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INTEGRATED DATA PORTAL FOR SMINO DATA ARCHIVING AND SHARING

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1. INTRODUCTION

The deliverable 7.6 is prepared in the context of the ITINERIS project, within the WP 7 that entails the integration of Research Infrastructures and activities in the geosphere and landsurface domains. The deliverable concerns the implementation of the new integrated portal of the Research Infrastructure (RI) SMINO (Sistema di Monitoraggio dell'Italia Nord-Orientale), the system of fixed and mobile seismological and geodetic instruments managed and ruled by the National Institute of Oceanography and Applied Geophysics –OGS, and in particular by its Centre for Seismological Research (CRS), in the North-eastern part of Italy. The portal represents the access point to SMINO information and data. The goal is to enable easy access to the various networks constituting SMINO, both seismological and geodetic, and to the various data and services, through the appropriate links. It also constitutes the link to the other platforms developed within the PNRR project MEET, bound to EPOS-Italia Research infrastructure and their services.

The overarching objective of this deliverable is to provide a general overview of the structure and contents of the SMINO platform. Secondly, the report also details the instrumental capabilities available at SMINO, The document is structured in 3 sections, including this introduction. An overview of SMINO, its components, is given in section 2. Section 3 describes the new portal, with the various components and links.

2. SMINO (SISTEMA DI MONITORAGGIO DELL'ITALIA NORD-ORIENTALE)

SMINO is a Research Infrastructure of national relevance (PNIR 2021-2027).

SMINO contributes to fulfilling the CRS institutional tasks, which, as provided by law 399/1989, has the task of surveillance and research on seismic activity in northeastern Italy, also for Civil Protection purposes.

Its roots are in the first seismometric network installed by OGS in the Friuli seismic area in 1977, one year after the destructive earthquake of Friuli, 1976, which caused about 1000 victims. The data were sent by radio to the Udine Castle's Casa della Contadinanza. In 1982, national law 382/1982 established the creation of the Centre for the Seismological Research in Udine; in 1989, national law 399/1989 defined the mission of CRS[1]. From then, the research of CRS developed together and in tight connection with the development of the network, both in terms of instrumentation and in relationship with other entities in Italy and in the neighbouring nations.

SMINO now consists of a seismic network, a widespread accelerometric network, and a geodetic monitoring network (FReDNet).

SMINO operates closely with national and international networks in neighbouring countries under framework agreements for real-time data exchange. Information on seismic events is disseminated to the public through a dedicated web portal.

Seismic bulletins containing information on earthquakes recorded in northeastern Italy are published regularly.

1 "*to carry out, in scientific autonomy, with specific projects, the research on seismicity and seismogenesis in north-eastern Italy, also managing and developing the connected seismic detection network, also for civil protection purposes, in coordination with the National Institute of Geophysics and Volcanology (INGV)*".

2.1 North-East Italy Seismometer Network Text here

The North-eastern Italy Seismic Network consists of 43 stations, 24 broadband, 15 short-period and four intermediate-period (Bragato et al., 2021). Furthermore, to ensure a wide dynamic range in recording high-intensity seismic events, 29 stations of the seismic network have been equipped with high-quality accelerometric sensors capable of accurately detecting accelerations generated during an earthquake. The network is managed by OGS on behalf of the Friuli Venezia Giulia and Veneto Regions. The stations are mostly installed in Friuli Venezia Giulia and Veneto, while a limited number of instruments are installed in Emilia Romagna and Lombardy (Figure 1).

