User Manual

PSTool - PSInSAR online platform for data visualization and analysis

Address: https://pstool.terrasigna.com/

March 2025

Contents

Figures

1 Introduction

The InSAR (Interferometric Synthetic Aperture Radar) and PSInSAR (Persistent Scatterers Interferometry) measurement techniques are based on combining radar microwaves emitted by a radar sensor at different times (passes). The combination technique is using the "coherent" property of the radar waves by "interfering" two different signals and extracting the so called "phase difference". This technique, called in general "Interferometry" is also applied to laser, LiDAR and GNSS signals.

Below are links with tutorials about the "Radar Interferometry"

1. NASA Jet Propulsion Laboratory – basic presentation of InSAR

https://nisar.jpl.nasa.gov/mission/get-to-know-sar/interferometry/

2. European Space Agency – basic tutorial

https://www.esa.int/Applications/Observing_the_Earth/How_does_interferometry_work

3. United States Geological Survey – basic presentation of InSAR

https://www.usgs.gov/index.php/programs/VHP/insar-satellite-based-technique-captures-overall-deformation-picture

4. European Space Agency – in-depth principles of InSAR

InSAR-Principles-Guidelines-for-SAR-Interferometry-Processing-and-Interpretation.pdf

5. Earth Observation College – InSAR student course

https://eo-college.org/resource/insar_basics/

6. German Space Center/Federal Institute of Technology Zurich ETH), InSAR/PolInSAR tutorial

2021_PolInSAR_IHajnsek_theory.pdf

2 Data layers

2.1 Organization

Data layers are grouped by different criteria, such as site, sensor type, and so on. One layer can belong to a single group, to avoid display redundancy. The preferred option is to group layers by site (as in Figure 1, Feijao dam, Brasil and Junction reservoir, SK) and information about sensor, beam, type of data or similar can be provided in the layer name.

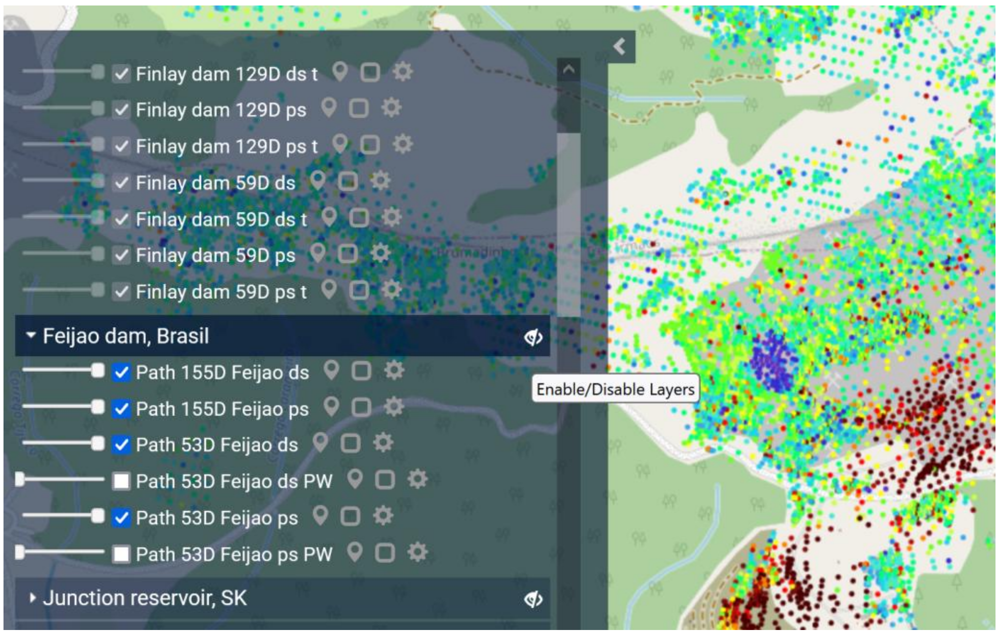

Figure 1 PSTool layers organization

2.2 Selection

Layers can be selected with the click box on the left side of the layer, or dragging the opacity slide.

If working with multiple sites simultaneously, the icon above the tooltip (Figure 1) can hide/show all selected layers belonging to a specific site/category (in this case Feijao dam, Brasil). In this way, if want to revert to a set of previously selected layers which were later hidden, with one click on the icon those layers will become visible again; this saves time to manually re-select each layer of interest.

2.3 Properties

On the right side of each layer there are three icons. From left to right, pan/zoom to layer (Figure 2), find reference point (Figure 3) and color legend settings (Figure 4).

