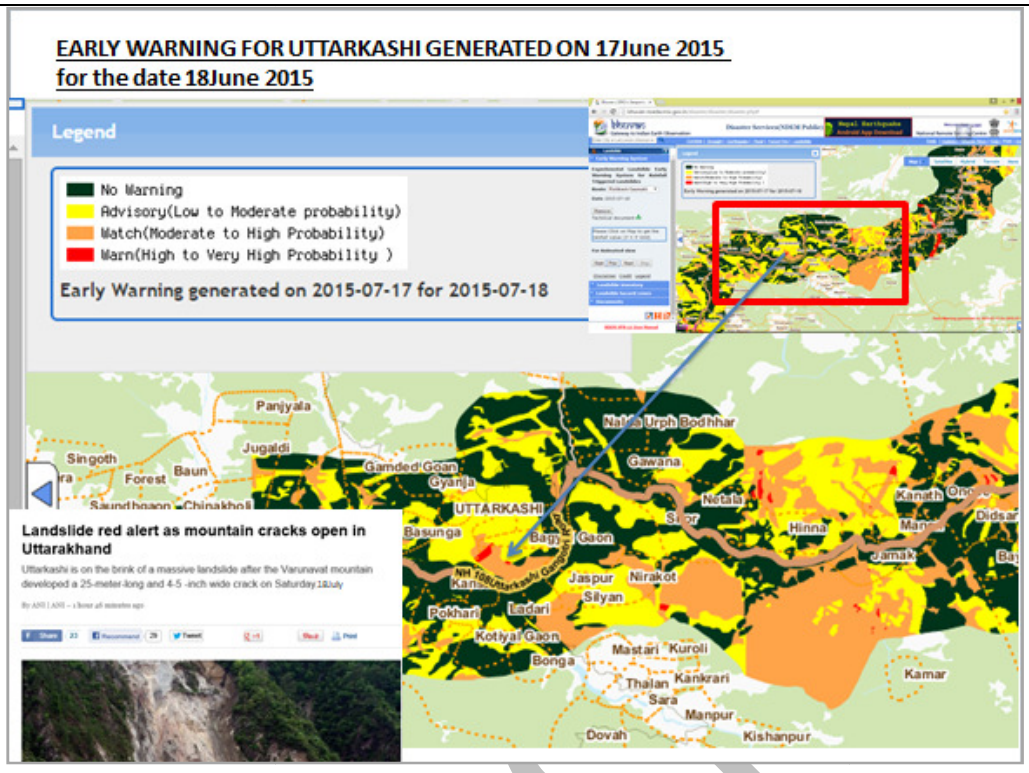


Figure 4.15a: Early warning map for rainfall induced landslides for Uttarkashi.

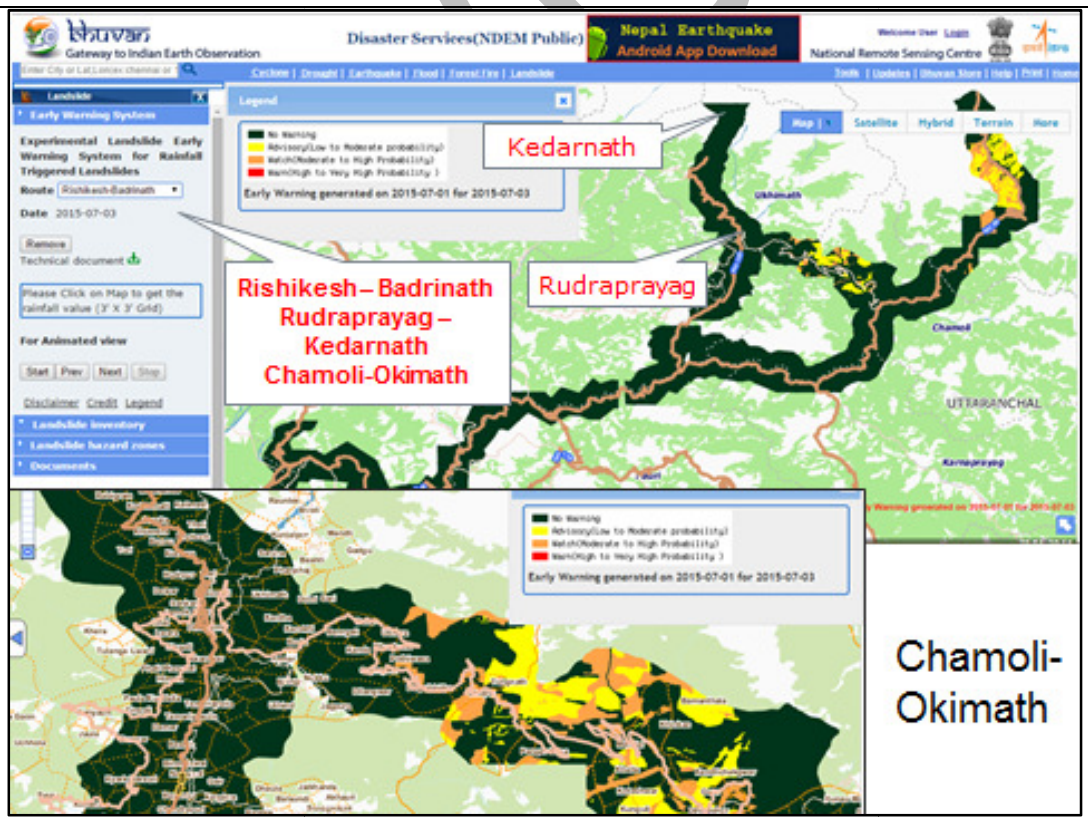


Figure 4.15b: Early warning map for rainfall induced landslides for Rishikesh-Badrinath-Rudraprayag-Kedarnath-Chamoli-Okimath area.

Advisory: Moderate Landslide Susceptibility and Moderate to High (>0.75) Trigger Probability (Low to Moderate probability of landslides)

Watch: Very High Landslide Susceptibility and Moderate (0.75 - 0.85) Trigger Probability OR High Landslide Susceptibility and Moderate to High (> 0.75) Trigger Probability (Moderate to High probability of landslides)

Warn: Very High Landslide Susceptibility and High (>0.85) Trigger Probability OR Severe Landslide Susceptibility (High to Very High probability of landslides)

4.5 EARTHQUAKES

Earthquakes are one of the geological disasters mostly associated with plate boundary regions, except a few as intra-plate types or related to the reservoir loading/unloading. Thus in the Indian context, the Himalaya form the most probable region of large magnitude earthquakes (plate boundary type) in addition to Kutch as one of the intra-plate seismic zone.

Bhuvan for Rapid Disaster Response

Bhuvan provides the image and infrastructure base layer for rapid response during an earthquake.

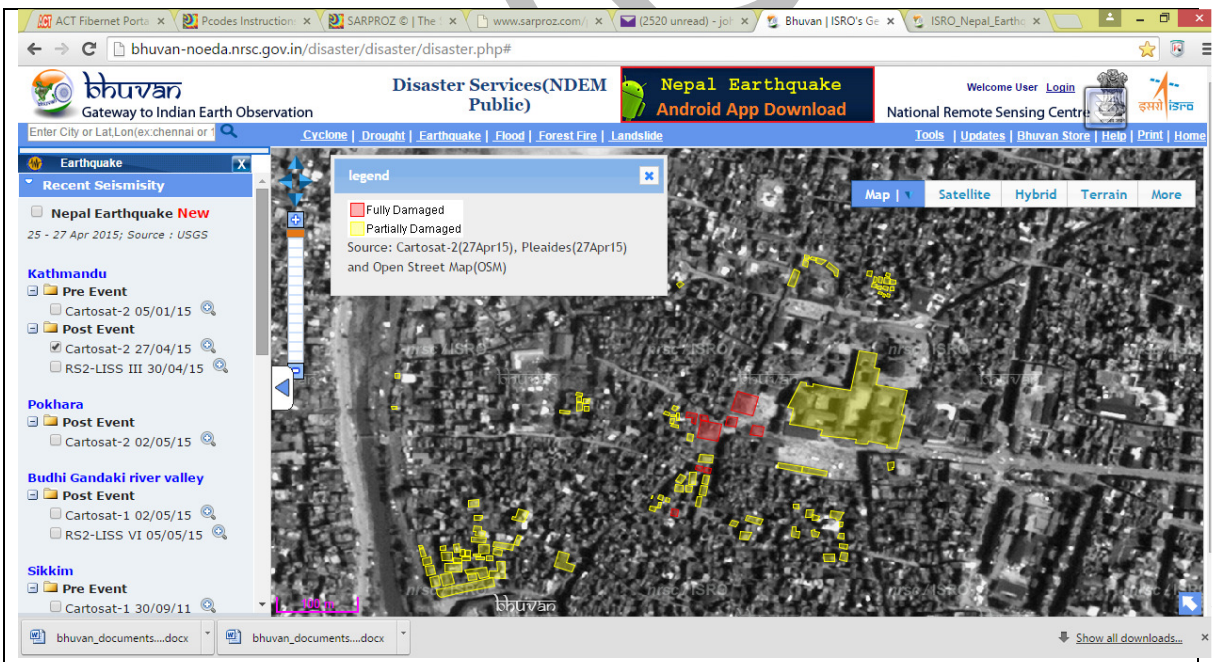


Figure 4.16:Damage assessment of Nepal earthquake

Due to the unpredictability of seismicity in time and space, the role of space support is realised post-earthquake scenario. High resolution satellite data along with geological and tectonic details of the areas around epicentre and other affected regions help to quickly

evaluate damage in terms of amount of damage to buildings, transportations networks and other infrastructure and property. These data acquired pre-and post event are immediately made available on Bhuvan with value additions on damage and tectonic/geological information. Bhuvan also serves as the platform for dissemination of inventory of landslides occurred during the earthquake. It has facility for crowd-sourcing for public to report the damage.

Rapid evaluation of the 25 April Nepal earthquake was carried out and the input were provided to international charter (Figure 4.16).

4.6 FOREST FIRE

Out of 67.5 million ha of Indian forests, about 55% of the forest cover is vulnerable to fires and may cause an economic loss of over Rs 440 crore every year apart from other ecological effects. The major causes of forest fires in India are anthropogenic, which include shifting cultivation practices, controlled burning, fire wood burning and others.

Forest fire monitoring has been taken up as part of the Disaster Management Support Programme /Decision Support center (DMSP/DSC) activities. Under DSC activities of NRSC, a comprehensive system “Indian Forest Fire Response and Assessment System (INFFRAS)” was established during 2006 to facilitate fire related operational and R&D activities.

INFFRAS was established to meet the following objectives

1. Daily near real time day-night forest fire alerts generation using MODIS data and dissemination of the alerts.

2. Fire burnt area assessment (includes both rapid and annual burnt area assessment) using Indian Remote Sensing Satellite (IRS) data sets.

With live integration of INFFRAS with Bhuvan, dissemination mechanism for the forest fire alerts has been established.

4.6.1 Near Real Time Active Fire Monitoring

The activity is carried out jointly with the Forest Survey of India..

Near real time alerts are produced using TERRA- and AQUA- MODIS satellite data received and processed at NRSC Earth Station, Shadnagar. Typically two MODIS passes are required to cover the Indian area Two, day-time and two night - time alerts are produced. Alerts are sent in a pass-wise manner. Alerts are sent to the user agency (FSI, Dehra Dun) by email and value added products is simultaneously published on the ISRO geo visualization portal, Bhuvan (Figure 4.17)

MODIS overpasses are at ~1030 hrs (TERRA) and ~1430 hrs (AQUA) and at the same times at night. The MODIS swath is 2,300 km and a single pass does not cover the entire country. Typically, two passes are required for complete coverage. The INFFRAS

production goal is to deliver near real time fire alerts within 30 minutes from LOS (Loss of Signal)

Active fires are detected using the MOD1KM and MOD03 products. A contextual detection algorithm that uses absolute thermal thresholds as well as background characterization and contextual tests is used to identify fire pixel (thermal anomaly). The output is the Level 1b MOD14 product. Processing routines for are obtained from the NASA DRL repository.

A true color image (daytime) and a thermal image (nighttime) are produced to show the coverage and cloud cover for a pass. The MOD14 product is converted to vector format (shape file) and attributes (satellite, date of pass and time) added to the shape file. Additionally a text file with fire locations is also produced. Products viz. shape file, text file and the image products are sent by email to the Forest Survey of India (FSI), Dehradun for value addition and dissemination to state forest department users.

Alerts are sent by SMS service to several forest departments. The service is provided as a no-cost basis and uses forest administration/ management layers linked with relevant mobile numbers provided by the respective state forest department. SMS alerts are sent through a gateway service provided by the state forest department. A user module for maintaining the mobile number database is used to ensure a current database.

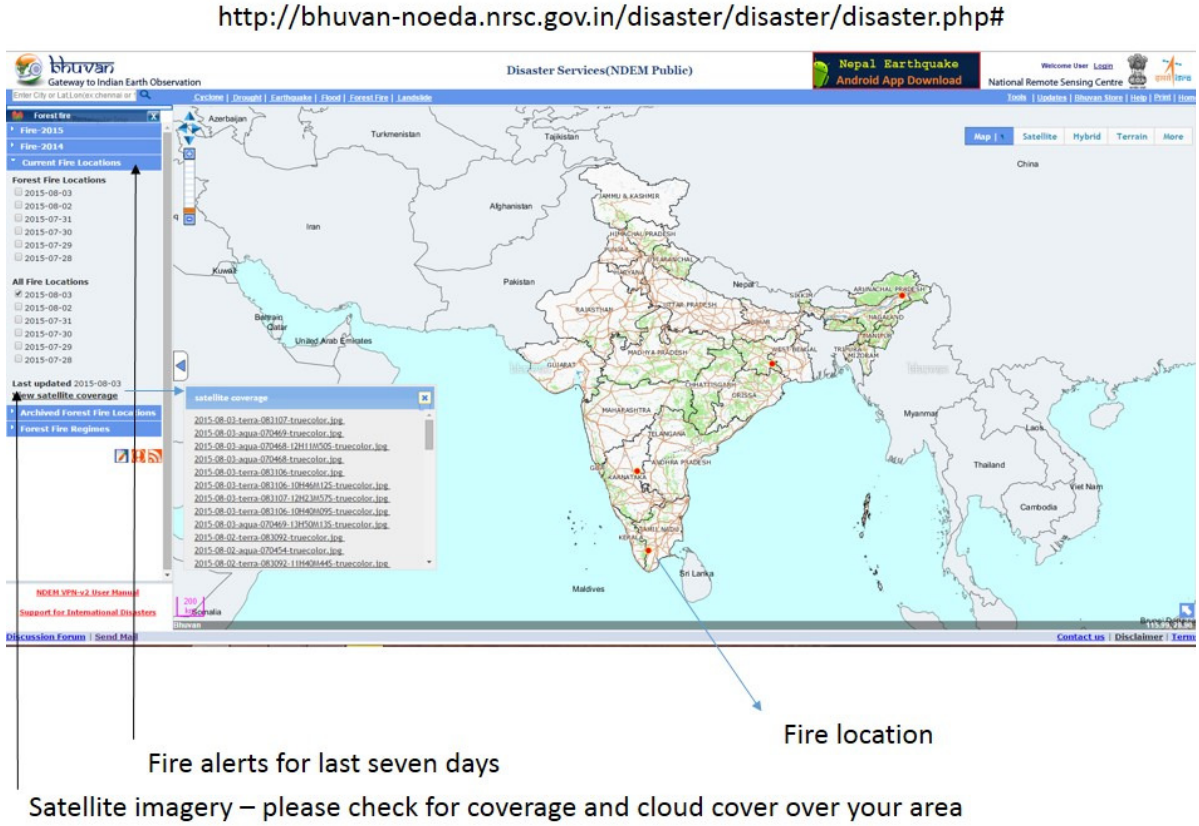


Figure 4.17: Forest fire alerts over BHUVAN

4.6.2 Rapid Burnt Area Reporting

Rapid burnt area reporting is carried out on event basis for significant fires based on user request. Burnt area assessment is carried out using IRS LISS-III and AWiFS satellite data received and processed at NRSC Earth Station, Shadnagar. IRS AWiFS has a revisit capability of five days, however because of overlap between successive days and coverage with two satellites i.e., ResourceSat 1 and 2, in practice coverage of the fire area is obtained within the revisit period as well. In exceptional events satellite data from international satellites is also used by raising a data request under the international charter. Burnt area assessment is sent within a few hours of completion of overpass to the state forest department and made available as a report on Bhuvan and also the NRSC website (Figure 4.18).

