

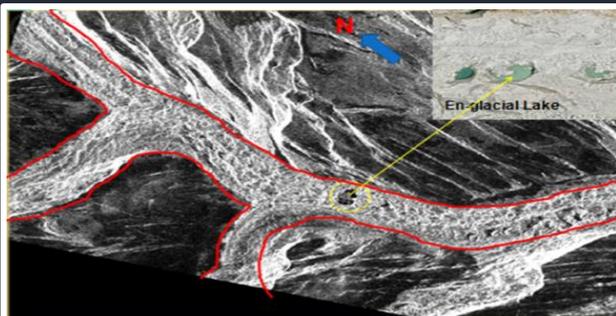


Potential Applications from NOVASAR-S



NOVASAR-S

The small Satellite approach to Synthetic Aperture Radar



NovaSAR-S Applications

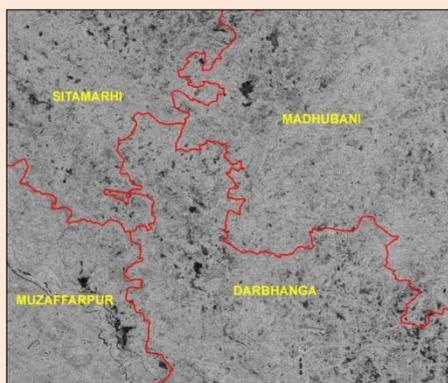
SAR imagery from NovaSAR-S has the potential to be used for a large and varied range of applications from environmental monitoring to more detailed assessment of specific target areas. As the only S-band (3.2 GHz; wavelength 9.4 cm) SAR in operation, it is a novel addition to the current suite of international civilian SAR satellites that operate in X-, C- or L-bands. Although wavelength is a key factor, the ability of NovaSAR-S to support specific applications is also dictated by other factors including resolution, coverage, imaging geometry, revisit time to an area of interest and the delay between image acquisition and information delivery to a user. It is a precursor to NISAR and helps to develop many models and algorithms for various themes. The instrument specification and mission characteristics of the NovaSAR-S satellite have been designed to provide benefit to a range of applications like forestry, disaster monitoring (particularly flooding) and agriculture, maritime surveillance (including ship and oil slick detection). Few varieties of potential applications that NovaSAR-S data can be used for are given below.

- **Disaster Monitoring:** Floods, Cyclones
- **Agriculture:** Crop area Mapping, Crop Growth Monitoring
- **Land Use and Land Cover:** Changes in Land Use
- **Geology:** Landslides, Glaciers
- **Forestry:** Forest Cover, Deforestation, above ground biomass estimation
- **Land Form:** Gullies and Ravines Mapping
- **Ocean:** Ocean Feature Mapping, Internal Waves Mapping, Oil Spill Monitoring, Ship and Wake Mapping

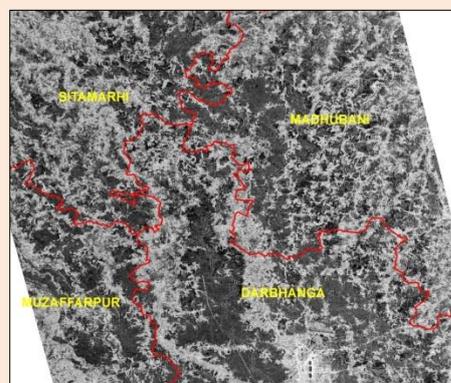
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Flood Monitoring

Synthetic Aperture Radar (SAR) sensors have emerged as one of the most desired mode of flood monitoring due to their all-weather imaging capabilities which becomes crucial during the monsoons. NovaSAR-S which operates in S-band occupies wavelength between L-band and C-band and is therefore of particular interest for flood mapping as it complements both the bands. The penetration capability of microwave SAR is a function of the wavelength and the S band wavelength of NovaSAR-S allows it to penetrate the vegetative cover and assess the floods that lie beneath the canopy.



