MINISTÉRIO DA CIÊNCIA, TECNOLOGIA, INOVAÇÕES E COMUNICAÇÕES

INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

Disaster management support at INPE: Brumadinho Dam Collapse

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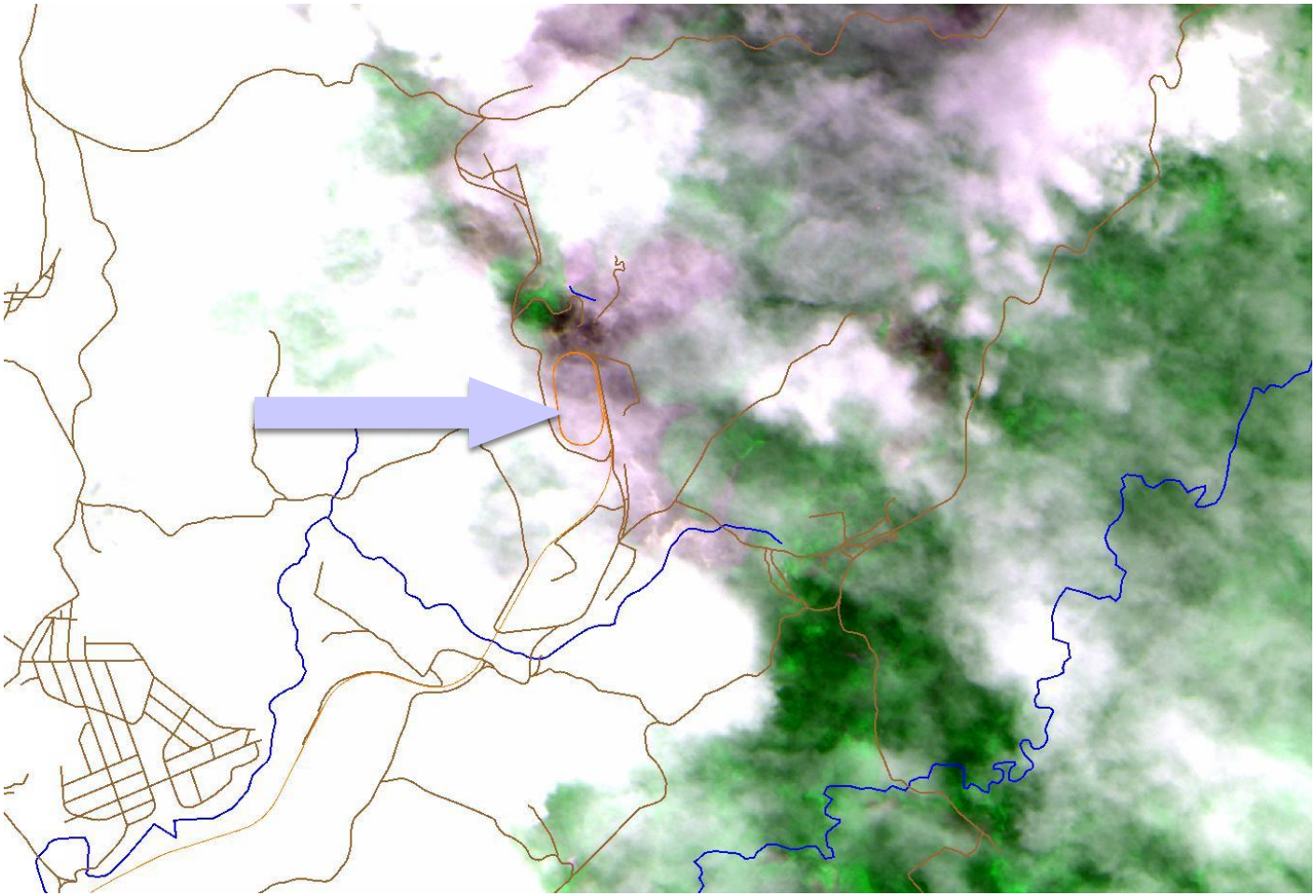
Brumadinho Dam Collapse

- The satellite images and geographic information systems developed at INPE supported the analysis of the tragedy caused by the collapse of the dam in Brumadinho;
- INPE is a member of the International Space and Major Disasters Charter, but to operate in Brazil, the consortium must be activated at the request of the National Center for Risk and Disaster Management (CENAD);
- INPE provided images from from the Sino-Brazilian satellite CBERS-4 and from other space agencies to CENAD in order to support the decision making process;
- Images from the Sino-Brazilian satellite CBERS-4 were obtained on an emergency basis the day after the disaster;
- CBERS-4 guarantees the possibility of obtaining high-resolution color images (5 meters) for any location in Brazil every three days.

