CONVERGING CONVENTIONAL APPRAISALS WITH EARTH OBSERVATIONS FOR DECENTRALIZED PARTICIPATORY PLANNING IN RURAL INDIA USING GEO-ICT FRAMEWORK- AN OVERVIEW

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ABSTRACT: Paradigmatic shifts have been witnessed in governance of development initiatives in various sectors across India due to infusion of Earth Observation (EO), GIS and Information Communication Technology (ICT). Number of programmes such as Mahatma Gandhi Rural Employment Generation Act (MGNREGA), Integrated Watershed Monitoring Program (IWMP) and Rashtriya Krishi Vikas Yojna (RKVY) etc. buoyed on a large scale by Ministry of Rural Development (MoRD) in India has monitoring mechanism through use of Geo-ICT based framework for developing futuristic plans. Programmes as such Pradhan Mantri Krishi Sinchai Yojna (PMKSY) and Soil Health Management (SHM) by allied ministries also make use of Geo-ICT tools for effective management of the assets created and information collected for the welfare of rural communities. Bhuvan is a Geo-ICT solution for panchayat and village level planning. Earth observation datasets available at high spatial-temporal scales is an integral component of these programmes and is used for precise mapping and regular monitoring of various activities under them. The recent availability of high resolution indigenous satellite data on board Cartosat 2 series missions (sub meter PAN and less than 2 meter MX) has higher potential for mapping and monitoring related to micro level governance. A substantial amount of ground inventoried geo-tagged assets has been also generated by involving the trained functionaries at grassroots level for monitoring these development schemes. The scale at which Geo-tagging has been accomplished under these projects indicates the degree of acceptance of Geo-ICT approach. The overall response of the state machineries in these projects has been overwhelming. The success of such approaches cannot be easily categorized within simple narratives of crowd sourcing as in many cases the realities are more complex. The potential uses of such data are open and multiple as it can play a very important role in developing comprehensive information services by applying big data analysis.

1. INTRODUCTION

"Just as the whole universe is contained in the self, so is India contained in the villages." **-** Mahatma Gandhi.

More than half the people of the world and the vast majority of the people in developing countries (Asia, Africa and Latin America) live in rural areas and gain part or their entire livelihood from some form of agriculture. Most of these people are also still very poor, living in isolated and often inhospitable places, with little access to the resources they need to improve their agriculture (Oakley and Garforth, 1985) and the scale of depravation is mind numbing. Many lead their lives barely at subsistence level that forces them to take the alternate ways for livelihood and even ending up their lives in desperation. Though, looking at the share of rural population alone makes it a strong case to promote rural development in these regions, the role of sustainable farming systems in meeting the global food security, mitigating climate change and the provision of ecosystem services in terms of water regulation and prevention of soil erosion done further substantiate its need. While efforts are multipronged and often overlapping, need for a clear framework to converge these at village level is paramount.

Broadly, rural development is integrated with economic and social objectives that seek to transform rural society and provide a better and more secure livelihood for rural people. The term rural development thus, connotes overall development of rural areas to improve the quality of life of rural people. The strategies for rural development usually take the form of programmes which implement projects in a specific rural area or addressing a specific issue. Such

programmes form the basis of most government and non-government efforts to assist rural areas, and they include both agricultural and non-agricultural projects, e.g., health, sanitation and education, *etc.* The critical success factors for these projects can be divided between the planning (strategic) phase and the action (tactical) phase of the project. Whereas top management support and a project schedule- outlining individual action steps for project implementation are critical to the planning phase, the action phase is considered to include communication with all stakeholders, recruitment of staff and obtaining the required technology and expertise etc. (Holland *et al*, 1999). However, there exist basic contextual difficulties in systematically planning the development of the rural sector due the issues related to scale. At one level, farm or a household is the unit of consideration for any activity to be undertaken, at the aggregate planning level, it is difficult to formulate and implement a plan that is based on the response from a large number of such individual families (Cliffe and John, 1972). Another issue faced is lack of capacity, manpower, technical assistance, finance at top level and insufficient training/participation of the stakeholders at the lowest administrative level (Chambers, 1974).

Also as these programmes are government funded they are usually executed by the concerned ministries in a linear set up fitting the most to its requirement. Thus, they are often flawed with the mismatch of the input/output needs among the different levels in the hierarchy with suboptimal solution and goals reached. The retrieval of information and delivery of services under these projects large remain opaque giving rise to corruption and misuse of funds (Sapru & Sapru, 2014). The success of the development project is therefore governed by institutional capacity, professionalism, transparency, and accountability, and the people's participation.

