

Varve - Ground movement from satellite: worked example

Dalli-Rajhara iron-ore mines & Hitkassa tailings dam, India

Balod, Chhattisgarh | prepared 25 Oct 2026

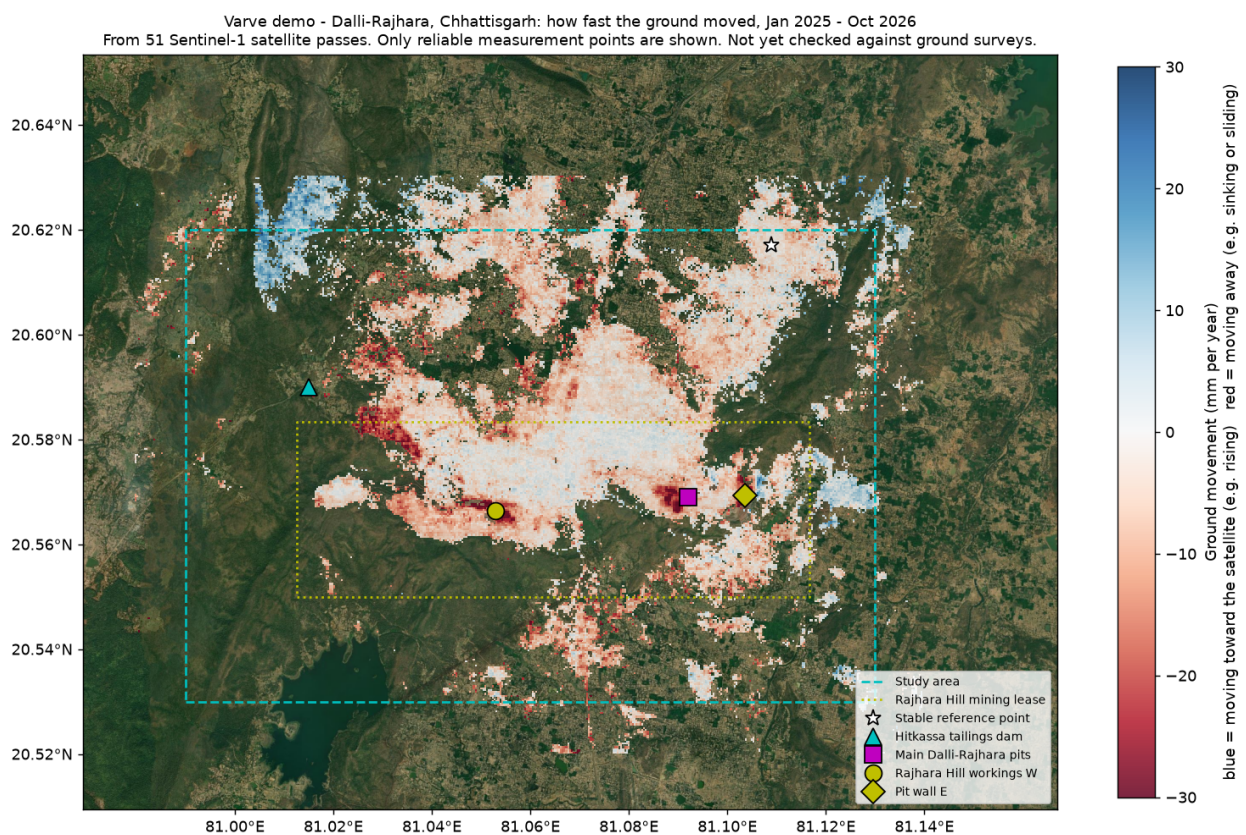
Status: a worked example built only from public satellite images, with no site visit and no operator data. Not yet checked on the ground, and not an engineering assessment. It says nothing about whether the site is safe.

In short

- Two small areas on the Rajhara Hill workings moved steadily away from the satellite, about **35-40 mm a year** (about 60 mm in 21 months). That usually means sinking or sliding. They are worth checking against the mine's survey data.
- The main pits moved too little to tell apart from background noise.
- The satellite got no reliable reading on the Hitkassa dam wall, so this run says nothing about the dam.

What we did

A radar satellite (Europe's Sentinel-1) passed over the site 51 times between 11 Jan 2025 and 16 Oct 2026. By comparing its images we measured how far the ground moved toward or away from the satellite at each 40 x 40 m square, relative to a stable point about 5-6 km from the mine. Only squares that gave a reliable reading are shown on the map.