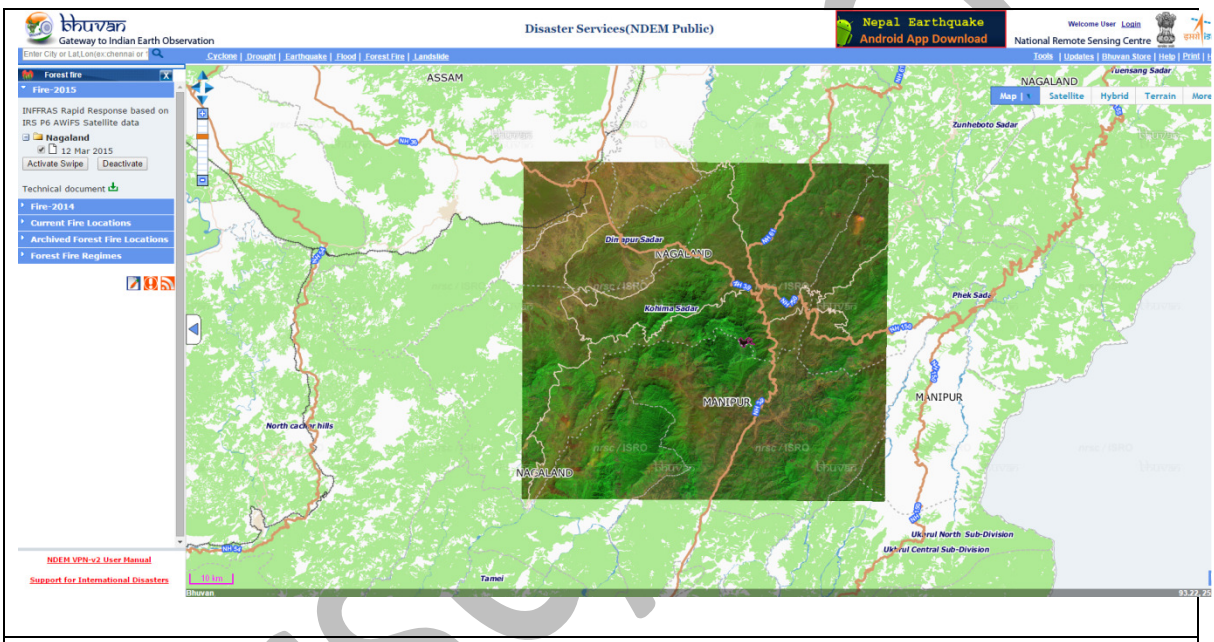


Figure 4.18: Rapid Burnt Area Assessment Reports on Bhuvan

Chapter 5

Bhuvan as platform for Government Agencies

Bhuvan provides platform to create, visualize, share, and analyze Geospatial data products and services towards Spatial Mashups. Any government agency can disseminate their data through Bhuvan platform and also host domain specific application on Bhuvan and their own websites. It helps the organizations to reduce cost, manpower and latency of creating and hosting infrastructure or own data centre. It also reduces delays in using the data as operational platform is ready for hosting. Bhuvan, acts like Cloud for other Government departments.

Thus government agencies need not maintain their own data centers and can use Bhuvan as a National platform with high availability assurance. They can share their spatial and non-spatial data with Bhuvan and use Bhuvan Platform as a service.

5.1 Guidelines for Data Sharing

For sharing the datasets certain guidelines have been set. Like data-sets to be hosted on Bhuvan should be in geographic coordinate system with WGS-84 datum. Data could be transferred via Bhuvan-ftp. If the data to be hosted needs to be updated on regular basis, the process could be automated. User requirements for the geo-processing tools along with simple visualization of datasets could be taken up as per the feasibility.

The collaborating agency need to provide No Objection Certificate (NOC) while hosting the data on Bhuvan. The ownership of the datasets provided lies with them however the data-sets once hosted on Bhuvan are irrevocable. They should also be in line with the Privacy policy and terms of mentioned in chapter 16.

5.2 Bhuvan Collaborators

Different Ministries and state governments have collaborated with Bhuvan. Some of the collaborators and the datasets provided by them are mentioned below :

Punjab Heritage & Tourism Promotion Board : Agency has collected information for Places of Tourists' Interest i.e. Hotel, Historical Places, ATM, Bus Stop etc and shared it with Bhuvan to bring out Web based GIS solution catering interests of tourists and users

Punjab Remote Sensing Centre : Detailed GIS database of Amritsar city and Ludhiana Municipal Corporation have been provided by Punjab Remote Sensing Centre to bring location based applications for users in collaboration with Bhuvan. Basic amenities information, road network, ward boundaries etc are hosted on Bhuvan reaching public for visualization.

Ludhiana Municipal Corporation : Ludhiana Municipal Corporation having rich information about its municipal area in collaboration with Punjab Remote Sensing Centre have shared it with Bhuvan to facilitate citizens to know about the wards and facilities available, various schemes executed by the government, grievances redressal system besides facilitating administrators/planners to have a one stop online planning tools towards better governance.

Karnataka Forest Department : The state government of Karnataka has shared the data from forest department with Bhuvan. Application enables users to visualize forest fires, assets, changes in forest cover, villages, water bodies, landscapes, national parks, beat boundaries etc.

Himachal Pradesh Forest Department : Himachal Pradesh Forest Department : Himachal Pradesh Forest Department has provided the administrative level

data as well as management related information for visualizing it on Bhuvan platform. Portal provides a number of features i.e. forest fire alerts to officials through SMS, up to beat level administrative boundaries, climate vulnerability, wildlife related data visualization etc.

Central Water Commission AIBP : Central Water Commission collaborated with NRSC/Bhuvan to bring out a portal which has inventory of projects carried under Phase-I, Phase-II and also tools, utilities for Satellite based online monitoring of the Phase-III projects.

India Meteorological Department (IMD) - Nowcast Data: Visualization of IMD Nowcast datasets Fog and Thunderstorm on Bhuvan through spatial mashup by provision of Bhuvan Satellite imagery and Basemap as a OGC Compliant WMS Service.

Andhra Pradesh State Housing Corporation - Andhra Pradesh state housing corporation formulate, promote and execute Housing Schemes for the benefit of people in general and particularly the Weaker Sections or persons living in Rural and Urban areas and to those who are affected or likely to be affected by natural calamities such as Cyclone and Tidal Waves. They are using Bhuvan for Geo-tagging these houses and monitor their various stages of construction.

In the later chapters we will further discuss about the different applications developed as the outcome of these collaborations. For example - Municipal GIS, Urban Growth Monitoring, Tourism WebGIS, Election portal for Andhra Pradesh, application related to water, agriculture, forestry and E-Governance.

Chapter 6
Bhuvan - A powering platform for Government

Bhuvan has rich Satellite data of 2.5 meter resolution for entire country and 1m resolution data for 300+ cities and towns along with administrative, infrastructure data. It also has rich thematic data Land Use Land Cover (1:10000, 1:50000, 1:250000), Waste land (1:50000), Geomorphology (1:50000), Urban Land Use (1:10000), Lineaments (1:50000), Land Degradation maps (1:50000), Multi-temporal Wasteland maps (1:50000), Groundwater maps (1:50000), multi-scale biodiversity maps and so one. Apart from this, Bhuvan also provides rich diverse data like Hydrological Boundaries, Climate and Environment, Disaster, Forestry, Tourism, Water, Urban, Agriculture etc. The standards provided by Open Geospatial Consortium (OGC) are implemented to provide these datasets as a service to users towards interoperability. These rich data sets can be integrated with any other OGC compliant web services. Thus Bhuvan doesn't limited to specific GIS platforms and increases of different user from various GIS platform to visualize, share and overlay maps and geospatial feature data through interoperability that implement the OGC standard. All the datasets are published with proper security mechanism for high availability and also Bhuvan applications are certified as per CERT-In guidelines.

An important dimension of the web services is the possibility of providing anytime-anywhere services and integrating with any technologies. Bhuvan datasets/web services along with respective government agencies datasets pave path for better understanding, perceive the things better and helps in decision making. Government agencies can take the help of Bhuvan web services and leverage the complete potential of remote sensing and geographical information system technologies. Spatial data has an added advantage along with the attribute information users can get to know the spatial distribution and spatial extent. Visualizing information/data rather than the textual information, visualizing on map will have a bigger impact in making the content understand, visualize and perceive the things better and helps in decision making. Bhuvan also planning to provide the Geocoding and Land Use Land Cover statistics Application Programming Interface (API).Thus Bhuvan provides platform for providing data as a service.

The following are few web portals using Bhuvan web services

1. Andhra Pradesh State Housing Corporation(APSHCL)- APSHCL using Bhuvan web services for integrating data collected through Mobile app into their Management Information System(MIS)
2. Sarva Shiksha Abhiyan- Andhra Pradesh(AP):AP SarvaShikshaAbhiyan using Bhuvan satellite WMS service to show all the school information

3. National Spatial Data Infra Structure(NSDI): NSDI using BhuvanSatellite, Base Map WMS services to show case Survery of India OSM(Open Series Map) Topo Sheets

4. Bombay Natural History Society (BNHS): BNHS using Bhuvan Satellite WMS service for important Bird Area Mapping

5. Surveykshan Portal of Survey of India: Surveykshanportal using Bhuvan Satellite WMS services for visualizing admin boundaries.

6. India Meteorological Department (IMD): Visualization of IMD Nowcast datasets Fog ,Thunderstorm and Heatwave prediction on Bhuvan through spatial mashup by provision of Bhuvan Satellite imagery and Basemap as a OGC Compliant WMS Service.

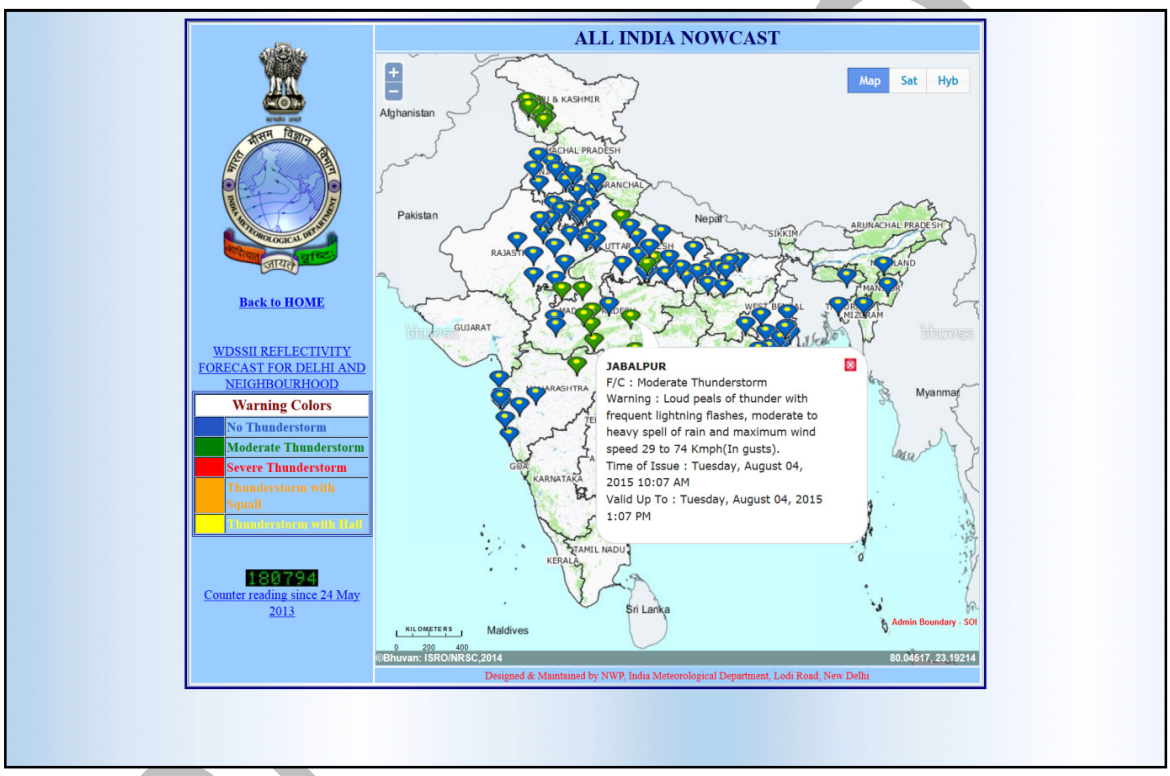


Figure 6.1: Nowcast information on Bhuvan base Map in IMD portal

Chapter 7
Bhuvan as a collaboration platform

1. Introduction:

Remote Sensing and Geospatial technologies have great potential to bring about significant enhancements in efficiency and management of many traditional processes and workflows. Government agencies can take the help of Remote Sensing and GIS to leverage the complete potential of these technologies. Spatial data has an added advantage along with the attribute information that users can get to know, especially the spatial distribution and spatial extent. Most of the Government functions use textual and tabular content, but there is a significant difference in the presentation of data and information in geospatial form.The technologies in the form of GIS and remote sensing products will have a better impact in presentation, analysis and decision making.

Bhuvan along with visualization, analysis capabilities and data services has enabled diversified its applications and services including disaster support, crowdsourcing and mashup applications in collaboration with State, Central Government agencies and other departments / ministries with *G-Governance* applications. Bhuvan with its proven applications and platform has enhanced its reach on user centric application through collaborative approach. Bhuvan provides platform to create, visualize, share, and analyze Geospatial data products and services towards Spatial Mashups. Bhuvan with its strong base of thematic data from NRSC/ISRO will enhance the spatial data and information provided by the agencies in bringing out enriched features and information to the users.

2. Applications:

To support the decision making, monitoring and evaluation various domain specific applications are built in collaboration with partner organizations and ministries. Bhuvan has initiated many major applications with various ministries. For example, urban master plan formulation for Ministry of Urban through Bhuvan-NUIS portal, monitoring and evaluation portal Bhuvan-IWMP under the flagship program on Integrated Watershed Management Program (IWMP) etc. Application catering through Bhuvan supporting various Government agencies and Ministries can be classified as:

a. Planning and Development:

Under the National Urban Information System (NUIS) projects detailed GIS database is being created for 152 towns in the country. The database would be useful for Master Plan / Development Plan preparation, Planning and Monitoring.Bhuvan-NUIS application is

developed for Master plan preparation using the Bhuvan Services and QGIS, it is rich open source GIS software. Customized plugin is developed under open source GIS software, QGIS, for authentication and consuming the services from the Bhuvan.QGIS has all the tools for spatial data creation and satellite Imagery, NUIS data, thematic data are provisioned through Bhuvan helping in master plan preparation. Web based Application with hierarchical logins provisioned from Town Users, Creators, to National level Administrations for spatial data upload, approving and status intimations.

Municipal GIS is an urban application where complete information from ward to house level is provided. Users can search by ward, locality, house number and proximity analysis is also provisioned. These applications can be of common user interest to know more about his locality and nearby facilities. This is available for Ludhiana as of now and can be extended to other Cities.