Timeline

- Collapse at 12:28 pm, January 25th 2019;
- https://www.youtube.com/watch?v=RMciW3KK9MQ
- INPE got the first information at 01:43 pm;
- INPE received a call from CENAD at 02:15 pm (CENAD was still analysing the situation to decide if the Charter would be activated);
- Starting of the activation of the CBERS-4 emergencial acquisition at INPE at 02:47 pm, programming concluded at 04:25 pm;
- Charter activated at 04:23 pm;
- Acquisition of the CBERS-4 image, sensor PAN5M and PAN10M (Panchromatic and Multispectral Camera with 5 and 10 meters of spatial resolution) at 10:57 am, January 26th 2019.

CBERS-4 PAN10M Image - January 26th, 2019

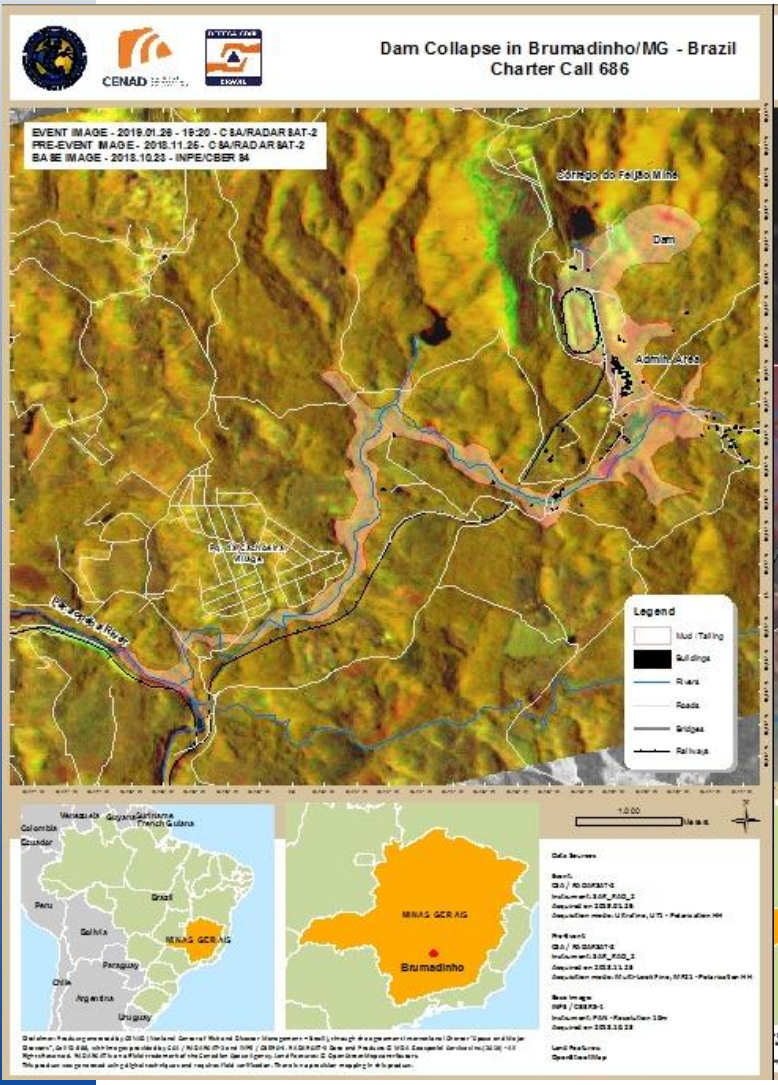


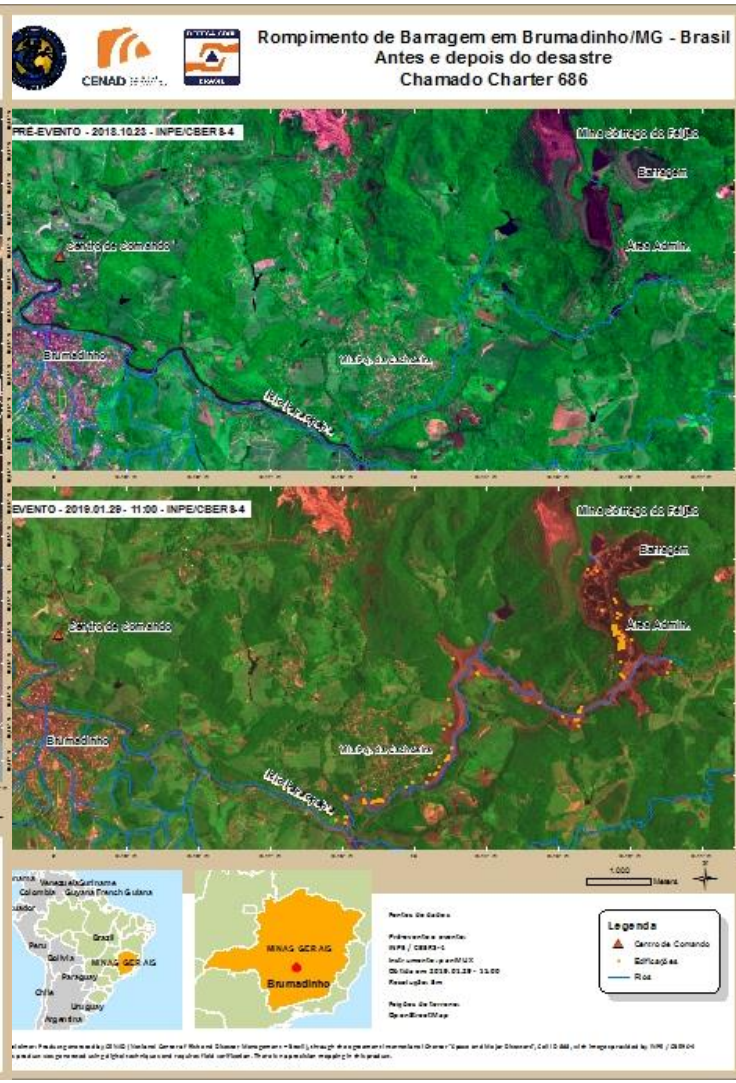
- Presence of clouds - Vale do Rio Doce Company area pointed by the arrow - Area covered with tailings in purple.

New Acquisition: Scheduled on January 28th, 2019 at 10:53 am to January 29th, 2019

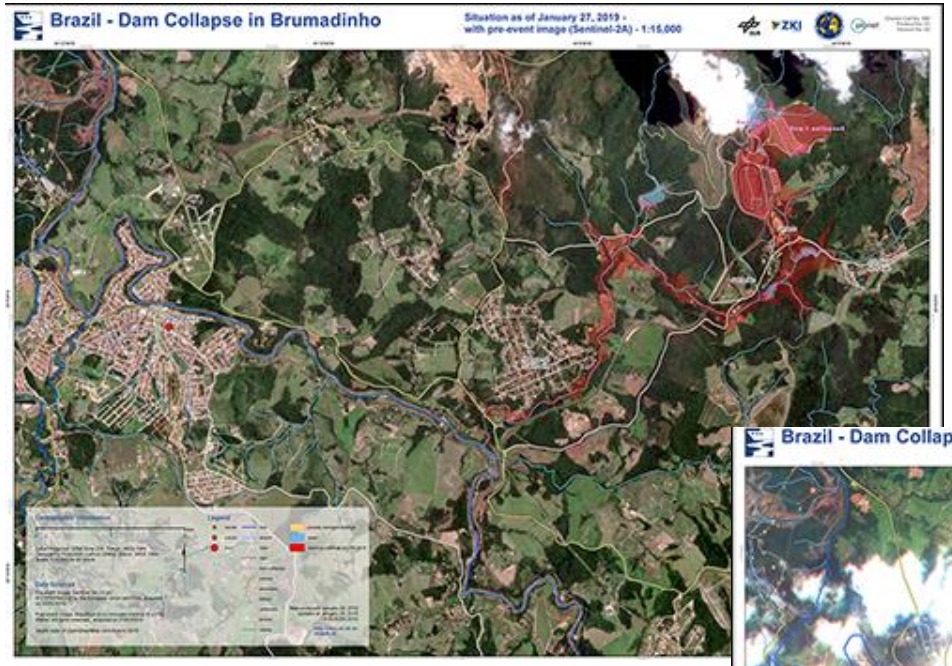
Comparison: images from January 29th, 2019 and from October 23th, 2018

