

Tailings dam collapse at Feijão iron mine in Brazil

Sentinel-1 CSAR IW acquired on 04 November 2015 at 08:21:34 UTC

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Sentinel-2 MSI acquired on 22 January 2019 at 13:12:41 UTC

Sentinel-2 MSI acquired on 27 January 2019 at 13:12:49 UTC

Sentinel-1 CSAR IW acquired on 29 January 2019 at 08:21:09 UTC

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Keyword(s): Geohazard, landslide, emergency, anthropic disaster, natural resources, geology, mountains, river pollution, toxic



[2D Layerstack](#)

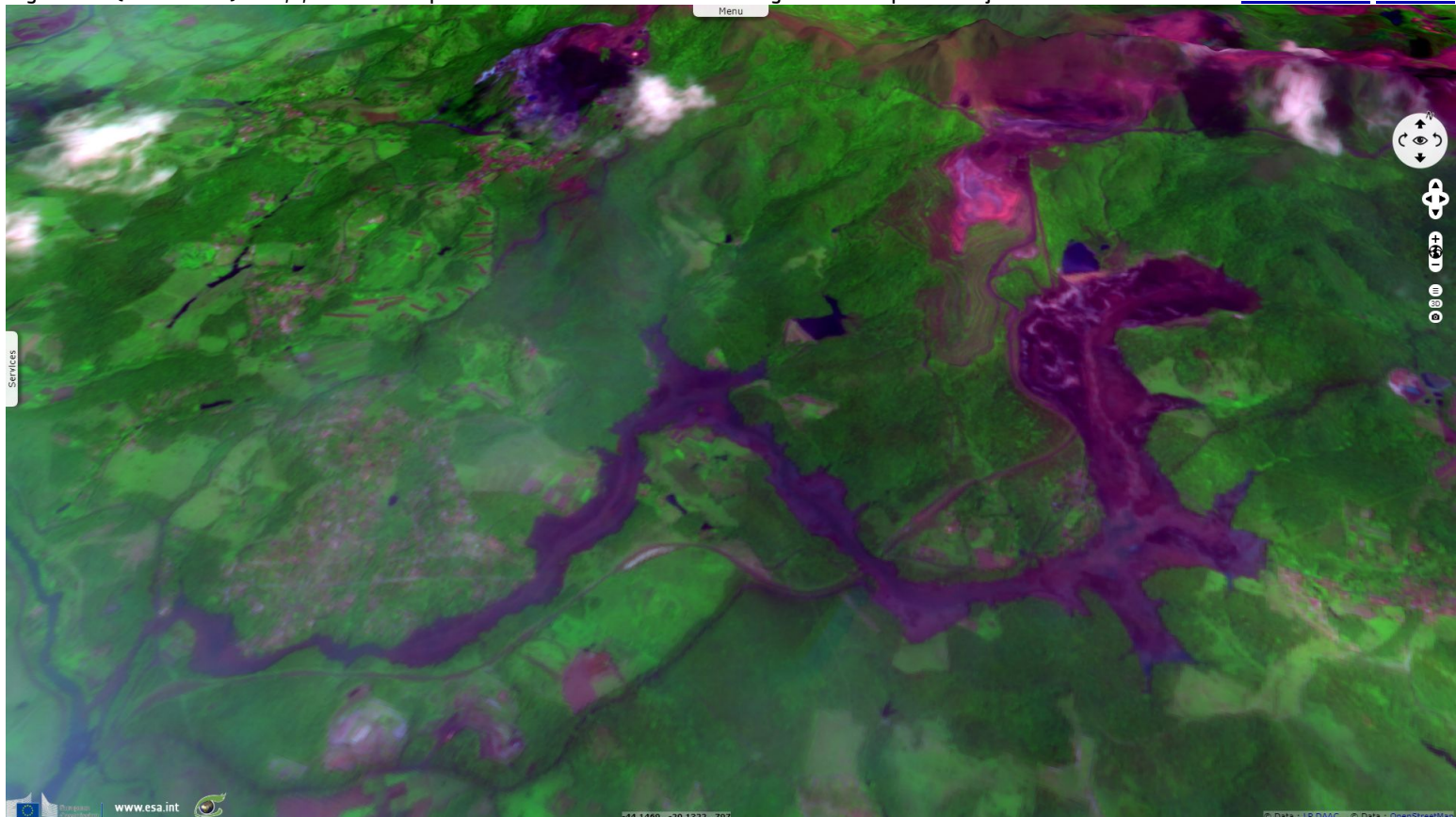
Fig. 1 - S2 (22.01.2019) - 12,8,4 colour composite - Brumadinho (Minas Gerais state, Brazil) before the disaster.

