Rheticus® Safeland
Satellite monitoring of the territory stability

Technical Specifications

▸ Document Info

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▸ Indice

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1. Rheticus®

Rheticus® is an automatic cloud-based geoinformation service platform (Figure 1), designed to deliver fresh and accurate data and information for monitoring the evolution of the Earth's surface. The platform includes services for dynamically monitoring the Earth's morphology, vegetation, infrastructure as well as coastal areas and seawater, covering both environmental and production aspects.

Access to Rheticus® is made available by subscription and allows users to have continually updated information.

Services update is guaranteed through the use of satellite images, mapping data and environmental information available online as open data. The service is updated with the availability of fresh incoming data, and the refresh rate frequency depends on the service characteristics.

Rheticus® is available through the web portal on portable devices, such as tablets and smartphones. Information is displayed on a pre-set dashboard that simplifies the analysis of monitored phenomena, providing users with a comprehensive overview. Rheticus® provides information through graphic indicators, dynamic diagrams and pre-set reports. The provided information allows customers to immediately perform assessment operations over areas of interest.

Services are also available in Machine to Machine mode (M2M) via standard sharing protocols, making the platform an information hub that delivers content to other online systems. Export capabilities of data and information are also available, allowing users to download standard formats and facilitate their use in other external application environments.
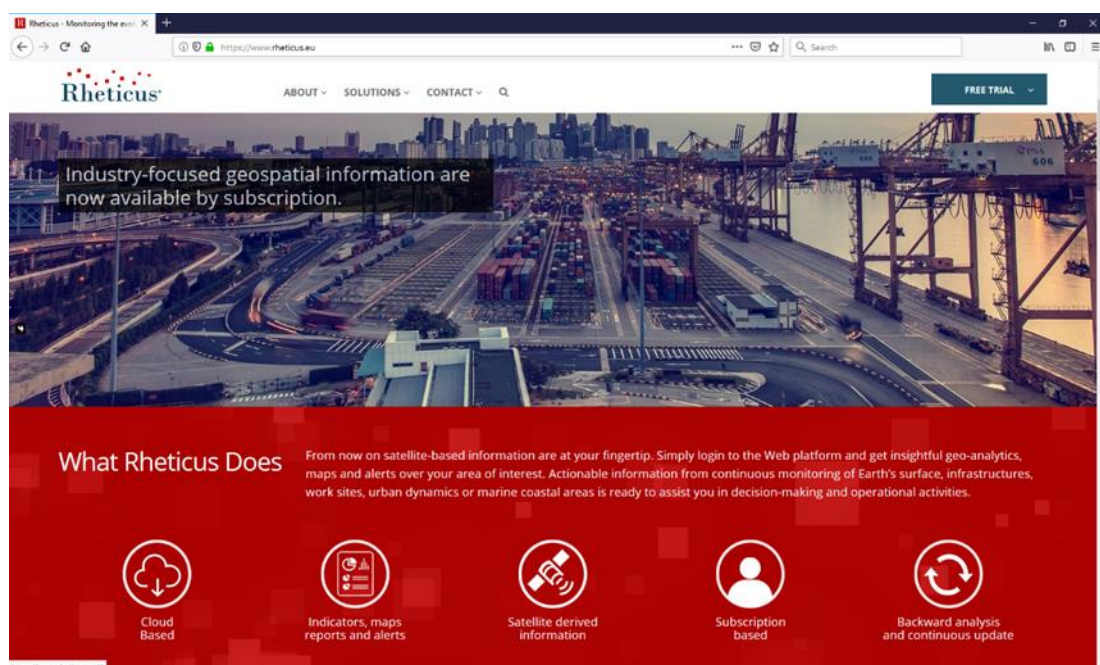