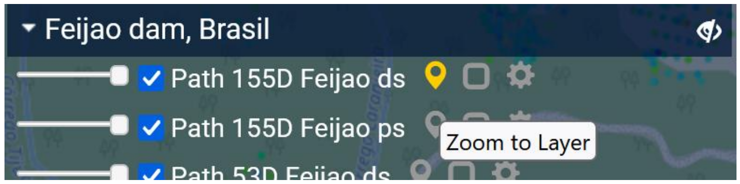

Figure 2 Automatic panning to layer

Figure 3 Finding reference point

Figure 4 Changing color legend

The background can be chosen from a street map, two choices of satellite images and two choices of terrain/topography maps (Figure 5).

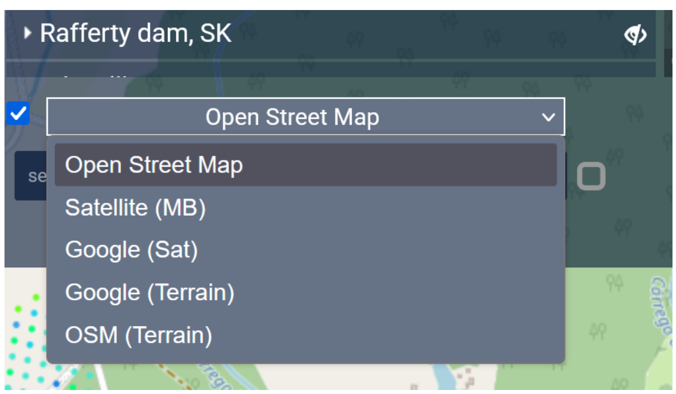

Figure 5 Background images

3 Data filtering/selection

Criteria to display data with specific characteristics are available (Figure 6). Data can be selected by several criteria, such as velocity, height, quality, and statistical parameter estimation of uncertainties in velocity and height. Maximum three such criteria can be set simultaneously.

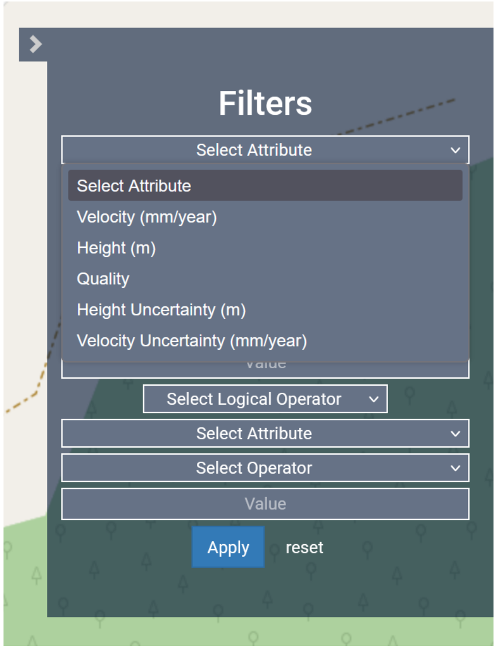

Figure 6 Data selection

4 Point size and zoom

The size of the points and the map zoom level can be changed using icons located at the bottom-right of the main application window (Figure 7).

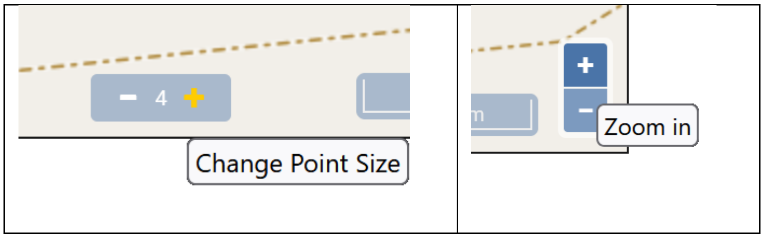

Figure 7 Changing point size and zoom level

5 Geographic search

Geographic search was implemented up to individual address level. This helps with quick identification of very local displacement information (Figure 8).

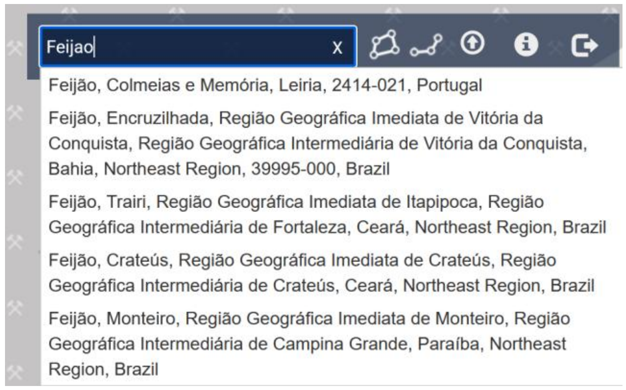

Figure 8 Address search

6 Data representation

The strength and utility of the platform is represented by the data representation functionality.