Characterization and Monitoring of the urban growth patterns using Multi temporal and multi spectral satellite data. Urban sprawl refers to the extent of urbanization, which is a global phenomenon mainly driven by population growth and large scale migration.

- Bridging Bhuvan and QGIS for applications with requirement of spatial data creation
- Search by Ward, Locality, House number
- Proximity Analysis
- Time series visualization of Urban Growth patterns.

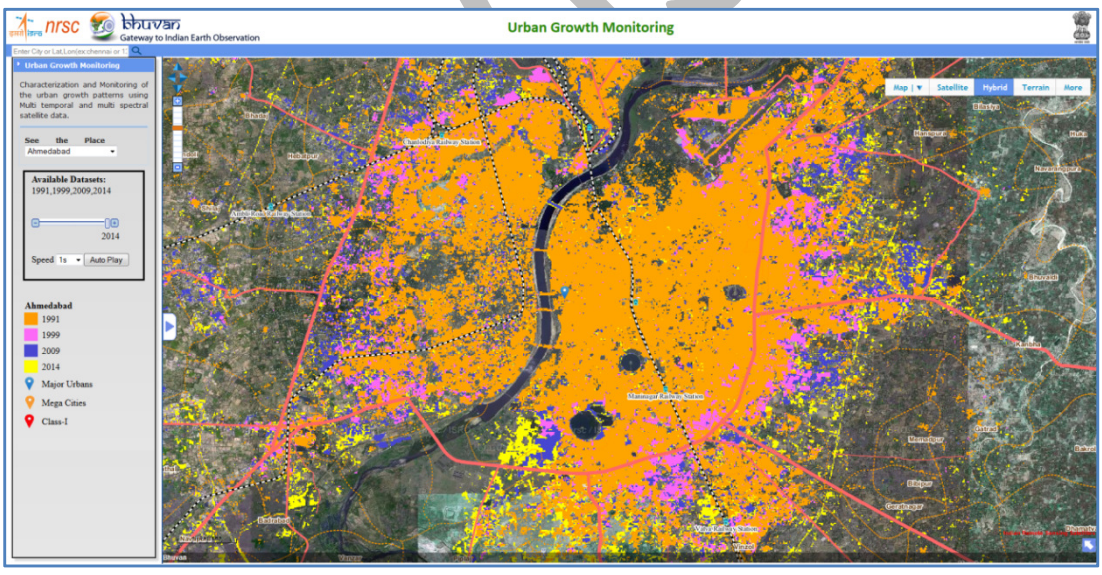


Figure 7.1: Urban Growth Monitoring with Time series visualization

b. Monitoring & Evaluation:

Bhuvan has applications for monitoring and evaluation in the Rural, Irrigation Forestry sectors etc. Addressing the requirements of these applications customized tools and utilities are built specific to project. For Integrated Watershed Management Project (IWMP) ofRural development ministry, specific online applications for monitoring and

evaluation with tools for preparing Action plan, provide online data through web interface, Android apps for field data collection etc have been developed and deployed.

Online monitoring of major Irrigation projects is facilitated with specific customised application, using the latest high resolution satellite imagery and tools provisioned for Central Water Commission (CWC) users for digitization of Canal Networks, Structures, Project boundary, providing field data, physical & financial progress data helps in online monitoring of Irrigation networks.

Similarly, State Forest Departments of Himachal pradesh and Karnataka use Bhuvan portal for with multi temporal datasets for change detection.

To support these applications following major components provisioned are:

- High Resolution Satellite data and thematic datasets.
- Multi-temporal datasets for change detection and progress monitoring
- Online tools for digitization for Canal networks, Structures, Project boundaries
- Provisioning of data through Web and Field through customized Android applications.
- Role based access for the system.
- Reporting and Summary generation modules.

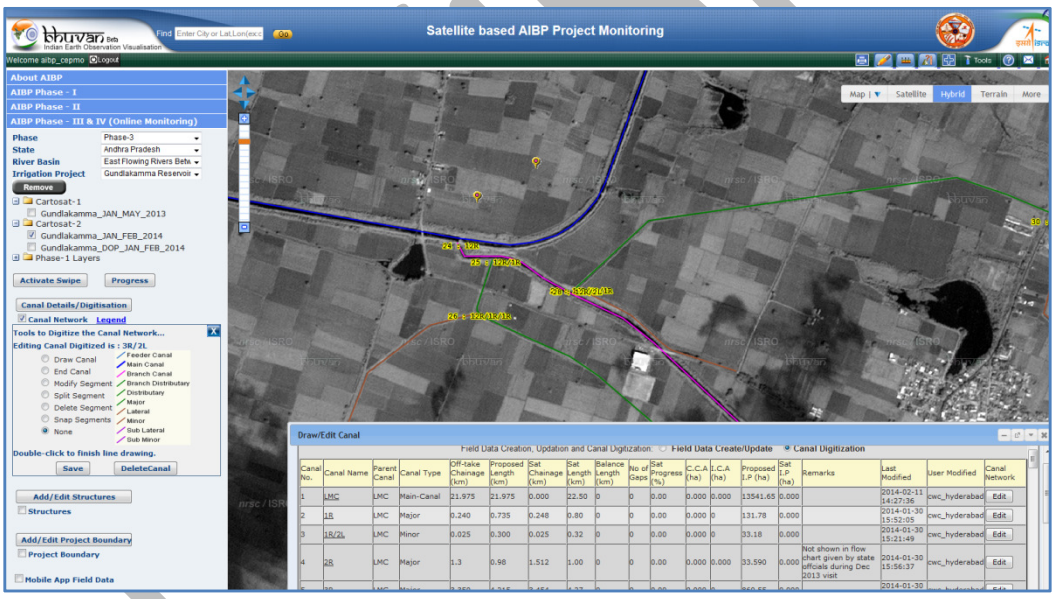


Figure 7.2: Sat-AIBP for online monitoring of Irrigation Projects with latest Satellite data

c. Asset Mapping and Inventory Creations

Bhuvan -APSHCL portal has been very popular for geo-tagging of houses constructed by the Andhra Pradesh State Housing Corporation wherein more than 3 million houses are geo-tagged in 3 months duration. Visualization of 33 lakhs of houses spatially, efficiently handling the 66 Lakhs of photos (~2TB). Geo-tagging of houses through Mobile apk with customized attributes and spatial visualization of Geo-tagged houses.

Analysis & Reports for collected and moderated Points, Moderation provision to have visual verification for the geotagged houses for authorized logins and spatial visualization of accepted & rejected points.

Customized Android Apps are provisioned for Asset mapping and Field data collection for many applications. More than 60 Android Applications addressing the project requirements with customized attributes were released. These can be used for mapping, reporting and decision making. More than 3.5 million points had been geotagged across various applications. Based on the project requirements the inventory created through field data can be visualized, moderated, summary reports can be generated.

- More than 60 Android Applications with customized attributes
- Assets collected are more than 3.5 million
- Integrated and dedicated viewers for visualizing Field data collected.
- Robust moderation mechanism for authentic users.
- Summary and Reporting mechanism for the Assets mapped

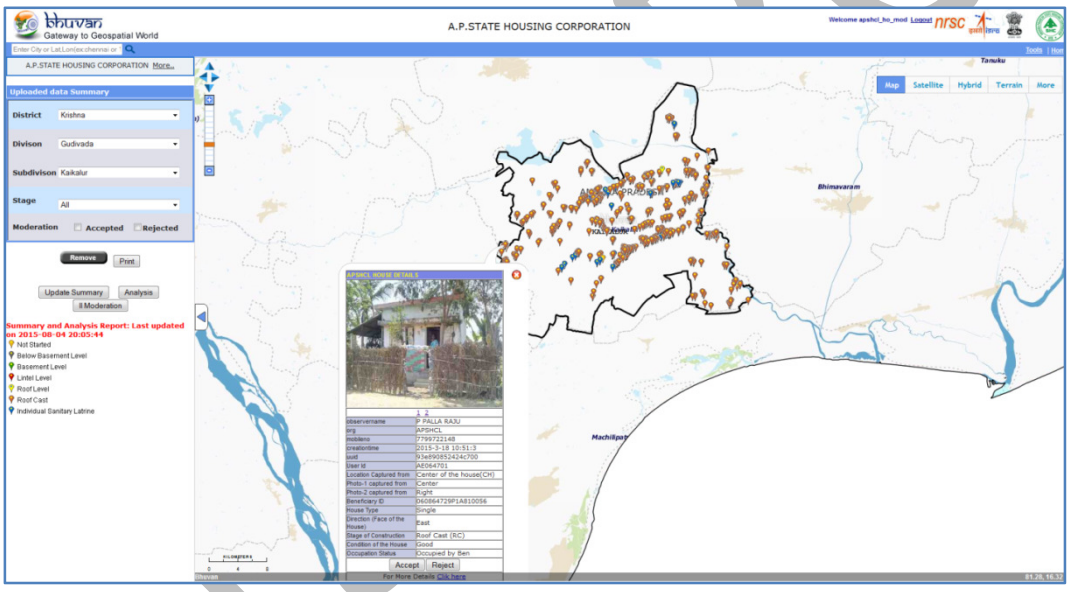


Figure 7.3: APSHCL application with Geotagged Houses

d. Decision Making

Bhuvan successfully provided support for planning and monitoring of polling in Andhra Pradesh during General Elections 2014 through geospatial technology based solutions for effectively conducting the various stages of 2014 AP general elections process. Basic Minimum Facilities, Vehicle Tracking, Incidence reporting modules were facilitated. Through this module various parameter of polling stations 68825 out of 69014 collected within 2 weeks' time. Vehicle Tracking, mobile based tracking applications to track the movements of polling officials during elections. Basic Minimum Facilities module to facilitate collecting 17 parameters of each Polling station by provisioning of Web Interface/Mobile App towards smooth conducting of Polling. Analysis & Reports module to generate detailed reports State/District/Assembly wise BMF statistics on updates and Spatial View along with option to download as Excel. These facilities assisted officials in decision making and report generations.

- Delivery of solutions with in weeks' time.
- Collection of 68825 polling station information in 2 weeks' time.
- Basic Minimum Features: Facility to collect parameters by Web Interface/Mobile App.
- Incident Reporting, Based on the SMS from public, track and update the nearest squad.
- Vehicle Tracking, Live mobile tracking of registered vehicles.

Visualize the track points, messages and photos received for a selected track.160 vehicles are active on Election Day (7th May 2014) out of 213 vehicles registered from 62 Assembly sectoral officers.

e. Reporting & Advisory

In Agriculture sector, Pest/Disease Surveillance application, a collaborative portal on Bhuvan, allows users to share, access and upload the pests and disease related information in a near real time basis. This application has provision to visualize all the Pests/Disease reported across the country along with basic information. Major component provisioned in this application is uploading of Pest/Disease information along with photograph.

'Add Content' utility is also used for reporting the damage assessment details in Mapping the Neighborhood in Uttarakhand (MANU) application, exclusive mapper for reporting earthquake hit damage details during Nepal Earthquake. Customized Android apps for reporting during Hudhud and Nepal Earthquake incidents.

- Enhanced selection mechanism for filtering State/District/Village wise incidents.
- Selection based on Crop, Pest, Severity etc.
- Upload of pest/disease data along with photograph.
- Customized Mapper for damage reporting and assessment.

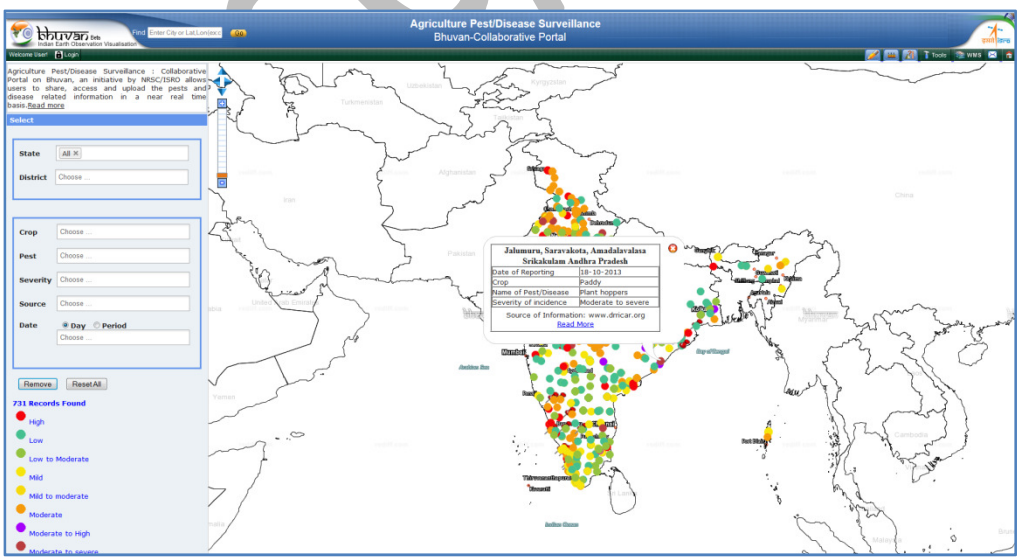


Figure 7.4: Pest/Disease Surveillance application showcasing reported incidents and severity

f. Resource Management:

Bhuvan also extending its support in Natural Resources Management through Open Data Archive and Thematic Services, from these portals user can freely download or consume

as a web services. Such examples are LULC and Vegetation Fraction. LULC 250K data is available through Thematic Services. National level LULC mapping on 1:250,000 scale using multi-temporal AWiFSdatasets to provide on annual basis, net sown area for different cropping seasonsand integrated LULC map at the end of each year. These datasets has brought out the temporally explicit spatialdistribution of the net sown area on national basis, besides creating spatial databases onother important LULC classes like fallows, plantations, forest, water etc.

Vegetation fraction (VF) is defined as the percentage or fraction of occupation of vegetationcanopy in a given ground area in vertical projection. It is popularly treated as a comprehensivequantitative index in forest management and vegetation communities to monitor respective landcover conditions.

- LULC 250K data available for 10 cycle starting from 2004-05
- LULC 250K can be consumed as WMS/WMTS service and can download through FTP
- Vegetation Fraction is available for download, every fortnight products are available.

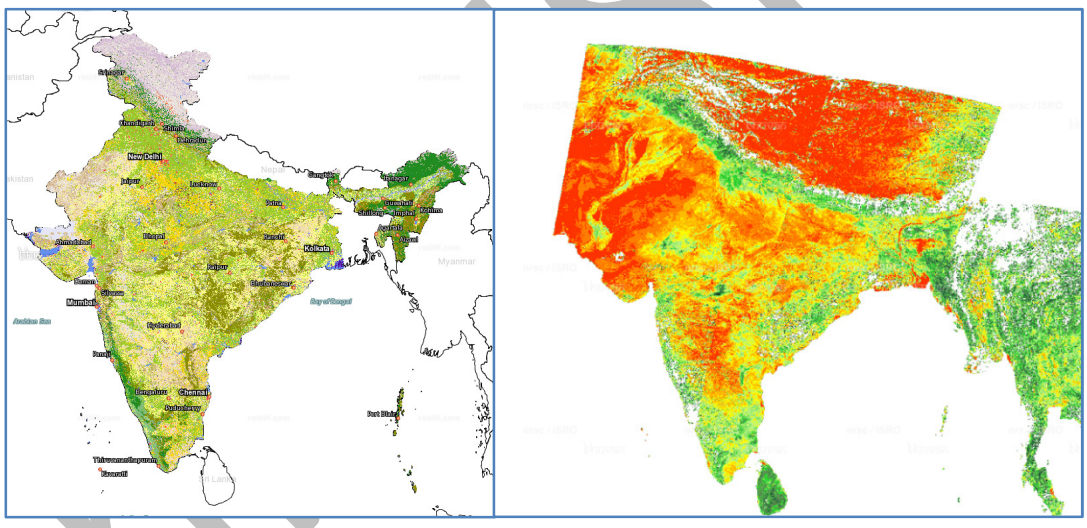


Figure 7.5: LULC 250K from Thematic Services and Vegetation Fraction from Open Data Archive

Apart from the Planning, Monitoring, decision making applications, specific Applications are also built on Bhuvan in collaboration with State/Central Government Organizations and Ministries. And these applications will act as a platform to host the data shared by concerned departments and user centric to outreach the data by making best use of it. Such examples are Punjab Tourism, Forestry, Archeology, School Bhuvan etc.