1.1 NEED FOR A CONVERGENCE TOOL

Set of approaches such as Rapid Rural Appraisal (RRA) and, more commonly Participatory Rural Appraisal (PRA) has been developed to enhance the participation of citizens through working with beneficiaries to compile data, information, and knowledge to ensure that the resulting plans are (and are perceived to be) valid and responsive to community needs. Some of the more developed and tested methods of PRA are participatory mapping and modeling, transect, walks, matrix scoring, well-being grouping and, ranking, institutional diagramming, seasonal calendars, trend and change analysis, and analytical diagramming, all undertaken by local people. In the last two decades ICT has become new rhetoric of development, providing enabling tools supporting rural development perspectives and inclusive growth. Several e-Governance applications have demonstrated the important role the Information and Communication Technologies (ICT) play in the realm of rural development in terms of increased outreach and accountability, enhancing the base, minimizing the processing costs, increased transparency, and reduction in the project cycle life. At a broader level e-governance has accelerated the integration of several stand-alone systems and services between Government-to-Citizens (G2C), Government-to-Business (G2B), Government-to-Government (G2G) as well as back office processes and interactions within the entire government framework resulting in effective delivery of the government schemes.

Though highly tangible and popular among the development practitioners, methods of PRA also have their own limitations. Investigation, sharing and analysis are open-ended, and often visual, by groups of people, and through comparisons. Decentralized and democratic processes as shaped by these approaches tend to generate, disparate data which central planners cannot, then easily add up or compare (Chambers, 1994). It is also widely discussed that proponents of participatory mode of development ignored the power relation in order to describe local knowledge of the people. Besides, role of facilitators are often not clear as they sometimes become the active stakeholder in the process (Mosse, 2001). There is also a lack of the civic engagement during the evaluation phase of the development project, which indeed is very critical (Cohen and Uphoff, 1980; Sutiyo and Maharjan, 2017). Similarly, issues are faced in the e-governance in terms of the processes were defined with compliance in mind, rather than enhanced citizen service. Most of the data available in the MIS of the e-governance system is static. It is not possible to represent the project impacts in real terms and ensuring that funds are actually used at the grassroots for a specific tangible of intangible activity.

The fact that all human activities have a measurable and predictable spatial footprint, Geo-information paradigm has emerged as a pivotal entity in development and planning. Convergence of satellite images, GPS enabled handheld devices and a Geographic Information Systems that manifests the Geo-information, is highly effective to develop an understanding of the Earth system and how it changes over time and space. Such an understanding in turn constitutes critical input for planning at the scale of a village, by providing information, measurements and quantifications of its various features. The synoptic

view provided by satellite imagery offers technologically the most appropriate method for quick and reliable mapping and monitoring of the physical environment of the earth and its various features. High resolution and multispectral sensors on board IRS satellite system, are increasingly delivering an unprecedented quantum of high quality Earth observation (EO) data in very short timescales after acquisition. EO offers added value and cost-effective solutions, to themes associated with the interplay between technical processes, systems and data management, rapid dissemination of data, results or services, and distribution channels. GIS technologies are capable of creating various resource information layers for and from EO data in the shortest possible time along with regular updates. The illustration of both pathways of data, collected from the ground and that available from EO, through GIS can be an innovative approach to assist planning process and in setting strategy for rural development. The spatial data created could be used for various levels of integrated decentralized planning by aggregating and visualizing it at different desirable scales. Over the last years, geospatial web platforms, social media, and volunteered geographic information (VGI) have opened a window of opportunity for traditional Public Participatory GIS (PPGIS) to usher in a new era (Atzmanstorfer et al, 2014). Geotagging that constitutes the process of defining, creating, and provisioning a set of geolocation objects, event or activity to a computing device securely has transformed the way, the maps have been looked upon from a static picture. Maps have been rendered as a dynamic platform for shared decision making and real-time collaboration, focusing the energy of the crowd and empowering state and citizens to work together to respond quickly to challenges at any scale (Diaz-Uda and Leinbach, 2013).

This paper presents an overview of rural India landscape and the major programmes floated for Rural Development in India by MoRD and other allied ministries. It discusses the major challenges faced in implementation, monitoring and evaluation of these programmes. A point of view is presented regarding the importance of Bhuvan - India's indigenous GEO-ICT solution developed by National Remote Sensing Centre (NRSC), Indian Space Research Organization (ISRO) for effectively using spatial data in rural development planning in India. A summary of projects where adoption of Geo-informatics has lead to a shift from As-Is approach to setting benchmarks of good governance is also presented. We conclude that Geo-informatics would continue to shape the enhanced delivery of services from the government schemes. More consideration needs to be placed on the application of data analytics in assessing the spatial patterns and process for enhancing rural development in future research.

