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G20 भारत 2023 INDIA

आज़ादी का अमृत महोत्सव

राष्ट्रीय सुदूर संवेदन केन्द्र NATIONAL REMOTE SENSING CENTRE
भारतीय अन्तरिक्ष अनुसंधान संगठन Indian Space Research Organisation

समाचार पत्रिका NEWS LETTER
जनवरी January 2023

सूचना inform | प्रेरणा inspire | प्रशिक्षण educate | संबद्ध engage | नई खोज innovate ▸▸▸ खंड Volume 12 ▸▸▸ अंक Issue 1

निर्देशक की कलम से ... from the director's desk...

पी2पी के सभी पाठकों को नव वर्ष की हार्दिक शुभकामनाए..

एनआरएससी ने महत्वपूर्ण उपलब्धियों का एक और वर्ष–2022 पूरा कर लिया है। इस वर्ष में S/Ka बैंड एंटीना के साथ IMGEOS का उन्नयन, SAN का 4PB, भूनिधि विस्टा डेटा प्रसार पोर्टल का विमोचन, दूसरे चरण की जन–संपर्क सुविधा और भू–स्थानिक ऊष्मायन केंद्र का उद्घाटन आदि विशिष्ट गतिविधियां संपन्न हुई।

वर्ष 2022 में, शीर्ष (सर्वोच्च शिखर) पास को संभालने के लिए भू–केंद्र को त्रिकोणीय अक्ष के साथ एक 7.5M S/X एंटीना के साथ संवर्धित किया गया। भारत–भूटान सहयोग कार्यक्रम के तहत थिम्पू, भूटान में एक भू–केंद्र स्थापित किया गया।

भू–प्रेक्षण उपग्रह–4 रीसैट–1 के डेटा अभिग्रहण और उत्पाद जनन के विभिन्न स्तरों के प्रसंस्करण को प्रचालनात्मक बनाया गया है और इसे भूनिधि पोर्टल के माध्यम से प्रयोक्ता समुदाय (कृषि एवं किसान कल्याण मंत्रालय, गृह मंत्रालय, जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय, पृथ्वी विज्ञान मंत्रालय तथा पर्यावरण एवं वन मंत्रालय) के लिए उपलब्ध कराया गया है। भू-प्रेक्षण उपग्रह-6 के संवेदक, प्रचालन के प्रारंभिक चरण में हैं। OCM-3 और स्कैटरोमीटर से प्राप्त शुरुआती डेटा सेट काफी आशाजनक हैं।

वर्ष 2022 के दौरान लगभग 26000 उपग्रह पासों से डेटा प्राप्त कर लगभग 4.6 लाख उत्पाद तैयार किए गए। 22000 मूल्य–संवर्धित उत्पादों के अलावा, कुल 1.23 लाख मूल्य के उत्पादों को प्रयोक्ताओं में वितरित किए गए। डिजिटल कृषि पहलों को पूरा करने के लिए कृषि और किसान कल्याण मंत्रालय के एग्रीस्टैक कार्यक्रम हेतु कार्टोसैट-2S डेटा राज्यों को प्रदान किया जा रहा है।

भूस्खलन के खतरों के अलावा, देश में चालू–मौसम के दौरान 14 राज्यों के 192 जिलों में अत्यंत बाढ़ की घटनाएं देखी गई हैं। आपदा सहायता समूह ने अधिकांशतः अपने भू–प्रेक्षण 4 SAR डेटा का उपयोग करके सभी घटनाओं के लिए बाढ़ मानचित्र प्रदान किया। उत्तर प्रदेश, आंध्र प्रदेश और पश्चिम बंगाल के लिए बाढ़ जोखिम क्षेत्र एटलस तैयार कर संबंधित राज्य सरकारों को प्रदान किया गया। एनआरएससी ने अंतर्राष्ट्रीय चार्टर के माध्यम से 13 आपदाओं के लिए भी सहायता प्रदान किया है। हिमालयी क्षेत्रों के कुछ हिस्सों में भूमि धंसना अध्ययन के लिए भी महत्वपूर्ण सूचना प्रदान की गई।

कालिक एविफ्स (AWiFS) डेटा से वार्षिक भूमि उपयोग / भूमि कवर (15 चक्र) पूरा किया गया और भुवन पोर्टल पर उपलब्ध कराया गया। एनआरएससी उपग्रह प्रेक्षणों का उपयोग करते हुए 5.5 किमी. और 750 मी. के स्थानिक विभेदन पर भारत के लिए निकट वास्तविक समय में दैनिक वास्तविक वाष्पोत्सर्जन (AET) उत्पन्न कर रहा है। वाष्पोत्सर्जन (ET) उत्पाद के सत्यापन के लिए देश भर में विभिन्न कृषि–पारिस्थितिकी प्रणालियों के तहत दस इड्डी कोवैरियंस फ्लक्स टावर्स स्थापित किए गए।

मानव–रहित हवाई–यान (UAV) सुविधा को प्रचालनात्मक बनाया गया और इसके विशिष्ट अनुप्रयोग जैसे तापीय संवेदकों से वाष्पोत्सर्जन (ET) अनुमान, फसल के प्रकार और कीटों की पहचान के लिए कई परियोजनाएं शुरू की गईं। कोसी बेसिन, बिहार के लिए यान–वाहित (एयरबोर्न) लिडार सर्वेक्षण और सिम्पीलाल (ओडिशा) परीक्षण स्थल में वन जैव–ईंधन (बायोमास) का आकलन शुरू किया गया।

भुवन पोर्टल पर औसत 216 लाख/माह विशिष्ट उपयोगकर्ता के आधार पर प्रति माह 62.34 करोड़ की औसत हिट प्राप्त हुई है। भुवन पोर्टल पर भू–स्थानिक डेटा के साथ समय श्रृंखला विजुअलाइजेशन सुविधा प्रदान की गई है और पॉकेट भुवन पर ध्वनि के साथ नेविगेशन को अद्यतन किया गया। नई प्रमुख परियोजनाओं में आवासन एवं शहरी कार्य मंत्रालय के लिए शहरी जल सूचना प्रणाली और कृषि एवं किसान कल्याण मंत्रालय के लिए डिजिटल कृषि पहल में भागीदारी शामिल हैं।

हम भारत सरकार के अंतरिक्ष सुधारों के अनुरूप अपने भारतीय सुदूर संवेदन संवेदकों से तैयार विश्लेषित उत्पादों को समय पर वितरित करने के लिए लगातार प्रयासरत हैं।

डॉ. प्रकाश चौहान, निदेशक, एनआरएससी

New Year Greetings to all the readers of P2P

NRSC has completed one more eventful year of 2022. The year has seen a significant events of IMGEOS upgradation with S/Ka band antenna, 4 PB of SAN, release of Bhoonidhi Vista data dissemination portal, inauguration of Phase II Outreach facility and Geospatial Incubation centre.

In 2022, the Earth Station has been augmented with one 7.5M S/X antenna with tri axis to handle zenith passes. A ground station has been established at Thimpu, Bhutan under the India Bhutan Cooperation programme.

The EOS-4 RISAT-1 data reception and processing of different levels of product generation is operationalised and is made avalaible to the user community (MoA&FW, MHA, MoWR, MoES and MoEF) through Bhoonidhi portal. The EOS 6 sensors are under initial phase of operations. The early data sets received from OCM-3 and Scatterometer are quite promising.

The data is acquired from about 26000 satellite passes during the year 2022, generating about 4.6 lakh products. A total of 1.23 lakh priced products in addition to 22000 value added products were disseminated to the users. Agristack programme of MoA&FW is being provided the CARTOSAT-2S data to states for meeting the objectives of digital agriculture initiatives.

The country has witnessed extreme flood scenario spread over 192 districts in 14 states in the current season in addition to the landslide hazards. The Disaster support group provided the flood maps for all the events mostly using our own EOS 4 SAR data. Flood Hazard Zonation Atlases were prepared and released for Uttar Pradesh, Andhra Pradesh & West Bengal. NRSC also responded to 13 disasters through international charter. Significant inputs were also provided for the land subsidence studies for a few pockets of Himalayan regions.

The annual land use / land cover (15th cycle) from temporal AWiFS data is completed and made avalaible on the Bhuvan portal. NRSC is generating near real time daily Actual Evapotranspiration (AET) for India at spatial resolutions of 5.5km and 750m using satellite observations. Ten Eddy Covariance Flux Towers have been established under various agro-ecosystems across the country for validation of ET product.

The UAV facility is made operational and several unique application projects like ET estimation from Thermal sensors, crop type and pest detection were taken up. The airborne LIDAR survey for the Kosi basin, Bihar and forest biomass estimation in Simpilal (Odisha) test site has been taken up.

The Bhuvan portal received average hits of 62.34 crore per month with an average unique user base of 216 lakh/month. The Bhuvan is facilitated with time series visualization of geospatial data and the pocket Bhuvan is updated with voice guided navigation. The new major projects includes the Urban water information system for MoHUA and Digital Agriculture initiatives of MoA&FW.

We are constantly striving to deliver the analysis ready products in timely manner from our Indian Remote Sensing sensors in tune with the Government of India's Space reforms.

Dr. Prakash Chauhan, Director, NRSC

विषय सूची index

1 भू-प्रेक्षण उपग्रह-04 मिशन और आंकड़ा उत्पाद EOS-04 Mission & Data Products

प्रयोक्ता समुदाय हेतु रिसैट–1 की सेवाओं की निरंतरता के लिए, इसरो द्वारा एक अनुवर्ती मिषन के रूप में ई.ओ.एस.–04 उपग्रह तैयार किया गया, जिसे पी.एस.एल.वी. सी–52 प्रमोचन यान द्वारा 14 फरवरी, 2022 को प्रमोचित किया गया। इस उपग्रह पर सी–बैंड सक्रिय एंटेना आधारित संष्लेशी द्वारक रेडार (एस.ए.आर.) नीतभार (पेलोड) (तालिका–1) लगा है जिसे एकल, युगल, वृत्तीय या पूर्ण ध्रुवण में बहु विभेदन के साथ संचालित किया जा सकता है। सूचना प्राप्त करने की अपनी क्षमता के कारण, मौसमी परिस्थितियों से स्वतंत्र और रातधदिन में प्रतिबिंबन क्षमता ने ई.ओ.एस.–04 को संभवतः महत्वपूर्ण बना दिया, विषेश रूप से उश्णकटिबंधीय क्षेत्रों में जहां लगातार बादल छाए रहने से ऑप्टिकल और निकट अवरक्त उपग्रह संवेदक से आंकड़ों का उपयोग सीमित हो जाता है।

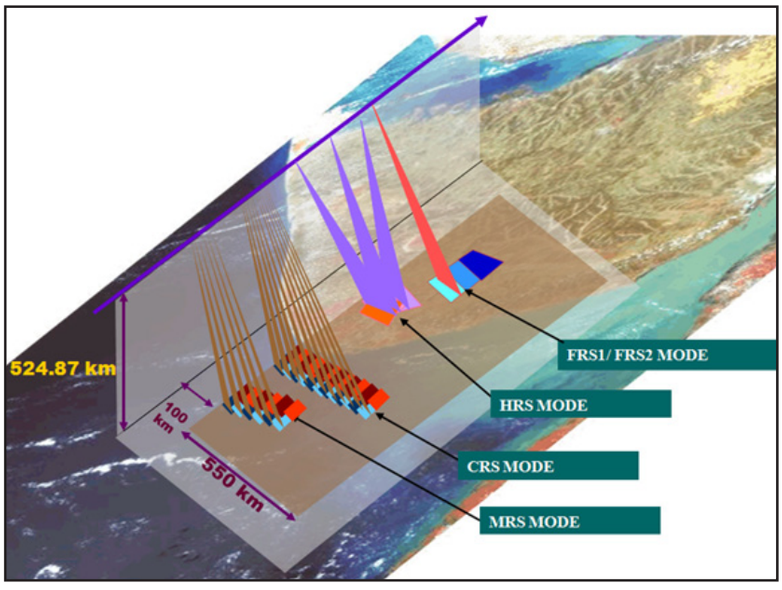
चित्र–1 में दर्षाए गए अनुसार, मध्यम विभेदन स्कैन एसएआर–एम.आर. एस., स्थूल विभेदन स्कैनसार–सी.आर.एस., सूक्ष्म–विभेदन स्ट्रिपमैप एफ.आर.एस.–1, एफ.आर.एस.–2, और उच्च विभेदन स्पॉटलाइटदृ एच.आर.एस. मोड में सार का प्रचालन होता है। इन मोड में तालिका 2 में दर्षाये अनुसार 10 कि.मी.– 223 कि.मी. के प्रमार्ज के साथ 1

To have the continuity of services of RISAT-1 to user community, ISRO has come with EOS-04 as a follow-on mission, which was launched on 14-February 2022 by PSLV C-52 launch vehicle. The satellite carries C-band active antenna based synthetic aperture RADAR (SAR) payload (Table-1) which can be operated with multiple resolutions in single, dual, circular or full polarization. Given its capability to obtain information, independent of weather conditions and day/night imaging made EOS-04 potentially important, particularly in the tropics where persistent cloud cover limits the use of data from optical and near infrared satellite sensors.

Medium Resolution ScanSAR-MRS, Coarse Resolution ScanSAR-CRS, Fine Resolution Stripmap FRS-1, FRS-2, and High Resolution Spotlight - HRS are the modes of SAR operation as shown in figure 1. In these modes, resolutions from 1m-50 m can be achieved with swath ranging from 10 km – 223 km as provided in Table 2. Beams can be changed as per different modes to acquire images within

तालिका 1.1. भू–प्रेक्षण उपग्रह–04 नीतभार विनिर्देशन Table-1.1 EOS-04 Payload Specifications

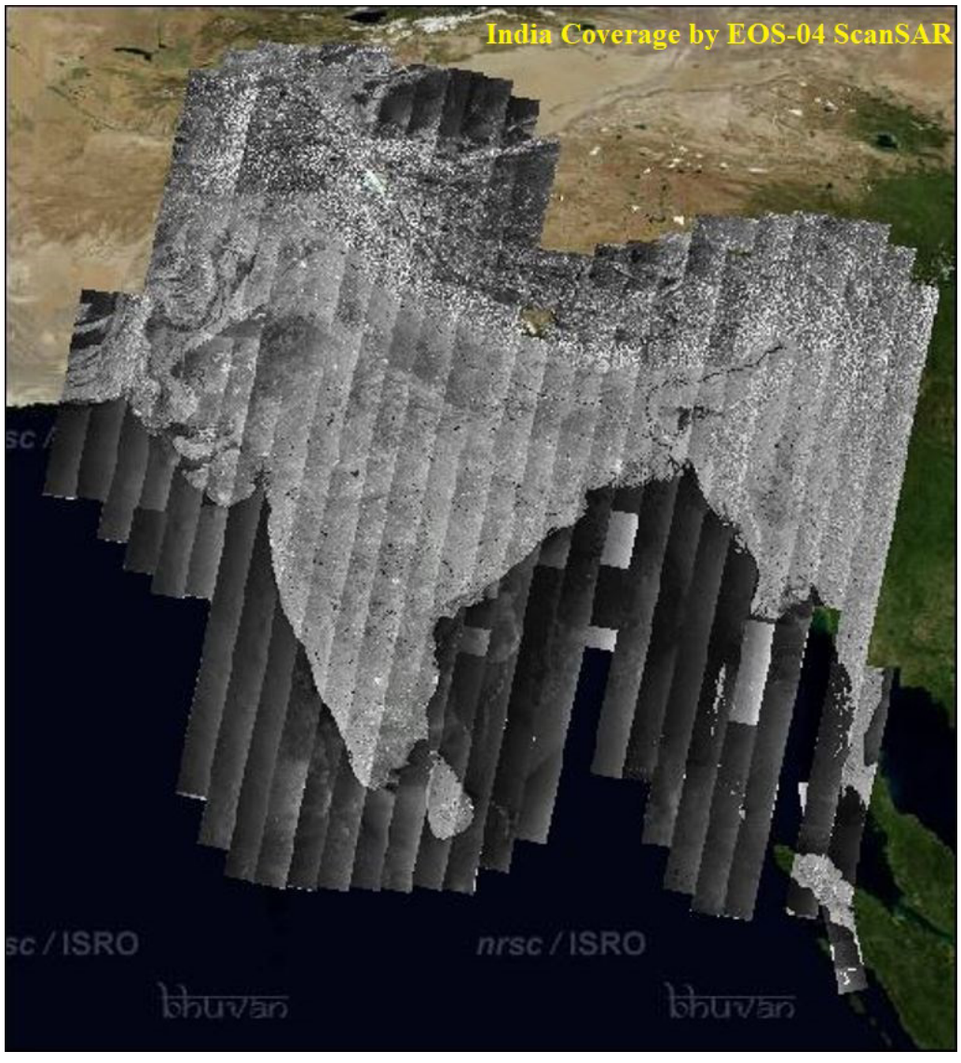
प्राचल Parameters	विनिर्देश Specifications
तुंगता Altitude	524.87 km
कक्षा Orbit	सूर्य तुल्यकाली (प्रातः 6 बजे–अवरोहणध्सा / 6–बजे भूमध्य रेखीय पारण) Sun synchronous (6 AM -descending / 6 PM equatorial crossing)
आवृत्ति Frequency	5.4 GHz + 37.5 MHz
ध्रुवण संयोजन Polarization Combination	एकल / युगल / पूर्ण / संकर ध्रुवणमापन Single / Dual / Full /Hybrid polarimetry
एंटेना रोलबायस (डिग्री) Antenna Roll Bias (deg)	± 36°
रेंज कवरेज (कि.मी.) Range Coverage (Km)	100-650 (फ्लाइट पथ के दोनों ओर (either side of flight track)
अवलोकन कोण (डिग्री) Look Angle (deg)	11.5 - 49.6
आपतन कोण (डिग्री) Incidence Angle (deg)	12.4 – 55.5



चित्र 1.1: ई.ओ.एस–04 की प्रतिबिंबन ज्यामिति Figure 1.1: Imaging Geometry of EOS-04

तालिका 1.2: ई.ओ.एस.–04 की प्रतिबिंबन विधाएं (मोड) **Table 1.2: Imaging Modes of EOS-04**

प्रतिबिंबन मोड **Imaging Mode**	प्रमार्ज(कि.मी.में) **Swath in km**	अधोतर कवरेज (कि.मी. में) **Off-nadir Coverage in km**	ध्रुवण **Polarization**	विभेदन (दिगंश x तिरछी रेंज) **Resolution (Azimuth x Slant Range)**
एफआरएस–1 FRS-1	25	100-650	एकल, युगल, वृत्तीय Single, Dual, Circular	3m x 2m
	20	100-400	पूर्ण Full	
एफआरएस–2 FRS-2	25	100-650	एकल, युगल, वृत्तीय Single, Dual, Circular	3m x 4m
	20	100-400	पूर्ण Full	
एमआरएस (8–बीम) MRS (8-Beam)	160	100-650	एकल, युगल, वृत्तीय Single, Dual, Circular	33m x 8m
	115	100-400	पूर्ण Full	
सीआरएस CRS	223	100-650	एकल, युगल, वृत्तीय Single, Dual, Circular	50m x 8m
	168	100-400	पूर्ण Full	

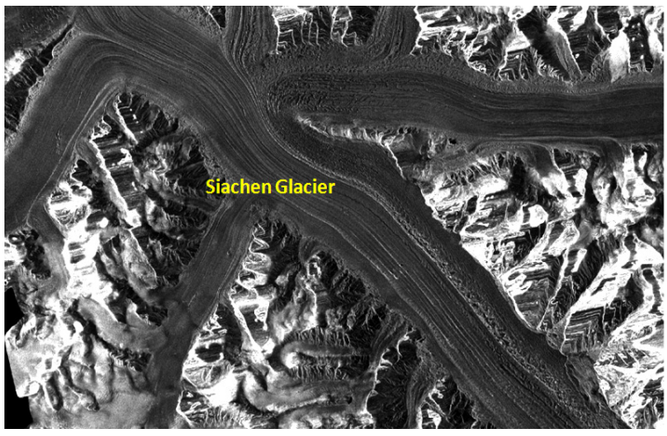


चित्र 1.2: भू-निधि विस्टा में प्रदर्शित किए अनुसार ई.ओ.एस.-04 एम.आर.एस. यथाक्रम कवरेज आंकड़े

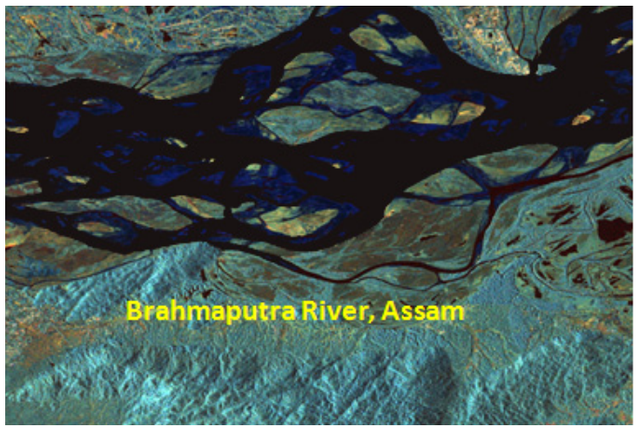
Figure 1.2: EOS-04 MRS systematic coverage data as displayed in Bhoonidhi vista

तालिका 1.3: ईओएस-04 आंकड़ा उत्पाद के स्तर **Table 1.3: Levels of EOS-04 Data Products**

मानक आंकड़ा उत्पाद **Standard Data Products**	
स्तर–0 Level -0	रॉ संकेत उत्पाद (जेनेरिक बाइनरी) Raw Signal Product (Generic Binary)
स्तर–1 Level-1	तिरछी रेंज जियो–टैग किए गए उत्पाद भू–रेंज उत्पाद (सी.ई.ओ.एस.धजियोटिफ) Slant Range Geo-Tagged Product Ground Range Products (CEOS/Geotiff)
स्तर–2 जियोरेफरेंस Level-2 Georef	संवर्धित भू–भाग परिष्कृत जियो–संदर्भित उत्पाद (जियोटिफ) Enhanced Terrain corrected Geo Referenced Product (Geotiff)
मूल्य वर्धित उत्पाद Value Added Products	
स्तर–1C Level-1C	जियो–टैग किए गए ध्रुवणमिति उत्पाद ळमव.जंहहमक Geo-tagged Polarimetric products
स्तर–3A Level-3A	भू–संदर्भित ध्रुवणमिति उत्पाद Geo-referenced Polarimetric products
मोजेक Mosaic	इंडिया मोजेक (यथाक्रम कवरेज के लिए) बृहद क्षेत्र मोजेक India Mosaic (for systematic coverage) Large Area Mosaic
प्रेक्षण : यूटीएम(स्तर–2), डेटम : डब्ल्यूजीएस84 (स्तर–2), पुनःप्रतिचयन : सीसी(स्तर–2) Projection : UTM (Level-2), Datum : WGS84 (Level-2) Resampling : CC (Level-2)	



चित्र 1.3: ई.ओ.एस–04, एफ.आर.एस.–1,ध्रुवण: एच.एच. स्तर–2
पास की तिथि: 15 अप्रैल, 2022
Figure 1.3: EOS-04, FRS-1, Polarization: HH, Level-2,
Date of Pass: 15th Apr 2022



चित्र 1.4: ई.ओ.एस.–04, एफ.आर.एस.-1, संकर ध्रुवणमिति
एम.–डेल्टा वियोजन
Figure 1.4: EOS-04, FRS-1, Hybrid Polarimetry, M-Delta
Decomposition

मीटर से 50मीटर तक विभेदन प्राप्त किया जा सकता है। नादिर दूरी से 100 कि.मी. से 650 कि.मी. के भीतर प्रतिबिंबों को प्राप्त करने के लिए विभिन्न मोड के अनुसार बीम को परिवर्तित किया जा सकता है। इसके अतिरिक्त, सीमित प्रमार्ज कवरेज और नादिर दूरी के साथ लक्ष्य वर्गीकरण क्षमताओं को बढ़ाने के लिए स्ट्रिपमैप और स्कैनसार मोड के लिए पूर्ण ध्रुवमापी मोड परिकल्पित की गई है।

भारतीय भौगोलिक क्षेत्र को 33 मी. विभेदन और 160 कि.मी. प्रमार्ज के साथ 17 दिनों की पुनरावृत्ति पर यथाक्रम कवरेज द्वारा आवृत्त किया जाना प्रस्तावित है। इन यथाक्रम कवरेज अभिग्रहण के लिए, मोजेक मूल्य वर्धित उत्पाद भौगोलिक प्रक्षेपण में भू–संदर्भित गामा 0 उत्पादों के रूप में उपलब्ध होंगे।

मानक उत्पाद श्रेणी में, भू–संदर्भन में प्रयुक्त डी.ई.एम. से स्तर–2 भू–भाग परिश्कृत जियो–संदर्भित उत्पाद को वास्तविक ऊंचाई के साथ उपलब्ध कराया जाता है। यह संबंधित स्थानीय आपतन कोण मानचित्र और मास्क फाइल से संबद्ध होता है।

स्तर–3ए ध्रुवणमिति उत्पाद, यू.टी.एम. प्रक्षेपण में भू–संदर्भित ध्रुवणमिति विघटित आंकड़ा उत्पाद है। इन उत्पादों में जियोटिफ प्रारूप में प्रयोक्ता

100 km to 650 km off nadir distance. Additionally, full polarimetric mode is envisaged for Stripmap and ScanSAR modes to enhance the target classification capabilities with limited swath coverage and off nadir distance.

