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Rural development using electromagnetic radiations: A review

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Abstract
India is a developing country as well as among largest economies in the world. Hence, India is progressing at a faster rate. Advancing new age technologies are acting synergistically to the developmental processes. At the same time India is a country of villages and its development is synonymous with the development of the people living in rural areas. With 73 percent of rural households, all round development of the nation without compromising rural Indiais a major challenge in front of policy makers and scientists. That is why rural development possesses prime importance while making development policies. Space application technologies play a vital role in the formulation of suitable policies, precise planning and timely execution.These techniques helps in providing tele-education, tele-healthcare, water management, natural resource management, e-governance, weather forecasting and various other services beneficial for rural development. Application of these sophisticated technologies avoids mismanagement, over expense and delay; hence, space application techniques always come handy by the planners. The present paper has been made to study the importance of space application technologies which uses different electromagnetic radiations, through various literatures of national and international repute and to provide comprehensive information toits readers about importance of these technologies. Since, it was rightly said by Mahatma Gandhi that "Real India lives in Villages", which simply means that development of whole nation could not be possible without developing rural India.

Keywords: agriculture, ISRO, remote sensing, rural development, space application technology

1. Introduction
Indian economy is the sixth-largest economy in the world measured by nominal GDP as the nominal GDP of Indian economy is 2.46 trillion dollars and purchasing power parity (PPP) is 9.59 trillion dollars (Economic survey, 2013) [2]. At the same time India is seventh largest country in area having 29 states and 6 union territories; the population of India has reached a tremendous 1.314 billion figure with 421 people per square kilometre and is expected to reach 1.66 billion in 2050 (population reference bureau, 2015) [5]. A big part of this huge population lives in rural areas which is equal to 73 percent of total households. That is why agriculture plays a vital role in India's economy; over 70 per cent of the rural households depend on agriculture as their principal means of livelihood. Agriculture, along with fisheries and forestry, is one of the largest contributors to the GDP. Agriculture generates huge employment for rural people as well as agro industries associated with dairy, fishery, forestry, grain and frozen food processing also acts as an important source of employment for both rural and urban people. As per the first advanced estimates by the CSO, the share of agriculture and allied sectors (including agriculture, livestock, forestry and fishery) is expected to be 17 per cent of the GVA during 2016-17 at 2011-12 prices. Agricultural export constitutes 10 per cent of the country's exports and is the fourth-largest exported principal commodity (Economic survey, 2016) [6].

Considering the above facts it is evident that agriculture is the backbone of Indian economy whereas the backbone of Indian agriculture are rural people who are directly or indirectly associated with the agriculture practices. Hence, rural development possess prime importance whenever developmental policies are planned and timely execution of such policies along with their proper management involves application of new age technologies. In absence of advance technologies rural development of such a big nation cannot be imagined. Among various advance technologies involved in rural development; remote sensing and GIS technologies are playing important roles which use infrared rays, microwaves etc.

These helps in selection of area for making watersheds, making maps by using topographic data, soil characteristic and ground water studies, weather forecasting, assessment of land suitability and irrigation scheduling. Application of these sophisticated technologies avoids mismanagement, over expense and delay and hence, remote sensing and GIS techniques always comes handy by the planners. That's why various literature of international and national repute has been thoroughly studied and their salient information has been presented here to facilitate readers with comprehensive knowledge about various applications and importance of these techniques in rural development.

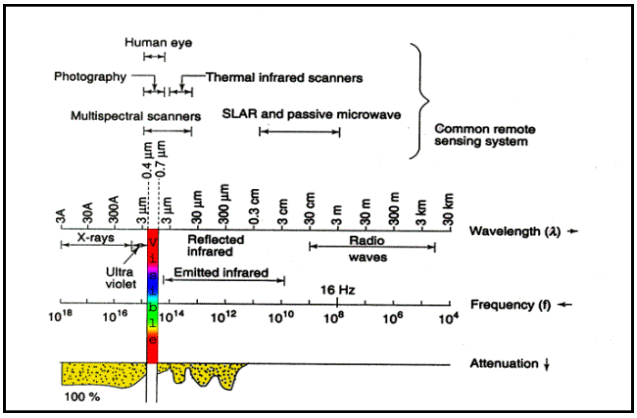

Fig 1: Classification of electromagnetic radiations

2. Rural development

The term 'rural development' is of focal interest and is widely acclaimed in both the developed and the developing countries of the world. There is however no universally acceptable definition of rural development and the term is used in different ways and in vastly divergent context. As a concept, it can notes overall development of rural areas with a view to improve the quality of life of rural people. In this sense it is a comprehensive and multidimensional concept and encompasses the development of agriculture and allied activities-village and cottage industries and crafts, socio-economic infrastructure, community services and facilities and above all, the human resources in rural areas (Chambers, 1983) [1].