[3D view](#)



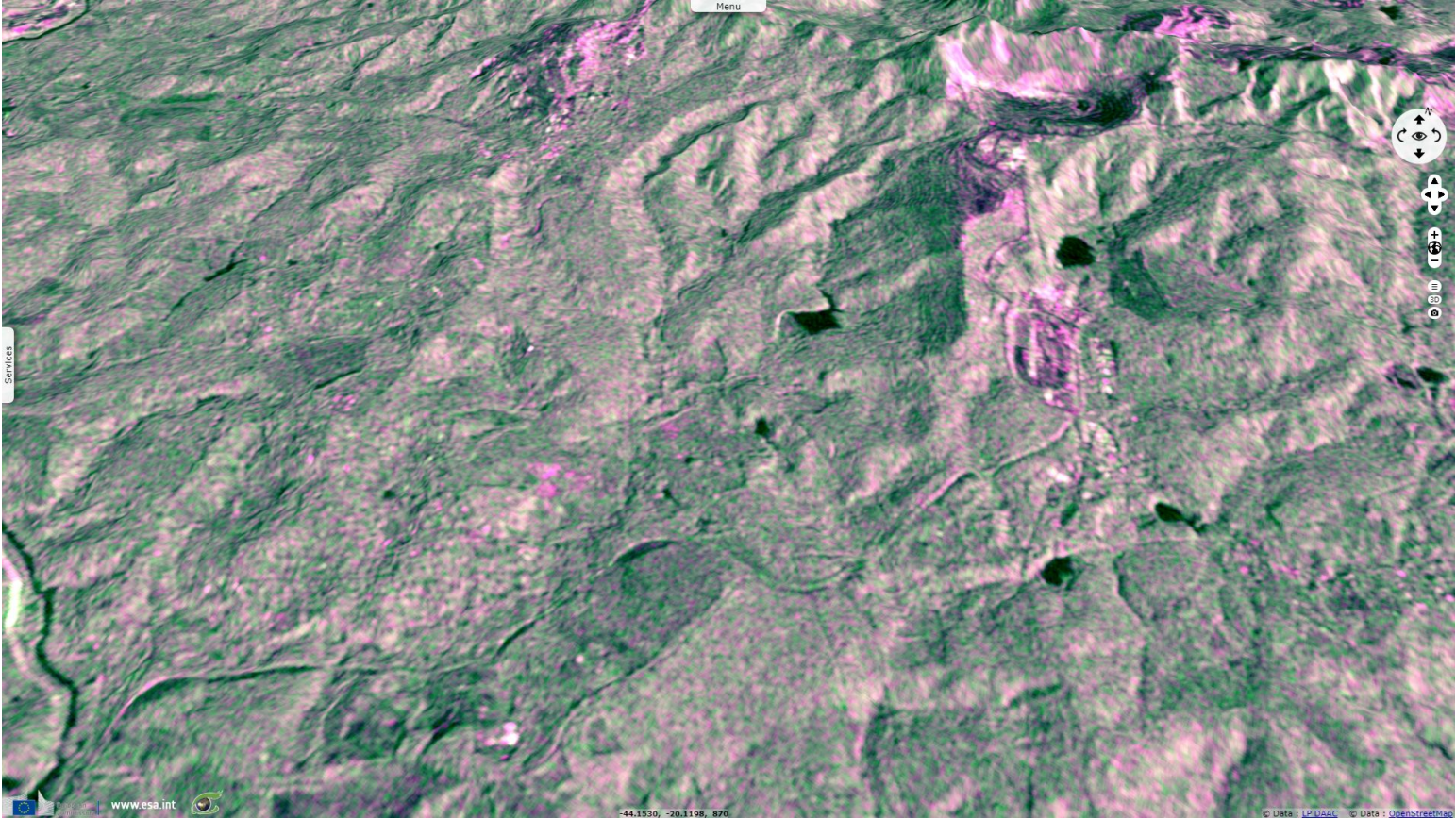
Fig. 2 - S2 (27.01.2019) - 12,8,4 colour composite - Brumadinho after the tailings dam collapse at Feijão mine.

[3D animation](#) [3D view](#)



