



Rheticus[®] Safeland

Satellite monitoring of ground stability

Technical Specifications

■ Document Info

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1. Rheticus®

...

Rheticus® is a cloud platform that delivers geo-information services for monitoring the evolution of the Earth's surface (Figure 1). The geo-information services delivered by the platform include services for monitoring the dynamics of land morphology, vegetation, infrastructure and marine-coastal waters, aimed at monitoring both environmental and production-related aspects.

Rheticus® is a subscription-based platform that provides constantly updated information.

Services are updated using satellite images, cartographic data and environmental information available online as open data. Services are updated every time new data become available and, depending on the service, the update frequency can range from monthly to daily.

Access to Rheticus® is multi-platform and the services can be used both through the web portal and on tablets and smartphones. The services include maps, reports and geospatial indicators. Information is accessed through a preset dashboard that simplifies the analysis of the monitored phenomena, providing an immediate overview.

The services can also be accessed in Machine to Machine (M2M) mode through standard sharing protocols, making the Rheticus® platform an information HUB that delivers content to other online systems. Data and information export functions are also available, allowing users to download them in standard formats for use in application environments outside the platform.

Rheticus® services can be activated by subscribing, which provides the credentials to access the platform. From their reserved area, users can consult the updated data and the historical information on their area of interest for the services they have activated.

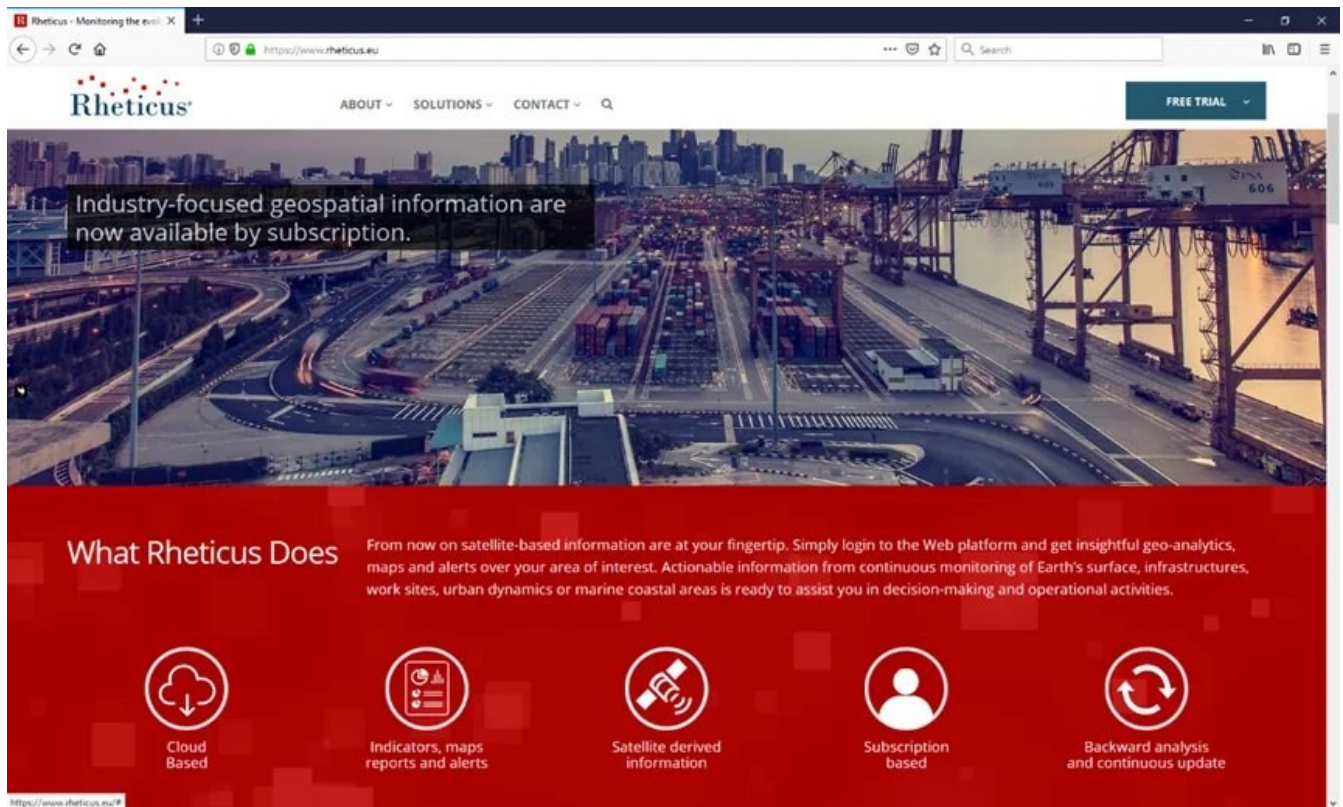


Figure 1 - Rheticus® Website <https://www.rheticus.eu>.

1.1. Rheticus®: Main features

Services

- Best cost/performance ratio thanks to the use of open data, automated processing and a cloud architecture.
- Geographic information services designed to meet users' needs.
- Monitoring services that can be activated on any area of the globe.

Data

- Use of geospatial information and open data available on the cloud.
- Direct access to the main satellite image providers, using the best data available on the areas of interest.

Processing

- Automatic data processing along the entire processing chain, ensuring timely and constant updating of the geo-information services.
- Standardised processing procedures for high-quality geo-information services.

Delivery

- Standardised outputs, with quality requirements measurable through predefined metrics.
- Geo-information services supplied with both the service metadata and the metadata of the data used to produce them.
- Download of the data and information of interest in standard formats, usable in the main office automation applications and in CAD and GIS software.
- Accessible from personal computers, tablets and smartphones through a graphical user interface (GUI) or through M2M (Machine-to-Machine) access.

Terms conditions

and

- Terms of use and licence 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. Rheticus® Services

Rheticus® Services

Satellite monitoring and periodic reporting services supporting production activities, environmental protection and citizens' well-being



Analysis of millimetric ground surface movements due to **slow landslides and/or subsidence** in urban and non-urban areas, measuring the extent of displacements and accelerations over time.



Analysis of **multi-hazard ground stability and hazard conditions across the territory**, through automatic classification of the territory based on satellite monitoring of surface displacements combined with multi-hazard factors (flood and landslide hazard, burnt areas).



Analysis of the **stability of transport infrastructure**, such as roads, railways and airports. The segmented infrastructure is classified on the basis of the velocities and accelerations measured over time.



Analysis of the level of **stress on water and sewer networks** and, more generally, on underground utilities beneath the road surface. The infrastructure is classified according to the level of stress related to ground movements.



Analysis of the **stability of buildings**, classified according to the level of stress related to the displacements and accelerations measured over time.



Analysis of the **quality of marine-coastal waters** by measuring chlorophyll, turbidity, temperature and algal blooms.



Analysis of the trends in **shellfish and fish growth** in aquaculture farms, supporting farm management and the identification of the optimal harvesting period.



Analysis of urban dynamics for monitoring the **land transformations** caused by construction works or by the implementation of local plans (EIA and SEA of master plans, PUG, building plans) or wide-area plans.



Analysis of **burnt areas** with classification of damage severity, assessment of vegetation regrowth and detection of anomalous transformations in areas already burnt and subject to restrictions.



Analysis of the **vegetative vigour of vineyards** to optimise agronomic practices and the selective harvesting of grapes for the production of high-quality wines.

2. Rheticus® Safeland

...

Satellite monitoring of ground stability

2.1. Overview

Ground instability is a serious threat to public safety, to the integrity of infrastructure and to the environment. Human activities and climate change can contribute to the evolution of these phenomena; landslides and ground failures can cause significant damage to infrastructure assets, economic losses and, in the most serious cases, loss of life.

For those responsible for managing land and infrastructure, it is therefore increasingly important to have effective systems for monitoring ground stability. Up-to-date, accurate information available at sustainable costs makes it possible to schedule timely inspections and targeted checks in the areas with the highest attention levels.

Rheticus® Safeland is a monitoring and reporting service on ground stability based on a multi-hazard approach. Through automated procedures, the service assigns an attention level to each portion of the territory by combining the evidence of surface deformation measured by satellite with the hazard, susceptibility, exposure and context information layers available for the area of interest.

The service provides a synoptic view of the territory and periodically updated information on the attention level. It makes it possible to distinguish stable areas from those affected by slow-moving landslides or subsidence, and to integrate information on burnt areas and flood hazard. Rheticus® Safeland is therefore a diagnostic tool that complements in-situ monitoring activities.

Rheticus® Safeland helps those responsible for protecting and managing the territory to identify the areas that should be prioritised for further diagnostic investigation and targeted inspection. The information provided forms an up-to-date knowledge base supporting land-planning and infrastructure-design decisions, without replacing the in-situ checks and specialist assessments needed to define any prevention or mitigation measures.