Pre Flood (03 June 2021) Sentinel SAR Image over Bihar, India



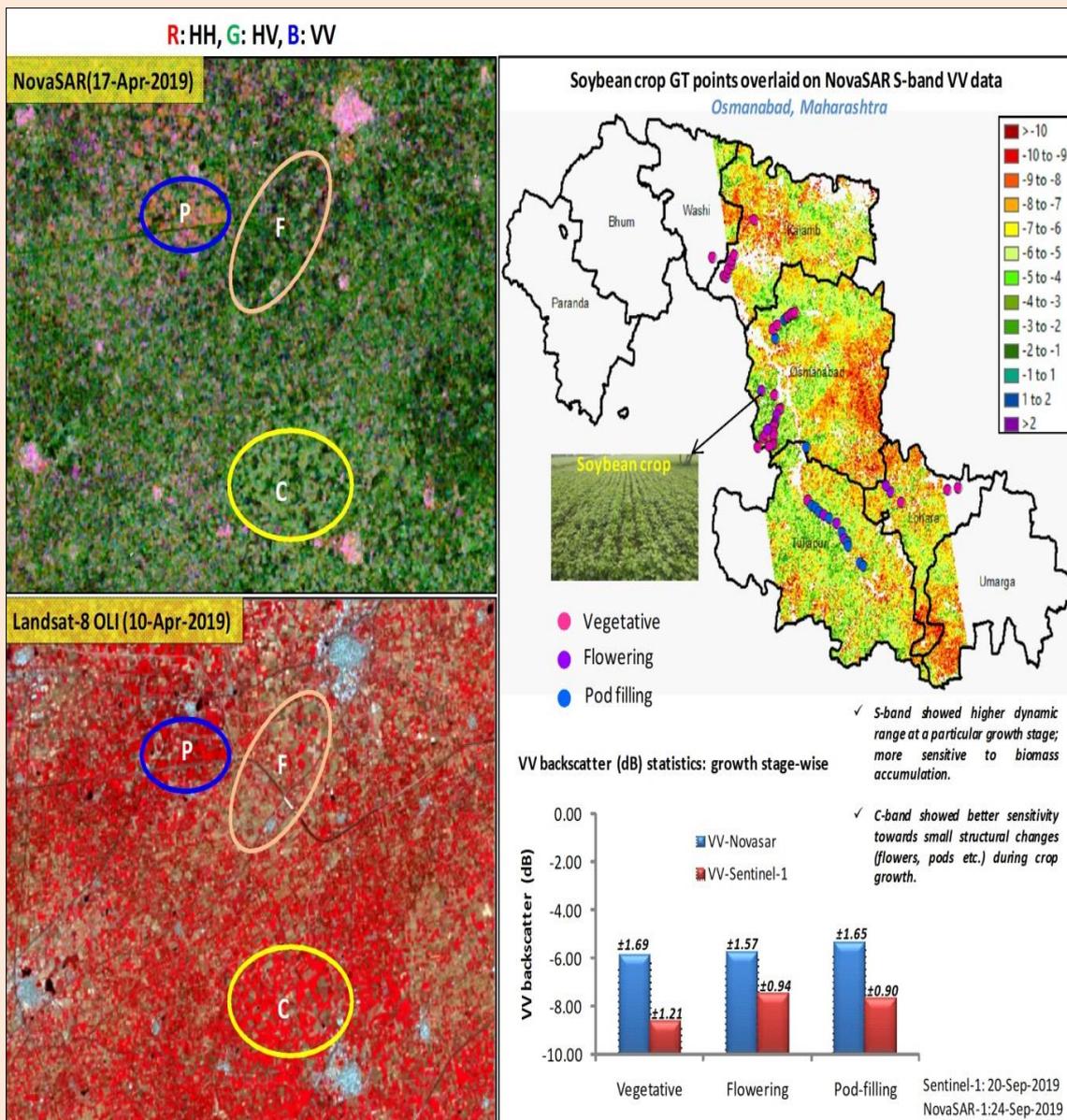
During Flood (10 July 2021) NOVASAR-S Image over Bihar, India

The pre vs during flood satellite imagery clearly indicate the floods in the area. The low backscatter due the flood waters help in identification of the flood pockets and prepare the flood maps.