Forestry Applications, joint effort of Forestry Departments and ISRO towards developing a geospatial query system resulting an enterprise image server (EIS) working as a virtual GIS laboratory providing organization wide access to spatial data including high resolution imagery and GIS tools with an emphasis on analysis, processing of spatial

data. Know Your Forest, Active Fire Mapper, Asset Management, Change Monitoring, Greening India, Wild Life layers visualization.

Plantation application for visualizing inventory of natural rubber and identifying potential wastelands for expanding area under rubber plantations

Tourism Web GIS through Bhuvan facilitates the users to select the city/tourism places of their interest and find the places of interest, search nearby places along with routing. Amritsar Tourism portal developed for Punjab Tourism Board with Spatial Mashup of Satellite and Geo-tagged tourism facilities. Vijayawada Tourism is one example of building up of application with the help of Crowdsourcing.

Archeological sites in India through Bhuvan facilitate the users to select any sites of their interest and find the places of interest, search nearby places.

Ground Water Prospects Information System, portal containing seamless state-wise mosaics of groundwater prospect maps for visualization. Presently it is populated with ground water prospects information for 24 states.

School Bhuvan, an e-learning portal for the students. A portal providing map based learning to bring awareness among the students about country's natural resources, environment and their role in sustainable development. It is an initiative of Bhuvan - NRSC/ISRO based on NCERT syllabus for visualizing of maps for the Class 9^{th}, 10^{th} students based on NCERT syllabus along with satellite data and administrative layers.

Smart Tracking, one of the applications that any organization can take help of is Vehicle Tracking, ‘Smart Tracking’ – Mobile based (Android app) individual/vehicle tracking application which is open for the common man. A user can even track his own vehicle, or vehicles registered under his own group created.

Chapter 8
Location Intelligence

Geospatial technologies have great potential to bring about significant enhancements in efficiency and management of many traditional processes and workflows. The value contribution of geospatial technologies goes beyond and higher than the current use of normal IT tools because of incorporation of rich geospatial data sets and its positional context i.e Location. GPS technology is extensively utilised in finding out a location and the prevalence of economical GPS enabled smart phone devices makes it possible to implement such location based services.

NRSC/ISRO brings out Customized Android apps enable effective use of Smartphones for collecting the location information towards decision making for planners/administrators besides collation of general point of interest data. Bhuvan is used as geoplatform to collate all these mobile collected location data and bring out various analytical tools in the web environment towards integrated geospatial information management thus evolving enterprise GIS. Vehicle/mobile tracking during some of the ISRO's internal applications in 2012 with the combination of Smartphone at client side and Bhuvan as platform to visualise store and analyse with other data sets in the common framework, field data collection for pest surveillance through web interface and crop monitoring through mobile applications have paved the way to realise massive data collection and effective data handling towards cloud from the crowd.

There are more than 60 Android Apps developed as on date for various needs of ministries starting from Crop Monitoring for Ministry of Agriculture to latest Clean Ganga Programme besides NRSC internal use for data collection, counting around 3.8 million points and 7.5 million photos. Intelligence built in apps such as Incident reporting and Vehicle tracking during General Election 2014 and AP State House Corporation monitoring applications are specific for certain tasks besides general Point of interest data collection. These general point of interest (POI) data will help the users to identify the location based on geocoding and some time using reverse geocoding. Proximity analysis built on top these POI data will aid the users to get options before narrow down their specific choice. Thus, these rich POIs play vital role in Location Based Services (LBS). On other side, scientific datasets like Pest or Crop related filed data aid the experts to identify not only the specific problem, also pattern, migration, trend etc. It will also enable the associated queries like crop name, crop type etc from the pest database as already the relations are established.

To represent the usefulness of this location intelligence, two case studies are presented 1. General Election 2014 and 2. APSHCL apps where the data is collected by smartphones and analysis are carried out using Web Interface.

1. General Election – 2014

Implementation of location based WebGIS applications on Bhuvan Geoportal of ISRO for partly supporting planning of General Elections 2014 in the state of Andhra Pradesh and

which is further scalable to cater to entire Country is explained. The rapid development is carried out under the guidance of Election Commission of India and Chief Electoral Officer, Andhra Pradesh and used during General Elections to Lok Sabha and State Legislative Assemblies of Andhra Pradesh.

The applications developed by NRSC for Election Commission of India are:

a. Basic Minimum Facilities

   The district-wise mobile apps are developed with last elections polling station info. User can download the android executable file (*.apk file) from respective district-wise login in Bhuvan website in smart phone. This app can be downloaded by clicking on BMF button. The authentication is required through Election - Commission Sign-in with user name / password.

   On other hand, browser based application has user interface look-a-like Mobile app interface to avoid confusion having mobile compatibility also which facilitates to collect polling station parameters – 17 parameters with user authentication. Further allow user to upload them into database with inspecting officer details to manage the facilities further as per the requirements.

   Both mobile and browser based applications are complementing each other to facilitate the EC officials to collect BMF more efficiently like upload from field and central unit.

b. Analysis and Reports

   This module allows the analysis and reporting of the collected Basic minimum facilities information. Based on the user login corresponding polling stations information is available. Central users can analyze all the polling stations information. The module allows users to spatially visualize the polling stations updation status. They can also view the status based on the availability or non-availability of all or any specific facility. Also there is a provision to download the summary reports, detailed report(Polling station details) like district/assembly wise updated/Not updated, facility availability/Not Availability list in the excel format.

   Using these modules, Administrators could collect the data (Figure 1) within 2 weeks of time in contrast to tradition data collection and used successfully for planning on pre-poll timing.

c. Smart Tracking of vehicles

   An android based mobile application is developed to track the vehicle of Sectoral officers on polling day. A browser based application is developed to download the mobile application into the mobile. Users have to have to activate the mobile append wait for initialisation, then the mobile with SmartLBS app is tracked by SmartLBS server.

   On Server side, each vehicle/mobile is activated automatically by linking them to the respective Assembly/Districts DB. If there is no match, vehicle will be treated as miscellaneous and go for further verification by the central unit. The following screen shot (Figure 2) shows results of vehicles tracked on browser based server application.

d. Incident Reporting

The incidents can be reported through an android based mobile application or through SMS. There are two reporting method using android application (a) by means of internet based upload method and (b) SMS based reporting. On successful submission of incident to the designated number, a unique 5 digit Incident ID will be generated and sent to the users for reference. The incident alerts will be delivered to the respective designated officials as SMS alerts on their cell phones.

The reported incidences are made available through a web interface as shown below. The application is accessible only to authentic users. And based on the hierarchy level of the user, the incidents are visible on the map. Users can also query incidences based on their type and date. This location can also be correlated with route officers vehicle for any further actions.

Summary

- Election commission AP has utilised the BMF module to collect various parameter of 69014 polling station and recorded 99.7 % (68825) completeness within 2 weeks time.
- Report module with Inspecting officer details facilitated them to identify the gaps and mobilise them during the election on 30 Apr 2014 and 09 May 2014.
- 160 vehicles were active out of 213 vehicles registered from 62 Assembly on 09 May 2014(Phase II).
- Role Based Access – HQ, District (23 Nos), Assembly (294 Nos) login

2. AP State Housing Corporation Limited

Mobile based data collection application and browser based moderation and reporting modules are developed to address following objectives of APSHCL.

- To formulate, promote and execute Housing Schemes for the benefit of people in general and particularly the Weaker Sections or persons living in Rural and Urban areas and to those who are affected or likely to be affected by natural calamities such as Cyclone and Tidal Waves.
- To undertake or regulate construction of houses and create or cause to be created other infrastructural facilities for the said housing scheme.

The applications developed by NRSC for APSHCL are:

a. Data collection
Mobile apps are developed to collect the beneficiary house stages out of 7 housing stage from 'not started level to Individual Sanitary level' with condition, occupancy status, direction, type, beneficiary id and supplemented with two photographs with photo captured location and location captured locations. This app can be downloaded from bhuvan site. The authentication is required through APSHCL Sign-in with user name / password. There were around 1100 Assistant Engineers / Work Inspectors are there in the ground with the target of 40 Lakhs

houses from 13 Districts. App is also built with intelligent if the location accuracy of GPS is less than 10 m, point will be rejected by default by server.

b. Moderation and Reporting
   Moderation is enabled for Deputy Executive Engineers (173 log ins) through bhuvan web interface. This I level moderation is carried out primarily by checking the photo and accurate entry of beneficiary id. District, Division, Sub-division level reports generated through 'report' module enables administrator to monitor the daily progress of the data collection and moderation status to streamline the activity towards accomplish the massive task.

c. II Moderation
   Level II moderation enabled for Executive Engineers facilitate them to identify the duplicates of the entry with in 10 m radius and further field verification. Print module available in this facilitates them for taking a print with satellite data and large scale infrastructure map to go for field verification.

Summary

- As on date, 36 Lakhs houses are geo-tagged and mmoderated 31 Lakhs against the target of 41 lakhs.
- Report module for PD, EE and DEE facilities them to monitor the progress of the data collection and moderation process to achieve the target.
- Role Based Access – HQ, District (13 Nos), Divison (43 Nos),Subdivison(179 Nos) login"

Chapter 9

Bhuvan EKTA - The Mapping tool for all

Bhuvan EKTA (Embedding Knowledge with Technology and Association) is a universal Mapper. It is a web based map data editor programmed with latest dynamic web environment and libraries which combines powerful visualization components and data-driven approach to respond to user events. It provides interactive and user-friendly tools for adding, modifying and updating points, lines and polygons with data versioning. This editor with open source libraries backend provides a robust system for map making process/ data collection.

The technological backend used for Bhuvan Mapper is very strong, generalized and extensible. The flexible design and strong data structure are key strengths which provide handle on each node (user digitized) and also to maintain the history / versions. In practical scenario of crowd sourcing, activity mapping and asset mapping, the versioning is a key feature. With this, any feature changes are recorded with time stamp and can be queried.

Flexible Open APIs facilitates users for quick usage and implementation. The hierarchy of assets and the attributes are customizable externally and can adapt to different projects. It also allows customisation outside the framework like attaching photo options as a part of review process.

The following applications are realized and in operation using Bhuvan Mapper-

- Crowd sourcing of location (Point Type) data, curvilinear feature (line) and area (Area) data along with the rich customized attributes as per features. Implemented in Generic Bhuvan Mapper for mapping cities and other areas (Fig 9.1).
- Mapping the neighbourhood of Uttarakhand to assess the damage
- Watershed development activity mapping / monitoring with hierarchical customized attributes in IWMP application
- Mapping of forest assets in Karnataka Forest application
- Mapping of reservoir / tanks with detail list of attributes for Maharashtra Water Resources Development System of MERI
- Neighbourhood mapping for School Kids
- Online Shapefile creation and downloading with user wise privileges

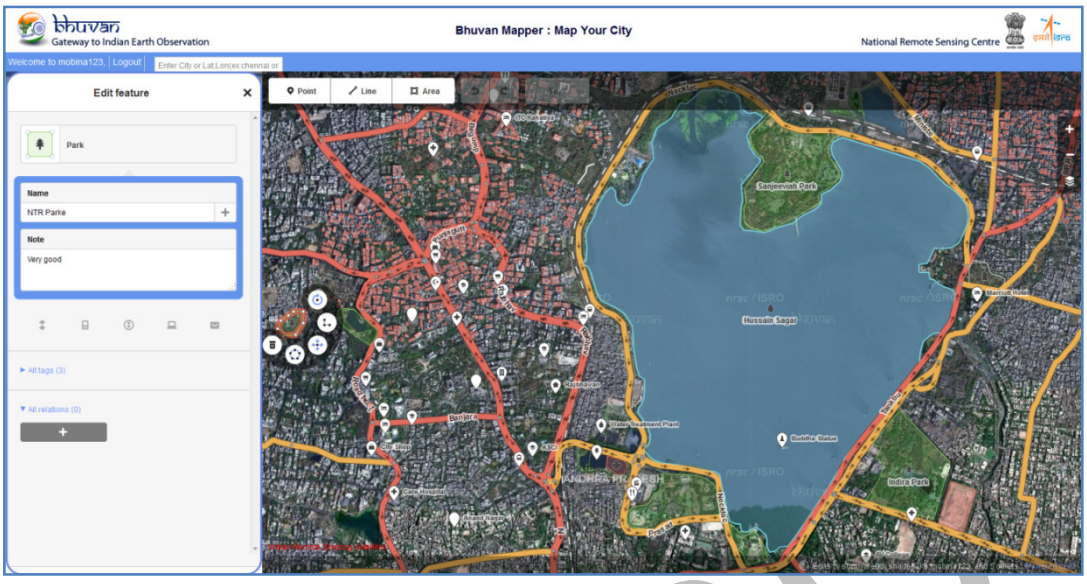


Figure 9.1: Generic Application for crowd sourcing

a. Bhuvan Mapper for IWMP

As part of IWMP Monitoring and Evaluation (M&E), Activity Planning is planned. Users are facilitiated with option to mark various private and common land activity by referring the various NR , cadastral, topography, time series satellite data and action plan available for particualr watershed as overlay layers. To acheive this, generic mapper is customised having the template as shown below (Figure 9.2).

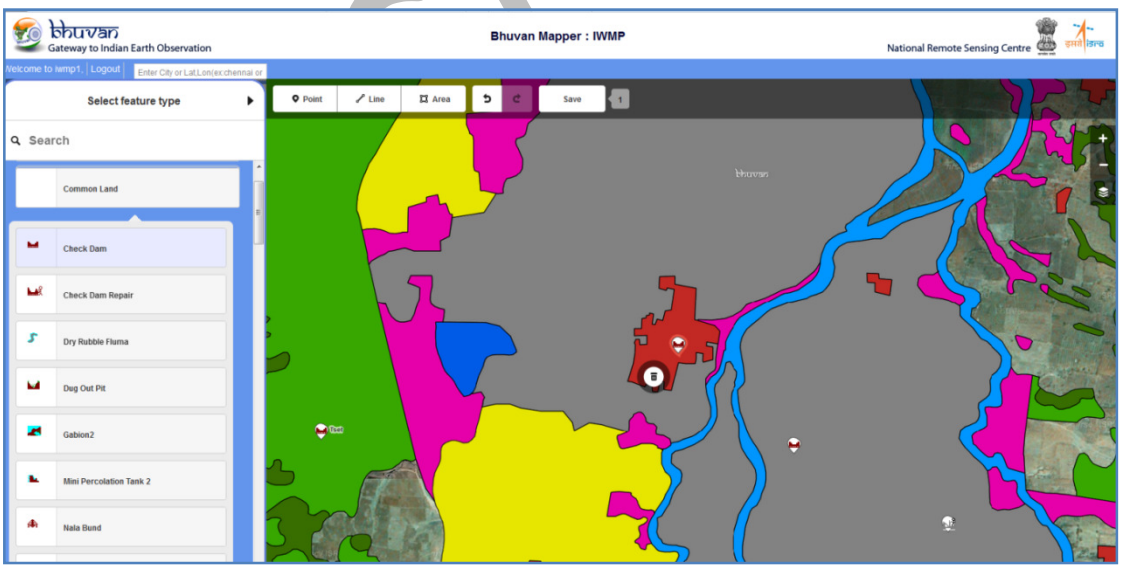


Figure 9.2: Mapping action plan(Checkdam) using the bhuvan thematic datasets

128 classes like check dam, nala bund etc (Fig. 3) having common and private lands are made for point, line and polygon mapping. Uniqueness of this application is all the 128 classes are iconised to represent the real world in intuitive way while preparing the activity planning.

b. Bhuvan Mapper for Water Resources of Maharastra

MERI (Maharstra Engineering Research Institutte) desires to have the online mapping of all reservoirs along with various reservoirs paramters like important reservior level, capacity details,Irrigation Command Area details etc. MERI users are enabled online mapping of reservoir location as shown in below figure (Figure 9.3) and online forms to uplink various reservoirs paramters (Figure 9.4 & 9.5). This module also have the facility to create dynamic reports having map, tables and graphical view like charts.