Rheticus® Safeland supports the following activities:

- identifying previously unknown unstable areas;
- analysing the flood and landslide hazard levels associated with each portion of the territory;
- monitoring the trends of known unstable areas and following their evolution over time;
- assessing the effectiveness of stabilisation works carried out in unstable areas.

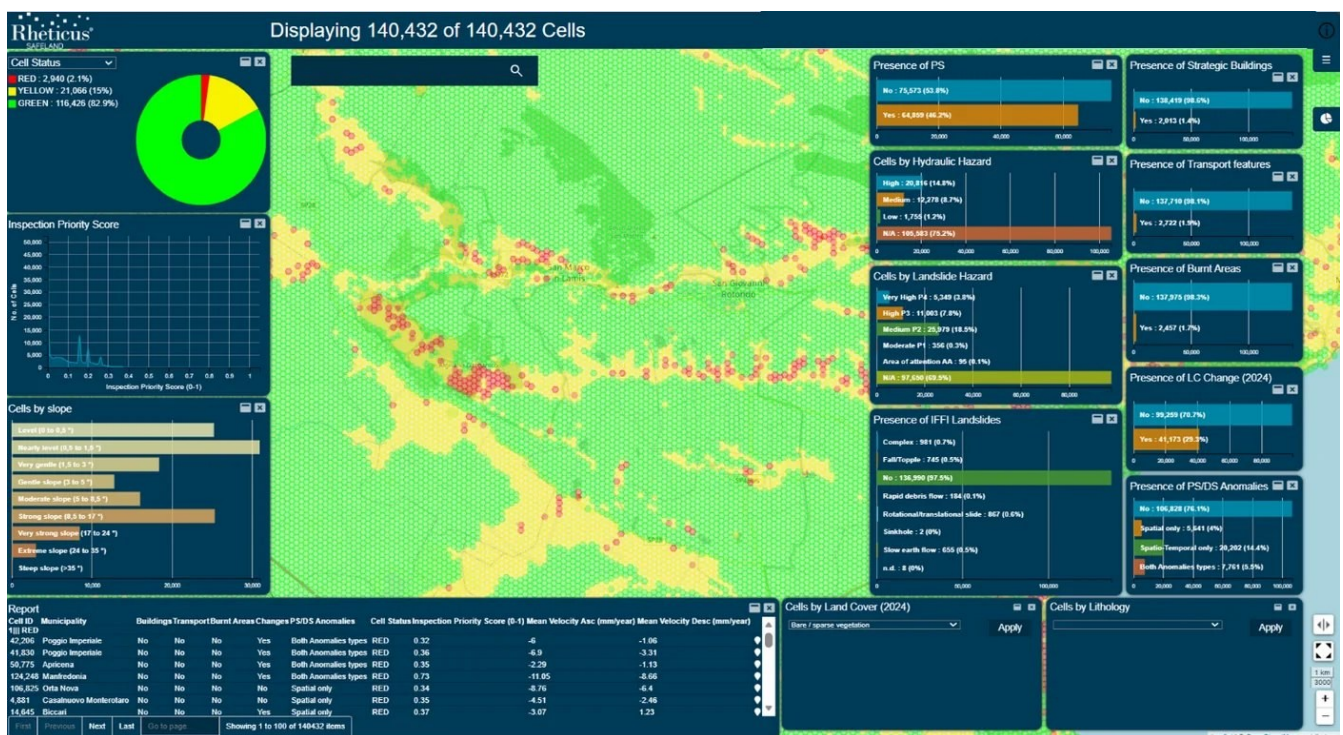


Figure 2 - User interface¹ of Rheticus® Safeland: example of multi-hazard land monitoring and related geo-analytics.

¹The user interface is continuously improved to offer an ever better user experience and new features

2.2. Who is it for?

Rheticus® Safeland has been designed to meet the monitoring needs of:

- Regional authorities
- Municipalities
- Metropolitan cities
- Regional Environmental Protection Agencies
- River Basin District Authorities
- Civil engineering companies
- General contractors

3. Technical Specifications

Rheticus® Safeland is a multi-hazard monitoring and reporting service that supports the integrated assessment of ground stability and of the attention conditions of the territory.

The monitored area of interest is divided into hexagonal cells of about 5 ha. Each cell is classified by automatic procedures that analyse the trends and anomalies of surface displacements and integrate landslide and flood hazard factors and information on burnt areas, depending on the availability and suitability of the data.

Each cell is assigned a low, moderate or high attention level, expressed through the Inspection Priority Score (IPS), a patented indicator. The IPS is calculated by a multi-hazard algorithm that combines the indicators derived from satellite measurements of ground movements and their anomalies with the amplification factors associated with the multi-hazard information layers available for the area of interest. The indicator has a diagnostic function, supporting the definition of investigation and inspection priorities, and does not replace in-situ checks or specialist assessments.

The system integrates further available information layers, such as land cover and its changes, morphology and exposure data on buildings and infrastructure, to provide an integrated view of the area of interest.

The service can be integrated with the other services of the Rheticus® family to create a complete land monitoring system: Rheticus® Displacement, Rheticus® Safeway, Rheticus® Building Check, Rheticus® Network Alert and Rheticus® Wildfires.

3.1. Activation

The subscription is activated on the area of interest (Aoi) provided by the customer as a georeferenced vector file (ESRI shapefile, KML, DWG/DXF).

When the service is activated, the customer receives access to the web platform for the entire duration of the subscription.

The service is available at <https://services.rheticus.eu/> with the credentials received on activation.

3.2. Using the service and dashboard description

After logging in, the user accesses the web platform and launches the application. The system then loads the map of the Aol, divided into hexagonal cells of about 5 ha (Figure 2, Figure 5), and the geo-analytics available in the Business Intelligence (BI) dashboard.

Each cell is classified according to two main components:

- Displacement measurements and their density within each cell of the Aol, derived from satellite radar data^{2,3,4,5}. In particular, the main information layers on velocity and displacement include:

▪ Spatial anomalies: unstable areas identified by grouping points with average velocities above a given threshold, measured along the LOS (Line of Sight). Each group of points (cluster) is bounded by a polygon and uniquely identified.	▪ Spatio-temporal anomalies: unstable areas identified by analysing displacement time series projected along the LOS, in order to detect recent changes (breakpoints) such as changes in velocity or sudden displacements. Points showing the same behaviour are grouped into clusters, each bounded by an identifying polygon. ▪ Persistent Scatterers and Distributed Scatterers (PS/DS) that do not belong to clusters of spatial or spatio-temporal anomalies.
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²Cells are classified on the basis of the velocity, acceleration and coherence measurements of Persistent Scatterers (PS), and of their density within the cell. PS are highly stable points on the ground. PS are identified and their velocity, acceleration and coherence are measured through the fully automatic multi-temporal SAR interferometric processing chain (MT-InSAR) called SPINUA[®]. Further 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

³Coherence (%) is a parameter directly related to PS quality: higher coherence means lower measurement uncertainty. The coherence value is also provided normalised in the 0-100 % range.

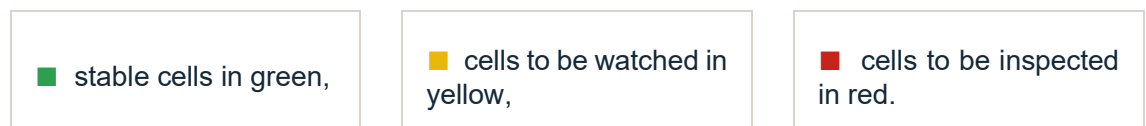
⁴Surface displacement measurements have a precision of ± 1.5 mm/year along the satellite line of sight (LoS, Line of Sight). Surface displacement is measured along the satellite line of sight. The spatial positioning of the PS has a precision of ± 10 m. Data are provided in a geographic reference system.

⁵The standard service uses free satellite data from the Sentinel-1 constellation of the European Copernicus Programme. Further information on the Sentinel-1 constellation is available at the following link: <https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/overview>.

Amplification factors that take into account:

- burnt areas, considered in relation to the average slope of the cell and to the extent of the burnt area within each cell of the AoI;
- flood and landslide hazard, assessed on the basis of the hazard class and of the affected area within each cell.

The three colour classes represent increasing levels of attention and inspection priority, making it possible to distinguish the status of the cells at a glance (Figure 3):



Each cell of the AoI is associated with an inspection priority score (Inspection Priority Score), which can range from 0 to 1. Increasing Inspection Priority Score values correspond to increasing levels of inspection priority. A sliding window makes it possible to select a score range and display the cells whose values fall within the selected range (Figure 4).

