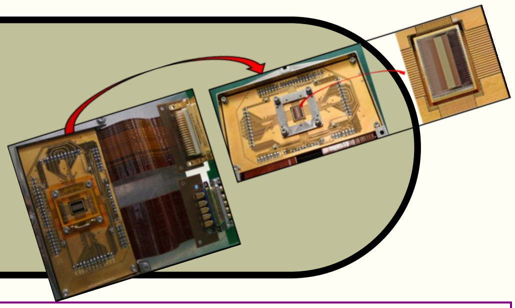
# Signatures

An ISRS Ahmedabad Chapter Newsletter

Volume 28, Issue 2 August 2021

# Self-Reliant Bharat and Remote Sensing



## Inside this issue




# FROM THE EDITORIAL DESK

*It is with great exuberance and anticipatory excitement that we bring out this issue of **Signatures** on the occasion of National Remote Sensing Day that is annually celebrated on August 12th to mark the birth anniversary of Professor Vikram Sarabhai - the founding father and architect of India's Space Program. The phenomenal growth story of India's space program from its modest beginning has its roots in the pragmatic vision of the institution builder that Prof. Sarabhai was. The narrative of societal applications and national development had been at the core of our space program from its initiation, and continues to thrive even as India strides towards space exploration and commercialization of its space assets. An integral part of this narrative has been the culture of self-reliance that ISRO has imbibed in all spheres in general, and in developing and operationalizing Remote Sensing (RS) instruments in particular. Undoubtedly, India is among a few leaders of space-based RS technology and applications with an ever-increasing trained workforce due to a successful outreach program. As the clarion call of 'Atmanirbhar Bharat' resonates in the functioning of government bodies and institutions across the country, one is reminded of the years of demonstrated excellence through self-reliance in space-based RS and its applications. With this backdrop, this issue of **Signatures** dwells upon the broad theme of 'Self-Reliance in Space-based RS-Technology, Applications and Outreach' to highlight Prof. Sarabhai's vision and India's journey since the formative years to the present time in terms of RS technology demonstration, operationalization, user applications, engaging the youth through capacity-building and participatory role of Indian industries and academia.*

*This issue features several special articles cutting across the spectrum of space-based RS activities that is sewed with the common thread of 'Self-Reliance' theme. The tone and tenor of this issue is set by a vivid narrative on Prof. Sarabhai and his multi-dimensional vision by none other than his illustrious son, Shri. Kartikeya V Sarabhai who is a well-known educationist. This issue is also adorned by special article on the evolution of payloads and applications for RS by Shri Nilesh Desai, Director, Space Applications Centre (SAC) and a doyen of microwave RS who has been closely associated with the development of space systems technology, processes and applications in SAC since the last 35 years. We are immensely grateful to him for enlightening us with his narrative that has surely enriched this issue. The special article on the saga of Indian industries growing as spin-off to the microwave RS payloads program of ISRO highlights the symbiotic relation between ISRO and industry stakeholders and we are happy and obliged to receive the thoughts of Shri Rajeev Jyoti, Distinguished Scientist and DD-MRSA, SAC. The special article by Dr. Prakash Chauhan, Director, Indian Institute of Remote Sensing is a comprehensive yet concise narrative of the systematic developments of the self-reliant program for earth observation applications. The democratization of entire gamut of space activities through capacity-building program is a vital dimension of self-reliance vision which this issue of **Signatures** talks about with views shared by Shri C P Dewan, GD (retd.), PPG-SAC.*

*We are extremely grateful to Prof. Bharat Lohani, IIT-Kanpur, who has shared his thoughts on the role of academia and centers of knowledge towards preparing the human resource for the Atmanirbhar RS program.*

# FROM THE EDITORIAL DESK

*As GoI releases the new geospatial policy, a note on the newly released policy by Dr. Shashikant Sharma, GD-VRG, SAC is quite relevant to this issue. The narrative on the role of Indian start-ups in geospatial data analytics by Ms. Pushpalata Shah, Vice President - GIS Solutions, Scanpoint Geomatics Ltd. adds substance to our eternal goal of self-reliance. Mindful of our commitment to the promotion of Hindi-our official language, the special article on the odyssey of planetary remote sensing from Chandrayaan-1 to Chandrayaan-2 by Mr. Ramdayal Singh and Dr. A S Arya adds a native flavor. The special coverage on the modern-day discourse on gender equality, neutrality and positivity in RS and GIS world by Ms. Shailee Rajak and Dr. Rashmi Sharma sketches the transition from parochial outlook towards gender issue around this field to a more liberal mindset and is sure to grab readers' attention.*

*This issue carries an obituary by Dr. C Patnaik to pay our homage to our dear colleague and a stalwart in the field of remote sensing, Dr Shibendu Shankar Ray whom we lost earlier this year due to COVID19 pandemic.*

*Several activities that have been carried out by ISRS-AC in recent months have been summarized in Secretary's report by Dr. Dhani Ram Rajak, Secretary, ISRS-AC. As customary, the regular articles of this issue features a short note related to the program on World Oceans Day, news snippets from the world of RS and GIS and upcoming conferences on RS and GIS. The book review by Dr. Rimjhim Bhatnagar and Mrs. Nimisha Singh, members "Signatures Editorial Committee", of the book- 'IKIGAI- The Japanese Secret of a Long Healthy Life' introduces our readers to the age-old secrets of Japanese people of Okinawa island towards leading a long and healthy life as the average longevity of this island is anything to go by.*

*As we release this issue, the editorial team is extremely grateful to the esteemed authors of special articles who have spared their precious time and obliged by penning their innate thoughts for this special issue. We acknowledge the untiring efforts put in by 'Signatures' editorial committee members- Dr. Rimjhim Bhatnagar, Ms. Nimisha Singh and Dr. S V V Arun Kumar towards timely release and publication of this issue. Right from concept to coordination, Dr. Rashmi Sharma, Editor, 'Signatures', has been a driving force and we are extremely thankful to her for her whole-hearted support. Last, but not the least, we thank Dr. Bipasha Shukla, for her kind support in bringing out this issue. We are sure that this special issue will be received well by our valuable readers and eagerly look forward to their feedbacks.*

*Happy Reading!*

*Guest Editors*

# CHAIRMAN'S ADDRESS

## RAJEEV JYOTI

It is a matter of great satisfaction that ISRS-Ahmedabad Chapter is bringing out this special issue of '***Signatures***' based upon the theme of 'Self-Reliance in Space-based Remote Sensing - Technology, Applications and Outreach' on the occasion of the National Remote Sensing Day, 2021. As India stands at the crossroads of a major overhaul in the space sector, this theme is very pertinent from the perspective of reliving the journey so-far in achieving self-reliance in remote sensing and exploring the myriad new opportunities thrown open by the country's emerging new data policy as well as the imminent role of private sector in this domain.

The journey of India's space program in general, and the remote sensing program in particular, had at its core the motif of societal development. Way back in the 1960s, Prof. Vikram Sarabhai had this unique vision that in a developing country like India, space technology should have a different narrative than indulging in space race like the developed nations. Over the years, the impressive growth trajectory of ISRO's space-based microwave and optical remote sensing program has stood upon the pillar of self-reliance, a culture that Prof. Sarabhai had imbibed. Today, our vibrant self-sustained remote sensing program is supporting a gamut of applications from alerting fishermen of potential fishing zones to accurately predicting cyclones, from annually forecasting crop-yield to biennial forest-cover mapping, from coastal-zone mapping to generating glacial maps and many more.

Recently, the Dept. of Science & Technology, Govt. of India has announced new set of guidelines, which aims to liberalize access of geospatial data to Indian private entities. This, coupled with the recent liberalization of the space sector by the Dept. of Space, GoI, will provide a huge impetus to the Indian industry, especially the startups, to come forward and compete globally by bringing in modern tools to cater to thematic demand-driven applications. India's self-reliance will hence increase manifold beyond the ambit of ISRO in developing space infrastructure and applications.

I reckon that this issue is adorned with articles that capture a retrospective view of achieving self-reliance in the Indian Remote Sensing Program and a prospective outlook towards the emerging future in terms of opportunities for the youth, participation of the Indian industry, data transparency and what all these mean for the societal and economic growth of the country. ISRS-AC is committed to popularizing the advancements in remote sensing in the country, and as the Indian remote sensing program braces for liberalization, larger outreach and inclusiveness, this issue will convey a powerful message to the aspirational youth.

I express my earnest gratitude to the authors who have contributed to make this thematic issue a success. I put on record my ardent appreciation of the Guest editors and the ***Signatures*** editorial team for conceptualizing and elegantly compiling this special issue that is worthy of NRS Day

# CHAIRMAN'S ADDRESS

**(CONTD.)**

release. I am sure that the editorial team would bring out many more such *Signatures*' issues in future.

Wishing the reader wonderful days ahead when we all can live without the scare of pandemic.

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Wishing the reader wonderful days ahead when we all can live without the scare of the on-going pandemic.

**Rajeev Jyoti**

Chairman, ISRS-AC

Deputy Director, MRSA, SAC-ISRO, Ahmedabad

# SECRETARY'S REPORT

## D. RAM RAJAK

**Let me wish you all Happy National Remote Sensing Day, 2021!**

Once again, the Editorial Team of *Signatures* is presenting a special issue which is dedicated to **Self -Reliant Bharat and Remote Sensing.** On this occasion, let me brief you all about the recent activities that have been carried out by ISRS – Ahmedabad Chapter.

On World Meteorological Day 2021, a lecture on the topic "Observation, Information and Advisory Services" was delivered by Dr. T Srinivasa Kumar, Director, Indian National Centre for Ocean Information Services (INCOIS), Hyderabad. ISRS-AC organised this activity jointly with IMSA and ISG-AC on March 23, 2021. The Earth Day 2021 was celebrated jointly by ISRS-AC, ISG-AC and IMSA by conducting a lecture on "Monitoring tigers and dolphins: small steps, big data for informed decision to protect nature for future". The lecture was delivered by a well-known ecologist Prof. Qamar Qureshi, WII, Dehradun on April 22, 2021. On World Environment Day 2021 (WED2021), June 5, 2021, ISRS HQ arranged a lecture by very distinguished ecologist and academician Dr. A.S. Raghubanshi, FNASc, Professor and Director, Institute of Environment and Sustainable Development, BHU, Varanasi on the topic "Ecosystem Restoration: A Historical Need Analysis and Future Strategies". ISRS-AC and VSSE/SAC arranged a WED2021 Leaf Drawing & Painting completion on June 6, 2021 for employees & family members of SAC and members of ISRS-AC and their family members. The World Oceans Day 2021 (WOD2021) was celebrated with a popular lecture on "Oceans, Life, Blue Economy and Sustainable Living" by Cmde S M Urooj Athar, Principal Director II, Directorate of Naval Oceanology and Meteorology, Naval HQ.

The previous issue of the *Signatures* was also a special issue dedicated to "Women in RS & GIS" which was released by Director SAC, on International Women's Day celebration at SAC, Ahmedabad. An executive committee meeting of ISRS-AC was held on July 1, 2021 and many important decisions were taken. The Annual General Body Meeting of ISRS-AC took place on August 7, 2021 and Prize Distribution to winners of WED2021 Drawing and Painting completion was also carried out.

Bringing out this special issue by the Editorial Team is a matter of happiness that the team is excelling in its delivery far beyond expectations. I heartily congratulate the energetic and enthusiastic team of the *Signatures*!


**D. Ram Rajak**

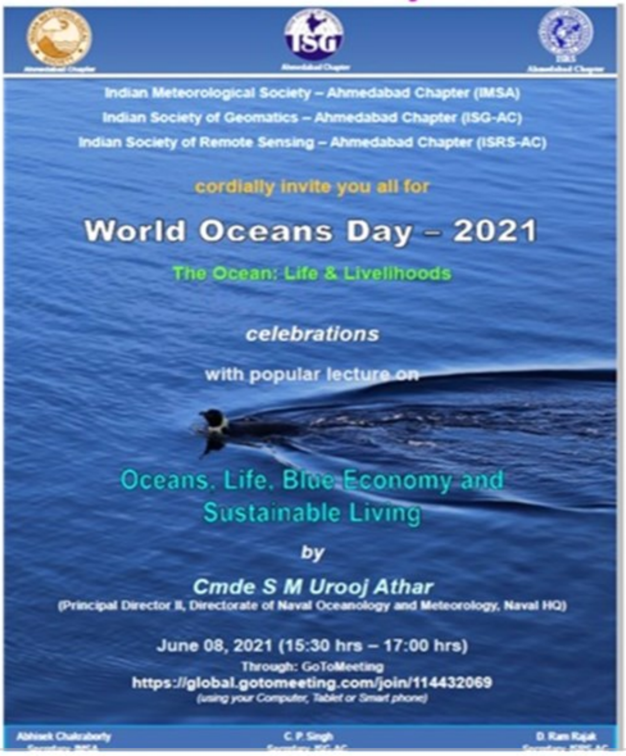
Secretary, ISRS-AC,

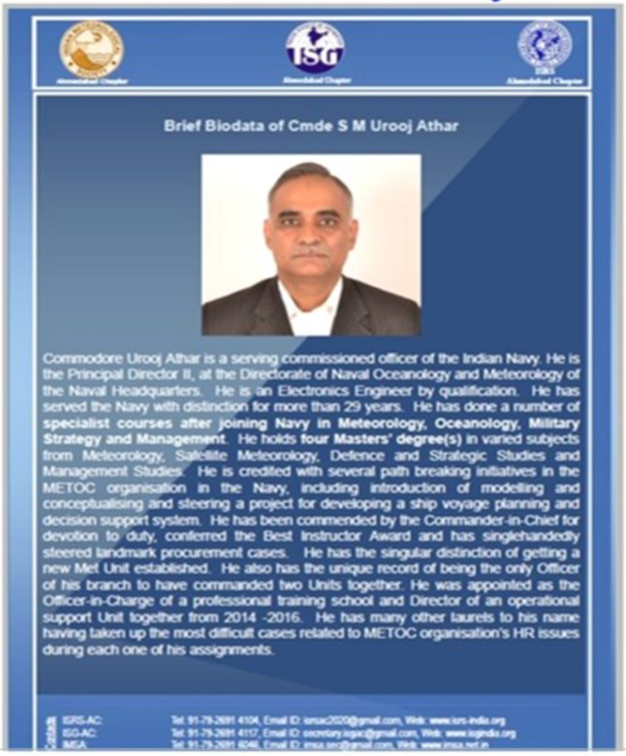
Scientist, SAC-ISRO, Ahmedabad

# ISRS-AC ACTIVITIES

**(CONTD.)**

## World Oceans Day 2021 Lecture : Cmde S M Urooj Athar




## World Environment Day 2021: Leaf Drawing & Painting Competition on Dec 6, 2021 (Sunday)


### विश्व पर्यावरण दिवस 2021

### पत्ती चित्रकारी एवं पेंटिंग प्रतियोगिता के विजेता

| | | | | | |
|---|---|---|---|---|---|
| | श्रेणी-I कक्षा 1 से 5 तक | | | | |
| क.सं. | प्रतिभागी का नाम | पुरस्कार | सैक कर्मचारी | क्षेत्र | फोन नं. |
| 1. | जागरवी टेलर | प्रथम | पीयूष टेलर | एसएनपीए | 8479 |
| 2. | वरदा गुप्ता | द्वितीय | कृष्ण मोहन | एसआरए | 4218 |
| 3. | देशना अध्वर्यु | तृतीय | पूर्वी जोषी | एप्सा | 4301/4380 |
| 4. | समता भंडारी | प्रोत्साहन | विमल भंडारी | एसएसएए | 2491 |
| | श्रेणी-II कक्षा 6 से 8 तक | | | | |
| क.सं. | प्रतिभागी का नाम | पुरस्कार | सैक कर्मचारी | क्षेत्र | फोन नं. |
| 1. | आन्या गंगेले | प्रथम | उज्ज्वल गंगेले | एसएनपीए | 8301/8315 |
| 2. | अदिति शर्मा | द्वितीय | अजय शर्मा | पीपीजी | 2417 |
| 3. | तेजस्विनी | तृतीय | प्रवीण आंबेटी | एसएनपीए | 8462/68 |
| 4. | आकाश पराशर | प्रोत्साहन | अजय पराशर | एसआईपीजी | 4735/64/63 |
| | श्रेणी-III कक्षा 9 से 12 तक | | | | |
| क.सं. | प्रतिभागी का नाम | पुरस्कार | सैक कर्मचारी | क्षेत्र | फोन नं. |
| 1. | अव्यय मिश्रा | प्रथम | मुकेश मिश्रा | पुस्तकालय | 4071 |
| 2. | अनिका सक्सेना | द्वितीय | अनिश सक्सेना | सेडा | 3805 |
| 3. | क्रिशा गायकवाड़ | तृतीय | राजेंद्र गायकवाड़ | एप्सा | 6219/37 |
| 4. | आध्या शर्मा | प्रोत्साहन | अखिलेश शर्मा | एसआरए | 4640/91 |
| | श्रेणी-IV सभी अन्य वरिष्ठ प्रतिभागीगण | | | | |
| क.सं. | प्रतिभागी का नाम | पुरस्कार | सैक कर्मचारी | क्षेत्र | फोन नं. |
| 1. | झलक साखिया | प्रथम | पार्थकुमार साखिया | एसएनपीए | 2203/01 |
| 2. | रुचि जैन | द्वितीय | राहुल जैन | एसएनपीए | 8357/21 |
| 3. | अर्चना राजपूत | तृतीय | आनंद रॉय | एसएनपीए | 8234/35 |
| 4. | जी माहेश्वर राव | प्रोत्साहन | जी माहेश्वर राव | ईएसएसए | 2316/17 |

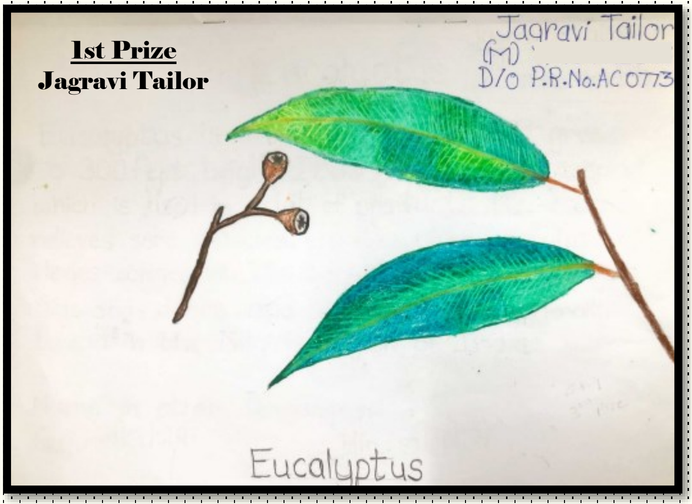
वीएसएसई/सैक और आईएसआरएस-एसी

सभी पुरस्कार विजेताओं को बधाई !!!