EOS-04 Data Products are announced to user community on 13th December 2022. EOS-04 data products are available from 23rd March 2022 onwards for user ordering through Bhoonidhi web portal https://bhoonidhi.nrsc.gov.in/bhoonidhi/home.html and day-to-day acquisitions can be visualized in Bhoonidhi vista.

Indian Region will be covered in Systematic coverage with a repetivity of 17 days with 33m resolution and 160km swath. For these systematic coverage acquisitions, Mosaic value added products will be available as georeferenced gamma0 products in geographic projection.

In standard products category, Level-2 Terrain corrected Geo referenced Products are provided with true height from DEM used in georeferencing. It is associated with corresponding local incidence angle map and mask file.

द्वारा चयनित ध्रुवणमिति विघटन आधारित एकल बाउंस, द्वि–बाउंस और आयतन प्रकीर्णन प्रतिबिंब निहित हैं। संकर ध्रुवणमिति प्रतिबिंबों के लिए एम–डेल्टा (M-delt) और एम–ची (M&chi) विघटन उपलब्ध हैं। फ्रीमैन–डर्डन और यामागुची विघटन पूर्ण ध्रुवणमितीय प्रतिबिंबों के लिए उपलब्ध हैं।

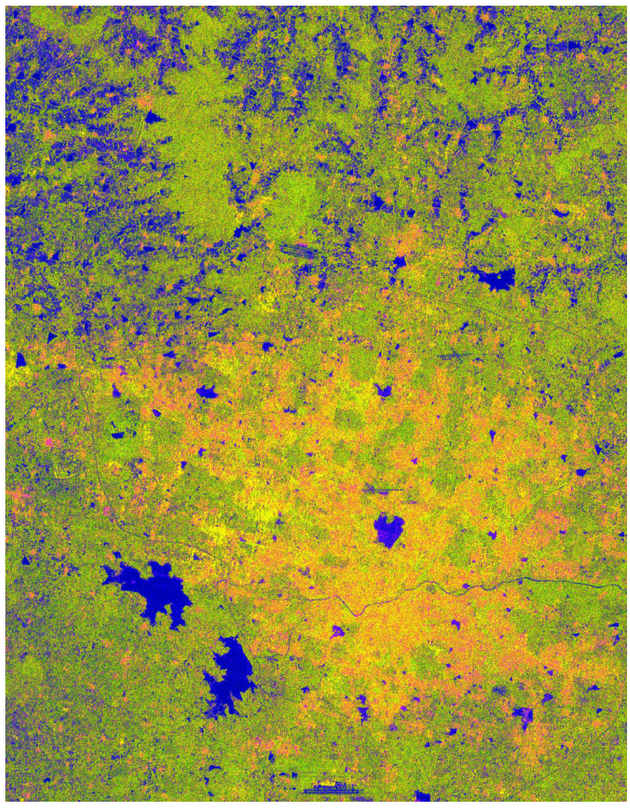
ई.ओ.एस.–04 का अपने बहु–विभेदन और ध्रुवीकरण विविधता के कारण वनस्पति, कृशि, वानिकी, मृदा नमी, भूविज्ञान, समुद्री हिम, तटीय प्रक्रियाओं, तेल रिसाव संसूचन, मानव निर्मित वस्तु पहचान, बाढ़ मानचित्रण आदि जैसे महत्वपूर्ण क्षेत्रों में प्रमुख अनुप्रयोग है। प्राकृतिक आपदाओं की स्थिति में नुकसान के आकलन के लिए प्रभावी ढंग से इसका इस्तेमाल किया जा सकता है।

चित्र 1.5: ई.ओ.एस.–04, पूर्ण ध्रुवणमिति आंकड़े, पास की तिथि: 27 अक्टूबर, 2022 यामागुची वियोजन

Figure 1.5: EOS-04, MRS, Full Polarimetric data, Date of Pass: 27th Oct 2022, Yamaguchi decomposition

Level-3A Polarimetric Products are georeferenced polarimetric decomposed data products in UTM projection. The product contains the single bounce, double bounce and volume scattering images based on user selected polarimetric decomposition in geotiff format. M-delta and M-chi decompositions are available for hybrid polarimetric images. Freeman-Durden and Yamaguchi decompositions are available for full polarimetric images.

EOS-04 with its multiple resolutions and polarization diversity is having the major applications in the thrust areas like Vegetation, Agriculture, Forestry, Soil Moisture, Geology, Sea Ice, Coastal Processes, Oil spill detection, Manmade object identification, flood mapping etc. It can be effectively used for damage assessment in the event of natural disasters.



चित्र 1.6: ई.ओ.एस.–04, एम.आर.एस., मिथ्या वर्ण सम्मिश्र प्रतिबिंब, हैदराबाद व नगरोपांत, पास की तिथि: 6th सितंबर, 2022

Figure 1.6: EOS-04, MRS, False Color composite Image, Hyderabad & Environs, Date of Pass: 6th Sep 2022

The Indian Society of Remote Sensing (ISRS) conferred **"NATIONAL GEOSPATIAL AWARD FOR EXCELLENCE-2021"** on Dr. V. Venkateshwar Rao in recognition of his significant contribution to the effective implementation of geospatial technology across government departments and academic institutions in India in the field of water resources and natural resource management. The award was presented to him on 15 November 2022 during the inaugural session of the ISRS/ISG annual convention & National Symposium held at HICC, Hyderabad.

2 भू-प्रेक्षण उपग्रह-०६ भू-खंड
EOS-06 Ground segment

ई ओ एस–06 (ओशनसैट–3) को इसरो के पोलर सैटेलाइट लॉन्च व्हीकल (PSLV&C54) द्वारा 26 नवंबर, 2022 को श्रीहरिकोटा, आंध्र प्रदेश का सतीश धवन स्पेस सेंटर (एसडीएससी) से 11:57। भारतीय मानक समय पर 8 सह–यात्री उपग्रहों के साथ सफलतापूर्वक लॉन्च किया गया था।

ओशनसैट–3 एक तीसरी पीढ़ी का उपग्रह है जो ओशनसैट–2 डेटा उपयोगकर्ताओं को सेवाओं की निरंतरता प्रदान करेगा। उपग्रह पृथ्वी की तस्वीरें संवेदकों नामतः ओशन कलर मॉनिटर (OCM), स्कैटरोमीटर (SCAT)और ARGOS से लेते हैं। यह परिचालन अनुप्रयोगों को बनाए रखने के लिए समुद्र के रंग और पवन सदिश डेटा की उपलब्धता सुनिश्चित करेगा। ऑन–बोर्ड सेंसर वैश्विक दिनध्रात मौसम पूर्वानुमान के संबंध में रिमोट सेंसिंग क्षमता को बढ़ाएंगे। अच्छी तरह से स्थापित अनुप्रयोग क्षेत्रों में सेवा देने और मिशन उपयोगिता को बढ़ाने के लिए उत्पाद से संबंधित एल्गोरिदम और डेटा उत्पादों में सुधार लागू किए गए हैं।

पिछले ओसीएम और स्कैटरोमीटर के संबंध में ईओएस–06 सेंसर में प्रमुख प्रगति

पेलोडः

❖ **ओसीएम–3**
- फ्लोरेसेंस के लिए प्रकाशीय क्षेत्र में 13 स्पेक्ट्रमी बैंड में और संशोधित स्पेक्ट्रमी विभेदन (20nm जव 10nm) के साथ वायुमंडलीय सुधार के लिए अवरक्त क्षेत्र में डेटा एकत्र करता है।
- स्वात 1500 किमी है और स्थानिक विभेदन 366m (स्थानीय क्षेत्र कवरेज– LAC मोड) और 1080m (वैश्विक क्षेत्र कवरेज– GAC मोड) है जिसमें प्रतिदीप्ति के लिए ऑप्टिकल क्षेत्र में 13 वर्णक्रमीय बैंड में 48X4000 डेटा क्षेत्र सरणी और व्ड में अवरक्त रेज पिक्सेल (से SNR को 1000 में सुधारें)।
- 13–दिन की ग्रहणशीलता के साथ परिक्रमा करके ग्लिंट से बचें
- डाउनलोड के लिए भूनिधि में सभी भौगोलिक भौतिक उत्पाद उपलब्ध हैं

❖ **स्कैटरोमीटर –3**
- नाममात्र मोड पवन वेक्टर के लिए 12.5 X 12.5 किमी ग्रिड प्रदान करता है और उच्च–रिजॉल्यूशन मोड 5 X 5 किमी ग्रिड आकार प्रदान करता है (प्रायोगिक)

❖**सीएनईएस द्वारा एआरजीओएस**, वन्य जीवन और बीउय्स पर नजर रखने के लिए एल – बैंड में संचालित होता है

EOS–06 (Oceansat – 3) was launched successfully by ISRO's Polar Satellite Launch Vehicle (PSLV-C54), along with 8 co-passenger satellites at 11:57 AM IST on November 26th, 2022 from Satish Dhawan Space Centre (SDSC), Sriharikota, Andhra Pradesh.

Oceansat-3 is a third generation satellite which will provide continuity of services to Oceansat-2 data users. The satellite images earth from sensors namely, Ocean Colour Monitor (OCM), Scatterometer (SCAT) and ARGOS. It will ensure availability of ocean colour and wind vector data to sustain the operational applications. The sensors on-board will enhance remote sensing capability with respect to global day / night weather forecasting. Improvements are implemented in product related algorithms and data products to serve in the well-established application areas and to enhance the mission utility.

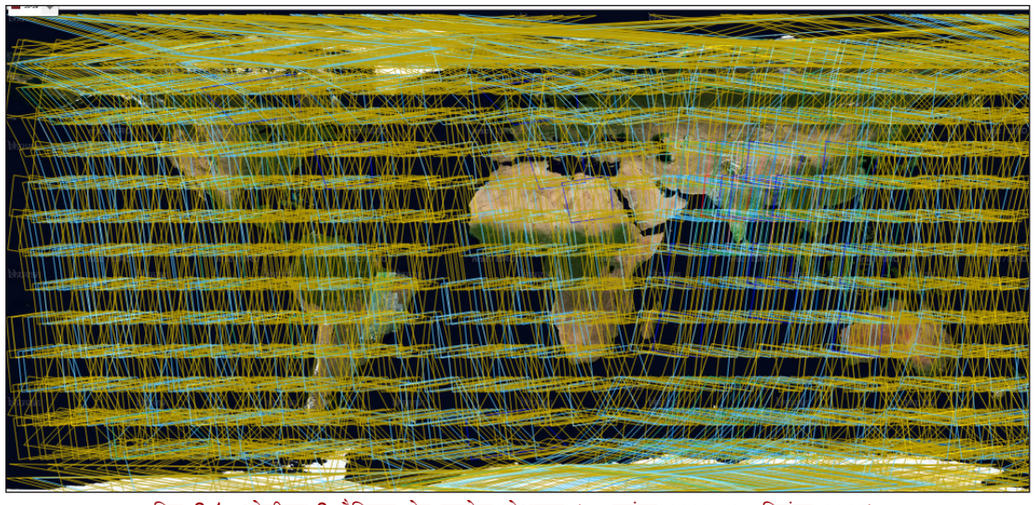
Major advancements in EOS-06 sensors with respect to previous OCM and Scatterometer

Payloads:

❖ **OCM-3**
- Collects data in 13 spectral bands in optical region for fluorescence and in infrared region for atmospheric corrections with improved spectral resolution (20nm to 10 nm)
- Swath is 1500 Km and spatial resolution is 366m (Local Area Coverage - LAC Mode) and 1080m (Global Area Coverage-GAC Mode) with area array 48X4000data in 13 spectral bands in optical region for fluorescence and in infrared reg pixels in OCM (to improve SNR to 1000).
- Avoid Glint by marching orbit with 13-day repeativity
- All Standard and Geophysical products are available at Bhoonidhi for downloads

❖ **Scatterometer-3**
- Nominal mode provides 12.5 X 12.5 km grid for wind vector and high-resolution mode provides 5 X 5 km grid size (experimental)

❖ **ARGOS** by CNES, operates in L-Band for tracking wildlife and buoys.



चित्र 2.1: ओसीएम-3 वैश्विक क्षेत्र कवरेज लेआउट (27 नवंबर 2022 - 27 दिसंबर 2022)
Figure 2.1: OCM-3 Global Area Coverage Layout (27 Nov 2022 - 27 Dec 2022)

ईओएस–6 अनुप्रयोग

ओसीएम–3 का उपयोग विभिन्न प्रकार के भूभौतिकीय और जैविक अनुप्रयोगों के लिए किया गया है, जिसमें संभावित मत्स्य क्षेत्र (PFZs) का पूर्वानुमान लगाना, प्राथमिक उत्पादकता का अनुमान लगाना, तटीय प्रक्रियाओं का अध्ययन करना, एरोसोल रेडिएटिव फोर्सिंग की गणना करना और भौतिक–जैविक युग्मित प्रक्रियाओं का अध्ययन करना आदि शामिल हैं।

स्कैट–3 डेटा अनुप्रयोगों को वनस्पति, मिट्टी की नमी, ध्रुवीय बर्फ, वैश्विक परिवर्तन, जैविक उत्पादकता– पीएफजेड परिवर्तन आदि पर सतही हवाओं के प्रभाव के अध्ययन के लिए लागू किया गया।

ई ओ एस–6 डेटा कार्य प्रवाह

भूनिधि से पेलोड प्लानिंग, डेटा रिसेप्शन, रीयल टाइम डेटाअधिग्रहण, डेटा प्री–प्रोसेसिंग, डेटा उत्पाद निर्माण, गुणवत्ता जांच, अभिलेखीय और कैटलॉगिंग, निगरानी और डेटा प्रसार से सभी प्रसंस्करण श्रृंखलाएं स्वचालित हैं। एलएसी के लिए उपयोगकर्ता इनपुट–आधारित योजना और ई ओ एस–6 के लिए सभी सेंसरों का आवधि क डेटा गुणवत्ता मूल्यांकन भी सक्षम है।

OCM-3 (GAC) और SCAT-3 (भूनिधि में चित्र मुफ्त डाउनलोड के लिए सहज सुविधा उपलब्ध हैं। OCM-3(LAC) मूल्य वाले उत्पाद भूनिधि पोर्टल पर मांग के आधार पर उपलब्ध हैं।

ई ओ एस–6 ओसीएम आवृत्त क्षेत्र

ओसीएम एलएसी मोड

- भारत क्षेत्र का व्यवस्थित कवरेज
- उपयोगकर्ता इनपुट–आधारित भविष्य के कार्य अनुरोध सेवाएं

ओसीएम जीएसी मोड

- हर दो दिनों में पूर्ण वैश्विक कवरेज (चित्र 2.1)

भूनिधि विस्टा @ ईओएस–6

LAC और GAC के लिए नेटिव विभेदन में वास्तविक समय डेटा विजुअलाइजेशन सक्षम है और SCAT का पवन वेक्टर उत्पाद भूनिधि विस्टा में एनीमेशन के रूप में उपलब्ध है। (चित्र 2.2)

- डिफॉल्ट GCS प्रक्षेपण के साथ OCM स्तर–1C उत्पाद
- L3WW SCAT3 उत्पाद

EOS-06 Applications

OCM-3 has been used for a variety of geophysical and biological applications, including forecasting Potential Fishing Zones (PFZs), estimating primary productivity, studying coastal processes, calculating aerosol radiative forcing, and studying physical-biological coupled processes etc.

SCAT-3 data applications applied to the study of vegetation, soil moisture, polar ice, global change, cyclone development and intensification. Effect of surface winds on biological productivity-PFZ changes etc.

EOS-06 Data Workflows

All the processing chains from payload planning, data reception, real time data acquisition, data pre-processing, data products generation, quality checks, archival & cataloguing, monitoring and data dissemination from Bhoonidhi are automated. User input-based planning for LAC and periodic data quality evaluation of all the sensors is also enabled for EOS-06.

All data products of OCM-3 (GAC) and SCAT-3 (Fig. are readily available for free downloads at Bhoonidhi. OCM-3(LAC) are priced products available on demand at Bhoonidhi.

EOS-06 OCM Coverage

OCM-3 LAC Mode

- Systematic Coverage of India Region
- User input-based future tasking requests Services

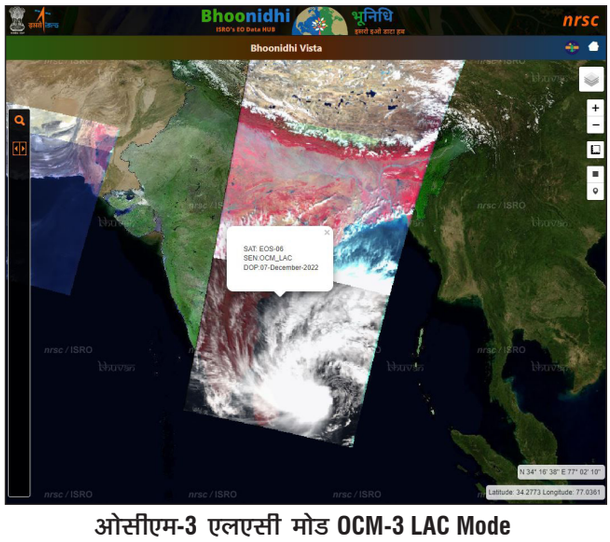
OCM-3 GAC Mode

- Full Global coverage in every two days. (Fig. 2.1)

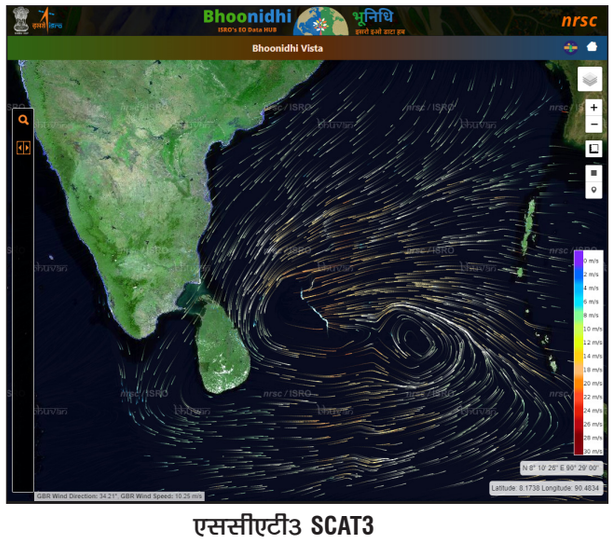
Bhoonidhi Vista @ EOS-06

Near real-time data visualization in native resolution for LAC and GAC is enabled and wind vector product of SCAT is available as animation at Bhoonidhi vista. (Fig. 2.2)

- OCM Level-1C products with default GCS projection
- L3WW SCAT3 products



ओसीएम-3 एलएसी मोड OCM-3 LAC Mode

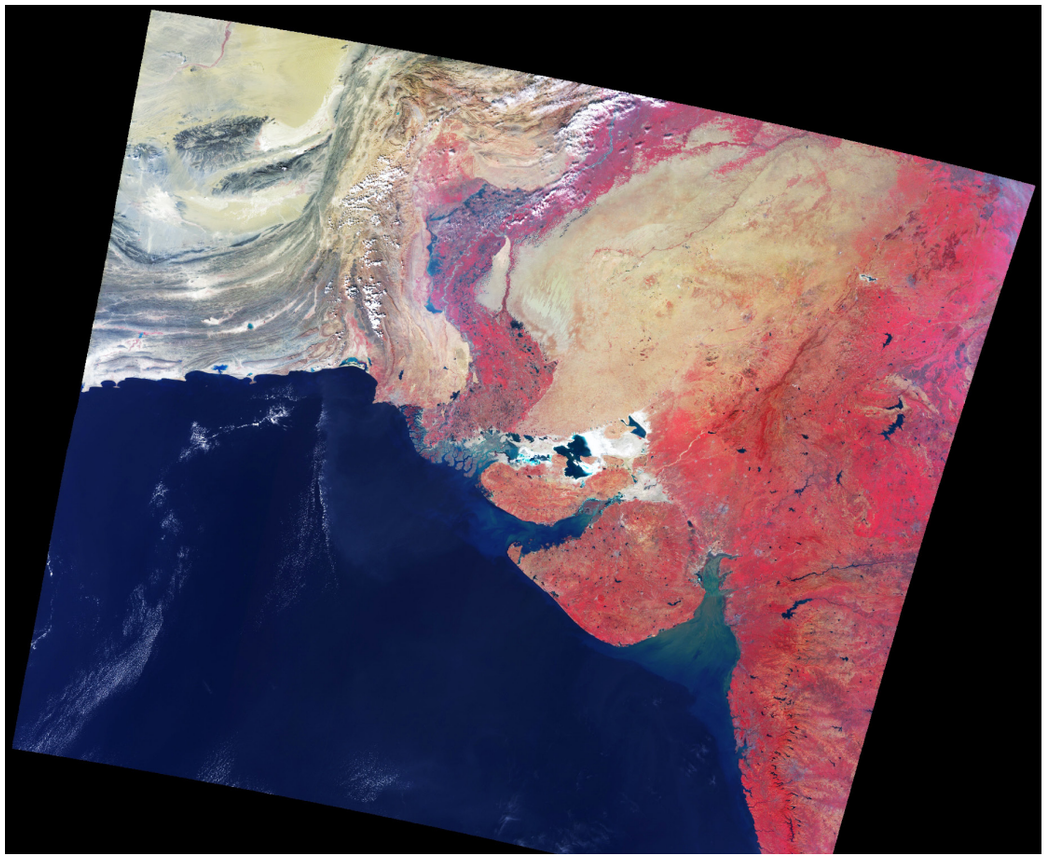


एससीएटी3 SCAT3

चित्र 2.2: भूनिधि में मैंडस साइक्लोन डेटा विजुअलाइजेशन (07 दिसंबर 2022)
Figure 2.2: Mandous Cyclone Data Visualization at Bhoonidhi (07 Dec 2022)