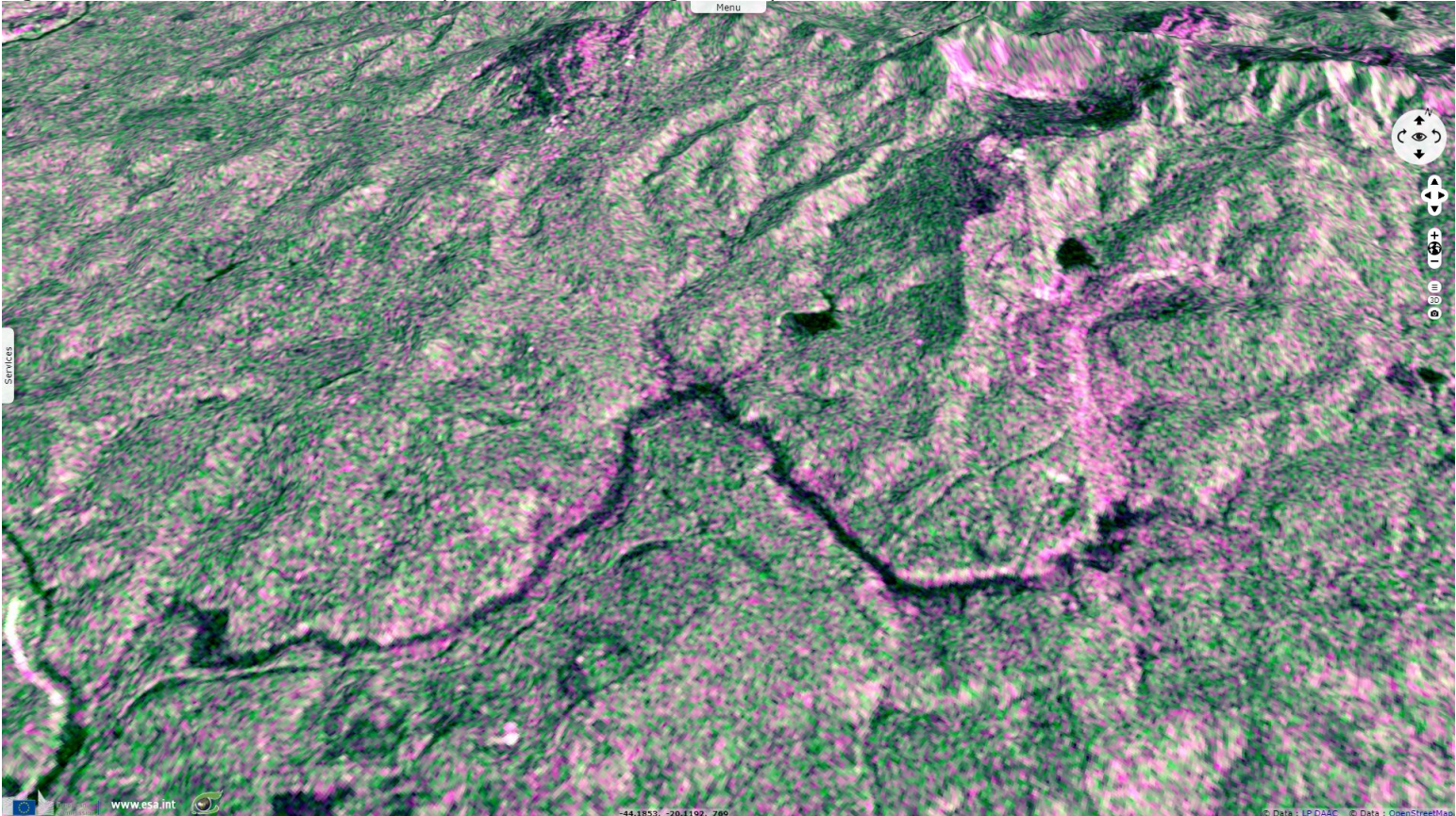
Another tailings dam collapsed in the mineral-rich state of Minas Gerais, Brazil. Feijão iron mine "*is the main economic activity in Brumadinho and now the cause of this unprecedented tragedy that will mark generations to come. The Paraopeba river that cuts through the town has been tinted by iron ore residue and now smells of dead fish.*", BBC [reported](#). According to the Brazilian news network [Globo](#), 121 people have died, 226 are still missing. And "*since the 26th January, there are no survivors found.*" Their [videos](#) of the disaster show the magnitude of the event.

Fig. 3 - S1 (12.12.2018, 24.12.2018, 05.01.2019 & 17.01.2019) - vv(mean before),vh(mean before),vv(mean before) colour composite. [3D view](#)



The 87-m high tailings dam had been built in 1976, it could hold 12.7 millions cubic meters according to its owner, Vale, the first mining company in Brazil. Among all its dams, Vale had [assessed](#) the risk of failure of this tailings dam in the lowest category.

Fig. 4 - S1 (29.01.2019) - vv,vh,vv colour composite - First descending radar acquisition after the disaster. [3D animation](#) [3D view](#)



The Brazilian Report [informed](#) that: "*In response to the mounting pressure, Vale has announced it will decommission all of its tailings dams which use the same structure as those in Brumadinho and Mariana, highlighted by experts as being a potential cause for the two catastrophic failures over the past three years. The dam in Brumadinho was raised using what is called an "upstream" design, where embankments, made from tailings, are piled on top of one another, creating a staircase effect and moving the dam upstream. This particular format is regarded as being the least safe and most cost-effective method of raising dams.*"