# WORLD ENVIRONMENT DAY- 2021

## LEAF DRAWING & PAINTING WINNERS

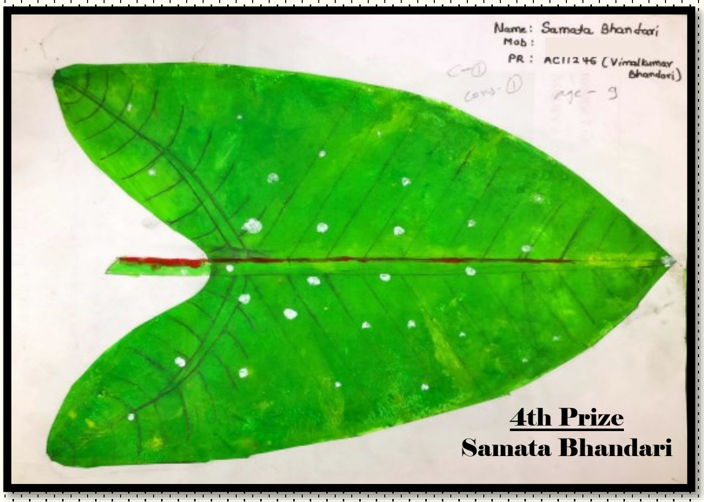
**Category 1 (Below 5th Standard)**




**1st Prize**
**Jagravi Tailor**


**2nd Prize**
**Varda Gupta**


**3rd Prize**
**Deshana Adhvaryu**




**4th Prize**
**Samata Bhandari**

**Category 2 (6th—8th Standard)**


**1st Prize**
**Aanya Gangle**

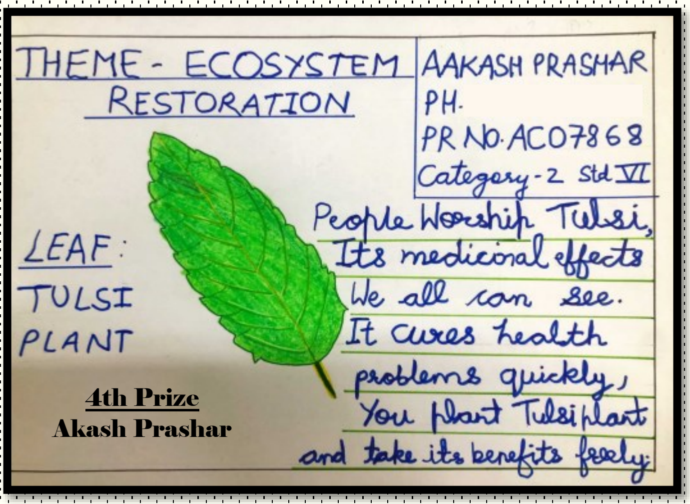

**2nd Prize**
**Aditi Sharma**

# WORLD ENVIRONMENT DAY- 2021

## LEAF DRAWING & PAINTING WINNERS

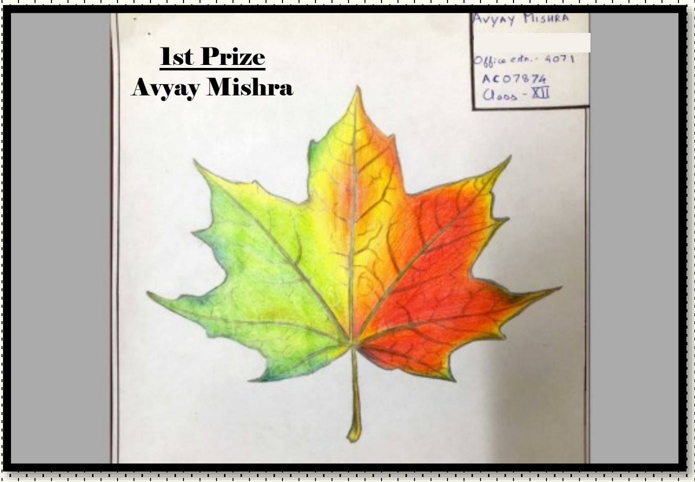
### Category 2 (6th—8th Standard)


**3rd Prize**
Tejaswini



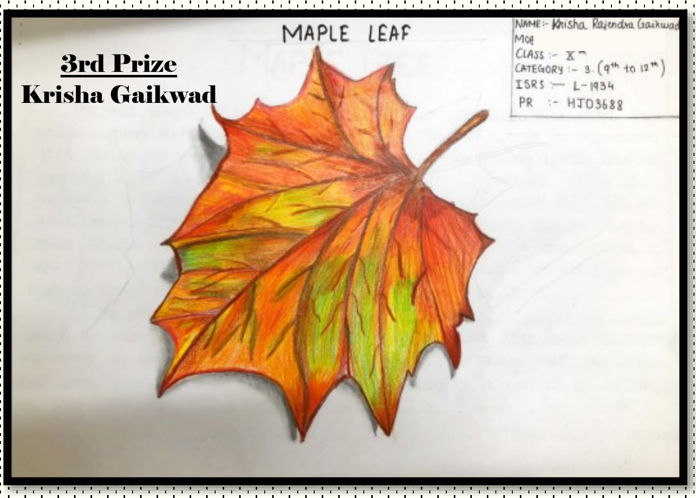

**4th Prize**
Akash Prashar

### Category 3 (9th—12th Standard)

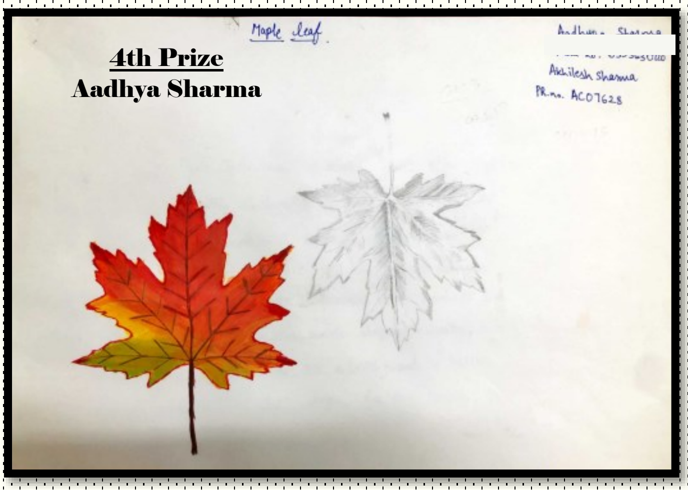



**1st Prize**
Avyay Mishra


**2nd Prize**
Anika saxena




**3rd Prize**
Krisha Gaikwad

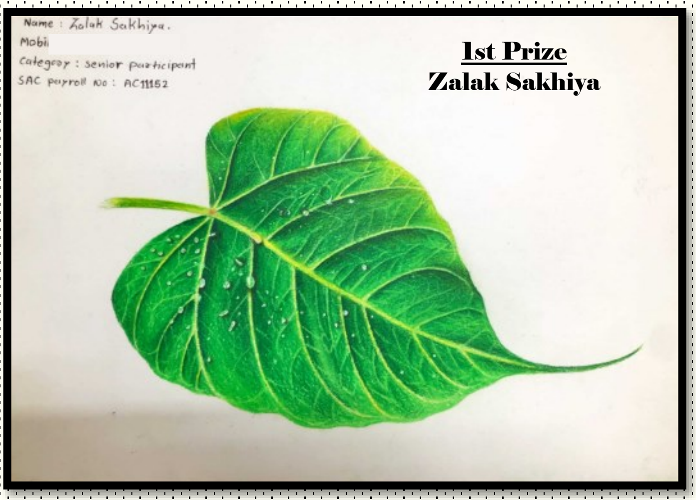


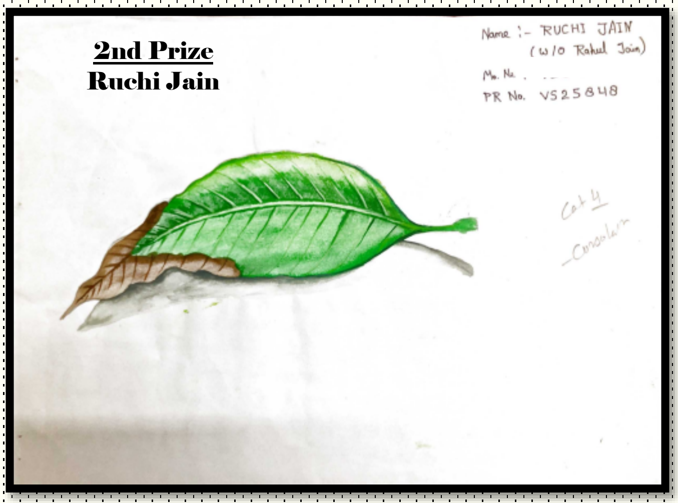

**4th Prize**
Aadhya Sharma

# WORLD ENVIRONMENT DAY - 2021

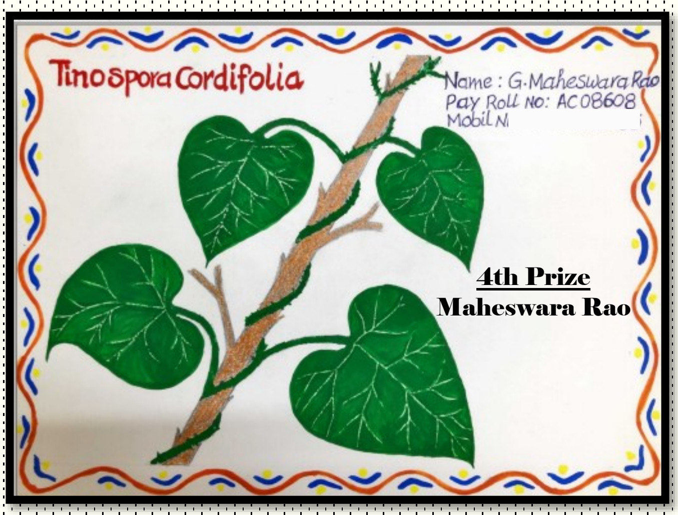
## LEAF DRAWING & PAINTING WINNERS

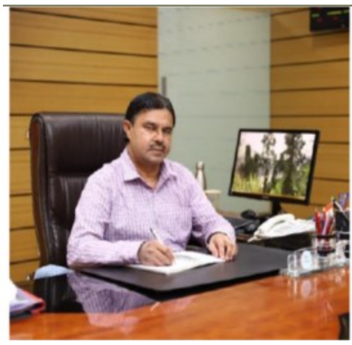
**Category 4 (Senior Participants)**









# SPACE TECHNOLOGY IN THE ERA OF SPACE REFORMS FOR ATMANIRBHAR BHARAT

**NILESH M DESAI** DIRECTOR, SAC

The concept of self-reliance and resilient India: "ATMANIRBHAR BHARAT '' is an elixir to boost Indian Economy in this Post-Covid era. The Five pillars of Atmanirbhar Bharat, which focus on Economy, Infrastructure, System, Demography and Demand, lay the direction and guidelines for skyrocketing and leapfrogging the futuristic Indian Space Program.

The self-reliance in the satellite payload development was heralded by the pioneering efforts of ISRO Scientists/Engineers, with the design and development of Bhaskara-I satellite in 1979, which consisted of TV cameras to study hydrology and forestry, along with a three-band Microwave Radiometer (SAMIR) for oceanographic studies. From those early days, ISRO has come a long way, while taking significant steps and sometimes giant technological leaps with satellites like Cartosat-3, RISAT-2B, GSAT-11, IRNSS-1I etc. to reach the skies literally and figuratively.

One of the major tenets of ISRO has been to utilize the space assets for societal benefits and inherent in it is the self-reliance principle. Indigenization in every aspect of space technology – satellites, payloads, launch vehicles, data dissemination, and applications – is something that ISRO has always strived for. Towards this end, there have been conscious and continuous efforts through technology development, prototyping, and transfer to local industry. Through these efforts, the proportion of indigenously developed technologies and components has steadily increased over a period of time. One can look back with pride at the number and quality of satellites and launch vehicles related technologies that ISRO has built and successfully productionized. Starting with Aryabhata's launch into space on April 19, 1975, a series of communication (INSAT and GSAT series) and Remote Sensing satellites (IRS series) were launched by ISRO. Currently multiple ISRO satellites from INSAT-3D, RISAT, CARTOSAT and RESOURCESAT series, are providing excellent data to the earth-observation user community.

There is a wide range of societal activities and research carried out by using these remote sensing and geospatial data, in the fields of agriculture, weather and climate, oceanography, geology, cryosphere, to name a few. This apart, regular monitoring of agriculture crops with agro-meteorological indicators, and accurate high-resolution weather forecasting over short, medium and extended ranges are also made available using high temporal frequency Indian geostationary meteorological payloads from INSAT-3D series. Disaster management is another pivotal application made possible due to space based observations wherein remote sensing, communication and Navigation satellites have definite respective roles. The cataclysmic threats due to cyclone, heavy rain, cloudburst etc. are continuously monitored, tracked, and predicted using indigenously developed payloads and algorithms fortifying the self-reliance in space applications.

In the field of interplanetary and science missions, India is set to become a major player with missions like Lunar missions (Chandrayaan-1/2/3), Mars mission (MOM) and the upcoming human space flight mission- Gaganyaan (mostly using indigenous technology, which had a recent successful test firing of a human rated Vikas engine). Recently, the National Space ecosystem got a boost from the government, which will be helpful in addressing private sector participation and partnership in the space sector, national level space services and global market assets. One of the decisions recently taken by the government is the Deregulation of the Geospatial sector in the country vide Department of Science and Technology (DST) guidelines declaration of the guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps dated 15th February, 2021. Now, a comprehensive policy framework under the draft National Geospatial Policy (NGP-2021), is being worked out, which will ensure availability of data to private players and help in the advancement of the sector, which is the need of the hour. This will further evolve an ecosystem for better governance, infrastructure development and empowerment of Indian citizens.

SAC is also the leading centre for the development of Navigation Payloads for NavIC Satellites – Navigation with Indian Constellation (formerly known as Indian Regional Navigation Satellite System-IRNSS), which aims to provide position accuracy comparable to GPS over Indian landmass and also provide navigation services beyond 1500 km of its geopolitical boundary. Herein, SAC has contributed to various innovations under “Atmanirbhar Bharat initiatives” such as design of new signal structure, our own ranging codes (IZ4), modulation scheme (SBOC) and Error correcting code (LDPC), development of indigenous rubidium atomic clock (IRAFS) etc., all of these are the backbone of any navigation system. This apart, SAC has also developed Pseudolite-Based Navigation System (PBNS) system, which is a standalone terrestrial navigation system and works without atomic clocks.

Recently, the Government of India has initiated reforms in India's Space Programme to encourage private sector involvement and investment to promote innovation and entrepreneurship. It encompasses Remote Sensing sector related reforms as well, and therein, current technology-driven approach of launching satellites is being re-oriented towards user-demand or applications-driven approach. It will also encourage participation of private industries including start-ups and academia along with other research institutes. These reforms in space sector will see further expansion of space activities and utilization of data and also bring more accountability in the system. With the proliferation of space technology applications in areas like infrastructure planning, governance and development, location-based services, societal communication and disaster risk reduction etc. There is also an urgent need to bring synergy of efforts in use of remote sensing/earth observation, communication and navigation satellites along with other traditional and newer technologies and ensuring its effective adoption and usage by various stakeholders. In fact, as per Government’s guidelines, ISRO has also worked out a Space Applications

# SPACE TECHNOLOGY IN THE ERA OF SPACE REFORMS FOR ATMANIRBHAR BHARAT

**(CONTD.)**

Management System (SAMS) to examine the need aspect of various satellite missions and associated ground segment, development of applications aligned with national imperatives and their optimal utilization to harness the benefits of space-based services. This will also help open up a huge market for activities related to space technology and applications.

Thus, the Space sector reforms under Open-Space policy and involvement of private players is another defining and significant step in the direction of leveraging the Indian ecosystem – native talent, manufacturing abilities, ISRO's immense and invaluable knowledge-base and infrastructure facilities, investors' appetite, 'Make in India' initiatives that the government is giving so much importance to, and the risk-taking abilities of young engineers. With the setting up of **IN-SPACe (Indian National Space Promotion and Authorisation Centre) and M/s. NewSpace India Limited (NSIL),** we expect the private and public sector partnership to flourish and contribute towards Atmanirbhar Bharat through for Space Tech ecosystem. Indeed ***"Sky is the Limit".*** The heritage of our stalwarts in space technology and science has paved the path of self-sustaining and self-dependent space technology and its applications. The future calls for indigenous, ingenious and innovative approaches to carry the legacy forward and be the vanguard in the mission of "ATMANIRBHAR BHARAT '' .

# VIKRAM SARABHAI AND HIS VISION

**KARTIKEYA V SARABHAI**
FOUNDER & DIRECTOR, CENTRE FOR ENVIRONMENT EDUCATION (CEE)

I was studying Theoretical Physics at Cambridge. Was at St. John's, the same college Papa had gone to. When I left India, I was quite sure that Physics was what I wanted to do. But in England, I would get into many debates and arguments about India, its democracy and its future. Realized, I did not know all that much about our country and what I argued was from my gut but could not support it with any data. So asked Papa to send me books about India, its developmental challenges and its politics. He had a whole set of books for me when I saw him next. I got to talk to him about the issues. I realized soon just how much he was concerned about the development of the country and his vision for how science and technology could play a critical role. Half way through Cambridge I had decided that I wanted to work in the 'Development field'. Papa fully supported this but also said why I should complete my degree in Science as it was one of the best building blocks to what I wanted to do next.

He had a powerful vision for India's development, its space programme and the way in which science could improve the quality of life and support decision making in the country. I talk here about five aspects of that vision.

- ⇒ **Inculcating a scientific temper** among students and the people of India.
- ⇒ **Increasing indigenous capacity** in science and technology. Strengthening research.
- ⇒ **Using science and technology to meet India's needs**. Using the country's scientific capacity to solve the developmental problems.
- ⇒ **Leapfrogging for a developed India.** Not to be imitative of the developmental pattern of the west.
- ⇒ **Developing the management capability** to undertake this task**.**

Vikram Sarabhai strongly believed that

*"The development of a nation is intimately linked with the understanding and application of science and technology by its people. ……History has demonstrated that the real social and economic fruits of technology go to those who apply them through understanding."*[1]

The establishment of the Group for the Improvement of Science Education (GISE) at the Physical Research Laboratory (PRL) was one instance of his interest and desire to improve the quality of education even at the school level. GISE then grew into the Community Science Center today renamed as the Vikram A Sarabhai Community Science Center (VASCSC). VASCSC was perhaps one of the last institutes he established and he would say that when he retires he would like to work at the Center focusing on the understanding of science amongst children.

The Satellite Instructional Television Experiment (SITE) was another example of how he placed emphasis on education. SITE was a great example of how science and technology could make it possible to reach some of the remotest places in India where even proper roads did not exist, with the latest educational programs.

# VIKRAM SARABHAI AND HIS VISION

## (CONTD.)

The concept of having more capacity in the satellite so that the ground segment, the receiving chicken mesh antennas, could be relatively inexpensive was one of the many examples of applying technology in a way appropriate and cost effective for India.

Vikram Sarabhai had focused his attention on solving the problem of access to knowledge for the most disadvantaged and remote communities. Today while our capacity has increased manifold we are yet to solve the problem of the digital divide. The COVID pandemic has seen India widely using virtual platforms including television for education. However, many children and especially the girl child in poor families do not have access to the basic hardware required to participate in this transition. Using technology in ways to solve development issues was central to Vikram Sarabhai's thinking.

Vikram Sarabhai envisaged a major role for the Department of Space in the connectivity revolution. He wrote:

*"In India, at the moment, we are deeply interested in an evaluation of the benefits that a synchronous satellite can provide for national needs of point to point communications, for mass communications through direct broadcast television to promote national integration as well as the economic development of isolated communities."*

*"Just for one application, namely, the provision of broadband communication for reaching half a million villages of India through television, it can be shown that the investment for using satellites would be only a third of what would be required with conventional technologies."*

He saw space and science in general, playing a major role in transforming India and in leapfrogging to a more sustainable future. Commenting on Dr. Sarabhai's vision, K. G. McCracken of CSIRO, Australia wrote:

"Vikram injected an element of realism into the fairy-tale world in which I was living. Thus, in 1961 he began speaking of the Indian view of Space research; a view that was clearly different from that of the developed countries which were active in Space at that time. He spoke of using satellites to provide television for the half million villages of India; TV in which there would be a single video channel, and 14 different sound channels to bridge the linguistic gaps that divide the Indian nation. He spoke of agricultural, family planning and health education being given to the non-urban population by satellite. He argued that it would be faster to use a satellite to provide a high quality, nationwide telephone system than to use a conventional ground based microwave system. That is, he spoke of a careful tailoring of Space science to the national goals of his country. He spoke of Space scientists applying their intellectual capabilities to practical problems, and set the example by doing so himself."[2]

India has a vast pool of scientific and technological personnel. We, so often hear of great achievements in science and technology by Indians settled abroad. There are perhaps many in this country who given the necessary facilities and resources, could achieve much more. Vikram Sarabhai was very conscious of

# VIKRAM SARABHAI AND HIS VISION

## (CONTD.)

this.

“Countries have to provide facilities for its nationals to do front rank research within the resources available. It is equally necessary, having produced the men and women who can do research, to organize task-oriented projects for the nation’s practical problems.”[3]

ISRO is perhaps one of the national Scientific Departments where this is done. But the vision would extend to many other fields and institutions including colleges and universities.

Indian science playing a critical role in leap frogging was very much a part of his thinking. This involved not only being at the frontier of science and technology, but also the ability to innovate and not just imitate. It is not possible let alone desirable to follow a development path as has evolved in the West. Today, we understand better the issues of sustainability, climate change and biodiversity loss. The development model in the way it has evolved is fossil fuel intensive and one which generates a huge amount of waste and pollution. The communication revolution was certainly one such example where we recognised that we did not first have to lay terrestrial lines for telephones but would go straight to satellite based connectivity.

In the words of Vikram Sarabhai,

*“There are those who preach, as guardians of the economic wellbeing of the developing nations, that we must proceed step by step following the same process by which nations themselves progressed.”* [4] *Our national goals involve leapfrogging from the state of economic backwardness and social disabilities – attempting to achieve in a few decades a change which has historically taken centuries in other lands. This involves innovation at all levels*.[5]

While strongly advocating building national capacity, he understood the importance of partnerships and international collaboration. *“One should ensure that nationals of the country at the operative level of the programme are sufficiently committed and are willing to stretch themselves to the fullest before asking for help outside.”*

Vikram Sarabhai was equally concerned about the role that science and technology could play globally. Speaking at The Global Earth Resources Survey programme he said, *“Hopefully (it would) help humankind realize that this is one world and that its resources are to be used wisely for the benefit of all humankind”*[6]

[1]Sarabhai, Vikram, Space Activity for Developing Countries, 1966 in Kamala Chowdhury edited Science Policy and National Development, Nehru Foundation for Development, 1974.

[2]McCracken, KG, “Bringing Space Research Down to Earth” in Yash Pal edited, **Space and Development**, Proceedings of the Vikram Sarabhai Symposium on Space and Development of the twenty-second Plenary meeting of COSPAR, Bangalore, India, May 29 – June 9, 1979, Pargamon Press, 1980.

[3]Sarabhai Vikram, Space Activity for Developing Countries, 1966, in Kamala Chowdhury 1974.