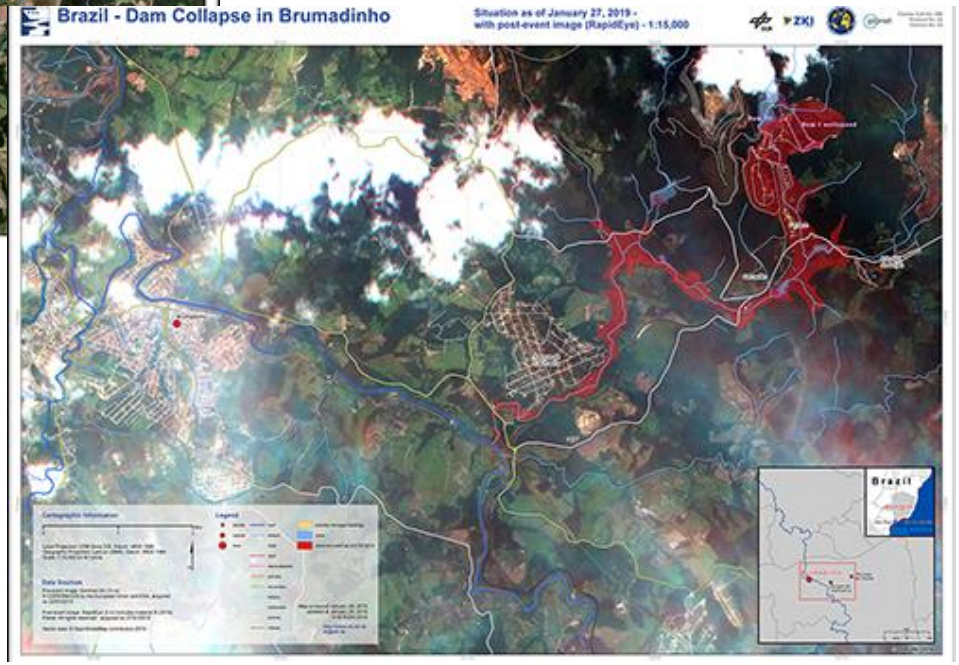
Support given to CENAD in the production of maps





Support given to CENAD in the production of maps





Generating flood risk areas and sludge trajectory using HAND (Height Above the Nearest Drainage)

- INPE' support allowed the production of the first maps used to guide the search for victims;
- Additionally, the sludge trajectory was calculated based on the satellite images applied to a digital model developed by INPE to map areas of risk and vulnerability to disasters (HAND);
- HAND considers the local flow direction to represent the water path in the ground to the nearest drainage;
- The model values are related to the depth of the water table and the vertical distance to the drainage;
- The map created indicates areas that are flooded when a flood height is reached;
- It does not consider the speed of the mass of material traversing the ground.