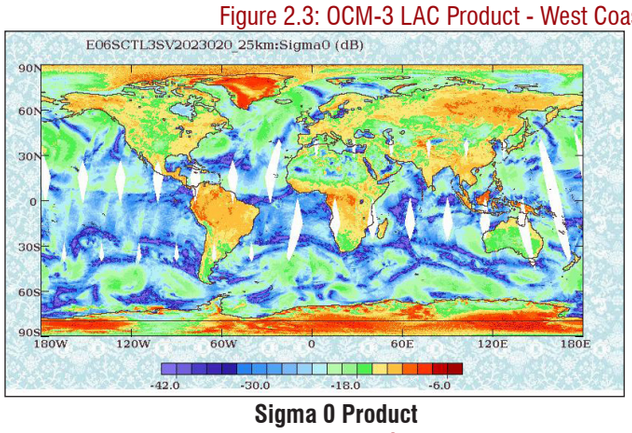
OCM-3 Data Products GAC/LAC Mode (Fig. 2.3)	
Level -1 Basic	• Radiance Product • Geo Referenced Products
Level - 2 Geo Physical	• Chlorophyll concentration • Total Suspended Matter • Aerosol Optical Depth • Diffuse Attenuation Coefficient • Remote Sensing Reflectance-NLW (with F-not) • Normalized Water Leaving Radiances • Top of the Atmosphere Reflectance • Normalized Differential Vegetation Index • Vegetation Fraction

SCAT-3 Data Products (Fig. 2.4)	
Level -1	Scan mode sigma - 0
Level - 2	• L2A - Grid mode sigma-0 • L2B - Grid mode wind
Level - 3	• L3SH - Global sigma-0 Horizontal Polarization • L3SV - Global sigma-0 Vertical Polarization • L3WW - Global wind products

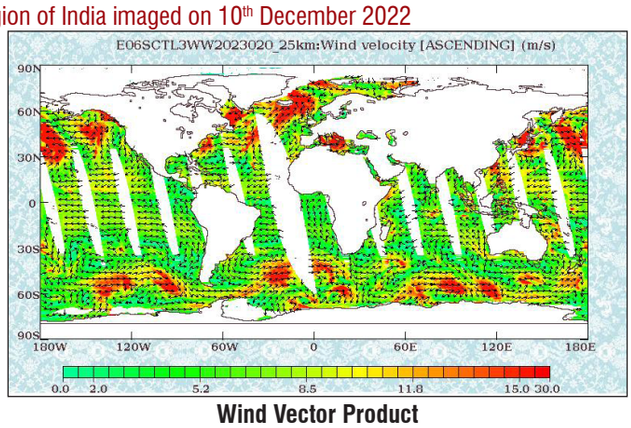


चित्र 2.3: ओसीएम-3 एलएसी 10 दिसंबर 2022 को उत्पाद – भारत के पश्चिमी तट क्षेत्र की तस्वीर ली गई

Figure 2.3: OCM-3 LAC Product - West Coast Region of India imaged on 10th December 2022



Sigma 0 Product



Wind Vector Product

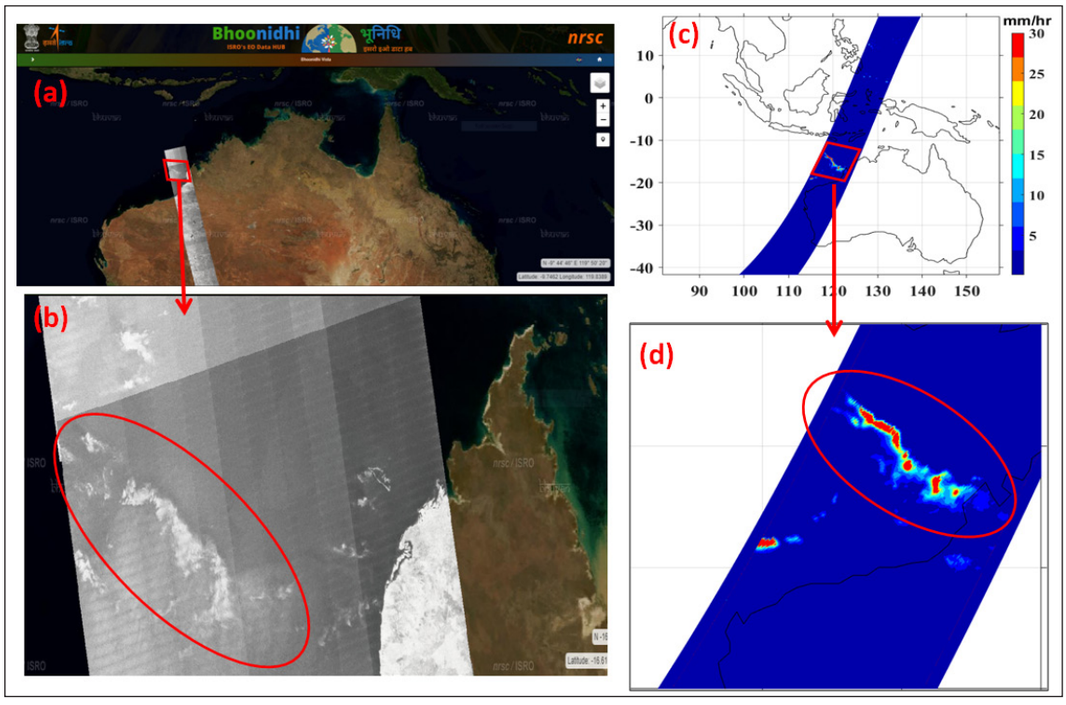
चित्र 2.4: 20 जनवरी 2023 के एससीएटी 3 का उत्पाद (ग्रिड आकार 25 किमी)

Figure 2.4: SCAT3 Products of 20 Jan 2023 (Grid size 25Km)

3 सी-बैंड सिंथेटिक एपर्चर रडार का उपयोग कर संवहन वर्षा कोशिकाओं के सिग्नेचर
Signatures of convective rain cells using C-band Synthetic Aperture Radar

अंतरिक्ष वाहित संप्लेशी द्वारक रेडार (SAR) का उपयोग आमतौर पर सभी मौसमी परिस्थितियों में पृथ्वी की सतह के प्रतिबिंबन के लिए किया जाता है। कृशि, वानिकी, जल–विज्ञान और बाढ़ मानचित्रण अनुप्रयोगों के लिए सी–बैंड संप्लेशी द्वारक रेडार (SAR) युक्त भू–प्रेक्षण उपग्रह (EOS)–04 का प्रमोचन 14 फरवरी, 2022 को किया गया। यह सर्वविदित है कि सभी रेडार आवृत्तियों में एस.ए.आर. (SAR) प्रतिबिंबों पर वर्शा सेल के प्रचिह्न संसूचित किए जा सकते है। यह विषेश रूप से सी–बैंड तरंगदैर्ध्य पर और भी अधिक जटिल हो जाते हैं, जहां पर यह ब्रैग प्रकीर्णन के संक्रमण क्षेत्र में स्थित होते हैं। वर्तमान अध्ययन में, वैष्विक वर्शा मापन (जी.पी.एम.) सूक्ष्मतरंगी प्रतिबिंबक (जी.पी.एम.–जी.एम.आई.) से सी–बैंड एस.ए.आर. प्रतिबिंबों और अर्ध–समकालिक प्रेशणों का उपयोग बहु संवहनी वर्शा सेल के प्रचिह्नों का अध्ययन करने के लिए किया गया। चित्र 1(a) 30 मई 2022 को ऑस्ट्रेलियाई तट पर अर्जित किया गया जो ई.ओ.एस.–4 सी–बैंड एस.ए.आर. प्रतिबिंब दर्षाता है, और चित्र 1(a) का जूम किया गया प्रतिबिंब एच.वी. ध्रुवण मोड के साथ आरोही कक्षा में चित्र 1(c) में दर्षाया गया है। एच.वी. निर्दिश्ट करता है कि संकेत क्षैतिज ध्रुवण पर प्रसारित होते हैं और ऊर्ध्वाधर ध्रुवण पर प्राप्त होते हैं। ष्वेत भाग (व्हाइट पैच), संवहनी वर्शा सेल निषानों के प्रचिह्न हैं। चित्र (b) उसी स्थान विषेश पर जी.पी.एम. जी.एम.आई. गमन को दर्षाता है और इसका जूम किया गया चित्र (d) में दर्षाया गया है, जहां यह स्पश्ट रूप प्रमाणित होता है कि वर्शा बैंड में बहु संवहनी प्रणालियां हैं और अधिकतम वर्शा दर 30 मी.मी.ध्घंटा से ऊपर पाई गई है। इस छवि से, यह स्पश्ट है कि सी–बैंड एस.ए.आर. प्रतिबिंब बहु संवहनी वर्शा सेल को दर्षाता है। सी–बैंड रेडार प्रतिबिंब में दीप्त क्षेत्र निहित होता है, जो गलन परत में मृदु वार्शिला या ओले जैसे जल–उल्का के परावर्तन के कारण होता है। इस प्रकार, वर्तमान अध्ययन संवहनी वर्शा सेल के प्रचिह्नों के लिए सी–बैंड एस.ए.आर. की क्षमता को निरूपित करता है।

The space-borne Synthetic Aperture Radar (SAR) is commonly used for imaging of Earth's surface under all weather conditions. Earth Observation Satellite (EOS)-04 launched on 14th February 2022, carries a C-band Synthetic Aperture Radar (SAR) for Agriculture, Forestry, Hydrology and Flood mapping applications. It is well known that the signature of rain cells can be detected on SAR images at all radar frequencies. It becomes more complex, especially at the C-band wavelength, where it lies in the transition region of Bragg scattering. In the present study, C-band SAR images and quasi-simultaneous observations from the Global Precipitation Measurements (GPM) Microwave Imager (GPM-GMI) are used to study the signatures of multiple convective rain cells. Figure 1(a) shows an EOS-4 C-band SAR image acquired on 30 May 2022 over the Australian coast, and the zoomed picture of Figure 1(a) is shown in Figure 1(b) in ascending orbit with HV polarization mode. HV denotes that the signal is emitted at horizontal polarization and received at vertical polarization. The white patches are the signatures of the convective rain cell footprints. Figure (b) shows the pass of GPM GMI over the exact location, and the zoomed one is shown in Figure (d), where it is clearly evident that the rain band has multiple convective systems and the maximum rain rate found to be above 30 mm/hr. From this picture, it is evident that the C-band SAR image shows multiple convective rain cells. The C-band radar image consists of bright area, which is caused by the reflection of hydrometeors such as graupels or hails in the melting layer. Thus, the present study demonstrates the potential of C-band SAR for the signatures of convective rain cells.



चित्र 3.1: (a) 30मई 2022 को अर्जित ई.ओ.एस.–4सी–बैंड एस.ए.आर. प्रतिबिंब और (ब) जूम की गई, (इ) व (क) जी.पी.एम.–जी.एम.आई. वर्शा–दर
Figure 3.1: (a) EOS-4 C-band SAR image on 30th May 2022 and (c) zoomed, (b) & (d) GPM-GMI rain rate distribution.

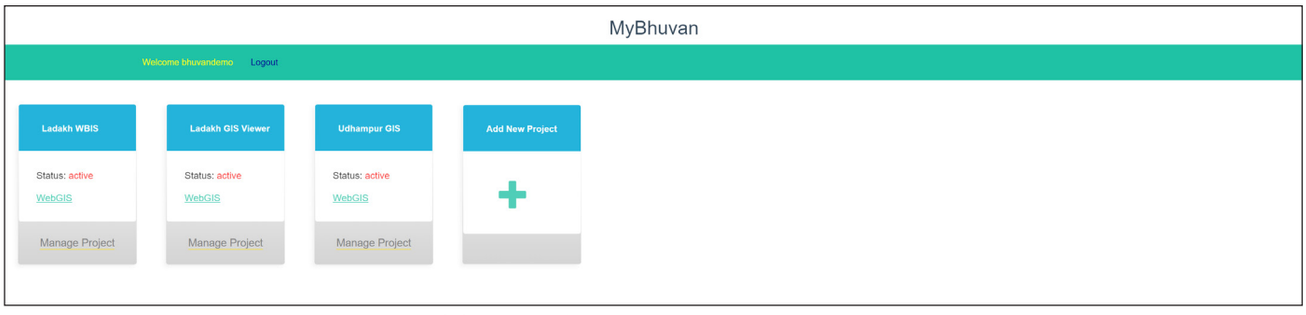
4 भुवन अपडेट Bhuvan Updates

माईभुवन(https://bhuvan-app1.nrsc.gov.in/2dresources/mybhuvan) अनुप्रयोग, प्रयोक्ता को सरलतम ड्रैग एंड ड्रॉप विकल्पों के साथ उपलब्ध भुवन डेटासेट का प्रयोग कर अनुकूलित वेब जीआईएस परियोजना बनाने की अनुमति देता है। माईभुवन का मुख्य उद्देश्य भुवन प्रयोक्ता को जियो–पोर्टल विकसित करने और बिना किसी प्रोग्रामिंग कौशल के इसे साझा करने में सक्षम बनाना है। प्रयोक्ता के पास कई परियोजनाओं के प्रबंधन का विकल्प होता है। माईभुवन अनुप्रयोग की मुख्य विशेषताएं हैं–

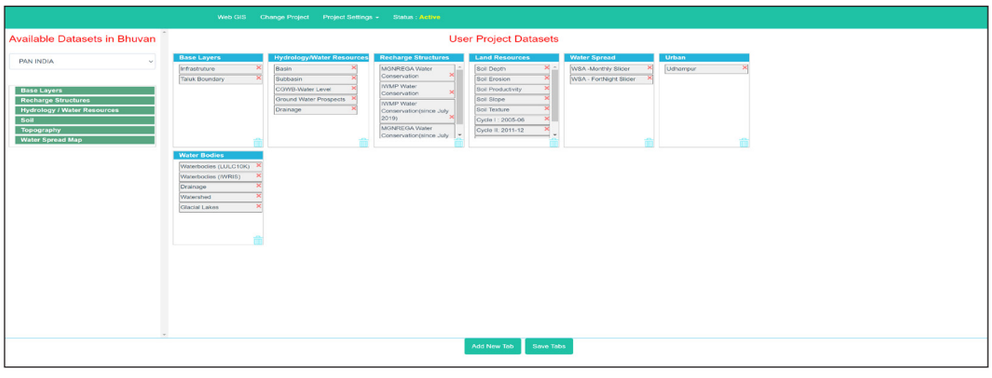
- प्रयोक्ता के लिए एकाधिक परियोजना जोड़ने/प्रबंधित करने
- टैब जोड़ने और परतों को प्रत्येक टैब पर खींचने का प्रावधान
- निर्मित परियोजना साझा करने, आवश्यकता होने पर
- परियोजना को सक्रियधनिष्क्रिय करने
- परियोजना हटाने
- वेब पोर्टल के रूप में बनाई गई परियोजना का दृश्यन

My Bhuvan (Fig. 4.1) (https://bhuvan-app1.nrsc.gov.in/2dresources/mybhuvan) application allows the user to create and customize Web GIS project using the available Bhuvan datasets with simple drag& drop options. The main aim of MyBhuvan is to enable Bhuvan User to develop the geo-portal and share it without having any programming skills. User can have option to manage the multiple projects. The Salient features of MyBhuvan application are

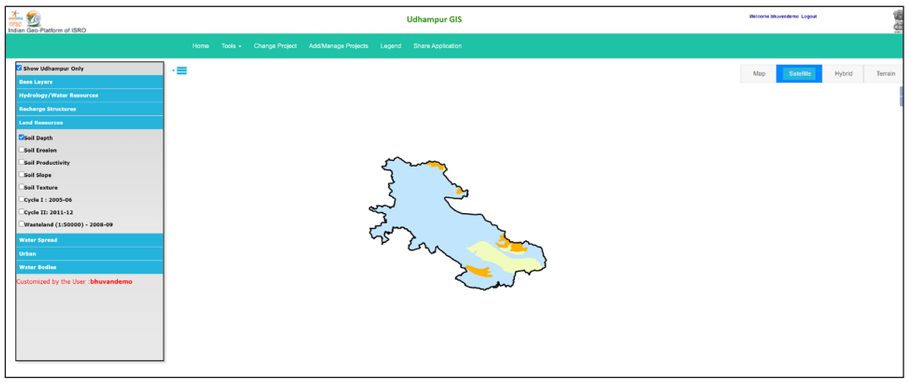
- Add/Manage multiple projects for user
- Provision to add tabs and drag the layers to each tab
- Share the created project if required
- Activate /Deactivate the project
- Delete the project
- Visualization of created project as Web portal



चित्र 4.1: परियोजना डैशबोर्ड Figure 4.1: Project Dashboard



चित्र 4.2: परतों को जोड़नेध्संपादित करने के लिए प्रयोक्ता इंटरफेस Figure 4.2: User Interface for Add/Edit layers



चित्र 4.3: अनुकूलित वेबपोर्टल के लिए प्रयोक्ता इंटरफेस Figure 4.3: User Interface for Customized Webportal

भुवन– टाईमलैप्स
(https://bhuvan-app1.nrsc.gov.in/timelapse)
कई घटित घटनाओं के स्थान और समय का विशेष महत्व होता है। इन घटनाओं की प्रवृत्तियों को जानने में इन आकड़े के दृश्य तस्वीरे और सूचनाएं विशिष्ट अवसर प्रदान करती हैं। इस परियोजना का उद्देश्य मौजूदा भुवन डेटासेट के साथ मुक्त–स्रोत समाधानों का उपयोग कर भू–स्थानिक डेटा के समय–श्रृंखला दृश्यन और जिफ फोर्मेट (प्रारूप) में डाउनलोड करने के लिए एनीमेशन प्रदान करना है। प्रयोक्ता के पास आयताकार बॉक्स में प्रशासनिक सीमा/बाउंडिंग बॉक्स में सीमांकन कर एनीमेशन क्षेत्र का चयन का विकल्प होता है।

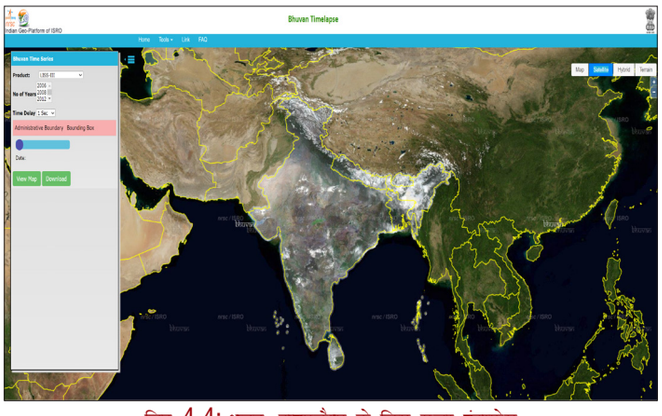
निकट वास्तविक काल चक्रवात की निगरानी
(https://bhuvan-app1.nrsc.gov.in/disaster/disaster.php?id=cyclone)

भुवन आपदा सेवा ने भारत मौसम विज्ञान विभाग(IMD) से लाइव सूचना प्राप्त कर निकट वास्तविक समय में चक्रवात को ट्रैक करने में विस्तारित सेवा का प्रदर्शन किया है। जिसमें कोण अनिश्चितता तथा 27 नॉट, 34 नॉट,50 नॉट और 64 नॉट से अधिक तेज हवा के लिए चारों दिशाओं का दृश्य भी शामिल है।

Bhuvan- Timelapse
(https://bhuvan-app1.nrsc.gov.in/timelapse)
Many things that happen are having space and time as major dimensions. Visual representation of these datasets and information brings out unique opportunity to identify meaningful trends. This project aims to have time-series visualization of geospatial data using Open source solutions with existing Bhuvan datasets and provide the animation for download in gif format. User have option to select the animation area by Administrative boundary/bounding box/ by drawing rectangle.

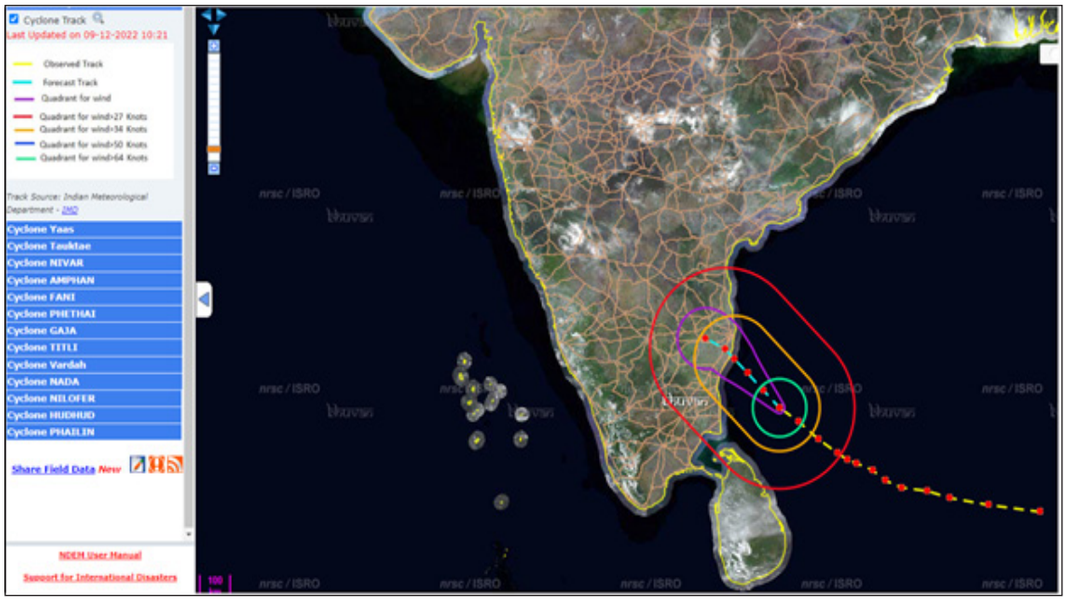
Near Real Time Cyclone Monitoring
(https://bhuvan-app1.nrsc.gov.in/disaster/disaster.php?id=cyclone)

Bhuvan Disaster services have been extended to showcase the near real time cyclone track by taking the live feed from the India Meteorological Department (IMD). It also includes the visualization of cone of uncertainty, quadrants for wind greater than 27 Knots, 34 Knots, 50 Knots and 64Knots.