[4]Sarabhai Vikram, Peaceful uses of Outer Space, 1968

[5]Sarabhai Vikram , Science and National Goals, Science Policy and National Development 1974
[6]Sarabhai Vikram, Space Activity for Developing Countries, 1966

## INDIAN JOURNEY FOR SELF-RELIANCE IN APPLICATIONS OF EARTH OBSERVATION SATELLITE DATA FOR SOCIETAL BENEFIT TO FULFIL VISION AND MISSION OF DR. VIKARM SARABHAI

**PRAKASH CHAUHAN**
DIRECTOR, IIRS

As we celebrated the birth centenary anniversary of Dr Vikram Sarabhai, it was amazing to recognize the fact that almost 50 years back, he had provided a detailed roadmap to all possible applications of Earth Observation (EO) data. We now see his vision being materialized in the fields e.g. oceanography, meteorology, coastal zone management, geosciences, hydrology, forestry, agriculture and natural resources management for sustainable development. His vision and mission to use space technology for the benefit of common people has been the guiding principle since the last five decades to build a self-reliant EO applications program in India for nation building and to address the challenges posed by threats such as climate change. The concept of the National Natural Resources Management System (NNRMS) had born out of this vision. Owing to such a farsighted approach, India is at the forefront of operational utilization of remote sensing data. Today we operationally use EO data to provide weather services to farmers, potential fishery zone advisories to fishermen, accurate and reliable forecast on cyclones and droughts, groundwater targeting for drinking water, biennial forest cover mapping, annual forecast of production of major food grains and climate response of glaciers in Himalayan regions. India has developed reliable and high quality sensors and satellite systems such as IRS series of satellites for achieving self-reliance in Earth Observation (EO) systems encompassing entire gamut of EO activities. Country is now on threshold to expand private sector participation in space-based services and enterprise. We will see a paradigm shift in coming years, when EO technology will play a vital role to develop a national system of EO applications in collaboration with industries to provide operational services to not only users in India, but also to other countries. A newly developed start up ecosystem in the country will pave way in translating technology development into innovative products and services for the benefit of all stakeholders with major players in space sector.

### Self-reliant Indian Remote Sensing and Meteorological satellites systems

India's first operational indigenously developed Remote Sensing Satellite IRS-1A launched on March 17, 1988 into the sun-synchronous orbit of 904 km with equatorial crossing time of the descending node being at 10.25 AM, which enabled the study of natural resources in various seasons under the same illumination conditions. The major payloads of IRS-1A consisted of two types of imaging sensors, which operated in push broom scanning mode using Linear Imaging Self Scanning Sensor (LISS). The first type of imaging sensor provided a spatial resolution of 72 m and designated as LISS-I and the other type consisted of two separate imaging sensors providing spatial resolution of 36 m and designated as LISS-IIA and LISS-IIB. As follow-on to IRS-1A, the second operational Remote Sensing Satellite, IRS-1B in the IRS series was launched successfully on August 29, 1991. IRS-1B was functionally identical to that of IRS-1A and phased in such a way as to provide a combined repeat cycle of 11 days, as against 22 days provided by each of them. IRS- 1C/1D launched in 1995/1997 have sensors such as (i) LISS-III (with spatial resolution of 23 m and SWIR- Short Wave Infrared band) (ii) PAN (Panchromatic band with 5.8 m spatial resolution) and (iii) WiFS (Wide Field Sensor- with 188m spatial resolution). The data from these sensors was utilized for various application projects. As part of Ocean thematic series the first OCEANSAT-1 was launched on May 26, 1999 and carried and Ocean Colour Monitor (OCM) along with a microwave radiometer called MSMR. OCM provided for the first time oceanographic parameters such as Chlorophyll, Suspended matter and diffused attenuation at 360m spatial resolution with 2-day revisit period. IRS-P6 (RESOURCESAT-1) was launched in October 2003 had sensors like LISS-IV (5.8 m spatial resolution in multi-spectral mode) AWiFS (Advanced Wide Field Sensor - with spatial resolution of 56 m) and LISS-III. India entered into era of high resolution remote sensing with a series of launch of cartographic satellites e.g. CARTOSAT-1,2 and 2A opening doors for multiple applications for urban and regional planning and high resolution digital elevation modelling (DEM). Microwave imaging satellites such as RISAT-1 and 2 enhanced the all-weather imaging capabilities and led to use of this data for unique applications such as Rice crop mapping, soil moisture estimation, forest biomass assessment and geological studies. SARAL-Altika was a joint mission with French space agency and carried a Ka band altimeter, which provided very high-resolution capabilities for Coastal Oceanographic studies. The continuity of the data services established from these satellites systems was ensured by the launches of RESOURCESAT-2 and 2A, OCEANSAT-2, SCATSAT-1, CARTOSAT-2B, CARTOSAT-2S series of satellites and more recently RISAT-2B, CARTOSAT-3 and RISAT-2BR1 in the year 2019. Currently two meteorological satellites namely INSAT-3D and INSAT-3DR launched in 2013 and 2016 are providing dependable services to the country for enhancing the weather forecast services and improved disaster risk management against hydro-meteorological hazards. These technological developments mostly achieved by Indian Space Research Organisation (ISRO) along with its institutions such as Space Applications Centre (SAC), UR Rao Satellite Centre (URSC), National Remote Sensing Centre (NRSC) along with industry and academia provided a solid foundation stone for world class Earth Observation program. These developments opened up world of remote sensing applications in the areas of agriculture, oceanography, cartography, meteorology, geoscience, environmental sciences and e-governance.

## Earth Observation Applications for nation building through institutional framework

Dr Vikram Sarabhai had recognized very early the importance of institutional structure and he himself was known as intuitional builder who created PRL, ATIRA, IIM and many such world-class organizations. He emphasized on developing domain expertise in the field of Earth Sciences and use of space technology to fully utilize the potential of remote sensing technology for major application areas such as agriculture, forestry, water resources, geology, land use, weather forecasting, disaster management and cartography for sustainable development.

Many institutions like Space Applications Centre (SAC), National Remote Sensing Centre (NRSC) and Indian Institute of Remote Sensing (IIRS), Regional Remote Sensing Centres, North Eastern Space Applications Centre (NE-SAC), State Remote Sensing Centres, INCOIS, MNCFC, NCCR, NCPOR along with many partners, local, regional and at national levels along with universities have spearheaded the remote sensing applications program in the country. These institutions have been instrumental in developing many applications of remote sensing and capacity building as visualised by the Dr. Sarabhai. Many of these applications have been institutionalized, especially in the areas of oceanography, weather, geoscience, environment, forestry, and agriculture.

National Natural Resources Management System (NNRMS) framework was instrumental in starting an era of operational utilization of remote sensing data in the country. The nine NNRMS Standing Committees provided necessary direction to develop a national system based primarily on remote sensing data. More recently, a new framework called Planning Committee of Space Applications Management System (PC-SAMS), has been implemented by Government of India to give a renewed impetus to space applications keeping the new geospatial and remote sensing data policy as prime driver. The Disaster Management Support Program (DMSP) of ISRO is contributing in a very effective manner for disaster risk reduction. DMSP program has been efficiently supported by International Chart activities during the time of disaster emergencies. The Central Water Commission under the Ministry of Water Resources uses satellite-based water resources information system for baseline data for irrigation projects, areas actually irrigated, crops grown, etc. The Ministry of Agriculture has been generating satellite-based forecasts of production of food grains and droughts conditions. Geological Survey of India uses remote sensing datasets essentially to carry out preliminary geological mapping in search of minerals. Institutional capacity building is one of the thrust area, which has played a key role in developing vital human resources to use this technology. Creation of Indian Institute of Remote Sensing (IIRS) and Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations, at Dehradun in India to building capacity in these frontier areas of remote sensing and communications for developing countries was a substantial effort. The Indian Institute of Space Science and Technology (IIST), deemed university, is providing a formal education in the field of all branches of space sciences and technology including applications of Earth Observation data. Recently, the Ministry of Electronics and Information Technology has created a national institution namely, Bhaskaracharya Institute of Space Applications and Geoinformatics (BISAG), Gujarat, for applications of remote sensing and communication technology for implementing e-governance at central and state levels. Many new privately owned startups are also making significant in-roads for providing services in the field of space applications.

## The Road Ahead

For near and long term future, it is needed to make sure that the growing needs of space-based data/ images of user institutions, R&D organizations, NGOs, private and public industry are met indigenously.

ISRO along with private sector participation needs to ensure continuity as well as easy and real-time access of remote sensing data. It is also important to provide access of analysis ready data to end users through cloud based data dissemination platforms. A large number of startups are like to make this sector a very competitive one, leading to higher economic activity. The adoption of these technologies by industries for realizing an operational system meeting the various user-requirements will also usher in times to come. The setting up of IN-SPACe (Indian National Space Promotion and Authorization Centre), an autonomous agency under the Department of Space, will ensure the involvement of private sector in realizing such system. Such system shall upwardly transform the social, economic and cultural aspects of the society. These technological innovations are required back up with sound policies. New Geospatial policy by government is a welcome step in this direction. However, there is an urgent need to formulate the new Space Policy for accelerated progress in the broad field of Space technology and its applications.

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# DEMOCRATISATION OF SPACE ACTIVITIES FOR AN ATMANIRBHAR BHARAT: ROLE OF CAPACITY-BUILDING

**C. P. DEWAN**
GROUP DIRECTOR (RETD.), PPG, SAC-ISRO

Since the past many decades, Indian Space Research Organisation has been implementing several remote sensing applications, especially for resource management and other science explorations. Our country has been benefitted with many fruits of various remote sensing applications. In order to achieve the excellence in remote sensing applications, there exists a need to have state-of-the-art technology in terms of launch vehicles, spacecraft, payloads and also in image processing domain. Since its inception, ISRO has been at the forefront of the Indian remote sensing programs, which was initiated by the launching of the series of remote sensing satellites like Bhaskara, IRS series, Cartosat series, Oceansat series, Chandrayaan, and Mars mission to name a few. During this journey of the development of various new technology and processes and to enhance the capacity building to take up challenging payloads, Space Applications Centre has always played a crucial role towards indigenous development of facilities, skill enhancement and knowledge upgradation of various stake holders, such as ISRO's capacity building, participation of industries and by academia.

**Development of Optical Imaging Detector Array for Hyperspectral Applications**

For the enhancement of specifications in each subsystem of remote sensing payloads, many efforts are put, e.g. in detector (sensor) development, Optics systems development, mechanical systems development etc. Detector is one of the most important subsystem for all the optical payloads. Since the technology of detector design and development is quite challenging and no OEM exists in India, the attempt to become "Atma Nirbhar" in this technology has been initiated by ISRO and was implemented in HySIS satellite. Hyper-spectral Imaging Satellite (HySIS), is an earth observing imaging spectrometer (spectral range: 0.4 to 0.95µm, spectral sampling: 10nm, number of spectral bands: 55, spatial sampling: 30m) operating in push-broom scanning mode from 630 km LEO orbit. Detector teams at SAC, Ahmedabad and SCL, Chandigarh indigenously developed Frame Transfer Charge Coupled Device (CCD 1000 X 66, 11µm x 26µm) for HySIS application. Chip architecture, device design, chip layout, and package design were carried out at SAC to meet project requirements with respect to Resolution (Spatial and Temporal), Dynamic Range, Modulation Transfer Function, Smear and spectral responsivity. A unique package is developed at SAC (Fig. 1) for this chip. Screening and space qualification was carried out at SAC. Raw image captured by the detector module during initial evaluation is given in Fig. 2.

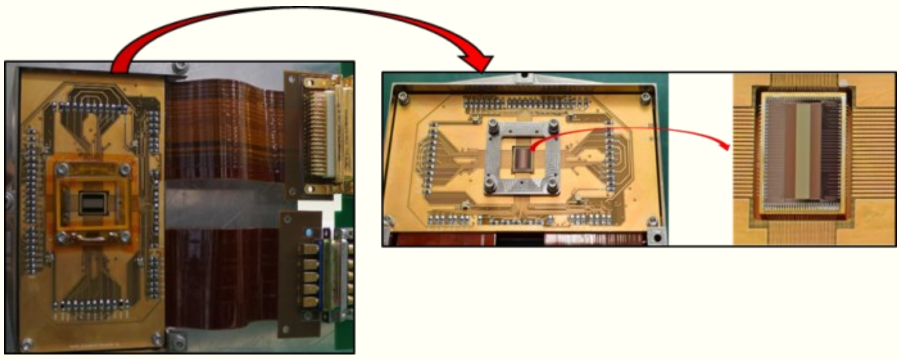

**Fig. 1 (Packaged FM detector)**

## DEMOCRATISATION OF SPACE ACTIVITIES FOR AN ATMANIRBHAR BHARAT: ROLE OF CAPACITY-BUILDING PROGRAM

**(CONTD.)**

## Optical Systems development

Optical subsystem is one of the most important sub-systems needs to be addressed for making India ‘Atmanirbhar’. Major breakthrough has happened in this indigenous development. LEOS has developed facility to develop mirrors as large as 1.5 meter diameter. Many local vendors are encouraged to commission high precision manufacturing equipment. SAC has played pivotal role to produce import substitutes in optics components manufacturing including metal mirrors and grating. Grating technology was thoroughly studied and manufacturing was carried out under close supervision of designer. Major milestone is achieved and indigenous optical systems were flown in Chandrayaan-2 payloads.

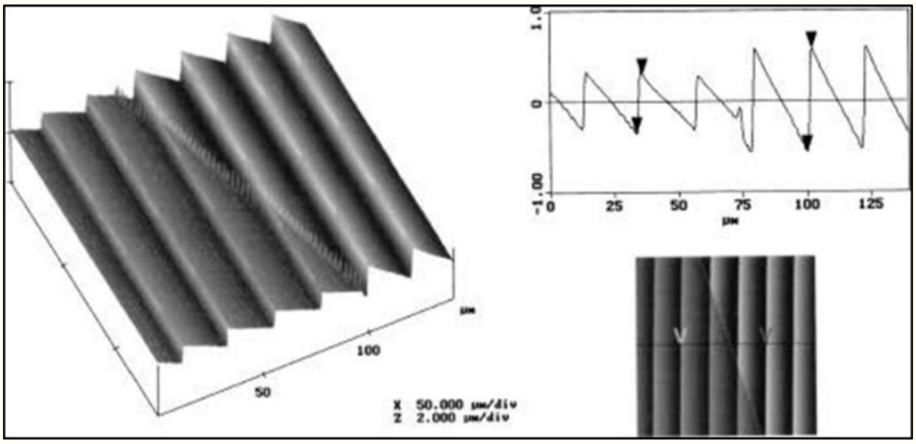


**Fig. 2**

SAC has also developed on-board focussing system, which is very useful in correcting focussing errors on-board. A unique indigenous development is carried out by using thermal actuators for micro movement. This would facilitate correction of telescope errors occurred/left during integration and dimensional instability (Fig. 3).

High resolution camera calls for ultra-low thermal expansion metering structure of telescope. This was being imported in initial few satellites, because such technology was not existing in India. SAC-VSSC had taken up the technology development for this and subsequently implemented in last many satellites, such as cartosat-2, cartosat-3 series, INSAT-3D and GISAT series satellites. Local industries are also being trained for such high definition structure developments.

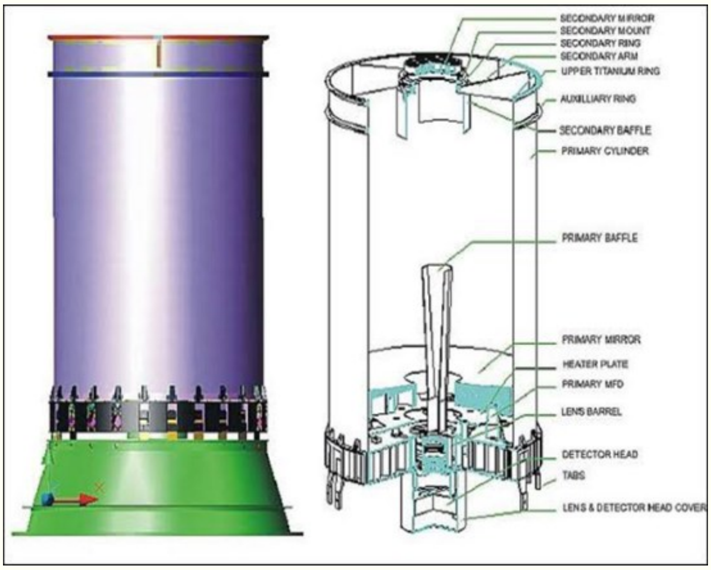


**Fig. 3**

# SELF-RELIANCE IN GEOSPATIAL DATA ANALYTICS

**PUSHPALATA SHAH**

VICE PRESIDENT, GIS SOLUTIONS, SCANPOINT GEOMATICS LTD.

The Indian Space program has definitely been leap frogging since the first launch of the optical remote sensing satellite in 1988. Our own satellites and our own data vow! At the 104th Indian Science Congress of 2017, it was informed that ISRO has gathered up to a whopping 17 million gigabytes of geospatial data which is set to cross 50 million GB by 2022.

Time is too short for everything. The days of being impressed by gigabytes are long gone. As the amount of data in the world increases exponentially, we've had to come up with new, unfamiliar words to describe data in numerical form. So long, gigabytes. These days, we are talking of terabytes, petabytes, exabytes and zettabytes. It's not hard to see how the world's data has exploded in recent years and will continue to grow at an incredible rate.

Where do we stand? Do we have our own technologies for handling, analyzing and making this data useful to society? Are we self-reliant? The space program includes a gamut of technologies, beginning with rocket science, payload engineering, communication systems, GPS, space data processing software and technologies such as image processing, GIS, CAD, artificial intelligence, machine learning, big data analytics and the list is endless. *It would be like walking on one leg and saying India is self-reliant in the space sector if we turn a blind eye towards indigenization in these areas.* Has India cleared all the frontiers?

The first indigenous integrated platform for Image processing and GIS, built with technical 'Know-How' from ISRO, and named IGiS, was released by Scanpoint Geomatics Limited in 2009. The 'Desi' product did not receive as much acceptance as expected from the Indian geospatial community. However, the company pursued its ambition and entered into the GIS Solution Provider role.

Today the IGiS platform is operationally being used in many government and defense projects. A few of them are, the North Eastern Spatial Data Repository of ISRO, the J & K Spatial Data Infrastructure, the Enterprise Geoportal for NATMO, implementing enterprise geographical information system for Municipal corporation of Surat & Pune and Smart City Missions of Agra, Aligarh, Lucknow, Ranchi, Dehradun, Jhansi and Biharsharif, modernization of the land records system for Gujarat and Rajasthan under the National Land Records Modernization Programme. The product has made headways and come a long way.

The IGiS Product is evolving. IGiS version 11 is on the horizon. This version includes additions in core GIS functions like 'find polygon errors', database versioning and comparing, project migration tools, union on multiple themes, joining features, local summaries, heat map generation and so on. Additions in the image processing modules deal with conditional computing, random points creation, spectral signature editing, object-based image segmentation, SVM classification, multi-layer profiling, high resolution shaded relief map generation, refining DEM tool for void removal/filling, generating geology, water and landscape indices and snow cover detection.

A total photogrammetry suite has been added which can perform orthorectification and produce DEM. A new dimension of SAR data handling is built-in with modules for CFAR ship detection, Radon Wake Detection, Canny Edge detection, sea state correction and many more functions. Geo-statistical tools, LiDAR data analysis tools and SWAT modelling are also packaged to make the IGiS V11 versatile and match up to the expectation of the user community.

The upcoming IGiS release is going to introduce functionality to convert different 3D file formats into a single file format and visualize in its 3D framework along with viewing attributes associated with different objects. This feature will help to get more detailed information of objects and visualize their geographical location. 3D tile is the cutting edge technology for City level planning and analysis. It is required for processing and display of high voluminous data at city level. IGiS has capabilities to view and analyse exterior and interior BIM objects.