As it is mentioned earlier that a big part of Indian population is rural and how important are they to nation's economy. Hence, rural development has been receiving increasing attention of the government; rural development assumes special significance for two important reasons. First about two thirds of the population still lives in villages and there cannot be any progress so long as rural areas remain backward. Second, the backwardness of the rural sector would be a major impediment to the overall progress of the economy.

The focus on rural development is also due to many constraints facing the rural areas, which generally suffer from inadequate infrastructure facilities and technological advancements. The rural areas are not well placed in terms of even minimum needs like safe drinking water, primary health and road transport. This apart, the rural population suffers from indigence, ignorance and illiteracy. Their traditional outlook towards development has been preventing them from taking full advantage of the incentives offered by the Government. Also, the ownership of land and other assets has been heavily concentrated in hands of a few. It is precisely for this reason that the benefits of rural development programmes failed to reach the rural population targeted for these benefits to the extent expected. Hence, a single approach to rural development would not be effective. In fact, rural development is the product of interaction between various physical, technological, economic, socio-cultural, institutional and environmental factors. Indeed, the rural sector should experience the required changes so that it can join the mainstream of national development and contribute its share for economic development (Gupta, 1987) [3].

3. Rural development and space applications

Rural life in India is basically oriented around agriculture; rural people are occupationally dependent on crop production, dairying and small scale industries. Rural people perform agriculture and cultural practices in their traditional manner and hence they depend a lot on each other which have made rural people more deeply connected to their community. This is why whenever rural development has been discussed; community development gets equal importance. Therefore, rural development must involve development of agriculture and associated industries, small scale village industries, socio-economic infrastructure of the village, community services such as health and sanitation facilities, transportation facilities and above all educational facilities. To meet out these developmental goals advance technologies are utmost required and among such technologies telecommunication technology should be applied and permanently established in rural areas. To achieve developmental goals that could enhance quality of life of rural people, a definite policy for communication support to rural people must be formulated and applied on large scale. To provide communication facilities space technologies plays a crucial role in enabling the villages connected electronically to the rest of the nation. India is world leader in space technologies related to communication technology, remote sensing and GIS. ISRO has made remarkable achievements in building advanced satellites and associated infrastructure system such as the INSAT for communication and the IRS satellites for earth observation. ISRO has always been the apex organisation having capability to use the space technology for social benefits such as rural development. This organisation has developed various space application projects such as SITE, TDCC and JDCP using INSAT and finding prospective groundwater zones to provide drinking water in villages, providing land and water resources development plans at watershed level using IRS.

Space application services such as Sat Command EO are playing key role in transforming rural societies. Sat Com is responsible for providing information and services across vast regions whereas EO provides community-centric spatial information in terms of geo-referenced land record, natural resources, sites for exploiting groundwater for potable and recharge, incidence of wastelands having reclamation potential, watershed attributes, environment, infrastructure related information, alternative cropping pattern, etc. Synthesising the spatial information with other collateral and weather information, EO also facilitates locale-specific advisory services at community level. Space based systems are effective in supporting disaster management at community level, wherein the vulnerability and risk related information, early warning, forecast of unusual/extreme weather conditions, etc., provide for building resilience at village community level. Thus Space technology should be harnessed by the local bodies to create an information base and for providing service.

4. Satellite Communication

As we have already discussed that communication is prime requirement for development in rural areas. A well communicated village could be a developed village as early as compared to a village not properly connected. That's why communication has been given highest priority before initiating any other developmental programme. Communication plays a key role in bringing desirable social and behavioural change among the rural society which is most vulnerable when it comes to application of new projects. Space communication technology has the potential to simultaneously communicate with a large population as well as can reach to vast distances in no time. ISRO had undertaken several projects that focused on development of humanity through sophisticated satellite-based communication. Right from the inception of utilizing space programmes for development, the experiments SITE, KCP, JDCP and TDCC have been carried out.