6.1 Single point

By clicking on one point of a selected layer, the temporal profile for that point is displayed. Temporal zoom by dates is available from the top-left corner of the profile window (Figure 9).

Note: every point has associated a set of characteristics extracted from the SAR data using the PSInSAR technique; these characteristics are displayed at the top of the profile window:

- The **"Velocity"** field represents **average displacement [mm/year]**, the measure of interest.
- The *"Height"* field represents the estimated height of the point but the accuracy of this parameter is low (tens of centimeters or meters) thus it does not make it suitable to be used as a survey measure. This parameter is used when selecting points based on their height (creating slices in infrastructure such as tall buildings, bridges) is desired.
- The *"Height uncertainty"* and *"Quality"* field represent a measure of the quality of the data associated to that specific point. Since the measurements are based on reflections of the radar signal from the ground, the quality of each measurement point depends primarily on the quality of the reflected signal from that point; thus, each point is characterized by its own quality. This parameter can be also used as a selection criterion when displaying the data on the platform.

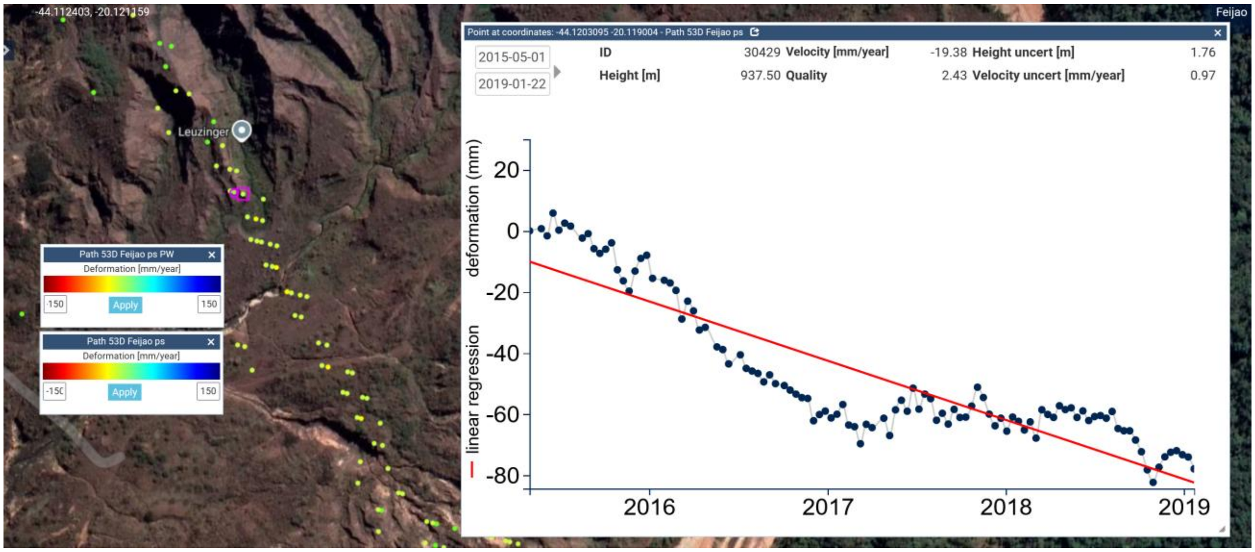

Figure 9   Temporal displacement profile of a PSInSAR point

For purpose of reproducibility, single point search by point ID is available (Figure 10). **The point ID is unique to a dataset/layer; thus, the correct layer must be selected. Additional layers need to be de-selected.**

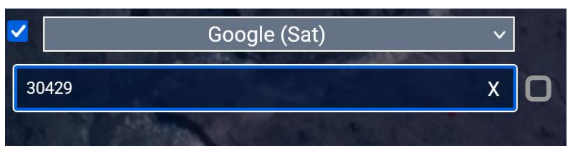

Figure 10 Single point search

6.2 Single point, detection of changes in displacement rates

Most of the times, the displacement rates of a point are changing in time. The moment of change and the periods of changed displacement rates can be detected by the piecewise temporal analysis (PW layers). With this functionality potential alerts can be defined.

Figure 11 illustrates a point with a global displacement rate of -19.38 [mm/year] but with a particular period where the rate reached the maxima of -155.0 [mm/year].