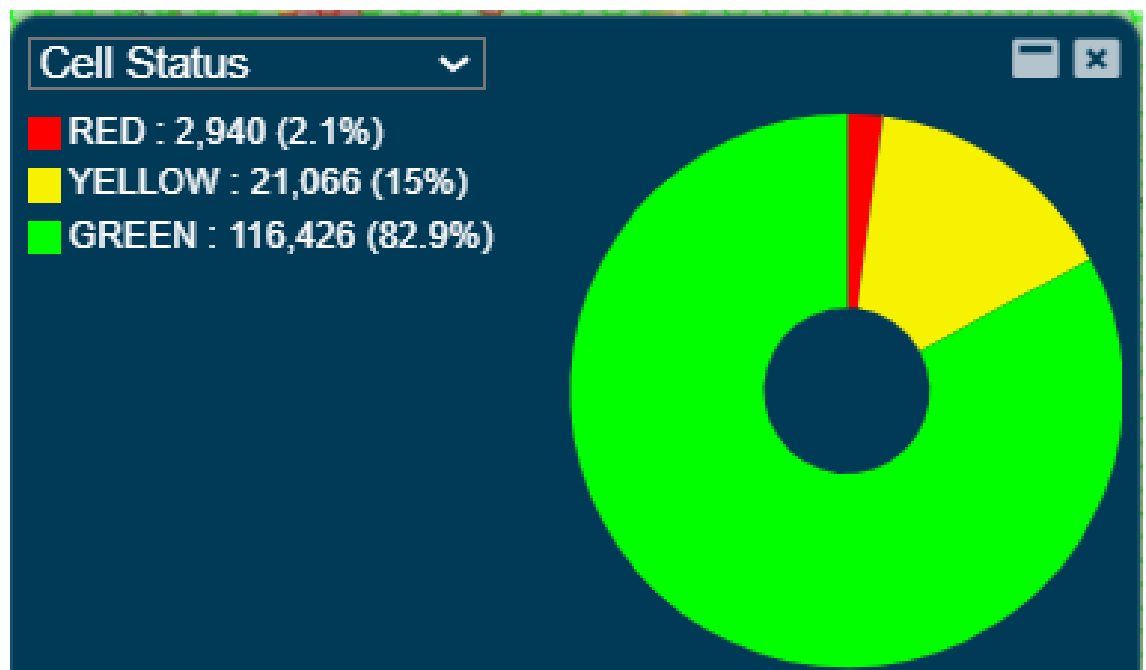


Figure 3 – Number of cells per attention class (“status”), with filtering.

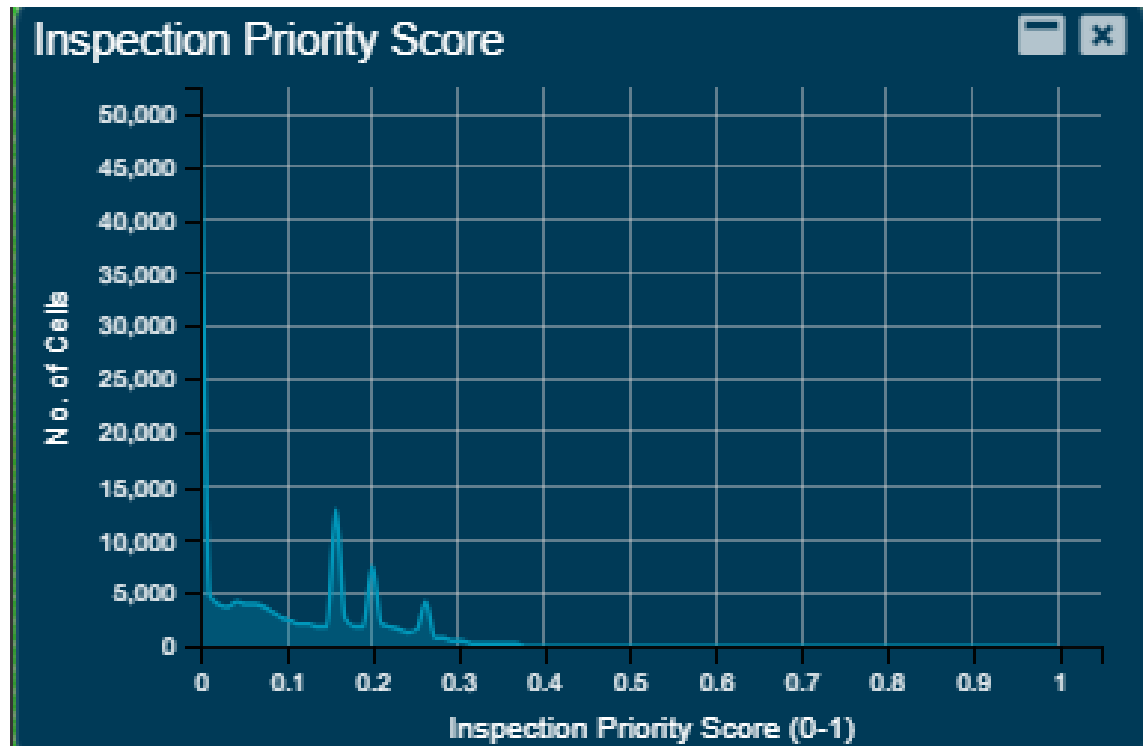


Figure 4 – Selection of the Inspection Priority Score range and filtering of the Aol cells.

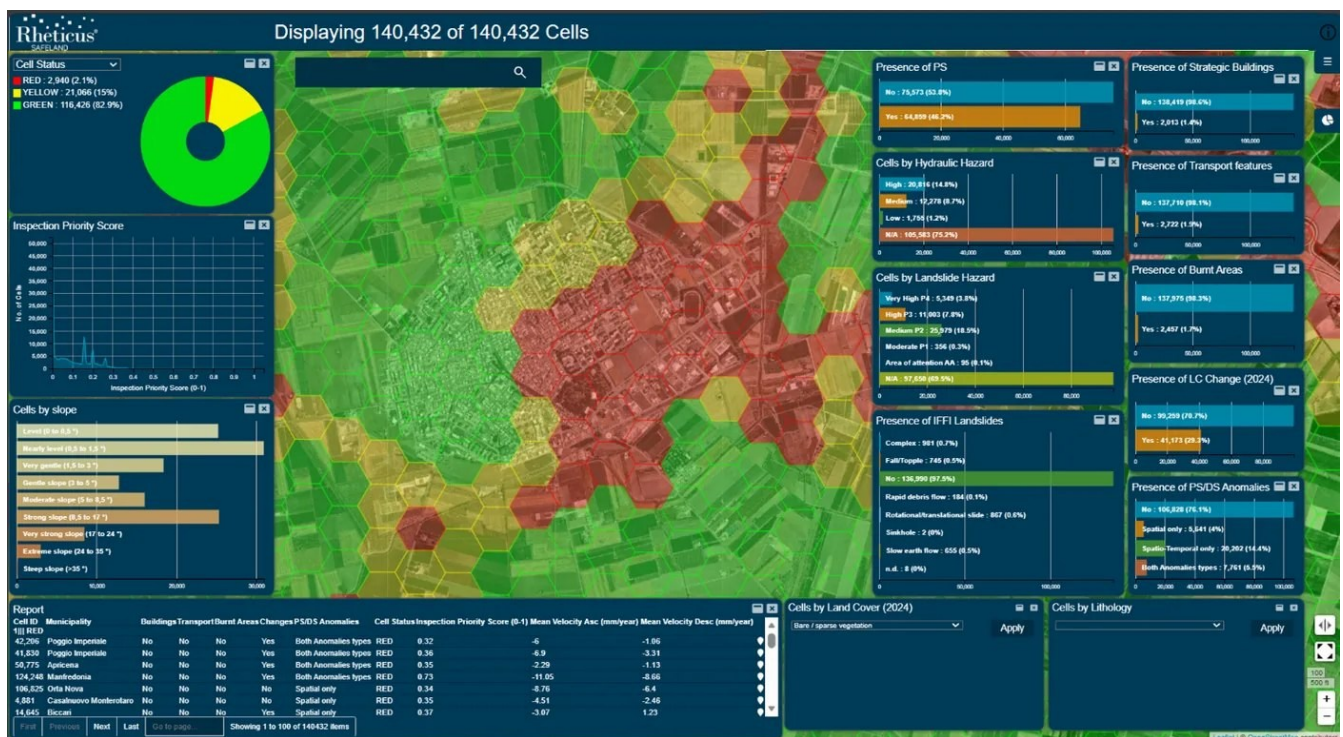


Figure 5 - Map interface of an urban area divided into hexagonal cells, classified by combining displacement measurements, measurement point density and the available multi-hazard factors.

Each cell can be queried by clicking on its geometry. A pop-up window shows the summary information associated with the selected cell (Figure 6).

