How the use of SAR data can contribute to the monitoring of illegal mining in the Amazon

Illegal mining over decades has constituted one of the most persistent and complex socio-environmental problems in the Brazilian Amazon. In recent years, with the increasingly intensive use of mechanized extraction, the associated environmental impacts—such as deforestation, intense soil disturbance, river siltation, and mercury contamination—have become broader, faster, and large-scale.

In addition, there are factors that hinder enforcement and ultimately favor the expansion of illegal mining, among them its predominant occurrence in remote regions of the Amazon and the limited atmospheric windows for monitoring by optical orbital satellites, which present lower cloud cover only between the months of June and September.

Given this scenario, the use of SAR imaging satellites combined with high-performance processing solutions, such as those available in ENVI SARscape, developed by NV5 and Sarmap and distributed by SulSoft, becomes essential to achieving effective monitoring of illegal mining in the Amazon.

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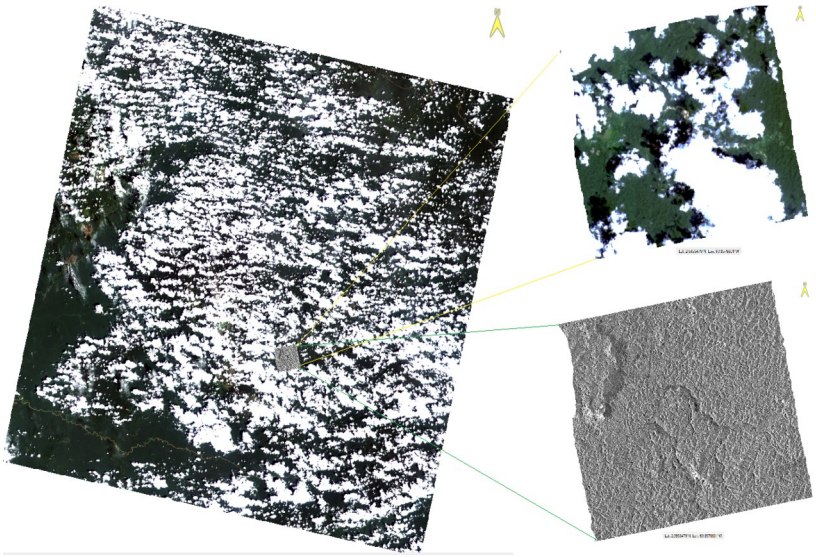
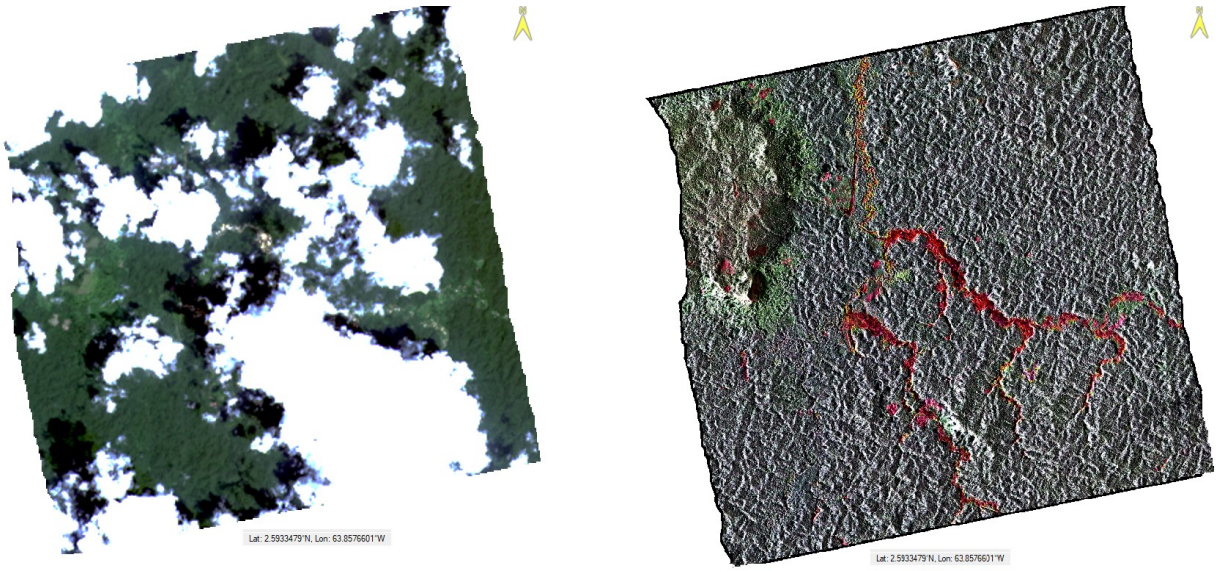