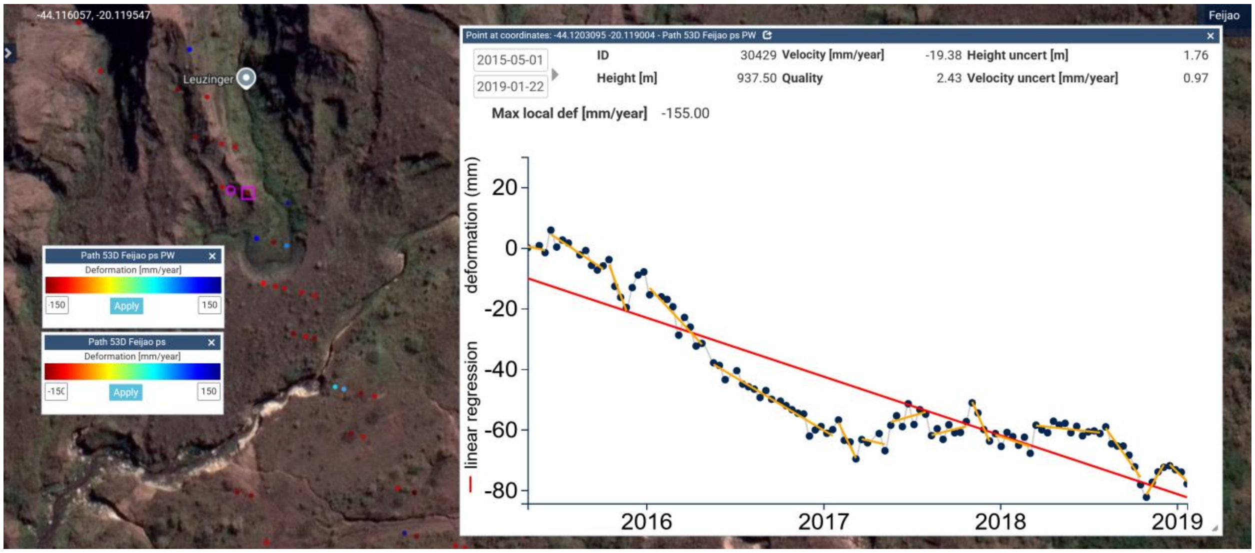

Figure 11 Piecewise analysis of displacement rates.

6.3 Multiple points

Multiple points can be selected using the shape icon (left most icon on top of Figure 12). The selection shape can be drawn with the mouse or a predefined selection shape (single shape only) can be loaded by clicking on the white arrow on blue background icon. Having a predefined shape for points selection enables the reproducibility of the analysis and data export results.

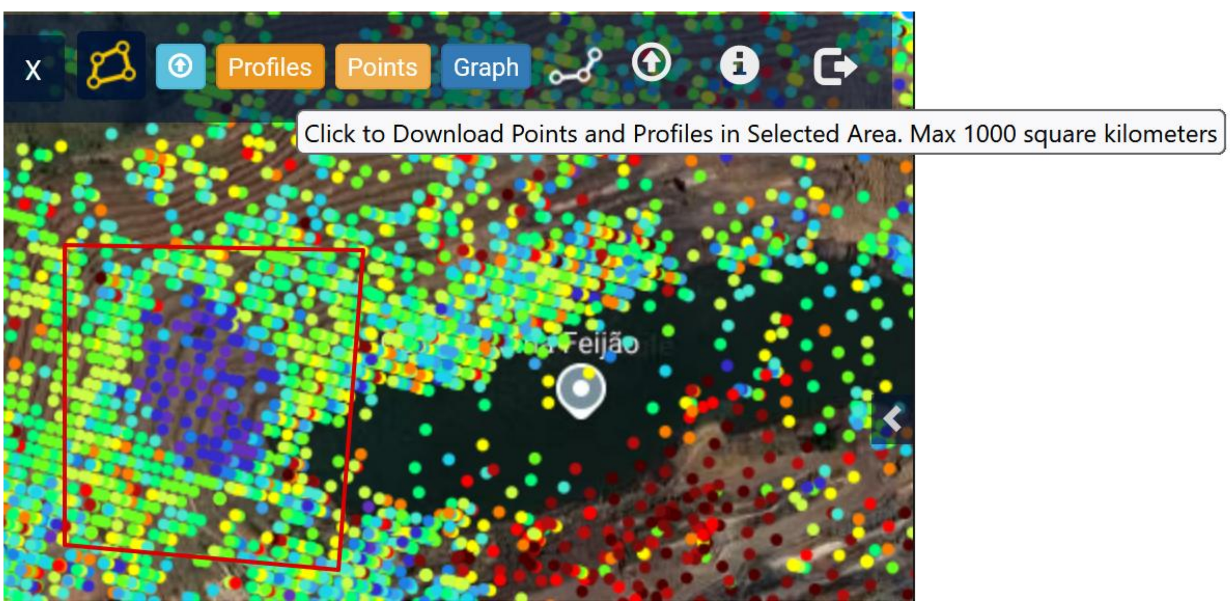

Figure 12 Selection of multiple points

Once a shape was drawn or loaded, averaged profiles from that area spanning multiple layers (that were previously selected) can be calculated and displayed, as in Figure 13. One average profile will be produced from each layer and the number of points averaged in each profile is displayed.