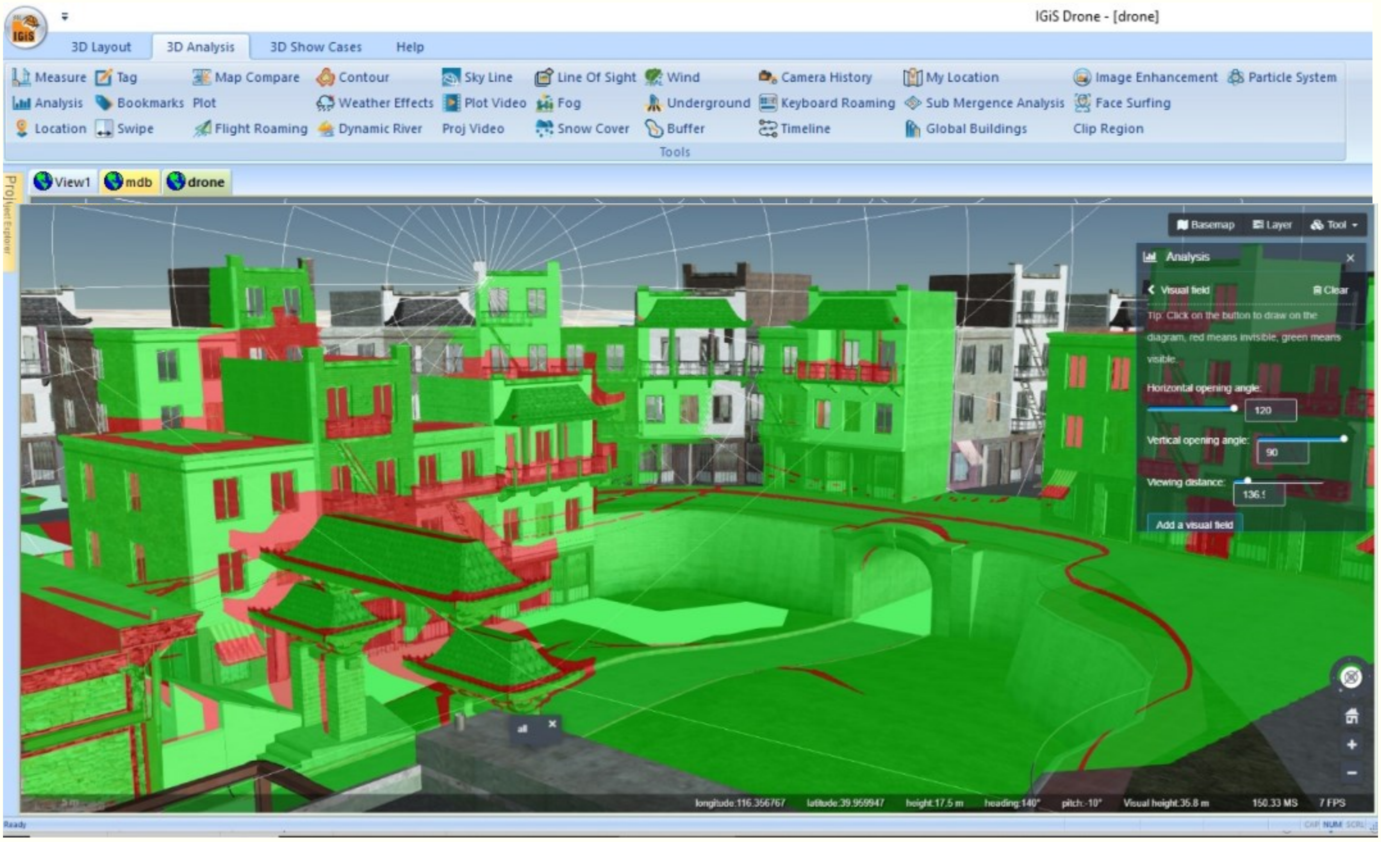


**Figure 1: 3D-Analysis: Dead Zone area of surveillance camera depicted in red colour**

# SELF-RELIANCE IN GEOSPATIAL DATA ANALYTICS

## (CONTD.)

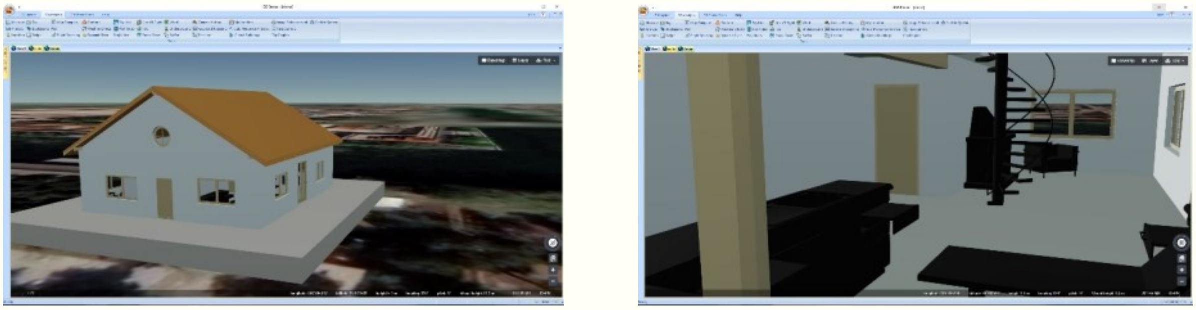

**Figure 2: BIM-External and Internal views of objects**

The new IGiS release is going to introduce Big Data Analytical platform (IGiS_BDA) to offer software tools for data storage & management, data analysis and visualization using multi nodes cluster (multi machines, multi storage) and parallel processing technologies to minimize time for generating desired output.

Artificial intelligence (AI), Machine Learning (ML) and Deep Learning (DL) technologies are showing their importance in GIS domain. Techniques and algorithms such as image classification, object detection, semantic segmentation and neural network are helping in improving image quality and easing image analysis and identification of specific type of objects. The new IGiS solution will introduce capabilities to train model and improve prediction precision by allowing to enhance quality of images and detect specific type of objects and cater to typical requirements of military applications.

BIM is the new technology for monitoring new construction projects. BIM-GIS integration has been applied on multiple cases such as visualization of construction supply chain management, emergency response, urban energy assessment and management, heritage protection, climate adaption and ecological assessment. Further, building approval systems can be made more efficient and tamperproof using BIM technology.

With extensive use of sensors in smart infrastructure, integrating sensor data with GIS in real time offers a completely new paradigm in the way we monitor and manage smart cities. IGiS offers such capabilities out of the box to enable spatially aware smart solutions for real time data analysis and interventions.

Smart cities of the future will require Smart Technologies, Smart Tools and Smart Analysis packages for Advanced Geospatial Data Analytics. The IGiS product is planned and designed to bring self-reliance in this field. The culmination of Smart Cities will eventually lead to a Smart, sustainable and self-reliant India.

# ROLE OF ACADEMIA AND KNOWLEDGE CENTERS IN NURTURING THE HUMAN CAPITAL FOR AN ATMANIRBHAR INDIAN SPACE PROGRAM

**BHARAT LOHANI**
PROFESSOR, IIT KANPUR & DIRECTOR, GEOKNO INDIA PVT. LTD.

When I thought of writing an article on this topic, I realized we need not to look farther than ISRO as a cynosure of Atmanirbharta (self-reliance). To me the best example of Atmnirbharta is ISRO, which, whenever there were restrictions on state-of-the-art technologies from other countries, rose to the occasion and developed these technologies in India. It was this zeal of ISRO towards Atmnirbharta that has placed it amongst the world leaders in space programme. However, having said this, there is still much scope for bringing Atmnirbharta in our space programme-yet we are not manufacturers of several hardware, yet we do not make software in India for data analysis despite having the largest information technology trained people, yet several basic science problems are not being solved in India, yet solutions for earth observation and creating digital twins are not coming from India. So, it is important to investigate reasons for this. While all stakeholders must pitch towards the goal of Atmnirbharta- be it government, ISRO and similar organizations, I would like to focus in this article on our academic institutions and how they can play a role.

When I say Atmanirbhar I do not mean that we are fully secluded from other countries and fully self-reliant. For me Atmnirbharta is-we also develop niche technologies, so we are in a position to bargain for technology bartering with other countries for creating a win-win situation. It is true that, "Not all technologies can be developed in all the places--rather each place should develop some specific technologies, so there is a level playing field for all for the good of all."

Coming back to how Indian academic institutions and knowledge centers can play a role towards realizing an Atmanirbhar Space Programme for India. Let me also define what I consider by Space Programme here – to me it starts from development of space launch vehicles, satellites, sensors to aerial sensing platforms and extending to the data analytics systems for the data produced by these platforms for solving the problems of common Indians including strong knowledge creation and knowledge transfer framework. I will highlight a few steps that should be undertaken by academic institutions towards the goal of Atmanirbhar Space Programme for Bharat:

## Academic Programme Development

The academic institutions should develop academic programmes including dedicated departments on space science and technology. Currently, institutions run several courses which contribute towards space programme but do not train students dedicatedly for pursuing career in space. The need of the hour is to develop more comprehensive programme which can attract and satiate those who want to pursue their career in space. The good news is, a few universities and IITs are coming up with the departments of space science and technology with the aim to cover entire spectrum of space programme under one umbrella. Such departments can start four year-long degree courses to prepare key professionals besides graduate programme.

This is a giant step as students will be exposed to entire scope including business and management related aspects. Thus far, institutions were training only on one or other aspect without giving the complete picture. There is no denying that such graduates from our universities have contributed immensely towards India's space programme, but future graduates should come more prepared from the dedicated departments which are being proposed now.

## Promotion of Entrepreneurship

Space programmes around the world were majorly funded and spearheaded by government as a national priority. However, recent past has seen emergence of private sector in space technology. It is well known that while government sponsored programme are major driver for space technologies, the entry of private enterprise brings more flexibility and options to work beyond the direction of government. This is the reason that private enterprises like SpaceX, VirginGalactic, Blue Origin, Lockheed Martin and several others have been leading development of new technologies for space. Further, it is well known that the best of the companies in space technology around the world have emerged as start-ups from academic institutions.

In India also now the private enterprise is being encouraged to work in space technologies. However, to create the right entrepreneurship ecosystem it is important to promote start-ups from academic institutions. Academic institutions can play a major role in this through their incubation centers. The good news is that student entrepreneurship and innovation (E&I) is being recognized and many academic institutions have started incubation centers including the possibility to engage students in E&I activity from their early student years. The recent E&I policy introduced at IIT Kanpur with option to earn E&I credits is an excellent example of this. The multifold role of academic institutions of providing comprehensive training, showing opportunities and promoting entrepreneurship can lead to a very active ecosystem of start-ups which can develop into mature companies leading to new technology development in India. Some of the academic institutions with dedicated space departments can consider, with the support of ISRO, to start space technology-oriented incubation centers. The fresh ideas and raw energy of students under the mentorship of faculty members and support of ISRO can definitely result in new technologies. Unlike large organizations start-ups are more inclined to take risk and experiment which increase the likelihood of new technology development.

## Collaborative Efforts

The academic institutions with focus on space programme or allied technologies should collaborate among themselves.

It is well known that most of our research is now theme based and to address a particular theme we need expertise of varied kind. Promotion of such collaboration by academic institutions will facilitate the convergence of minds and expertise thus leading to research which will help in developing technologies for Atmanirbhar space programme. At the same time academic institutions should interact more regularly with national organizations like ISRO on a continual basis for joint research. There are already some platforms like RESPOND available for this. However, there should be more aggression to leverage on the freedom of academic institutions and the knowledge and facility base available with national organizations.

## International Outreach

Academic institutions have flexibility to interact with international institutions and researchers, which may not be always possible with some organizations. Such collaborations result in knowledge transfer, co-supervision, co-learning and co-development which would ultimately benefit the space programme of the country including better trained human capital. Therefore, such international collaboration should be promoted by the academic institutions and supported by ISRO.

## Alumni Network

Academic institutions have a very special position, unlike government organizations, due to their vast alumni network working in the best of laboratories around the world. While some alumni can contribute and help directly in the space related research due to their similar background, the entire network can be explored for supporting research and entrepreneurship activities in space technologies. Considering the nation-wide impact that space technologies make alumni donors should be willing to support these initiatives.

I have served for long in IIT and I am aware of the potential of the human capital--in the form of expert faculty and smart students, there. The same is true for other universities also in India. This human capital with right nurturing can produce wonders in science and technology related to space. The need of the hour is to realize this potential and channelize the same for the goal of Atmanirbhar space programme through dedicated efforts, a few of which I could outline in this article.

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# INORGANIC GROWTH OF INDIAN INDUSTRIES AS A SPIN OFF FROM ISRO'S MICROWAVE REMOTE SENSING PROGRAM

**RAJEEV JYOTI**
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The advent of ISRO's microwave remote sensing (MRS) program started with India's first remote sensing satellite Bhaskara 1, which carried aboard a three-channel passive microwave radiometer. Since then ISRO's MRS program has designed and developed various active and passive microwave payloads to cater applications for both Earth observation and planetary sciences. The engagement of ISRO with Indian industries also played a crucial role in the development of this program, where the industries role started with providing manufacturing support for initial satellites and has matured to production of advanced electronic subsystems.

In order to facilitate this inorganic growth, ISRO generated the required Intellectual property (IP) in-house, provided the expert training needed to handle advanced technologies and provided procurement guarantees to mitigate the commercial risk of producing large capital expenditure low volume items.

This paper describes the synergistic development of ISRO's MRS program along with industries by describing the role they played in development of both sensor electronics and applications. For completeness sake, global and future trends are also enumerated.

## Space infrastructure for Indian Microwave remote sensing

Microwave remote sensing (MRS) carried out at longer wavelengths (1cm to 1m), is not susceptible to atmospheric scattering due to clouds and rain (up to a certain extent). Active microwave sensors such as SAR, Scatterometer & Altimeter have their own source of illumination making them capable of imaging in all weather & in both day and night. Longer wavelengths can penetrate through canopy and surface providing information about Biomass and soil moisture. These capabilities have made microwave sensors very popular for applications related to agriculture, forest studies, disaster management, cyclone prediction and ocean studies. Moreover, the scattering at these frequencies provides unique information about the target compared to the one received during imaging in optical and other frequencies.

Microwave remote sensing has been massively adopted by Indian users in the past decades for eg RISAT-1 C-band SAR data is used for national agricultural program (FASAL), Scatterometer data is being used for cyclone prediction & Numerical Weather Prediction. Both Scatterometer and RISAT 1 showcased the capabilities of building ISRO nascent microwave sensors ecosystem in terms of applications, data handling, payload technologies for different applications.

Recent deployment of constellation of three X band SAR satellites (RISAT-2B/R1/R2) in two years span for urban monitoring and disaster management is the testimony of robust infrastructure requirements of microwave payloads in space. This is the first constellation of Indian microwave X band RADAR remote sensing satellites in the orbit.

Many more are envisaged in future for building microwave humidity and temperature payloads, flood mapping, maritime surveillance and radiometer. The joint collaboration of building NASA ISRO SAR payload (NISAR) demonstrates recognition of strong foundation and confidence in building microwave ISRO SAR expertise.

With the global advancement in development of techniques like SAR interferometry (InSAR), polarimetry (PolSAR), Tomography the requirement of SAR data over a region with high repeativity is growing exponentially. This requires a rapid proliferation of satellites.

## Industry participation in ISRO's MRS program

Microwave remote sensing program includes not only building technology & space infrastructure but also ground segment and data processing/handling/dissemination. In this segment industry participation is discussed in developing whole ecosystems.

ISRO has developed a series of active phased array antenna-based SAR satellites such as RISAT-1/ 1A/1B, RISAT-2A and NISAR. Phased Array based SAR's. This requires a large number of antenna radiators, digital controllers, Transmit Receive modules their TR Controllers, Power Conditioning and processing units and Power distribution networks. This necessitated the need to outsource their assembly and characterization. Development of newer technologies like unfurlable antenna and feed systems and high power modules & butler matrix is essentially required for X band SAR payload. The design and development of all these technologies are realized in house and the contracts for mass production are awarded to multiple Indian Industries as shown in Table 1 below.

**Table-1: Industry participation for production of ISRO's Microwave Remote Sensors**

| Name of Subsystem | Vendor |
|---|---|
| Antenna array | SLT, Gandhinagar, AMPL Hyderabad |
| MMICs | M/s Gaetec, Hyderabad UMS, France<br>(Foundry qualified for Space Usage) |
| Power Amplifier Modules | M/s BEL Gaziabad<br>M/s AMPL Hyderabad, Azista Ahmedabad |
| TR Modules | M/s AMPL, Centum Bangalore, Gatech Hyderabad, |
| Power Conditioning and processing units | M/s Centum, Bangalore, VCB electronics, Pune |
| Integration Block & Calibration Switch Matrix | M/s AMPL Hyderabad, BEL, Bangalore |
| Payload Controller | M/s Centum, Bangalore |
| Receiver | M/s Azista, Ahmedabad<br>M/s AMPL Hyderabad, BEL, Bangalore |
| Harnessing | Ananth Technologies, Hyderabad, Times Microwave |

Industries has been qualified and certified for space level developments. Industry has made efforts to develop facilities qualified for the development and qualification of following process.

* Screening, assembly hermitically sealing and qualification of TR Modules,
* Production and Screening of LTCC Modules, MMIC, Power Amplifier & LNA Modules
* Assembly and screening of Controller boards using having OBC 2.3 ASICs (SCL foundry)
* Assembly and Screening of dual polarized TRiMs/ TRiBS/TRM.
* A custom-built Automated Test Set-Up (ATS) for Testing and Characterization of multiple TRM at a time.
* Qualification of multilayer substrates for PCB and antenna tiles.
* FM/QM Assembly, testing and screening of subsystems (DC burn-in, EMI/EMC, Vibration, Shock, Constant Acceleration, Thermo Vacuum, Life test etc.)
* Design and development of Power supply modules.
* High power transmit modules.

Currently the Indian industry is involved in the development of expertise and facilities to fabricate/ develop various RF and digital sub-systems based on the knowhow provided by ISRO. In the next phase, it is imperative to enhance the role of Indian industries in taking up the design and development of systems/payloads to cope up the enormous demand and requirements of applications & users. The demand-based system gives huge opportunity to private industries in taking lead towards achieving this goal. One of the area to be explored is the system studies and development for constellation of small satellites which will be economically viable and meets large synoptic applications.

The participation of industry in microwave remote sensing applications has to make more efforts before reaching a substantial contribution as far as Indian scenario is considered. But it is also very clear that near future there will be considerable contribution of industry in Indian MRS applications, especially in the fields where optical data can not provide the required information. One of the major drivers of information gathering and data analytics during the monsoon season of India where Indian agriculture is at its peak, is of course the active microwave remote sensing technique. In addition, the archaeological, geological and cryosphere communities stand to gain from this data. The private sector is waking up and realising the finer nuances of the data which can be put to large scale use where creation of intelligent data products, is the need of the day.

New space data policy along with establishment of InSpace and NSIL bodies of DOS it is envisaged that some of the start-ups are currently looking at the data and exploring possibilities of usage at a bigger scale. Economics plays a significant role due to the high cost of data. Bigger entities are expanding their capacities and capabilities to harness this data. Globally, this is the scenario and Indian industries are fast

**Table 2. Global MRS programs and their industry collaborators**

| Agency | Satellite Program | Prime Industry Collaborator |
|---|---|---|
| Canadian Space Agency | RADARSAT-1/2, RCM | MDA , RSI |
| Agenzia Spaziale Italiana (ASI) | Cosmos-Skymed | Thales Alenia Space |
| ESA , DLR | ENVISAT,ERS-1/2, Sentinel-1A, TerraSAR | Airbus Defence and Space |

catching up. Notable global players are MDA (Canada), Geosolutions Inc, (USA/Europe), Interreg etc. There is a paradigm shift in the perception of things today; from a mere mapping of features to extracting information which can fetch revenue for the industries. Industries vie with each other to be a cut above the rest and MRS would play a significant role by way of information retrieval. A lot of industries would use and profit, notable amongst them who are involved in agriculture, forestry, oceanography, disaster monitoring to name a few. Additionally, objective information from a microwave satellite would add value to other sensor based information which the users can readily exploit and derive information from local to regional level.

## Global scenario of Industry participation in MRS

The development of various global microwave remote sensing programs around the globe consisted of various collaborations with industries (individual and consortiums) in terms of both sensor development as well as ground segment for acquisition, processing, marketing and distribution of data (Table 2).

This model of joint venture between national space agencies and industries has proven to be very successful globally. Progression of industries from being subsystem manufacturer to OEM is significantly challenging in an industry like space because of the high cost of development of advanced technologies.

The last two decades have seen tremendous technological advances in the field of MRS especially from the sensor development prospective. There has been significant miniaturization of electronics, onboard data processing and development of low weight deployable antennas. This has made it possible to bring down the weight of SAR satellites from a few tons to few hundred kilograms, making it possible to launch a constellation of multiple satellites together. This has brought down the revisit time of the targets and made high temporal resolution applications such as meteorology, subtle change detection, construction monitoring possible. Privately owned companies like Capella, Ice-Eye, SSTL, Umbra, I-QPS have successfully demonstrated indigenous development and operation of 100 kg class SAR sensors. All these SAR sensors are operating in X-band with an exception of S-band, NovaSAR-SSTL satellite.

# INORGANIC GROWTH OF INDIAN INDUSTRIES AS A SPIN OFF FROM ISRO'S MICROWAVE REMOTE SENSING PROGRAM

(CONTD.)

**Future of ISRO's MRS program**

Persistent change monitoring is amongst the strongest techniques of SAR which caters to various applications such as ship traffic monitoring and control, disaster damage assessment etc. This technique demands for producing processed images with a very low turnaround time. This requires large number of satellites in orbit along with onboard processing. It would require industries to move up in the value chain from being component and subsystem manufactures to start production of satellites. The Indian space industry value chain breakdown mentioned in (the white paper India's space industry), states that 75% of private space industries in India are SME's producing components (Tier 3); 19% of the industries surveyed contribute to the final delivery of subsystems (Tier 2) and only 6% of the industries are OEM's (Tier 1). In order to fulfill the rapidly increasing requirements of MRS data more industries need to move up in the value chain.

Indian Space Ecosystem can take a cue from the global scenario and utilize the opening of space sector reforms introduced by government of India in 2020 to move up more industries in the value chain in order to cater to the data requirements of SAR.

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# THE NEW GEOSPATIAL POLICY FOR NEW INDIA

**SHASHIKANT A SHARMA**
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Department of Science and Technology, Government of India announced "**Guidelines for acquiring and producing Geospatial Data and Geospatial Data Services including Maps"** on February 15, 2021. It is a very bold and welcome step in the right direction. The policy aims to liberalise the access to geospatial data among private Indian entities. Geospatial data refers to all the data - natural or man-made, imaginary or physical features, whether they are above or below the ground.