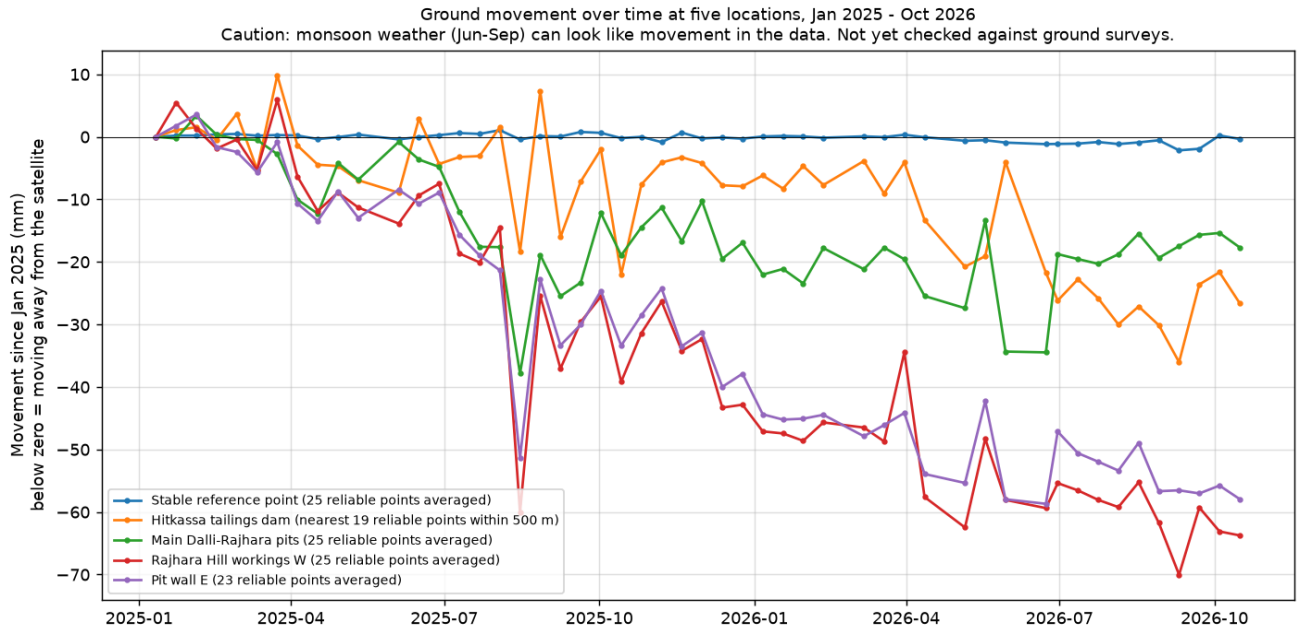


Basemap: Esri World Imagery. Contains modified Copernicus Sentinel data 2025-2026, processed by ASF HyP3.

How much each location moved (negative = moving away from the satellite)

Location	Rate (mm a year)	Total, 21 months (mm)	What it means
Rajhara Hill workings W (20.566N 81.053E)	-40	-64	Worth checking: clearly above noise, steady both years
Pit wall E (20.569N 81.104E)	-36	-58	Worth checking: clearly above noise
Main Dalli-Rajhara pits (20.569N 81.092E)	-11	-18	Too small to tell from noise
Hitkassa tailings dam area*	-16	-27	Too small; no reading on the dam wall itself
Stable reference point (20.617N 81.109E)	-0.8	-0.3	Zero by definition

Background noise: on ground far from the mine that should be still, readings scatter by about +/-8 mm a year (most between -16 and +11). So only movement faster than about 16-20 mm a year clearly stands out. *No reliable reading on the Hitkassa dam wall itself; the value is the average of 19 reliable points within 500 m, so it does not describe the dam crest. 34% of the study area and 49% of the mining lease gave reliable readings.



What this study cannot tell you

1) **Not checked on the ground.** No survey prisms, piezometers, GPS or slope-radar data were available. 2) **One viewing angle only.** The satellite sees this site from one direction, so up-down and sideways movement can't be separated. Pit walls often move mostly sideways. 3) **Mining can look like movement.** Digging, dumping and haul-road work change the surface, so a "moving" area may be moved material, not unstable ground. 4) **Weather noise.** Monsoon moisture in the air still affects some readings; the sharp drop in Jul-Aug 2025 at all mine points is most likely weather, not real movement. A full project would add weather corrections. 5) **Second satellite inconclusive.** Early, provisional data from NASA and ISRO's NISAR satellite (Jun-Oct 2026) did not agree with Sentinel-1 and was not used. 6) **Not real-time.** One reading per satellite pass (every 6-12 days): good for trends, not for warning of a collapse in progress.

What a full project would add

Sharper maps (20 m) and point-by-point readings on the dam crest; weather corrections and extra quality checks; a second viewing direction to split movement into up-down and east-west; low-cost metal reflectors on the Hitkassa embankment where the satellite gets no reading; checks against the operator's survey, prism or GPS data; movement history back to 2016; and an automatic alert after each satellite pass, with limits agreed with the geotechnical team.

Get a free movement history of your site: vyom@mitchi.xyz | <https://varve.mitchi.xyz>

Technical details, for remote-sensing specialists: Sentinel-1 C-band, relative orbit 92 descending, bursts 092_196415_IW2 + 092_196416_IW2; 147 interferograms (each date with the next 3), ASF HyP3 ISCE2 multi-burst, 40 m; MintPy 1.6.4 SBAS inversion, phase-elevation troposphere and DEM-error correction, temporal coherence ≥ 0.7 mask; reference 20.617N 81.109E; formal velocity sigma ~ 1.5 mm/yr, empirical 1-sigma 7.9 mm/yr; no ERA5/GACOS or unwrapping-error correction; NISAR L-band GUNW (provisional) cross-check showed 20-50 mm ionospheric ramps. Contains modified Copernicus Sentinel data 2025-2026 processed by ASF HyP3 (NASA); NISAR data courtesy NASA/ISRO via ASF DAAC (provisional). Basemap: Esri World Imagery. Software: ISCE2 (via HyP3), MintPy (Yunjun et al., 2019).