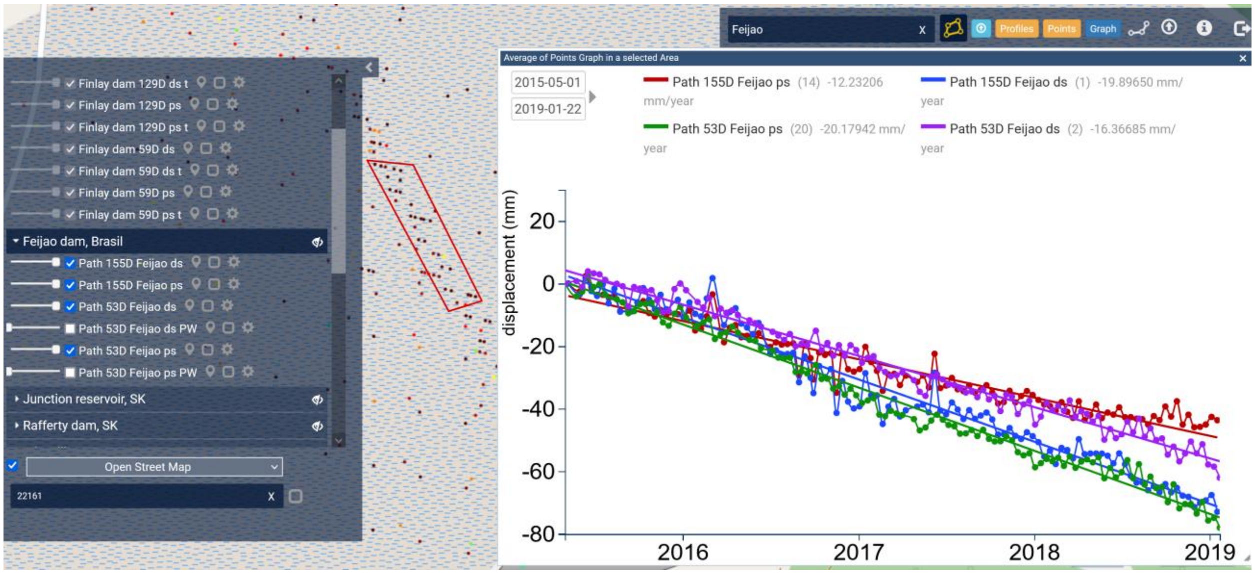

Figure 13 Display of average profiles from multiple layers

6.4 Data export

The Profiles and Points icons (with orange background in Figure 13) can be used to export the profiles from the selected area to either text file or Google Earth kmz formats (Figure 14). The export is available only to individual profiles and not to averaged profiles.

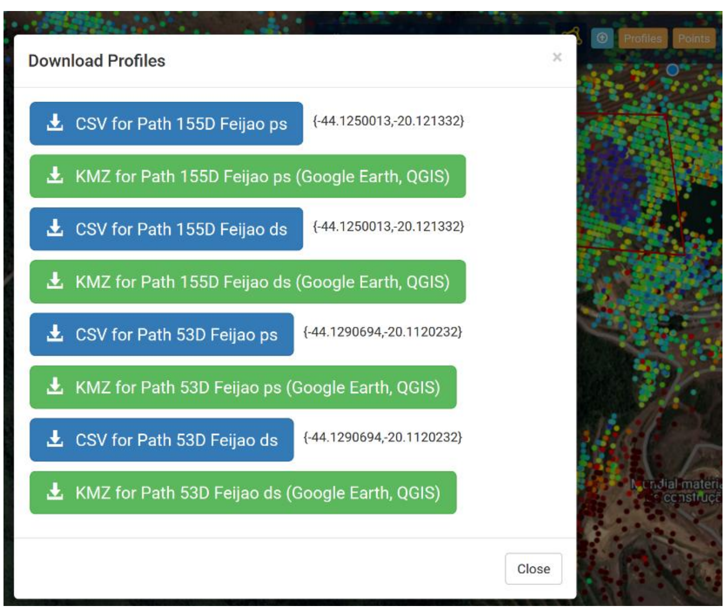

Figure 14 Data export

6.5 Transects

Analysis along or across the area of interest, regardless of the shape of the area, can be carried using the transect tool. The tool is enabled by clicking on the second icon from left to right in Figure 15 (yellow shape).