Data and softwares used

- Digital Elevation Model - SRTM (Shuttle Radar Topographic Mission) - 30 meters, from the United States Geological Survey (USGS), avaliable at https://earthexplorer.usgs.gov/;

- Softwares

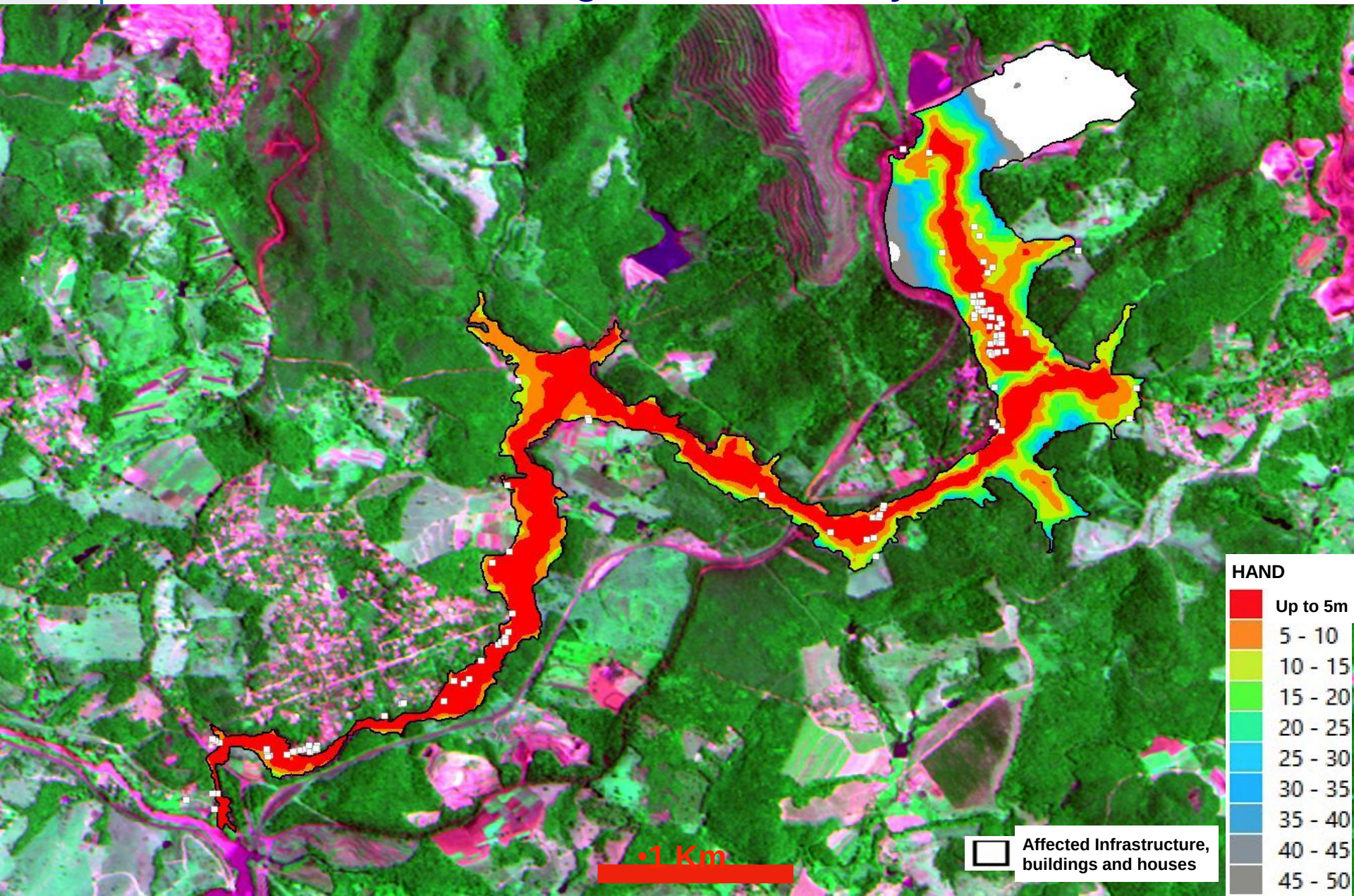
  - To generate the HAND model: TerraHidro, available at http://www.dpi.inpe.br/terrahidro;

  - To process the images: Terraview and SPRING, available at http://www.dpi.inpe.br/terraview_previous/php/dow.php?body=Dow; and http://www.dpi.inpe.br/spring/;