Figure 1 - Rheticus® Website https://www.rheticus.eu

1.1. Rheticus® Key Features

The service	▶ **Best cost/performance ratio thanks to the use of open data, automatic processing chains, and the adoption of a cloud architecture.** ▶ **Geo-information services designed to meet users' needs.** ▶ **Services available worldwide.**
Data	▶ Use of geospatial information and open data available on the cloud. ▶ Direct online access to major satellite image providers using the best data available over the areas of interest.
Processing	▶ Automatic data processing throughout the entire production chain, ensuring timely and regular updating of geo-information services. ▶ Standardised processing procedures for high-quality geo-information services.
Delivery	▶ Outputs following standard specifications and quality requirements, measurable through predefined metrics. ▶ Metadata are provided with geo-information services. ▶ Information and data are provided in standard formats for use with office automation, CAD and GIS applications. ▶ Accessible from desktop PCs, tablets and smartphones through web browsers or M2M mode.
Terms & Conditions	▶ Conditions of use and license for the data, information and services offered by the platform: https://www.rheticus.eu/wp-content/uploads/2018/05/terms_and_conditions.pdf

1.2. Servizi Rheticus®

Rheticus® Services	Satellite monitoring/reporting services to support production activities, environmental protection and citizens' well-being
Rheticus® DISPLACEMENT	Periodic monitoring of soil surface millimetre movements due to landslides and / or subsidence in urban and extra-urban areas with information on displacement and accelerations over time.
Rheticus® SAFELAND	Periodic reporting service on the stability of the territory through the segmentation of wide areas and their classification based on the movement trends and anomalies detected from a satellite.
Rheticus® SAFEWAY	Periodic reporting service for monitoring and checking the stability of transportation infrastructures such as roads, railways and airports. The segmented infrastructures are classified based on velocity and acceleration measured over time.
Rheticus® NETWORK ALERT	Periodic reporting service that informs about the stress level of water and sewage networks. The pipeline networks are classified based on the stress level related to ground movements over time.
Rheticus® BUILDING CHECK	Periodic reporting service on building stability, based on stress level related to ground movements over time.
Rheticus® MARINE	Periodic monitoring of coastal seawater quality and marine resources through the measurement of parameters such as chlorophyll, turbidity, temperature and algae bloom.
Rheticus® AQUACULTURE	Periodic monitoring and reporting of shellfish growth trends to support and optimize aquaculture activities and farm management. Insightful data are also provided to estimate the best harvesting time and the amount of production.
Rheticus® URBAN DYNAMICS	Periodic reporting on urban dynamics for monitoring land use/cover changes caused by construction works and implementation of urban plans.
Rheticus® WILDFIRES	High-performing geo-information service for burnt area detection, fire severity classification, vegetation regrowth monitoring and detection of illegal changes within past official burnt areas.
Rheticus® OENOVIEW	Periodic reporting on the biophysical parameters of vineyards to support winegrowers and/or winemaking cooperatives for the optimisation of their activities, the improvement of the productivity and quality of their vineyards through an accurate operational mapping of each plot.

2. Rheticus® Safeland

Satellite monitoring of the territory stability

2.1. Overview

Land instability represents a serious source of danger for citizens safety, infrastructure safeguarding and environmental protection. Under the pressure of anthropogenic activities and climate change, the intensity and frequency of land instability phenomena are faster growing than before. As calamitous events, land instability phenomena can cause human injury, loss of life and economic devastation, and destroy facilities, properties and/or infrastructures, increased costs and delays to new development.

There is a huge need to prioritise areas based on the level of concern to better manage inspection and investments for stability works. Traditional campaigns for the regular monitoring of hundreds of thousands of square kilometres requires considerable financial resources and time and are often complex to implement.

Rheticus® Safeland is a turnkey web-based vertical solution for the continuous monitoring and reporting on the stability of territory. The service gives a level of concern to each portion of a territory (Error! Reference source not found.**), based on trends and anomalies of surface displacement measured through satellite RADAR interferometry.**

The service offers a synoptic point-of-view of the territory by providing constantly updated information on the levels of concern, highlighting stable areas from those affected by slow-moving landslides and/or subsidence, working as a complementary diagnostic tool together with in-situ monitoring activities.

Rheticus® Safeland gives access to dynamic maps, reports and alerts, allowing customers to easily detect areas with a high level of concern, prevent potential damage, better organise field inspections, and achieve cost-effective management of the territory. The service provides the proper knowledge to support planners to avoid critical issues deriving from not full pictures of in progress phenomena.