Agriculture

Recent launch of NovaSAR-S data has unlocked the opportunities for the S-band data utilization for crop mapping and assessment. S-band being relatively longer wavelength than C-band is useful to analyze the medium biomass crops (viz., soybean, maize etc.). Single-date multi-polarized data can better discriminate different crops and other land cover classes such as crop, fallow (recent harvest/old fallow), plantations, etc.

Multi-temporal single/dual-polarized data are useful for crop phenology monitoring, biophysical parameter estimation, planted/sown area detection for early-season drought assessment. Further, S-band also has the potential to assess the soil moisture conditions owing to its relatively high penetrability into the soil surface.

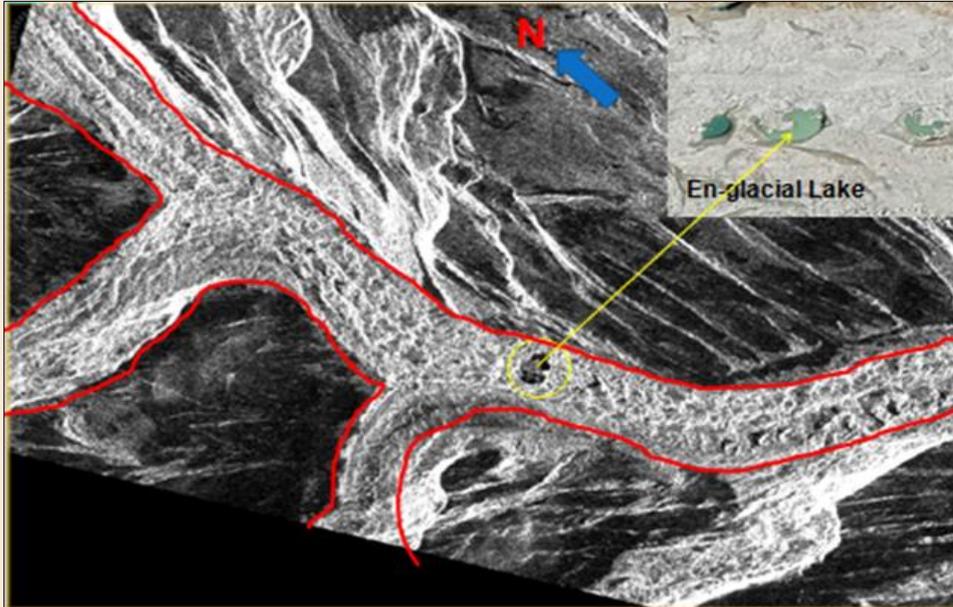


ScanSAR 30m tri-pol data over part of Surat, Gujarat, India discriminating broad land cover categories (P: Plantation, F: Fallow, C: Crop)

Colour coded VV-backscatter of NovaSAR S-band data (24 Sep, 2019) showing the spatial variability in Soybean crop lands