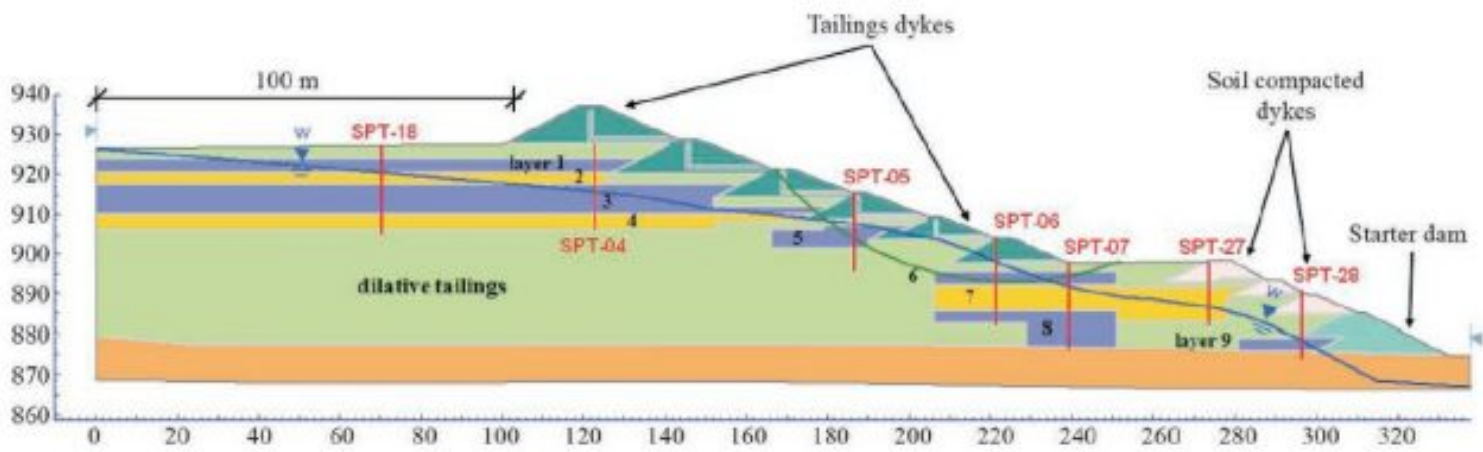
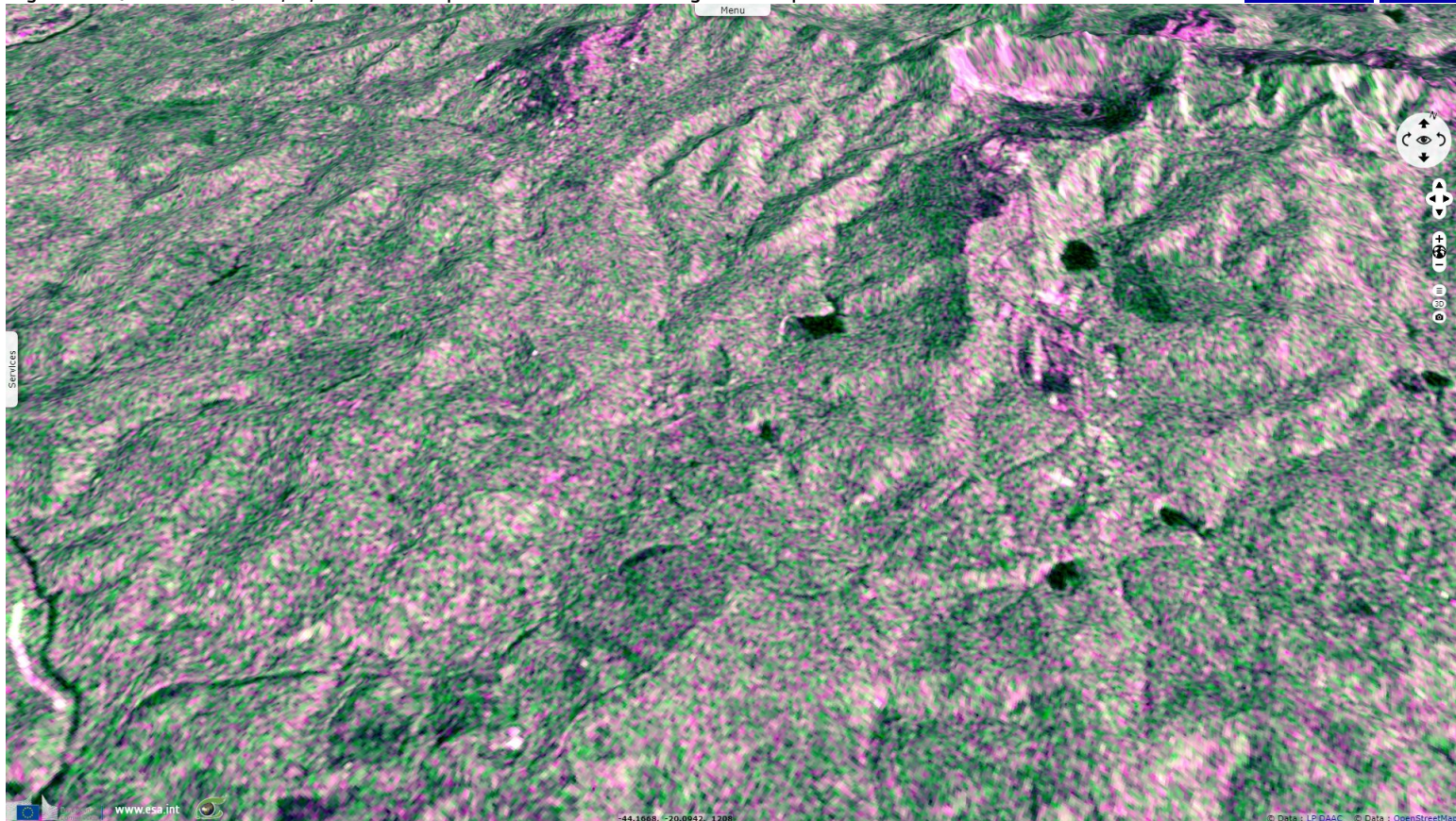