Earlier, the geospatial industries had following five major concerns:

1. Lack of reliable base data
2. Absence of a comprehensive policy
3. No clear-cut guidelines on data sharing
4. Absence of a single-window clearance
5. Lack of CORS network

The new policy is also in line with our 'Digital India' and '*Atmanirbhar Bharat'* initiatives. In the policy, the government says that at the moment, India was relying on foreign resources to a large extent. However, with the liberalisation of the sector as well as the currently available datasets, the domestic companies would be able to give an innovative push to this area and would also be able to use modern technologies to compete globally in this sector. As per the policy, only Indian entities would be able to get unrestricted access to data regarding ground truthing/verification, augmentation services for real time positioning and Indian ground stations. Apart from that, street view survey, terrestrial mobile mapping survey and Indian territorial waters surveying would also only be permitted for Indian entities.

The policy has set threshold values for spatial accuracy and Geospatial data having values and accuracy up to the threshold, can be uploaded to the cloud. However, for maps and data going beyond the threshold, would only be allowed to be stored and processed on servers or clouds within the country.

The government also clarified that for political maps of the country, state or any other boundary, the maps or digital boundaries published by Survey of India would be taken as standard and they would be made easily downloadable.

Some of the key positive features are :

1. Self Certification of Maps
2. Shift in Denial Regime (Negative list to be provided by DST)
3. Administrative boundaries prepared by SoI will be the standard and will be available for free and downloadable

# THE NEW GEOSPATIAL POLICY FOR NEW INDIA

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4. On-site spatial accuracy shall be one meter for horizontal or Planimetry and three meters for vertical or Elevation (refers to 1:4K scale)
5. Indian entities can map from any source at any scale, use CORS data and also conduct terrestrial mapping, street views……….

Although there is no mention of Standards and Interoperability in the guidelines, these are well known (ISO/BIS/OGC….) and available for Geospatial industries.

Finally, the new geospatial policy guidelines is a giant step forward, followed by more definitive policies and processes. It is hoped that all the agencies including Departments of Science and Technology, Department of Space, NIC are working together to make the Policy Guidelines implementable.

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# THE ROLE OF 'GENDER' IN RS&GIS: MOVING FROM DISPARITY TO EQUALITY, NEUTRALITY & POSITIVITY

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With exponential development and progress within the field of Remote Sensing and Geographic Information System (RS&GIS) in the 21st century, the scientific importance and community around this field has only grown. With the awareness about inequalities and discrimination increasing in recent years, the conversation surrounding the ethics and morals practiced within different international scientific communities have also come to the forefront. It has become increasingly difficult to separate the logical, rational realm of science from the realities of hierarchies and power relationships that it is inextricably intertwined with. Theoretically, there is no denying the fact that a holistic, wholesome and truly progressive scientific and academic community can only exist when every individual-no matter their sex or gender identity-has equal social, cultural and economic access to opportunities, whether it be within the field of science, arts or commerce. In reality, this still remains a far-fetched dream.

Only a few decades back, it would have been easy to assume that the concept of gender disparity is far removed from the field of RS&GIS based on the justification that the technology used is mostly intuitive with a multitude of uses in various industries/areas and should thus, appeal to everyone with a curious bent of the mind, irrespective of their sex or gender. However, that is hardly the case today. Statistics show that the distribution of women across multiple levels of involvement in this field are far below the required percentage. Other minority gender-identity groups are severely under-represented as well. The field of RS&GIS refers to all components and dimensions of the field, whether it's the study of the subject in college as students, teaching of the subject as teachers/professors in colleges/universities, applying the subject knowledge and techniques as field experts in developing different applications for societal needs or researching the subject for further advancements.

In mainstream patriarchal-heteronormative society (a society that only recognizes two genders-masculine and feminine- of which, the masculine gender is considered to be the primary one), minority gender identities are automatically at a disadvantage and are subject to oppressive, discriminatory and exploitative laws, customs and norms- both overt and subtle at the local, national and international scale. Furthermore, inequality in access to markets, climatic and natural resources, and various professional and academic opportunities have intensified the gaps in income, assets, and power amongst different gender groups.

However, in the recent past, steps have been taken at the micro and macro level to create a society in which gender is not considered relevant to the development goals while societal norms and relationships function independently of gendered norms. Such a society where an individual's roles and relations are not affected by gender may be called a gender-neutral society. On the other hand, in a gender-positive society, gender is central to achieving positive development outcomes. Special considerations for women or minority genders at the institutional and global levels are examples of this.

For now, though, gender disparity is the way of the world and the field of scientific research is no exception.

# THE ROLE OF 'GENDER' IN RS&GIS: MOVING FROM DISPARITY TO EQUALITY, NEUTRALITY & POSITIVITY

**(CONTD.)**

Even within the areas of research in geographical events such as climate changes/crisis and disaster management, there is a serious lack of gender diversity. There is a dearth of gender-oriented research that identifies the differences in the responses to climate changes or the impacts and consequences of different geographical events/disasters on minority gender identity groups despite there being an abundance of evidence that clearly points to the ability of minority gendered groups to identify with, react and recover from these in different, often more efficient ways.

This lack of exploration has impeded the development of resilient risk management systems. This is where remote sensing and GIS comes into use to better facilitate the creation and promotion of global responses aimed towards gender equality and inclusion.

GIS and spatial analysis can help in exploring and improving the gender dynamics in multiple ways. Inclusion of research that studies the disparities in climate impacts based on different genders, addresses the under-representation of minority groups with respect to responses to climate and improvement in risk management systems based on this could go a long way in achieving gender-positivity. To this end, SERVIR-Mekong (2015) published ''The Gender and GIS: Guidance Notes'' which is targeted at GIS application developers and potential application users. The research seeks to provide a step-by-step guide on the integration of gender concerns in the production of GIS applications for environmental/natural resource management, disaster risk management and building resilience to climate change. Their research gives some of the best examples of gender-integrated GIS applications in scholarly literature that clearly demonstrates the effectiveness of integrating gender with GIS technologies and production processes and their potential to empower through action-oriented benefits. RS&GIS applications, using gender-analytical information, can potentially influence decisions in policy making, serve as a tool for raising awareness on gender-blind policy practices, and enable communities to minimize gender-unequal risks and address multiple global challenges like environmental degradation, climate change issues, increasing disaster risks etc. Furthermore, RS&GIS can be productively used to illustrate how global, national, local and intimate spaces are inherently gendered and sexualized through the creation of maps of measures of gender inequalities. These can include the gender equality index, maps describing the gendered access to basic education, health and life expectancy differences, inequalities of economic opportunity, and uneven political empowerment.

While tools and techniques from RS&GIS can be applied for combating gender disparity, it's important to note that the RS&GIS community itself is skewed as far as gender neutrality is concerned. Leszczynski and Elwood (2014) argue for the necessity of gender-neutrality in the world of RS&GIS because "gender continues to matter" vis-à-vis new spatial media in three key dimensions: i) new practices of data creation and curation; ii) affordances of new technologies; and iii) new digital spatial mediations of everyday life.

Some of the major reasons for working upon gender equality/neutrality are–

◊ It will help in ensuring that the subject domain is equally relevant to both men and women within different social settings.

# THE ROLE OF 'GENDER' IN RS&GIS: MOVING FROM DISPARITY TO EQUALITY, NEUTRALITY & POSITIVITY

**(CONTD.)**

◊ It will help RS&GIS practitioners, and the overall society, in understanding how and why gender groups can play different roles in managing various elements of the subject in multiple ways, and how this can change over time.

◊ It will also help in ensuring that the decision-making power is more equally distributed among all genders.

◊ It will further help in developing the subject with a good understanding of the local context, existing vulnerabilities, and capacities.

Thus, there is growing evidence that integrating gender into projects can increase the benefits of conservation of nature and protection for humans. It is important to look for opportunities, not only to empower vulnerable groups, but to provide a safe space to share knowledge, perceptions, and experiences while avoiding an exacerbation of existing inequalities.

The following practices may be applied to make the RS&GIS world more gender equal and eventually, neutral–

◊ Analysis of gender based influences on power before, or in the early stages of, the planning of RS&GIS activities in order to ensure a solid understanding of the different levels of power, vulnerabilities, knowledge, and capacities in the community.

◊ Collection of sex disaggregated data for project activities/evaluation.

◊ Exploration of the drivers of change in gender roles and relations – how power dynamics shift in response to the pressures and stresses of RS&GIS applications over time.

◊ Ensuring gender considerations are included at all stages in the RS&GIS project cycle-tailoring methods and tools to the local context; ensuring they are appropriate for responding to local gender dynamics.

◊ Creation of awareness about power dynamics in decision makers so that they can recognize individuals whose voices may not be heard or who may not be able to raise their voice in order to find ways to address these power imbalances in representation.

◊ Creation of safe spaces (sometimes 'minority gender only' spaces) right from the beginning of the project planning.

◊ Identification of steps to profile all genders equitably in project communications.

◊ Assessment of potential project partners in terms of gender-related qualifications and experience.

◊ Design and development of a system to ensure that project benefits (including decision-making opportunities, training, and financial flows) are available to all vulnerable groups equitably.

# THE ROLE OF 'GENDER' IN RS&GIS: MOVING FROM DISPARITY TO EQUALITY, NEUTRALITY & POSITIVITY

**(CONTD.)**

The good news is that gender positivity in RS&GIS domain is gradually improving. Sarah Lewin, head of pre-sales and tech research at Esri UK, notes that when she studied her GIS master's degree at Edinburgh University (some 20 years ago), less than a third of students in the course were girls. In the beginning of her career, she found that the research community and industry was equally male-dominated. However, it is far more balanced today. Still, there is much more progress to be made towards the creation of a more gender-neutral senior management line-up in the boardroom- the gender ratio is still skewed towards the top (Lewin Sarah, 2016). Similarly, guest editors of Remote Sensing (2020) have pointed out in their special issue "She Maps" that female authorship is estimated at less than 25% while talking about publications in the field of remote sensing. Hopefully, the encouraging trends and initiatives by RS&GIS experts towards gender empowerment seen in various domains will address this balance in the coming years. United Nations now recognizes the importance of gender equality in the development of sustainable development goals.

The inclusion of basic elements of RS&GIS in the curriculum at schools/colleges has also led to the technology being used in a range of fields including geophysics, geology, earth-sciences, natural resources monitoring & management, geography etc. The sheer number of students being exposed to the potential of RS&GIS is increasing sharply. Graduates of all genders are coming up through the ranks of education establishments, ready to explore a career in the field and consequently leading towards an equitable community.

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# आत्मनिर्भर भारत की ग्रह सुदूर संवेदन में नए कदम : चन्द्रयान–1 से चन्द्रयान-2 तक

**रामदयाल सिंह और ए. एस. आर्या**

ग्रहीय विज्ञान प्रभाग (पीएसडी) , बीपीएसजी, एप्सा , सैक - इसरो

कोरोना वायरस महामारी से उत्पन्न आर्थिक संकट ने 12 मई 2020 को आत्मनिर्भर भारत अभियान को जन्म दिया। यह विचार सर्वप्रथम प्रधानमंत्री श्री नरेन्द्र मोदी जी द्वारा प्रस्तावित किया गया । आत्मनिर्भर भारत की विशेषताए 7 अगस्त 1905 को ब्रिटिश शासन के दौरान शुरू किये गए स्वदेशी आंदोलन के समान है । आत्मनिर्भर भारत अभियान, भारत को एक आत्मनिर्भर राष्ट्र बनाने के लिए एक दृष्टिकोण है, जिसमे वैश्वीकरण का बहिष्कार नही किया जायेगा अपितु दुनिया के विकास में मदद की जायेगी । आत्मनिर्भर भारत अभियान के प्रमुख 5 स्तम्भ अर्थव्यवस्था, बुनियादी ढांचा, प्रौद्योगिकी, जन सांख्यिकी और मांग है । अंतरिक्ष क्षेत्र में सुधारों के लिए प्रधानमंत्री नरेन्द्र मोदी ने 22 जून 2020 को भारतीय राष्ट्रिय अंतरिक्ष संवर्धन और प्राधिकरण केन्द्र (आई एन एस पी ए सी ई) के निर्माण की मंजूरी दी; यह निर्माण भारत को आत्मनिर्भर और तकनिकी रूप से उन्नत बनाने में एक और कदम है ।

वर्तमान काल में चन्द्रयान-1 और चन्द्रयान-2 भारत के आत्मनिर्भर मिशन का एक महत्वपूर्ण हिस्सा है। चन्द्रयान–1, भारत का प्रथम चन्द्र अन्वेषण मिशन था, 15 अगस्त, 2003 को प्रधानमंत्री श्री अटल बिहारी बाजपेयी जी द्वारा चन्द्रयान-1 परियोजना की घोषणा स्वंत्रता दिवस कार्यक्रम के दौरान की गयी थी । चन्द्रयान–1 मिशन को 22 अक्टूबर, 2008 को भारतीय समयानुसार सुबह 6 बजकर 22 मिनट पर ध्रुवीय उपग्रह प्रमोचन वाहन – एक्स एल 11 (पी एस एल वी—एक्स एल 11) द्वारा सतीश धवन अंतरिक्ष केन्द्र (एस एच ए आर), श्रीहरिकोटा के द्वितीय प्रमोचन पैड से सफलता पूर्वक प्रक्षेपित किया गया था । चन्द्रयान-1 अन्वेषण मिशन का प्रक्षेपण पूर्णतः आत्मनिर्भर था । चन्द्रयान–1 मिशन 8 नवम्बर, 2008 को भारतीय समयानुसार सुबह 5 बजे चन्द्रमा की कक्षा में स्थापित हुआ था । चन्द्रयान-1 ऑर्बिटर मिशन द्वारा चन्द्रमा के सतह की रासायनिक और खनिजीय मानचित्रण, प्रकाश-भौमिकी, तात्विक बहुतायत की जानकारी का अध्ययन किया गया था ।

चन्द्रयान–1 ऑर्बिटर मिशन में कुल 11 वैज्ञानिक उपकरण (पे-लोड) थे, जिनसे चन्द्रमा के सतह की रासायनिक और खनिजीय मानचित्रण, प्रकाश-भौमिकी, तात्विक बहुतायत की जानकारी का अध्ययन किया गया था, वैज्ञानिक उपकरणों के नाम इस प्रकार है : 1. टेरेन मैपिंग कैमरा-1 (टी एम सी -1), 2. उच्च- स्पेक्ट्रमी प्रतिबिम्बक (एच वाई एस आई), 3. चन्द्रमा खनिजोग्य मापक (एम 3), 4. स्मार्ट निकट अवरक्त स्पेक्ट्रोमीटर (एस आई आर – 2), 5. मिनी सिंथेटिक अपर्चर रडार (मिनी – एस ए आर), 6. चन्द्रयान–1 एक्स–रे प्रतिप्दिप्ती स्पेक्ट्रोमीटर (सी 1 एक्स एस), 7. उच्च ऊर्जा एक्स-रे स्पेक्ट्रोमीटर (एच इ एक्स), 8. चन्द्र लेजर परासन उपकरण (एल एल आर आई), 9. चन्द्र प्रभाव प्रोब (एम आई पी), 10. उप-किलो इलेक्ट्रॉन वोल्ट एटम परावर्तक विश्लेषक (एस ए आर ए), 11. विकिरण खुराक मॉनिटर प्रयोग (आर ए डी ओ एम) ।

भारत के पूर्ण रूप से आत्मनिर्भर वैज्ञानिक उपकरण (पे-लोड) के नाम इस प्रकार है: टेरेन मैपिंग कैमरा-1 (टी एम सी -1), उच्च- स्पेक्ट्रमी प्रतिबिम्बक (एच वाई एस आई), उच्च ऊर्जा एक्स-रे स्पेक्ट्रोमीटर (एच इ एक्स), चन्द्र लेजर परासन उपकरण (एल एल आर आई), और चन्द्र प्रभाव प्रोब (एम आई पी) । टेरेन मैपिंग कैमरा-1 (टी एम सी -1) ने चन्द्रमा के सतह को पैन क्रोमेटिक मोड में मैप किया और रूपात्मक अध्ययन के लिए चन्द्रमा के सतह की तीन आयामी चित्र को प्रदान किया । उच्च- स्पेक्ट्रमी प्रतिबिम्बक (एच वाई एस आई) ने ~80 मीटर के स्थानिक रिज़ॉल्यूशन पर 64 वर्णक्रमीय बैंड में चन्द्रमा के सतह को 0.42 - 0.96 माइक्रोन वर्णक्रमीय श्रेणी में मैप किया गया जिससे चन्द्रमा के सतह की रासायनिक और खनिजीय जानकारी प्राप्त हुई । उच्च ऊर्जा एक्स-रे स्पेक्ट्रोमीटर (एच इ एक्स) ने कम ऊर्जा वाले गामा किरणों का पता लगाकर चन्द्रमा के सतह के वाष्पशील तत्वों के परिवहन का अध्ययन किया । चन्द्र लेजर परासन उपकरण (एल एल आर आई) ने चन्द्रमा के वैश्विक स्थलाकृत क्षेत्र का मानचित्रण किया । चन्द्र प्रभाव प्रोब (एम आई पी) ने द्रव्यमान स्पेक्ट्रोमीटर का उपयोग कर चन्द्रमा के क्षणिक वातावरण का अध्ययन किया और चन्द्रमा के सतह के निकटवर्ती वातावरण में पानी के अणुओं कि खोज की ।

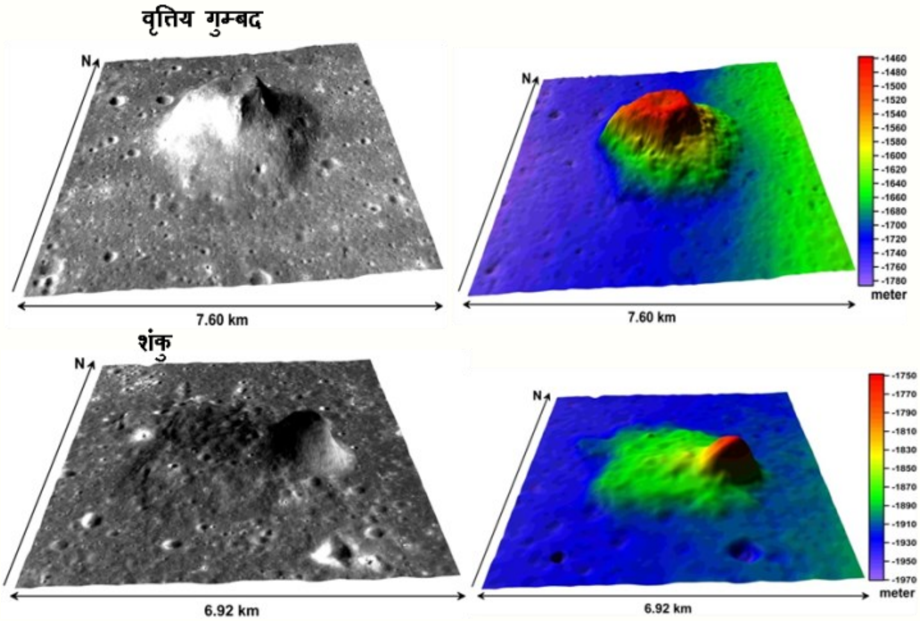
चन्द्रमा खनिजोग्य मापक (एम 3) नासा का एक अतिथि वैज्ञानिक उपकरण था, चन्द्रमा खनिजोग्य मापक (एम 3) ने 85 वर्णक्रमीय बैंड में चन्द्रमा के सतह को 0.50–3.0 माइक्रोन वर्णक्रमीय श्रेणी में मैप किया जिससे चन्द्रमा के सतह की खनिजीय जानकारी प्राप्त हुई । स्मार्ट निकट अवरक्त स्पेक्ट्रोमीटर (एस आई आर – 2) मैक्स प्लैंक इंस्टिट्यूट, जर्मनी का एक अतिथि वैज्ञानिक उपकरण था, निकट अवरक्त स्पेक्ट्रोमीटर (एस आई आर – 2) जो कि एक गैर-इमेंजिंग पॉइंट स्पेक्ट्रोमीटर था जिससे चन्द्रमा की सतह को 0.94–2.4 माइक्रोन वर्णक्रमीय श्रेणी में मैप किया गया जिससे चन्द्रमा के सतह की खनिजीय जानकारी को प्रदान प्राप्त हुई । मिनी सिंथेटिक अपर्चर रडार (मिनी – एस ए आर), नासा का एक अतिथि वैज्ञानिक उपकरण था, यह एक लघु सिंथेटिक अपर्चर रडार है जिससे स्थायी रूप से छाया वाले ध्रुवीय क्षेत्रों में परिपत्र ध्रुवीय अनुपात (सी पी आर) के आधार पर पानी–बर्फ जमा होने के गुणों की जानकारी प्राप्त हुई । चन्द्रयान–1 एक्स–रे प्रतिप्दिप्ती स्पेक्ट्रोमीटर (सी 1 एक्स एस) में चन्द्रमा के सतह के तात्विक प्रचुरता के आधार पर उत्पन्न सोलर एक्स–रे द्वारा प्रतिदीप्ति उत्सर्जन के आधार पर रासायनिक मानचित्रण किया गया । यह वैज्ञानिक उपकरण रदरफोर्ड एपलटन प्रयोगशाला, यू के, इ एस ए और इसरो के बीच सहयोग से बनाया गया । उप-किलो इलेक्ट्रॉन वोल्ट एटम परावर्तक विश्लेषक (एस ए आर ए) का उपयोग चन्द्रमा के सतह के साथ सोलर हवा के प्रभाव के अध्ययन के लिए किया गया था, यह यूरोपियन स्पेस एजेंसी (इ एस ए) का एक अतिथि वैज्ञानिक उपकरण था; जबकि विकिरण खुराक मॉनिटर प्रयोग (आर ए डी ओ एम) का उपयोग विकिरण बजट निगरानी के लिए किया गया था, यह बल्गेरिआई विज्ञान अकादमी का एक अतिथि वैज्ञानिक उपकरण था ।