चित्र 4.4: भुवन–टाइमलैप्स के लिए यूजर इंटरफेस
Figure 4.4: User Interface for Bhuvan –Timelapse

चित्र 4.5: भुवन टाइमलैप्स – वाराणसी के लिए यूजर इंटरफेस
Figure 4.5: User Interface for Bhuvan Timelapse – Varanasi



चित्र 4.6: चक्रवात–मैनडाउस ट्रैक Figure 4.6: Cyclone-MANDOUS Track

5 नॉक्टुलिका स्किंटिलन्स के बड़े पैमाने पर शैवाल के खिलने से अरब सागर में CO_2 गैस अधिक मात्रा में निकलता है

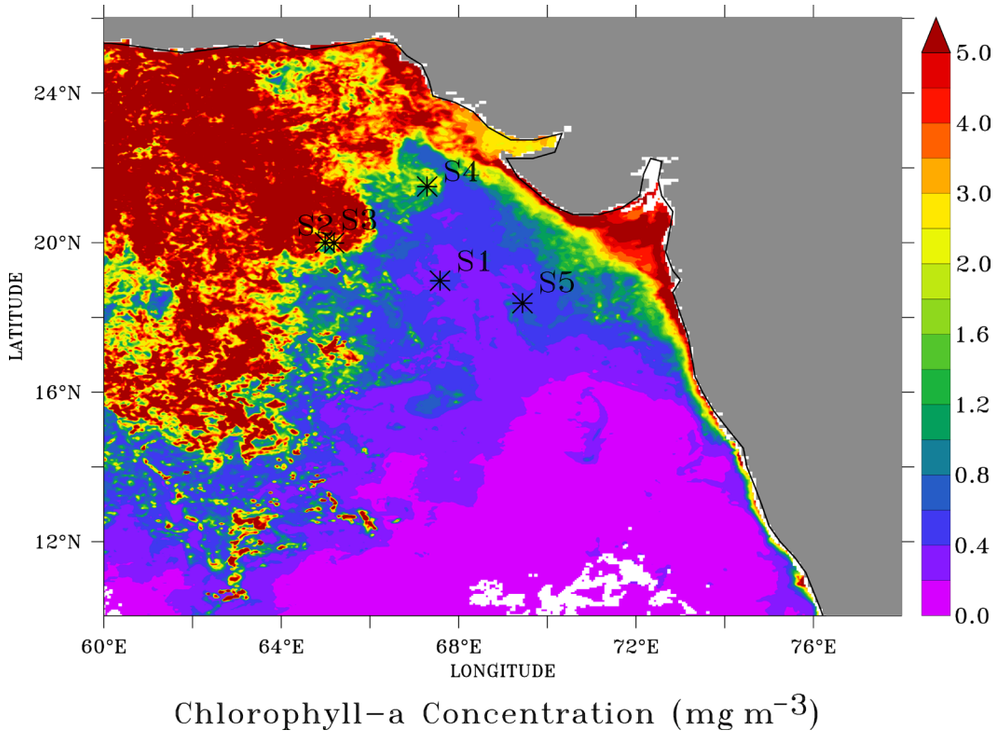
Massive algal blooms of Noctulica Scintillans promotes CO_2 out gassing in Arabian Sea

डिनोफ्लैगलेट, नोक्टिलुका सिंटिलांस के आवधिक प्रस्फुटन ने वैश्विक ध्यान आकर्षित किया है, जिसमें कुछ रिपोर्टें बढ़ती प्रवृत्ति की ओर इशारा कर रही हैं। हालांकि, समुद्री कार्बन चक्र पर इसके असर को अभी भी ठीक से समझा नहीं गया है। नोक्टिलुका स्किंटिलन्स एक हेटरोट्रॉफ है जो फैगोसाइटोसिस द्वारा भोजन को निगल लेता है, जिसमें प्लैंकटन, डायटोम्स, अन्य डायनोफ्लैगलेट्स, मछली के अंडे और बैक्टीरिया शामिल होते हैं और अक्सर समुद्र के पानी में बायोल्यूमिनेसेंस से जुड़े होते हैं। विश्व स्तर पर, शैवाल प्रस्फुटन अक्सर पोषक तत्व संवर्धन से जुड़े होते हैं और बड़े पैमाने पर मछली की मौत का कारण बन सकते हैं और जलीय खाद्य शृंखला और स्थानीय पर्यटन को बाधित कर सकते हैं। ऐतिहासिक रूप से, अरब सागर में अधिकांश शैवाल प्रस्फुटन दक्षिण–पश्चिम मानसून की वापसी, मौसमी उत्थान के प्रभाव और नदी के वर्धित आदानों से जुड़े हैं । वर्तमान कार्य उत्तरी अरब सागर के अपतटीय (ऑफशोर) जल में किया गया है (चित्र–1)। बोर्ड पर भारतीय पृथ्वी विज्ञान मंत्रालय (एमओईएस) अनुसंधान पोत ''मत्स्य समुद्र विज्ञान अनुसंधान पोत (एफओआरवी) सागर सम्पदा'' (क्रूज संख्या 348) (चित्र 1)।

कई जैव–भू–रासायनिक मापदंडों को ब्लूम के अंदर और बाहर मापा गया जिसमें लवणता, तापमान, घुलित ऑक्सीजन, पोषक तत्व, पीएच, कुल क्षारीयता, घुलित अकार्बनिक कार्बन, क्लोरोफिल शामिल हैं । pCO_2 (पानी) की गणना, CO_2SYS-EXE सॉफ्टवेयर का उपयोग करके लवणता, तापमान, पीएच, पोषक तत्वों (फॉस्फेट और सिलिकेट), और क्षारीयता की गई। अरब सागर मेसोपेलैजिक क्षेत्र (150–1000 मीटर) के भीतर सबसे बड़ी घुलित ऑक्सीजन(O_2)की कमी रखता हैय इसलिए, कार्बन सायक्लिंग में कोई गड़बड़ी वैश्विक महत्व रखती है । यहाँ हम नोक्टिलुका स्किंटिलन्स के प्रसार के कारण कार्बन डाइऑक्साइड प्रणाली में परिवर्तन प्रस्तुत करते हैं जो विश्व

The periodic bloom of dinoflagellate, Noctiluca scintillans in the Arabian Sea has gained global attention with few reports suggesting an increasing trend. However, its impact on the marine carbon cycle still remains poorly understood. Noctiluca scintillans is a heterotroph that engulfs, by phagocytosis, food which includes plankton, diatoms, other dinoflagellates, fish eggs, and bacteria and often associated with bioluminescence in oceanic waters. Globally, algal blooms are often linked to nutrient enrichment and can cause massive fish kills, disrupting aquatic food chains and local tourism. Historically, most of the algal bloom in the Arabian Sea were associated with withdrawal of the southwest monsoon, the influence of seasonal upwelling and increased riverine inputs. The present work was carried out in offshore waters of the northern Arabian Sea (Figure 5.1). On board the Indian Ministry of Earth Sciences (MoES) research vessel "Fishery Oceanographic Research Vessel (FORV) Sagar Sampada" (cruise no. 348).

Several biogeochemical parameters were measured both inside and outside the bloom which includes, salinity, temperature, dissolved oxygen, nutrients, pH, total alkalinity, dissolved inorganic carbon, chlorophyll. The pCO_2 (water) was computed using measured salinity, temperature, pH, nutrients (phosphate and silicate), and alkalinity using CO_2SYS.EXE software. Arabian Sea holds the largest dissolved oxygen (O_2) deficiency within the mesopelagic zone (150–1000 m); therefore, any perturbation in carbon cycling assumes global significance. Here we present the changes in the carbon dioxide system due the proliferation

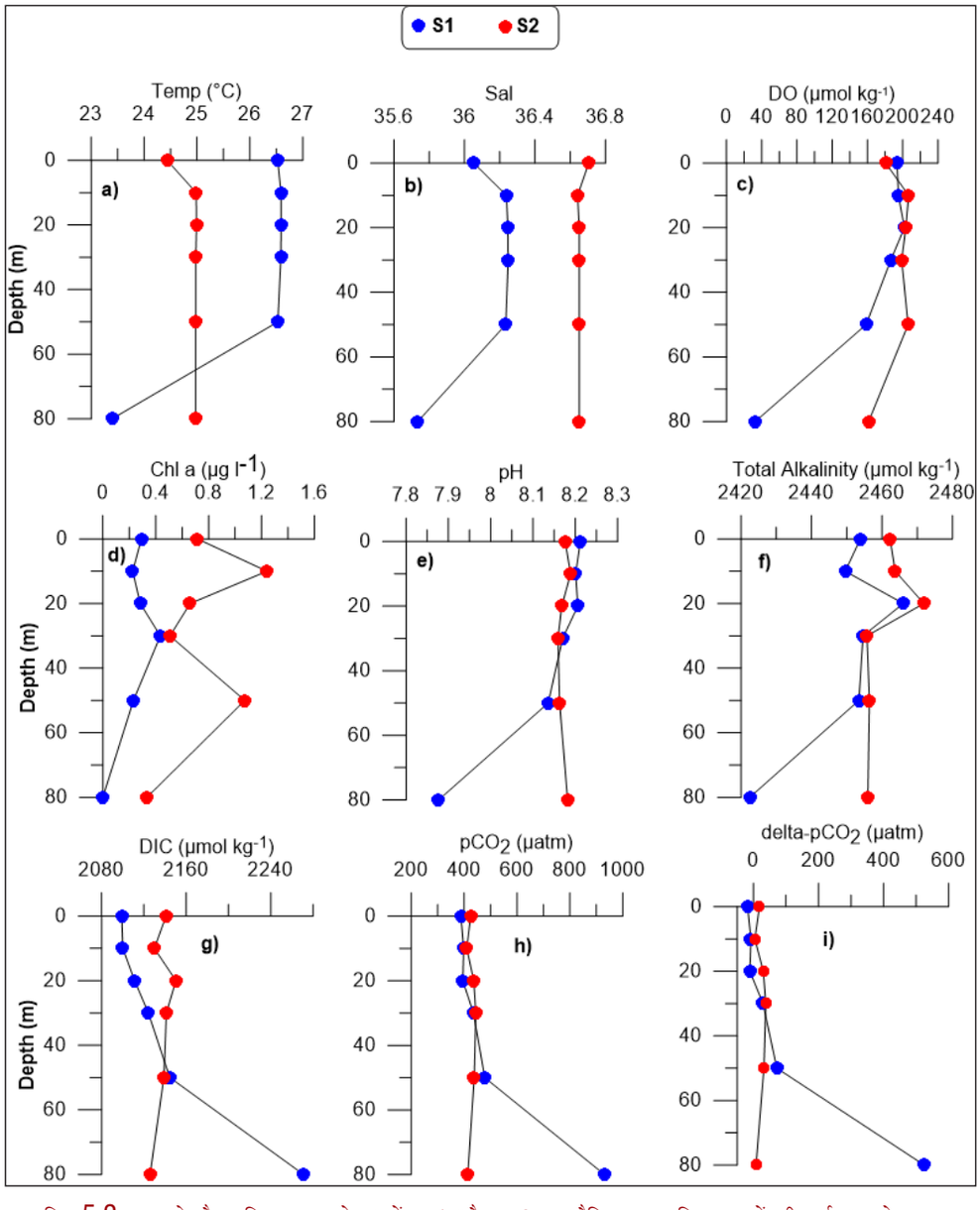


चित्र 5.1: उत्तरी अरब सागर में ग्रीन नोक्टिलुका ब्लूम और नॉन–ब्लूम स्टेषनों के भीतर नमूना स्थान ँ1 से ँ5।

Figure 5.1: Sampling locations S1 to S5 within the Green Noctiluca bloom and non-bloom stations in the northern Arabian Sea

स्तर पर अप्राप्य हैं। हम बाहर के स्टेशनों की तुलना में नोक्टिलुका स्किन्टिलन के प्रस्फुटन से प्रभावित क्षेत्रों के आसपास सतही जल में मध्यम सांद्रण (ΔpCO_2 = 3 - 75 μatm) की रिपोर्ट करते हैं। ये संख्याएँ अरब सागर के खुले महासागर के अपवेलिंग क्षेत्रों से रिपोर्ट किए गए मूल्यों के साथ तुलनीय हैं। जैसे–जैसे ब्लूम आगे बढ़ता है, सतह pCO_2 धीरे–धीरे बढ़ता है, देर से घातांक औरध्या गिरावट चरण के दौरान बढ़ी हुई संतृप्ति के साथ सहपरिवर्ती होता है। यद्यपि वर्तमान डेटा पर्याप्त नहीं है, हम मानते हैं कि नोक्टिलुका स्किंटिलन्स के शरीर विज्ञान और शिकारी व्यवहार संभवतः हमारी देखी गई परिवर्तनशीलता को प्रभावित करते हैं। जैसा कि पहले प्रस्तावित किया गया था, हमने ब्लूम–प्रभावित क्षेत्रों के आसपास सतही जल में हाइपोक्सिक स्थिति नहीं देखी। जलवायु परिवर्तन और समुद्री प्रक्रियाओं पर इसके प्रभाव के दृष्टिकोण से, वर्तमान अवलोकनों के आलोक में पोषक तत्वों की कमी वाली स्थितियों में इसके जीवित रहने की रणनीति के कारण इस प्रस्फुटन की निरंतर निगरानी आवश्यक हो जाती है ।

of Noctiluca scintillans which remain uncharacterised globally. We report a modest supersaturation (ΔpCO_2 = 3 - 75 μatm) in surface waters around the regions affected by the bloom of Noctiluca scintillans compared to stations outside. These numbers are comparable with values reported from Arabian Sea open ocean upwelling regions. The surface pCO2 increased gradually as the bloom progressed, covarying with increased saturation during the late exponential and/or the decline phase. Although the present data is not sufficient, we believe the physiology and predatory behaviour of Noctiluca scintillans possibly influence our observed variability. As earlier proposed, we did not see hypoxic condition in the surface waters around the bloom- affected regions. From the viewpoint of climate change and its influence on oceanic processes, constant monitoring of this bloom becomes essential due to its survival strategy in nutrient-depleted conditions in light of the present observations.



चित्र 5.2: क्रूज के दौरान किए गए नमूने स्थानों एस1 और एस2 पर भौतिक–रासायनिक मानकों की ऊर्ध्वाधर प्रोफाइल

Figure 5.2: The vertical profiles of physico-chemical parameters at sampling locations S1 and S2 made during the cruise.

6 शहरी जल निकाय सूचना प्रणाली (यूडब्ल्यूएआईएस) Urban Water Body Information System (UWaIS)

तीव्र जनसंख्या वृद्धि, भारत के शहरौ पर भारी दबाव डाल रही है, विषेश रूप से बुनियादी ढाँचा (जैसे आश्रय, सड़कें, उपयोगिताएँ...) और इसके प्राकृतिक संसाधन जैसे भूमि और पानी की उपलब्धता प्रदान करने में अत्यधिक प्रभाव डालती है।

आवासन और शहरी कार्य मंत्रालय, कायाकल्प और शहरी परिवर्तन के लिए अटल मिषन (अमृत) के दूसरे चरण के तहत शहरी क्षेत्रों में और उसके आसपास जल संसाधनों के संरक्षण और कायाकल्प को विकास कार्य के रूप में शुरू किया है।

एनआरएससी ने षहरी जल निकाय सूचना प्रणाली (UWaIS) को अपने भुवन प्लेटफॉर्म पर विकसित किया है–(https%//bhuvan&app3-nrsc-gov-in/jjm_ver2/), यह 500 अमृत षहरों को कवर करते हुए आवासन और षहरी कार्य मंत्रालय के लिए अमृत 2.0 के तहत एक वेब आधारित निर्णय लेने वाला उपकरण है। यह संरक्षण, कायाकल्प और विकास के लिए अपने पड़ोस में झीलों की निगरानी और प्राथमिकता के लिए षहरी स्थानीय निकायों (ULBs) या नगर प्रषासन की सुविधा प्रदान करेगा।

यह सुरक्षित लॉगिन एक्सेस के माध्यम से संचालित होता है। यह पो. र्टल प्रत्येक षहर के लिए जल निकायों का भंडार (संख्या एवं आकार), जल प्रसार की गतिषीलता, स्थिरता (एक वर्श में जल उपलब्धता अवधि) तथा षॉर्टलिस्ट किए गए जल निकायों के लिए जल निकाय गुणवत्ता सूचकांक (आविलता और क्लोरोफिल लाइन और बार ग्राफ के माध्यम से) के आधार पर सूचना प्रदान करता है।

सुदुर संवेदन उपग्रहों से प्राप्त न होने वाले जल निकायों की जानकारी, जैसे–जल निकाय का नाम, उपयोगिता, जल निकायों के स्वामित्व आदि के संग्रह के लिए एक प्रयोक्ता आंकड़ा संग्रह मॉड्यूल भी मौजूद है।

पोर्टल के माध्यम से प्रयोक्ता जल निकाय गुणवत्ता मूल्यों, जल प्रसार क्षेत्र और जल निकाय क्षेत्र के मूल्यों के बारे में प्रष्न पूछ सकते हैं। पूछताछ उपयोगकर्ता को जल निकायों के कायाकल्प के लिए कई मापदंडों के आधार पर निर्णय लेने में मदत करती है।

Rapid population growth is exerting enormous pressure over urban India, especially in terms of providing infrastructure (like shelter, roads, utilities etc.) and its natural resources like land and water availability.

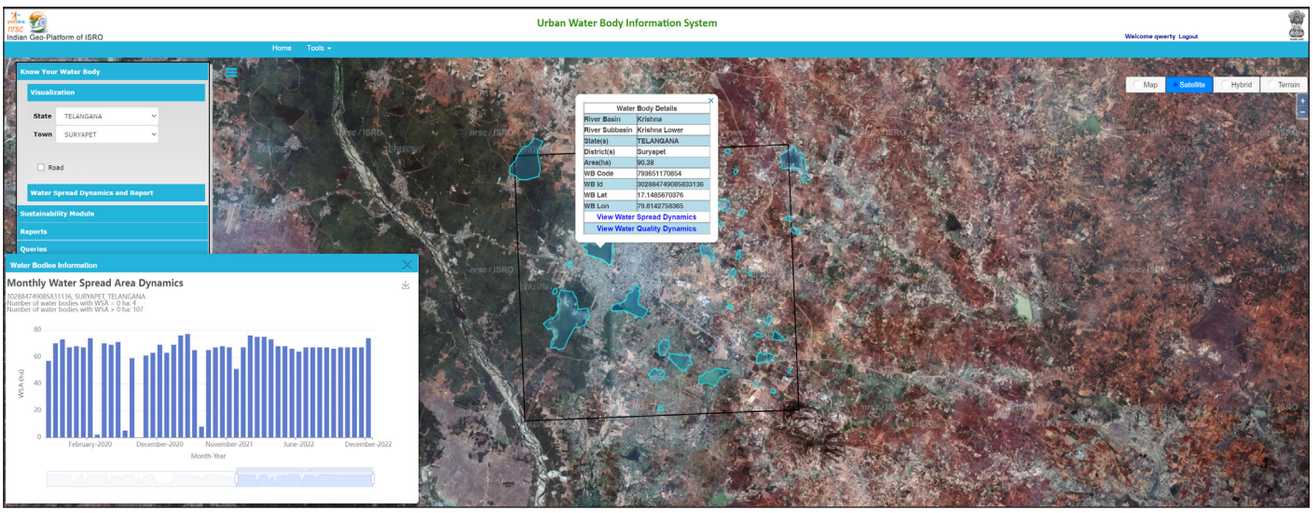
Ministry of Housing and Urban Affairs is taking up conservation and rejuvenation of water resources in and around urban areas as one of its growth foci under Phase-II of Atal Mission for Rejuvenation and Urban Transformation (AMRUT).

NRSC has developed Urban Water Body Information System (UWaIS) on its Bhuvan platform – (https://bhuvan-app3.nrsc.gov.in/jjm_ver2/), a web-based decision-making tool under AMRUT 2.0 for Ministry of Housing and Urban Affairs (MoHUA, GoI) covering 500 AMRUT cities. This will facilitate the Urban Local Bodies (ULBs) or the town administration to monitor and prioritise lakes in its neighbourhood for conservation, rejuvenation and development.

Operated through a secure login access, for every town, this portal provides information on inventory of water bodies (number and size), water spread dynamics, sustainability (water avaibility period in a year), and water body quality indices (Turbidity and Chlorophyll through line and bar graphs) for shortlisted waterbodies.

A user data collection module is also present for collection of the information of the water bodies which are not obtained from the remote sensing satellites, like water body name, usability, ownership of the water bodies etc.

Through the Portal users can query on water body quality values, water spread area, and water body area values. Querying helps user to make decisions based upon several parameters for the rejuvenation of the water bodies.



चित्र 6.1: सूर्यापेट शहर, तेलंगाना जल निकाय सूचना और जल प्रसार क्षेत्र गतिशीलता का दृश्य

Figure 6.1: Visualisation of Suryapet Town, Telangana Water body Information and Water Spread Area Dynamics

पोर्टल में विज्वलाइजेषन टूल जल निकायों की संक्षिप्त सूची तैयार के लिए आसान निर्णय लेने की सुविधा प्रदान करता है। यह मासिक जल विस्तार क्षेत्र, भूमि उपयोगभूमि कवर परिवर्तन, जल गुणवत्ता सूचकांक, स्थानिक और सारणीबद्ध या ग्राफिक दोनों रूप में भी विवरण प्रदान करता है।

प्रयोक्ता जल निकायों की पूरी सूची तथा स्थायी जल निकायों के साथ हाइलाइट किया गया नक्षा के अलावा, अनुकूलित प्रयोक्ता इनपुट मानदंडों का प्रयोग करके उपयुक्त जल निकायों पर फ्लाई रिपोर्ट तथा संबंधित दस्तावेज तैयार कर सकते हैं।

Visualization tools in the Portal facilitates for easier decision-making for shortlisting of water bodies. It provides details like monthly water spread area, land use/land cover changes, water quality indices, both spatially, and also in tabular or graphic form.

User can generate on the fly reports and dossiers on sustainable water bodies using customised user input parameters, besides complete inventory of water bodies and a map highlighted with sustainable water bodies.

ISRS - ISG - GEO SMART India - 2022 Symposium

The ISRS-ISG-GeoSmart India 2022 symposium was held at HICC, Hyderabad during Nov 15-17, 2022 with the theme '#geospatialbydefault: Empowering billions!'. The Symposium witnessed over 2,000 attendees from different sectors which included delegates from government and private industries, academic students, and people from the geospatial fraternity. This symposium was preceded by two programs; First one was the pre-symposium tutorials (held at the NRSC Outreach facility, Jeedimetla, Hyderabad during Nov 12-13, 2022), wherein around 85 participants were exposed to various topics under the sub-themes viz,. Machine Learning and Deep Learning for Remote Sensing Applications;

Microwave Remote Sensing: SAR applications with EOS-04; and Recent trends in UAVs for Remote Sensing Applications. The other was, Geospatial Artha (held at HICC, Hyderabad on Nov 14, 2022); was a one-of-its-kind geospatial conference for the business professionals of India.

Dr Prakash Chauhan and Dr Raj Kumar gave addresses on the activities of ISRS and ISG respectively. There was also two keynote addresses by Agendra Kumar, Managing director ESRI India and Boris Skopljak, Trimble Inc. Dr. M Ravichandran, Secretary, MoES and Dr. S. Somanath, Secretary, DOS and Chairman, ISRO gave the guest address in the inaugural session (Shri S. Somanath, virtually). Sri Gajendra Singh Shekhawat, Honorable Minister, Jal-Shakti delivered inaugural address.

Sri. A S Kiran Kumar, former chairman, ISRO delivered the valedictory address for the concluding session. He emphasised the India's role in digitization and FinTech solutions that came from the government and industry. Achieving the ~20% share of the space economy will only be possible with significant participation from fellow citizens in various areas of the space sector and technologies.

7 First operational Surface Reflectance products from Resourcesat-2/2A Sensors

The satellite images are attenuated by molecular, aerosol scattering and absorption by trace gases present in the atmosphere. More importantly Signals recorded from the satellite or airborne platforms in visible and near infrared region is a combination of surface, atmosphere and sensor contribution. Thus, to enable quantitative studies of the earth, the atmospheric component needs to be removed from the measured signal. The process of removing atmospheric contribution is commonly referred as atmospheric correction or atmospheric compensation. Products which are corrected for atmospheric perturbations are called Surface Reflectance (SR) or Bottom of Atmosphere (BOA) products. Surface Reflectance (SR) or atmospherically corrected product is the basic input for retrieval of any biophysical parameter from remote sensing images.

Atmospheric correction of optical remotely sensed data can indeed be categorized into two major classes: Relative atmospheric correction based on image processing and Absolute atmospheric correction on the other hand is based on the physical process of Radiative Transfer (RT) and is, therefore, very complex and it requires a great amount of information regarding sun-surface-sensor geometry, atmospheric condition at the time of data acquisition, spectral and radiometric specifications of the sensor.

Fully automated chain is developed based on Second Simulation of the Satellite Signal in the Solar Spectrum (6S) RT code to generate SR products from Resoursesat-2A AWiFS and LISS-III sensors. This chain is split into two live parallel components which are made operational; First component retrieves the daily atmospheric data viz. Aerosol optical depth (AOD), Water vapor (WV) & ozone from Terra-MODIS level-2 data products over Indian sub-continent and processes and arranges into finer grid. Second component supplies this data along with Resourcesat-2A sensor data to 6S-RT and derives surface reflectance per pixel basis for four spectral (Green, Red, NIR and SWIR) bands.