The shape of the transect is drawn with the mouse and the size of the cells (width W – across the transect, length L – along the transect) is set in the edit boxes illustrated in Figure 15.

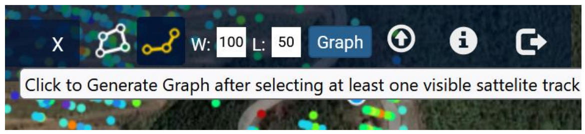

Figure 15 Transect parameters

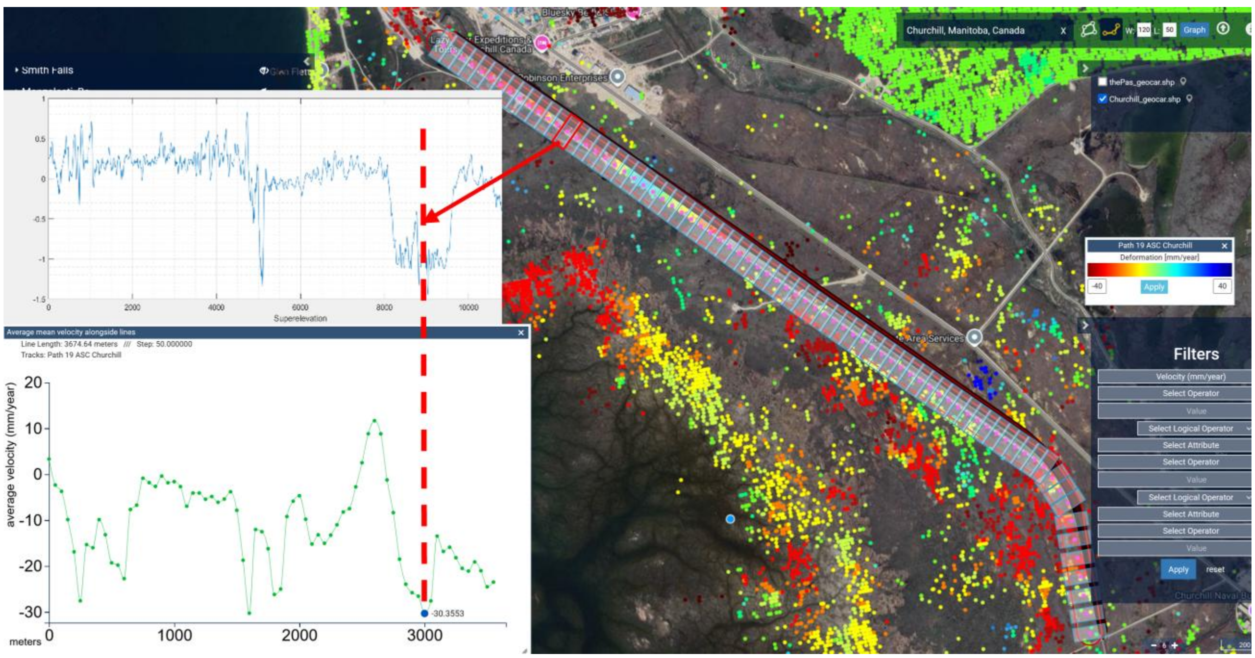

Figure 16 Transect analysis tool

An example of a transect (in the form of hockey shape) following the Hudson Bay railway is illustrated in Figure 16. Seventy analysis cells (each 120 meters wide and 50 meters long) were created along a 3500 meters rail section and the average displacement rate per cell was calculated and displayed on the green graph. By moving the mouse along the green graph, the cell transect cell corresponding to the location of the mouse on the graph is highlighted in red on the transect (red arrow originates from the selected transect cell that corresponds to the point at the intersection of the interrupted vertical red line with the green graph).

Furthermore, Figure 16 illustrates one of the application of the online PSTool platform, detection of abnormal superelevation (height difference between the inner and outer rail track) areas. The maximum subsidence rate value of -30.35 mm/year corellates with the maximum superelevation value displayed on the blue graph (top left) and measured by the ground-based geocar sensor. The vertical interrupted red arrow shows the correlation between the area of maximum subsidence with the area of extreme superelevation.

6.6 Transect animation

The averaged displacement dynamics in every transect cell can be displayed as temporal animation, where the total displacements along the transect are illustrated at every data acquisition time.

Figure 17 Generating spatial deformation time series

Figure 17 illustrates the setup of a transect (cell width 25 meters, cell length 35 meters) and with a shape drawn with the mouse (as in Figure 18 left). By clicking the green "Time series' button, the animation will start. The date at which the cumulated deformation is illustrated with the green graph is displayed on the top-left of the figure. The animation is automated but a sliding bar is available for manual operation.