ISRO's Gram SAT satellite connects rural development ministry with 1100 panchayats. This exercise was aimed at getting feedback on the various rural development schemes under operation in the state and to gain an insight into the problems at the field level, on which the ministry needed to focus further planning efforts. The effort was equally aimed at enhancing the awareness of the beneficiaries on their entitlement and various processes involved for availing the benefit of the schemes. The Gram SAT initiative was part of the ministry's effort to bring about transparency and efficiency in implementation of its various schemes all over the country, for which it has been initiating different proactive measures like online monitoring and social auditing, among others.

Gram SAT pilot projects are being run in some select states of the country and are being utilised to reach out development messages directly to the villagers by ensuring community listening, viewing and linking up large body of villagers.

5. Village resource centre (VRC)

Village resource centre is like an IT hub to facilitate the information exchange between village and rest of the country. The satellite system behind VRC is INSAT in collaboration with IRS. Various advantages of VRC are summarised below:

5.1 Tele-education: In these programme rural children especially from those villages which are remotely located distant enough to restrict them to reach nearby city for education can avail facility of tele-education where education has been given through video conferencing at their very own place. Tele-education also aims at providing vocational training at local level to children as well as adults to impart skill development and capacity building that will help rural people in catalysing.

5.2 Tele-healthcare: Provision of better health facilities is a major challenge in rural areas. Rural people are generally poor and could not afford additional expenses onconveyance and expertise in nearby cities for availing health services and hence they rely on traditional treatments or superstitions. Tele-healthcare system at VRCs consists of customised medical software, with certain medical diagnostic instruments. With the help of local doctor/ paramedic, expert medical consultation and counselling are provided to the villagers from specialty hospitals. Healthcare awareness is also a major activity of VRCs.

5.3 Land & Water Resources Management: With increasing population land area for agriculture is shrinking and it is being converted into housing and other non-agricultural purposes. Over grazing, deforestation and other soil related problems are being ignored by the rural people which are causing detrimental effects on land, soil and water resources. Information on land and water resources extracted from satellite images is organised in GIS, and provided to the villagers through the VRC. The local farmers along with the support of skilled personnel such as ADO can utilise this information for better management of their land resources.

5.4 Interactive advisory services: A village in itself is a small society where villagers from different trades help each other through their services in proper functioning of village society. However, at various stages such as: agricultural, educational, legal and judicial, guidance from experts is required. VRCs facilitate interactions between the local people and experts from Agricultural Universities, Technical and law Institutions. Such interactions are beneficial in many aspects such as opting cropping system, selection of seeds, pesticides and fertilizers, market awareness, insurance policies, etc.

5.5 Tele-Fishery: Fishery is another potential area of agriculture especially in coastal areas. Farmers as well as fishermen require information about tidal behaviour at and around their fish farms and fishing sites. VRCs located at coastal tracts are being provided with near real time information on satellite derived PFZ. Information related to inland fisheries, aquaculture, etc., is also provided through VRCs.

5.6 e-Governance Services: Local people are generally unaware of their rights as well as policies being released by the government particularly for their benefits. Consequently, it leads to rise in corruption and poor rural people remain underprivileged. VRCs provides information and guidance to local people on village oriented governmental schemes on agriculture, poverty alleviation, rural employment, social safety, animal husbandry and livestock related, micro-finance related, elections, news, etc.

5.7 Weather Services: It was rightly said by former Prime Minister Jawaharlal Nehru that "everything can wait but, agriculture can't". It simply means that agriculture practices require timely application of inputs and further attention especially according to local weather to crops. Hence, timely information related to weather conditions facilitates local farmers to execute mandatory measures on time which prevents crop failure as well as sustains rural economy. At VRCs Short, medium and long-term weather forecasts and agro meteorological advices are being delivered to local farmers time to time.

5.8 Employment generation: Since VRC is an IT hub so it is made up of computer network and other peripherals which are sophisticated instruments and require proper care and skilled professionals to maintain and operate. Apart from instrumentation, a VRC requires suitable and spacious building, various accessories and electronic equipment for conducting programmes. From manufacturing to its optimum functioning series of workers from different trade are required. Hence, VRC generates employment for rural people.

5.9 Other services: Various other need based services are also provided by VRCs time to time.

Fig 1: Various functional aspects of Village resource Centre (VRC).