Figure 9 - CF - RS subdivided in nine layers susceptible to liquefaction (SPT analysis).

Indicative cross section of the tailings dam that collapsed to generate the Brumadinho disaster - Source: [Pirete and Gomes \(2013\)](#).

Fig. 5 - S1 (17.01.2019) - vv,vh,vv colour composite - Latest descending radar acquisition before the failure.

[3D animation](#) [3D view](#)



The image above highlights the difference between a single acquisition and the mean of several images acquired with the same viewing geometry. The latter processing is computed on the fly. By reducing the speckle, finer details are revealed and photo interpretation is made easier.

The Brazilian Report further [explains](#) "Vale administers a further ten upstream dams, all of which are situated in Minas Gerais, and are currently inactive (no further tailings are being deposited there). At the same time as the company has pledged to get rid of its own upstream dams, Minas Gerais courts have ordered that no licenses can be granted or renewed for such structures in the state."

"Vale takes the tailings drained from its dams to manufacture a product called Brazilian Blend Fines (BRBF), a mixture of different types of iron ores which has quickly become one of the company's most important products. Even before the Brumadinho disaster, BRBF was set to be Vale's highest volume product in 2019. The sale of BRBF is now particularly attractive, due to the high price of iron ore around the world. While it may appear to be a sacrificial measure in response to the dozens of lives lost in Brumadinho, Vale's decision to decommission these upstream mines may actually be quite profitable."

Fig. 6 - vv(mean before),vv(after),vv(mean before) colour composite - Multidate VV polarisation composite.

[3D view](#)