The accuracy of SR products is validated with both In-situ and contemporary satellite measurements. In-situ measurements are handheld spectro-radiometer measurements over pseudo invariant targets like Thar Desert, red and black soil of calibration-validation site at shadnagar, snow & glaciers at Gulmarg. The correlation (R2) with ground measurements is about 90% for all spectral bands. The accuracy of the product is also assessed by comparing RS2A SR values with Landsat-8 OLI sensor over various land use land cover targets and found a good agreement with R2>90%. In addition to this, Intra sensor validation is also carried out by comparing the SR products from LISS-III and AWiFS of same date of pass and the correlation is about 97%. The stability and consistency of the SR products are also checked by comparing reflectances of pseudo invariant targets of different dates loaded with various levels of aerosol concentration. The measured variability is better than 4 % which indicates the accuracy and reliability of the atmospheric correction procedure.

Improvements in geo-physical parameter retrievals when SR products are used are analyzed by normalized difference vegetation index (NDVI) from both SR and Top of the atmosphere (TOA) reflectance products. It is found that SR products account for dynamic changes in vegetation 20% better than TOA products. Resoursesat-2A (R2A) is a follow on mission of Resoursesat-2 (R2) and was launched in 2017. Sensor's (LISS-III, AWiFS & LISS-IV) configuration is similar for both the missions each a temporal

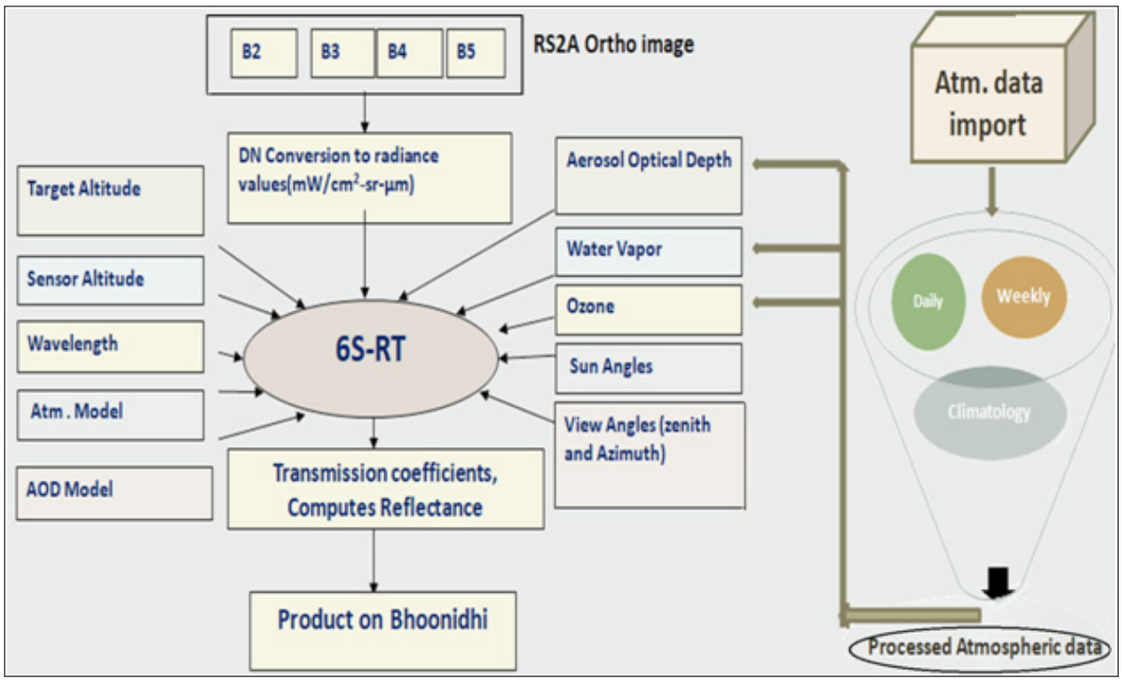


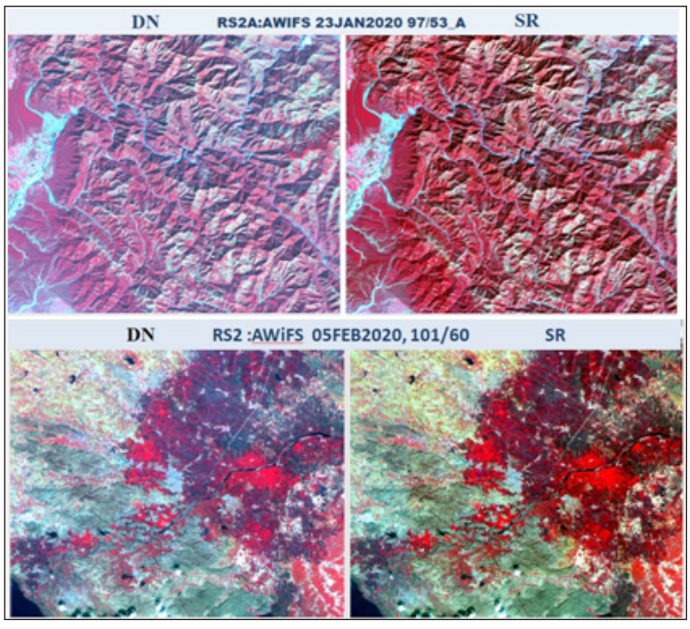
Figure 7.1: Process flow of Operational SR product generation

resolution of 24 days.Many land monitoring applications require more frequent observations than cannot be obtained from a single class of sensor. Numerous studies have documented the need for higher temporal resolution data to better monitor land cover change, agricultural management, disaster response, water, and vegetation phenology. Observations from multiple missions can be merged to provide improved temporal coverage.

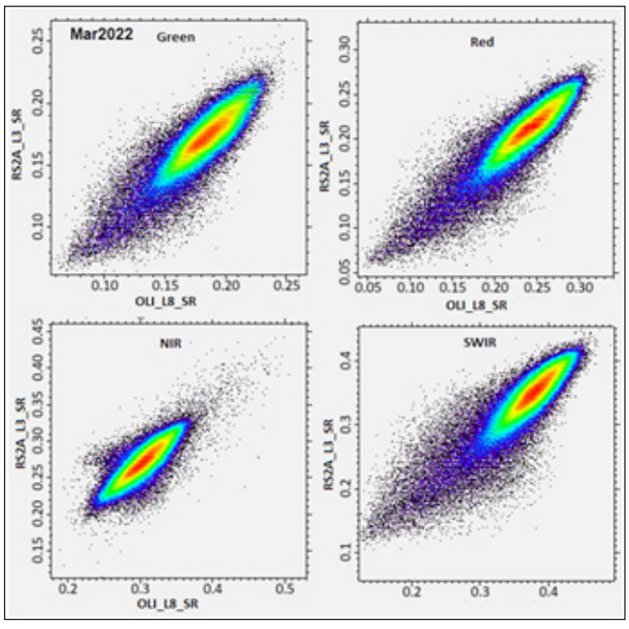
The joint use of R2 and R2A will double the temporal coverage. To use seamless combination of EO products from Resourcesat (2 &2A), radiometric harmonization is required to account for individual sensor differences.

Radiometric harmonization of RS-2(L-3, AWiFS) wrt RS-2A is achieved by collecting common Pseudo invariant targets covering entire reflectance dynamic range of sensors since 2017 to till date and performing regression analysis for each spectral band. Harmonized R2 datasets are in good agreement with corresponding R2A with coefficient of determination better than 95 %.

Surface Reflectance also plays a major role in realizing analysis ready data (ARD). SR products from Resoursesat-2A sensors (AWiFS and LISS-3) and Harmonized Surface Reflectance (SR) products from RS-2 are available on ISRO's Bhoonidhi portal as BOA(Bottom of Atmosphere) products.



TOA Vs. Surface Reflectance Image



OLI/L8 Vs. RS2A-L3 Surface Reflectance

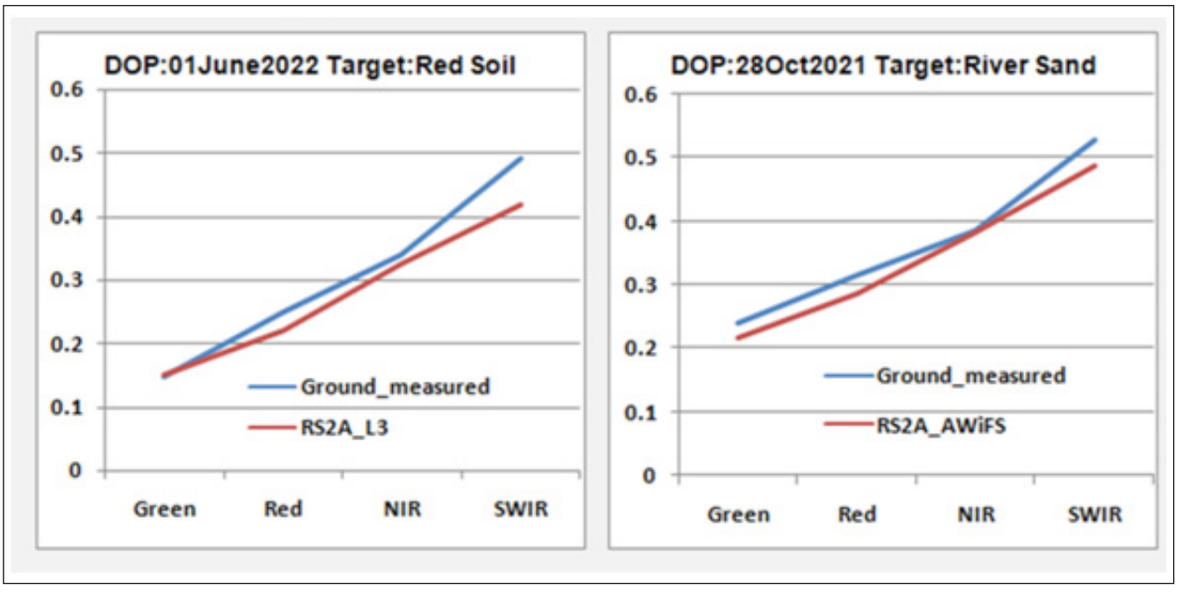
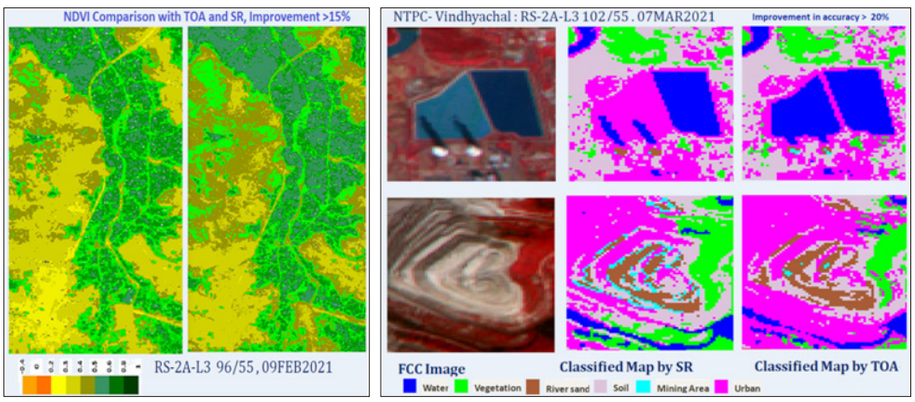
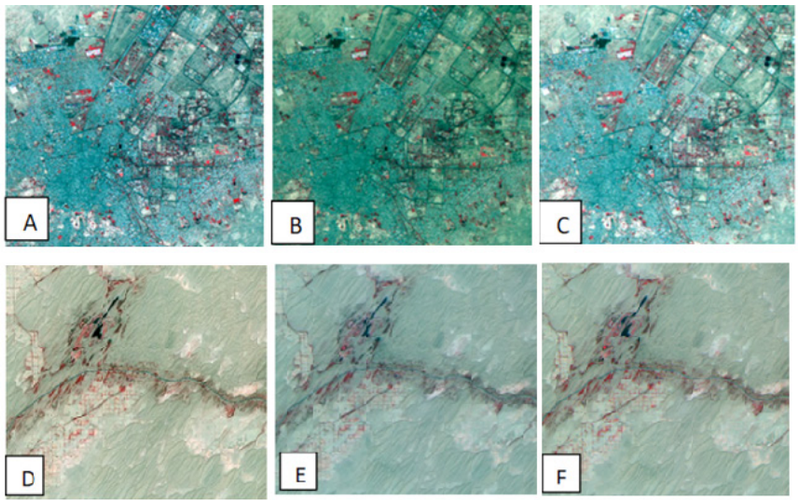


Figure 7.2: Process flow of Operational SR product generation

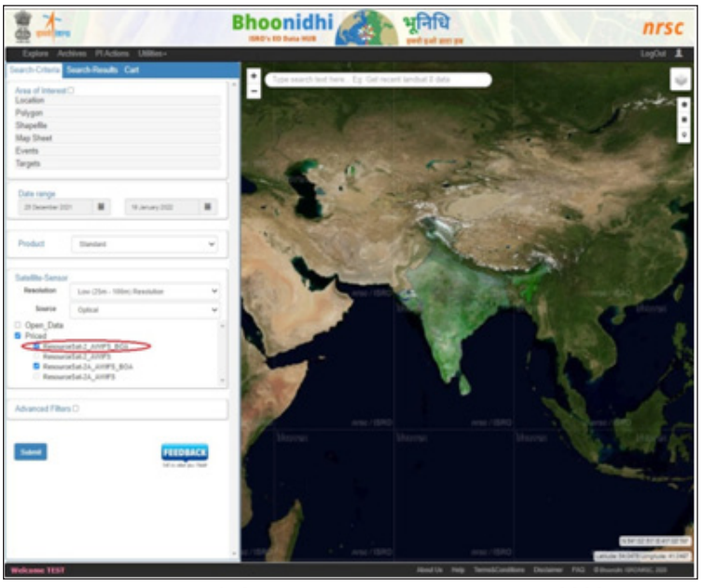




RS-2 Surface Reflectance Images: Native and Harmonized

A) RS2A-L3 (DOP: 05 Mar 2022; Path/Row: 92/52) - Original
B) RS2-L3(DOP: 17 Mar 2022; Path/Row: 92/52)-Original
C) RS2-L3(DOP: 17 Mar 2022; Path/Row: 92/52)-Harmonized
D) RS2A AWiFS (DOP: 22Apr 2022; Path/Row: 92/53) - Original
E) RS2 AWiFS (DOP 10 Apr 2022; Path/Row: 92/54) - Original
F) RS2 AWiFS (DOP 10 Apr 2022; Path/Row: 92/54) - Harmonized

Figure 7.3: Classified output of vacant site in 2006 which has been converted to built-up in 2019 (alarm site)



Product format specification

Number of image bands	: 4
Image File Format	: Geo TIFF
Projection	: LCC for AWiFS UTM for L-3
Datum	: WGS-84
Spatial Resolution	: 56m for AWiFS, 24m for L-3
Radiometric Resolution	: 16 bits per pixel
Correction Level	:Terrain corrected
Datatype	: Unsigned 16 bit integer
Scale factor	: 0.0001
Valid range	: 0 – 10000
Meta Data	: Text file
Thumbnail Image	: Jpeg file

Data Products Access

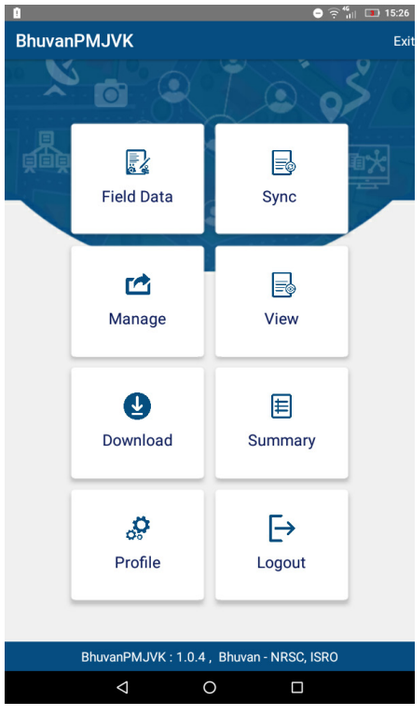
Surface Reflectance (BOA) products are to be ordered from Bhoonidhi using the following URL https://bhoonidhi.nrsc.gov.in/

Figure 7.4: Classified output of vacant site in 2006 which has been converted to built-up in 2019 (alarm site)

PMJVK – Pradhan Mantri Jan Vikas Karyakram 8

The PRADHAN MANTRI JAN VIKAS KARYAKRAM (PMJVK) is an area development programme implemented by Ministry of Minority Affairs in identified Minority Concentration Areas (MCAs) for developing socio-economic infrastructure and basic amenities. The area coverage for the purpose of geo-tagging would include all those areas where projects are sanctioned under the scheme.

The priority sectors under the scheme at present are Education, Health and Skill Development with special focus on women centric projects. However, proposals are also sanctioned in sectors like sports, sanitation, drinking water etc. depending on the need of the identified MCA. The mechanism for monitoring of the projects exists at the Ministry as well as at the State/UT level. Ministry continuously reviews the progress of construction and commissioning of the sanctioned projects during the Empowered Committee meetings with the state authorities and also through other modes. In order to further strengthen the monitoring mechanism, Ministry proposes to Geo-tag all the physical assets already created under the PMJVK scheme as well as those which will be created in the years to come.



NRSC caters to various geospatial data and solutions, at national level, with specific focus on Earth Observation data visualization, applications development and providing customized solutions through 'Bhuvan' portal. Bhuvan - PMJVK Portal & Android App released supporting Ministry of Minority Affairs, Government of India for geotagging, visualization & moderation of all the assets created under Pradhan Mantri Jan Vikas Karyakram. Various roles such as facilitator, moderator exists for geotagging and its approval process. National rollout of the project happened on 07-july-2022. This portal also has the facility to auto generate 17 custom reports for effective monitoring of the programme .

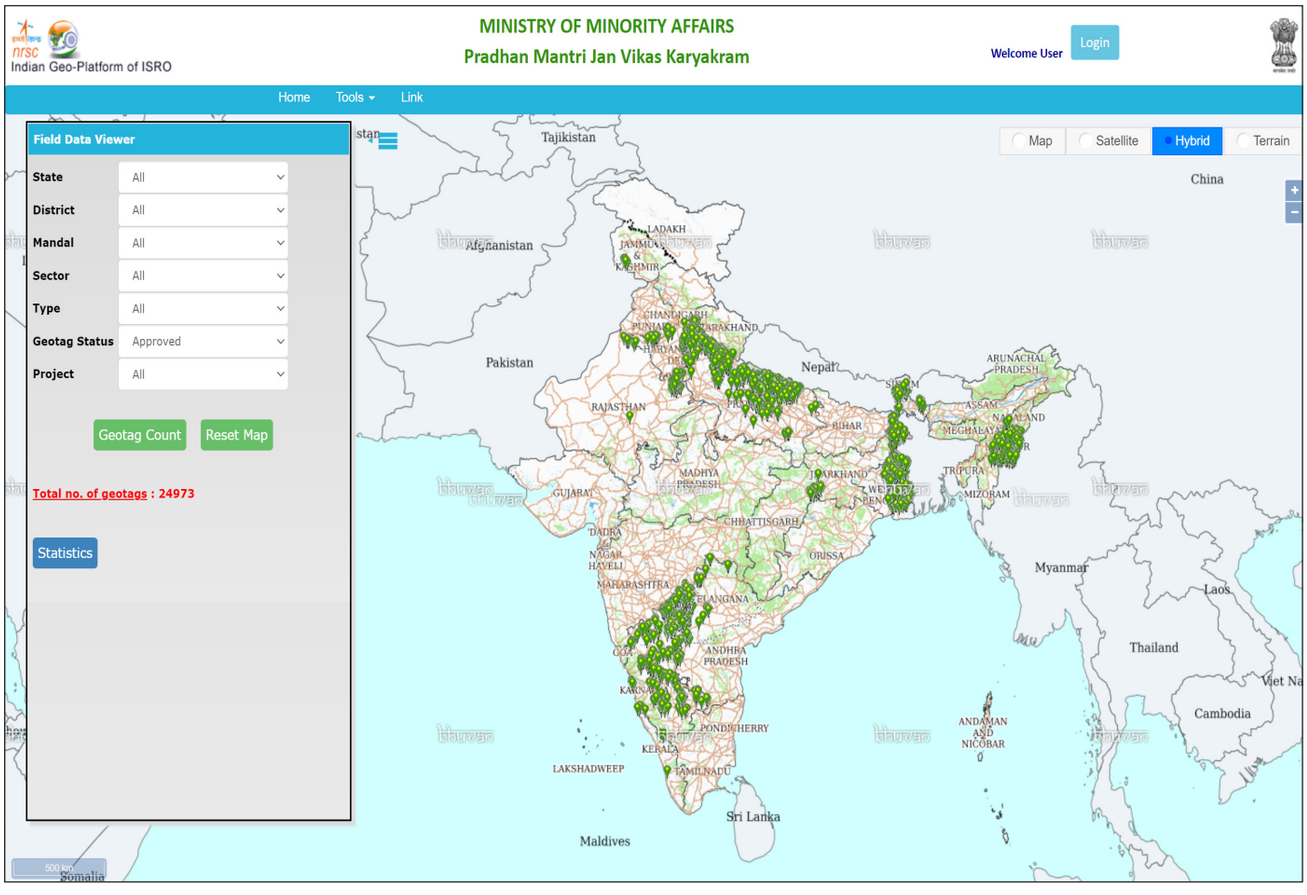


Figure 8.1: Geotagged Locations of Assets created under PMJVK

9 Red gram (tur) crop area assessment using dual-polarized SAR

Pigeon pea (Red gram or Arhar) commonly known as Tur is grown under rain-fed conditions and is cultivated as a Kharif crop in India. Tur crop is sown usually during June-July and harvested during Nov-Jan. For Kharif crops, microwave SAR (Synthetic Aperture Radar) data plays a significant role, since crop discrimination is quite challenging due to persistent cloud cover with optical remote sensing. The study explores the use of Sentinel-1 dual-pol Single Look Complex (SLC) data with phase and intensity information, for pre-harvest acreage estimation of Tur Crop in Afzalpur Taluk of Kalburgi district, Karnataka. Polarimetric analysis of SAR SLC data was carried out using time series (pre-sowing: 10th July, pre-harvest: 8th Sept and 14th Oct of 2019) of Sentinel-1 data with VH and VV polarization. Polarimetric features (i.e., entropy H, alpha angle α) were analyzed using the Unsupervised H-α Wishart Classification method for understanding the temporal behavior of tur crop vis-à-vis, other classes. Decomposition based on surface, double-bounce, and volume scattering mechanisms were analyzed in the H-α space. Ground truth data collection was carried out during the months of August' 2019 for tur crop along with other crop categories (banana, jowar, cotton, paddy and sugarcane).

The data pre-processing steps for SLC data include: sub setting of bursts/swaths, applying satellite precise orbit file, radiometric calibration to generate complex sigma naught values, debursting and merging to concatenate adjacent bursts or append sub-swaths respectively, polarimetric speckle filtering, terrain correction and resampling for generation of terrain corrected image. Standard unsupervised iterative Wishart classification method in the H / Alpha plane was adopted for separating data into nine cluster zones: dihedral reflector, dipole, bragg surface, double reflection, anisotropic particles, random surface, complex structures, random anisotropic scatterers and non-feasible. Crop classification accuracy for tur vis-à-vis other crops is greatly improved with the use of temporal variation in entropy and alpha angle values due to the phenological stages of the crop giving rise to differences in structural characteristics and water content of crops. The RS based tur crop area during 2019 for Afzalpur Taluk was 72832 ha in comparison to reported area of 64192 ha showing a relative deviation of 13.45 per cent.