Rheticus® Safeland is useful to:

- ▶ Identify unstable areas not known;

- ▶ Monitor known unstable areas and follow their evolution over time;

- ▶ Evaluate the effectiveness of interventions carried out in unstable areas.
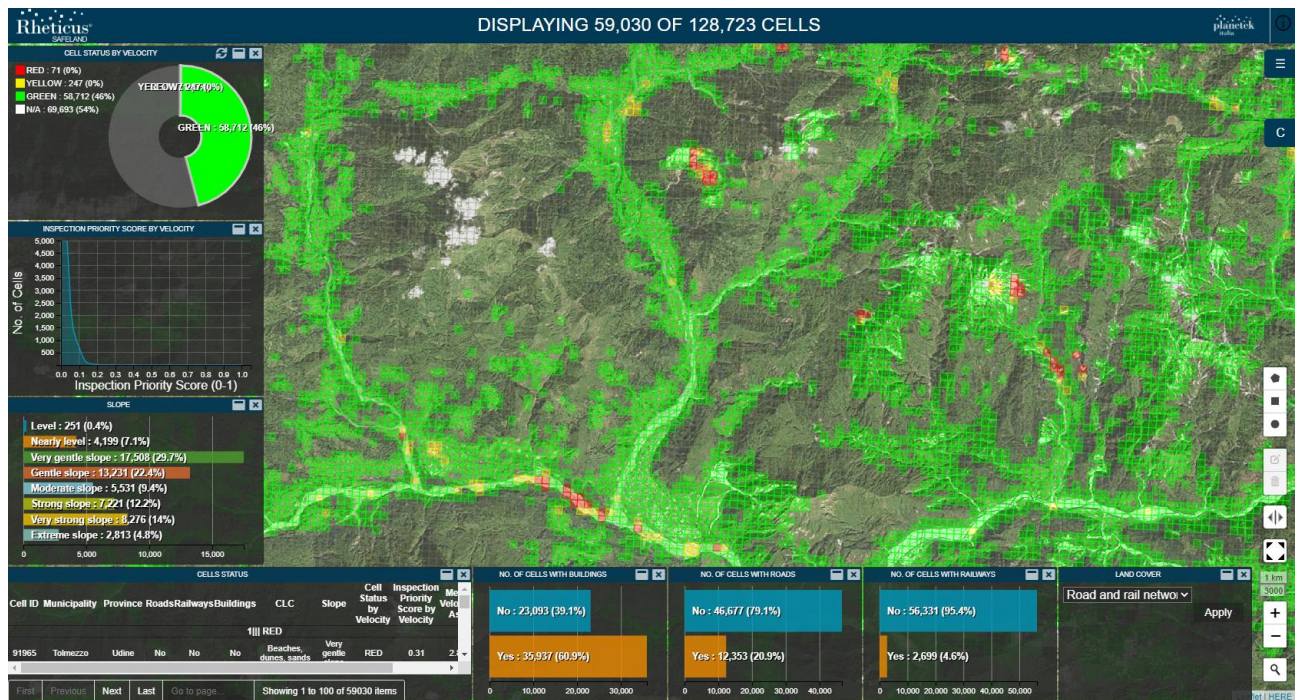
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Figure 2 - Rheticus® Safeland User Interface[1]. Example of monitoring an area affected by landslides, with a summary report, trend instabilities, and filtering tools.

2.2. Who is it for?

Rheticus® Safeland is useful to different target users involved throughout all stages of monitoring territory stability:

▸ Regional to local authorities, e.g. regional geological agencies;

▸ Environmental protection agencies;

▸ Civil engineering companies;

▸ General contractors

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[1] User interface is continuously enhanced to offer a better user experience and new features.

3. Technical Specifications

Rheticus® Safeland is a periodic reporting service on the stability of territory.

The Area of Interest (AoI) is splitted in cells 250 x 250 m. A level of concern is associated to every cell, based on trends and anomalies of surface displacement measured through satellite RADAR interferometry, together with other parameters such as morphology, land cover, presence of buildings and/or other infrastructures.