Multispectral image scene acquired by the Landsat 8 satellite in November 2025 over an Amazonian region along the Brazil–Venezuela border. In detail, a highlight of a high-resolution SAR image scene acquired by the StriX-3 satellite, courtesy of Synspective (Japan).

The SAR images acquired by the StriX constellation have specific characteristics (X-band, VV polarization, high spatial resolution, and high revisit frequency) that make them efficient for operations supporting the monitoring and enforcement of illegal activities and territorial security.

Below are some of the main applications of high-resolution SAR imagery in ENVI SARscape for monitoring illegal mining:

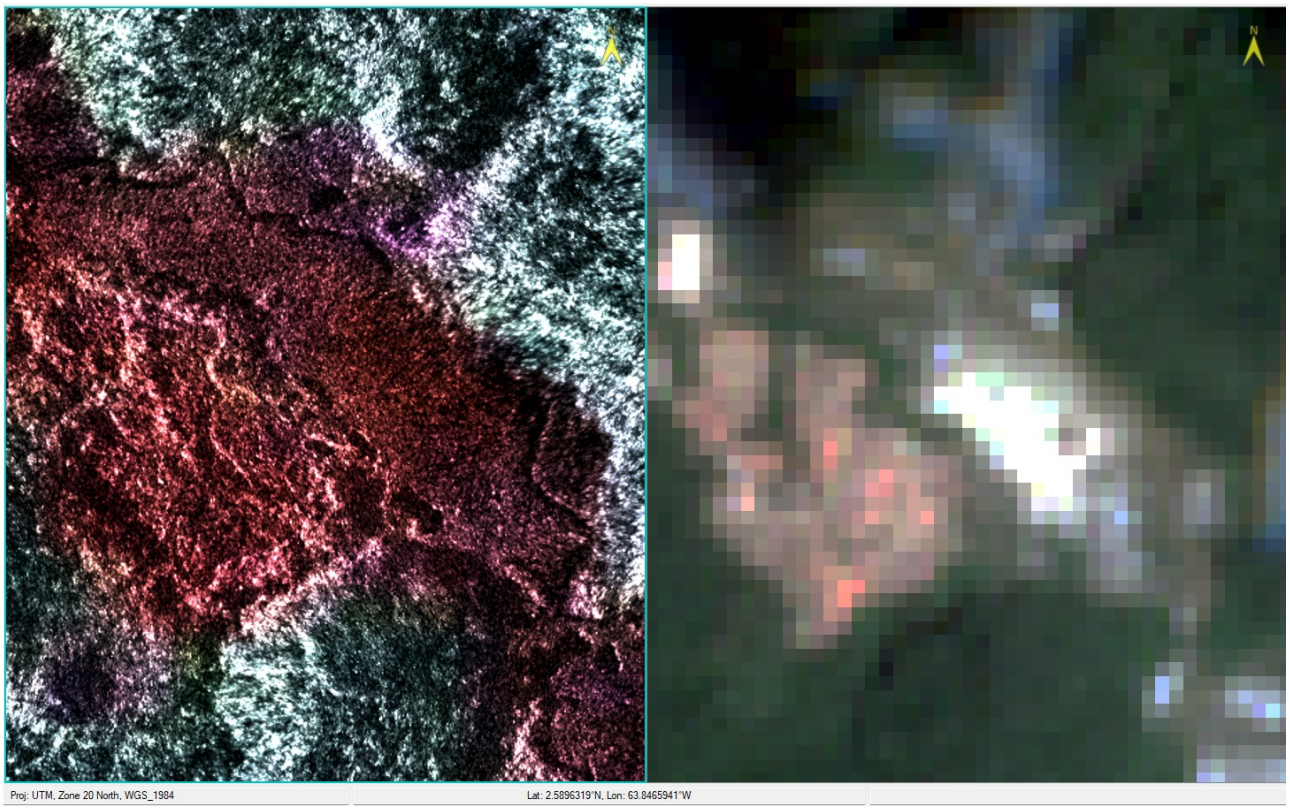
- Detection of river dredges and ships;
- Identification of clandestine airstrips;
- Mapping of recent clearings;
- Monitoring and detection of ground changes;
- Detection of reoccupation of areas after enforcement operations.