2. RURAL INDIA AND GOVERNANCE

With around 600,000 villages spread across the country against 500 odd cities, the vast majority of Indians lives in rural India. According to the 2011 census, the country's rural population is almost 83.25 crore, that means nearly 70 percent of the India's total population resides in rural areas. Ironically, the rural areas are characterized by various social and economic problems like poverty, illiteracy, low level of income, unemployment, poor food and health standard. The rural communities in India are faced by unrelenting agrarian crisis and lack of infrastructure. Low agricultural productivity has been listed as one of the major structural constraints facing the Indian economy as per the latest Economic Survey. There has been also the unprecedented decline in cultivators in absolute terms due to agrarian and migration that is a testimony of the hardship faced by the small and marginal farmers and landless labor in rural areas. Although agriculture accounts for only 14 per cent of Gross Domestic Product (GDP), it is still the main source of livelihood for the majority of the rural population. It is in this context that rural development in India assumes greater significance, especially garnered by state-of-the-art technological interventions (Pujar, 2017).

There has been a wide consensus that the rural development should be inclusive and sustainable in order to alleviate the poverty. The Government has been, since country's independence, formulating policies, programs, projects and schemes and investing significant financial resources through every Five Year Plan to accelerate the rural development. The tentative Gross Budgetary Support (GBS) for the MoRD for the Twelfth Five Year Plan (2012-17) is Rs. 44,3261 crore (against the Rs. 29,1682 crore of Eleventh Plan period) which includes the several major programs. For example employment is covered through the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and the National Rural Livelihoods Mission (NRLM) or Aajeevika, housing via the Indira Awaas Yojana (IAY), sanitation through the Total Sanitation Campaign (TSC), provision of drinking water via the National Rural Drinking Water Programme (NRDWP), social security through the National Social Assistance Programme (NSAP), watershed development via the Integrated Watershed Management Programme (IWMP), road connectivity through the Pradhan Mantri Gram Sadak Yojana (PMGSY) and electrification via the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), education through Sarva Siksha Abhiyan (SSA); Child welfare

through Integrated Child Development Services (ICDS); Nutritional Support to Primary Education or Mid-Day Meal Scheme (MDM); Rajiv Gandhi Panchayat Sashastrikaran Abhiyan (RGPSA); rural irrigation through the umbrella programme of Pradhan Mantri Krishi Sinchayee Yojana (PMKSY); Jawaharlal Nehru National Urban Renewable Mission (JNNURM), Backward Regions Grant Fund (BRGF) and other Central Sector and Additional centrally Assisted Schemes. These schemes have received varied degree of response and performance across the rural landscape in India and have an important contribution as the productivity enhancement and empowerment instruments.

3. MAJOR CHALLENGES

With a number of ambitious rural development programmes in place as discussed, but there has been the multitude of issues in their implementation, enforcement and coordination. Some of these challenges include their large geographical coverage and scale, similar spectrum of work, traditional linear approach and sporadic use of NRM (natural resource management) principle. It also includes lack rural entrepreneurship and effective communication among the intended beneficiaries. The paucity of data on microlevel impacts, especially with a geographic reference, has rendered many good intentions unrealized. Such issues are explored herewith.

Geographical Coverage and Scale: The challenge of developing programs and institutions at national or regional scale in a country like India is intense. The sheer scale of the development programmes spanning across the country leaves monitoring the activities using ground inventories and traditional methods inadequate, slow and simply tedious to manage. Surveys have been useful tools as representative technique, but still there remains a problem in their design and to ensure that whether the respondents provide accurate, honest answers.

Lack of Spatially Explicit Data: Community mapping has been considered as an integral part of rural development programmes since the beginning of conventional approaches. However, these maps face issues of accuracy, scales and commensurability. Also, most of the times these maps are prepared during the project planning phase. It is difficult to access these maps by the end of project completion and also there is no spatial mapping of the activities undertaken in the course of project implementation so that its success can be evaluated.