टेरेन मैपिंग कैमरा-1 द्वारा ली गयी चन्द्रमा के सतह की छवियां बेहद उपयोगी पाई गयी और ये छवियां अभूतपूर्व दृश्य लौटाती है । टेरेन मैपिंग कैमरा-1 ने चन्द्रमा के सतह के उपग्रह आधारित मॉर्फोमेट्री को सक्षम किया जो कि पुराने पारंपरिक टेलीस्कोप आधारित फोटोग्रेमेट्री की तुलना में बहुत सटीक माप प्रस्तुत करता है । चंद्रयान-1 मिशन पर टेरेन मैपिंग कैमरा-1 (टी एम सी-1) ने चंद्र सतह का लगभग 40% मैप किया है । चन्द्रमा के ज्वालामुखी को समझने का एक महत्वपूर्ण पहलू चन्द्रमा के गुम्बद और शंकु की मैपिंग करना है, यह क्षेत्र अतीत में बने हुए इमारतों और मैग्मा के निकलने के स्थल हैं । गुम्बद और शंकु चन्द्रमा के मारे और हाईलैंड क्षेत्रों में व्यापक, उत्तल और वृत्ताकार भू-आकृतियाँ होती हैं । वे आमतौर पर 8-12 किलोमीटर व्यास के होते हैं, लेकिन पूरे 20 किमी तक हो सकते हैं । टेरेन मैपिंग कैमरा के ऑर्थो इमेज और डिजिटल एलीवेशन मॉडल (डी इ एम) के डेटा सेट मॉर्फोलॉजिकल मैपिंग के लिए पर्याप्त हैं; गुम्बद और शंकु जिनके व्यास 100 मीटर से अधिक की होती है, उनके भी मॉर्फोमेट्रिक मापदंडों की माप की जा सकती है । उच्च रिज़ॉल्यूशन स्टीरियो छवियों से अंतरिक्ष उपयोग केंद्र (एस ए सी), अहमदाबाद ने "मारिअस हिल्स क्षेत्र में लूनार गुंबदों की सूची" तैयार की है , जो मारिअस हिल्स क्षेत्र के चंद्र गुंबदों के रूपमितीय मापदंडों का चित्रण करता है (अंतरिक्ष उपयोग केन्द्र, 2013) । यह पहला चन्द्रमा का गुंबद कैटलॉग है जो टेलिस्कोपिक डेटा सेट का उपयोग करके पूर्व के प्रकाशित कैटलॉग की तुलना में उच्च रिज़ॉल्यूशन टेरेन मैपिंग कैमरा-1 के स्टीरियो व्युत्पन्न डिजिटल उन्नयन मॉडल (डी इ एम) का उपयोग करके तैयार किया गया है । चित्र 1 में चन्द्रमा के मारिअस हिल्स कॉम्पेक्स क्षेत्र में गुम्बद और शंकु का टेरेन मैपिंग कैमरा-1 के आर्थो चित्र द्वारा त्रिआयामी परिपेक्ष्य का अवलोकन (बाएं) और तलरूप (दाएं) मैप दिखाया गया है । चन्द्रमा के लिथो-स्ट्रेटीग्राफिक इतिहास और शामिल प्रक्रियाओ को समझने के लिए चन्द्रमा के ज्वालामुखी का अध्ययन आवश्यक है। मारिअस हिल्स का क्षेत्र महत्वपूर्ण है क्योकि यहाँ चन्द्रमा के आधे से अधिक ज्ञात गुम्बद और शंकु मौजूद है। टेरेन मैपिंग कैमरा -1 द्वारा लिया गया एक ज्वालामुखी निर्माण, जो कि चित्र 2 में दर्शाया गया है, चन्द्रमा के रीमा गैलिरिया के दक्षिण में स्थित है, यह एक प्रवाही गुम्बद है (आर्या एट आल., 2011अ) । गुम्बद और पास के मारे प्लेन्स की आयु क्रमशः 3.6 और 3.17 बिलियन वर्ष है । गुम्बद की चौड़ाई और गहराई क्रमशः 51-100 मीटर और 169-183 मीटर पाई गयी, गहराई और चौड़ाई यह दर्शाती है कि मैग्मा कक्ष का श्रोत मेंटल के निचले हिस्से में था ।

# आत्मनिर्भर भारत की ग्रह सुदूर संवेदन में नए कदम : चन्द्रयान–1 से चन्द्रयान-2 तक

## (CONTD.)

रुपमिति अध्ययन से यह पता चलता है कि यह एक ज्वालामुखी जैसी संरचना है जो कि धरती के हवाई क्षेत्र में स्थित ज्वालामुखी के समान है । द्रव्य प्रवाह सम्बन्धी गुणों के अध्ययन से ज्ञात होता है कि ऐसे स्थलीय समकक्ष बहुस्तरीय गुम्बद की स्थापना, मैग्मा तापमान में संरचनागत परिवर्तन या परतो के बीच हुई विस्फोट के कारण हुई है ।

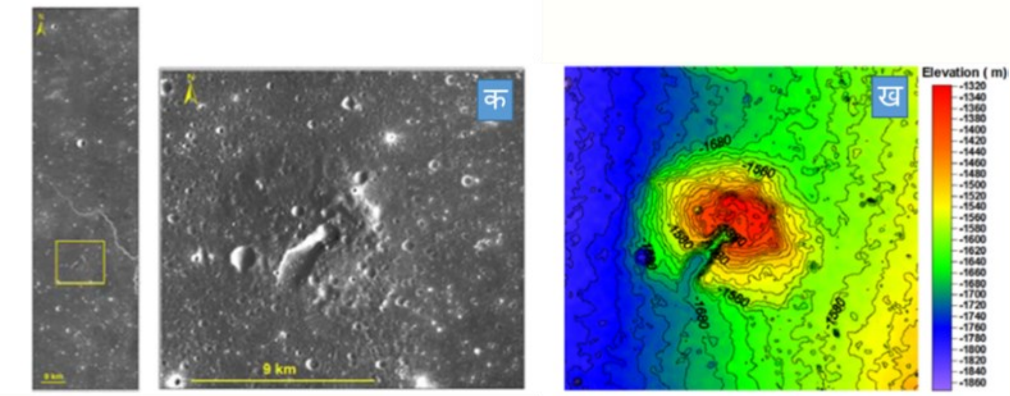



**चित्र 1** : चन्द्रमा के मारिअस हिल्स कॉम्पेक्स क्षेत्र में गुम्बद और शंकु का टेरेन मैपिंग कैमरा –1 के आर्थो चित्र द्वारा त्रिआयामी परिपेक्ष्य का अवलोकन (बाएं) और तलरूप (दाएं) मैप ।

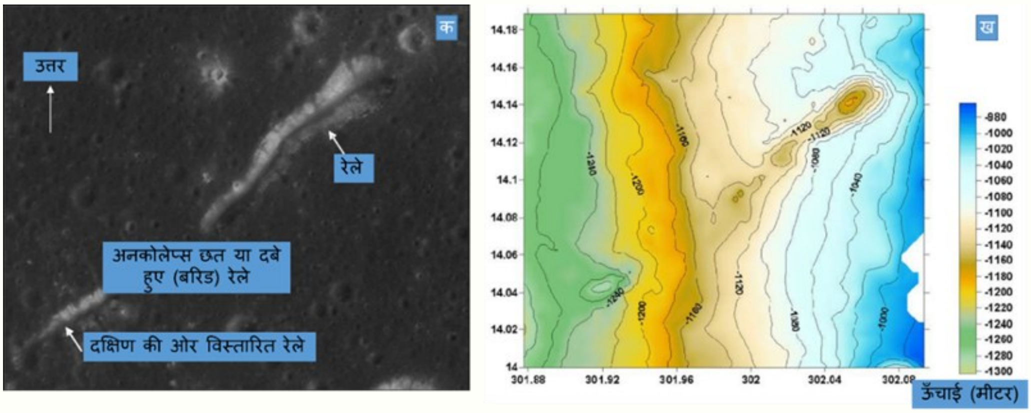
भविष्य में चन्द्रमा पर मानव बंदोबस्त और स्थायी बेस स्टेशनों की पहचान करने के लिए मिशन हो सकते है । चन्द्रमा पर उल्कापिंडो से बचने के लिए कोई निवारक (प्रिवेंटिव) वातावरण नही है जो मानव बंदोबस्त (सेटलमेंट) के लिए बहुत ही संवेदनशील विषय है, इसलिए ऐसे स्थानों की पहचान करने की आवश्यकता है जो उल्कापिंड के प्रभाव से बच गए है ।

चन्द्रमा पर मनुष्यों के निवास के लिए, उल्कापिंड के प्रभाव से बच गए स्थान उत्कृष्ट क्षेत्र प्रस्तुत करते है, ऐसा ही एक इकाई है जिसका नाम है "रेले सिस्टम", जो चन्द्रमा की सतह पर एक संकीर्ण चैनल है और यह ज्वालामुखी नली का एक अवशेष है । अनकोलेप्स छत या दबे हुए (बरिड) रेले वह क्षेत्र होते है, जहाँ छत के साथ एक घाटी बन जाती है; ऐसे स्थानों पर छत अंदर नही गिरे है और खोखले इंटीरियर के साथ बरकरार है । एक ऐसे ही ज्वालामुखी नली की खोज ओशनस प्रोसेलरम क्षेत्र में चन्द्रयान–1 के टेरेन मैपिंग कैमरा-1 के डाटा का प्रयोग से की गयी (आर्या एट आल., 2010; 2011ब) । यह रेले उत्तर पूर्व – एक करीबी अवलोकन से पता चलता है कि 1.73 किलोमीटर लम्बाई की छोटी रेले; जो कि मुख्य रेले के 2 किलोमीटर दक्षिण – पश्चिम में स्थित है और यह छोटी रेले, मुख्य रेले का विस्तार प्रस्तुत करती है । दो रेले के बीच होने वाला क्षेत्र एक लावा की अनकोलेप्स छत को प्रस्तुत करता है जो किन्ही कारणों से आज तक नही टूटी है, यह 360 मीटर चौड़ी और 2 किलोमीटर लंबी है ।

चित्र 3 (क) अध्ययन क्षेत्र का नादिर दृष्टिकोण दिखाता है और चित्र 3 (ख) ओशनस प्रोसेलरम क्षेत्र की ऊँचाई का रंगीन कंटूर मैप दिखाता है । दो रेले के बीच का क्षेत्र भविष्य में चन्द्रमा पर मानव बंदोबस्त और स्थायी बेस स्टेशनों के लिए सुरक्षित और पर्याप्त स्थल प्रस्तुत करता है ।




**चित्र 2** : गुम्बद का टेरेन मैपिंग कैमरा चित्र और टेरेन मैपिंग कैमरा का मोजेक (कक्षा संख्या 1130 और 798). अध्ययन क्षेत्र का टेरेन मैपिंग कैमरा-1 व्युत्पन्न डिजिटल उन्नयन मॉडल (डी इ एम) के साथ रुपरेखा (कंटूर) मैप (आर्या एट आल., 2011अ)




**चित्र 3** : (क) चन्द्रयान–1 के टेरेन मैपिंग कैमरा-1 के डाटा का प्रयोग से ओशनस प्रोसेलरम क्षेत्र में ज्वालामुखी नली, (ख) ओशनस प्रोसेलरम क्षेत्र की ऊँचाई का रंगीन कंटूर मैप (आर्या एट आल., 2010)। चित्र 3 (ख) ओशनस प्रोसेलरम क्षेत्र की ऊँचाई का रंगीन कंटूर मैप दिखाता है । दो रेले के बीच का क्षेत्र भविष्य में चन्द्रमा पर मानव बंदोबस्त और स्थायी बेस स्टेशनों के लिए सुरक्षित और पर्याप्त स्थल प्रस्तुत करता है ।

चन्द्रयान–2, भारत का चन्द्रयान–1 के बाद भारत का द्वितीय चन्द्र अन्वेषण मिशन है, 18 सितम्बर 2008 को प्रधानमंत्री श्री मनमोहन सिंह जी द्वारा चन्द्रयान-2 कार्यक्रम की स्वीकृति दी गयी थी । चन्द्रयान-2 से चाँद की भौगोलिक संरचना, सतह और उपसतह पर पानी, खनिजों की मौजूदगी और वितरण का अध्ययन करके चन्द्रमा के अस्तित्व में आने तथा उसके क्रमिक विकास के बारे में नई जानकारियां मिल सकेंगी । चन्द्रयान–2 मिशन को 22 जुलाई, 2019 को भारतीय समयानुसार दोपहर 2 बजकर 43 मिनट पर भूस्थिर प्रक्षेपण यान मार्क III (जी एस एल वी एम के III) द्वारा श्रीहरिकोटा के सतीश धवन अंतरिक्ष केन्द्र के दूसरे लांच पैड से सफलता पूर्वक प्रक्षेपित किया गया ।

भूस्थिर प्रक्षेपण यान मार्क III (जी एस एल वी एम के III) इसरो द्वारा विकसित किया गया उच्च प्रणोदन क्षमता वाला यान है, इसके द्वारा भारत के 4 टन श्रेणी के भू-तुल्यकालिक उपग्रहों को कक्षा में स्थापित किया जायेगा और सफल प्रक्षेपण के बाद भारत उपग्रह प्रक्षेपण के मामले में पूर्णत: आत्मनिर्भर हो गया ।

# आत्मनिर्भर भारत की ग्रह सुदूर संवेदन में नए कदम : चन्द्रयान–1 से चन्द्रयान-2 तक

**(CONTD.)**

चन्द्रयान–2 के तीन मुख्य विन्यास ऑर्बिटर, विक्रम लैंडर और प्रज्ञान रोवर है, जिसे भारतीय अंतरिक्ष अनुशंधान संगठन (इसरो) द्वारा विकसित किया गया है । चन्द्रयान–2 ऑर्बिटर मिशन में कुल 8 पे-लोड है, जिनके नाम क्रमशः 1. टेरेन मैपिंग कैमरा-2 (टी एम सी-2), 2. ऑर्बिटर हाई रेसोल्यूशन कैमरा (ओ एच आर सी), 3. इमेजिंग आई आर स्पेक्ट्रोमीटर (आई आई आर एस), 4. ड्यूएल फ्रीक्वेंसी एल और एस सिंथेटिक अपर्चर रडार (डी एफ एस ए आर), 5. सोलर एक्स–रे मॉनिटर (एक्स एस एम), 6. लार्ज एरिया सॉफ्ट एक्स–रे स्पेक्ट्रोमीटर (सी एल ए एस एस), 7. एटमॉस्फियरिक कम्पोज़िशनल एक्स्प्लोरर (चेस-2), 8. चन्द्रमा पर जा रहे हाईपरसेंसिटिव आयनमंडल और वायुमंडल की रेडियो एनाटॉमी - ड्यूल फ्रीक्वेंसी रेडियो साइंस एक्सपेरिमेंट (आर ए एम बी एच ए–डी एफ आर एस) है । ऑर्बिटर मिशन 100 किलोमीटर दूर की कक्षा से रिमोट सेंसिंग अध्ययन करेगा ।

चन्द्रयान–2 विक्रम लैंडर को चन्द्रमा की सतह पर भारत की पहली सफल लैंडिंग के लिए डिजाईन किया गया है । विक्रम शब्द भारतीय अंतरिक्ष कार्यक्रम के जनक डॉ. विक्रम साराभाई के नाम से लिया गया है । चन्द्रयान–2 विक्रम लैंडर मिशन में कुल 4 पे-लोड है, जिनके नाम क्रमशः 1. चन्द्रमा पर जा रहे हाईपरसेंसिटिव आयनमंडल और वायुमंडल की रेडियो एनाटॉमी-लैंगमुइर प्रोब (आर ए एम बी एच ए-एल पी), 2. चन्द्रमा का सतह ताप-भौतिकी परीक्षण (सी एच ए एस टी इ), 3. चन्द्रमा का भूकंपीय गतिविधि नापने का यंत्र (आई एल एस ए), 4. लेसर रेफ्लेक्टोमीटर ऐरे (एल आर ए) । चन्द्रयान–2 प्रज्ञान रोवर ए आई संचालित 6 पहिया वाहन है, प्रज्ञान शब्द संस्कृत के "ज्ञान" शब्द से लिया गया हैं । चन्द्रयान–2 प्रज्ञान रोवर मिशन में कुल 2 पे-लोड है, जिनके नाम क्रमशः 1. लेजर इंड्यूस्ड ब्रेकडाउन स्पेक्ट्रोस्कोप (एल आई बी एस) 2. अल्फा पार्टिकल इंड्यूस्ड एक्स-रे स्पेक्ट्रोस्कोप (ए पी एक्स एस) है । चन्द्रयान–2 का विक्रम लैंडर और प्रज्ञान रोवर चन्द्रमा पर लगभग $70^{o}$ दक्षिण के अक्षांश पर स्थित दो क्रेटरों मंज़िनस सी और सिमपेलियस एन के बीच वाले मैदान पर उतरने का प्रयास करेगा, यह क्षेत्र अधिक छाया में रहता है जिससे इसके चारों ओर पानी होने की सम्भावना है ।

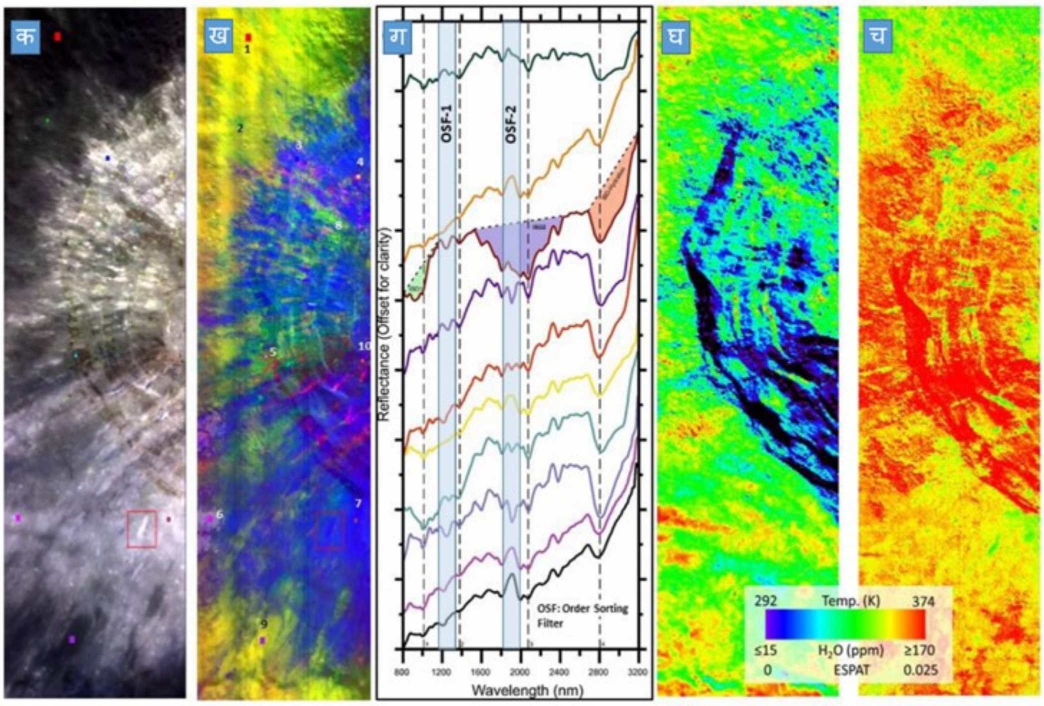
चन्द्रयान–2 ऑर्बिटर मिशन के मुख्य पे-लोड टेरेन मैपिंग कैमरा-2 (टी एम सी-2) का मुख्य प्रयोग चन्द्रमा की सतह का नक्शा बनाना, ऑर्बिटर हाई रेसोल्यूशन कैमरा (ओ एच आर सी) का मुख्य प्रयोग हाई रेंज टोपोग्राफी, इमेजिंग आई आर स्पेक्ट्रोमीटर (आई आई आर एस) का मुख्य प्रयोग सतह पर पानी, खनिजों की मौजूदगी और वितरण की पुष्टि, ड्यूएल फ्रीक्वेंसी एल और एस बैंड सिंथेटिक अपर्चर रडार (डी एफ एस ए आर) का मुख्य प्रयोग ध्रुवीय क्षेत्र मानचित्रण और उप-सतही पानी और बर्फ की पुष्टि, विस्तृत क्षेत्र सॉफ्ट एक्स–रे स्पेक्ट्रोमीटर (सी एल ए एस एस) का मुख्य प्रयोग चन्द्रमा की मौलिक रचना का विश्लेषण करना है ।