The service can be integrated with other Rheticus® services: Rheticus® Displacement, Rheticus® Safeway, Rheticus® Building Check, Rheticus® Network Alert, Rheticus® Wildfires[2].

3.1. Activation

Once the client performs the subscription to the service and provides the extent of the AoI (ESRI shapefile, KML, DWG/DXF), the service is activated over the customer's AoI.

At service activation, the client gains access to the web platform throughout the subscription duration.

The service is available at https://services.rheticus.eu/ with the credentials provided at activation.

3.2. Operation

Once the client logs into the web platform and launches the web application, the AoI subdivided into cells 250 x 250 m(**Error! Reference source not found.**, Figure 5) together with relevant analytics are loaded within a Business Intelligence (BI) dashboard (Figure 10).

Each cell of the AoI is classified accordingly to the measurements of displacement over itself, measured through satellite radar data[3, 4, 5, 6].

The status of each cell is represented with 3 classes/colours[7] that correspond to increasing levels of concern and inspection priority (Figure 3):

- ▸ Stable cells in green,

- ▸ Cells to assess in yellow,

- ▸ Cells to inspect in red.

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[2] Additional costs may occur.

[3] The cells are classified accordingly to the measurements of velocity, acceleration and coherence of Persistent Scatterers (PS). Persistent Scatterers are highly stable points on the ground. PS are identified and their velocity/acceleration are measured through a fully automatic Multi-Temporal SAR Interferometry (MT-InSAR) processing chain based on the extensively tested SPINUA© algorithm applied on satellite radar data. Additional information on the SPINUA© algorithm is available at the following link: https://www.rheticus.eu/wp-content/uploads/2018/12/SPINUA_a_flexible_processing_chain_for_ERSENVISAT_.pdf

[4] Coherence is a parameter directly connected to Persistent Scatterers (PS) quality: the higher the coherence, the lower the uncertainty.

[5] Measurements of displacement of the transport network and of the nearby areas are provided with a precision of ± 1.5 mm/year along the satellite's Line of Sight (LoS). The direction of measured displacement is defined by the satellite's LoS. Horizontal localization of PS is provided with a precision of ± 10 m. Data are supplied in geographic coordinate system.

[6] The standard service exploits satellite open data provided by the Sentinel-1 constellation of the European Copernicus programme. Additional information on the Sentinel-1 constellation are available at the following link: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/overview

[7] If it is not possible to classify any cell of the AoI, the N/A class is attributed.

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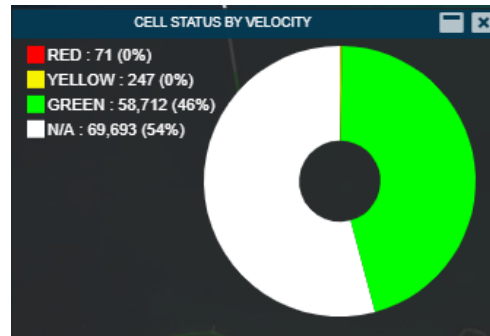
Figure 3 - Number of cells by status

Each cell of the AoI has an Inspection Priority Score, ranging between 0 and 1. The greater the Inspection Priority Score, the greater the level of concern. Through a dynamic window, it is possible to select a particular range of Inspection Priority Score and, as a consequence, the related cells having a score belonging to the selected range (Figure 4).