Linear Service Delivery: Most of the ministries/institutions have vertical linkages between its different levels of organization. Such vertical linkages are useful as different kinds of skills are required at each level. This however, results in the delivery of Government schemes follow a linear approach fitting the most to its structure. Each unit in the chain works as a fully independent unit and the outputs from the lower one form a direct input to the next higher level of hierarchy. Such linear service delivery is often flawed with the mismatch of the input/output needs among the different levels in the hierarchy with suboptimal solution and goals reached thus leading to the slowdown and bureaucracy.

Lack of Effective Communication: Any rural development activity **r**equires developing and implementing a set of activities that contribute to a solution to the problem, or the realization of the goal. The solution has to support and accompany this initiative through participatory development communication (FAO, 2005). Paradoxically, appropriate communication structures, methodologies and tools for information sharing are lacking or limited to the extension services that are also often under-equipped in terms of staff, transport and accommodation as well as inadequately trained in effective communication. This leads to poor participation and hence slogged performance of the projects.

Mutually Reinforcing Tasks: Most of the projects undertaken by the government consist of mutually reinforcing tasks due to similar spectrum of work. Thus, there exists significant overlap and horizontal linkages between the different programmes. Several development programmes are undertaken jointly by the ministries and department under the convergence mode. It aims to optimize public investments made under existing schemes through suggested ways of linking and steering them towards a common/shared recipient end, both physical (area, infrastructure, natural resource) and human (person, group, agency). However, there remains chances of unauthorized claims and transfer of assets, double booking and creation of ghost assets due to misappropriation of funds.

Sporadic Use of Natural Resource Management (NRM) Principles: Integrated management of the natural resources is indispensible for sustainable development and inclusive growth. Though, there is a foundation of the NRM principles in some of the projects e.g. MGNREGA, IWMP etc, the majority of the schemes and sub-schemes floated for the rural development fails to address them. There is a need to have a scientific understanding of the NRM in all the

projects that are enthralled with promotion land, water and forest development in the rural areas due to their high dependence on natural resources for livelihood and living.

No Room for Biophysical Parameters: Rural communities and agriculture are worst affected due to the natural calamities such as drought and floods. Pest infestation and poor crop yield also take a toll of agriculture productivity. Unfortunately, small farmers remain vulnerable to the vagaries of the weather which has become increasingly unpredictable due to climate change. The large number of solutions developed and prepared by the scientists based on the understanding of biophysical parameters and climatic data are poorly roped into the development projects.

Limited Entrepreneurship: Many policy makers want to encourage entrepreneurship given its perceived role in economic growth and development. Rural development is more than ever before linked to entrepreneurship. Institutions and individuals promoting rural development now see entrepreneurship as a strategic development intervention that could accelerate the rural development process. Though, efforts are made in providing enabling environment and development of skills problems remain with scanty financial belief in rural capability, finding a potential market for the products, and availability of basic resources and amenities, i.e. availability of electricity, water supply, transport facilities and required energy etc.

4. GEO-ICT FRAMEWORK FOR DECENTRALIZED PARTICIPATORY PLANNING

Decentralized participation and planning is the core of rural development. Achieving rural development in a big country like India is only possible by helping the rural sector realize its own potential for development by using the gains of modern science and technology. The computer-based environments are known to offer a, variety, of novel ways to involve the public in planning processes. ICT has significantly contributed in streamlining some of the basic problems faced in rural development and the Digital India Campaign of the government is a big boost in this direction. However, challenges as presented in the previous section have been glaring and it is in this pretext that Geo-information has a key role in community driven rural development and acquires special importance in decentralized planning. The rise of Web 2.0 and suite of technologies like e.g. web mapping, have opened even more possibilities for advanced information, exchange, consensus finding and decision-making among the various stakeholders (Henning and Vogler, 2011). In India Geo-spatial technology is becoming the core to many IT programmes in the government (Thakur, 2013). Geo-ICT has emerged as a field integrating Geo-spatial technology with the mainstream ICT. The growing need to organize data across different disciplines and organizations has resulted in the development of Geo-spatial approaches to facilitate the coordinated exchange of spatial information amongst spatial data stakeholders globally. Interaction amongst ministries/departments and state governments towards enhanced utilization of the space technology in governance and development in India has been also encouraged by The Prime Minister Shri Narendra Modi in the National Meet on “Promoting Space Technology based Tools and Applications in Governance & Development” held in New Delhi on 7th September 2015.