Dihedral Reflector
Dipole
Bragg Surface
Double Reflection
Anisotropic Particles
Random Surface
Complex Structures
Random Anisotropic Scatterers
Non-feasible

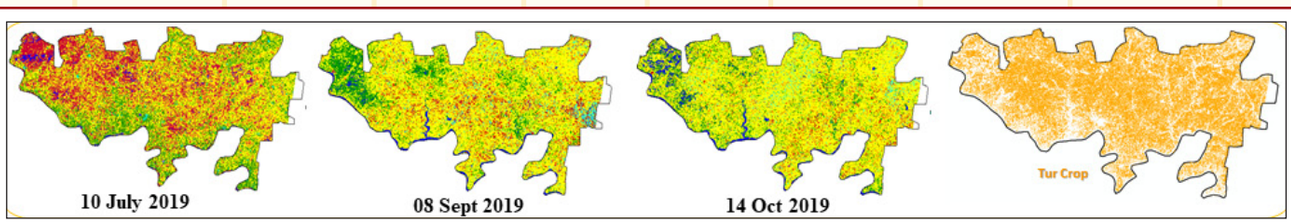


Figure 9.1:Temporal Classified outputs from SAR SLC data for delineation of Tur Crop

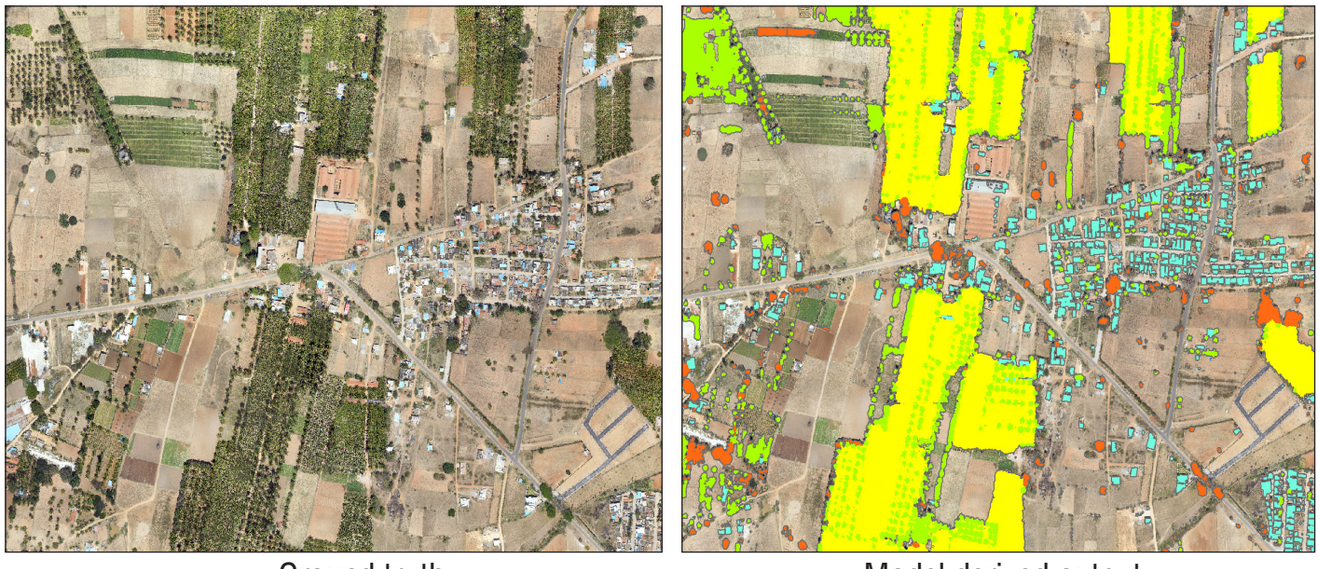
Workshop on EOS-04 (RISAT-1A) and Release of Data Products & RISAT-1A Handbook on 13.12.2022 at DOS Branch Secretariat, New Delhi

The EOS 4 (RISAT-1A) SAR data products were released by Hon'ble Minister of Agriculture and Farmers Welfare, Shri Narendra Singh Tomar and the RISAT 1A Handbook was released by Hon'ble Minister of State (Independent Charge) for Science & Technology; Earth Sciences, /DoPT; Atomic Energy and Space Dr Jitendra Singh, in the presence of Secretary, DOS; Secretary, MoA&FW; Scientific secretary, ISRO; Director, SAC; Director, NRSC and other Senior officials of ISRO, MoA&FW, ICAR, MHA, MNCFC, NIC,NCMWRF, Ministry of Jalshakti, IMD and NWIC. Hon'ble MoA & FW, Shri Narendra Singh Tomar called for strengthening of the farm sector through adoption of space based applications for decision making and use the RISAT 1A to the full extent.

10 Discrimination of plantation crops in multi-tier agroforestry land use systems using UAV Images and Deep Learning

In the present study, utility of very high-resolution images acquired from Un-manned Aerial Vehicles (UAV) was explored for inventory of coconut and plantations under multi-tier cropping systems using deep learning. The study area consists of Belagumba village, Tumkur District, Karnataka. UAV images in RGB (4cm) and Multispectral (15 cm) modes were acquired during March 28-30, 2021. The visual inspection of the image indicated that the coconut plantations were manifested in larger star shaped patterns on the UAV images due to canopy geometry and large crown which is quite distinct from arecanut plantations. The spectral and spatial patterns of individual coconut trees within the multi-tier cropping system were also clearly visible. Field visits were carried out synchronous with UAV flying period. Multi-class labelled training samples covering five classes viz., coconut, arecanut, trees, buildings and others were created using visual interpretation. About 208 images chips and corresponding labelled training samples (512 x 512 pixels) were extracted in raster format as an input for DL model. Semantic segmentation with U-Net architecture was implemented for development of DL model. The hyperparameters such as no. of epochs, learning rate, weight decay etc. for the DL model were optimized, iteratively. The DL based classification has been implemented in two steps a) training & validation and b) inferencing. About 80 % of the training samples were used for training DL model while 20% used for model validation.

The results indicated that the validation accuracy of the trained DL model was about 86.2%. The trained DL model was applied to the entire image covering the study area for classification. The classified map showing major land use classes is depicted in the Figure 10.1 given below. The accuracy of classified output was performed by generation of confusion matrix using independent samples. The results revealed that the overall accuracy as well individual class accuracy was consistently higher in RGB image as compared to multi spectral image which may be attributed to higher spatial resolution. The classification accuracy was better than 82.5% for the two dominant plantations of the study area viz., coconut and arecanut. The individual trees have also been captured from the RGB image. The study revealed the requirement of very high-resolution data for inventory of plantation crops in the complex agroforestry systems and thus, UAV imaging techniques offer an attractive option for mapping of plantation types in multi-tier cropping systems. Further research is focused on analysis of spectral and spatial characteristics of different components of agroforestry systems using a combination of very high-resolution satellite and UAV images.



Ground truth | Model derived output

Figure 10.1 DL based classified map showing major plantations like coconut and arecanut

Announcement:

User Interaction Meet - 2023

at NRSC, Hyderabad

14/03/2023 (Tuesday) &

15/03/2023 (Wednesday)

11 Variation of Tropical Cyclone Heat Potential over North Indian Ocean

Oceans cover approximately 70.8 % of the Earth surface; being the largest solar energy collector, it store huge amounts of heat energy within the upper few layers on shorter time scales and in the deeper layers on longer time periods. The heat content in the upper ocean layers is thus important for understanding the role of air-sea interaction processes and its contribution to global climate variability. The oceanic heat content which accounts for the integration of subsurface oceanic temperature up to the depth of 26° C isotherm also known as D26 is defined as tropical cyclone heat potential (TCHP). Under National Information system for Climate and Environment Studies (NICES) program, daily TCHP data has been derived from remote sensing and model derived parameters using Two Layer reduced Gravity Model (TLGM) with the following equation

$$TCHP = C_p \rho \int_0^{D26} (T - 26) dz$$

Typical TCHP values vary from 0 kJ/cm2 to more than 200 kJ/cm2. TCHP playing a crucial role in exchange of fluxes, development and intensification of tropical cyclones and global energy budget, it is very important to study the long term variations and its implications on changing climate. In the present study TCHP derived from TLGM has been analyzed over two major basins of the North Indian Ocean (NIO) i.e., Bay of Bengal (BoB) and Arabian Sea (AS) for the period of January, 1993 to July, 2021. Daily time series of TCHP over BoB (red color) and over AS (blue color) for the analysis period is showed in the figure 11.1. From the analysis it has been observed that TCHP is in increasing trend in both the basins. However Arabian Sea shows higher trend of 1.65 kJ/cm2/yr as compared to the Bay of Bengal with 1.25 kJ/cm^2/yr. Further analysis has been carried out for Northern BoB (15N-19N & 85E-90E) and Southern BoB (5N-10N & 82E-92E), this analysis also showed that these two sub basins are also showing an increase trend of 1.0 kJ/cm^2 and 1.45 kJ/cm^2 respectively. This observed increase in heat content of NIO might be contributing towards high intense cyclones, extreme events and change in the monsoon rainfall patterns in the recent period. This will be further examined by considering other ocean and atmosphere parameters, which are playing crucial role in changing climate.

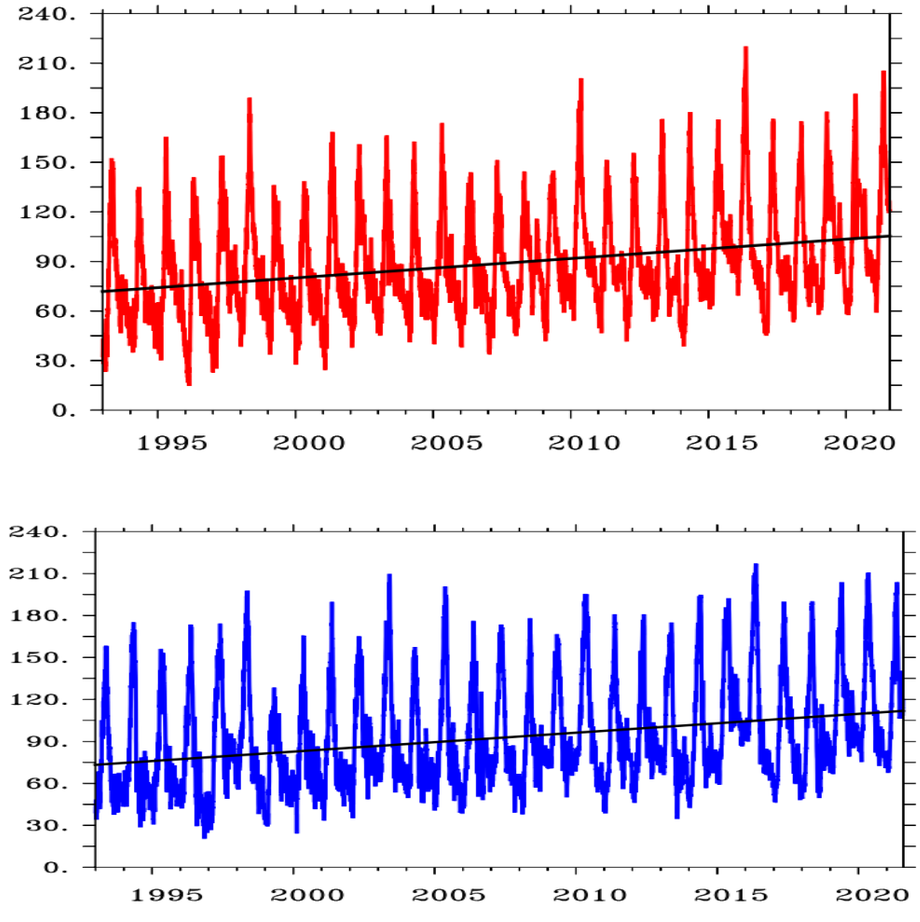


Figure 11.1 Daily time series of TCHP over Bay of Bengal and Arabian Sea from Jan, 1993 to Jul, 2021derived using TLGM

UAVs and Sensors – Inducted and Operationalised 12

The Aerial Services and Data Management Area of NRSC has inducted and operationalized two hybrid UAVs (fixed wing Unmanned Aerial Vehicles (UAVs) with Vertical Take-off Capability) along with RGB Digital Cameras and an integrated Multispectral and thermal sensors to cater to different Remote Sensing applications in the areas of Agriculture, Geohazards, Water resources, Forestry, geometric and radiometric calibration of high resolution satellite images etc.

UAV: The salient specifications of the Trinity F90+ UAVs (Fig12.1) are, it has a maximum take-off weight (MTOW) of 5 kg with a payload carrying capacity of 700g, it is battery operated (using a Lithium Polymer battery) and has an endurance of 90 minutes with an operational range of more than 5 km. It can fly up to an altitude of 250 m Above Ground Level (AGL) and can be launched in terrains with elevations ranging from 0 up to 4000 m above mean sea-level (AMSL).

Figure 12.1: Trinity F90+ Hybrid UAVs

Figure 12.2 RGB Digital Camera

The UAV uses Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) for position and orientation. The onboard GNSS receiver data (code and carrier data) is processed in conjunction with GNSS ground reference receiver in differential mode using Post Processed Kinematic (PPK) method to estimate precise trajectory at cm level for Direct georeferencing of the images.

The UAV flies at a speed of 17m/s and can withstand wind speed of up to 8 m/s. It has safety features such as Return-To-Home (RTH) and has Automatic Dependent Surveillance – Broadcast (ADS-B). The UAV and accessories can be transported in one box and weighs around 20 kg.

RGB Digital Camera: The colour digital camera, Sony RX1 RII (Fig 12.2) is a full frame sensor with focal length of 35mm and sensor pixel size of 4.5 microns, it has sensor resolution of 42 Megapixels, i.e., 7952 pixels and 5304 pixels in along and across track directions respectively. At a flying height of 120m AGL, (Maximum flying height permissible according to DGCA regulations for Civilian UAV operations in India), the

Figure 12. 3: Integrated Multispectral and Thermal Sensor

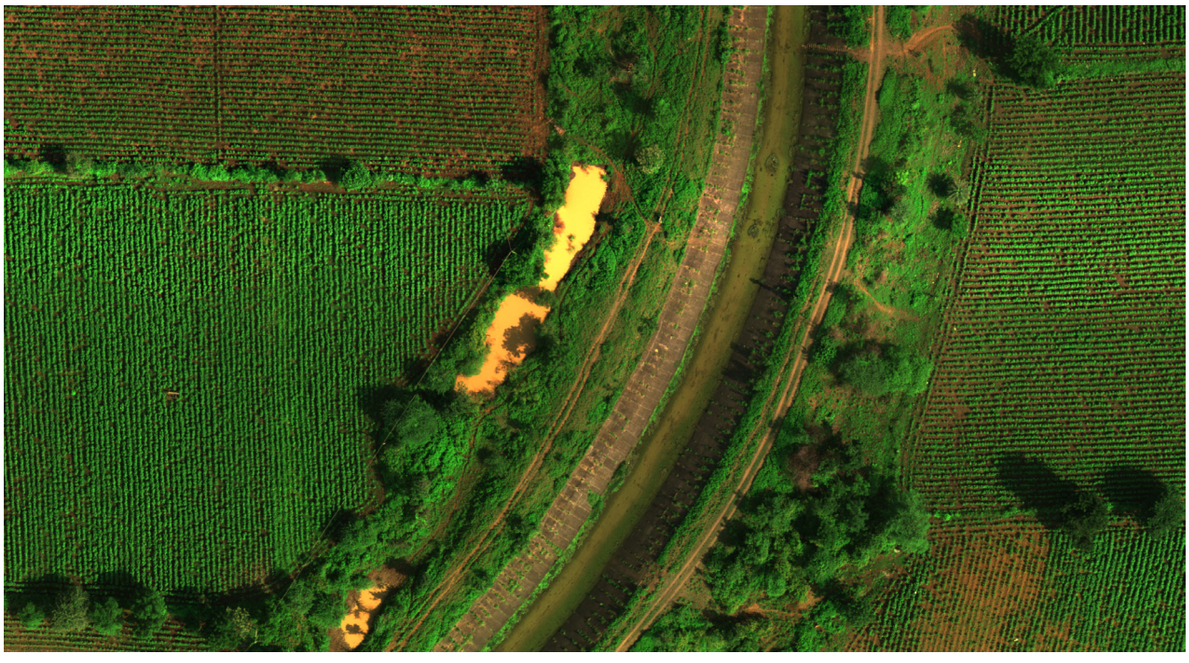


Figure 12.4: Orthoimage (GSD: 6 cm), part of Morshi, Amaravati, Maharashtra

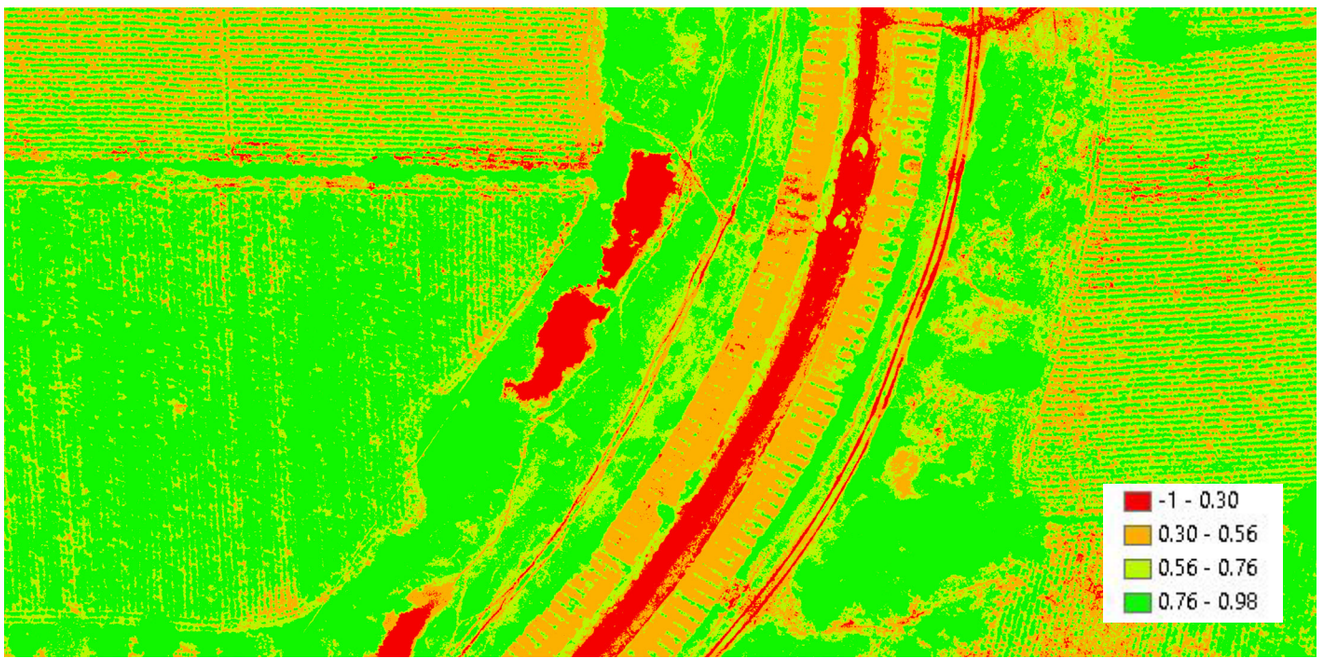


Figure 12.5: NDVI Map, part of Morshi, Amaravati, Maharashtra

Ground Sampled Distance (GSD) attainable is around 1.5 cm. The images are in jpg format and are used to generate high resolution Digital Surface Model (DSM), Digital Terrain Model (DTM) and Orthoimages.

Integrated Multispectral and Thermal Sensor: The multispectral (MS) sensor captures images in five spectral bands namely Red, Green, Blue, RedEdge and NIR with 3.2 Megapixels per each MS band at a GSD of around 5.3 cm and the thermal sensor has a single band in Long Wavelength Infra-Red region from 7.5 to 13.5 microns and provides a GSD of 33.5 cm at 120 m flying height.

The Micasense Altum Sensor (Fig12.3) comes with a Downwelling Light Sensor (DLS) which is used during data acquisition to measure the light intensity i.e., solar irradiance at sensor, for carrying out radiometric corrections. The images are in Tiff format and used for generation of DSM, DTM, Orthoimage and more importantly generation of various indices such as NDVI, NDRE and Heat Maps.

The Orthoimage at GSD of 6 cm, Normalized Difference Vegetation Index (NDVI) map generated from integrated multispectral and thermal sensor for crop growing area in part of Morshi, Amaravati District of Maharashtra are shown in Fig.12.4 and 12.5.

Second United Nations World Geospatial Information Congress

The Second United Nations World Geospatial Information Congress (UNWGIC 2022) was held in Hyderabad during Oct 10-14, 2022. The five-day conference was hosted by the Department of Science & Technology, Ministry of Science and Technology and convened by the United Nations Committee of Experts on Global Geospatial Information Management.

With the theme of 'Geo-Enabling the Global Village: No one should be left behind,' the Second UNWGIC 2022 addressed the importance of integrated geospatial information infrastructure and knowledge services to support the implementation and monitoring of sustainable development goals. It also deals with the well-being of society, a environmental and climate challenges, digital transformation and technological development.

Indian Space Research Organization / NRSC participated in this event along with Space on Wheel Bus and also arranged the exhibitions on Indian Remote Sensing Satellites capabilities for the benefit of visitors.

Satellite based analysis of Bank Erosion & Deposition of Brahmaputra & Kosi Rivers 13

India, is home to one of the large river systems such as The Ganges, The Brahmaputra and The Meghana river basins which account for more than 60 % of the country's water requirements. Primarily, the perennial river systems as mentioned above are snowfed rivers which carry massive sediments and challenge the water carrying capacity of the rivers and also overtop their banks during the monsoon and snow melt season, causing severe floods in their catchment areas. In order to investigate the amount of Bank Erosion & Deposition, two case studies were conducted along the Brahmaputra river in Assam State and Kosi river, one of the chief tributary of Ganga in the Bihar State. These case studies aim to study and analyse the bank line erosion & deposition of Brahmaputra in Assam and Kosi river in Bihar over a period of 2010-2021.

The combination of Indian Remote Sensing Satellite data and Sentinel-2 Series satellite datasets during the periods of 2010 – 2021 for Brahmaputra and 2011-2021 in Kosi River were acquired, banklines for two timelines were delineated using onscreen digitisation techniques. Further the banklines were intersected and investigated to quantify the amount of Bank Erosion & deposition in these two rivers.

The Brahmaputra river in Assam has shown that Erosion is more when compared to Kosi river in Bihar, which depicted that Deposition is higher as against Brahmaputra river. It is observed that Brahmaputra river has total erosion of 39, 024 hectares in 22 districts of the state with a maximum erosion of 5328 hectares in Biswanath District as shown in Fig 13.1.

The Kosi river on the other hand experienced a higher deposition along its banks to the order of 14,600 hectares spread along 14 districts of the state with a maximum deposition of 3423 hectares was observed in Supaul district as shown in Fig 13.2.