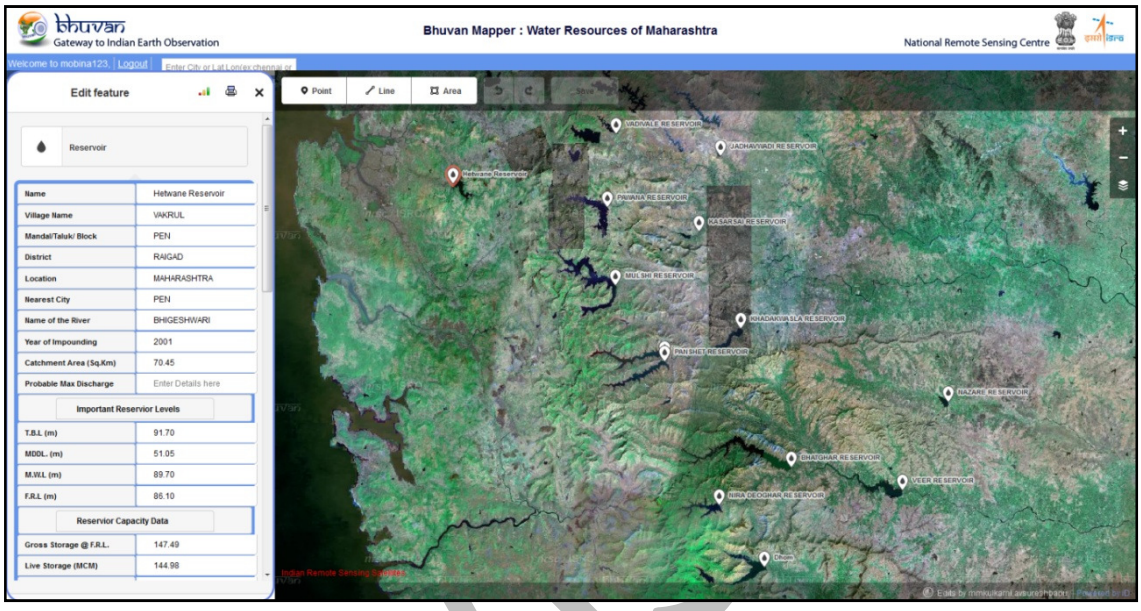


Figure 9.3: Mapping the reservior along with project specific attributes

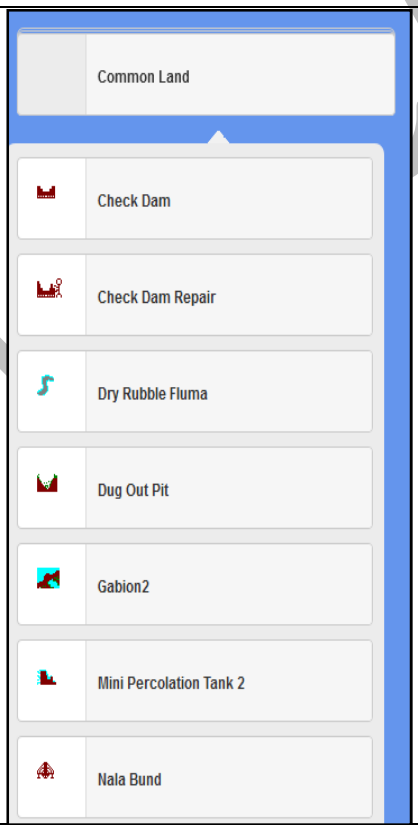


Figure. 9.4: Custmozed Categoriesof action plan

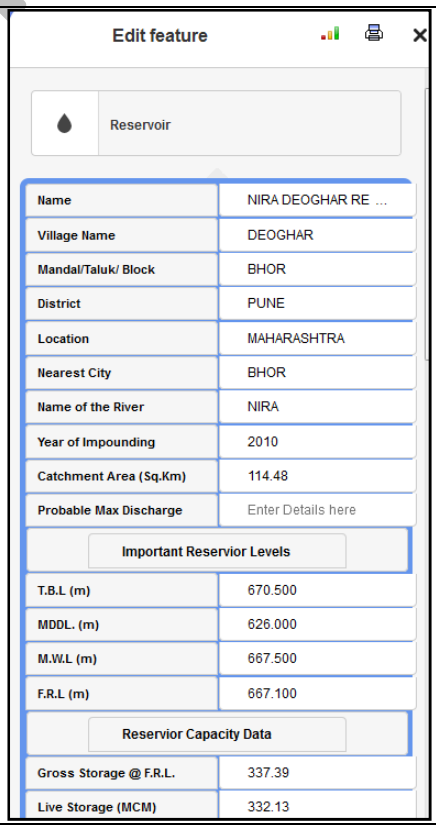


Figure 9.5: Custom attributes of reservoir

c. Create your own map : Enhanced Online Shape file creation and download

2D objects (Point/line/polygon) drawn using mapper with attributes are allowed to download as shapefile for a particular user log in by filtering with dates. Downloadable shape files (Zipped folder containing .shp, .prj, .shx, .dbf) will have all the points, line and polygon features with attributes for the selected time period. Users can create their own map like locality map or any natural resource maps, city maps using high resolution data as background.Thus the large scale mapping is leverage to the users having HRS data and intuitive mapping tool in the web GIS environment.

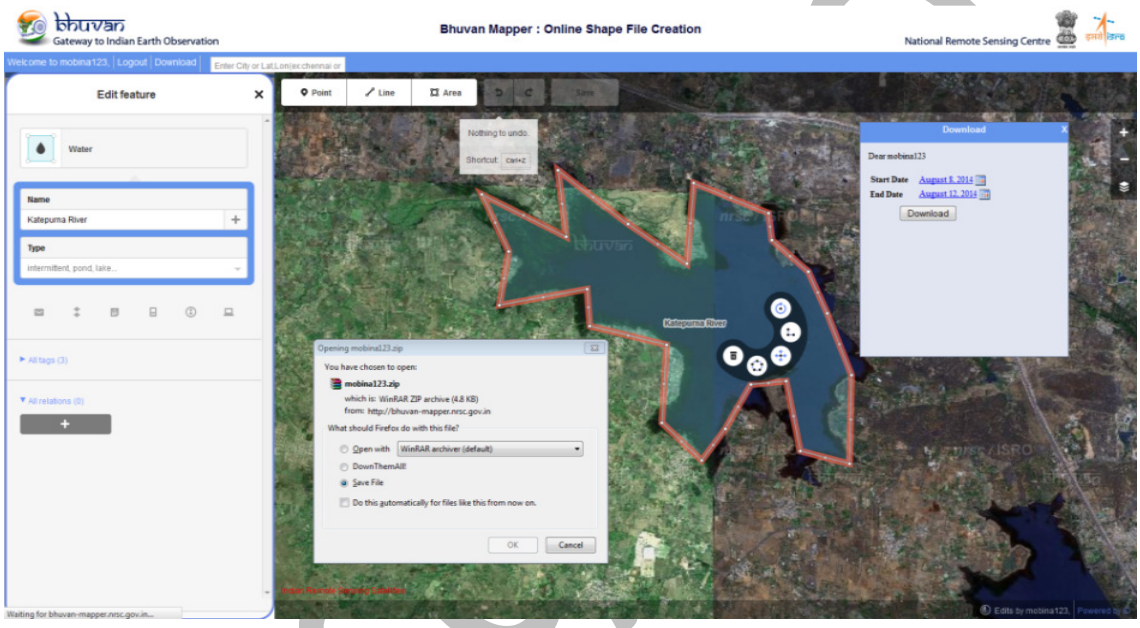


Figure 9.6 : Create of shape file for user digitized data

Chapter 10
State Portals : Platform for States to use

Bhuvan provided robust platform for state to host their geoportals. Thus giving platform as a Service. State portal consist of all the data-sets pertaining to that particular state belonging to different categories. This includes huge amount of spatial and non-spatial data shared by State Departments. Other State departments can use these state portals as a platform to host their data. Figure 10.1 shows the available state portals in Bhuvan.

Datasets are divided in different categories for each state portal. Table 10.1 shows the list of layers available for Punjab state portal.

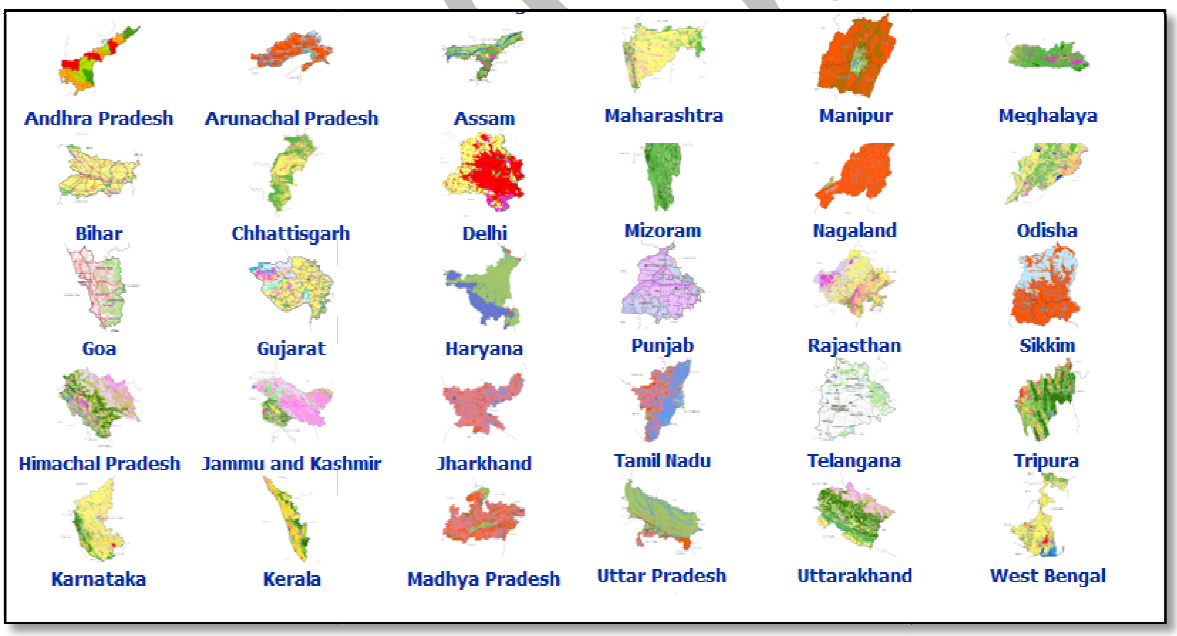


Figure 10.2 List of State Portals in Bhuvan

Table 10.1 List of layers available for Punjab state portal

Administrative layers - District, Tehsil, Block, Panchayat, Village Boundaries	**Disaster specific datasets** - Flood Inundation Maps, Seismic Zones
Agriculture - Cropland (2 cycles 1:50000), Salt Affected and Water Logged Areas, , KrishiVigyan Kendra, Horticulture Plantations , Cropping System, Area Under Crops (Cotton, Maize, Vegetables), Agro-Ecological Zones, Warehouse and Mandi, Agro-Climatic Zones	**Infrastructure layers** - Transport Network (Roads, Railway, Civil Airports), Settlements, Administrative Head Quaters (District, Tehsil, Block), Meteorology Stations, Warehouse and Mandi
Soils - Soil fertility of Moga, Amritsar, Hoshiarpur, Ludhiana, Tarn Taran(Boron, Copper, Iron, Manganese, Phosphorous, Potassium, Sampling Location,Sulphur, Zinc, Organic Carbon)	**Census** - District-wise and Village-wise Chloropleth Maps (Population Age-06, Population Literacy, Population SC) Classification based on all attributes
Election 2014 - Parliamentary Constituencies, Assembly Constituencies, KanungoCircle, PatwarCircle, Polling Stations	**Land use land cover** - Land Use Land Cover (2011-12), Land Use Land Cover (2005-06), Wastelands (2008-09), Wasteland (2005-06), Land Use Land Cover(1:100000 8 cities)
Geology & Mining - Geomorphology (2005-06), Lineament (2005-06)	**Ground water** - Ground Water Prospects, Rural Drinking Water Sources & Quality, Grey Blocks 2004, Water Level
Urban - Municipal Corporation (Ludhiana ,Bathinda), National Urban information System (6 cities), Village Mapping (13 villages)	**Irrigation** -Irrigation (Ground Water Quality for Irrigation), Canal Command Area, AIBP Funded Projects : UBDC - IX Canal Command Area (Project Boundary, Canal Network, Structures on Canal)
Forest - Forest(2005-06), Forest (2011-12)	**Tourism** - Amritsar, Fatehgarh Sahib
Health - Health Sectors, Health Institutions, Primary Health Centers	**Water Resources** - Basin, Sub Basin, Watershed, Reservoir, Wetland
Wetlands - Harike, Kanjli, Keshopur Miani, Hussainiwala, Nangal, Ropar, Dholbaha	**Police GIS** - Hoshiarpur Crime Location, Ludhiana Police, Bathinda Police

Below are few snapshots of the Punjab state portal.