Indian Earth Observation data and services provided by the Indian Space Research Organization are assisting the MoRD and allied ministries towards realization of the potential of Geo-ICT for good governance in rural development. Bhuvan, a niche product/service of ISRO is the India’s indigenous Geo-ICT solution developed by National Remote Sensing Centre (NRSC) for effectively using spatial data in development planning in the country. Bhuvan sits at the heart of Geo-information framework of the decentralized development planning in India and facilitates the coordinated exchange of geospatial information on various aspects of rural development planning among the intended stakeholders (Figure 1). It is supported by the vast amount of spatial data, satellite data of Indian Remote Sensing Satellites. It also hosts the legacy data that have been prepared by the various departments across the disciplines in the country and keeps them updated subject to the availability of appropriate database. A key thematic database serving the user requirement for rural development is Land Use and Land cover database at 1:10000 scale created under ISRO’s flagship programme SIS-DP (Space based Information Support for Decentralized Planning) along with drainage and road layers at same scale based on high resolution ortho-rectified multispectral satellite images. Land use land cover database has 27 classes and characterizes the landscape for micro level planning. A Digital Elevation Model derived from the 2.5 m spatial resolution Cartosat-1 images is also available, representing the differences in physiographic and terrain details across the country. Being digital in nature the maps can be zoomed to the lowest administrative boundary of the state, district and the village made available on Bhuvan. The biophysical products Land-terrain, Land-Vegetation and Ocean physical are also disseminated for free download under NICES (National Information Centre for Climate and Earth Sciences). Point of Interest data is a repository of

Geo-tagged data on Bhuvan collected using project specific mobile apps for recording the location based devices and smart phones. The summary of the data available on Bhuvan is given in table 1.

The framework currently implemented provides a host of services covering visualization, free data download, thematic map display and analysis, timely information on disaster and project specific GIS applications. It has the options of getting state and district wise statistics, Area of Interest (AOI) based analysis, URL for WMS/WMTS services, view based print and adding external WMS layers thus, making it easy for the Scientific and Research community as well the government machineries to use the Geoinformatics inputs for various applications. Standing as a hallmark of EO service infrastructure it is based on an open data philosophy facilitated by NRSC Open EO Data Archive (NOEDA). The data available on Bhuvan is spatially explicit and can be freely downloaded for various applications.