Glacier Studies

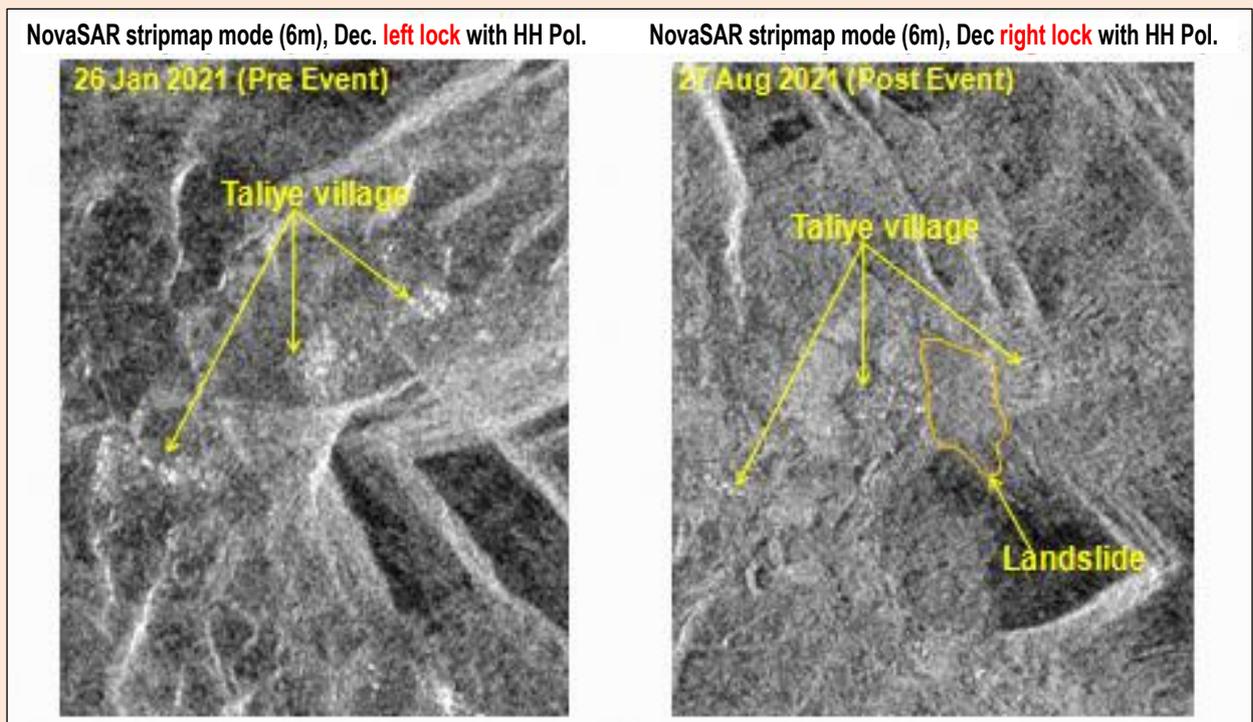
NovaSAR-S stripmap data can be useful to delineate glacier boundaries and various glacio-morphic features (glacier lake, moraine, accumulation and ablation zone etc) based on its terrain sensitivity and frequency (3.2 GHz) to distinguish between water/debris content in the glacier.



NovaSAR-S data showing various features of a glacier

Landslide Studies

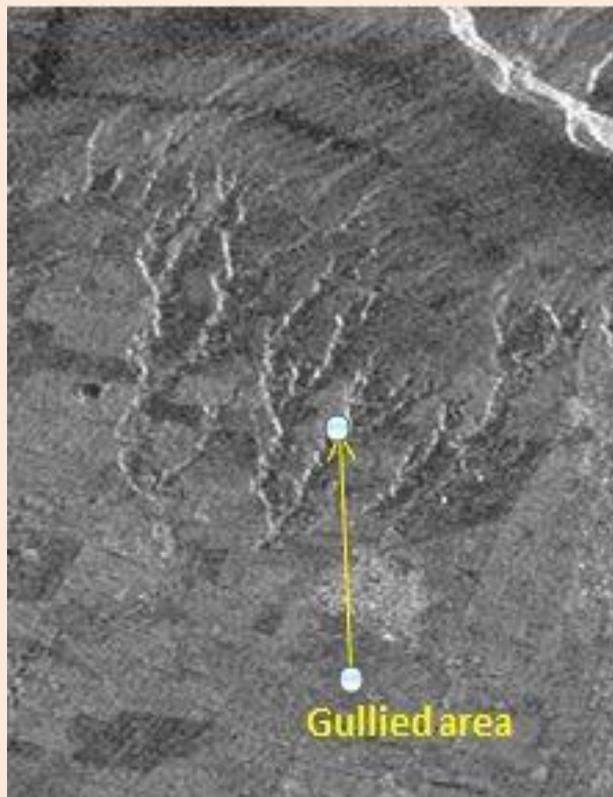
NovaSAR-S stripmap data can be useful for damage assessment due to landslide. The figure shows pre and post event (Taliya landslide, Maharashtra) NovaSAR-S images indicating damaged/debris covered houses exhibit low backscatter in the post event SAR data.