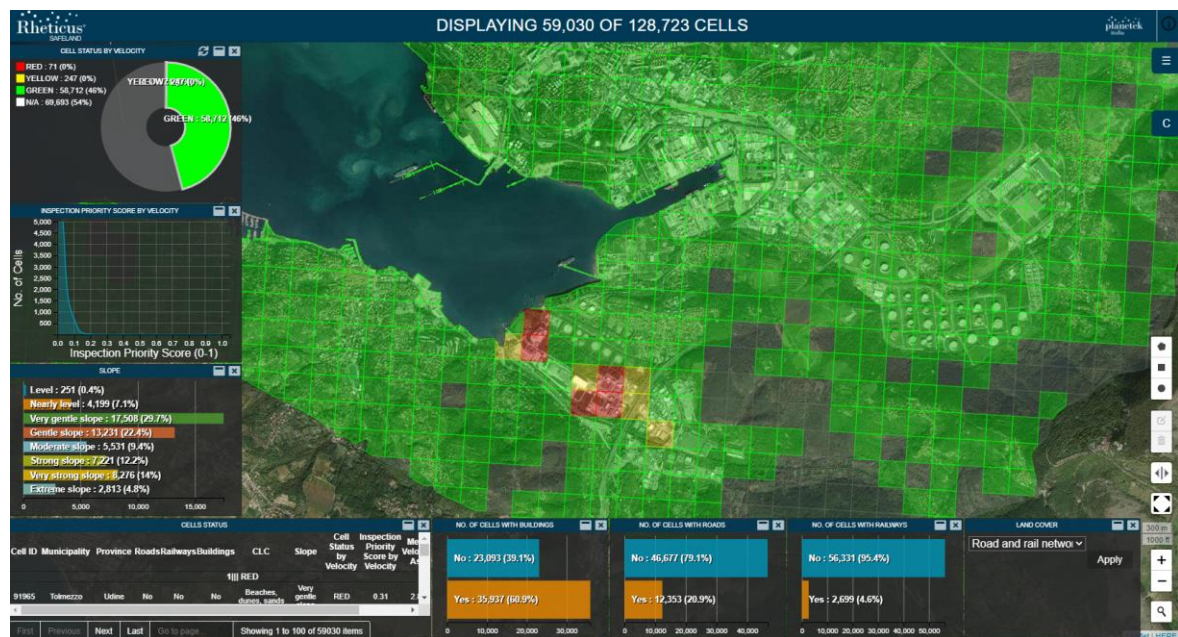*Figure 4 - Inspection Priority Score associated with every cell of the AoI*

Figure 5 - User interface over an urban area, subdivided into cells 250 x 250 m. Every cell is classified based on surface displacement measurements and density of those measurements within every cell.

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Clicking over each cell a pop-up window shows all information related to the selected cell (Figure 6):

- ▸ Cell ID;

- ▸ Geographic coordinates (latitude, longitude);

- ▸ Municipality and Province;

- ▸ Presence of buildings;

- ▸ Presence of transportation infrastructure;

- ▸ Main land-cover;

- ▸ Class of slope;

- ▸ Level of concern;

- ▸ Average velocity;