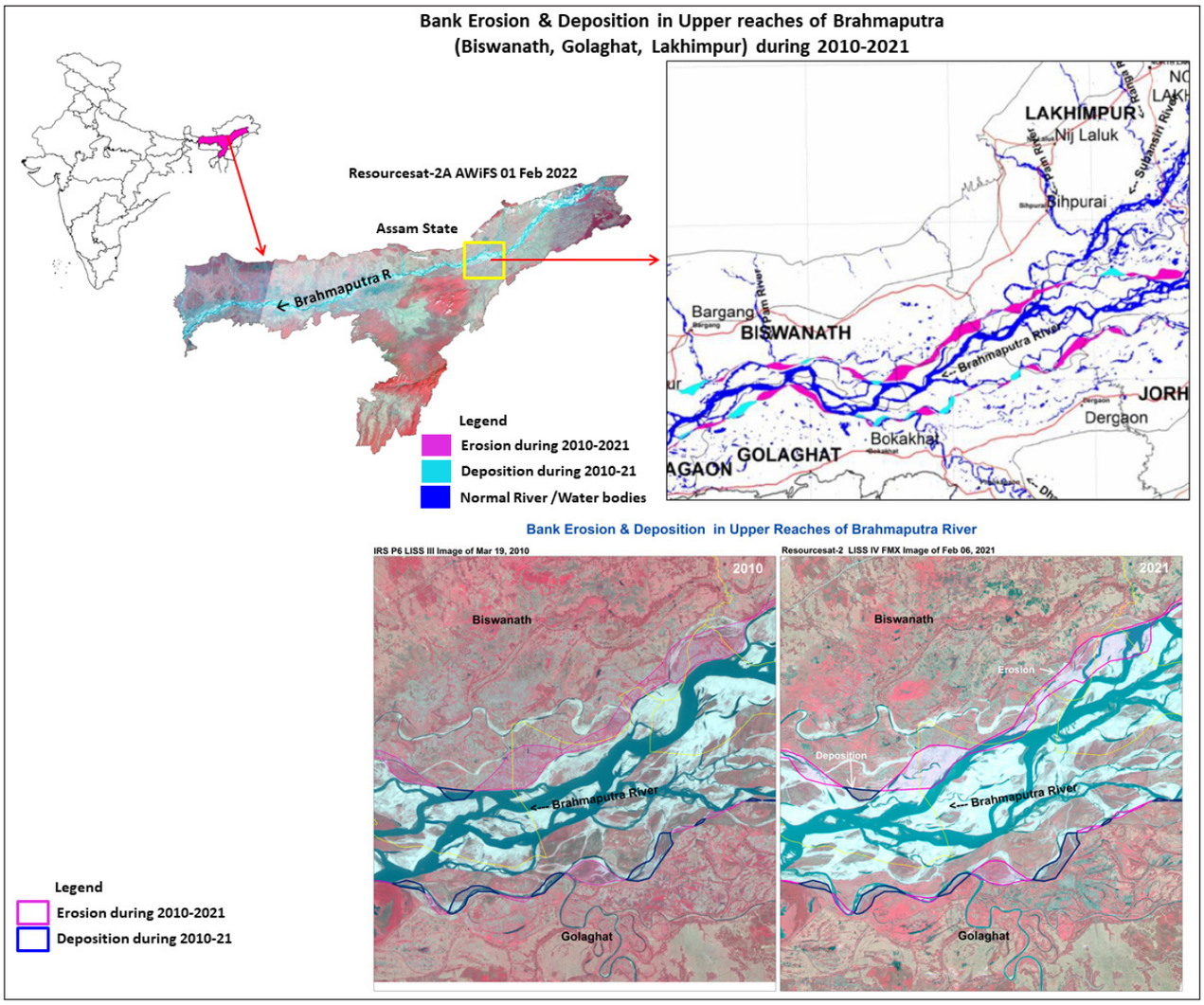


Figure 13.1: Bank Erosion & Deposition in Upper Reaches of Brahmaputra during 2010-2021

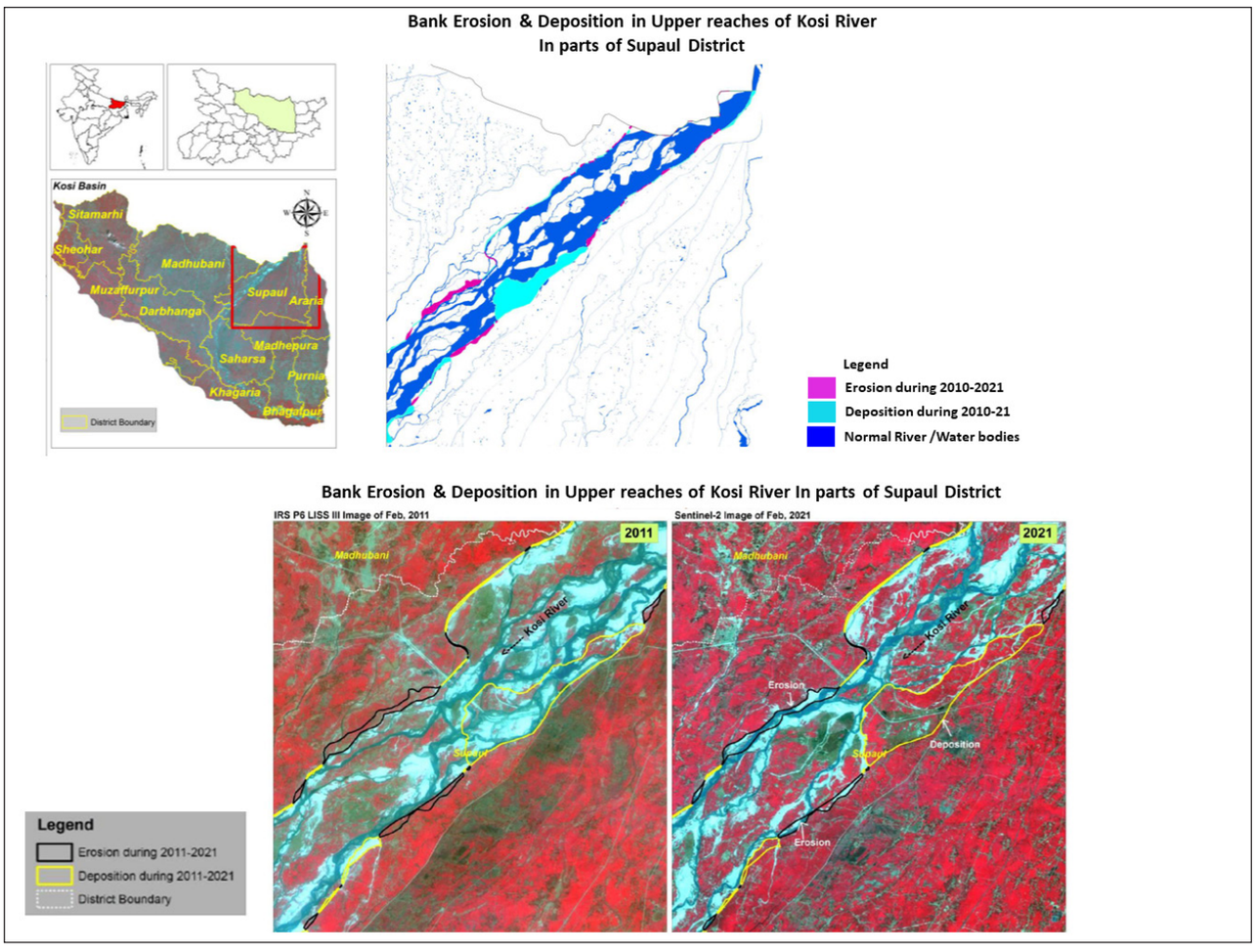


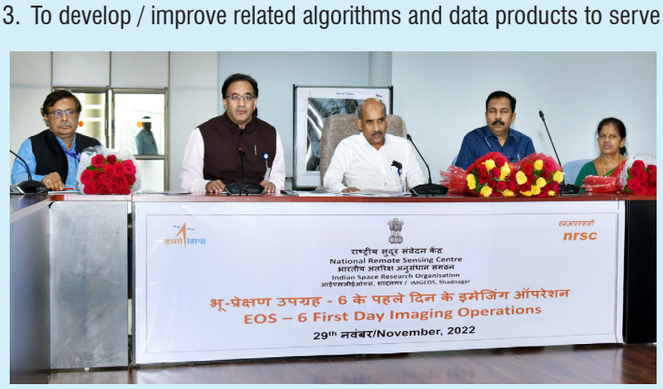
Figure 13.2: Bank Erosion & Deposition in Upper Reaches of Kosi River during 2011-2021

EOS-6 First Day Imaging Operations (29th Nov, 2022)

Oceansat is a series of earth observation satellites built, launched, and operated by Indian Space Research Organisation, and dedicated to oceanography and atmospheric studies.

EOS-6 is the third-generation satellite in the Oceansat series. This is to provide continuity services of Oceansat-2 spacecraft with enhanced payload specifications as well as application areas.

1. To ensure the data continuity of Ocean colour and wind vector data to sustain the operational applications.
2. To improve the applications, some additional datasets such as Sea Surface Temperature and more number of bands in Optical region for florescence and in Infrared region for atmospheric corrections are accommodated.
3. To develop / improve related algorithms and data products to serve in well- established application.



14 Real-time Operational Spatial Flood Early Warning during 2022 floods for Godavari and Tapi Rivers

Flood causes drastic damage to life and properties every year all over the world. India is one of the most flood vulnerable countries in the world and has a long history of dealing with floods. During the past decades, the frequency of floods in India has increased along with the damages caused by floods. To mitigate the impact of floods, the government has been developing flood preparedness to better equip the country to deal with floods. Flood early warning is one of the most effective non-structural flood disaster damage mitigation methods. Development of Medium range Spatial Flood Early Warning models for large catchments is a challenging task to the hydrologists. Considering the requirements at national level and its importance, National Remote Sensing Centre (NRSC) has developed spatial flood forecast models for the Godavari and Tapi Rivers using space based inputs under National Hydrology Project (NHP). Flood forecast models are developed for Godavari and Tapi basin using NAM hydrological model and one dimensional hydrodynamic approach. CARTO DEM, landuse land cover grid (derived from IRS P6 satellite data) of the study area, and soil textural grids were used in deriving the input parameters for the study. The developed models are calibrated and validated thoroughly using historic discharge and rainfall data obtained from CWC and IMD respectively. Spatial flood early warning models for major floodplains of these two rivers are developed using high resolution digital terrain models (ALTM DTMs).

Real time operation during 2022 floods:

Models are being run in real time for the year 2022 (June to October) using real-time rainfall data obtained from IMD Hyderabad and Gandhinagar, rainfall forecast data from IMD WRF/GEFS. Flood alerts were disseminated through Bhuvan, NDEM, and National Hydrology Project Geo-portals. Godavari flood alerts were also given to Andhra Pradesh State Disaster Management Authority (APSDMA) during floods in Godavari River in 2022.

Spatial flood early warning using very high resolution Digital Terrain Models (ALTM DTM) is a new dimension to the conventional flood early warning. These models can give spatial flood alarm prior to the flood event with sufficient lead time that can minimize the damage to property and life. Apart from the spatial flood alarming, these models provide flood depth and velocity of flood in spatial domain which is a very vital input in flood damage assessment. Flood discharge forecast accuracy is found to be more than 85% with a lead time of 50 hours at downstream forecast station (Koida). Inundation simulation accuracy (simulated using ALTM DTM) is also found to be more than 80%. This study will help in improving in flood forecasting lead time (2 days and more) with more accurate flood discharge computations in spatial domain. This will help in relief and rescue operations during floods, flood disaster risk reduction, and flood disaster management in the Godavari and Tapi Basins.

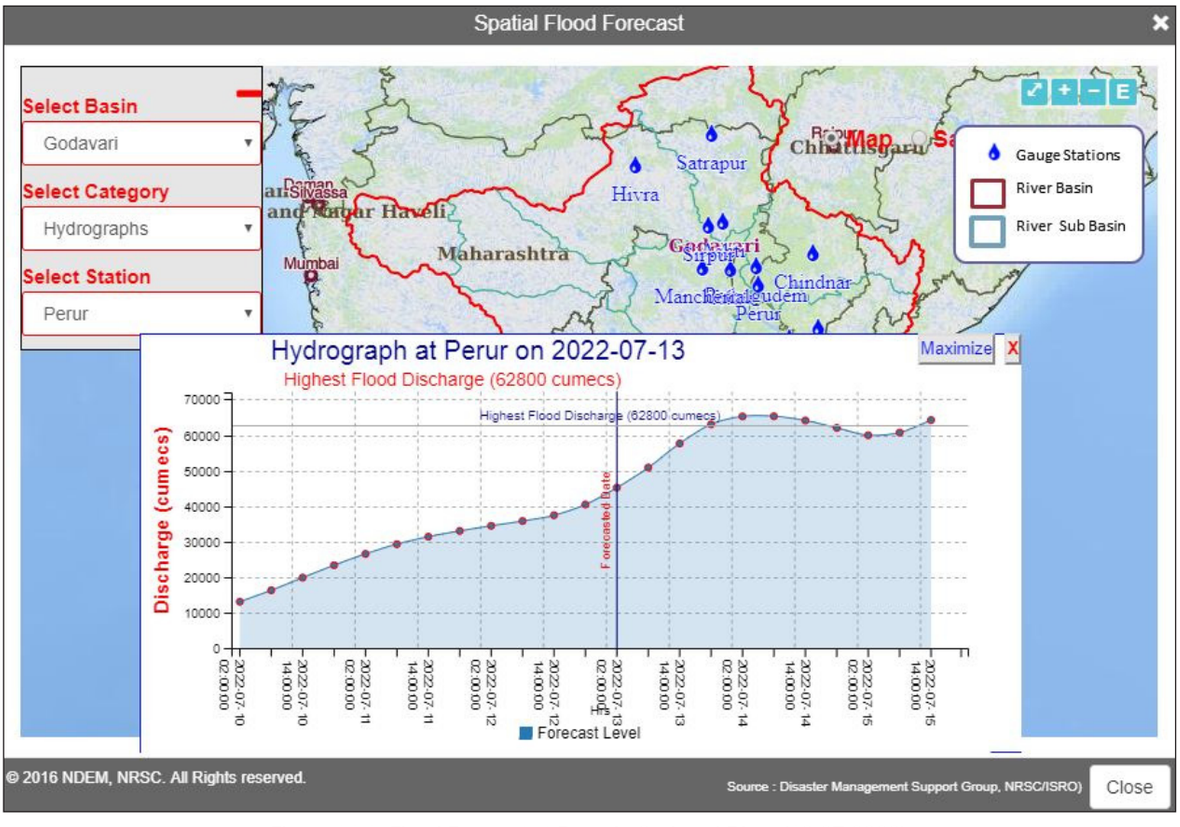


Figure 14.1: Flood Forecast at Perur in Godavari River (13.07.2022)

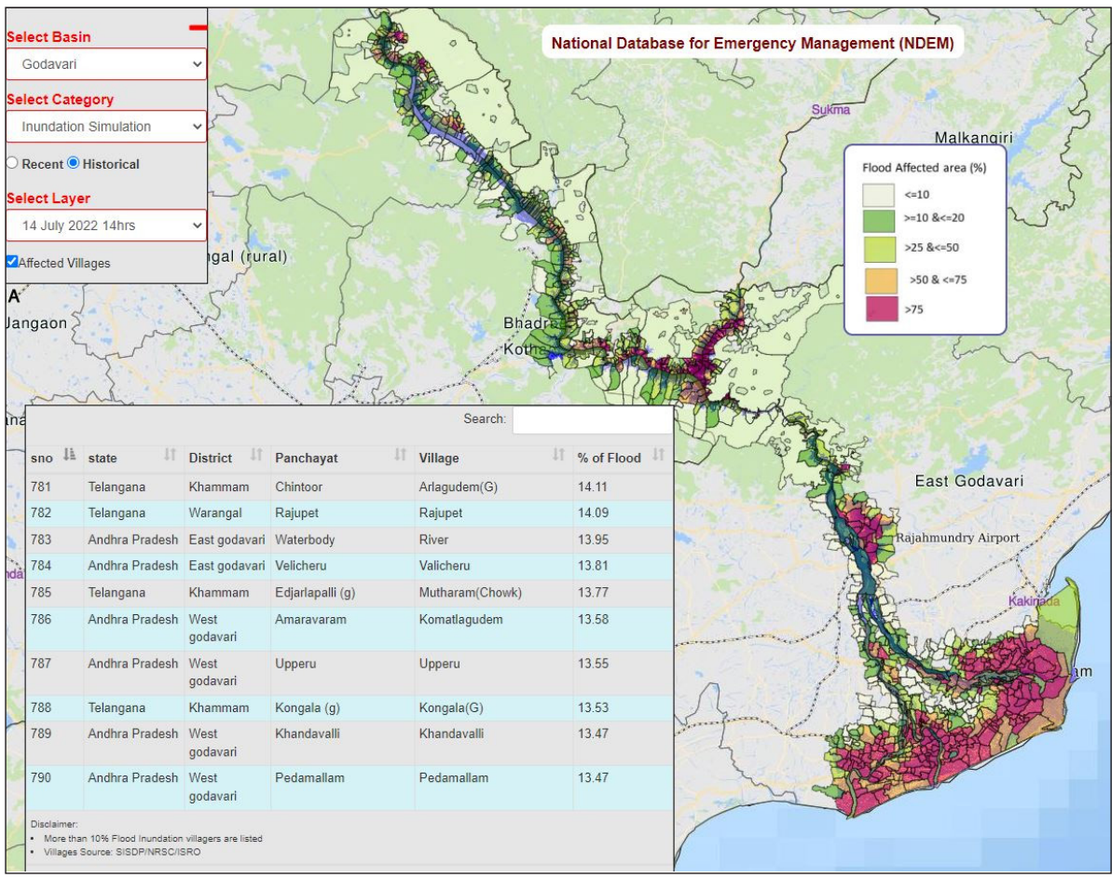


Figure 14.2 Village affected during July 2022 flood event in Godavari River

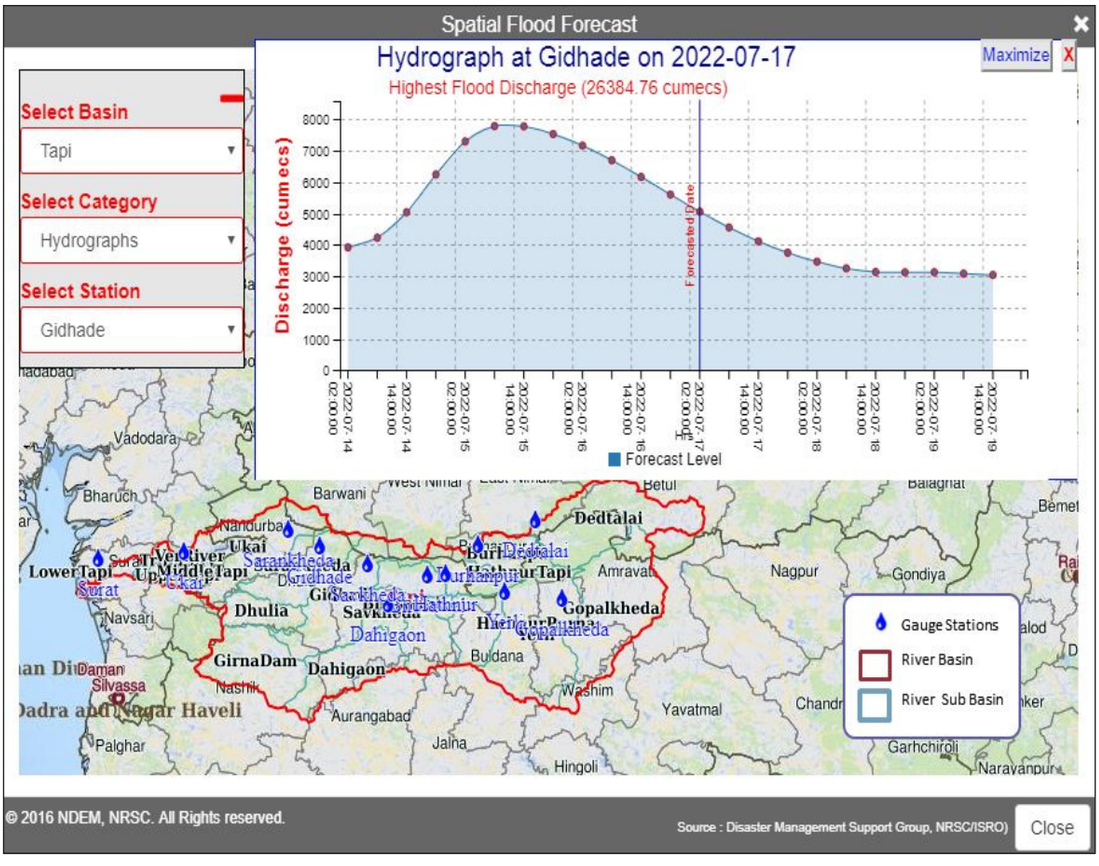


Figure 14.3 Flood Hydrograph at Gidhade in Tapi River (17 Jul 2022)

EOS-04 data for Jute Crop Discrimination and Mapping 15

Satellite-based inputs on in-season crop parameters and pre-harvest production estimates are crucial requirement for agricultural management and policy making. With the availability of Indian microwave sensor EOS-04, several studies are envisaged in the area of agriculture using the specific features of full polarimetric data. These include crop-specific mapping using distinctive scattering mechanisms of various crops due to their geometry, orientation, planting patterns, stage, etc.

This study had two objectives – (a) analysis of temporal Medium Resolution ScanSAR (MRS) dual pol data to evaluate the sensitivity of backscatter to crop growth, and (b) study of scattering mechanisms of crops using Full Polarimetric Fine Resolution Stipmap (FRS) data. The jute crop in West Bengal's Murshidabad district was selected for the study.

(a) Dual-pol MRS data for Jute crop mapping

Level-2A Enhanced Terrain Geo-Referenced systematic coverage MRS products were procured via Bhoonidhi portal. Temporal MRS dual pol data of West Bengal's Murshidabad district from April to August 2022 - encompassing the entire jute crop growing cycle - were analyzed. Pre-processing of the data in terms of speckle-filtering, Sigma0 ($\sigma 0$) conversion and temporal image stacking was carried out.

The jute crop was sown between last week of March and first fortnight of April, and harvested in July end. The temporal backscatter response from jute crop at HH and HV polarizations was studied. It was observed that backscatter return was low at both HH and HV polarizations during the first fortnight of April. This was due to the dominant background soil rather than the crop canopy, as the jute plants were in germination stage. The temporal backscatter profiles of jute crop at HH and HV polarization are shown in Fig.1. The backscatter values ranged from around -12 to -10 dB and from around -26 to -22 dB at HH and HV polarizations, respectively, during the sowing period. Further, the HH backscatter showed significant increase and ranged from -10 to -7 dB because of the double bounce scattering due to vertical canopy around last week of April, whereas the HV backscatter ranged from around-21 to -20 dB.

Following the crop growth, the accumulated biomass of the jute crop increased, and hence a significant increase in the backscatter was observed at both HH and HV polarizations. In contrast to HH, where the rate of rise in backscatter was only about 2-5 dB, HV polarization showed a high rate of increase of 7-9 dB, indicating higher volume scattering in mid-May.

In order to classify the jute crop, decision rules based on temporal backscatter of HH and HV were formulated, utilizing three dates (8 Apr to 12 May). The jute crop could be delineated with around 85% accuracy. Fig.2 shows the classified jute map and the FCC of the HH-backscatter.

Analysis of full polarimetric SAR data acquired in Fine Resolution Stipmap (FRS-1) mode was carried out for the discrimination and mapping of jute crop. Synchronous ground truth data was also collected on crop type and stage. Yamaguchi decomposition data provided under Level-3A polarimetric data products was used this study. The polarimetric data acquisition was programmatically planned over the study area. Jute was the major crop in the study area along with banana plantation and a few fallow fields. The jute crop was at vegetative growth stage as on 7th June. The mean scattering mechanisms from each crop/land cover class are plotted and shown in Fig.3.