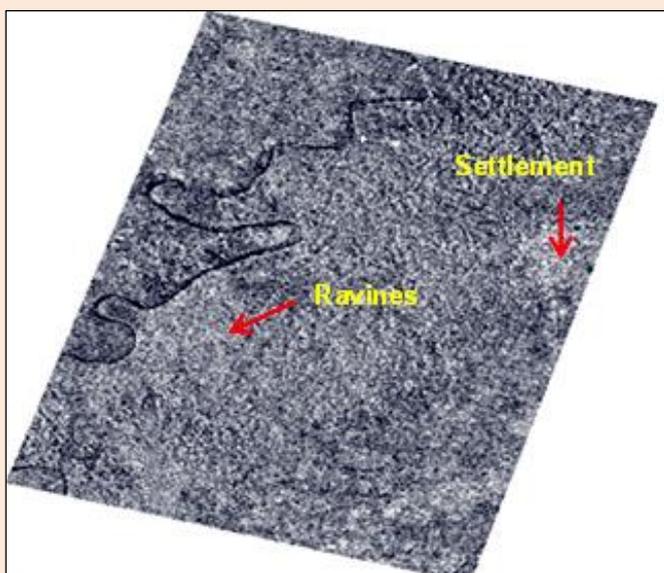
Gullied and Ravine Land Assessment

NovaSAR-S S band data is useful in assessing land cover/ecological monitoring. S-band has the capabilities to penetrate the canopy hence providing more structural information and better discrimination of land features. NovaSAR-S data can distinguish differences in surface roughness, moisture content and geometry of different land surfaces, making it ideal for identifying and delineating land degradation processes due to terrain deformation.

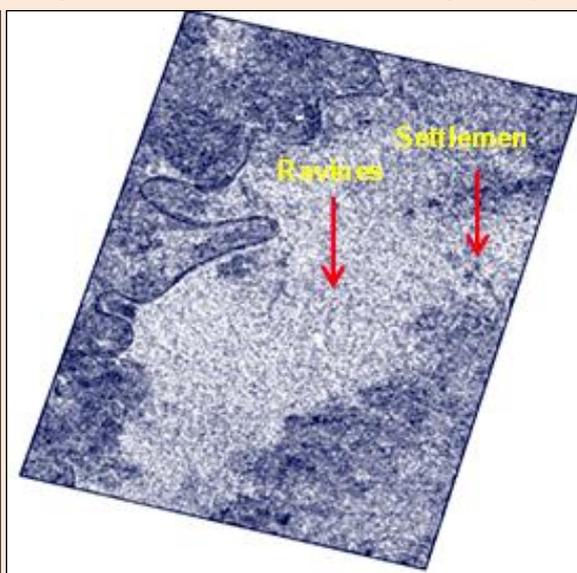
NovaSAR-S datasets covering parts of Aurangabad, Maharashtra and Jalun, Uttar Pradesh were used for identification and characterization of gullies and ravines. Discernibility of small gullied land is clearer in NovaSAR-S in the foot hill zones located in South of Aurangabad.



Gullies as viewed on NovaSAR-S band data in parts of Aurangabad, Maharashtra (NovaSAR S - Strip map of 6 m spatial Resolution HH data of 26-Apr-2019)