- ▸ Link to analyse displacement trends of all PS within the cell in Rheticus® Displacement (Figure 7).
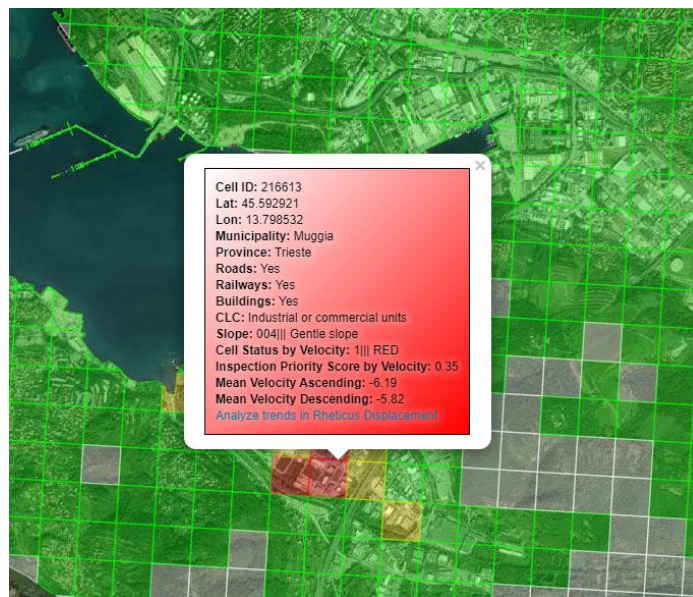
Figure 6 – Details of information available in the pop-up window by clicking on each cell
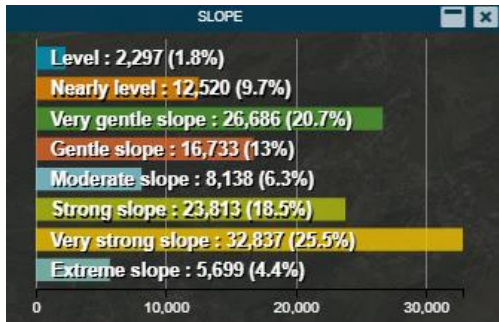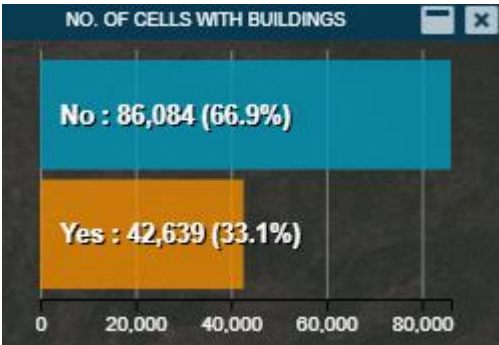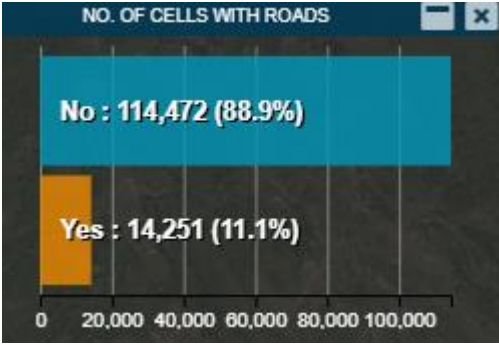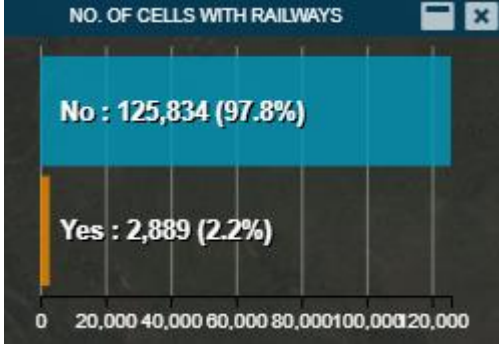
Figure 7 – Integration with Rheticus® Displacement

A detailed report is available on the table at the bottom left side of the web interface, providing users with the following information: Cell ID, Municipality, Province, Presence of buildings, Presence of transportation infrastructures, Main land-cover, Class of slope, Level of concern, Inspection Priority Score, Zoom-to-Feature tool, sorted by Cell Status (Figure 8).

Figure 8 - Detailed report on the stability of the AoI, with cell status, presence of buildings/infrastructures, land cover, and zoom-to-feature tool.
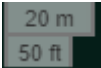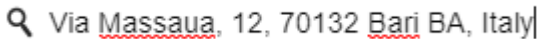
The following table describes the additional analytics available in the Business Intelligence dashboard:

	Number of cells per class of slope
	Number of cells with buildings
	Number of cells with roads
	Number of cells with railways

	Filtering toll per mail land-cover

Through a right-side menu, it is possible to have access to several functionalities, described here below:

	Access to layers, analytics, filters, switch- on/off functionalities.
	Access to the dashboard of Business Intelligence of Rheticus® Safeland (Figure 10)
	Selection of a subset of the AoI by drawing a polygon, square, or circle on the map.

◀▶	Swipe between layers, if any
◤◥◣◢ 20 m 50 ft + −	Zoom- in/out, zoom extent, and scale bars
🔍	Address search engine 🔍 Via Massaua, 12, 70132 Bari BA, Italy

An overview of filtered cells through interaction with analytics or with the map is available in the header of the web interface (Figure 9).