In particular, each cell is associated with basic information, always available, and with additional attributes derived from the layers activated in the specific service configuration. The basic information includes at least the unique cell identifier, the geographic coordinates, the attention level, the Inspection Priority Score and the available displacement indicators; further hazard, context and exposure attributes depend on the datasets available for the area of interest. The information that can be associated with each cell is listed below:

▪ Type of layer queried;	▪ Unique cell identifier;
▪ Geographic coordinates (latitude, longitude);	▪ Administrative or territorial unit, according to the subdivision available for the area of interest;
▪ Attention level class;	▪ Inspection Priority Score;
▪ Average displacement velocity along the LOS in ascending orbit;	▪ Average displacement velocity along the LOS in descending orbit;
▪ Number of ascending PS/DS in the cell;	▪ Number of descending PS/DS in the cell;
▪ Maximum area among the spatial anomalies in the cell;	▪ Maximum area among the spatio-temporal anomalies in the cell;
▪ A link to Rheticus® Displacement to analyse the displacement trends of all measurement points (PS ³) within the cell (Figure 7).	
▪ Average elevation and slope;	▪ Prevailing lithology type;
▪ Prevailing land cover;	▪ Average land cover change;
▪ Extent of burnt areas;	▪ Prevailing landslide and flood hazard;
▪ Presence of landslides;	▪ Presence of buildings;
▪ Presence of transport infrastructure;	▪ Average summer temperature;
▪ Average wind speed in summer;	▪ Prevailing wind direction in summer;
▪ Average annual precipitation;	▪ Maximum monthly precipitation;
▪ Month with the highest precipitation;	



Figure 6 - Detail of the information shown in the pop-up when clicking on a single cell.

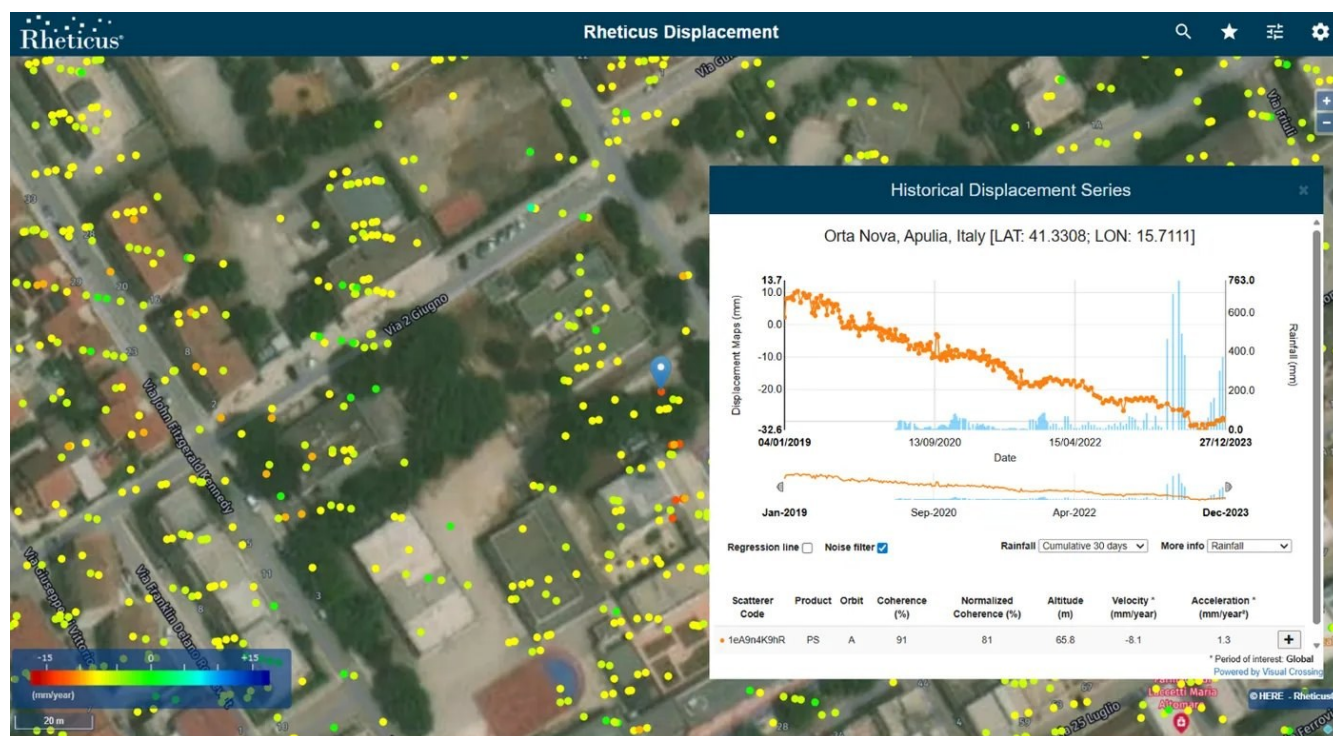


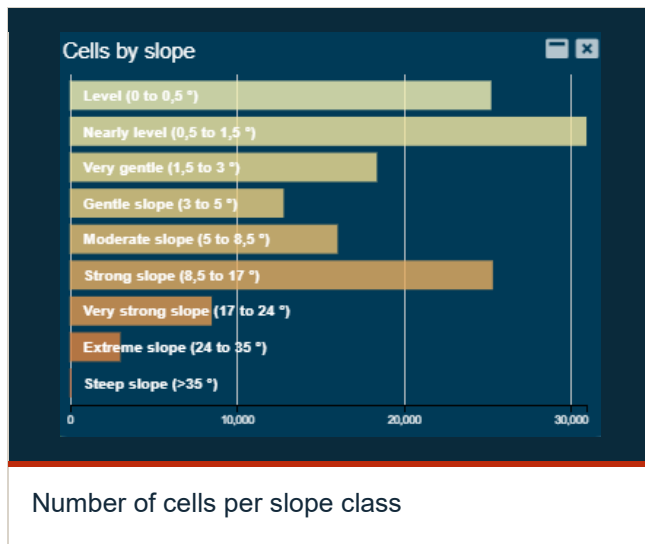
Figure 7 - Integration with Rheticus® Displacement.

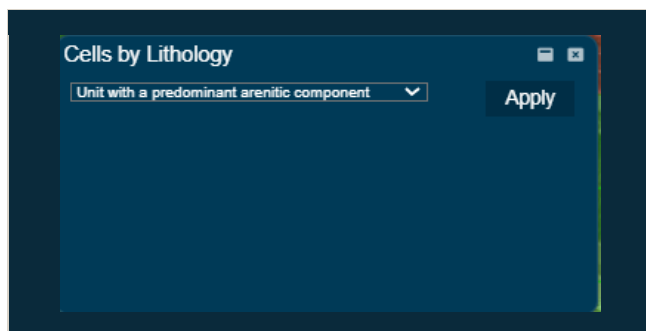
The table shown in the lower part of the web interface provides a detailed report on the status of the entire Aol. For each cell it shows: identifier; administrative or territorial unit, according to the subdivision available for the area of interest; presence of buildings, transport infrastructure and burnt areas; land cover changes; spatial and spatio-temporal anomalies; cell status; Inspection Priority Score; average displacement velocities along the LOS for ascending and descending orbits; Zoom-to-Feature command (Figure 8).