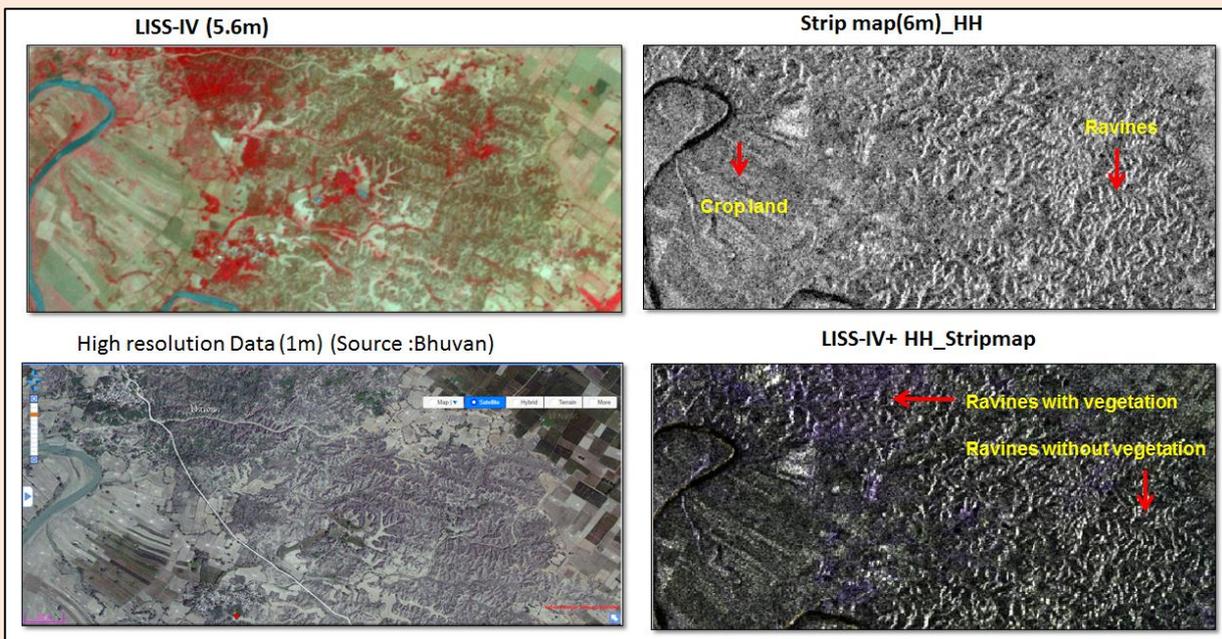
NovaSAR S - Strip map of 6 m spatial resolution (HH) data of 26-Apr-2019



Sentinel 1A-VV Interferometric wide 5*20m data of 28-Apr-2019

Ravines as viewed on NOVASAR-S & Sentinel-C band data in parts of Jalun, UP

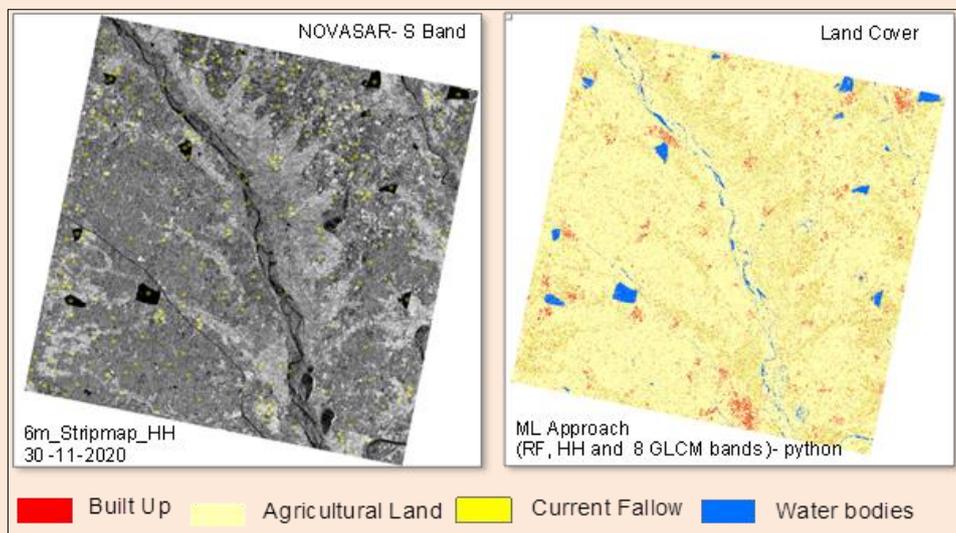
Similar observations were also recorded for areas with ravines in parts of Jalun district. There is a signature overlap between settlements and ravines in both 20m ScanSAR VV-S and sentinel VV-C band data. However, NovaSAR-S stripmap data with 6m spatial resolution can be potentially used for identification of ravines (below Figure). Besides, the fusion of S band stripmap data with high resolution optical LISS-IV allows to discriminate between ravines with / without vegetation cover.