चन्द्रयान–2 भारत का पहला ऐसा अंतरिक्ष मिशन है जो चन्द्रमा के दक्षिण ध्रुव क्षेत्र के पास स्वदेशी तकनीक से लैंडिंग का संचालन कर रहा था परन्तु 6 सितम्बर 2019 को लैंडिंग का प्रयास करते समय 2.1 किलोमीटर ऊँचाई से शुरू होने वाले अपने इच्छित प्रक्षेपवक्र से विचलित होने पर दुर्घटनाग्रस्त हो गया; विक्रम ने रफ ब्रेकिंग चरणों को सफलतापूर्वक पूरा कर लिया था, और फाइन ब्रेकिंग चरणों में प्रवेश कर लिया था लेकिन सॉफ्ट लैंडिंग से पहले इसका धरती पर मौजूद स्टेशन से संपर्क टूट गया । विफलता विश्लेषण रिपोर्ट के अनुसार यह दुर्घटना एक सॉफ्टवेयर की गड़बड़ी के कारण हुई थी । ऑर्बिटर के कुल 8 पे-लोड चालू है और लगातार महत्वपूर्ण वैज्ञानिक डाटा प्रदान कर रहे है । अधिग्रहित पे-लोड डाटा को संसाधित (प्रोसेस) और संग्रहित किया जाता है और फिर भारतीय अंतरिक्ष विज्ञान डाटा सेंटर (आई एस एस डी सी) द्वारा संचालित वेब अप्लिकेशन प्रदान के माध्यम से उपयोगकर्ताओ को प्रसारित किया जाता है । प्रदान (पी आर ए डी ए एन) का अर्थ निति आधारित डाटा पुनर्प्राप्ति, विश्लेषिकी, प्रसार और अधिसूचना प्रणाली है (मित्तल एट आल., 2021) ।

## आत्मनिर्भर भारत की ग्रह सुदूर संवेदन में नए कदम : चन्द्रयान–1 से चन्द्रयान-2 तक

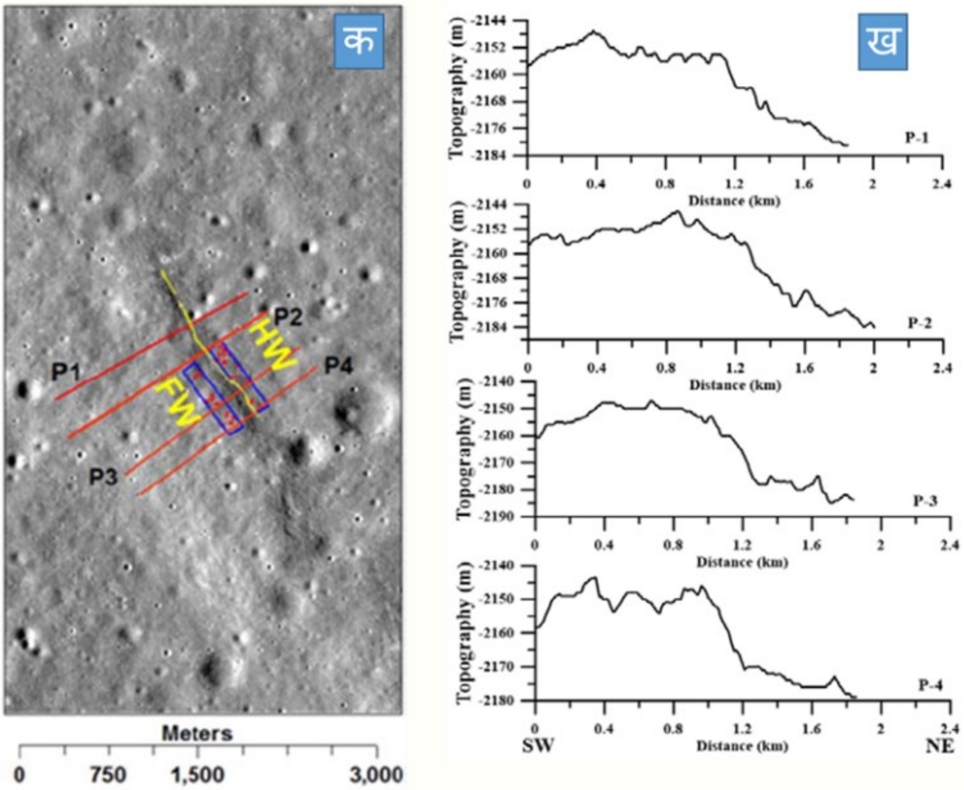
**(CONTD.)**

चन्द्रयान–2 इमेजिंग इन्फ्रा – रेड स्पेक्रोमीटर (आई आई आर एस) के प्रमुख उद्देश्य चन्द्रमा के सतही खनिजों का पता लगाना और उसका नक्शा बनाना है और साथ में ही चन्द्र सतह जलयोजन की प्रकृति का पता लगाना है । अरिस्टार्कस (23.6 डिग्री उत्तर, 47.5 डिग्री पश्चिम) 40 किलोमीटर व्यास का कोपरनिकन युग का क्रेटर है । वर्णक्रमीय परिवर्तनशीलता को दर्शाने के लिए कृत्रिम रंग समग्र (एफ सी सी) बनाया गया जो कि चित्र 4 (क) में दिखाया गया है; जहां, लाल चैनल को 995 नैनोमीटर आई आई आर एस बैंड, हरे को 1366 नैनोमीटर आई आई आर एस बैंड और नीले को 2091 नैनोमीटर आई आई आर एस बैंड चैनल से सौंपा गया है । अरिस्टार्कस क्रेटर के भीतर मौजूद वर्णक्रमीय परिवर्तनशीलता को दर्शाने के लिए एकीकृत बैंड डेप्थ (आई बी डी) भी तैयार किया गया । कृत्रिम रंग समग्र (एफ सी सी) बनाया गया जो कि चित्र 4 (ख) में दिखाया गया है; जहां, लाल चैनल को आई बी डी 1000 नैनोमीटर, हरे को आई बी डी 1000 नैनोमीटर और नीले को 1535 नैनोमीटर एल्बीडो चैनल से सौंपा गया है । मैफिक मिनरल हरे से पीले से नारंगी रंग में दिखाई देते है जबकि परिपक्व हाईलैंड मिट्टी प्लेजिओक्लेज के साथ अनार्थोसाईट मिनरल नीले रंग में दिखाई देते है। वर्णक्रमीय सिग्नेचर के अध्ययन के विभिन्न लिथोलोगिकल क्षेत्रों के स्पेक्ट्रा (चित्र 4 ग) बनाये गए । स्पेक्ट्रा हमे विभिन्न चट्टानों और जलयोजन के कारण 1000, 1350, 2000 और 3000 नैनोमीटर पर उत्पन्न होने वाले अवशोषण दिखलाते है। पहले तीन वर्णक्रमीय (स्पेक्ट्रल) फीचर हमे पाईरोक्सिन, ओलिविन और प्लेजिओक्लेज से युक्त सिलिकेट के चट्टानों को दर्शाता है । 1000 और 2000 नैनोमीटर पर प्रमुख स्पेक्ट्रल अवशोषण के कारण इम्पैक्ट मेल्ट से युक्त क्षेत्र नीले और चट्टान हमे हरे और लाल से मेंजेंटा दिखाई देते है ।




**चित्र 4**: (क) चन्द्रयान–2 इमेजिंग इन्फ्रा – रेड स्पेक्रोमीटर (आई आई आर एस) के कृत्रिम रंग समग्र (एफ सी सी) जिसमे 995 नैनोमीटर चैनल को लाल, 1366 नैनोमीटर को हरा और 2091 नैनोमीटर को नीला दर्शाया गया है। रंगीन बॉक्स रूचियो वाले क्षेत्र दर्शाते है जो वर्णक्रमीय रूप से सजातीय क्षेत्र है। (ख) एकीकृत बैंड डेप्थ (आई बी डी) – एल्बीडो कृत्रिम रंग समग्र (एफ सी सी), रूचियो वाले क्षेत्र 1 से 10 तक चिन्हित किये गए है । (ग) प्रमुख स्पेक्ट्रल अवशोषण (घ) तापमान मानचित्र (च) अरिस्टार्कस क्रेटर का एच 2 ओ सांद्रता मैप (भट्टाचार्य एट आल., 2021) ।

दोनों 1000 और 2000 नैनोमीटर की स्पेक्ट्रल अवशोषण के कारण पायरोक्लास्टिक निक्षेप (डिपोजिट) हमे पीले से हरे रंग में दिखाई देते है, हालाँकि इसके स्पेक्ट्रल अवशोषण की ताकत चट्टान की तुलना में कमजोर है। प्रमुख डबल और असममित स्पेक्ट्रल अवशोषण जो कि 3000 नैनोमीटर के पास देखी जा सकती है, जिसकी निम्न स्पेक्ट्रल अवशोषण सीमा 2810 नैनोमीटर और उच्च अवशोषण सीमा 3030 नैनोमीटर है । प्रमुख डबल और असममित स्पेक्ट्रल अवशोषण जलयोजन की प्रकृति के साथ- साथ हमे एच 2 ओ की तुलना में अधिशोषित ओ एच की प्रचुरता दर्शाती है । पानी की सांद्रता इ एस पी ए टी पैरामीटर द्वारा गणना की गयी जो किसी दिये गये स्थान पर मौजूदा पानी की मात्रा से रेखीय रूप से सम्बन्धित है । अध्ययन स्थल का तापमान मानचित्र चित्र 4 घ में दर्शाया गया है । अध्ययन स्थल पर पानी की मात्रा 80 पी पी एम की औसतम मूल्य के साथ 15-170 पी पी एम की सीमा तक पाई गयी (चित्र 4 च)। 3000 नैनोमीटर पर जलयोजन की प्रकृति का अध्ययन चन्द्रयान–2 इमेजिंग इन्फ्रा – रेड स्पेक्रोमीटर (आई आई आर एस) द्वारा 80 मीटर स्थानिक रेजोल्यूशन पर पहली बार किया गया ।



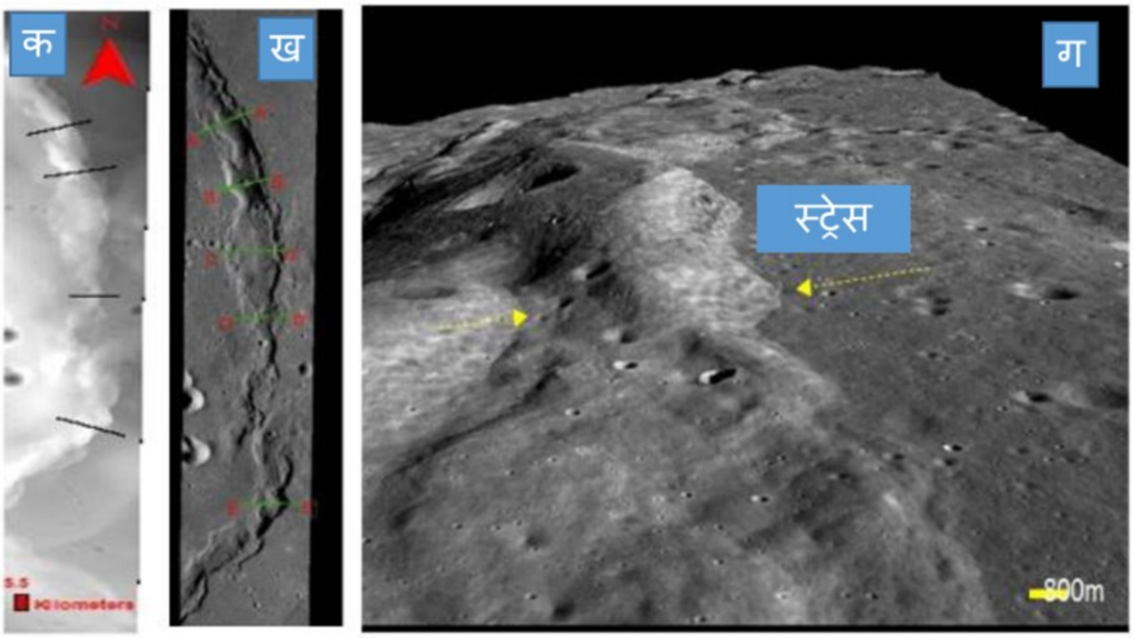

**चित्र 5** : (क) टेरेन मैपिंग कैमरा-2 (टी एम सी-2) द्वारा ली गयी लोबेट स्कार्प्स की आर्थो इमेज, चित्र में लोबेट स्कार्प्स (पिला लाइन), क्रेटर्स (लाल रंग के गोले) , फूट वाल (एफ डब्लू) और हँगिंग वाल (एच डब्लू) (नीले रंग के बहुभुज) और प्रोफाइल्स पी 1-पी 4 (लाल रंग के लाइनों) दर्शाये गए है (ख) पी 1-पी 4 स्थलाकृत प्रोफाइल (राजशेखर एट आल., 2021) ।

टेरेन मैपिंग कैमरा-2 (टी एम सी-2), चंद्रयान-1 मिशन में इस्तेमाल किये गये टेरेन मैपिंग कैमरा-1 के समान चन्द्रयान-2 मिशन का मुख्य पे-लोड है । इसका मूल उद्देश्य चन्द्रमा के 100 किलोमीटर की ध्रुवीय कक्षा से 20 किलोमीटर स्वाथ में पांच मीटर की हाई स्थानिक रिज़ॉल्यूशन से पैन-क्रोमेटिक स्पैक्ट्रम बैंड (0.5 से 0.8 माइक्रोन) में चन्द्रमा की सतह का नक्शा तैयार करना है ।

टेरेन मैपिंग कैमरा-2 (टी एम सी-2) के स्टीरियो जोड़े की छवियों द्वारा उत्पन्न डिजिटल उन्नयन मॉडल / स्थलाकृति लगभग 10 मीटर के स्थानिक रिज़ॉल्यूशन का होगा । टेरेन मैपिंग कैमरा-2 (टी एम सी-2) से एकत्र आंकड़ों से हमें चन्द्रमा के अस्तित्व में आने और उसके क्रमिक विकास के बारे में संकेत मिल सकेंगे और हमें चन्द्रमा की सतह का त्रिआयामी मानचित्र तैयार करने में मदद मिलेगी । टेरेन मैपिंग कैमरा-2 (टी एम सी-2) को अंतरिक्ष उपयोग केन्द्र, अहमदाबाद में विकसित किया गया है (आर्या एट आल., 2020) ।

लोबेट स्कार्प्स छोटे और युवा टेक्टोनिक लैंड फॉर्म है और यह चन्द्रमा के मारे और हाई लैंड दोनों क्षेत्रों में पाया जाता है । टी एम सी-2 द्वारा मारे फेकुंडीटेटीस के लोबेट स्कार्प्स को मैप किया गया, लोबेट स्कार्प्स की लम्बाई 1415 मीटर है, और औसतन ऊँचाई 24 मीटर है, फूट वाल और हॅंगिंग वाल की आयु क्रमशः 53.2 और 64 मिलियन वर्ष है, यह आयु दर्शाता है कि लोबेट स्कार्प्स की संरचना चन्द्रमा के कोपेर्निकन काल में हुई थी (राजशेखर एट आल., 2021) । चित्र 5 (क) में टेरेन मैपिंग कैमरा-2 (टी एम सी-2) द्वारा ली गयी लोबेट स्कार्प्स की आर्थो इमेज और 5 (ख) में पी 1-पी 4 स्थलाकृत प्रोफाइल दर्शाये गए है ।

सुकड़ी हुई लकीरे (रिंकल रिजेज) चन्द्रमा के सतह की वह अभिव्यक्ति होती है जो संकुचित दबाब (कम्प्रेशनल स्ट्रेस) के परिणाम स्वरुप होती है । चन्द्रमा पर सुकड़ी हुई लकीरे (रिंकल रिजेज) चन्द्रमा के मारे और उसके चारो ओर के क्षेत्र में 3.5 से 1.2 बिलियन वर्ष पूर्व की बनी हुई है । अध्ययन क्षेत्र डोरसा गीकी (चित्र 6) वैश्विक संकुचन के लम्बे इतिहास का प्रतिनिधित्व करता है जो कि मुख्य रूप से स्थानीयकृत बेसिन था । अध्ययन में यह पाया गया कि डोरसा गीकी का गठन, फेकुंडीटेसिस बेसिन में बेसाल्टिक ज्वालामुखी की शुरुआत के बाद हुआ है । टेरेन मैपिंग कैमरा-2 (टी एम सी-2) के डिजिटल उन्नयन मॉडल (डी इ एम) डोरसा गीकी के छैतिज विस्तार और रूप-परिवर्तनिक (मार्फो-टेक्टोनिक) विश्लेषण में मदद की है, डोरसा गीकी क्षेत्र में कुल संचित तनाव (स्ट्रेन) लगभग 1 से 3.9 प्रतिशत है जो कि चन्द्रमा के सुकड़ी हुई लकीरे (रिंकल रिजेज) की औसतन कुल संचित तनाव के अनुरूप है । अनुमानित प्रमुख दबाव (स्ट्रेस) की व्यवस्था उत्तर पूर्व – दक्षिण पश्चिम की दिशा दर्शाती है




**चित्र 6** : (क) डोरसा गीकी क्षेत्र मैपिंग कैमरा-2 (टी एम सी-2) का डिजिटल उन्नयन मॉडल (डी इ एम), (ख) डोरसा गीकी क्षेत्र का आर्थो इमेज और प्रोफाइल (रेखाए), (ग) डोरसा गीकी क्षेत्र का त्रिआयामी परिप्रेक्ष्य (आर्या एट आल., 2021)।

## आत्मनिर्भर भारत की ग्रह सुदूर संवेदन में नए कदम : चन्द्रयान–1 से चन्द्रयान-2 तक

**(CONTD.)**

जो कि सम्भवतः डोरसा गीकी क्षेत्र के कुछ सुकड़ी हुई लकीरों के समानांतर है जो कि डोरसा क्षेत्र के बाहर है । हाल ही में प्रकाशित आर्या एट आल., 2021 वैज्ञानिक पत्रिका में टेरेन मैपिंग कैमरा-2 (टी एम सी-2) द्वारा डोरसा गीकी क्षेत्र के संरचनात्मक विकास का विस्तृत वर्णन प्रस्तुत किया गया है । ऐसा विश्लेषण चन्द्रमा पर सभी सम्भावित सुकड़ी हुई लकीरों (रिंकल रिजेज) के लिए किया जा सकता है जिससे अतीत में चन्द्रमा के कुल संकुचन (सृन्केज) की मात्रा को निर्धारित किया जा सकेगा ।

प्रस्तुत लेख के पिछले अनुच्छेदो द्वारा चन्द्रयान–1 और चन्द्रयान-2 के कुछ प्रमुख बिन्दुओ और प्राप्त वैज्ञानिक परिणामों की चर्चा की गयी है । भारत द्वारा सुदूर संवेदन में चन्द्रयान–1 से चन्द्रयान-2 तक के नए कदमों से ग्रहीय विज्ञान के क्षेत्र में उपग्रह प्रक्षेपण, वैज्ञानिक उपकरण के निर्माण और डाटा के अनुप्रयोग तक, आत्मनिर्भरता का एक उदाहरण प्रस्तुत किया गया है । भविष्य में भी चन्द्रयान-2 के डाटा के अनुप्रयोग से हम सभी को चन्द्रमा के नए खोजों की आशा है जो हमारे चन्द्रमा के ज्ञान के सागर को भरने में मदद करेगी । चन्द्रयान–2 के लैंडिंग गाइड सॉफ्टवेयर की गड़बड़ी के कारण, लैंडर का सॉफ्ट लैंडिंग का प्रयास असफल रहा, पर अब सॉफ्ट लैंडिंग के प्रदर्शन के लिए एक नया लैंडर मिशन चन्द्रयान-3 प्रस्तावित किया गया है । चन्द्रयान-3 मिशन में चन्द्रयान-2 मिशन की तरह ही लैंडर और रोवर होंगे पर ऑर्बिटर नही होगा । चन्द्रयान-3 का प्रक्षेपण 2022 की तीसरी तिमाही में होने की सम्भावना है । चन्द्रयान-3 के बाद भारतीय अंतरिक्ष अनुसंधान संगठन (इसरो) और जापान एरोस्पेस एक्स्प्लोरेसन एजेंसी द्वारा रोबोटिक लूनर पोलर एक्स्प्लोरेसन मिशन (एल यू पी इ एक्स) की अवधारणा की गयी है जो चन्द्रमा के दक्षिणी ध्रुव पर लैंडर और रोवर भेजेगा । हाल में ही घोषित आत्मनिर्भर भारत मिशन से अंतरिक्ष सेक्टर में प्राइवेट एंटरप्राइज की भागीदारी का फैसला अत्यन्त महत्वपूर्ण है, भारतीय अंतरिक्ष सेक्टर में स्टार्ट-अप सेगमेंट भारतीय अंतरिक्ष अनुसंधान (इसरो) की सुविधाओ और बुनियादी ढांचों का उपयोग कर सकेगा । पिछले कुछ वर्षों में भारत के अंतरिक्ष स्टार्ट-अप के विकास ने सेटेलाइट और प्रक्षेपण में गतिविधियों और अविष्कार को बढ़ावा दिया है । भारतीय अंतरिक्ष अनुसंधान (इसरो) द्वारा पूर्व में 90 के दशक के शुरुआत से ही तकनीक के ट्रांसफर की पहल की है जिसके तहत अलग-अलग प्राइवेट और सरकारी कम्पनियों को तकनीक का ट्रांसफर किया जाता रहा है जो उद्योग के लिया फायदेमंद है, आशा है आत्मनिर्भर मिशन, अंतरिक्ष सेक्टर को ज्यादा आत्मनिर्भरता बनाएगी ।

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**आभार :**


हम इस अध्ययन में अंतरिक्ष अनुप्रयोग केंद्र (एस ए सी), इसरो के निदेशक श्री निलेश देसाई जी को समर्थन और प्रोत्साहन के लिए धन्यवाद देते हैं । हम डॉ आई एम बहुगुणा जी, उप निदेशक, ई पी एस ए, एस ए सी, इसरो के मूल्यवान मार्गदर्शन के लिए आभारी हैं। हम डॉ बिमल भट्टाचार्य जी, समूह निदेशक, ई पी एस ए, एस ए सी, इसरो के मूल्यवान मार्गदर्शन के लिए आभारी हैं।


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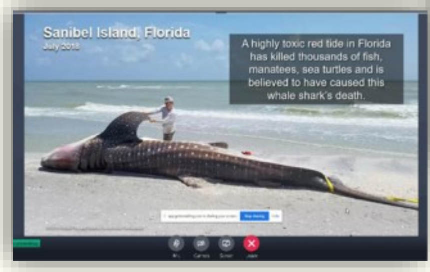
# JOINT CELEBRATION OF THE WORLD OCEANS DAY – 2021 - BY IMSA, ISRS-AC AND ISG-AC

**RASHMI SHARMA**
GROUP DIRECTOR, AOSG, EPSA, SAC-ISRO


Ahmedabad Chapters of Indian Meteorological Society (IMSA), Indian Society of Remote Sensing (ISRS-AC) and Indian Society of Geomatics (ISG-AC) celebrated the World Oceans Day (WOD) jointly on June 08, 2021. Realizing the need to move towards sustainable oceans, in 1992 on 8th June at the Earth Summit – UNCED in Rio de Janerio, Canada's ocean institute and ICOD proposed an idea to celebrate 8th June every year as International Oceans Day. In December 2008, United Nations officially recognized June 8 as the World Oceans Day. Since then, this day is being celebrated with different themes every year to create awareness and unite citizens for the sustainable management of our oceans. This year, the day was celebrated with the theme "The OCEAN: LIFE AND LIVELIHOODS" .