Report	Municipality	Buildings	Transport	Burnt Areas	Changes	P505 Anomalies	Cell Status	Inspection Priority Score (0-1)	Mean Velocity Asc (mm/year)	Mean Velocity Desc (mm/year)
Cell ID										
42,206	Foggia Imperiale	No	No	No	Yes	Both Anomalies types	RED	0.32	-6	-1.06
41,830	Foggia Imperiale	No	No	No	Yes	Both Anomalies types	RED	0.36	-4.9	-3.31
50,775	Apricena	No	No	No	Yes	Both Anomalies types	RED	0.35	-2.29	-1.13
124,248	Mariludonia	No	No	No	Yes	Both Anomalies types	RED	0.73	-11.05	-8.66
108,625	Ottia Nova	No	No	No	No	Spatial only	RED	0.34	-3.16	-4.4
4,981	Casaleveve Monferrato	No	No	No	No	Spatial only	RED	0.35	-4.51	-2.46
14,645	Bicari	No	No	No	Yes	Spatial only	RED	0.37	-3.67	1.23
15,512	Castelluccio Valmaggiore	No	No	No	Yes	Spatial-Temporal only	RED	0.38	-8.82	-9.17
15,197	Orsara di Puglia	No	No	Yes	Yes	Spatial only	RED	0.32	0	0
24,805	Lecina	No	No	No	No	No	RED	0.32	-1.71	-4.52
31,276	Ancano di Puglia	No	No	Yes	No	No	RED	0.31	0	0
35,821	Lecina	No	No	No	Yes	Spatial-Temporal only	RED	0.37	2.17	1.9
37,834	Borino	No	No	No	Yes	Spatial only	RED	0.34	-2.34	1.24
42,686	Deliceto	No	No	No	Yes	Spatial-Temporal only	RED	0.31	-1.2	0.57
44,553	Deliceto	No	No	No	Yes	Both Anomalies types	RED	0.3	-2.1	-1.37
45,553	Apricena	No	No	No	Yes	Both Anomalies types	RED	0.31	-4.11	-2.6
46,444	Tinà	No	No	No	No	Spatial-Temporal only	RED	0.45	-0.56	0.3
56,196	Rocchetta Sant'Antonio	No	No	No	Yes	Both Anomalies types	RED	0.45	-4.68	0.28
60,508	Castelluccio dei Sani	No	No	No	No	No	RED	0.34	0	0
61,532	Foggia	No	Yes	No	Yes	Both Anomalies types	RED	0.3	-1.52	-0.78
61,494	Apricena	No	No	No	No	No	RED	0.31	-1.12	-0.96
61,885	Apricena	No	No	No	No	No	RED	0.33	-1.85	-0.85
65,977	Ascoli Satriano	No	No	No	No	Spatial only	RED	0.4	-4.37	-3.14
66,609	Rignano Garganico	No	No	No	Yes	Both Anomalies types	RED	0.44	-1.31	-0.53
69,151	Ascoli Satriano	No	Yes	No	No	Both Anomalies types	RED	0.33	-3.81	-3.18
69,544	Ascoli Satriano	No	Yes	No	No	Both Anomalies types	RED	0.32	-3.61	-3.27
73,784	Ascoli Satriano	No	No	No	No	Both Anomalies types	RED	0.33	-4.66	-4.87
74,248	Foggia	No	No	No	Yes	Both Anomalies types	RED	0.33	-1.6	0
74,241	Foggia	No	No	No	Yes	Both Anomalies types	RED	0.35	-1.7	-0.81
75,123	Rignano Garganico	No	No	No	Yes	Both Anomalies types	RED	0.33	-1.26	-0.1
82,387	San Giovanni Rotondo	No	No	No	Yes	Spatial-Temporal only	RED	0.31	-0.94	0.12
93,421	Carpinella	No	No	No	Yes	Both Anomalies types	RED	0.32	-4.57	-3.41
93,639	Cagnano Varano	No	No	Yes	No	Spatial-Temporal only	RED	0.32	-1.85	-0.54
95,386	Foggia	No	No	No	No	Both Anomalies types	RED	0.5	-7.22	-8.1
100,275	Ottia Nova	No	No	No	No	Spatial only	RED	0.33	-5.81	0
100,142	San Giovanni Rotondo	No	No	No	Yes	Spatial-Temporal only	RED	0.39	-1.69	-1.37
101,388	Stomara	No	No	No	Yes	Spatial only	RED	0.32	-4.39	-3.16
101,677	Iscillella	No	No	No	Yes	No	RED	0.31	-1.57	0
102,339	San Giovanni Rotondo	No	No	Yes	Yes	Spatial-Temporal only	RED	0.34	-1.66	-0.38
102,362	San Giovanni Rotondo	No	No	No	Yes	Both Anomalies types	RED	0.36	-2.65	-0.86
102,576	Ottia Nova	No	No	No	Yes	Both Anomalies types	RED	0.35	-3.29	-4.4
102,950	Ottia Nova	No	No	No	Yes	Both Anomalies types	RED	0.66	-8.6	-7.6
102,971	Ottia Nova	No	No	No	No	Spatial only	RED	0.4	-7.14	-4.88
106,193	San Giovanni Rotondo	No	No	No	Yes	Spatial-Temporal only	RED	0.41	-1.35	-3.29
107,576	Ottia Nova	No	Yes	No	No	Spatial only	RED	0.77	-9.93	-9.05
110,101	Iscillella	No	No	No	Yes	Spatial-Temporal only	RED	0.31	-0.97	0
110,102	Iscillella	No	No	No	Yes	Spatial-Temporal only	RED	0.36	-2.14	-1.99
110,565	Carpinella	No	No	No	Yes	Both Anomalies types	RED	0.32	-5.82	-4.56
111,488	San Giovanni Rotondo	No	No	No	No	Both Anomalies types	RED	0.31	-1.62	-0.06
111,709	Carpinella	No	No	No	No	Spatial only	RED	0.37	-9.23	-9.82
112,454	Carpinella	No	No	No	No	Both Anomalies types	RED	0.44	-9.4	-7.77
113,552	Carpinella	No	No	No	Yes	Spatial only	RED	0.41	0	0
115,772	Carpinella	No	Yes	No	Yes	Both Anomalies types	RED	0.33	-6.14	-5.67
117,248	Carpinella	No	Yes	No	Yes	Both Anomalies types	RED	0.62	-6.73	-6.65
117,218	Carpinella	No	No	No	No	Spatial only	RED	0.32	0	-10.97
117,778	Mariludonia	No	No	Yes	Yes	Spatial-Temporal only	RED	0.38	-1.73	0.28
118,361	Carpinella	No	Yes	No	Yes	Both Anomalies types	RED	0.73	-9.7	-8.79

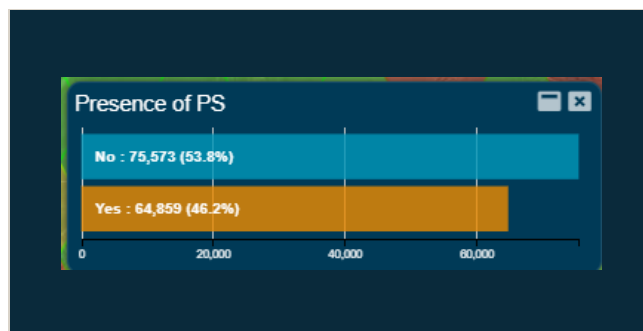
Figure 8 - Detailed report of the information associated with the cells of the entire Aol.

The following table describes the additional analytics available in the Business Intelligence dashboard. The widgets make it possible to dynamically filter the displayed cells according to the selected parameters and the type of analysis performed.

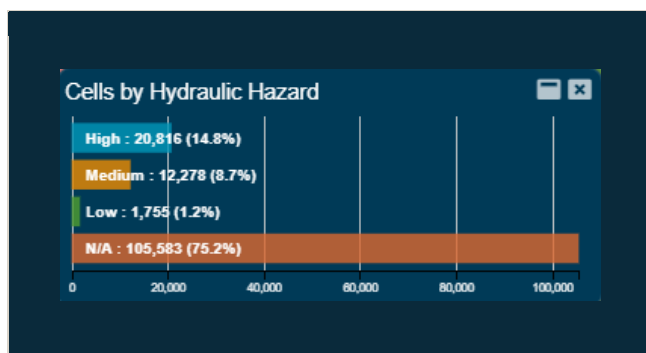




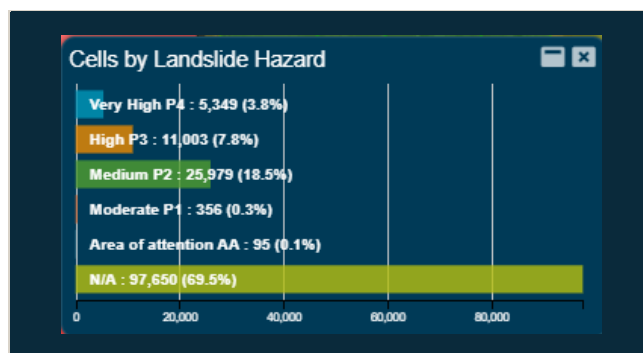
Number of cells per prevailing lithology