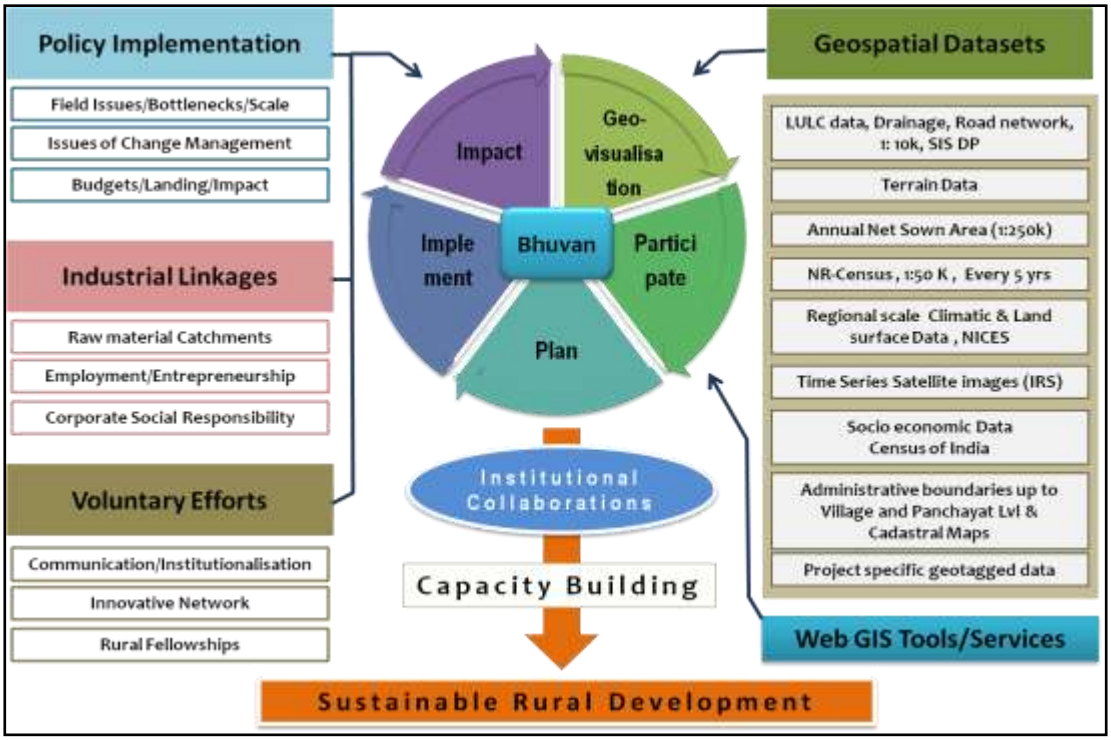

Figure 1: Geo-ICT Framework for Rural Development Convergence

The services of Bhuvan are increasingly being used in rural development planning. It is overcoming the bottlenecks of wide geographical coverage and scale; limited commensurability caused due lack of spatially explicit data. Seamless PAN-India high resolution satellite data with 2.5m spatial resolution and 15 m accuracy, visualization supported by WMS layers is available on Bhuvan. This can be overlaid and compared in tandem with other thematic maps thus making spatial convergence of the output of the various development projects obvious and clear. It also overcomes the problems associated with evaluation faced in the conventional approaches by providing highly accurate and near real time spatial data and maps.

Geo-web portals have a capability to present and/or explain an object or phenomenon in a vivid and, realistic manner. Through Bhuvan, the stakeholders can effectively communicate with the intended beneficiary and share information with them in such a way that even without great knowledge of a subject they can perceive, and understand it and create a pertinent idea thereof. It facilitates the creation of non-linear operational links among the stakeholders through increased interaction among them thus making, service delivery under the projects more integrated thereby overcoming the issues of tradition service delivery chains. There can be further enhanced by explanations and statements made available by e.g. multimedia

(Henning and Vogler, 2011) to make them more interactive and dynamic.

The fact that every human activity has the specific spatial footprint and it can be viewed on the EO data and further analyzed using GIS has lead to address the problems with the project having mutually reinforcing tasks and similar spectrum of work. Mapping of resources in time and space and its visualization on Bhuvan is a unique service offering for bringing synergy between different government programmes and /or schemes in term of their planning, process and implementation.

Natural resources can be effectively managed with due regard to Ridge to Valley principle so as to conserve rainwater and recharge ground water, growth of vegetation, prevention of erosion and a whole lot of conservation channels. With its ability to provide greater details of land surface over time and space, remote sensing is widely used in NRM. Use of digital terrain models and thematic data derived available on Bhuvan facilitates increased pervasiveness of using the NRM principle across the development projects. MoRD is realigning its activities to water conservation based on the ridge to valley principles and has made role of remote sensing, GIS and GPS technologies central to their planning, implementing and monitoring. This discourse envisages a fundamental shift in support policies for rural areas from a sectoral approach (essentially agriculture) to one that is territorial.

The satellite images can be used to create user specific data on the resource availability and their distribution in an area. Use of GIS helps mapping the resources, business locations based on available infrastructure viz. cluster of industries, roads, electricity) and social capital (viz. community engagement points, gender and ethnicity). Mapping of this data helps to illustrate and identify the geographic trends while also providing the spatial reference to the region/point of interest (Steinberg et al, 2013).

Satellite Base Layers	**Vector Base Layers**
2.5m Color (Enhanced) for Entire India 1m Color for India Cities & Tiles AWIFS (56m) Layers LISS-3 (24m) Layers LISS-4 (5.8m) Multi spectral Layers etc	Administrative layers (State/Dist/Mandal/Village) Infrastructure layers (Road/Rail/Drainage) Major water bodies etc. Base Map
Thematic Layers	**NICES datasets**
Land Use/ Land Cover 1: 250k &1: 10k Urban land use 10k (NUIS) Wasteland 50k (2008-09) Glacial Lakes\ Water bodies Geomorphology 50K (2005-06) Lineament 50K Flood hazard layer and flood annual layers Erosion 50K (2005-06) Salt affected and water logging 50K (2005-06) Urban sprawl etc	Terrestrial, Ocean, Atmosphere and Cryosphere Products at upto 5 km gridded. OCM-NDVI-Global and Local Coverage, Vegetation Fraction, Albedo Ocean- Heat Content, Ocean Wind- Stress, Curl, Velocity (total 18 oceanic Products) , Snow Cover and Melt, Cloud Fraction, Planetary boundary ht, Derived Tropo.Ozone
	Geotag Datasets
	Geotags of MGNREGA, IWMP, RKVY, Pest Surveillance, and other Crowd Sourced Data (eg. MANU)
Free Data Download	**Derived Products**
AWiFS-Ortho-rectified satellite images LISS III-Ortho-rectified satellite images DEM- CartoDEM at 30m resolution HyS I- Hyper- spectral for Pan Indian .etc	AWiFS- Snow Cover Fraction Water bodies fraction CartoDEM etc.