Rheticus SAFELAND   DISPLAYING 15,215 OF 15,215 CELLS   planetek italia ⓘ
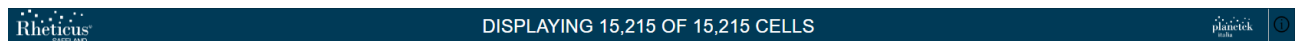
Figure 9 Header of the user interface

3.2.1. Additional layers

The right-side menu gives access to additional layers:

▶ Italian catalogue of landslides IFFI;

▶ Open Street Map.

3.2.2. Final specifications

Measurements are continuously updated. The standard service provides an update every three months. At each update, all newly acquired measurements are made available. The standard service, based on the Sentinel-1 data, provides 4-year historical measurements starting from the activation date, with at least one measurements every 12 days, and with all available measurements within 2 years backwards the activation date.

For client's specific-purposes, exploitation of commercial satellite data (i.e. COSMO-SkyMed, TerraSAR-X, etc.) is possible [8].

The service is accessible as a cloud service and as web service following OGC standards. It is available in Machine-to-Machine (M2M) via standard sharing protocols.

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[8] Additional costs may occur.

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The service is available worldwide, and is accessible via web 24/7, with any portable device.

3.2.3. Integration with other Rheticus® services

Rheticus® Safeland can be integrated with other Rheticus® services becoming a complete system for territory monitoring[8].

Through the dashboard of analytics, it is possible to access all the analytics of Safeland and all other Rheticus® services possibly integrated (Figure 10).
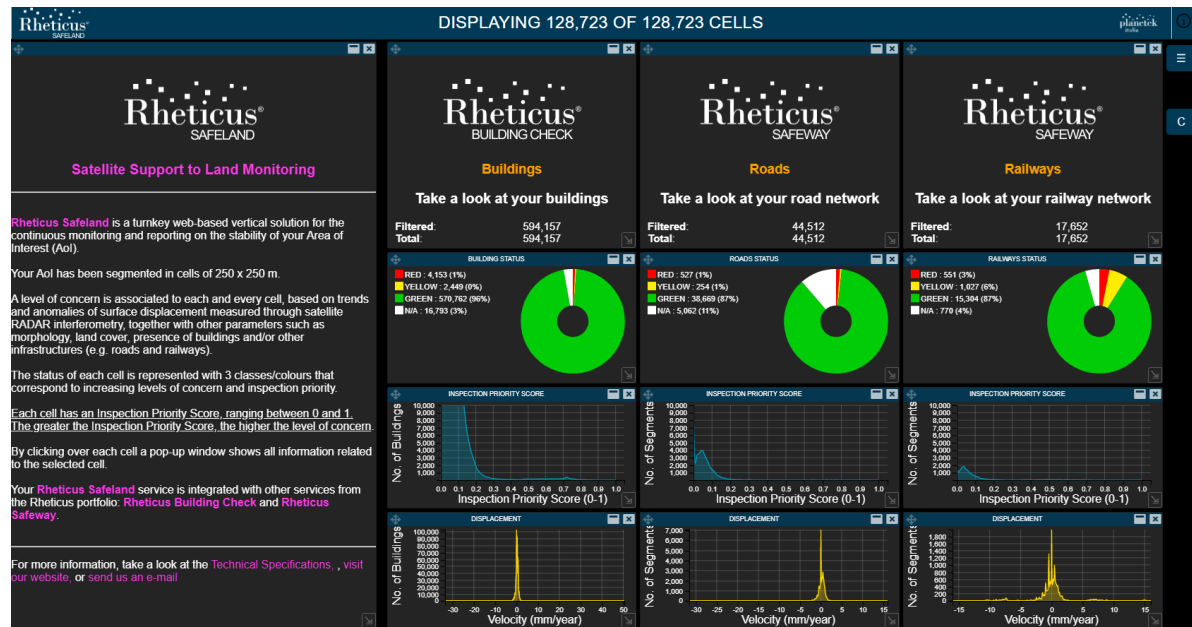

Figure 10 - Dashboard of analytics in the integrated version

For each portion of the territory, further detailed levels of information are available for buildings and/or transportation infrastructures, allowing to analyse phenomena with high precision over time (Figure 11).