So far around 461 VRCs has been set-up in 22 States/Union Territories by the help of ISRO and local government in which over 6,500 programmes have been conducted addressing the issues in Agriculture/ Horticulture, Fisheries, Livestock, Water resources development, Tele-healthcare; Awareness programmes; Women empowerment; Supplementary education; Computer literacy; Micro-credit; Micro-finance; Skill development/ vocational training for livelihood support, etc (ISRO, 2017) [4].

6. Tele-Education

The tele-education programme launched by ISRO, serviced by the exclusive satellite 'EDUSAT', is primarily intended for school, college and higher levels of education to support both curricula based as well as vocational education. With 5 Ku-band transponders providing spot beams, and one Ku-band transponder providing national beam, and 6 extended C-band transponders with national coverage beams, EDUSAT is specifically configured for audio-visual medium, employing digital interactive classroom and multimedia multi-centric system. Many important institutions such as the IGNOU, UGC, IITs, and many State Education Departments and Universities are making use of the EDUSAT network. Presently, more than 34,500classrooms are in the EDUSAT network out of which 3,400 are interactive terminals.

Satellites can establish the connectivity between urban educational institutions with adequate infrastructure imparting quality education and the large number of rural and semi-urban educational institutions that lack the necessary infrastructure. Besides supporting formal education, a satellite system can facilitate the dissemination of knowledge to the rural and remote population about important aspects like health, hygiene and personality development and allow professionals to update their knowledge base as well. Thus, in spite of limited trained and skilled teachers, the aspirations of the growing student population at all levels can be met through the concept of tele-education.

7. Tele-Medicine

A healthy citizen contributes to make a healthy nation. Over the years, the government has introduced various healthcare initiatives and policies, which has resulted in the increase in life expectancy of our citizens. However, providing healthcare to millions of people in rural India is really a formidable challenge. It is a matter of concern that a meager 3% of the qualified doctors, who are attached to about 23,000 Primary and 3,000 Community Health Centres, are available to attend to the 70% of the Indian population. Satellite communication technology, combined with information technology provides a technological means of taking the benefits of the advances in medical sciences to large sections of people spread out in remote and inaccessible villages.

Telemedicine is a confluence of Communication Technology, Information Technology, Biomedical Engineering and Medical Science. The Telemedicine system consists of customised hardware and software at both the Patient and Specialist doctor ends with some of the Diagnostic Equipments like ECG, X-ray and pathology Microscope/Camera provided at the patient end. They are connected through a VSAT system and controlled by the Network Hub Station of ISRO. Through a Telemedicine system consisting of simple computer with communication systems, the medical images and other information pertaining to the patients can be sent to the specialist doctors, either in advance or on a real time basis through the satellite link in the form of Digital Data Packets. These packets are received at the specialist centre.

ISRO's telemedicine network has enabled many poor rural villagers hitherto denied with quality medical services to get the best of medical services available in the country. As of now, we have 377 tele-medicine nodes consisting of 320 remote/ district/ medical college/ mobile hospitals connected to 57 super specialty hospitals in different cities through ISRO's satellites. The ISRO telemedicine network is expanding to various regions in the country and has become one of the most visible and sociological applications in the world today.

Mobile Telemedicine Unit consisting of Medical equipment along with Telemedicine hardware, software and VSAT system mounted in a Bus/Van can establish a Mobile Telemedicine centre at any place. The major area of Mobile Telemedicine applications are in the field of Tele Ophthalmology and Community Health. Under Mobile Tele Ophthalmology, Rural Eye Camps can be conducted and the Rural Population can undergo eye screening for Cataract, Glaucoma and Diabetic Retinopathy. Under Community Health Program, Mobile Telemedicine units are very useful not only for Disease Prevention but also for Health Promotion in terms of running awareness camps & teaching hygienic practices. Village Resource Centres and Telemedicine Recently, ISRO has also initiated pilot projects for integrating Telemedicine/Tele-health with the Resource Information database as well as Tele-Education facilities at the Village Resource Centres/Community Centres (VRC) to reach out to more rural areas of the country. The first of the pilot projects has been implemented in the state of Tamil Nadu wherein the nodal centre operated by an NGO agency at Chennai is connected to remote villages in three districts and more are to come in the future.

