The Scientific Temper
July, 2010; No.1: pp199-206

Academy of Innovative Research
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THE ROLE OF REMOTE SENSING TECHNOLOGY IN COUNTER-NAXALITE OPERATIONS: PROBLEMS AND PROSPECTS

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The internal challenges to Indian security are growing serious day by day. India has long history of separatist and secessionist violence, be it in North-East, Punjab or Kashmir. The nation, presently, is facing not one but two wars within its own borders. The first, as we all know, is the rising threat of Islamic terrorism, but the second often overlooked dimension to this internal war, is that of the naxalite terrorists, who are bred and sustained by the Communists Party of India (Marxist-Leninist) CPI (ML). In April 2006, Indian Prime Minister Manmohan Singh called the naxalite threat the "biggest internal security challenge ever faced by our country" [1].

Naxalism is pure and simple terrorism, which disguises itself with terms like "class struggle" and "social justice."[2] The term 'naxalite' is derived from Naxalbari in Darjeeling district of West Bengal where, the rebel cadres of the CPI (M), the ruling party of the state, led by Charu Majumdar and Kanu Sanyal launched a peasants' uprising on May 25, 1969 after a tribal youth, who had a judicial order to plough his land, was attacked by "goons" of local landlords on March 2. Tribals retaliated and started forcefully capturing back their lands. The CPI (M)-led United Front government cracked down on the uprising and in 72 days of the "rebellion" a police sub-inspector and nine tribals were killed. The incident echoed throughout India and naxalism was born.[3] The naxalites claim to represent the most oppressed people in India, those who are often left untouched by India's development and bypassed by the electoral process. Invariably, they are the Adivasis, Dalits, and the poorest of the poor, who work as landless labourers for a pittance, often below India's mandated minimum wages. Ideologically, the naxalites claim they are against India as she exists currently. They believe that Indians are still to acquire freedom from hunger and deprivation and that the rich classes - landlords, industrialists, traders, etc -control the means of production. Their final aim is the overthrow of the present system; hence they target politicians, police officers and men, forest contractors, etc. The ideology of naxalism soon assumed larger dimension and entire state units of CPI (M) in Uttar Pradesh and Jammu and Kashmir and some sections in Bihar and Andhra Pradesh joined the struggle. Chhattisgarh, Orissa and Jharkhand have replaced Andhra Pradesh and Bihar as the states most affected by it.[4]

The root cause for the rise in naxalism is the inability of the states to address the many genuine grievances of the people. The gape between the unrealistic expectations, fuelled by populist rhetoric, and their actual fulfillment has increased and not decreased over the years. The younger generation is no longer willing to put up passively with injustice and humiliation without a fight. The bitterness of angry young men against the prevailing unjust socio-economic system is spilling over. The older generation is not unsympathetic to them. Educational systems which produce unemployable young boys and girls have not helped. Pressure on land has made

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the task of survival on agriculture more difficult. Callous district administrations, especially in the rural areas, a clogged judicial system and feudal attitudes have compounded the problem. The land disputes have multiplied, but the land records and the judicial system to settle them is in disarray. There is a sense of frustration and anger.[5]

Naxalites have exploited the dissension among the havenots very deftly and several naxalite groups have mushroomed in recent years. The most prominent among them are the People's war Groups (PWG) and the Marxist Communist Centre (MCC). But it is not ideology and revolutionary zeal that is driving them. For many, joining these groups is the only way to survive. Their main activity is extortion. Huge funds amounting to hundreds of crores of rupees are being extorted by them. What they cannot get through legitimate means they obtain through arms and explosives. Their tactics are no different from the insurgent and terrorists. Create terror and extort money.[6] According a report naxalite extorted Rs. 40 crores annually in the Jharkhand only.[7] They are, however, not secessionists. Their aim is to overthrow what they call an unjust socio-economic system. But they are in hurry to achieve their ideological aims as they can extort enough money. Corrupt politicians, policemen and civil servants have made their own adjustments with these groups. A live and let to live attitude is mutually beneficial to all of them

Presently, naxalism has spread to more than 170 of India's 600 districts in 15 states, constituting more than 27 per cent of the land area of the country. The area under the naxalite influence has been nicknamed the "red corridor".[8] Starting from Andhra Pradesh, the 'Red Corridor' runs through eastern Maharashtra, Madhya Pradesh, eastern Uttar Pradesh, Chhattisgarh, Jharkhand, West Bengal and Bihar. It links the 'liberated zones' of India with the Maoist held territories of Nepal. The 'Red Corridor' unites the left-extremists of India with their comrades in Nepal.