Table 1: Summary of the data available on Bhuvan
(Source: http://Bhuvan.nrsc.gov.in/2dresources/documents/2_Bhuvan_Geospatial_Content.pdf)

5. ON-GOING APPLICATIONS

Some of the GEO-ICT applications demonstrating the convergence in rural development programmes in India through Bhuvan summarized as follows:

GeoMGNREGA: Geo-MGNREGA is a geospatial component of MGNREGA of MoRD aims to implement GIS for the entire range of activities implemented under the scheme across the country. This unique Geo-ICT application is an integration of NREGASoft an ICT tool developed National Informatics Centre for MoRD and Bhuvan. The successful implementation of the model is evident from the accomplished 2.04 crore asset geotag

database, out of 2.93 crore targeted assets created since the inception of the scheme up till date (Fig 2). This project has been hailed as a key Geospatial intervention by Central Government and has been recognized for the level of transparency it brought in governance. The quality of each geotag collected is ensured by a block level officer after enumerator uploads it. In the first phase, only the completed assets available under NREGASoft are being geotagged by calling individual asset information on to Bhuvan android app. National level implementation of such simple looking procedure entailed challenging yet, variety of iterative approaches as well as redesigning of several services, implemented through open source software modules. Recent development has focused , as desired by DoRD on monitoring each asset creation by geotagging selected site, one time record of ongoing activity and that of completed asset, which is poised to bring a higher degree of transparency in entire paradigm. Apart from this, the whole MGNREGA process will be planned on the ridge to valley based approach in all critically ground water poor blocks. The massive level of geospatial tools usage is envisaged, targeting participatory planning at panchayat level, which is unprecedented. Enthusiastic involvement of state department teams in this exercise duly motivated by Central team seems to have enabled a techno-driven realignment of world's biggest rural development exercise, in turn bringing in more votaries for the approach.

Fig 2: Bhuvan interface showing asset geotag status for GeoMGNREGA. Panchayat wise MSE Registration Status Report of Pushprajgarh, Anuppur (M.P) is on the right side.

Bhuvan Drishti-Srishti: Earliest national level implementation of geospatial technology was accomplished through this portal, which heralded overarching innovation for rural areas. The Department of Land Resources was provided a comprehensive solution to monitor the impact of watershed management activities using WebGIS and Android app. Geoportal facilitates monitoring and evaluation of 8211 IWMP projects distributed across India across its various states. It enables image and map display, monitoring tools, summary statistics of all the IWMP watersheds viz. preparatory, ongoing and completed spread across the country. The application also enables National, State, District and watershed level access for information and report generation. So far 6768 project having 67323 micro-watersheds can be visualized. Classified maps and reports are also available. Till date, a total of 6.73 lakh geotags have been collected (accepted 4 Lakhs) for various activities executed on the ground. Each geotag is coded automatically in Bhuvan server following a specific structure to identify the asset (activity done on the field), which Department of Land Resources uses for official purposes (Fig 3).

Bhuvan RKVY: Ministry of Agriculture desired to inventorize all the infrastructure assets created under this Centrally Assisted scheme bridging the Sate Agriculture Plan requirements. The assets created in 85 sub categories spanning all hues of farm operations/management, including animals, birds, fish and insects based ventures are being geotagged using customized app. Bhuvan RKVY portal provides facility to visualize asset spread in the context of high resolution image backdrop with GIS analytical capabilities. Geo-information on infrastructure assets for agriculture production created under RKVY can be used in conjunction with the assets created under MGNREGA, IWMP, PMKSY and SHC as well the thematic information available on Bhuvan such as road

network etc. has the ability for planning and promoting rural entrepreneurship by fill the gaps in information about the rural that provide access to social and economic services. They are an entry point for poverty alleviation and act as facilitators to create agricultural surplus. Total RKVY Assets Geotagged on Bhuvan portal are 60836 of which number of moderated assets are 28922.