Speaker: Cmde. S.M.U. Athar

Due to the worldwide pandemic, this is a second virtual celebration of the WOD. So to celebrate this day, we had with us a very decorated and ocean enthusiast, Cmde Urooj Athar from Indian Navy, who delivered his talk on "Oceans, Life, Blue Economy and Sustainable Living". The invited talk was highly suited to the theme. Chairman IMSA welcomed the audience and gave a lucid introduction of the speaker. More than fifty members attended the event across the different societies. The talk started with different types of revolutions (agricultural, industrial etc.) and their impact on the oceans. He also touched upon industrial emissions, greenhouse gasses, oil productions, use of fertilizations, forest burning etc. and associated pollutions. There were other issues like the global warming, sea level rise and their impacts on the society were addressed.





The talk was followed by a brief, but very interesting Q&A session managed by the Secretary ISRS-AC. The event concluded with the formal vote of thanks by Secretary ISG-AC. The Secretary IMSA coordinated the entire event.

# WORLD ENVIRONMENT DAY – 2021: ECOSYSTEM RESTORATION


## C. P. SINGH

SCIENTIST, EPSA, SAC-ISRO


World Environment Day, initiated in 1974, has become a global platform for spreading awareness and raising current environmental issues. The World Environment Day, celebrated every year on 5th June, help engaging governments, citizens and all other stakeholders to address pressing environmental issues. We have been exploiting and damaging our ecosystems for too long. Therefore, this year's theme "Ecosystem restoration" is very pertinent which stresses on preventing, halting and reversing this damage – to go from exploiting nature to healing it. This World Environment Day kicked off the UN Decade on Ecosystem Restoration, a global mission to revive our ecosystems (forests, mountains, sea). While a decade sounds like a long time, but it is these next 10 years, which matter the most in bending the curve on biodiversity loss. Restorations of already damaged ecosystems, can help enhancing livelihoods, bring sustainable development, curb human mediated climate change and stop the degradation of biodiversity. Governments must invest in repairing the ecosystems; academicians must inspire students to take-up actions; and NGOs must work towards the cause of building a cleaner and greener future through ecosystem restoration. Ecosystem restoration contributes to the achievement of all the 17 Sustainable Development Goals (SDGs) by 2030 target date.

**REIMAGINE. RECREATE. RESTORE.**

This is our moment.

We cannot turn back time. But we can grow trees, green our cities, rewild our gardens, change our diets and clean up rivers and coasts. We are the generation that can make peace with nature.

Let's get active, not anxious. Let's be bold, not timid.

Join #GenerationRestoration

https://www.worldenvironmentday.global/

Ecosystems are defined as the interaction between living organisms (biotic) - plants, animals, people - with their surroundings – nutrients, weather (abiotic). This interaction in nature is also influenced by human-made systems such as cities or farms. Ecosystem restoration is essential to make more carbon sinks and to have healthier, cleaner and aesthetic life. The emergence of COVID-19 pandemic has also shown that, how catastrophic the consequences of ecosystem loss can be. By shrinking the area of natural habitat for animals, we have created ideal conditions for pathogens. Nevertheless, we can build back better. Just by planting trees on our streets, we can reduce around 0.5 to 2.0° C in summer maximum air temperatures. Ecosystem restoration is a global mission for repairing billions of hectares of land in order to bring back plants and animals. It also includes many small steps everyone can take, every day like, growing trees around us, making gardens on dumping grounds, cleaning up trash alongside rivers and coasts.

Ahmedabad Municipal Corporation (AMC) demonstrated one of the befitting example of ecosystem restoration with persuasion of Space Applications Centre (SAC), ISRO. The garbage dumping ground opposite to new SAC Campus in Bopal was an eye sore and people around were having trouble with foul smell and flying garbage on the streets. The leachates from the dumping ground are known to pollute the water table as well. Now this dumping site has been restored as an Ecology Park by AMC. A Tree Plantation event was organised by AMC and SAC at the Ecology Park on World Environment Day (5th June 2021).

This park is now coming up with beautiful landscaping in about 11000 sq. m. area and many fruit and spice plants are planted now. SAC scientists participated in this plantation activity. Now this park will not only bring back the aesthetic beauty of the place but also help sequester some carbon and attract many


**Fig.1: Google Earth Imageries depicting clearing of the garbage-dumping site**

**Fig.2: Collage of World Environment Day (5 June 2021) tree plantation activity in Ecology Park by SAC officials in collaboration with AMC.**

avifauna. Such efforts to restore and renew the degraded, damaged, or destroyed ecosystems is very timely and joint effort of SAC and AMC in this direction is notable.

**Acknowledgements**

Shri Nilesh M Desai, Director, SAC; Shri D.K. Singh, DD, HSTA, SAC; Dr. I.M. Bahuguna, DD, EPSA, SAC; Dr. Rashmi Sharma, GD, AOSG, SAC; Shri Anand Pathak, GD, MESA, SAC; Shri Rakesh Jain, GD, CMG, SAC; Ms. Harshida Modi, Sr. Admin. Officer, SAC; Shri C.P. Dewan, former GD, PPG, SAC; Shri S.K. Singhal, CMG, SAC and Staff of Ahmedabad Municipal Corporation.

# IKIGAI — THE JAPANESE SECRET TO A LONG HAPPY LIFE

BOOK REVIEW

**RIMJHIM BHATNAGAR SINGH**
Scientist, BPSG, EPSA, SAC-ISRO

**NIMISHA SINGH**
Scientist, GHCAG, EPSA, SAC-ISRO

Many a times, we all go through that phase in life when life appears to have stopped moving, nothing is moving-in profession or in personal life. This is when we lose the sense of purpose, and then slowly we drift to that abominable arena of illnesses, stress, lack of happiness and contentment. What if we start early on the way to happiness? “Ikigai: The Japanese Secret to a Long and Happy Life" inspires us to stay connected to our real self, have a life of purpose to live passionately, happily and long!

The book talks heavily about the Japanese island of Okinawa which has strikingly high longevity of its residents with many centenarians. It also talks about the secrets of living in other four blue zones of the world where the average life expectancy is very high-The Sardinia, Italy; Loma Linda, California; Costa Rica’s Nicoya Peninsula and Ikaria-the Greek island. The language of the book is lucid, the flow is decent and the content is easily understood by all adult population.

The word ‘Ikigai’ derives from ‘iki’, meaning life and ‘gai’, meaning the realisation of hopes and expectations. Japanese believe everyone has their Ikigai-some have found, some have not. It is hidden deep inside us. It transpires to-whatever you do, don’t retire.

The book teaches that the keys to longevity lie in your diet, exercise, Ikigai (i.e. finding a purpose in life) and strong social ties-family and friends. A few takeaways from the book are:

* *Hara Hachi bu*-The 80% secret-fill your belly just this much
* Eat healthy, eat local, avoid overindulgence.
* Have your *Moais*-the group of local people within community having common interests who look out for one another. Nurture friendships.
* Mental workout is a game changer—it keeps you youthful
* Stress ages you fast, but, a little stress is good. It keeps you going. At the minimum, have a daily routine.
* To control stress, practice mindfulness -Meditate, try Yoga, Surya Namaskar, Tai Chi, etc. A lot of sitting ages you.
* Discover the meaning of your life-the purpose, which, you only can do
* Keep flowing lying a river. Find your ‘flow’ in all that you do.

- Practice *Wabi Sabi*-finding beauty in imperfect, incomplete things, because they resemble nature.
- Celebrate small things in life. After all, happiness is in the doing, not in the result

At the end, an ode to longevity by a Japanese centenarian:

*To keep healthy and have a long life,*
*Eat just a little of everything with relish,*
*Go to bed early, get up early, and then go out for a walk.*
*We live each day with serenity and we enjoy the journey.*
*To keep healthy and have long life,*
*We get on well with all our friends.*
*Spring, summer, fall, winter,*
*We happily enjoy all the seasons.*
*The secret is not to get distracted by how old the fingers are;*
*From the fingers to the head and back once again.*
*If you keep moving with your fingers working, 100 years will come to you.*

Unearth your Ikigai!!

## Centre to rely on satellite imaging to resolve border disputes between northeastern states

Following the recent clash on the Assam-Mizoram border, the central government has decided to demarcate boundaries of northeastern states through satellite imaging to settle inter-state border disputes. The task of demarcating boundaries has been given to the North Eastern Space Applications Centre (NESAC). The idea for demarcation of inter-state boundaries through satellite imaging was mooted by Union Home Minister Shri. Amit Shah a few months ago.

## Remote sensing used to tackle modern slavery in Greece

Nottingham's Rights Lab combined different data sources including remote sensing data and methods to build a set of criteria measuring the extent of labor exploitation in a settlement. Through remote sensing data, identification and location of informal settlements of workers in potential situations of labour exploitation over a large geographic area were identified.

# REMOTE SENSING NEWS

## More than 250 major Fires detected in the Amazon this year, despite Brazil's ban

There have been 267 major fires detected in the Amazon this year, burning more than 105,000 hectares (260,000 acres). More than 75% of these fires blazed in the Brazilian Amazon, in areas where trees have been cut to make way for agriculture, despite a June 27 ban on unauthorized outdoor fires by the Brazilian government. Amazon Conservation Association's Monitoring of the Andean Amazon Project (MAAP), detects major fires using heat alerts from the ground as well as aerosol emission data. Fires are verified using Planet satellite imagery and reported using their real-time Amazon fire monitoring app.

## New Report Explains Landsat's Role as 'Gold Standard' for Calibration

A new report outlining why Landsat data are recognized as the standard for radiometric and geometric calibration was recently released by the Landsat Advisory Group of the National Geospatial Advisory Committee. The report explains how satellite images are calibrated for location and color with a variety of visual examples. It spotlights the usefulness of products that help monitor and interpret land cover change over time.

**Compiled by Rimjhim Bhatnagar Singh**

# UPCOMING CONFERENCES

## (AUGUST — DECEMBER 2021)

| Dates | Name | Place/ Organiser |
|---|---|---|
| **20 Aug 2021** | Technical Webinar: Nowcasting Weather prediction using latest remote sensing technologies Online • Virtual Workshop | The Institute of Engineering and Technology, UK |
| **16 - 27 Aug 2021** | GIS and Remote Sensing in Climate Change, Food Security and Agriculture Course Online • Virtual Workshop | Upskill Development Institute Kenya |
| **30 Aug - 02 Sep 2021** | Conference on Characterization and Radiometric Calibration for Remote Sensing | Space Dynamics Laboratory, North Logan, USA |
| **30 Aug - 03 Sep 2021** | GIS and Remote Sensing for Agricultural Resource Management Course | Dembesh Hotel, Juba, South Sudan, Upskill Development Institute, Kenya |
| **07 - 08 Sep 2021** | Remote Sensing and Geomatics symposium Online • Virtual Conference | Universitas Gadjah Mada Indonesia |
| **06 - 09 Sep 2021** | Anniversary Conference on From Imaging to Digital Reality: Remote Sensing and Photogrammetry | Racurs Co, Irkutsk, Russia |
| **13 - 16 Sep 2021** | SPIE Remote Sensing | IFEMA - Feria de Madrid, Madrid, Spain by SPIE- International Society For Optical Engineering |

# UPCOMING CONFERENCES

## (AUGUST — DECEMBER 2021)

| | | |
|---|---|---|
| **13 - 16 Sep 2021** | Earth Resources and Environmental Remote Sensing/GIS Applications Conference | |
| | Remote Sensing for Agriculture, Ecosystems, and Hydrology Conference | |
| | Remote Sensing of Clouds and the Atmosphere Conference | |
| | Image and Signal Processing for Remote Sensing Conference<br>Remote Sensing of the Ocean, Sea Ice, Coastal Waters, and Large Water Regions Conference | |
| **14 - 17 Sep 2021** | International Scientific Conference Regional Problems of Remote Sensing of the Earth | Krasnoyarsk, Russia<br>Siberian Federal University |
| **12 - 14 Nov 2021** | International Conference on Mining, Automation and Remote Sensing | Hilton Garden Inn Sanya China, Sanya,<br>Yaseen Academy, Wuhan<br>Yaseen Media Co., Ltd<br>China |
| **22 Nov 2021** | The Asian Conference on Remote Sensing | Can Tho University, Can Tho, Vietnam |
| **6-10 December 2021** | InGARSS 2021<br>IEEE India Geoscience and Remote Sensing Symposium 2021 | Ahmedabad, Gujarat, India |

**Compiled by Arun Kumar Surisetty**

# OBITUARY OF DR. SHIBENDU SHANKAR RAY

## FOOTPRINTS IN THE SANDS OF TIME (1963 – 2021)

It is said that at the end, it is not the years you live but the life in your years that you spent; this adage is apt for Dr. Shibhendu Shankar Ray, our colleague with an ever smiling face, a vivacious person, who was always helpful and took a leading role in the organization of things. He was born on July 02, 1963 at Bhadrakh, Odisha and graduated from the Odisha University of Agriculture & Technology. He was one of the few who laid great stress on self-learning, finding solutions to challenges and implementing the home grown ideas for analysis of remote sensing data to meet the requirements of the user agencies. The spectrum of his work spreads through optical and microwave remote sensing, from conceptualization to operationalization, from farm to national level and from national to the international level.

He joined the Space Applications Centre in December 1991 after his post-graduation from IARI, New Delhi. He started off with the Cotton Acreage & Condition Assessment (CACA) project and within a short period he was also in the Crop Acreage & Production Estimation (CAPE) project. Both these projects awakened his spirit of agriculture monitoring from remote sensing and he rendered great service in the field. He has been instrumental in bringing forth new ideas in monitoring of crops, spatial data collection and optimizing many routine input activities to a remote sensing program. Notable contributions include ideating the role of remote sensing for precision agriculture, cropping systems analysis and effect of certain micro-climatic variables on crop vigour. He was associated with many organisations during his research. Utility of hyperspectral remote sensing for agriculture is yet another feather in his cap. During his tenure at SAC, he was the Chair of the Working Group: WG VIII/6 of the ISPRS: Agriculture, Ecosystem and Biodiversity, Joint Secretary and Second Vice President of the Indian Society of Remote Sensing (ISRS) during different terms.

His insights into the nuances of the utilization of remote sensing data for crop monitoring, his research ideologies and an innate urge to improve the outreach, earned him the coveted post of the founder Director of the Mahalanobis National Crop Forecast Centre, Ministry of Agriculture & Farmers' Welfare, New Delhi which he joined in April 2012 and had been serving it till the last day. His foundation which he developed at SAC, Ahmedabad, stood him in good stead and he brought accolades to the Centre. He led a team of scientists and researchers in operational national-level agricultural programs on Crop Forecasting (FASAL), Drought

Assessment and Monitoring (NADAMS), Horticulture Inventory & Development (CHAMAN), Crop Insurance (KISAN), and Crop Intensification, amongst others. He had initiated the technology based yield estimation, optimization of Crop Cutting Experiments (CCEs), generation of CCE points through Smart Sampling for smooth implementation and timely settlement of claims to the eligible farmers of India under Pradhan Mantri FASAL Bima Yojana (PMFBY). Many national programs which were in the nascent stage were being nurtured under him and his vision was echoed in the Ministry which gave him almost a free hand to implement the latest technologies to improve the agricultural monitoring in India. He organized numerous national and international conferences to provide young scientists and researchers with the opportunity to learn from distinguished leaders in remote sensing and provide them a platform for networking.

His outreach extended beyond the boundaries of India and slowly he was actively involved in many international crop monitoring programs. He was instrumental in developing international relations for the Indian remote sensing society with Global Earth Observations – Global Agriculture Monitoring (GEOGLAM), JECAM, Asia-Rice, NASA Harvest, China Crop-Watch, JAXA, FAO, ESA, and many more were in the offing. These endeavours of him will live beyond his physical contribution of his life and provide great opportunities to aspiring researchers and relevant scientists of the field.

Needless to say, he published numerous articles, research reports, and books in the field of remote sensing based agriculture monitoring. He received prestigious awards as National Geomatics Award 2015, Satish Dhawan Award 2014, ISRO Merit Award 2014, ISRO Team Award 2007, Prof. P.R. Pisharoty Memorial Award 2006, Hari Om Ashram Prerit Dr. Vikram Sarabhai Research Award and many more. Currently, he was serving as the Associate Editor of the Journal of Indian Society of Remote Sensing, JISRS.

As a sad irony, one of his last papers was on the crop situation in India pre and post Covid lockdown and his untimely demise on May 04, 2021, due to Covid complications, was of course a shock to the community. A sudden rude stop to a visionary and vibrant human being. Truly it can be said of him, quoting H W Longfellow, "When a great man dies, for years the light he leaves behind him, lies on the path of many".

Om Shaanti !

- C. Patnaik

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## (2020-2022)

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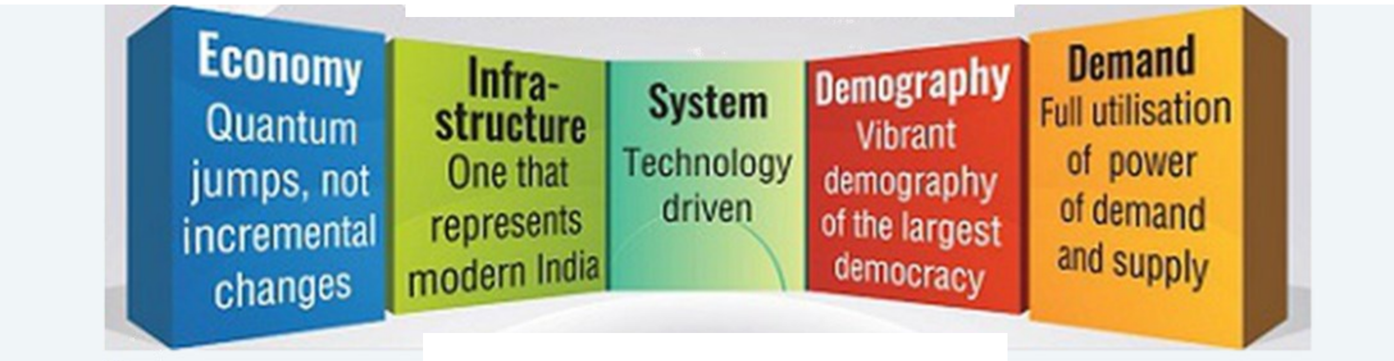
# *Five pillars of Atmanirbhar Bharat*

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