The 'Red Corridor' makes nonsense of any official claim, made either by state governments or the Union government, that security agencies are battling the Naxalites with full force. Its expansion at a rapid pace[9] betrays the fact that our security agencies and their political patrons are both clueless and lacking in courage to tackle India's enemy within.

Nor does it make sense to pretend that Naxalites pose a 'law and order problem.' The threat from Naxalites is much more than that — they pose a challenge to India's democratic polity and rule of law; they pose an ideological threat that questions the legitimacy of the Indian State. The naxalites have not only extended their paws upto more than a quarter of the total land area of the country but also they have established liberated zone in the Dandakaranya forest where they run a parallel government. It extends from Gadchiroli in Maharasthra to Abduz and Bastar in Chhattisgarh, covering an area of 92,000 square kms which twice the size of Keral. The most disturbing and conspicuous feature of this area is total absence of Indian Tri-colour.

In Jahanabad 1000 naxalites stormed a police complex housing a district jail in eastern Bihar on November 13, 2005 exemplifying their capacity to strike. In the Dandakaranya they have shown their capacity to rule.[10]

Seen from the perspective of internal security, the Naxalites are fast turning into India's 'Fifth Columnists,' more than willing to join hands with external forces that have been trying to undermine India's territorial integrity and rend its social fabric. They are today's Trojan forces.[11] **A**ccording to intelligence reports; naxalites have joined hand s with Jihadi fundamentalists for the purpose of subverting the Indian state. India's intelligence agencies have evidence to prove that Naxalites are being used by Pakistan's ISI for drug-trafficking and pumping fake currency notes. In return, the ISI is providing the Naxalites with sophisticated weaponry and the know-how for making and using improvised explosive devices. Seized weapons and ammunition bear witness to this evidence.[12]

A Union Home Ministry report indicated that the Naxalites could capture nearly 60 per cent of the land area of Chhattisgarh by 2010, if decisive operations are not carried out to dismantle their bases. The report also said that a total of 749 people, including 285 civilians, were killed in Naxalite violence in India during the year 2006.[13] Official sources said the Army had detected at least 120 militant camps in interior parts of the three districts by using Remote Sensing Satellite System. The camp comprised 32 huts, two training grounds, a firing range and a play field, the release said. One rifle with magazine and ammunition, 10 grenades, two radio sets and 40 kg of explosive materials were recovered from the spot.[14] The Maharashtra government had introduced a helicopter for anti-naxal operations with much fanfare April 2008.[15] Jharkhand police have planned to install video cameras for surveillance in Parasnath hills. Khammam police in Andhra Pradesh conducted on aerial survey of naxal infested areas with helicopter fitted with latest gadgets including zoom cameras, on March 11, 2008.[16]

Keeping in view the magnitude and expansion of the naxalite menace, we can easily guess the difficulties and risks involved in gathering information required for counter-operations. The conventional method of patrolling not only requires huge manpower but also incur heavy losses in terms of life and material both. To make the counter-naxalite operations cost-effective and result-oriented, employment of modern surveillance technology i.e. Remote Sensing Technology would be highly beneficial. Though helicopters are being used for aerial surveillance and counter-naxalite operations by paramilitary forces in some states, there is vast scope for remote sensing. A Memorandum of Understanding (MoU) was signed by Central Reserve Police Force (CRPF) and Indian Space Research Organisation (ISRO) on March 15, 2008 for developing a focused Geographical Information System (GIS) using high-resolution satellite images to hunt down terrorists and naxalites from their hideouts in hilly areas and dense jungles across the country. India is set to use satellite images for the first time for the purpose. It will first be used by the CRPF which is the main counter-insurgency force in the country.

Remote sensing has provided a new impetus for national development and security. During the last four decades, through space observation programme, it became possible to gather accurate information about the whole globe or a specific area without disturbing or taking permission from any country or whole body. These geo-graphical and positional informations have become an integral element in the development and in fighting wars. Increasing firepower and diminishing time have compelled our defence planners, strategists and scientists to consider better ways for reconnaissance, surveillance and target acquisition for combat effectiveness through remote sensing techniques.

What is Remote Sensing?

The science (and art) of acquiring information about an object, without entering in contact with it, by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information.

Remote sensing refers to the process of gathering information about an object, at a distance, without touching the object itself. The most common remote sensing method that comes to most people's minds is the photographic image of an object taken with a camera. Remote sensing has evolved into much more than looking at objects with our eyes. It now includes using instruments, which can measure attributes about objects which unaided human eyes can't see or sense.

According to Colwell, "Photogrammetry and Remote Sensing are the art, science and technology of obtaining reliable information about physical objects and the environment, through a process of recording, measuring and interpreting imagery and digital representations of energy patterns derived from noncontact sensor systems" (Colwell, 1997).