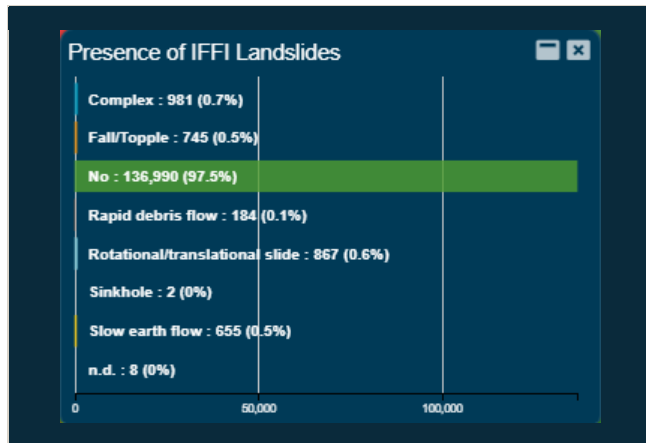
Number of cells with PS



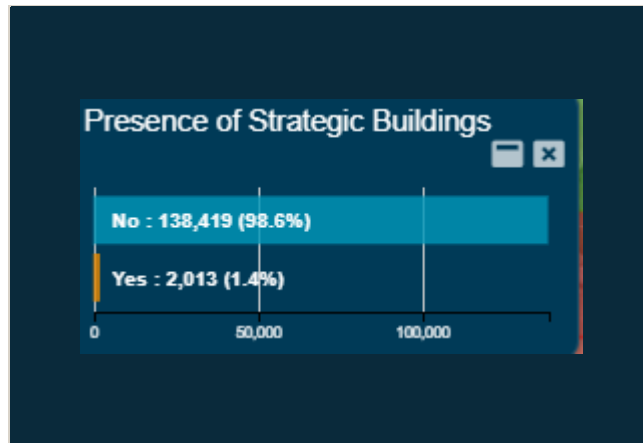
Cells per flood hazard level



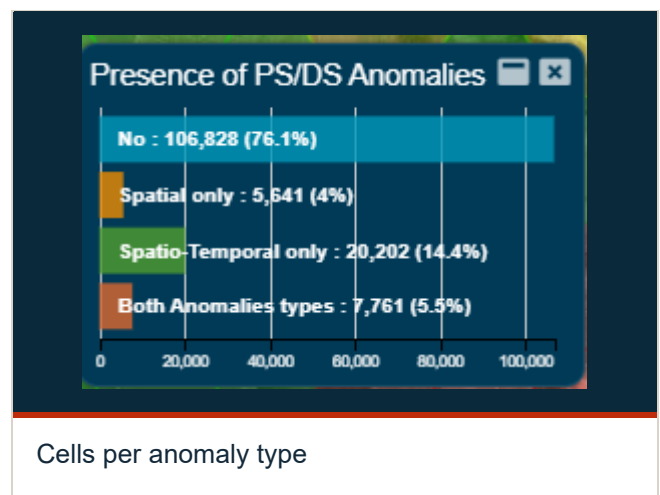
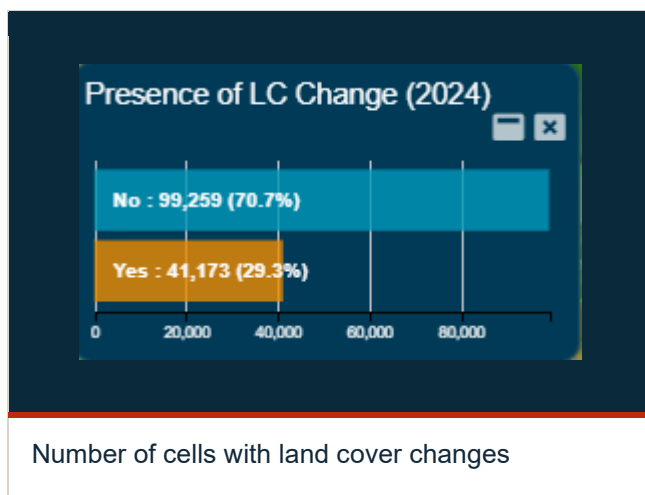
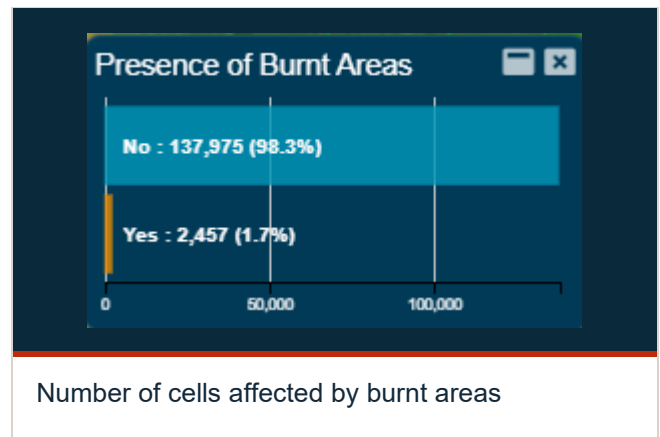
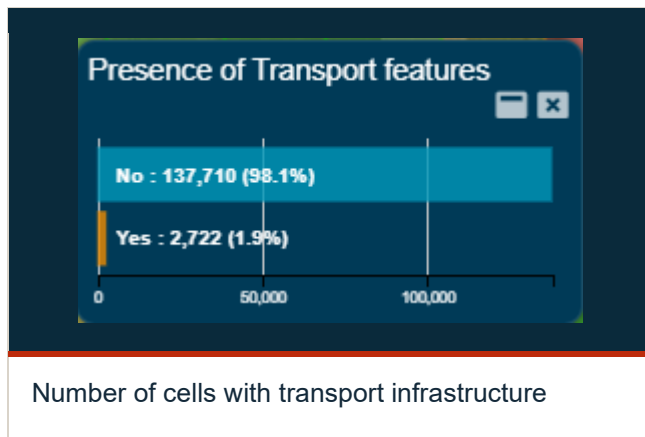
Cells per landslide hazard level



Cells per landslide type



Number of cells with strategic buildings



The pop-up side menus on the right-hand side of the dashboard give access to the display, analysis, filtering and navigation functions described below:



Provides access to:

- the list of information layers in the web app;
- the analytics;
- the filters;

with the option to show/hide them on the map.



Makes it possible to dynamically compare two information layers displayed on the map.



Map zoom and scale bar



Address and place search

Q Via Massaua, 12, 70132 Bari BA, Italy

The header of the web interface shows an updated overview of the cells resulting from the filters applied through the analytics or directly on the map, as shown in Figure 9.

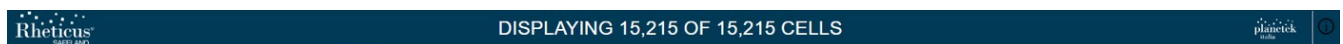


Figure 9 - Summary of the cells resulting from the filters applied in the web interface.

3.2.1. Information layers

The side menu makes it possible to activate or deactivate the information layers configured for the service. Depending on the hazards considered and on the availability of suitable data for the area of interest, the catalogue may include:

- Cells themed by Inspection Priority Score (IPS);
- Spatial anomaly clusters and spatio-temporal anomaly clusters;
- Ground motion map (PS/DS);
- Strategic buildings/infrastructure (buildings, roads, railways);

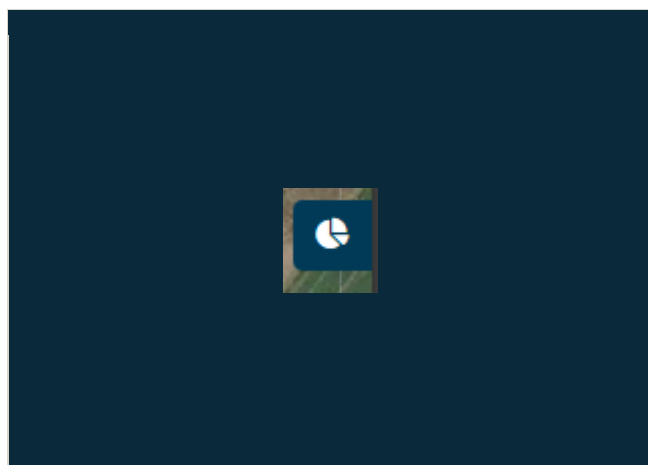
- Lithological map;
- Burnt area map;
- Land cover change map;
- Flood and landslide hazard map;
- Official landslide inventories and maps available for the area of interest, from national, regional or local authorities or from suitable supranational or global datasets. For service configurations covering Italian territory, the national IFFI catalogue can be used.

The information layers can be queried by clicking on their geometries, as shown in Figure 10.

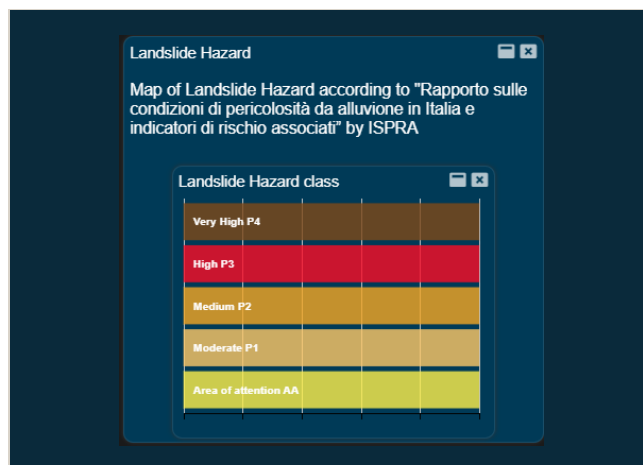


Figure 10 – Detail of the information available for the burnt area layer.