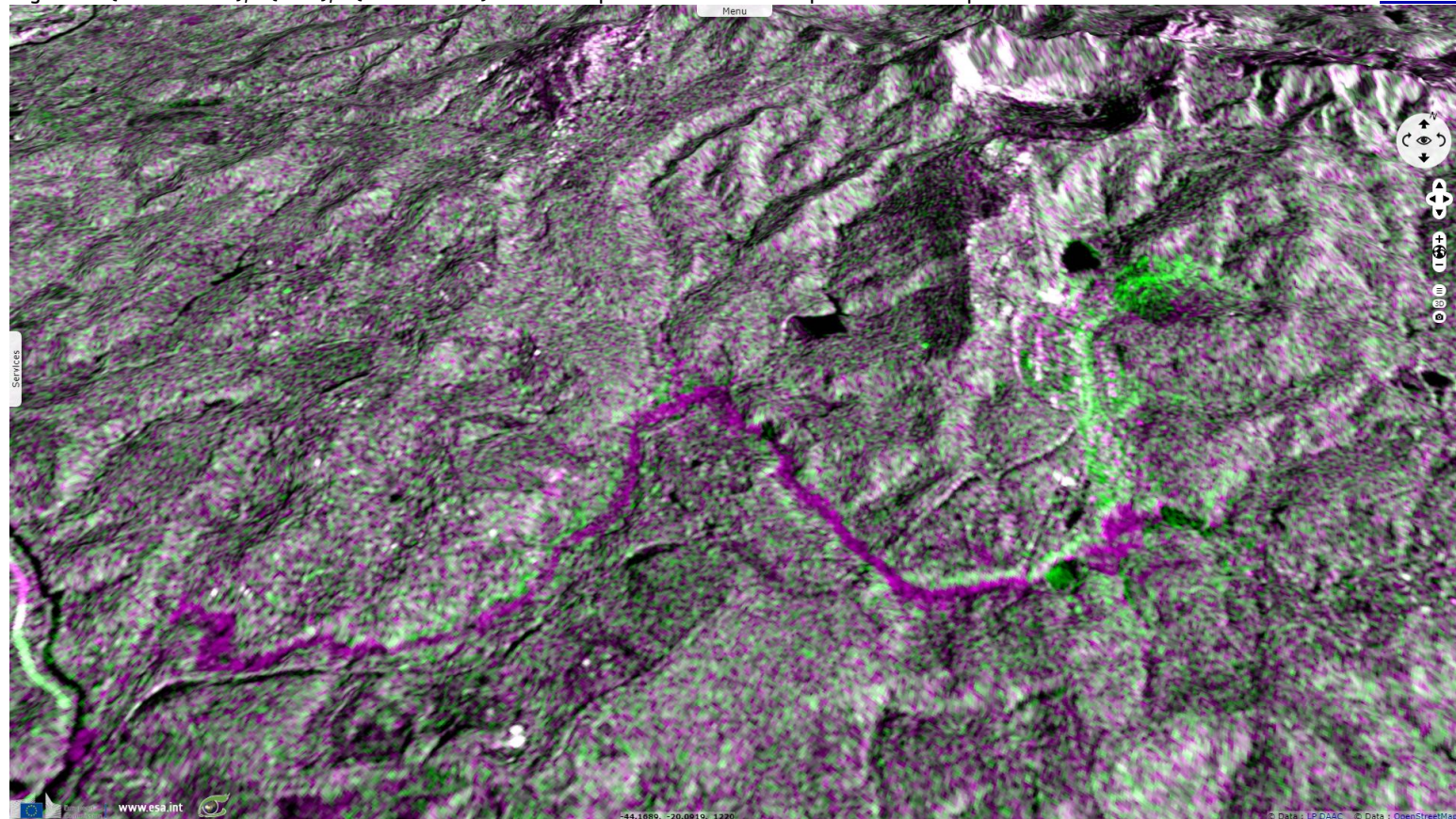
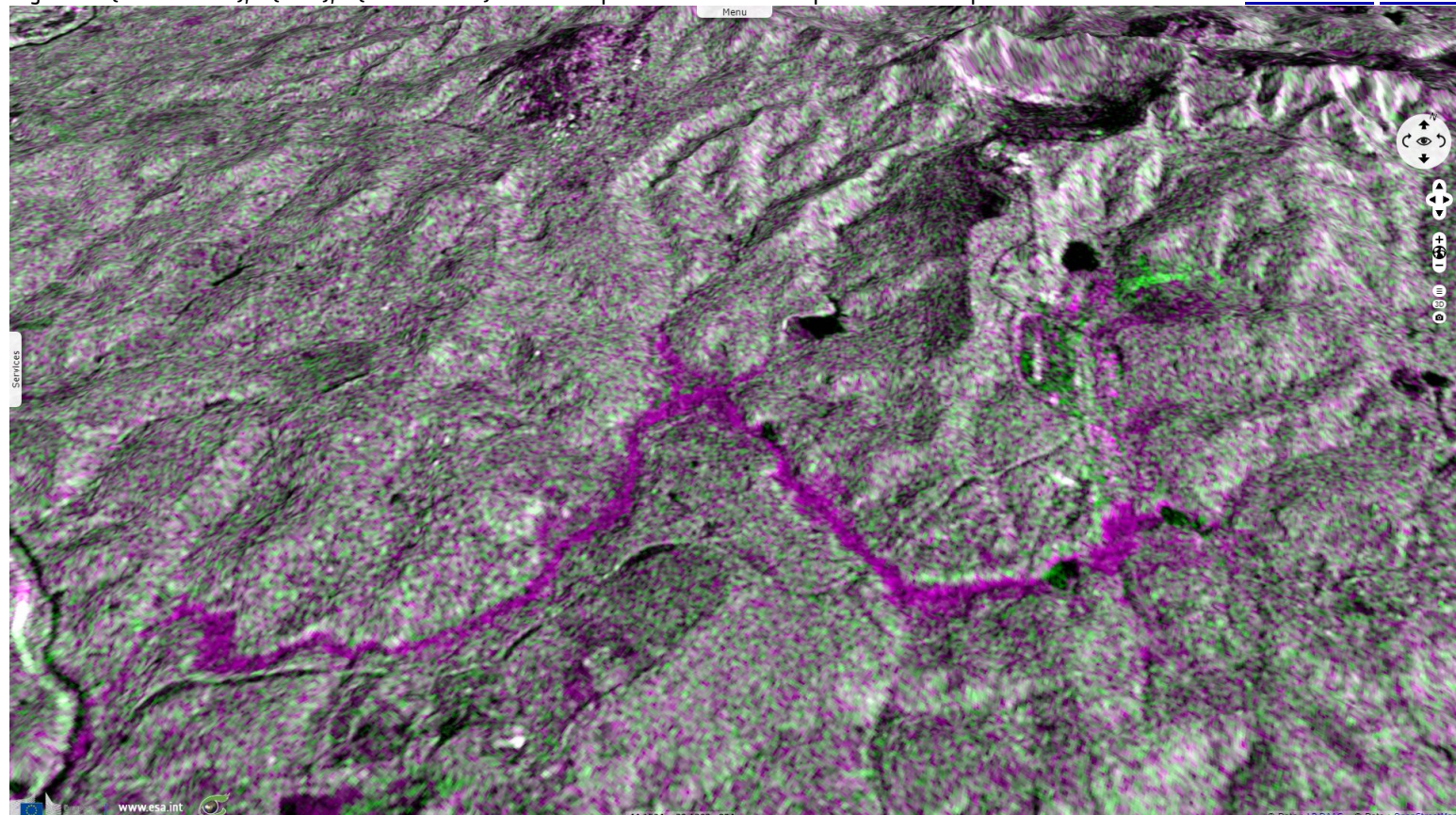