According to Sabins, "Remote sensing may be broadly defined as the collection of information about an object without being in physical contact with the object. Aircraft and satellites are the common platforms from which remote sensing observations are made. The term remote sensing is restricted to methods that employ electromagnetic energy as the means of detecting and measuring target characteristics" (Sabins, 1978).

According to Aronoff, "Remote sensing is the art and science of obtaining information from a distance, i.e. obtaining information about objects or phenomena without being in physical contact with them. The science of remote sensing provides the instruments and theory to understand how objects and phenomena can be detected. The art of remote sensing is in the development and use analysis techniques to generate useful information" (Aronoff, 1995).

More precisely, it can be defined as: "The acquisition and measurement of data/information on some property (ies) of a phenomenon, object, or material by a recording device not in physical, intimate contact with the feature(s) under surveillance".[17]

Thus, we can say that remote sensing is any observation made at a point removed from the object under investigation. More commonly it refers to observations of areas of land and water covering the earth by airplane or satellite. In the broadest sense, remote sensing is the small or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing device(s) that is not in physical or intimate contact with the object –such as by way aircraft, spacecraft, satellite, buoy or ship .

Components of a Remote Sensing System:

While the definition of remote sensing describes a very wide array of technologies and types of research, all remote sensing technologies are based on certain common concepts, and all remote sensing systems consist of the same basic components. These four basic components of a remote sensing system include a target, an energy source, a transmission path, and a sensor.

The target is the object or material that is being studied. The components in the system work together to measure and record information about the target without actually coming into physical contact with it. There must also be an energy source which illuminates or provides electromagnetic energy to the target. The energy interacts with the target, depending on the properties of the target and the radiation, and will act as a medium for transmitting information from the target to the sensor. The sensor is a remote device that will collect and record the electromagnetic radiation. Sensors can be used to measure energy that is given off (or emitted) by the target, reflected off of the target, or transmitted through the target.

Once the energy has been recorded, the resulting set of data must be transmitted to a receiving station where the data are processed into a usable format, which is most often as an image. The image is then interpreted in order to extract information about the target. This interpretation can be done visually or electronically with the aid of computers and image processing software.[18]

Remote sensing involves collecting an image of a region on the Earth by one of two means- passive and active.[19]

1. Passive sensing monitors the objects under investigation by using electro-optic sensors to collect solar radiation reflected off the object. Passive sensors are those which sense natural radiations, either reflected or emitted from the earth.
2. Active sensing uses a source of electromagnetic radiation. RADAR is an example of active remote sensing where the time delay between emission and return is measured, establishing the locations, height, speed and direction of an object.

Remote sensing can also be broadly classified as optical and microwave. In optical remote sensing, sensors detect solar radiation in the visible, near-, middle- and thermal-infrared wavelength regions, reflected/scattered or emitted from the earth, forming images resembling photographs taken by a camera/sensor located high up in space.[20] Remote sensing sensors are generally classified as panchromatic (PAN) or multispectral (MS). The former produce data in black and white, while the latter produce data in color. MS sensors record images that provide the means to identify and study characteristics of different surface features. These sensors usually include portions of the spectrum in both the visible and infrared regimes. Recently, hyper spectral sensors have been developed that divide up the spectrum into many more, smaller bands than MS sensors for even more detailed characterization of surface features.

Earlier remote sensing satellites recorded images on film. All current satellites use digital systems to record the images. Digital image data can be transmitted to ground-based stations and digital data are able to be processed on computers. An important feature of remote sensing systems is resolution. There are four measures of resolution[21]

1. Spectral resolution,
2. Temporal resolution,
3. Radiometric resolution, and
4. Spatial resolution.

Spatial resolution refers to the size of a pixel that is recorded in a raster image - typically pixels may correspond to square areas ranging in side length from 1 to 1000 meters.

Spectral resolution refers to the number of different frequency bands recorded - usually, this is equivalent to the number of sensors carried by the platform(s). Current Land sat collection is that of seven bands, including several in the infra-red spectrum. The MODIS satellites are the highest resolving at 31 bands.

Radiometric resolution refers to the number of different intensities of radiation the sensor is able to distinguish. Typically, this ranges from 8 to 14 bits, corresponding to 256 levels of the gray scale and up to 16,384 intensities or “shades” of colour, in each band.

The **temporal resolution** is simply the frequency of flyovers by the satellite or plane, and is only relevant in time-series studies or those requiring an averaged or mosaic image as in deforesting monitoring.