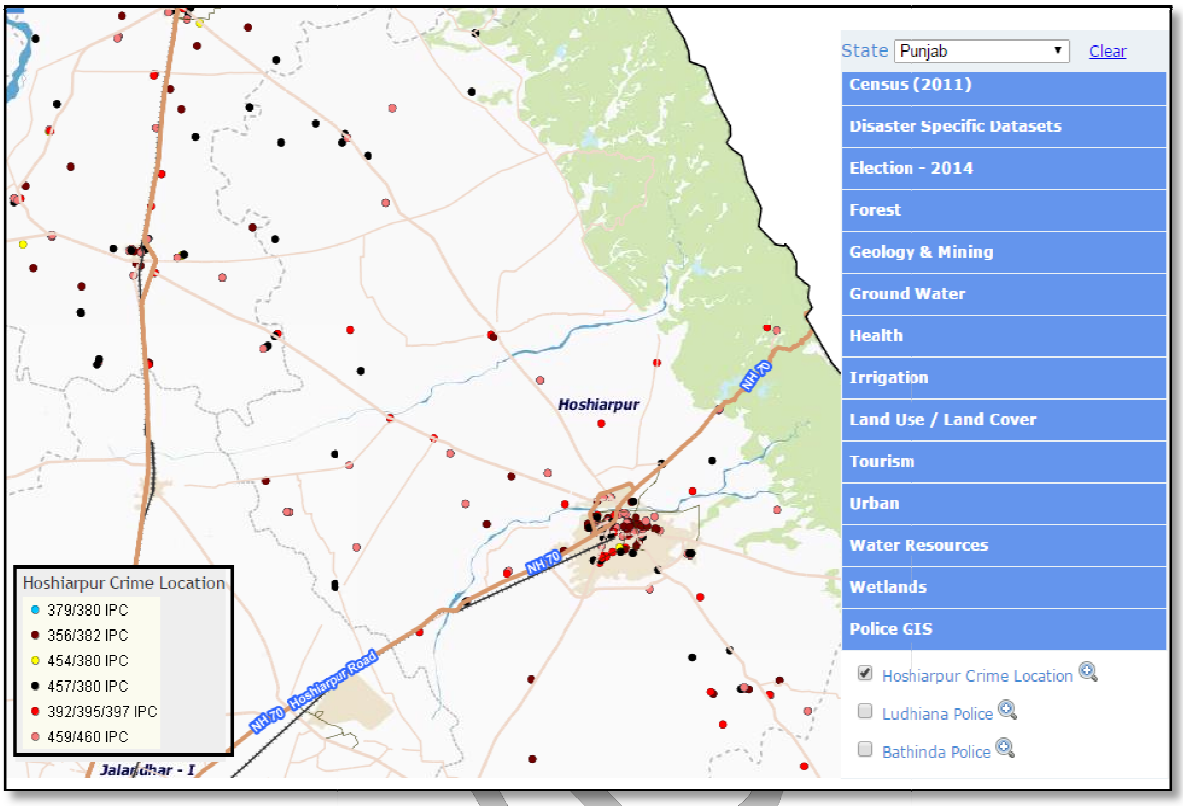


Figure 10.2Hoshiarpur Crime Location in Punjab State Portal

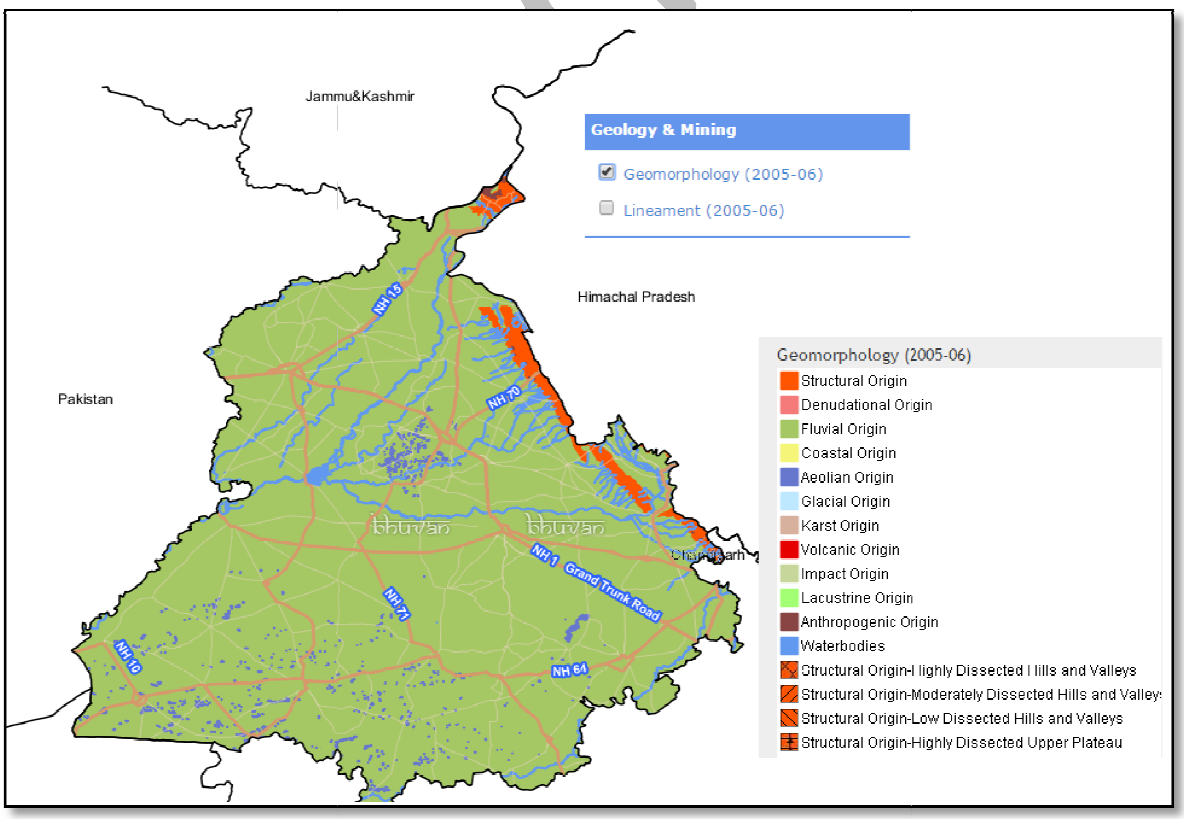


Figure 10.3 Geomorphology of Punjab State Portal

Chapter 11
G-Governance Dashboard for Ministries

Geospatial governance dashboard developed for ministries allows the users including administrators to directly reach the specific programmes / projects according to their interest in alphabetical order. This framework is also developed using responsive design to access the applications in mobile phones or tabs. There are around 64 applications developed for ministries linked to alphabets. Each alphabet is sub grouped to three category i. Central Ministries, ii. State Government and iii. Flagship Programme (Fig. 1). Hence any programme can be categories in one or more than one. This dashboard is completely driven by database to accommodate any future additions having **categories**.

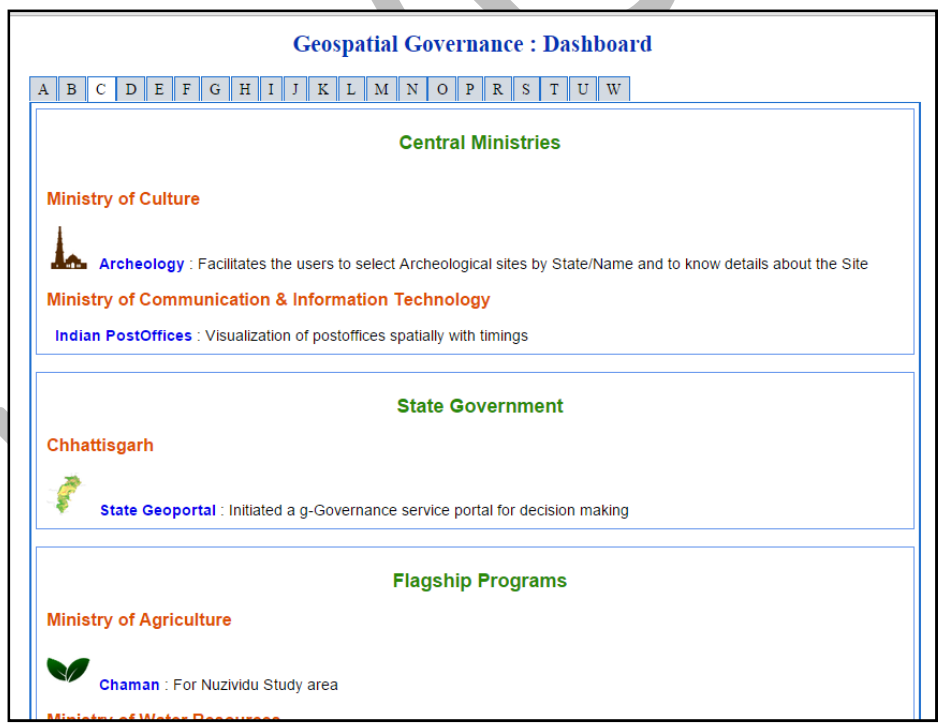


Fig.11.1 Selection of Alphabet 'C' showing three categories – central, state and flagship

Table 11.1. The list of Ministry application available under Bhuvan

Ministry / Department / State Government	Bhuvan Application	Contents
Prime Minister's Office Pragati Program	**Bhuvan-PRAGATI**	• Multi-date satellite images and Project specific GIS layers to support in assessing the progress of the project. • Ground Photographs of few projects
Ministry of Agriculture- Dept of Agriculture and Cooperation (DAC) MNCFC	Mobile apps for MNCFC- Ground Truth to facilitate Crop acreage and production estimation	
	MNCFC Drought Services	Monthly situation of drought condition, NDVI, NDWI, Soil Moisture Index, SASI, Intra-seasonal analysis and agricultural drought assessment documents.
	Chaman	**Nuzividu Mango** plantation area with Field Photographs **Horticulture** - Banana, Citrus, Grapes, Oil palm information
Dept of Agriculture Research and Education -ICAR	Land Resources Inventory	Bhuvan Thematic , Satellite and Base map services for LRI mapping and the Customized Bhuvan Plug-in for QGIS.
	Pest Surveillance	Collaborative Portal allows users to share, access and upload the pests

		and disease related information in a near real time basis
	Agriculture Plantation	Tea Garden locations for Assam and West Bengal, Agriculture plantation rubber for Tripura – Reserved Forest, Rubber Map, Potential Wasteland, Field photographs
Ministry of Culture – Archaeological Survey of India	Archeology	Archeological sites search by State or Site, User added content. Details of Hampi, Badami and Nalanda with Field photographs.
		Geospatial database of World Heritage sites for Cultural Resources Management plan – Karnataka and Dharwad
Ministry of Communication and Information Technology – Department of Posts	Post offices and their details of services	**Post Office** – Head, Sub, Branch and Delivery Office locations for Mysore with timing and various services available. **Road Layer** - Mysore.
Telecommunication	Planning for Tower Network in Un-covered Villages	**5 states –** village boundary, uncovered and proposed villages/tower **24 states –** Existng tower location
Ministry of Drinking Water supply and sanitation	Ground Water Prospects	Ground water prospects information for 29 states +UTS and detailed legend on successful login
	Solid waste disposal	SITE SUITABILITY ANALYSIS FOR SOLID WASTE DISPOSAL for Vizag city having input and out layers
	Water supply pipe line grid using geospatial technologies	Online and QGIS based desktop solution having inputs of LULC, Geomorphology and DEM and other base alyers and Groundwater prospects maps
Ministry of Earth Sciences : **1. INCOIS** **2. Indian Metrological Department**	Ocean Services	Potential Fishing Zone (PFZ) Advisories, Sea Surface Temperature, Chlorophyll. Fog details with 5 visibility range.

		Thunderstorm information with 5 different level of warning.
Ministry of Environment , Forest and climate change	Ministry Portal on Bhuvan covering requirements of different divisions	Afforestation & Eco-Development - Green India Mission (HP Proposed) – Entry point JFMC and GIM plantation, Ecology restoration and development, National Parks & Sanctuaries, Western Himalayas, LULC 25K, LULC 50K, Wasteland, Conservation & Survey – Wetland, Biosphere Reserves, Desertification – Erosion, Water logging, Mining, Forest Conservation – Asset plantation, Protection, Air Pollution, Industrial Pollution, River Conservation – Waterbodies, Ganga action plan, Hydrologic units, Cities/Built up areas (As sources of pollution)
	Centralised Resource Inventory System - CRIS	Organization of inventory of various types of centers in India and onclick detailed information about the center.
	Greening India Mission - Kerala	Identification of Landscapes in Kerala L1 Broad landscapes, L2 Operational units of sub watershed size, Biodiversity(Biological Richness Forest Fragmentation), Forest boundary, Census Village, DEM, Surface waterbody , Watershed, Urban/PeriUrban areas, District boundary
	Forest working plans including reconciliation of forest boundaries	Generation of geospatial database of forest boundaries for karnatka state
	Forest Loss Alert	Automated Detection of Forest Cover Loss using IRS AWiFS for 8 states
Ministry of Home Affairs - Disaster Management Division	• Disaster Services under ISRO DMSP program • NDEM Public	**Cyclone**(Nilofer, Hudhud and Phailin) – Track, Quick Mobile Survey, Crowd Sourced data and Inundation. **Drought** – NDVI, NDWI, Soil

		Moisture Index, SASI, Intra-seasonal analysis and agricultural drought assessment documents. **Earthquake**- Recent and historical Seismicity and damage assessment documents. **Flood –** Recent and historical flood layers, Flood annual layers, Flood hazard zones, Aggregated flood layers **Forest Fire-**Fire 2014, Current and archived Forest Fire Locations and Forest Fire regimes. **Landslide –** Early warning system (Rainfall triggered landslides), inventory, Hazard zones and documents on major events.
	Island information System	All islands location of east and west coast including Andaman Nicobar and Lakshadweep. Attributes inhabitated/habitated, Satellite imageries.
Ministry of Human Resources Development – Dept of School Education and Literacy	NCERT	**An e-learning portal and teaching aid -** Map based learning to bring awareness among the students about country's natural resources, environment and their role in sustainable development besides teaching aid for teachers.
Ministry of Law and Justice	Indian Courts	Indian Courts – High Courts and District Courts locations, Search by Court name
Ministry of Labour and Employment	Data viewer – location of the offices and features.	Android app download for data collection and hosting on Bhuvan.
Ministry of mines		Location of Mines,Landuse, Wasteland, Geomorphology, Lineament, Mines in Karnataka,
Ministry of Panchayati Raj	Bhuvan Panchayat	Satellite Imagery, Elevation data, Administrative Boundaries, Parliament and Assembly constituencies, Schemes, Thematic data – Drainage & Water bodies, LULC, Slope.

		Settlements, Infrastructure – Road, Rail, Waterways and Canal Hydrological Units – Basin, Sub-Basin, Watershed, Micro-Watershed Assets – Mapped by PRIs and Citizens
Ministry of Petroleum and Natural Gas	GAIL pipelines Monitoring	HR Satellite data for monitoring. Base layers and Bhuvan services.
Ministry of Rural Development- Dept of Land Resources	**IWMP** **<u>Thematic Services</u>** Wasteland, LULC, Geomorphology, Lineament, Erosion, Salt affected, Water logging etc.	IWMP Micro-watersheds, Special MWS (50 Districts). Enables image and map display, monitoring tools, summary statistics of all the IWMP watersheds. The application enables National, State, District and watershed level access for information and report generation. Wasteland, LULC, Geomorphology, Lineament, Erosion, Salt affected, Water logging etc.
Department of Rural Development	Rural Housing Rural Roads Rural Employment	Links to various schemes – "Pradhan Mantri Gram SadakYojana, Swarnjayanti Gram SwarozgarYojana, Indira AawasYojna, Mahatma Gandhi National Rural Employment Guarantee Scheme, National Social Assistance Programme, Council for Advancement of People's Action & Rural Technology, DRDA Administration, Provision of Urban Amenities in Rural Areas"
Ministry of Road Transport and Highways	National Toll Plaza information System	Toll information system – Public funded,BOT, OMT, SPV and Bridges. Search Toll plaza by name.
	Geo hazard zonation and Disaster prone area mapping	Landslide prone area mapping in pilgrimage routes of HP and Uttarakand and Experimental

		landslide earlning system with BRO
Ministry of Science and Technology	Mapping the Neighborhood in Uttarakhand (MANU)	Manu Collaboration Portal. Field data viewer, Base and thematic layers.
Ministry of Urban Development- Town and Country planning organization	Master Plan Formulation	NUIS - Urban Landuse maps 1:10,000 Urban Sprawl - 2005-2011 Urban Growth - 32 Cities NCRPB Related Maps Cities > 1 Lakh population
	Urban Growth	Characterization and Monitoring of the urban growth patterns using Multi temporal and multi spectral satellite data areavailable for 32 cities.
	Urban sprawl	Urban Sprawl Information available for 5 states.
Ministry of Tribal Affairs	Tribal Areas	State wise ST Population and statistics. Proposal for Connecting Important Places in Tribal/Naxal-affected Areas
	Road Connectivity – Ranchi to Eluru and Jabalpur – Ambaji	
	Surface water bodies maps of Districts	
Ministry of Water Resources- **Central Water Commission**	Irrigation Bhuvan- AIBP	**Accelerated Irrigation Benefit Program (AIBP)** phase–I (53 projects) and phase –II (50 projects) and online monitoring of phase –III (150 projects).
	India-WRIS	Single Window' solution for comprehensive, authoritative and consistent data & information of India's water resources along with allied natural resources in a standardized national GIS framework (WGS-84 datum and LCC projection) tools to search, access, visualize, understand and analyze the data for assessment, monitoring, planning, development and finally Integrated Water Resources Management (IWRM)