Fig.6 and Fig.7 show the mean of the latest four Sentinel-1 ascending images acquired before the disaster in the blue and red channel. The green channel shows the first post-disaster Sentinel-1 ascending acquisition. Greyish tones indicate little change before and after while saturated green or magenta colours show important change in the land backscattering. The impact of the mud flood is well visible: the reservoir emptied, buildings and bare soil were covered, some forested areas were destroyed, the river network was swollen by the volume of mud and its banks were flooded as well.

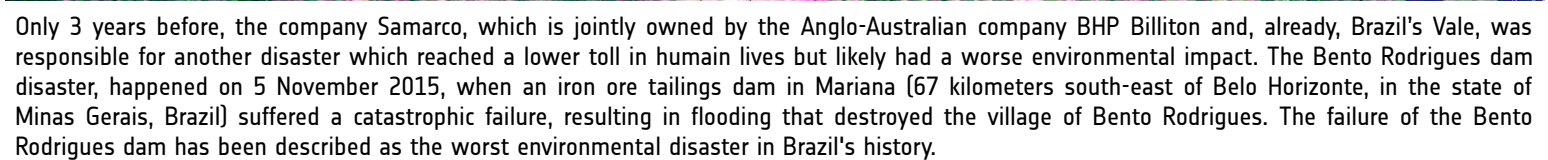
The Brazilian Report [concludes](#) : "Much of the outrage surrounding the Brumadinho catastrophe concerns the fact that the collapsed tailings dam had all of its environmental permits and licenses up to date at the time of the incident. The fact that these safety concerns were "unnoticed," casts a shadow over the inspection process of this and the rest of Brazil's dams. In truth, big Brazilian mining companies have been given an easy ride by environmental regulators, with Vale even receiving some slack from state legislators just days after the collapse in Mariana, in 2015."

Fig. 7 - vh(mean before),vh(after),vh(mean before) colour composite - Multidate VH polarisation composite.

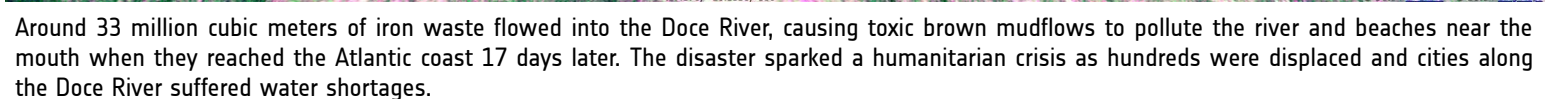
[3D animation](#) [3D view](#)



3D view



3D animation 3D view



A United Nations report [counts](#) "Nineteen people were killed", "the tailing slurry traveled 620 km downriver, eventually reaching the Atlantic Ocean", "entire fish populations – at least 11 tons – were killed immediately when the slurry buried them or clogged their gills" and "the force of the mudflow destroyed 1 469 hectares of riparian forest". The mudflow "contained high levels of toxic heavy metals and other toxic chemicals" such as

This figure shows an aerial photograph of a forested area, likely a reserve or park, with a yellow boundary line. A red circle highlights a specific location within the forest. An inset map in the bottom right corner shows the location of the study area within the state of São Paulo, Brazil, with coordinates -40.5132, -19.4549, 0. The inset map also shows the state capital, São Paulo, and the state border with Paraná. The main image includes a 'Menu' button in the top right corner and a 'Santos' label in the bottom left corner.