The other type of remote sensing, active systems, primarily use radar as the source of electromagnetic radiation. Radar has two major advantages over reflected solar radiation: it can penetrate cloud cover and it can be used at night because it does not depend on the sun. Active systems, therefore, can make observations that cannot be made by passive systems. Radar observations, however, are more complex and costly than passive systems and have been slower to develop. Advances in radar imaging technology, however, have increased interest in these systems in recent years. In addition to technologies for obtaining images, a very important aspect of remote sensing is the processing of the raw images to facilitate the analysis and application of the data. It consists primarily of the development and application of software to analyze the content of the images. Because the latter are in a digital format, much of this processing is done with the use of computers. In addition to computer software, human expertise in interpreting remote sensing images is an important component.[22]

Applications of satellite remote sensing are varied and growing. The type of application varies primarily with the portion of the spectrum that can be observed by a sensor, by the spatial resolution of that sensor, and by whether the sensors are passive or use radar. Most current satellites carry a range of sensors so that they can perform a variety of applications. Satellites with low spatial resolution-over one kilometer-are generally used for collecting meteorological and environmental data. Medium resolution satellites, that is, less than 100 m, are used primarily for environmental monitoring and a range of other applications including military observations and mapping of urban areas. High resolution remote sensing satellites, that is, 10 m and less, are relatively recent. Recently, India launched a 1 m PAN satellite. Beside a range of mapping applications these satellites also offer increased potential for national security applications. The U.S. satellite of this category, Ikonos 2 is being used by the U.S. military in the current war in Afghanistan. In addition, images from that satellite were used extensively by the media following the September 11 attacks on the World Trade Center and the Pentagon. A range of other national security applications, including force monitoring and treaty verification, are envisaged for these high resolution satellites.

Evolution of Remote Sensing Technology in India

Starting from Bhaskara, the first experimental Earth Observation (EO) satellite launched in 1979, to the recently launched Cartosat-2 in 2007, a range of spatial resolution ability from 1 km to better than 1 m has been achieved and operationalised. The Indian Space Programme was initiated in 1980 when National Remote Sensing Agency (NRSA) came under the Department of Space. The National Remote Sensing Agency (NRSA), an autonomous society under Department of Space (DOS) has been converted into a full-fledged Government organisation called National Remote Sensing Centre (NRSC) from September 1, 2008. Since then, the country has crossed many a major milestones in this field. India entered operational remote sensing arena by launching indigenously built first Remote Sensing Satellite IRS-1A in March 1988 under Indian Earth Observation Programme. IRS-1A had two types of payloads one with a resolution of 72.5 m and the other with 36.25 m, providing a swath of about 148 km.[23] Since then, a number of IRS Satellites have been launched and remote sensing capability has grown many folds in the country as shown in Table-1.

Table 1. Major Specifications of Present IRS Series of Satellites

Satellites	Year
IRS-1A	1989
IRS -1B	1991
IRS-P2	1994
IRS-1C	1995
IRS-1D,	1997
IRS-P3	1996
IRS-P4 (Oceansat)	1999
IRS-P6 (Resourcesat-1)	2003
IRS-P5 (Cartosat-1) PAN	2005
Cartosat-2	2007

The evolution of the Indian EO satellites can be classified into three broad categories, viz. first generation of experimental satellites (Bhaskara-1 and 2), second-generation of operational satellites (IRS series) and present generation of theme-specific satellites (Oceansat-Resourcesat-1, Cartosat-1 and 2). The Bhaskara-1 and 2 satellites provided necessary experience in handling a total remote sensing system. It carried two payloads, viz. a Television Camera and a Microwave Radiometer. IRS-1A and IRS-1B with identical payloads (LISS-I and LISS-II sensor) were the first operational satellites launched for both marine and land applications. While LISS-I and LISS-II systems were found useful in many national level natural resource management studies, a need was felt to have panchromatic sensor with high spatial resolution for urban mapping.[24]