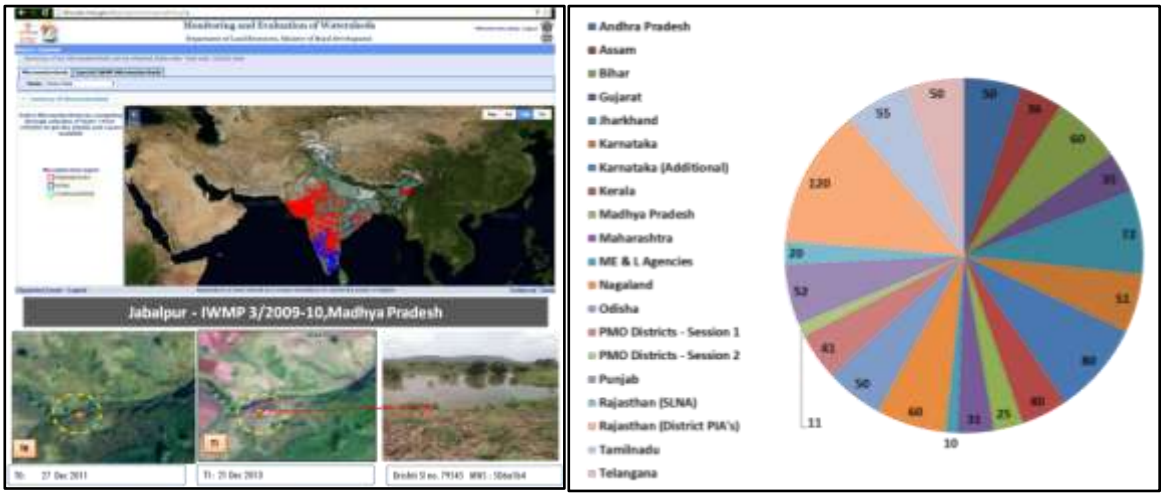

Fig 3: Bhuvan Srishti Portal Showing the Indian overview along with Sample impact reporting in Madhya Pradesh. Pie chart depicts the total capacity building done for state departments (1200 officers)

Soil Health Card (SHC): The soil health card portal at Bhuvan is currently implemented in six states namely, Andhra Pradesh, Assam, Haryana, Telangana, Tamil Nadu and West Bengal. This Web portal has modules like (i) Soil Samples Registration and editing (ii) Test Result Entry by Soil Testing Labs (iii) Fertilizer Recommendations based General Fertilizer Recommendations (GFR) (iv) Soil Health Card generation: single as well as bulk (v) A dashboard to monitor the progress. The portal has detailed steps through the technical manual for users and a user friendly video for ease of operation. Essentially, this portal enables site specific recommendations through web /app service and importantly provides the context of soil health status (Fig 4). It is planned to place further remote sensing based inputs on the portal with respect to nutrient status and related recommendations. With advent of better remote sensing systems and stronger field inventory, farmers are expected to get substantial benefits for farm management, so that key rural economic activity gets the best boost.

Fig 4: Bhuvan Soil Health Card Application showing location of samples collected and the overall workflow for generating soil health information

Bhuvan Panchayat: Web GIS services for SIS-DP database have been rendered through this web portal, along with a range of spatial information datasets including Panchayat layer. It is a comprehensive

system consisting of planning, implementation and monitoring of rural development activities at Panchayat level. Bhuvan Panchayat facilitates visualization and monitoring of assets created under various projects at Panchayat level for the selected villages. It also gives the detailed information regarding household amenities data and Census data at district and village level, respectively. It is planned to serve, support services for rural area plan formulation as well as a ridge to valley treatment under GeoMGNREGA at Panchayat level. The entire set of assets created under panchayat administration has also been mapped using customized smart phone applications which will strengthen transparency in rural governance. The framework provided by this interface to the catalogue entire range of assets created vis-à-vis range of developmental projects specifically implemented through respective Panchayat, with a socio-economic context such as socially disadvantage, makes it desirable for grass root governance. This portal has been put to use by various agencies across country and has rendered micro level contexts useful for facilitating developmental discussions.

6. CONCLUSION

Paradigmatic shifts have been witnessed in governance of development initiatives in various sectors across rural India due to infusion of Earth Observation (EO) and Information Technology (IC). Application of Bhuvan in various ongoing programmes of rural development demonstrates how ISRO has contributed in translating user needs into addressable technology. The keen interest of the concerned ministries, state machineries and development of integrative approaches which seek to build state capacity, citizen participation is the prime factors for achieving this. However, there is a greater need for coordinated and collaborative efforts at all levels of implementation and planning both vertically as well as horizontally so that potential of Geo-ICT can be utilized to see a bigger picture through a common lens for transforming lives of people in rural India. The success of such approaches cannot be easily categorized within simple narratives of crowd sourcing as in many cases the realities are more complex. The potential use of such data spans wide spectrum of solutions, as it can play a vital role in developing comprehensive information services through various analytics. Critical value added by Geo-information for economic evaluation certainly stands vindicated in a rural context.

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