HAND for Brumadinho Dam Collapse

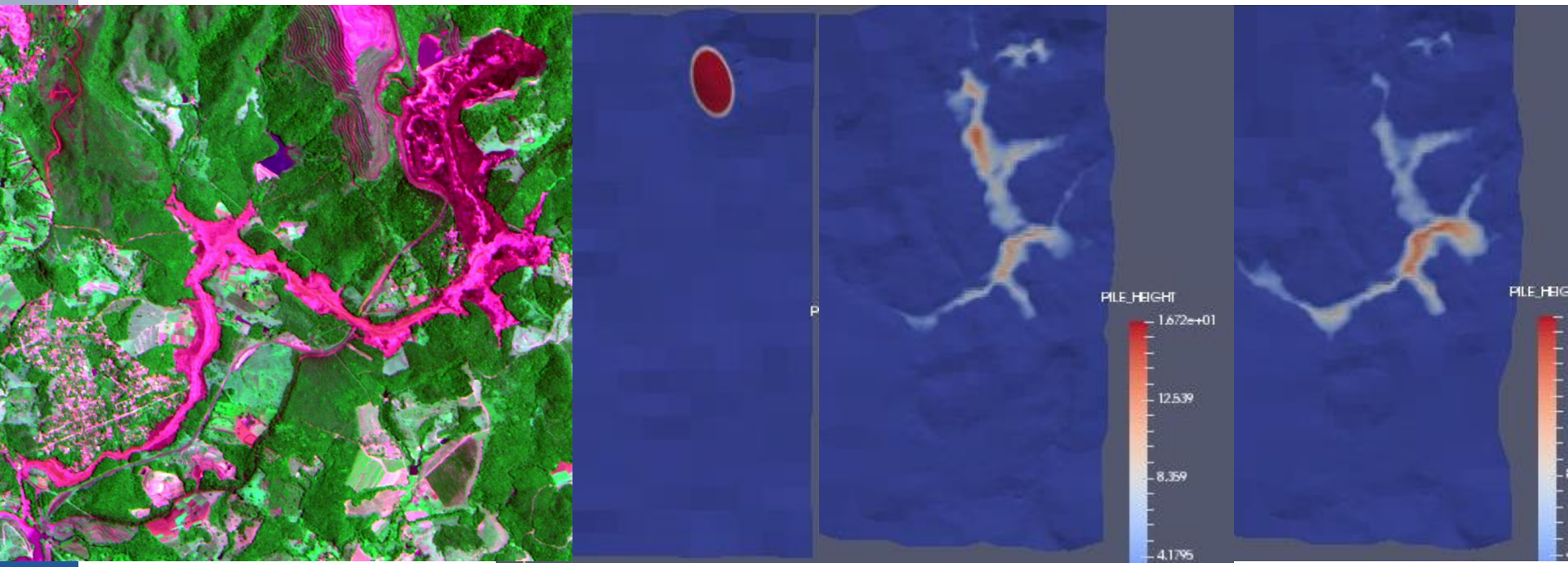
Animated GIF

HAND - CBERS-4 image from January 29th, 2019



Titan2D

•In addition, it was generated a dynamic simulation using the Titan2D, a computer program developed by the GMFG (Geophysical Mass Flow Group) at State University of New York for the purpose of simulating granular avalanches over digital elevation models of natural terrain.



Conclusion

- After approximately 3 kilometers, the initial sludge sliding loses speed and the HAND model indicates that the area reached is in the range of 0 to 10 meters in height above the nearest drainage;
- Most of the affected buildings are within the same range (up to 10 meters) including the Vale internal area;
- All the structures above the 10-meter range that were struck are from Vale;
- This is due to the proximity to the ruptured dam, where the mass displacement speed is very high.

Final Remarks

- Data from CBERS-4 are available to support any kind of disaster in Brazil (including droughts);
- The mapping results are valuable tools for decision making;
- Sophisticated models require high quality data of restricted or non-existent access;
- Areas susceptible to flooding and sludge sliding can be mapped using free tools and data;
- Corroborates with INPE's policy of free access to data and open source software.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