Ravines as viewed on NovaSAR stripmap data, LISS-IV and High Resolution data in parts of Jalun, UP

Land Cover Mapping

NovaSAR-S data offers a great potential for monitoring land cover classes like Kharif Crop Areas, Extent of water in water bodies, Agricultural Plantation, Waterlogged areas particularly during cloudy period. Multi-polarized NovaSAR-S data can distinguish differences in surface roughness, moisture content and geometry of different land surfaces, thus enabling in identifying and primary level of land cover classes.



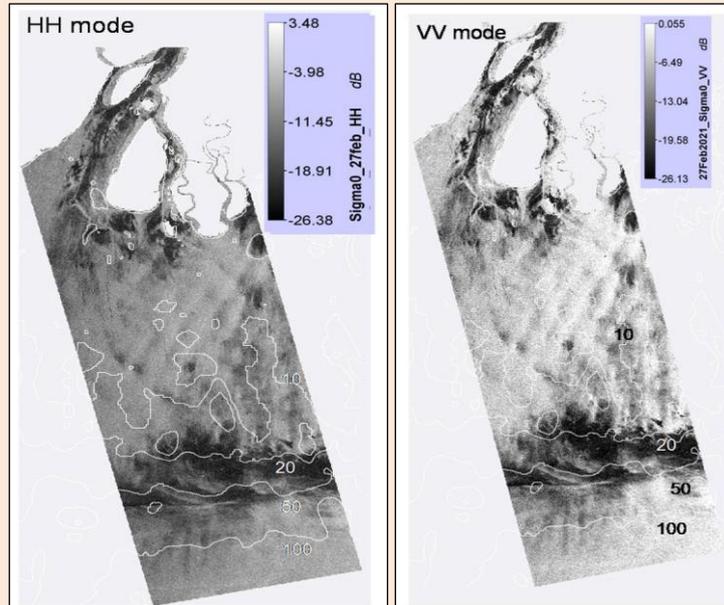
Land Cover classification for Gudur and Environs, Nellore District, Andhra Pradesh

Ocean Studies

NovaSAR-S can be used for a number of Ocean applications including ocean feature mapping, internal waves mapping, oil spill monitoring and ship and wake mapping.

Ocean Feature Mapping

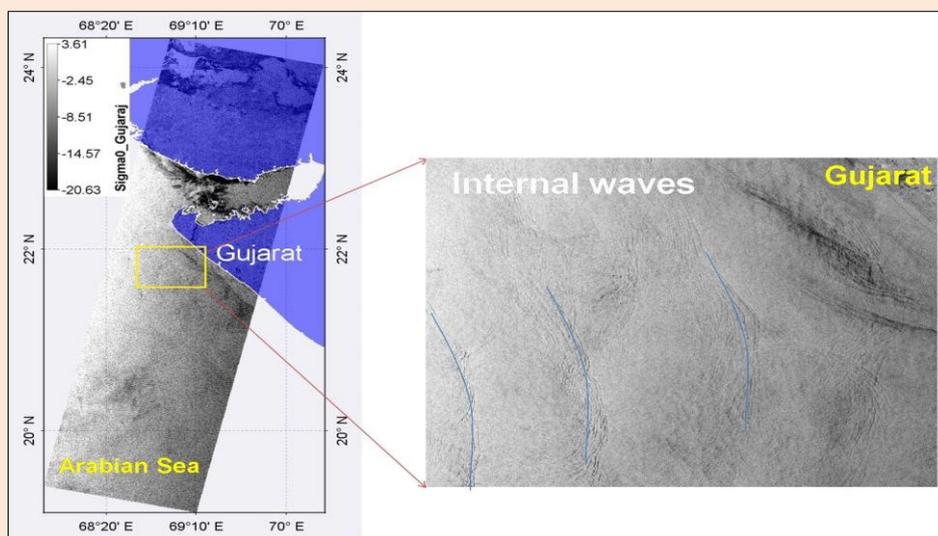
NovaSAR-S ScanSAR mode data of VV and HH polarization shows distinct coastal geometry of Hooghly estuary and tributaries over continental shelf region. Along-channel circulation patterns in the Hooghly, modulation of bathymetry in the shelf are visible in the images. Dark regions in the southern part, shows frontal regions with isobaths (parallel to the bathymetry) circulation. This is inferred from ancillary data analysis: thermal front density, residual circulation.