Considering these needs, as a follow-up to IRS-1A and IRS-1B satellites, IRS-1C and IRS-1D satellites were launched with newer payloads such as Panchromatic camera (PAN), LISS-III camera and a Wide field sensor (WiFS). The PAN camera was the highest spatial resolution (5.8 m) civilian system in the world at the time of launch of IRS-1C satellite in 1995. The four-band multi spectral camera LISS-I/LISS-II was modified into four band multi-spectral LISS-III camera with inclusion of SWIR band in place of the blue band. The SWIR band was included due to need for detection of moisture stress in crops and discrimination of snow from clouds. The WiFS camera was conceptualized from the need of frequent observation for monitoring of crops at national scale. The WiFS camera provided large area information at a temporal resolution of five days, which was found highly useful in national level wheat area and production forecast and cropping system analysis. While availability of data from the operational EO systems starting from IRS-1A/1B to IRS-1C/1D facilitated applications in the fields of agriculture, forestry, land use, coastal zone, etc., strong need was felt to design application- specific sensors for ocean observations, cartography and land resources. This started the era of theme-specific missions such as Oceansat-1, Resourcesat-1 and Cartosat- 1 and 2. Experience gained in ocean colour studies from IRS-P3 MOS data helped to formulate the sensor specifications of IRS-P4 (Oceansat-1), which became the first Indian satellite, primarily built for ocean applications. Oceansat-1 carried Ocean Colour Monitor (OCM) sensor and Multi-Frequency Scanning Microwave Radiometer (MSMR). Resourcesat-1 (IRS-P6) is a mission primarily dedicated to agricultural applications in India. It caries three cameras, viz. LISS-IV, LISS-III and Advanced WiFS (AWiFS). The selection of Resourcesat-1 sensor parameters was based on the experience gained from earlier satellites as well as experimental campaigns conducted over agricultural region. Cartosat-1 and recently launched Cartosat-2 satellites are state-of-the-art remote sensing satellites intended for cartographic applications. The present IRS systems discussed so far, gave an idea of application- driven development of imaging technology, within a span of two and half decades.[25]

In addition to the present EO missions, there are specific remote sensing satellites planned in future to address issues of monitoring disasters, ocean observations, atmospheric profiles and global change. The planned EO missions include Oceansat-2, INSAT-3D, RISAT, Megha-Tropiques and Resourcesat-2. The improved OCM, Ku-band Scatterometer, C-band SAR, Imagers and Sounders are some of the important sensors planned in future missions as shown in Table 2.

Table 2. Satellites Planned for Near-Future Launching and Their Sensor Characteristics

Satellite	Sensor Spectral Bands
TWSAT	Multi-spectral camera
RISAT	SAR
Megha Tropiques	MADRAS
	SAPHIR
	SCARAB
Oceansat-2	Scatterometer
	OCM
INSAT-3D	Imager
	Sounder

On April 28, 2008, ISRO scientists have marked the history by sending 10 satellites out of which 6 nano satellites were collected in the bundle and 2 nano were projected separately from Satish Dhawan Space Centre in Sriharikota, Andhra Pradesh through Polar Satellite Launch Vehicle (PSLV-C9) orbit. Eight satellites out of ten were from Germany and Canada. The bundled satellites were collectively named NLS-4 that were put into orbit including major Cartosat2A, mini satellite (IMS-1) and two nano satellites and projected on the set target. The rocket reached on the destination point within 20 minutes as per calculated time without any slightly deviation, as per ISRO sources said.[26]

The major Cartosat2A is a remote-sensing satellite inbuilt with a high-resolution camera, which will supply data for maps precise enough to detail every house in the country. With a life span of five years, Cartosat2A is the third in the 'carto' or mapping series. ISRO will use the received information for managing infrastructure and natural resources.[27]

Conclusion and Suggestions:

Being an important and responsible country of this part of the continent, it is our sheer responsibility to evaluate the strategic importance of this region periodically . So, it is necessary to have a modern system of reconnaissance and surveillance. For better management of forces and materials, it is necessary to monitor the inaccessible infested areas and the neighbouring region including Indian Ocean and it's under water regularly. This can only be possible through advance spy or military satellites, navigation system, airborne intelligence system along with powerful ground intelligence network. Although we have IRS series of satellites and various others ground intelligence for collecting different information about the region but at the same time to meet the future challenges, it is need of the hour that to make our distinct mark in the field of remote sensing by developing and launching high resolution remote sensing satellites specially for military purposes at the regular interval of every two years.

So to avoid more Kargils in future to cater our future needs relating to internal security and to counter the future naxal activities in the country effectively, it is now pertinent to strengthen our electronic intelligence capability through modern means of remote sensing and information technology.

The status of remote sensing technology in India is very advanced. The employment of remote sensing technology gathering information for security forces involved in counter-naxalite operations will certainly enhance their capabilities and effectiveness manifolds. Though the employment of remote sensing technology will greatly help the forces engaged in countering the naxalite menace, they, in no way, help in eradicating the epidemic. For eradicating the internal security challenges, be it naxalism, religious fundamentalism, terrorism etc. the country require sensibility towards its security and integrity in political leaders and policy makers more than remote sensing. In the end, the military principles of Sun Tzu and Carl Von Clauswitz among others of the ages will reaffirm the need to constantly re-evaluate and refine our current operational doctrine as the only constant throughout military history is change.

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