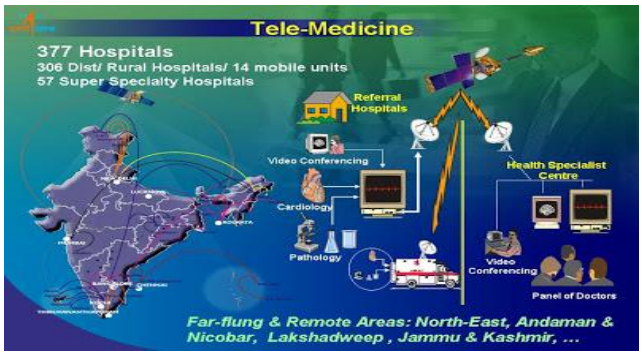

Fig 3: Tele medicine at a glance.

One of the major advantages of Telemedicine technology has been the saving of cost and effort to the rural patients as they are not required to travel long distances for obtaining consultation and treatment. A study conducted by an independent agency on one thousand patients in the Chamarajanagar district hospital in Karnataka has revealed that there was a cost saving of 81% to the patient. That is, the patients who availed the telemedicine consultation and treatment spent only 19% of the money which they would have otherwise spent if they had to travel to the nearest cities for a similar treatment. In the case of remote off shore islands, this is much more significant both to the patient and the Government administration. In such cases, not only the patients have the cost saving but can be provided with quick and timely medical aid.

8. Remote sensing applications

Remote sensing has enabled mapping, studying, monitoring and management of various resources like agriculture, forestry, geology, water, ocean etc. It has further enabled monitoring of environment and thereby helping in conservation. In the last four decades it has grown as a major tool for collecting information on almost every aspect on the earth. With the availability of very high spatial resolution satellites in the recent years, the applications have multiplied. In India remote sensing has been used for various applications during the last four decades and has contributed significantly towards development.

India has its own satellites like IRS series – Resources at, Cartos at, Oceansat etc which provide required data for carrying out various projects. Some of the important projects carried out in the country include Groundwater Prospects Mapping under Drinking Water Mission, FASAL, Forest Cover/Type Mapping, Grassland Mapping, Biodiversity Characterization, Snow & Glacier Studies, Land Use/Cover mapping, Coastal Studies, Coral and Mangroves Studies, Wasteland Mapping etc. The information generated by large number of projects have been used by various departments, industries and others for different purposes like development planning, monitoring, conservation etc.

9. Some future programmes

Realizing the potential and capability of remote sensing and GIS for providing cost and time-effective resource database, the Planning Commission, Ministry of Panchayati Raj and Ministry of Rural Development has proposed to prepare District Resource Atlases using remote sensing and GIS techniques to strengthen various aspects of decentralized district level planning through a co-ordinated approach.

The ICT enabled geospatial platform can be formed using space based EO systems and engaging local bodies for planning and carrying out area developmental activities in a decentralized, speedy and transparent manner. The major objectives are:

9.1 Spatial depiction of land & water resource along with their attribute information for preparation of District Resource Geospatial Atlas keeping Village Cadastral data as base on seamless manner for entire country; (States which are already covered may be brought to uniform standard with respect to content and accuracies).

9.2 Development of software tools and utilities (including web based GIS applications and standalone) for providing multipurpose user driven applications for speedy, accurate and transparent decision making for district planning.

9.3 Capacity building in state departments along with training of manpower and capability for spatial data analysis, which will maintain, update & manage database for decentralized planning.

Village cadastral maps will be collected, scanned, vectorised and geo-referenced to be overlaid onto ortho-rectified imagery. Attribute data from user departments will be converted into spatial layer and various customized information system will be developed for use in planning activity. One node for each state will be created for providing centralized facility for archiving, organizing, updating and dissemination of information at grassroots level.

The objective of the Space based Information System for Decentralized Planning mission is to establish and enable the information system comprising of spatial natural resources and non-spatial data towards supporting the districts for the decentralized planning. This GIS database will be customized to meet the requirements of stake holder departments/concerned in providing the digital resource atlases and any other requirements of the States based on their problems/ priority/ developmental programme at Village/ Block/ Taluka/ District level. The Mission is intended to be executed and supported by State Remote Sensing Application Centres / Institutes / IT Departments and Industries and ownership of the database and resource information will be with respective individual stakeholder departments.

10. Conclusion

Planning and managing rural areas is a challenging task and requires advanced technologies, skills and approach. Space application technologies are highly advanced and sophisticated technologies that provide necessary input and intelligence of high utility in the betterment of rural areas. Also, space application technologies possess huge potential which can be harnessed by incorporating additional skilled manpower, capital and government initiatives in synergistic manner for the common goal i.e. all round rural development.

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