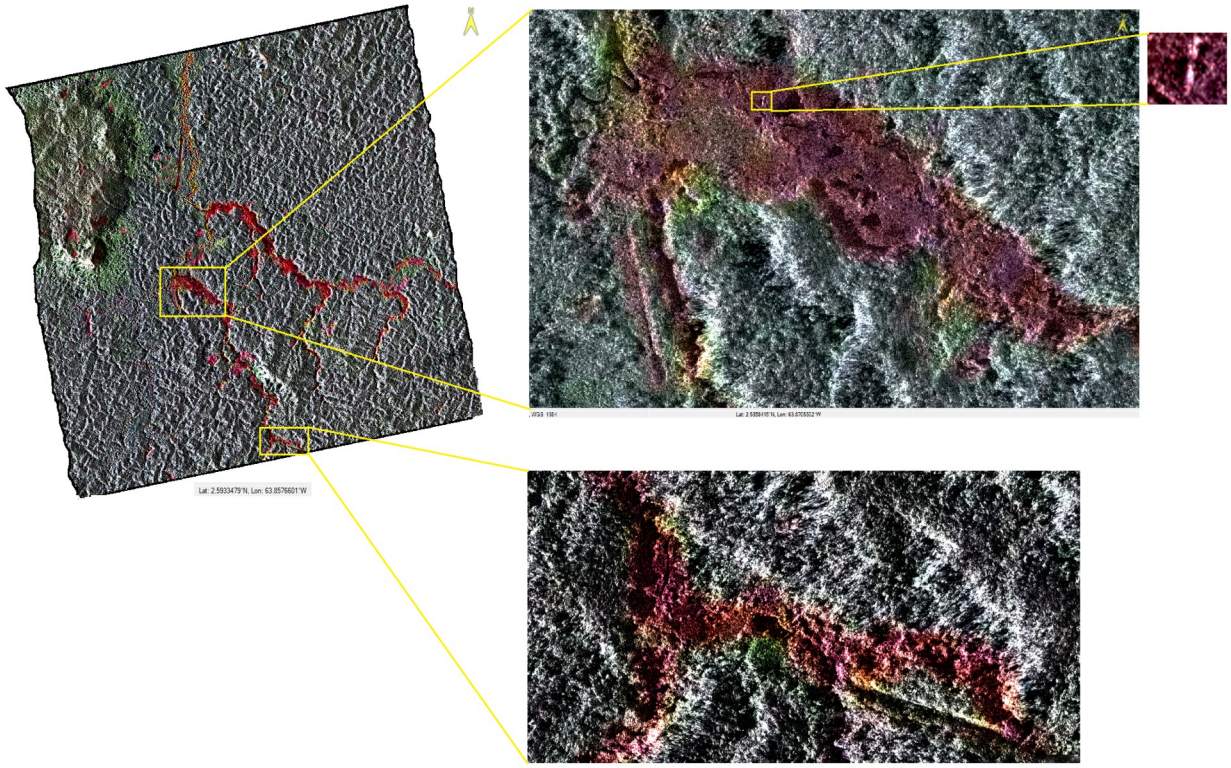
The illustration shows homologous Optical and SAR areas in November 2025; on the left, a true-color composite from the Landsat 8 satellite; on the right, the StriX SAR + Landsat 9 fusion processed in ENVI SARscape 6.2 software.