It is observed that the volume scattering (46%) was found to be dominant scattering mechanism in jute crop along with the odd bounce (40%) as on 7th June. This was due to the multiple

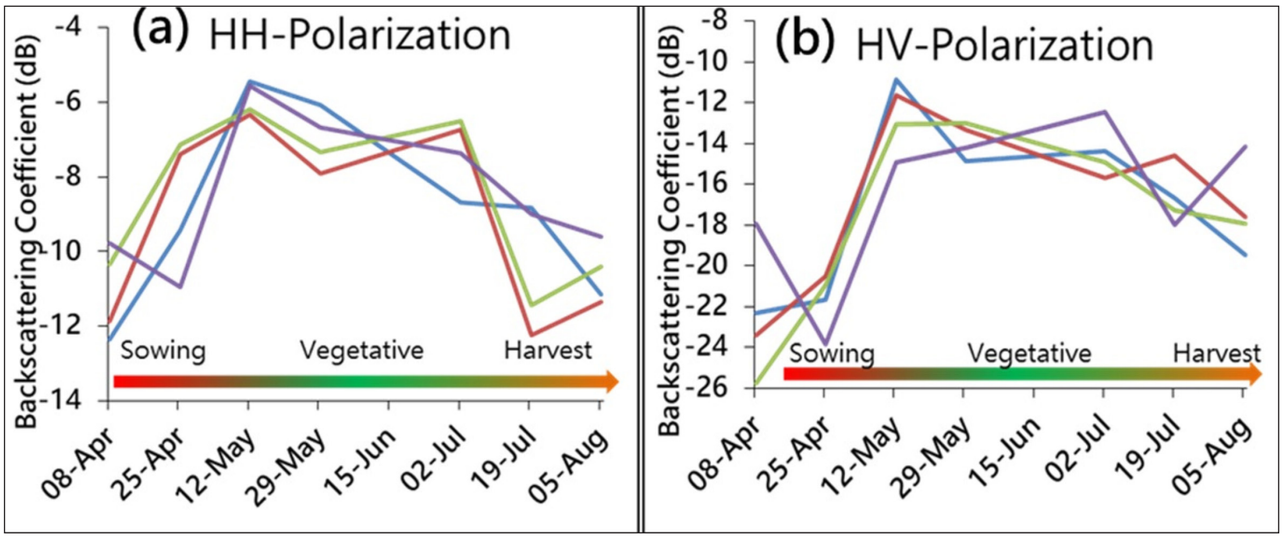


Fig.16.1: Temporal backscatter profiles of Jute crop at HH (a) and HV (b) polarizations

scattering in jute crop due to the canopy volume in terms of leaves, stem etc. and also significant odd bounce due to multiple scattering components (as in case of a trihedral). Similarly, the dominant scattering mechanisms in banana, fallow and settlement were found to be odd & volume, odd bounce and even bounce respectively.

The classification of decomposition parameters resulted in very good discrimination between jute, banana, fallow and settlement classes as shown in Fig.4. The jute crop classification results from temporal MRS data and polarimetric SAR data were compared and it was seen that there was 80% agreement between the jute cropped areas derived from these data.

This study showed the potential of single date full polarimetric data for discrimination of jute crop

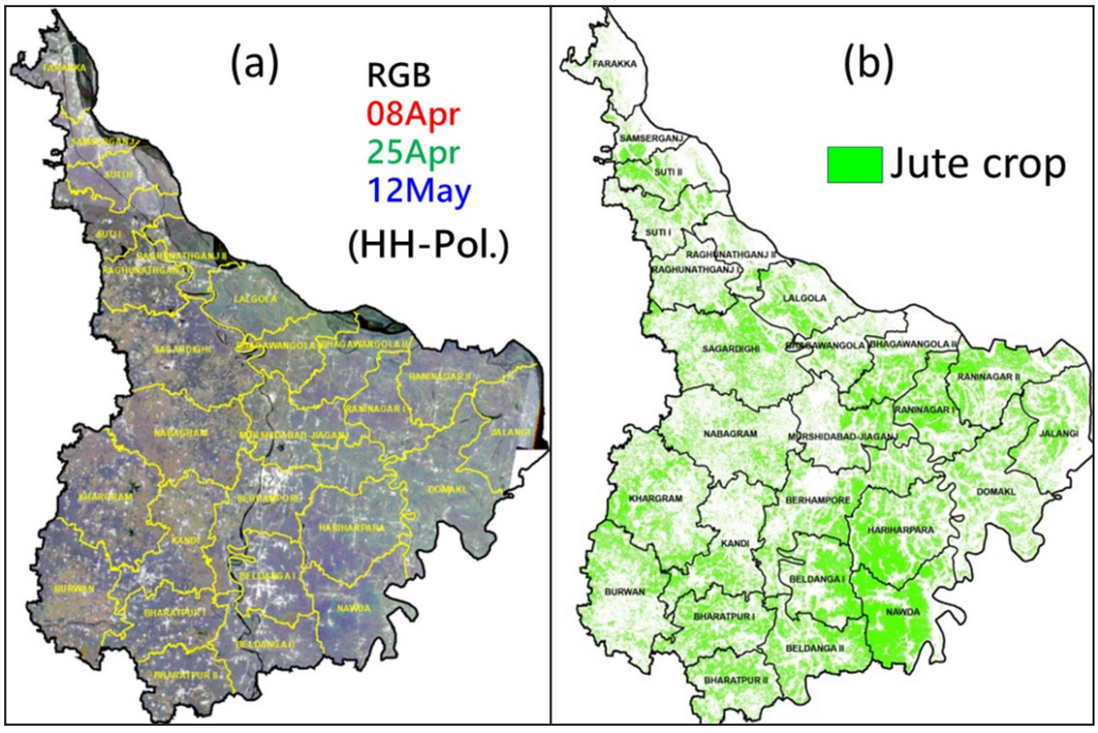


Fig16.2 (a) FCC of HH polarization and (b) Jute crop classified image(b) Full Polarimetric FRS data for Jute crop discrimination

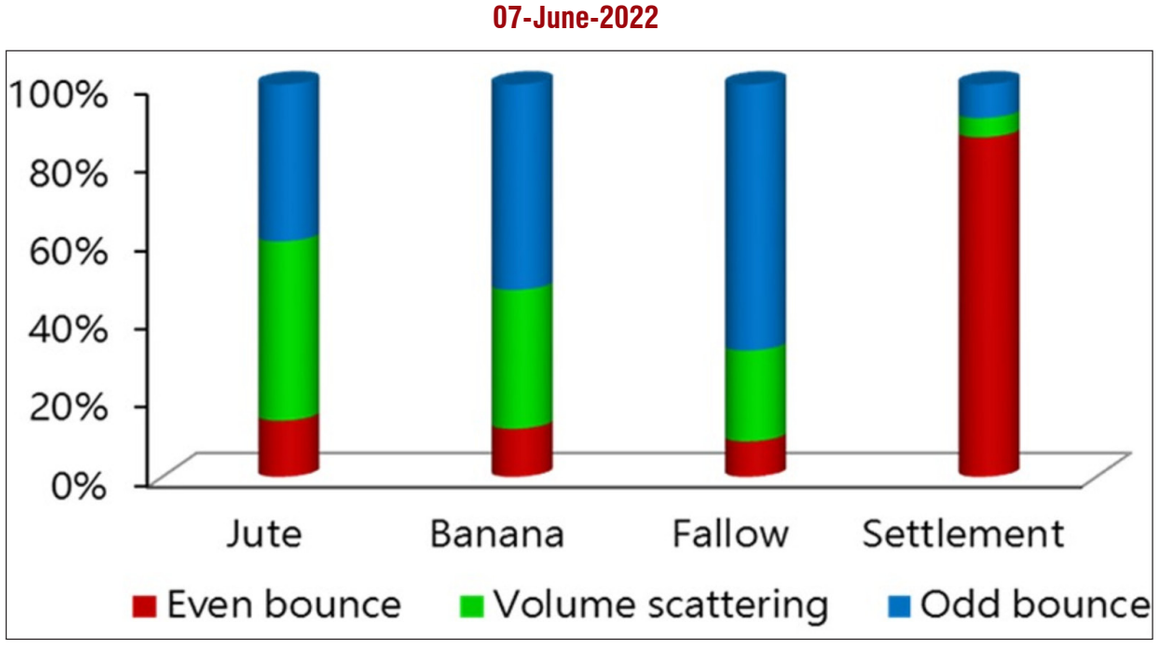


Fig.16.3: Bar diagram of scattering mechanisms in crops, fallow and settlement

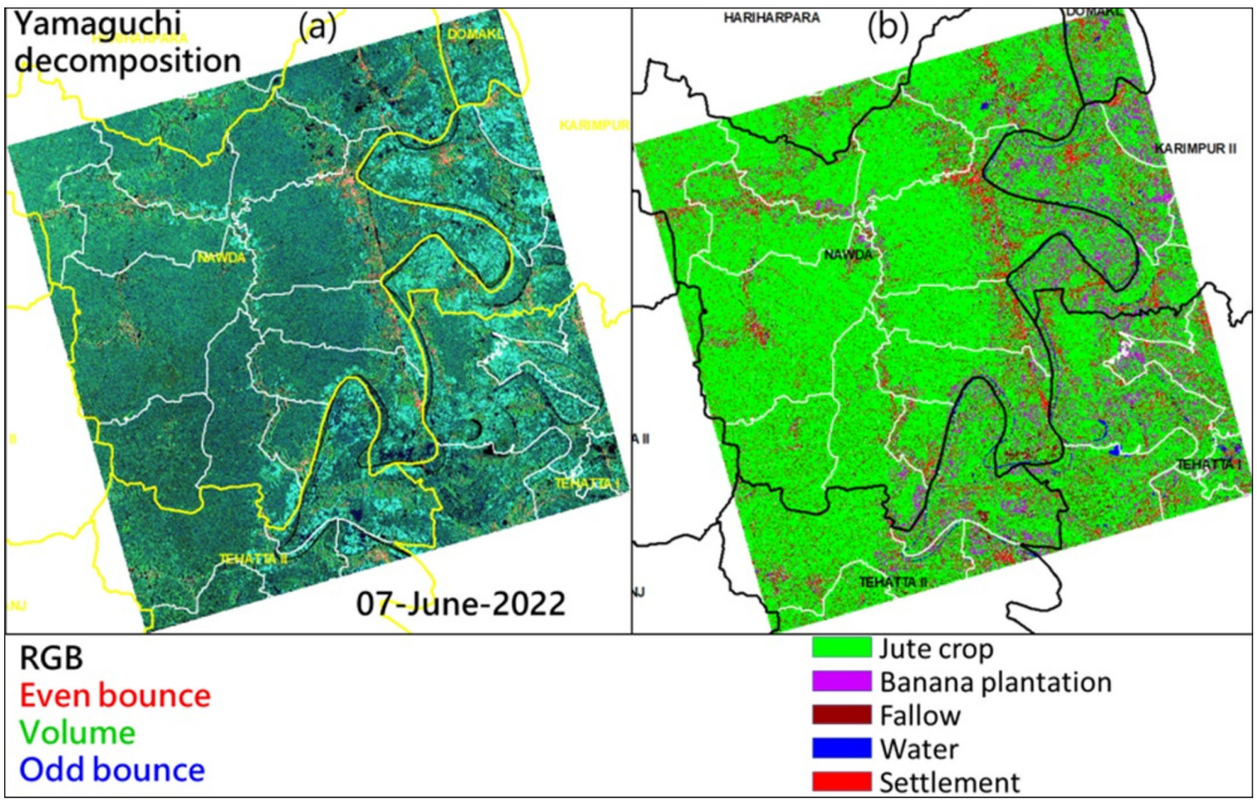
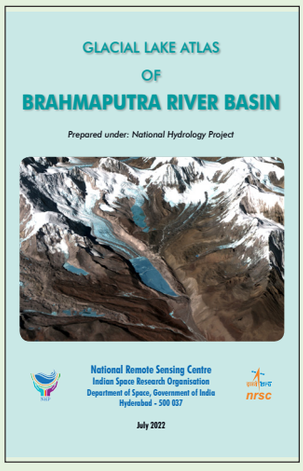


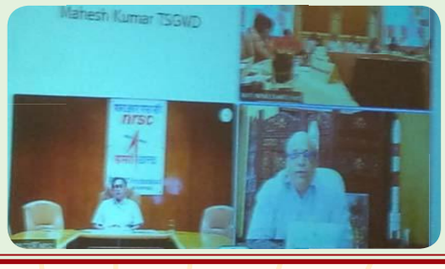
Fig16.4: (a) FCC of Yamaguchi decomposition (b) Classified image (parts of Murshidabad district, West Bengal)

Release of Glacial Lake Atlas of Brahmaputra River Basin Prepared under National Hydrology Project

National Remote Sensing Centre is one of the Central Implementing Agency under National Hydrology Project (NHP) sponsored by Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD&GR), Govt. of India with financial aid from the World Bank. As part of this, NRSC is carrying out 'Glacial Lake Outburst Flood (GLOF) Risk Assessment of Glacial Lakes in the Himalayan Region of Indian River Basins' under which an updated inventory of Glacial Lakes in the Brahmaputra river basin is generated for use in prioritization of critical glacial lakes and GLOF risk assessment.

Using above, Glacial Atlas of Brahmaputra River Basin has been prepared and formally released by Shri. Pankaj Kumar, Secretary, DoWR, RD&GR, Ministry of Jal Shakti in the presence of Dr. Shantanu Bhatawdekar, Scientific Secretary/ISRO, DOS & Dr. Prakash Chauhan, Director, NRSC and on 05 July, 2022 through a Video Conference event. The Brahmaputra basin glacial lake atlas depicts spatial distribution of 18,001 glacial lakes of size greater than 0.25 ha mapped using high resolution Resourcesat-2 LISS4 MX satellite data of 2016-17 covering geographical area of 3,99,833 sq.km. The atlas presents the details of glacial lakes in terms of area, type and elevation and administrative unit wise. The atlas is useful for identifying the potential critical glacial lakes and consequent GLOF risk assessment. It also assists disaster mitigation planning and related programs for Central and State Disaster Management Authorities. It may be noted that Glacial Atlases of Indus and Ganga River Basins were already released on 02-Dec-2020 and 29-Jun-2021 respectively.





Release of 'Glacial Lake Atlas of Brahmaputra River Basin' by Shri. Pankaj Kumar, Secretary, DoWR, RD&GR, Ministry of Jal Shakti in the presence of Dr. Prakash Chauhan, Director, NRSC and Dr. Shantanu Bhatawdekar Scientific Secretary/ISRO, DOS on 05 July, 2022 through a Video Conference event.

16 Ground Water Resource Assessment & Management (GRAM) – Village level ground water source and sustainability planning

The main objective of the study is to develop and operationalize the methodology for village level groundwater prospects and sustainability planning on 1:10,000 scale for major hydro-geological provinces in India under the Ground Water Recourses Assessment & Management (GRAM) project. This follows ISRO's decadal vision of making country's groundwater sustainable and to provide safe and sustainable drinking water under Jal Jeevan Mission program of Ministry of Jal Shakti. Pilot studies have been planned in 9 different hydro-geological provinces (Fig.17.1). Presently, 6 pilot studies are being carried out in Granitic area, Eastern ghats, Basaltic rocks, Gondwana rocks, Vindhayan rocks and hilly terrain of North East.

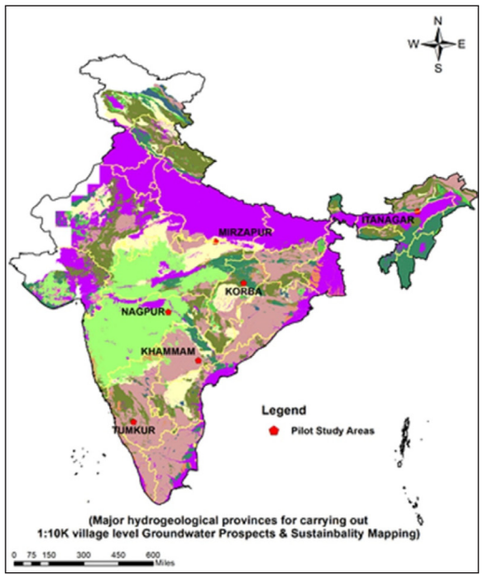


Figure 16.1: Pilot studies planned in different hydro-geological provinces

Mapping for three of the pilot study areas, Jayachandrapura (JCPura) gram Panchayat, in Tumkur district, Karnataka; Narkhed in Maharashtra & Korba in Chhattisgarh state has been carried out on priority basis, based on the request from the respective states. Variability in the groundwater availability, potential and its usage was demonstrated in peninsular gneissic complex, Deccan basalts and Gondwana rocks of central and south India. The ground water problem in Tumkur and Narkhed are very challenging as they fall under overexploitation zones where less groundwater availability is due to variability in rainfall and excessive groundwater withdrawal for irrigation according to CGWB (2019) and the aquifer is draining due to the nearby coal mining in Korba. Using VHR (CARTOSAT-2E, KOMSAT-3) and High resolution (IRS-P6 LISS-4) satellite data, detailed hydrogeological mapping was carried out in all the three pilot study areas. Groundwater well observation was carried out systematically in a gridded manner. Data integration was carried out using heuristic knowledge guided methodology for sustainable groundwater development plan on 1:10K scale including ground water prospects and recharge zones (Fig17.2). In one of the pilot study area, JC Pura, Tumkur, Karnataka, it was observed that more than 1000 bore wells have been constructed in 24 sq.km areas (Fig.17.3). Well inventory analysis clearly

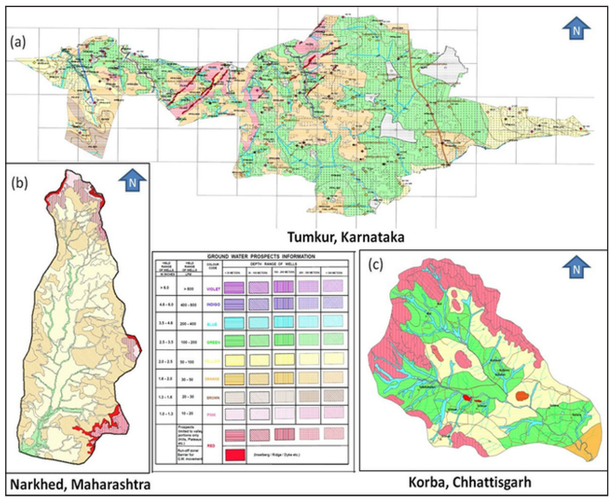


Fig16.2: Village level groundwater prospects map of (a) JCPura, GP, Karnataka, (b) Narkhed, Maharashtra, (c) Korba, Chhattisgarh (Maps are not to scale)

highlights the excessive withdrawal of groundwater. Wells in the shallow aquifers zones are mostly dried up and majority of the wells are exploiting groundwater from the deeper (200-300 m depth) confined aquifers. This has led to uneven distribution of ground water and erratic discharge of ground water bore wells. It was emphasized for the extensive construction of recharge structures for sustainable development of groundwater in this area. Similarly, in the Narkhed area, Maharashtra, ground water is being exploited for orange cultivation. Because of the poor water holding capacity of the basaltic region, the area has become ground water deficient. Sustainability measures have been suggested for aquifer restoration.

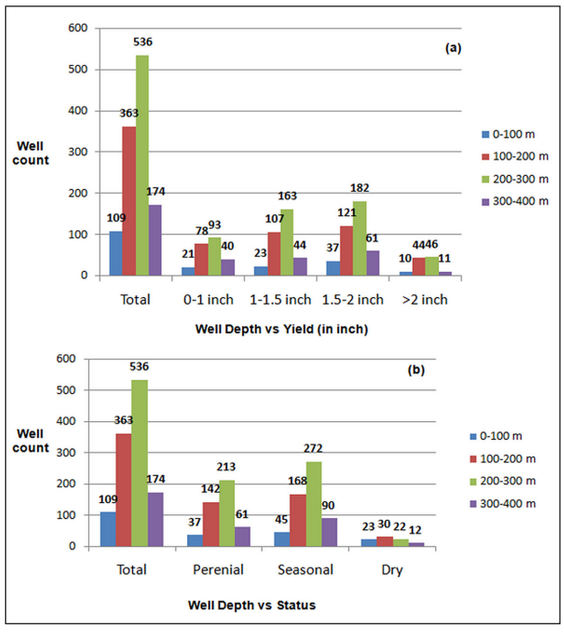


Figure17.3: Well Inventory analysis of JCPura, Karnataka (a) Well Depth vs Yield (in inch); (b) Well depth vs status

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NRSC Annual Training Calendar - 2023

2023	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T
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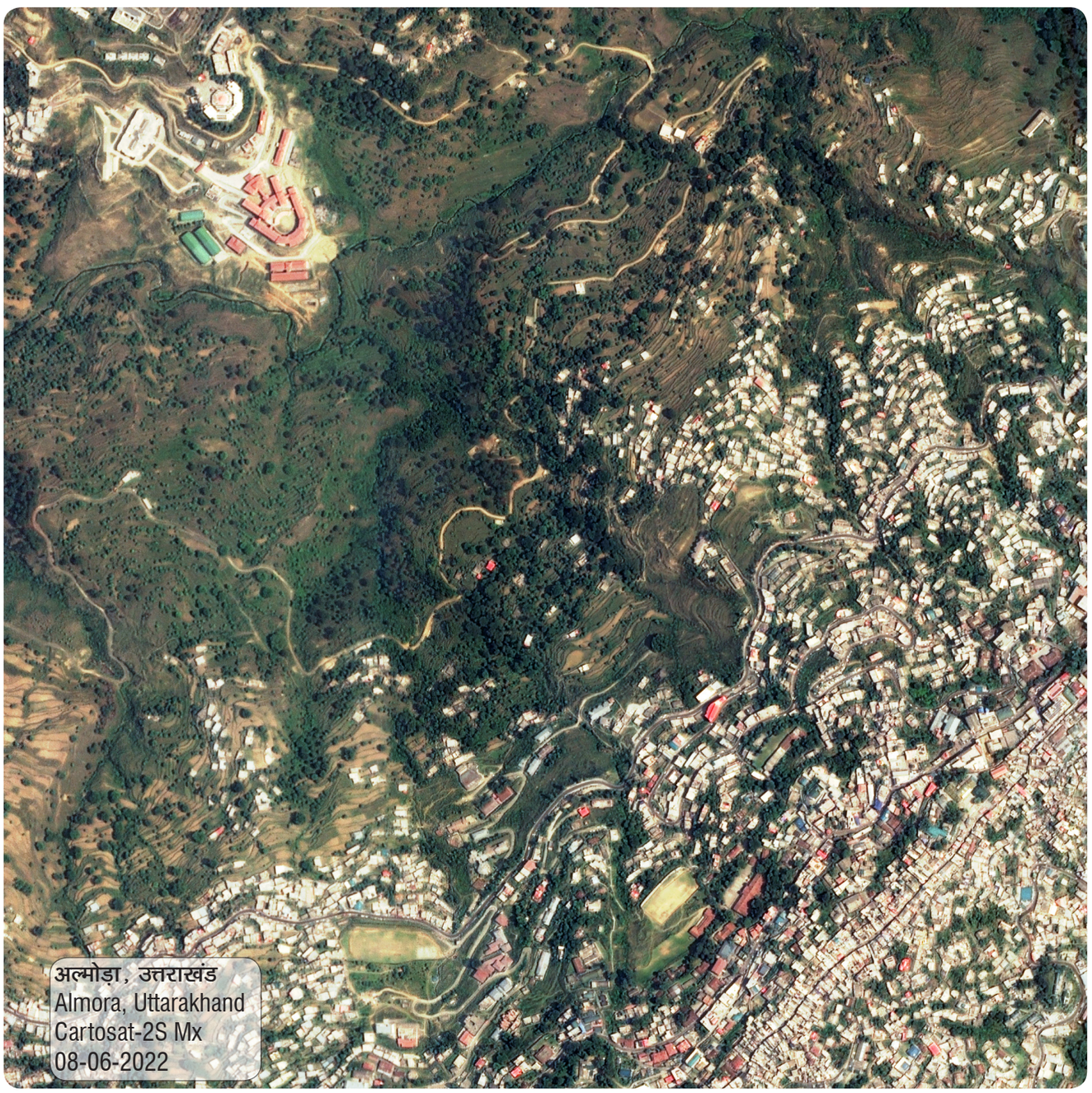
B-Bhuvan, NHP-National Hydrology project



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