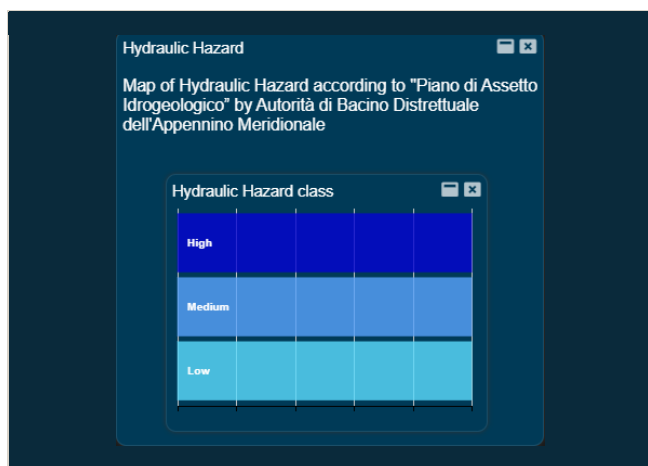
The secondary page makes it possible to filter the information layers and keep visible only those relevant to the analyses in progress on the area of interest. To apply the filter, the information layer must be active, as shown in Figure 11:



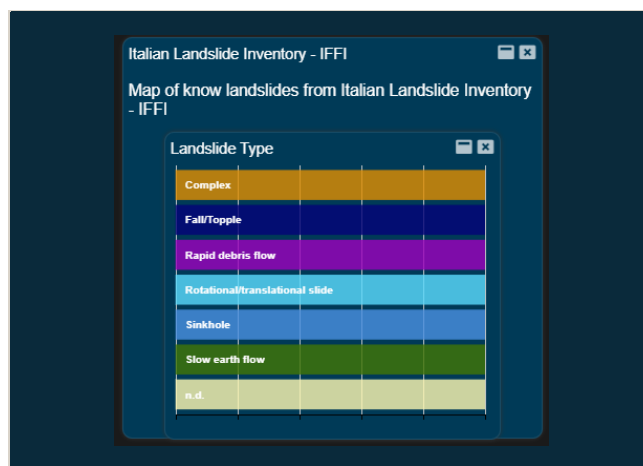
Button that opens the secondary page



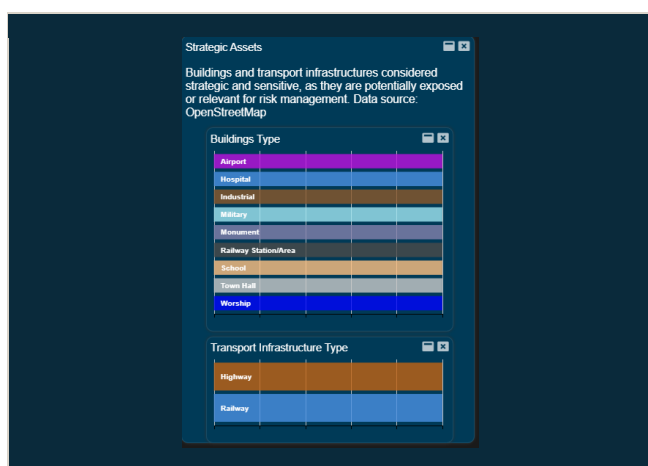
Layer by landslide hazard type



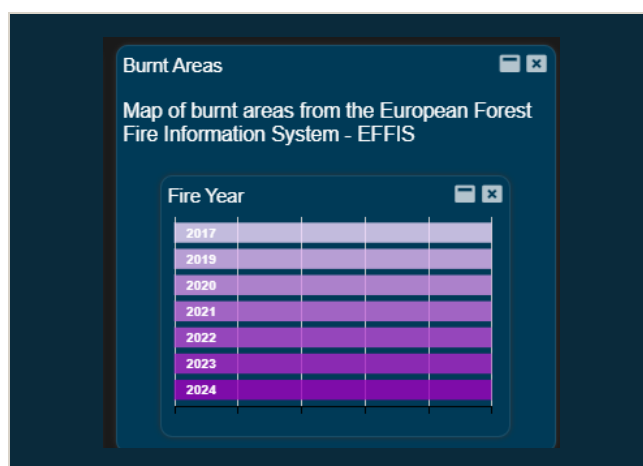
Layer by flood hazard type



Layer by landslide type



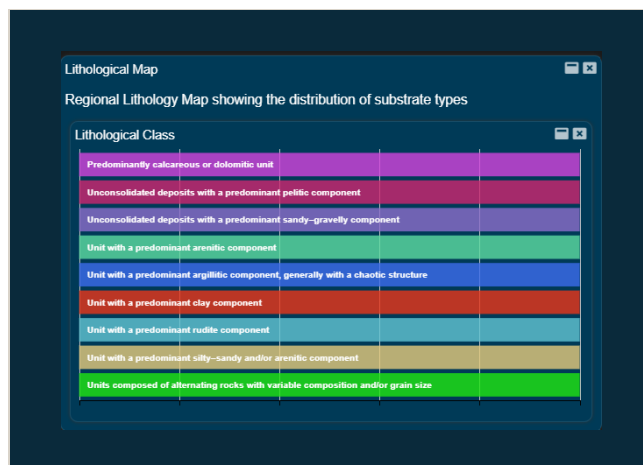
Layer by building and infrastructure type



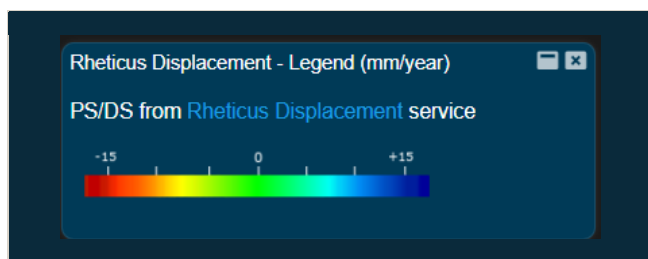
Layer by year of fire occurrence



Layer by land cover type and land cover change



Layer by lithology type



PS/DS legend in Rheticus® Displacement



Figure 11 – Filter on the landslide hazard information layer.

3.2.2. Service configuration and delivery

Measurement data are updated at the frequency set in the service configuration. For the standard service, updates are quarterly. At each update, the new measurements obtained from the usable acquisitions are made available⁶. The standard service, based on Sentinel-1 data, includes the generation of displacement time series for the area of interest, going back up to ten years before activation, with a nominal measurement frequency of up to 6 days.

The service also includes support and discussion with the end user, aimed not only at making the information provided easier to interpret, but also at taking into account the user's expectations, knowledge of the territory and operational priorities. These elements can be incorporated into the service configuration and into the definition of attention priorities for the monitored areas, contributing to the determination of the Inspection Priority Score (IPS) consistently with the available evidence and with the end user's operational needs.

For specific user purposes, commercial satellite data can be used (e.g. COSMO-SkyMed, TerraSAR-X, etc.).⁷

The service can be accessed via browser, both through an intuitive web interface and through WMS (Web Map Service) services compatible with GIS software. It is also available in Machine-to-Machine (M2M) mode through standard sharing protocols that allow the data to be integrated automatically into other systems or applications.

The service is available worldwide and can be accessed via the web, 24 hours a day, 7 days a week, from any device, including mobile devices.

3.2.3. Integration with other Rheticus® services

Rheticus® Safeland can be integrated with the other services of the Rheticus® family to create a complete land monitoring system⁹.

⁶Further information on the revisit times of the Sentinel-1 constellation is available at the following link: <https://sentiwiki.copernicus.eu/web/s1-mission>

⁷Additional costs may apply.

The Business Intelligence dashboard gives access to all the analytics of the Safeland service and of any other integrated Rheticus® services (Figure 12).