Inside each cell, it is possible to query buildings and transportation infrastructures (Figure 11). By clicking over each building/road/railway a pop-up window shows all information related to the selected feature (Figure 12):

- ▸ Building/Road/Railway ID;

- ▸ Geographic coordinates (latitude, longitude);

- ▸ Relative Cell ID;

- ▸ Building/Road/Railway Status;

- ▸ Velocity (mm/year);

- ▸ Acceleration (mm/year^2);

- ▸ Distance of the critical PS from the segment (m);

- ▸ Inspection Priority Score.

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Figure 11 Detail of a cell 250 x 250 m, together with buildings and roads
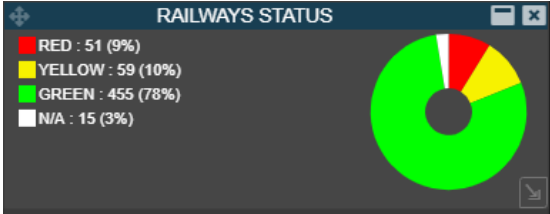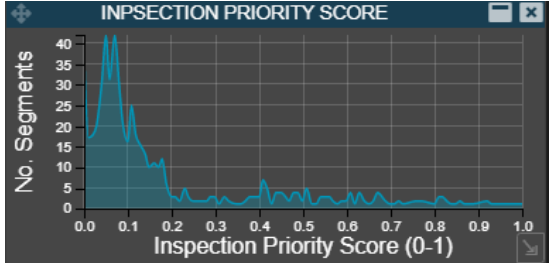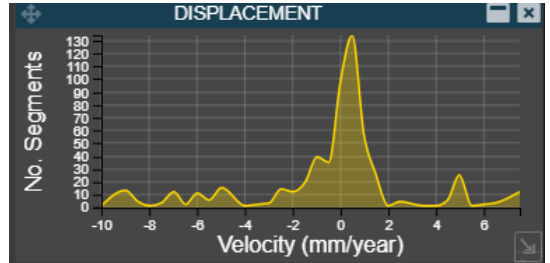

Figure 12 Details of information available in the pop-up window by clicking on each building/road

Moreover, the map of PS[3] can be switched on/off from the right-side menu (Rheticus®
Displacement). Each PS is classified accordingly to the average velocity of displacement
(mm/year) of the PS itself, measured through satellite radar data. The average velocity of PS
is represented through a colour ramp, ranging from red (PS moving downwards along the
satellite's LoS) to blue (PS moving upwards along the satellite's LoS), through green for
stable ones (Figure 13).

Figure 13 Scale of displacement velocity

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The following table describes the additional analytics of the other integrated vertical services available in the Business Intelligence dashboard:

Rheticus® Safeway e Rheticus Building Check: analytics	
	Overview of buildings and/or transportation segments by status. By interacting with the widget, it is possible to dynamically filter all analytics and cells.
	Each building and/or each segment of the transportation network has an Inspection Priority Score, ranging between 0 and 1. The greater Inspection Priority Score, the greater level of concern. Through a dynamic window, it is possible to select a particular range of Inspection Priority Score and, as a consequence, the related buildings/segments having a score belonging to the selected range.
	Frequency of occurrence of velocity values measured over the buildings and/or segments of the transportation infrastructure. Through a dynamic window, it is possible to select a particular range of velocity and, as a consequence, the related buildings/segments.

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4. Key Benefits

▸ **Optimised Monitoring:** identifying locations with high levels of concern due to instability where invest money to ensure people and assets safety and security.

▸ **Regular Monitoring of the territory and assets:** keeping up with management, monitoring, maintenance and rehabilitation needs over time with regularly-updated information powered by BI analytics.

▸ **Unparalleled Plan Insight**: planning with an informed understanding of necessary project precautions such as slope-stability intervention, allowing the customer to predict and minimize risks.

▸ **No Required Expertise with GIS or Earth Observation Data**: Complex, multi-source data is geoprocessed by the application platform, which presents you with a simple yet dynamic interface to easily perform analytics and derive project-specific insight.

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