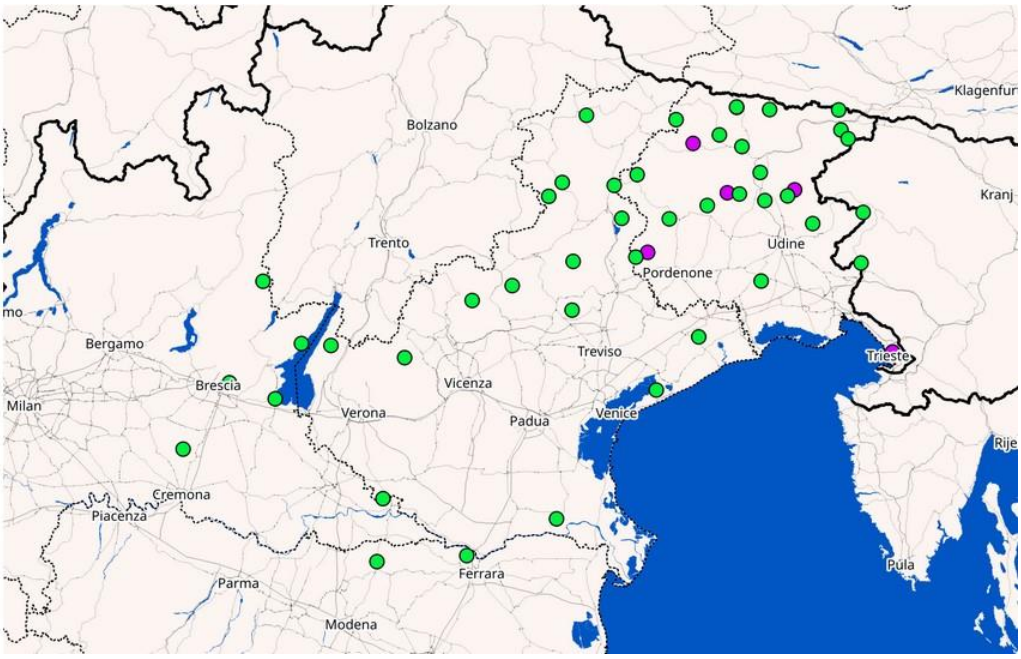

Figure 1 - The stations of the OGS seismometric network (green dots); the violet dots indicate the station owned by OGS and the University of Trieste or the INGV.

Data recorded from all stations are acquired in real-time at the OGS's Center for Seismological Research (CRS) headquarters in Udine.

The network also supports the national seismic surveillance system through real-time data exchange with the Civil Protection Department and the National Institute of Geophysics and Volcanology (INGV). Additionally, to improve the quality of locations and magnitude estimation in border regions, the network exchanges real-time data with the seismic networks of Austria, Slovenia, Switzerland, the Autonomous Provinces of Trento and Bolzano, and the University of Genoa.

The North-eastern Italy seismic network is part of the CE3RN cross-border network, in which seismic networks of Croatia, Slovakia, Hungary, Romania, Albania, and Bulgaria also participate. CE3RN is an example of excellence in transnational collaboration and the sharing of infrastructure, data, and resources.

Network data is made available through the ORFEUS EIDA nodes and the website terremoti.ogs.it.

2.2 Widespread accelerometric network

In addition to the seismic network's accelerometers, within various strategic projects, including the "Sentinel Buildings" project, funded by the Regional Civil Protection of the Autonomous Region of Friuli Venezia Giulia, and the Interreg V-A Italy-Austria Armonia project, a dense network of accelerometric sensors has been installed between Friuli Venezia Giulia and Veneto. The urban accelerometric network sensors were developed within these projects through the synergy between OGS and ADEL that guarantee high performance in recording ground accelerations for moderate and strong events while having a reduced cost. The availability of these sensors has enabled an important integration to large-scale seismic monitoring, improving data collection capabilities in sensitive areas.

Furthermore, the Veneto Region has commissioned OGS to implement Action 5.1 of the POR-FESR 2014-2020 "Integration and development of multi-risk prevention systems, including through interoperable digital networks for early operational coordination" through the project VenetONE (Integration and development of multi-risk prevention systems, also through interoperable digital networks for early operational coordination). The project led to the creation of a capillary network of approximately 300 additional medium-cost accelerometric sensors installed at the base of 317 buildings in 306 municipalities of Veneto. 26 of the buildings have been equipped with an additional accelerometer on the top to evaluate the general movement, to be associated with the eventual damage in case of earthquake (Figure 2).

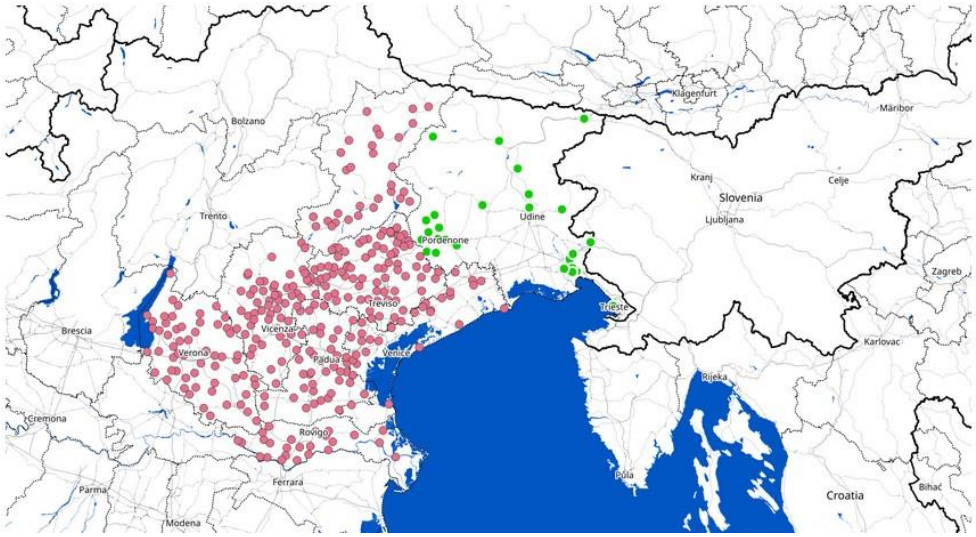

Figure 2 - Map of the accelerometric stations installed thanks to the interreg project Armonia and the POR-FESR VenetONE: in green the stations within the Friuli Venezia Giulia Region, in pink the station of the Regione del Veneto.