		Portal contains 12 major info systems, 35 sub info systems having 95 spatial layers along with large attribute data of the water resources assets and temporal data of 5-100 years
Department of Forest , Himachal Pradesh	Himachal Pradesh Forest	Know your Forest, LULC, Wasteland, Watershed, Village locations, Current and Archived Fire locations, Forest Fire regimes, Asset management, Green India Mission – Entry point JFMC, GIM plantation, Bio carbon plantation, Climate Vulnerability, Wild life sanctuary locations etc.
Department of Forest , Karnataka	Karnataka Forest	Know your Forest, LULC, Wasteland, Watershed, Village locations, Current and Archived Fire locations, Forest Fire regimes, Asset management, Change Monitoring, Wildlife, Greening India, Cadastral Boundary and Mobile & online Mapper.
Government of Andhra Pradesh	Disaster Management Portal for HUDHUD Cyclone	**Cyclone Hudhud**– Track, Quick Mobile Survey, Crowd Sourced data and Inundation layers.
Government of Andhra Pradesh	Andhra Pradesh Housing Corporation Ltd	To formulate, promote and execute Housing Schemes for the benefit of the Weaker Sections or persons living in Rural and Urban areas and to undertake or regulate construction of houses and create or cause to be created other infrastructural facilities for the said housing scheme.
Election commission of India- Chief Electoral Officer Andhra Pradesh	Support for Planning the polls for General Election 2014	To provide information on smooth conducting of Election on pre-polling and during polling time. Basic Minimum Facility, Analysis and Reports, Vehicle tracking and incident reporting.
Government of Andhra Pradesh	State geoportal Andhra Pradesh	Administrative Boundaries, Cropland, Erosion, Salt affected, Census data – District and Village Choropleth Maps, Disaster specific datasets for Flood and Drought, Election-2014, Forest

		related datasets, Geomorphology, Lineament, Ground water prospects, LULC 50K, Wasteland, AIBP Funded projects, Cadastral Boundary, Slope, Contour, Tourism – Archaeology and Vijayawada, NUIS maps and Water Resource – Barrage/Weir/Annicut, Basin, Dams, Drainage Nework.
Government of Bihar	State geoportal for Bihar	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Chhattisgarh	State geoportal for Chhattisgarh	Administrative Boundaries, Erosion, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Delhi	State geoportal for Delhi	Administrative Boundaries, Erosion, Geomorphology, Lineament, LULC 50K
Government of Goa	State geoportal for Goa	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, AIBP Funded projects, NUIS maps
Government of Gujarat	State geoportal for Gujarat	Administrative Boundaries, Salt affected, Flood inundation Layer, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Haryana	State geoportal for Haryana	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, NUIS maps
Government of Himachal Pradesh	State geoportal for Himachal Pradesh	Administrative Boundaries, Erosion, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Jammu and Kashmir	State geoportal for Jammu & Kashmir	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Jharkhand	State geoportal for Jharkhand	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps

Government of Karnataka	State geoportal for Karnataka	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Kerala	State geoportal for Kerala	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Governement of Madhya Pradesh	State geoportal for Madhya Pradesh	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Maharashtra	State geoportal for Maharashtra	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
NE States : State Governments & DONER	State Geoportal for Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura	Administrative Boundaries, Erosion, Salt affected, Tea Garden Locations, Disaster specific dataset – Flood inundation and Flood hazard zonation, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps.
Government of Odisha	State geoportal for Odisha	Administrative Boundaries, Erosion, Salt affected, Disaster specific dataset – Flood inundation and Flood hazard zonation, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Punjab	State geoportal for Punjab	Administrative Boundaries, Infrastructure layers, Agriculture&soils, Census, Disaster Specific Datasets, Election – polling station, Forest, Geology&Mining, Ground Water, Health, Irrigation, LULC, Tourism, Urban, Water Resources, Wetlands, Police GIS related layers.
Government of Rajasthan	State geoportal for Rajashtan	Administrative Boundaries, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Tamilnadu	State geoportal forTamilnadu	Administrative Boundaries, Erosion, Salt affected, Flood inundation,

		Geomorphology, Lineament, LULC 50K, Wasteland
Government of Telangana	State geoportal forTelangana	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Uttar Pradesh	State geo-portal for Uttar Pradesh	Administrative Boundaries, Erosion, Salt affected, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps
Government of Uttarakhand	State geoportal forUttarakhand	Administrative Boundaries, Erosion, Geomorphology, Lineament, LULC 50K, Wasteland
Government of West Bengal	State geoportal for West Bengal	Administrative Boundaries, Salt affected, Flood inundation, Geomorphology, Lineament, LULC 50K, Wasteland, AIBP Funded projects, NUIS maps

Chapter 12
Bhuvan Discussion Forum

Currently Bhuvan having more than 60000 registered users and it allows to do knowledge transfer ,share their queries from each other through Discussion forum. Bhuvan facilities Online Discussion Forum for Bhuvanites to discuss, share their experience and queries related to Bhuvan. This forum has 2 versions, 1. Guest version having option to view all the threads and 2. Log in version allows users to participate in the discussion by creating new thread or answering any questions by having simple registration in Bhuvan.

Bhuvan forum is having – Updates, Usability, 2D, 3D, NOEDA, Thematic Services, Pocket Bhuvan, Developers Section, Bhuvan wish list, Success stories as sub forums (Figure. 1) to address queries related the specific component of Bhuvan. Every sub forums has the sticky notes as announcement to have the better outreach of any new features or important features.

Figure. 1Bhuvan forum with sub forum

Bhuvan is also having project specific closed forums where all project specific discussions are enabled among the project officials like special forums for AIBP, ENVIS etc to streamline the projects. This will enable the administrators to monitor the project progress and also technically assist the team by clarifying the issues. All the queries rose by the users and answers can be moderated by specific user group called moderators.

a. AIBP Forum

Bhuvan – AIBP forum (Figure. 2) is created to assist AIBP officials to share their technical doubts while digitising the canal physical progress and share the financial progress. This forum is divided according their jurisdiction – central, north, south, east and west. All users are mapped to one of the jurisdiction. Thus users from one group may not answer the queries of other group but view the threads as per the project requirement. But the super user can view all the transaction and participate.

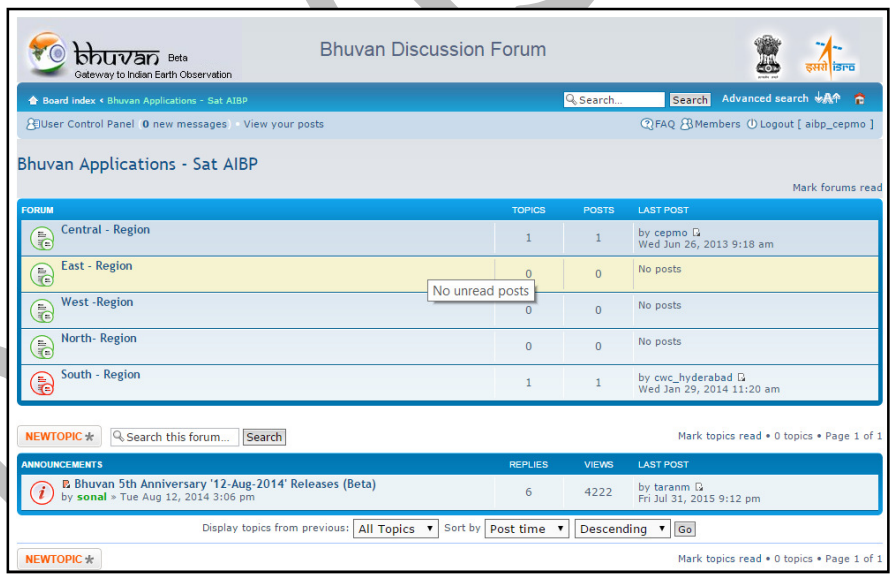


Figure. 2 Bhuvan-AIBP forum with sub forum

b. ENVIS Forum

Bhuvan – ENVIS forum (Figure. 3) is created to assist ENVIS officials to share their technical doubts while developing the application using bhuvan framework. Uniqueness of this forum is allowing likeminded developers to help each other. Thus allows rapid development of any applications.

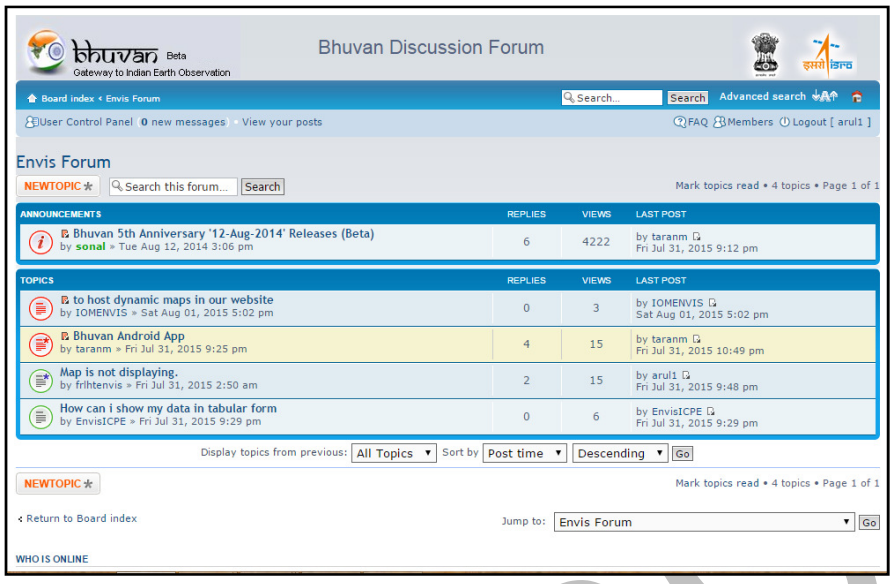


Figure. 3 Bhuvan-ENVIS forum with threads

Chapter 13
Bhuvan Collaborators

Different Ministries and state governments have collaborated with Bhuvan. Some of the collaborators and the datasets provided by them are mentioned below :

Punjab Heritage & Tourism Promotion Board: Agency has collected information for Places of Tourists' Interest i.e. Hotel, Historical Places, ATM, Bus Stop etc and shared it with Bhuvan to bring out Web based GIS solution catering interests of tourists and users

Punjab Remote Sensing Centre: Detailed GIS database of Amritsar city and Ludhiana Municipal Corporation have been provided by Punjab Remote Sensing Centre to bring location based applications for users in collaboration with Bhuvan. Basic amenities information, road network, ward boundaries etc are hosted on Bhuvan reaching public for visualization.

Ludhiana Municipal Corporation: Ludhiana Municipal Corporation having rich information about its municipal area in collaboration with Punjab Remote Sensing Centre have shared it with Bhuvan to facilitate citizens to know about the wards and facilities available, various schemes executed by the government, grievances redressal system besides facilitating administrators/planners to have a one stop online planning tools towards better governance.

Karnataka Forest Department: The state government of Karnataka has shared the data from forest department with Bhuvan. Application enables users to visualize forest fires, assets, changes in forest cover, villages, water bodies, landscapes, national parks, beat boundaries etc.

Himachal Pradesh Forest Department: Himachal Pradesh Forest Department : Himachal Pradesh Forest Department has provided the administrative level data as well as management related information for visualizing it on Bhuvan platform. Portal provides a number of features i.e. forest fire alerts to officials through SMS, up to beat level administrative boundaries, climate vulnerability, wildlife related data visualization etc.

Central Water Commission AIBP: Central Water Commission collaborated with NRSC/Bhuvan to bring out a portal which has inventory of projects carried under Phase-I,

Phase-II and also tools, utilities for Satellite based online monitoring of the Phase-III projects.

India Meteorological Department(IMD): Nowcast Data: Visualization of IMD Nowcast datasets Fog and Thunderstorm on Bhuvan through spatial mashup by provision of Bhuvan Satellite imagery and Basemap as a OGC Compliant WMS Service.

In the later chapters we will further discuss about the different applications developed as the outcome of these collaborations. For example - Municipal GIS, Urban Growth Monitoring, Tourism WebGIS, Election portal for Andhra Pradesh, application related to water, agriculture, forestry and E-Governance.

Chapter 14

Bhuvan Privacy Policy and Terms of Use

The draft privacy policy and Terms of Use are given here for reference and could undergo changes from time to time.

Privacy Policy

There are many different ways you can use our services – to search for and share information, to communicate with other people or to create new content. When you share information with us, for example by creating a Bhuvan Account, we can make those services even better – to show you more relevant search results and sending newsletters, to help you connect with people or to make sharing with others, quicker and easier. As you use our services, we want you to be clear how we're using information and the ways in which you can protect your privacy.

Our Privacy Policy explains:

- What information we collect and why we collect it.
- How we use that information.
- The choices we offer, including how to access and update information.

Your privacy matters to NRSC, ISRO so whether you are new to Bhuvan or a long-time user, please do take the time to get to know our practices – and if you have any questions contact us for details.

Information we collect

We collect information to provide better services to all of our users.

We collect information in two ways:

- **Information you give us.** For example, many of our services require you to sign up for a Bhuvan Account. When you do, we'll ask for personal information, like your name, email address, telephone number.
- **Information we get from your use of our services.** We may collect information about the services that you use and how you use them, like when you view and interact with our content. This information includes:
    - **Device information**

      We may collect device-specific information (such as your hardware model, operating system version, unique device identifiers, and mobile network information including phone number). Bhuvan may associate your device identifiers or phone number with your Bhuvan Account.

- **Log information**

  When you use our services or view content provided by Bhuvan, we may automatically collect and store certain information in server logs. This may include:

  - Details of how you used our service, such as your search queries.
  - Internet protocol address.
  - Device event information such as crashes, system activity, hardware settings, browser type, browser language, the date and time of your request and referral URL.
  - Cookies that may uniquely identify your browser or your Bhuvan Account.

- **Location information**

  When you use a location-enabled Bhuvan service, we may collect and process information about your actual location, like GPS signals sent by a mobile device. We may also use various technologies to determine location, such as sensor data from your device that may, for example, provide information on nearby Wi-Fi access points and cell towers.

- **Unique application numbers**

  Certain services include a unique application number. This number and information about your installation (for example, the operating system type and application version number) may be sent to Bhuvan when you install or uninstall that service or when that service periodically contacts our servers, such as for automatic updates.

- **Local storage**

  We may collect and store information (including personal information) locally on your device using mechanisms such as browser web storage and application data caches.

- **Cookies and anonymous identifiers**

  We use various technologies to collect and store information when you visit a Bhuvan service, and this may include sending one or more cookies or anonymous identifiers to your device.

How we use information we collect

We use the information we collect from all of our services to provide, maintain, protect and improve them, to develop new ones, and to protect Bhuvan and our users.

We may use the name you provide for your Bhuvan Profile across all of the services we offer that require a Bhuvan Account. In addition, we may replace past names associated with your Bhuvan Account so that you are represented consistently across all our services. If other users already have your email, or other information that identifies you, we may show them your publicly visible Bhuvan Profile information, such as your name and photo.

When you contact Bhuvan, we may keep a record of your communication to help solve any issues you might be facing. We may use your email address to inform you about our services, such as letting you know about upcoming changes or improvements.

We use information collected from cookies to improve your user experience and the overall quality of our services.

We may combine personal information from one service with information, including personal information, from other Bhuvan services – for example to make it easier to share things with people you know. We will not combine personally identifiable information unless we have your opt-in consent.

We will ask for your consent before using information for a purpose other than those that are set out in Terms of uses and Policy.

Transparency and choice

People have different privacy concerns. Our goal is to be clear about what information we collect, so that you can make meaningful choices about how it is used. For example, you can:

- Review and control certain types of information tied to your Bhuvan Account by using Bhuvan Dashboard.
- Take information out of many of our services.

You may also set your browser to block all cookies, including cookies associated with our services, or to indicate when a cookie is being set by us. However, it's important to remember that many of our services may not function properly if your cookies are disabled. For example, we may not remember your language preferences.