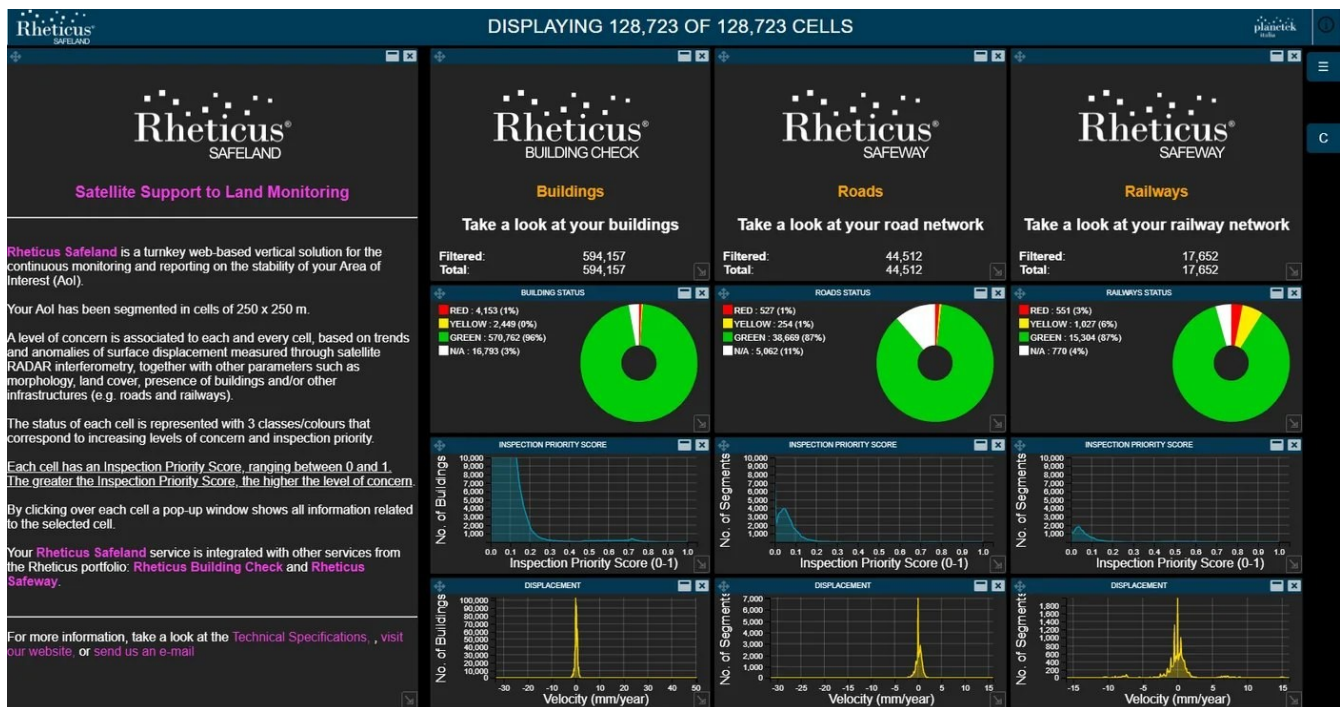


Figure 12 - Analytics dashboard of the integrated version.

With the integration, additional detailed information layers become available on the stability of the buildings and infrastructure in the AoI.

Within each cell, the buildings and infrastructure in that cell can be queried (Figure 13). Clicking on the geometry of a building, road or railway opens a pop-up window with the summary information of the selected infrastructure (Figure 14):

- Building/road/railway ID;
- Geographic coordinates (latitude, longitude);
- ID of the cell it belongs to;
- Building/road/railway status;
- Velocity, acceleration and distance of the critical PS from the building/road/railway;
- Inspection priority;



Figure 13 - Detail of the hexagonal cells and of the buildings and transport infrastructure within them.



Figure 14 - Detail of the information shown in the pop-up when clicking on a single infrastructure

In addition, clicking on the “Analyze trends in Rheticus Displacement” link opens the map of the PS/DS measurement points available in Rheticus® Displacement.

In particular, PS displacements are shown in classes of different colours: stable PS in green, PS moving away along the LoS (subsidence) in red and PS moving towards the satellite along the LoS (uplift) in blue (Figure 15).

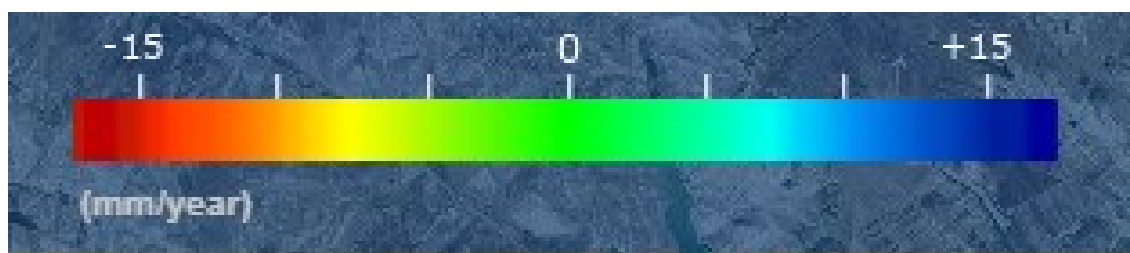
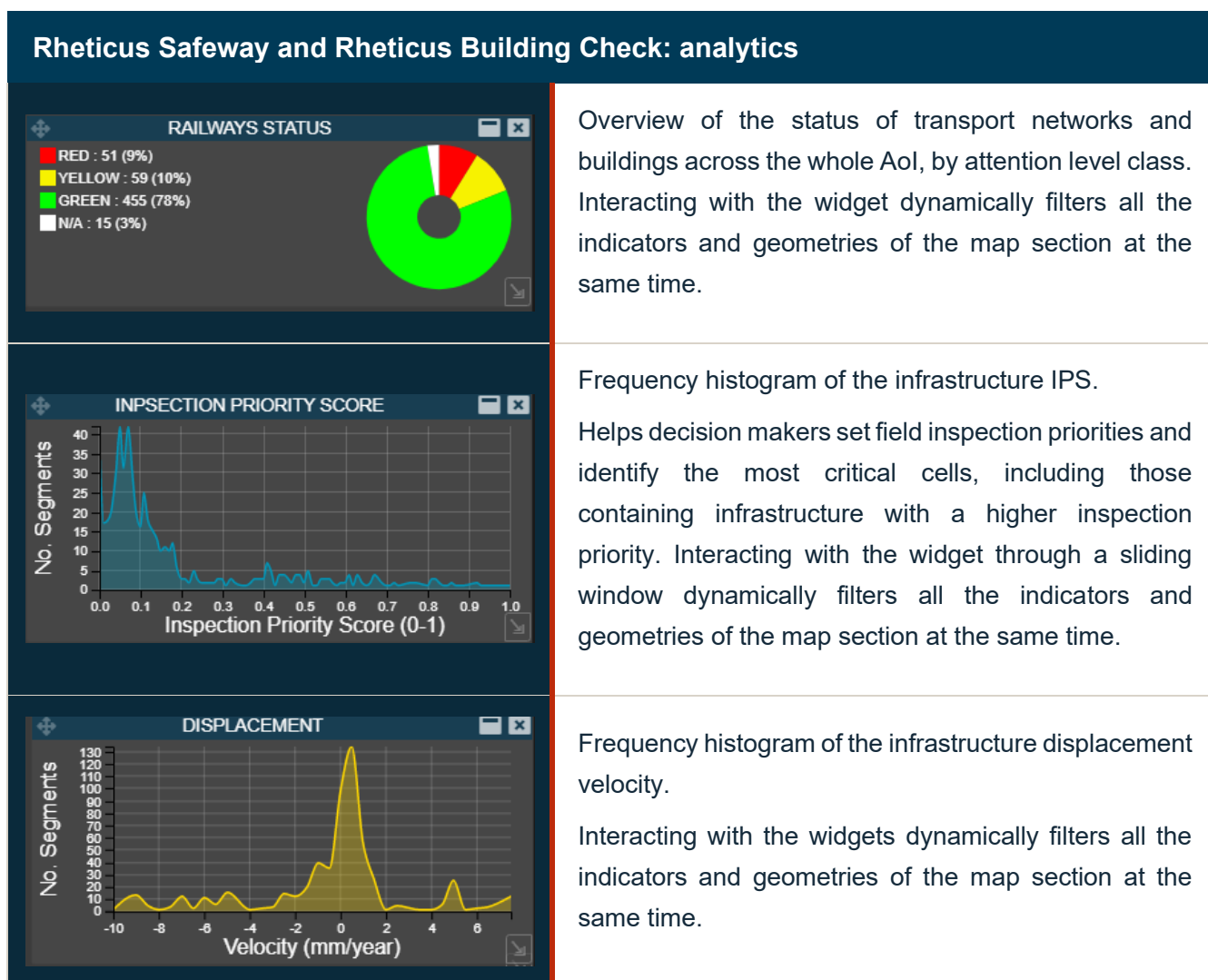


Figure 15 - Colour classes associated with the displacement velocities along the LOS of the PS/DS points (mm/year)

The table below introduces the Business Intelligence dashboard analytics for the additional integrated vertical services:



4. Benefits

...

Continuous monitoring of the entire area of interest

thanks to constantly updated satellite radar data that feed the BI analysis functions.

Scalable and consistent land analysis

across the whole area of interest;

Automatic identification of areas with ground movement anomalies

and their contextualisation against the available hydrogeological hazard levels, with the possibility of following their evolution over time;

Support for the prevention of potential damage

by identifying ground surface movements associated with subsidence or landslides and contextualising them against the further hazard factors available for the area of interest.

Support for investment optimisation

by identifying millimetric ground surface movements and defining investigation priorities, supporting land planning and infrastructure design.

No experience with GIS systems or satellite data required.

The results of the automatic processing chain are delivered through a simple, dynamic interface that allows users to analyse the status of the area of interest and consult the available information on the observed surface movements.