In the fusion result, alterations in the hydrological pattern, vegetation suppression, soil disturbance, and clearings typical of mining activity are easily perceptible.

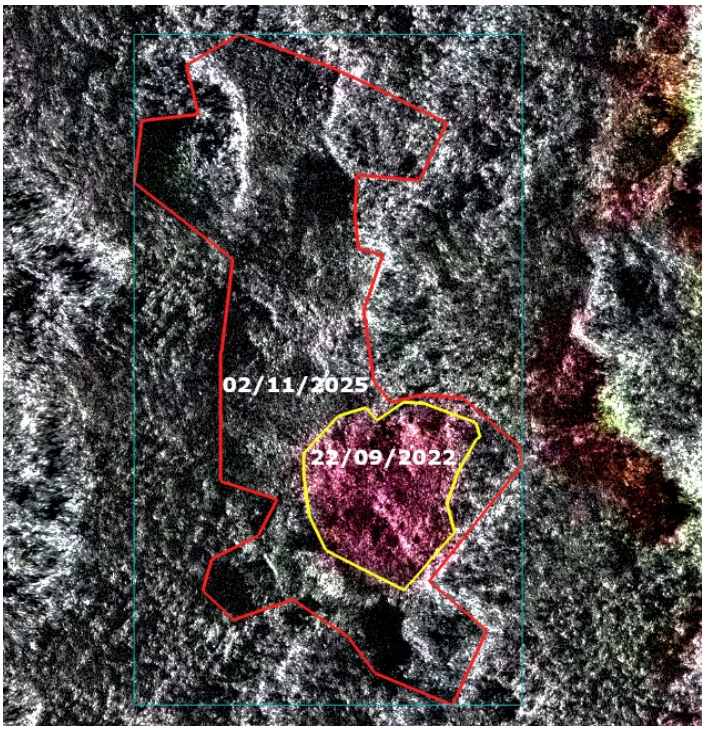
The Image Sharpening process is one of the most effective and robust techniques for detecting illegal mining areas in the Amazon, precisely because it combines temporal continuity (radar) with visual and semantic interpretation aspects (optical).



In the illustration, we can compare the result of the StriX SAR + Landsat 9 fusion at 1-meter spatial resolution with the 10-meter true-color composite from Sentinel-2.



In detail, near the illegal mining areas it is possible to observe the presence of clandestine airstrips for small aircraft landings, dredging pits, non-natural siltation along the margins of watercourses, and machinery and equipment (high-intensity point signals).



From the fused image, we can observe the expansion of deforested areas between the acquisition dates of the Landsat 9 scene (09/22/2022), delineated by the yellow polygon, and the acquisition date of the StriX-3 scene (11/02/2025), delineated by the red polygon.

The deforested area increased from 4.3 hectares in September 2022 to 25 hectares in November 2025.

Complementary analyses involving SAR time series, AI-assisted classification, ground movement analysis using the DinSAR technique, among others available in ENVI SARscape software, significantly expand the capacity for early detection of illegal mining activity.

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ENVI : Geoprocessing/GIS software with AI and automation capabilities for processing large volumes of data, developed by NV5 and distributed by SulSoft in Brazil:
https://www.sulsoft.com.br/produto.php?nome=ENVI

ENVI SARscape: ENVI software's specialized module dedicated to SAR data processing, developed by NV5 in partnership with SARMAP and distributed by SulSoft in Brazil:

https://www.envi.com.br/envi_modulo_sarscape.pdf

SAR **StriX** satellite constellation:

https://synspective.com/satellite/strix-constellation/