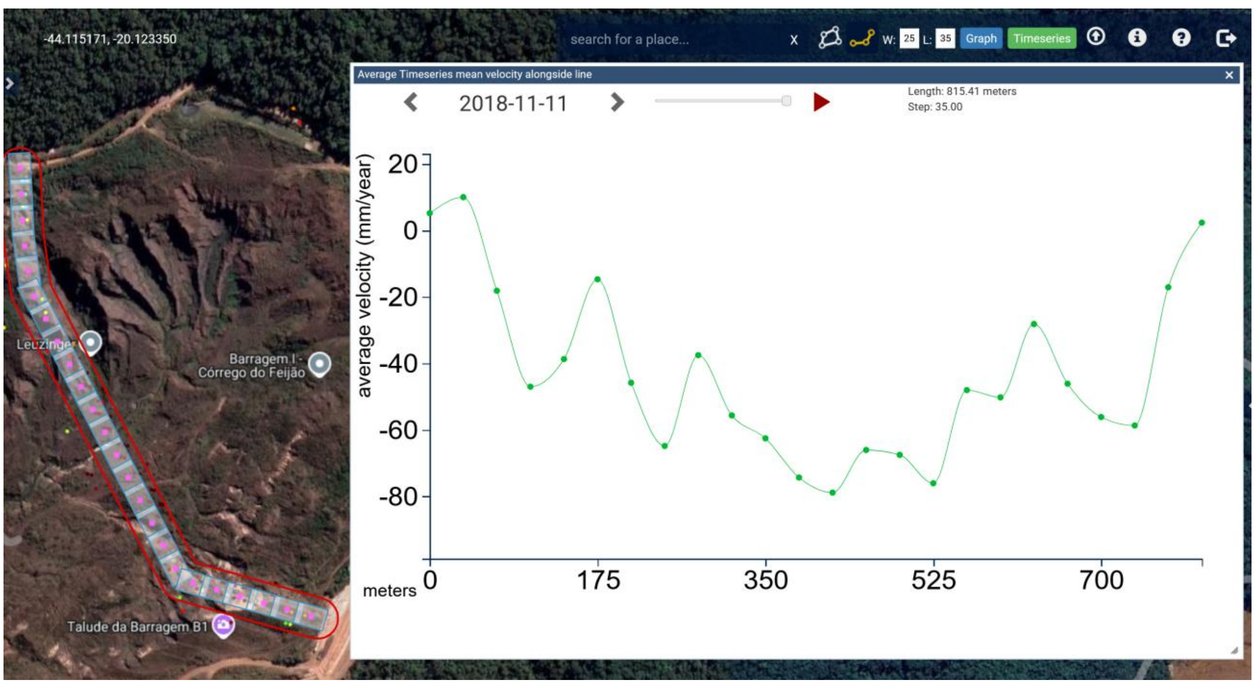

Figure 18 Total deformation – end of the animation

6.7 Export of transect results

The transect results (spatial average of yearly deformation rates, one value for each transect cell) can be exported in text format for future analysis (Figure 19).