The data collected from this sensor network is acquired in real time thanks to sophisticated transmission and communication systems. The immediate processing of this information significantly contributes to the rapid assessment of seismic events' impact, providing useful tools for authorities in emergency management. This advanced monitoring system allows for a timely response in case of earthquakes, improving the safety and protection of people and buildings in at-risk areas. Additionally, as part of the project, the Department of Geosciences of the University of Padua acquired site effects and building characteristics studies.

2.3 Friuli Regional Deformation Network (FReDNet)

FReDNet (Friuli Regional Deformation Network) is the crustal deformation monitoring system in Friuli Venezia Giulia that the Centre for Seismological Research began developing in 2002, with the installation of the first station (Zuliani et al., 2018; Tunini et al., 2024). In most cases, the receivers have been installed in sites that already host the sensors of the OGS seismic network. FReDNet is also part of a broader geodetic survey program of the Adriatic microplate that includes repeating episodic measurements of geodetic points.

FReDNet currently comprises 22 permanent GNSS receivers (GPS+GLONASS+Galileo+Beidou) for geodetic monitoring of crustal deformations in northeastern Italy. It also provides a real-time service for high-precision georeferenced navigation according to differential correction modes (RTK - Real Time Kinematic, and VRS - Virtual Reference Station). The service is freely accessible to public, private, and scientific users (Figure 3). The Network is integrated with the Friuli Venezia Giulia Region's geodetic network (Antonio Marussi network), the National Dynamic Network (RDN) of the Military Geographic Institute (IGM), and the European EUREF Permanent Network (EPN).

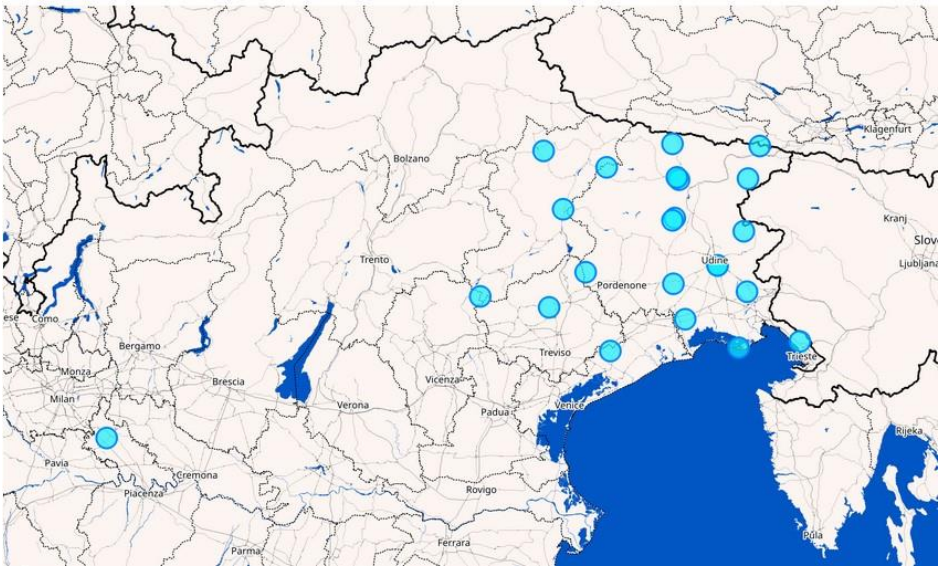

Figure 3 - The GNSS stations of the geodetic FReDNet network of OGS.

Data produced with FReDNet is shared within the European Plate Observing System (EPOS) . Network data is made available through the FReDNet website and the GLASS CEGNxEPOS node of the EPOS platform. The latter includes data from FReDNet, the Antonio Marussi network and from the surrounding countries of Slovenia, Austria.

Data and further information are available through the network portal (https://frednet.crs.ogs.it/en/).

2.4 Fiber network

To achieve the objectives of ITINERIS, the Center for Seismological Research (CRS) of OGS has purchased six units of the iDAS optical interrogation model (intelligent Distributed Acoustic Sensor). These devices are being integrated into the existing regional communication infrastructures. The use of existing standard linear optical fibers of various kilometers in length will allow for both cost reduction and the possibility of continuously and thoroughly monitoring the ground motion associated with seismic phenomena.