VtWeb

3D view

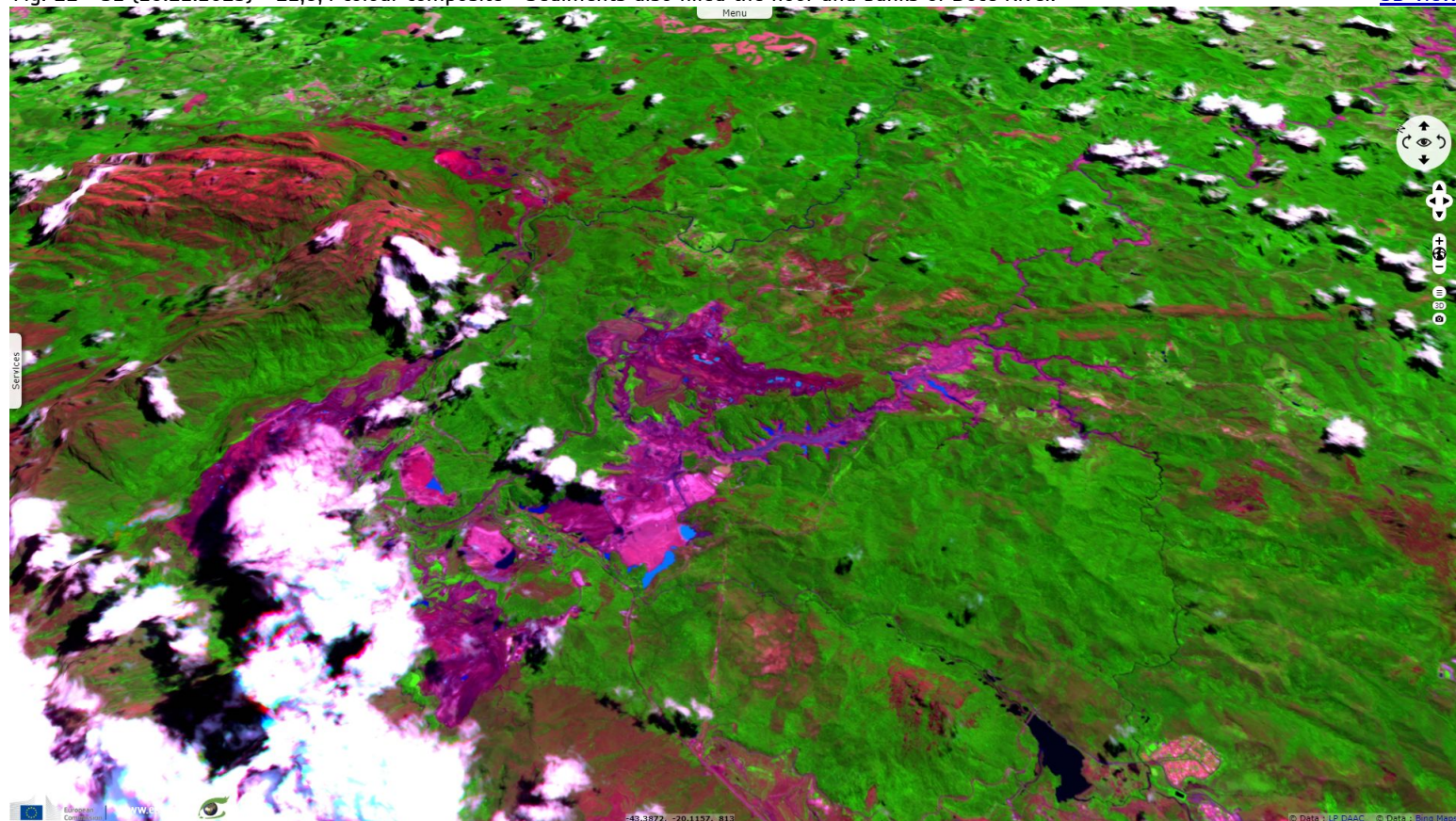


The Guardian then [reported](#): "In Rio de Janeiro, the headquarters of Vale have had regular protests since the accident on 5 November. But the government has also come in from strong criticism for the laxity of the dams' inspection regime and Brazil's weak environmental legislation." "So far, Samarco has agreed to pay R\$1bn (US\$270m) in clean-up costs and compensation, along with a further R\$250m in fines. But critics argue this is nowhere near the cost of the damage. 'The economic value of the fines that have been applied so far are comical,' Mario Moscatelli, a Rio-based ecologist, said. 'They merely provide an incentive for big companies to continue polluting Brazil because it's worth it.'"

All the more since Globo has [signaled](#) that: *"Companies involved in environmental disasters have paid only 3.4% of the fines they received."*

Fig. 11 - S2 (26.12.2015) - 12,8,4 colour composite - Sediments also filled the floor and banks of Doce River.

[3D view](#)



This time, it could be more painful for Vale, Agence France Presse [wrote](#): "*Brazilian judicial authorities announced they had frozen \$3 billion of Vale's assets, saying real estate and vehicles would be seized if the company could not come up with the full amount. The company also has been hit with fines by the federal and state government totaling some \$92.5 million.*" Furthermore, at the end of January 28, Vale's stock price had fallen by 24%. Vale's debt was downgraded to a rating of BBB- by Fitch Ratings. Vale S.A. lost more than R\$70 billion (approximately US\$19 billion) in market value.

The views expressed herein can in no way be taken to reflect the official opinion of the European Space Agency or the European Union.

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