Information you share

Many of our services let you share information with others. Remember that when you share information publicly, it may be indexable by search engines.

Accessing and updating your personal information

Whenever you use our services, we aim to provide you with access to your personal information. If that information is wrong, we strive to give you ways to update it quickly or to delete it – unless we have to keep that information for legitimate business or legal purposes. When updating your personal information, we may ask you to verify your identity before we can act on your request.

We may reject requests that are unreasonably repetitive, require disproportionate technical effort (for example, developing a new system or fundamentally changing an existing practice), risk the privacy of others, or would be extremely impractical (for instance, requests concerning information residing on backup tapes).

Where we can provide information access and correction, we will do so for free, except where it would require a disproportionate effort. We aim to maintain our services in a manner that protects information from accidental or malicious destruction. Because of this, after you delete information from our services, we may not immediately delete

residual copies from our active servers and may not remove information from our backup systems.

Information we share

We do not share personal information with companies, organizations and individuals outside of Bhuvan unless one of the following circumstances apply:

- **With your consent**

  We will share personal information with companies, organizations or individuals outside of Bhuvan when we have your consent to do so. We require opt-in consent for the sharing of any sensitive personal information.

- **For external processing**

  We provide personal information to our affiliates or other trusted businesses or persons to process it for us, based on our instructions and in compliance with our Privacy Policy and any other appropriate confidentiality and security measures.

- **For legal reasons**

  We will share personal information with companies, organizations or individuals outside of bhuvan if we have a good-faith belief that access, use, preservation or disclosure of the information is reasonably necessary to:

  - Meet any applicable law, regulation, legal process or enforceable governmental request.
  - Enforce applicable Terms of Service, including investigation of potential violations.
  - Detect, prevent, or otherwise address fraud, security or technical issues.
  - Protect against harm to the rights, property or safety of NRSC/ISRO, our users or the public as required or permitted by law.

Information security

We work hard to protect Bhuvan and our users from unauthorized access to or unauthorized alteration, disclosure or destruction of information we hold. In particular:

- We review our information collection, storage and processing practices, including physical security measures, to guard against unauthorized access to systems.
- We restrict access to personal information to Bhuvan employees, contractors and agents who need to know that information in order to process it for us, and who are subject to strict contractual confidentiality obligations and may be disciplined or terminated if they fail to meet these obligations.

Application

Our Privacy Policy applies to all of the services offered by Bhuvan and its affiliates, including services offered on other sites but exclude services that have separate privacy policies that do not incorporate this Privacy Policy

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Enforcement

We regularly review our compliance with our Privacy Policy. We also adhere to several self regulatory frameworks. When we receive formal written complaints, we will contact the person who made the complaint to follow up. We work with the appropriate regulatory authorities, including local data protection authorities, to resolve any complaints regarding the transfer of personal data that we cannot resolve with our users directly.

Changes

Our Privacy Policy may change from time to time. We will not reduce your rights under this Privacy Policy without your explicit consent. We will post any privacy policy changes on this page and, if the changes are significant, we will provide a more prominent notice (including, for certain services, email notification of privacy policy changes). We will also keep prior versions of this Privacy Policy in an archive for your review.

B. Terms of Use

The terms and conditions contained herein, the privacy policy which is mentioned above, and any other policies/guidelines that may be made available by NRSC or ISRO from time to time (collectively the "**Terms**") consist the entire agreement between you and National Remote Sensing Centre located at Balanagar, Hyderabad-500037 (the "**NRSC**"), which is a one of the centre of the Indian Space Research Organisation headquartered at Antariksh Bhavan, New BEL Road, Bangalore- ("**ISRO**"). The Terms, as a whole, detail the manner in which you may use the Portal (as defined hereinafter) and any Products (as defined hereinafter) or Services (as defined hereinafter) provided under it, and restrictions you may be subject to whilst using the portal or any products or services provided through the same.

Please read the Terms in their entirety before you continue to use this portal, or avail of any products or services provided through this portal. By continuing and/or by accessing, downloading from or using this portal or any products or services offered through this portal or otherwise, in any manner, you indicate your understanding of the Terms, and your agreement to abide by the same.

1. Portal; Services; Software and Content:

1.1. Portal and Services: Your use of the Bhuvan Portal provided at http://bhuvan.nrsc.gov.in (the "**Portal**") and/or any services, ancillary or otherwise, provided on the Portal (the "**Services**") is subject to the Terms as agreed upon between you and NRSC/ISRO.

1.2. Products: The Portal may provide for download of certain products in the form of software or otherwise (the "**Products**").

1.3. Content: The Portal and/or Products allows you to access and view a wide variety of content including but not limited to photographic imagery, map and terrain data, reviews, and other related information provided by NRSC, ISRO, its licensors,

and/or its users (the "**Content**"). Additionally, you may choose to access other third party content made available in the Products or through the Services such as project specific pages.

2. Use of Portal; Services; Products and Content:

2.1. Permitted use: NRSC/ISRO grants to you, a non-exclusive, non-transferable, limited license to access the Portal, to download and use the Software, access the Content within the Products, and use other Services as may be available, in the limited manner as specified in the Terms, and subject to any restrictions as set out herein.

2.2. Restrictions on use**:** Unless specific written authorization has been provided to you from NRSC, ISRO or the provider of the Content as may be applicable to specific Content, you may not perform or abet the performance of any of the following acts:

(a) Copy, translate, modify, or make derivative works of the Portal, Products, Services, Content or any part thereof;
(b) Redistribute, sublicense, rent, publish, sell, assign, lease, market, transfer, or otherwise make the Portal, Products, Services or Content available to third parties;
(c) Reverse engineer, decompile or otherwise attempt to extract the source code of the Products, Services or any part thereof, unless this is expressly permitted or required by applicable laws, in which case, you shall make best efforts to provide prior notification to NRSC and ISRO of such requirement, where permitted;
(d) Use the Portal, Products or Services in a manner that gives you or any other person access to mass downloads or bulk feeds of any Content, including but not limited to numerical latitude or longitude coordinates, imagery, and visible data;
(e) Delete, obscure, or in any manner alter any warning or link that appears on the Portal or in the Products, Services or the Content;
(f) Use the Portal, Products, Services or Content to create a database of places or other local listings information;

2.3. Prohibited activities: You may not perform or abet the performance of any of the following acts with respect to the Portal, Products, Services or Content, as applicable:

(a) Defame, abuse, harass, stalk, threaten or otherwise violate the legal rights (such as rights of privacy and publicity) of other users or by your use of the Portal, Products, Services or Content;
(b) Upload, post, email, transmit or otherwise make available any inappropriate, defamatory, obscene, or unlawful content to other users or by your use of the Portal, Products, Services or Content;
(c) Upload, post, transmit or otherwise make available any content that infringes any patent, trademark, copyright, trade secret or other proprietary right of any party, unless you are the owner of the rights, or have the permission of the owner or other legal justification to use such content;

(d) Upload, post, email, transmit or otherwise make available messages that promote pyramid schemes, chain letters, or disruptive commercial messages or advertisements;
(e) Upload, post, email, transmit or otherwise make available any other content, message, or communication prohibited by laws that may be applicable in your jurisdiction or the Terms;
(f) Download any file posted by another user that you know, or reasonably should know, cannot be legally distributed in such manner;
(g) Impersonate another person or entity, or falsify or delete any author attributions or proprietary designations or labels of the origin or source of Content, Products, Services or other material;
(h) Restrict or inhibit any other user from using and enjoying the Portal, Products or Services;
(i) Use any robot, spider, site search/retrieval application, or other device to retrieve or index any portion of the Portal, Products, Services or Content, or collect information about users for any unauthorized purpose;
(j) Submit Content that falsely expresses or implies that such content is sponsored or endorsed by NRSC or ISRO in any manner;
(k) Create user accounts by automated means or under false or fraudulent pretenses;
(l) Promote or provide instructional information about illegal activities;
(m) Promote physical harm or injury against any group or individual;
(n) Transmit any viruses, worms, defects, Trojan horses, or any items of a destructive nature; or
(o) Indulge in any activities that are illegal, or not in consonance with the Terms or to the detriment of the Portal, Products, Services or Content.

2.4. You agree that you are responsible for your own conduct and content while using the Portal, Products or any Services, and for any consequences thereof. You agree to use the Portal, Products, Services and/or any Content you are authorized to use, only for purposes that are proper and in accordance with the Terms and indemnify NRSC, ISRO and the Content provider against any claims, to the extent your use of the Portal, Products or any Services is not authorized by the Terms or any applicable policies or guidelines NRSC or ISRO may make available from time to time.

2.5. You understand and agree that the Portal, Products, Services and Content are provided for regional planning and research purposes only. You should exercise judgment in your use of the same. You further understand and agree that certain Content is provided under license from third parties, and is subject to copyright and other intellectual property rights owned by or licensed to state nodal centres and communities who contribute to the Content including attributes of such Content.

2.6. You are solely liable for any unauthorized copying or disclosure of any Content. Your use of the Content, including but not limited to printing or use in marketing or promotional materials, is subject to the Terms and other laws as may be applicable to you in your jurisdiction.

3. Your Content in our Products and Services

3.1. Some of our Products and Services (Bhuvan Add content [http://bhuvan.nrsc.gov.in/map], Bhuvan Mapper [http://bhuvan-mapper.nrsc.gov.in], and Bhuvan Android Apps for field data collection) allow you to submit content (the "**User Content**", which shall be treated as a subset of Content). You retain ownership of any intellectual property rights that you hold in the User Content. In short, what belongs to you stays yours.

3.2. When you upload or otherwise submit User Content to our Products or Services, you give NRSC, ISRO and those we work with, a non-exclusive, worldwide license to use, host, store, reproduce, modify, create derivative works (such as those resulting from translations, adaptations or other changes we make to the User Content so that it works better with our Products or Services), communicate, publish, publicly perform, publicly display and distribute such content. Please note that the rights you grant by this license are for the limited purpose of operating, promoting, and improving our Products and Services, and to develop new ones. This license continues even if you stop using our Products or Services.

3.3. Some Products or Services may offer you ways to access and remove User Content provided by you. Also, in some of our Products or Services, there are terms or settings that narrow the scope of our use of the User Content submitted in those Products or Services. Make sure you have the necessary rights to grant us this license for any User Content that you submit to our Products or Services.

3.4. You can find more information about how your User Content is used and stored in the privacy policy mentioned above,and/or additional terms for particular Products Services.

3.5. Any feedback or suggestions submitted by you about our Portal, Products, Services or Content may be used by NRSC and/or ISRO, and those they work with, without further obligation to you.

4. About our Services

4.1. When certain Services require or include downloadable software, this software may update automatically on your device once a new version or feature is available. Some Services may let you adjust your automatic update settings.

4.2. NRSC and ISRO grant you a personal, worldwide, royalty-free, non-assignable and non-exclusive license to use the software provided to you as part of the Services. This license is for the sole purpose of enabling you to use and enjoy the benefits of the Services as provided by NRSC and ISRO, in the manner permitted by the Terms and subject to restrictions on use as detailed in the Terms. More specifically, you may not copy, modify, distribute, sell, or lease any part of our Services or included software, nor may you reverse engineer or attempt to extract

the source code of that software, unless laws prohibit restrictions as detailed in the Terms, or you have the written permission of NRSC or ISRO to do the same.

5. Disclaimer of Warranties and Limitations on Liability.

5.1. All information provided in the Portal, Products and Services is provided for information purposes only and does not constitute a legal contract between NRSC/ISRO and any person or entity unless otherwise specified.

5.2. Information on the Portal, Products and Services is subject to change without prior notice. Although every reasonable effort is made to present current and accurate information, NRSC and/or ISRO makes no guarantees of any kind in this regard, or otherwise.

5.3. The Portal, Products and Services may contain information that is created and maintained by a variety of sources both internal and external to NRSC/ISRO. These sites may be unmoderated forums containing the personal opinions and other expressions of the persons who post the entries. NRSC/ISRO does not control, monitor or guarantee the accuracy or authenticity of information contained on these sites or information contained in links to other external web sites, and does not endorse any views expressed, or products or services offered therein. In no event shall NRSC/ISRO be responsible or liable, directly or indirectly, for any damage or loss caused or alleged to be caused by, or in connection with the use of or reliance on any such third party content, goods, products or services available on or through any such third party sites or resources.

5.4. Any links to external websites and/or non- NRSC/ISRO information provided or returned from NRSC/ISRO web search engines are provided as a courtesy. They should not be construed as an endorsement by NRSC/ISRO of the content or views of the linked materials.

6. Other provisions:

6.1. You agree that if NRSC/ISRO do not exercise or enforce any legal right or remedy available to it under the Terms or any applicable laws, NRSC/ISRO will not be deemed to have waived its rights or remedies, and those rights and remedies will still be available to NRSC/ISRO. Any waiver of any provision of these Terms will be effective only if NRSC/ISRO expressly states in a signed writing that it is waiving a specified part of the Terms.

6.2. The Terms, and your relationship with NRSC/ISRO under the Terms, are governed by the laws of India. You and NRSC/ISRO agree to submit to the exclusive jurisdiction of **the courts in Hyderabad, India** to resolve any legal matter arising from or related to the Terms. Notwithstanding this, you agree that NRSC/ISRO will be allowed to apply for injunctive remedies or an equivalent type of urgent legal relief in any jurisdiction.

6.3. Complete Agreement: The Terms constitute the whole legal agreement between you and NRSC/ISRO in connection with, and govern your use of, the Portal, Products, Services and Content. These Terms completely replace and supersede any prior agreements between you and NRSC/ISRO, written or oral, in connection with the Portal, Products, Service and Content.

Acknowledgements

Government Departments

1. Survey of India (SOI, DST)
2. Registrar General & Census Commissioner
3. National Bureau of Soil Survey and Land Use Planning (NBSSLUP)
4. Rajiv Gandhi Drinking WaterMission (MDWS)
5. Central Water Commission, MOWR
6. India Meteorological Department(IMD), MOES
7. Indian National Centre for Ocean Information Services (INCOIS), MOES
8. Meteorological and Oceanographic Satellite Data Archival Centre (MOSDAC)
9. National Council Of Educational Research And Training (NCERT), MHRD
10. Punjab Heritage & Tourism Promotion Board
11. Punjab State Remote Sensing Application Centre,
12. Ludhiana Municipal Corporation
13. Karnataka State Forest Department
14. Himachal Pradesh State Forest Department
15. AP State Remote Sensing Centre
16. Election Commission of Andhra Pradesh
17. Andhra Pradesh State Housing Corporation Limited
18. Haryana Space Application Centre, Hisar
19. Odisha Space Applications Centre, Bhubaneswar

Private & Professional Bodies

1	Rediff Maps
2	Map My India
3	Kompsat
4	SRTM
5	Skyline Globe
6	OpenLayers
7	MapServer
8	GeoServer
9	Cesium JS
10	QGIS

11	iD editor
12	OpenStreetMap
13	PostgreSQL
14	MySQL
15	PHP Community
16	Apache Community
17	JASIG CAS
18	phpBB

Contact Us

Purpose	Contact Details
For Feedback and specific requests	Write to : Email: bhuvan@nrsc.gov.in Phone- 040 23884589, 040 23884584
For Training	Write to : Email: bhuvantraining@nrsc.gov.in
For initiatives / collaboration with Bhuvan	Write to Group Director (G & WGS) , Email : vinod_bothale@nrsc.gov.in Phone : 040-23884587, Fax : 040-23870447 Mobile : 9963006644 Address : **Group Director** **Geoportals and Web GIS Services** Data Processing, Products, Archival and Web Applications Area **(DPPA & WA)** **National Remote Sensing Centre** **Indian Space Research Organisation** Department of Space, Govt. of India, Balanagar, Hyderabad- 500037