NovaSAR ScanSAR mode data of 27 Feb 2021 for Hooghly and northern BOB along with bathymetry Contours (white color lines in numbers)

Internal Waves Mapping

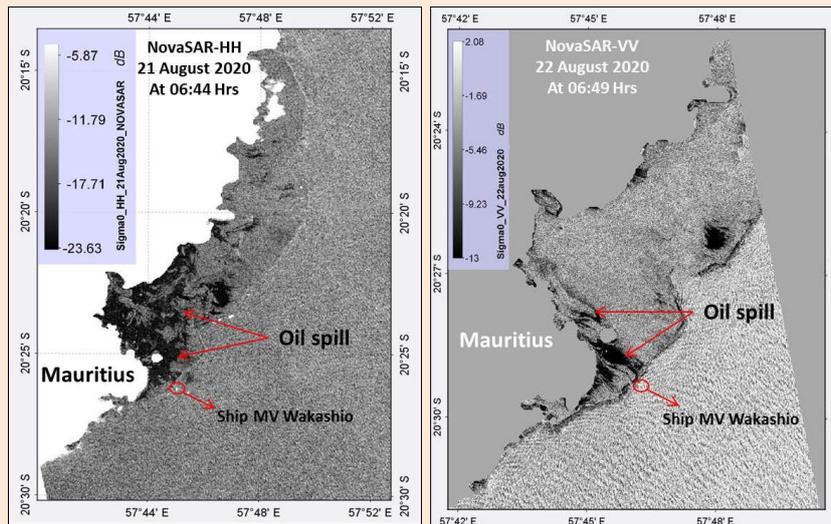
This image shows the NovaSAR-S S band data along the Gujarat coast on 4 Oct 2019, in VV Polarization at 30m resolution. Well distinct surface signatures of internal waves are observed of varied wave numbers (λ varies between few m to few Kms) along with well defined alongshore currents and frontal zone near the shore (dark region). Dark regions in the south and in the north inside the Gulf of Kutch represent the bathymetry channels and modulated along channel flow.



NovaSAR-S ScanSAR mode data of 04-Oct-2019 along the Gujarat coast

Oil Spill Monitoring

An oil spill occurred due to grounding of MV Wakashio heavy cargo ship on a coral reef near southeast of Mauritius coast on 06 August 2020. Analysis has been carried out with the NovaSAR-S SAR data available on 21 and 22 August 2020 for the Mauritius coast. Land masking, calibration, speckle filtering and geometric corrections are applied the NovaSAR-S data. Oil spills dampens the sea surface roughness and appears as dark patches in the SAR data. The dark signatures along the coast of Mauritius represent the oil spill signatures. The dark features are observed near the Coast of Pointe d'Esny and Vieux Grand Port



Land masked NovaSAR-S S band ScanSAR mode data for Mauritius oil spill on 21st and 22nd August 2020 shown in below figure (Left and right respectively). Dark patches in the images show the oil spill signatures. MV Wakashio heavy cargo ship is marked with red circle which appears as a bright object in comparison to the ocean background.

Ship and Wake Mapping

NovaSAR-S S band VV polarization ScanSAR mode data mapped the ship and wake near the Mumbai coast. Calibration, speckle filtering and geometric corrections are applied to the NovaSAR-S data. The Ships appears as a bright object against the background sea and wakes appears as dark tail behind the ships.

Ship and wake mapping for the Mumbai coast region with NovaSAR-S S band VV polarization ScanSAR data. The profile plots show the backscatter Sigma0 value across the ships, wake and background Sea.