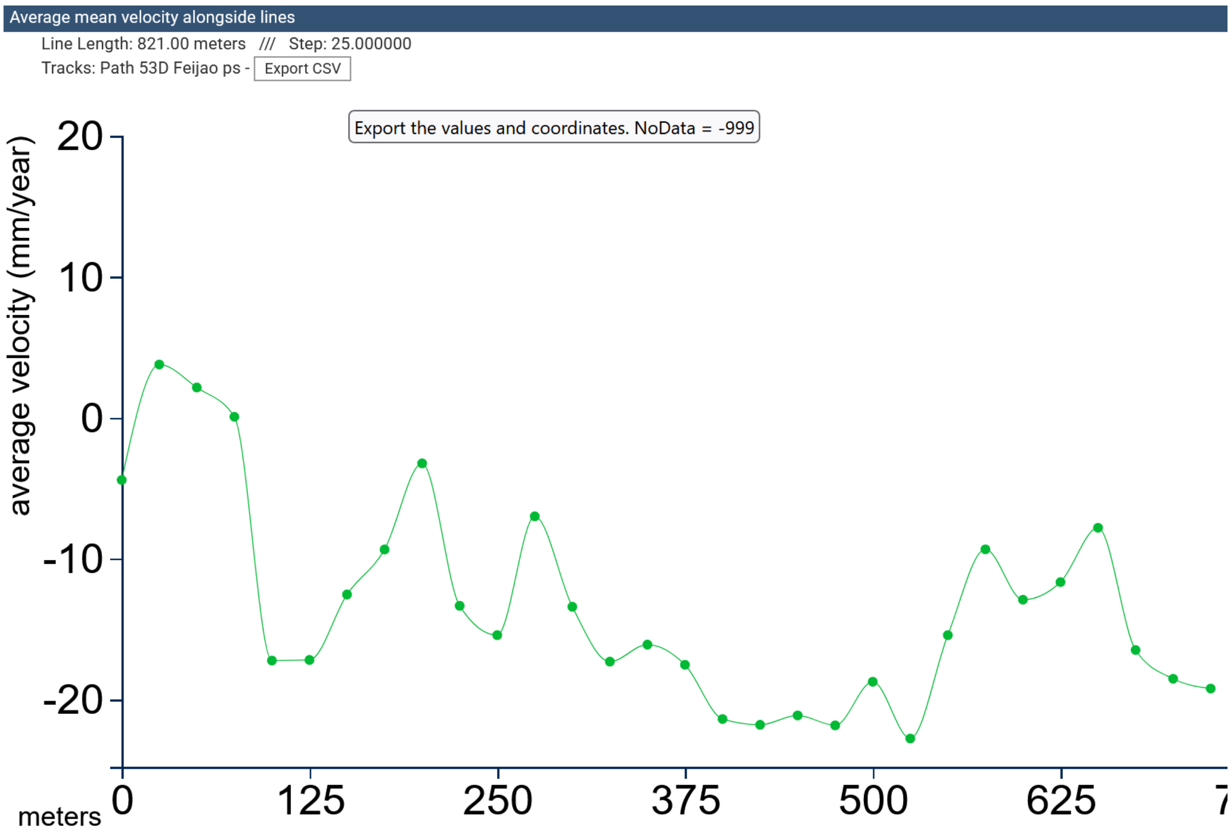

Figure 19 Export of transect values (average within each transect cell of yearly displacement rates)

6.8 User layers

User layers in geotiff (RGB only) and shape (zipped archive) formats can be loaded by clicking on the arrow icon on top-right corner of the image in Figure 20. The example illustrates a Sentinel-1 radar image.

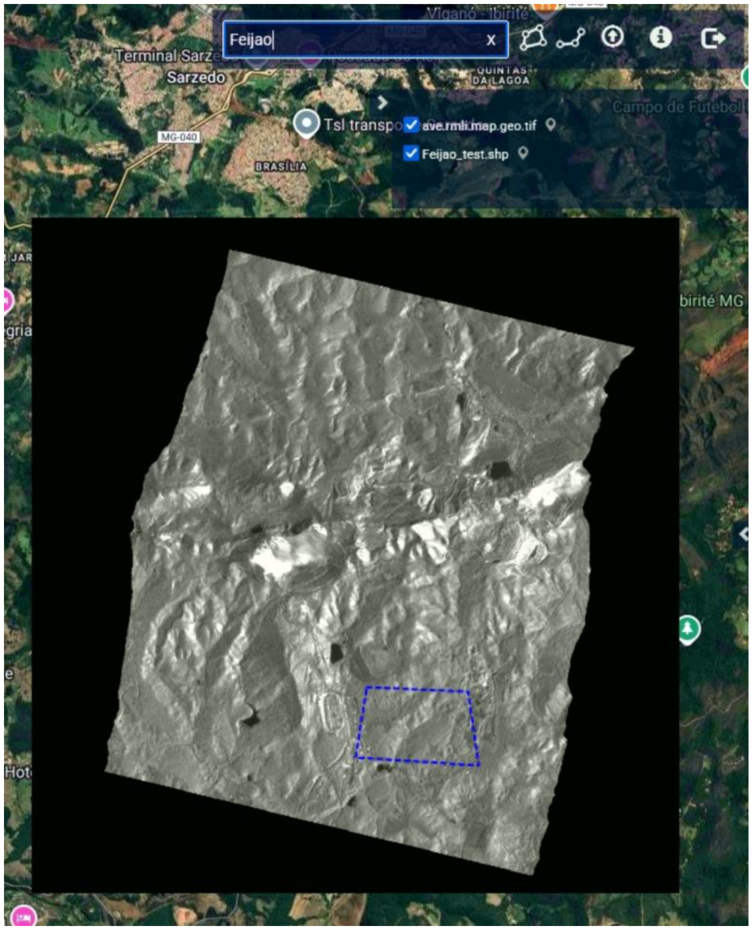

Figure 20 User layers in RGB geotiff and shape formats

7 Logout

The logout button is illustrated in Figure 21. At logout, any additional background layers loaded by the user will be unloaded.

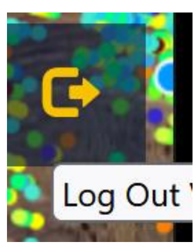

Figure 21 Logout icon