The integration of DAS systems into the Monitoring System of North-Eastern Italy (SMINO), managed by CRS, will enhance the monitoring infrastructure. This will significantly improve the detection and early warning capabilities of seismic phenomena, as well as ensure more effective monitoring of medium- and long-term deformations, such as subsidence. This represents a fundamental advancement for Civil Protection, increasing the capacity for response and mitigation of natural risks.

The large-scale application of DAS technology in urban and regional areas represents the first experiment of its kind in Italy and one of the first in Europe, with a positive impact on seismic risk management and territorial safety. A collaboration agreement is being defined between OGS and other local and regional entities to support Civil Protection in prevention and emergency response activities, promoting greater safety for the population.

2.5 Gravimetric network

The Regional Gravimetric Network is an ongoing project that involves establishing a series of reference points distributed throughout North-Eastern Italy, where precise measurements of the Earth's gravitational acceleration will be conducted. This project continues the historical gravimetric monitoring activity carried out by the National Institute of Oceanography and Applied Geophysics -OGS.

The network will consist of relative measurement points, where the difference in gravity between one point and another will be measured. The relative measurements will be connected to two new absolute benchmarks of the National Gravimetric Network, where absolute gravity values will be recorded (Figure 4). Absolute measurements will be conducted in the OGS laboratories in Udine and Trieste.

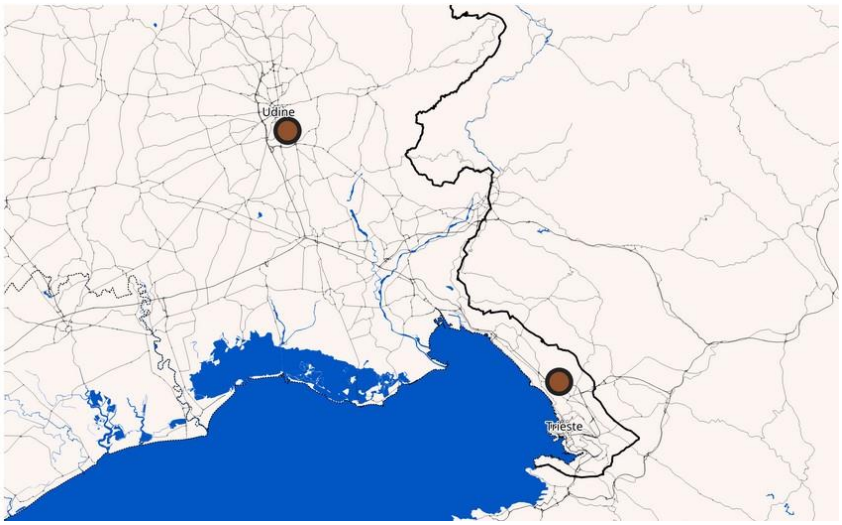

Figure 4 - The location of the two absolute gravity measuring points, in the OGS Udine and Trieste headquarters.

This new network will provide a detailed mapping of variations in Earth's gravity in the region. From a geodetic perspective, it will be useful for accurately determining the shape of the local geoid, the physical reference surface for elevations. In the geophysical field, the network will be used for subsurface exploration, serving as a primary reference for new detailed surveys. These measurements will especially aid in identifying and modeling active tectonic structures (such as faults) and hydrogeological structures related to groundwater flow (aquifers).

Furthermore, the constant maintenance of the network will allow for the monitoring of any changes in gravitational acceleration over time. The integration of these data with those from the SMINO

seismometric, accelerometric, and geodetic networks will enable a more precise reconstruction of the tectonic and hydrogeological evolution of North-Eastern Italy.

3. THE NEW WEB PORTAL

The SMINO web portal (smino.ogs.it) will serve as a centralized online platform, enhancing the visibility, accessibility, and effective use of all the SMINO's components and data. From the above description, it is evident how the SMINO's data differ from each other and have different degrees of FAIRness. The SMINO web portal will enhance the user experience by organizing information in a way that is accessible and user-friendly, collecting and displaying information from multiple sources, making it easier for users to find what they need in one place, and linking to the various data access points.

3.1 The structure

The site was created using a combination of standard web technologies and custom solutions:

Figure 5 - Home page of the SMINO portal (smino.ogs.it).

Hosting: The site is currently hosted on an internal National Institute of Oceanography and Applied Geophysics-OGS server. This approach offers the greatest control over the site's security and performance.

Technologies used:

- PHP: For server-side logic and dynamic content generation;
- HTML: To structure the content of web pages;

- Bootstrap Italia: A front-end framework specific to Italian public administrations, which provides predefined components and styles compliant with PA website design guidelines, ensuring visual consistency and accessibility.

The site is integrated into the OGS site and has been created within the frame of the coordinated image of OGS, with colours, fonts, and style in agreement with the OGS principal site and the other hosted ones. In Figure 5, the home page.

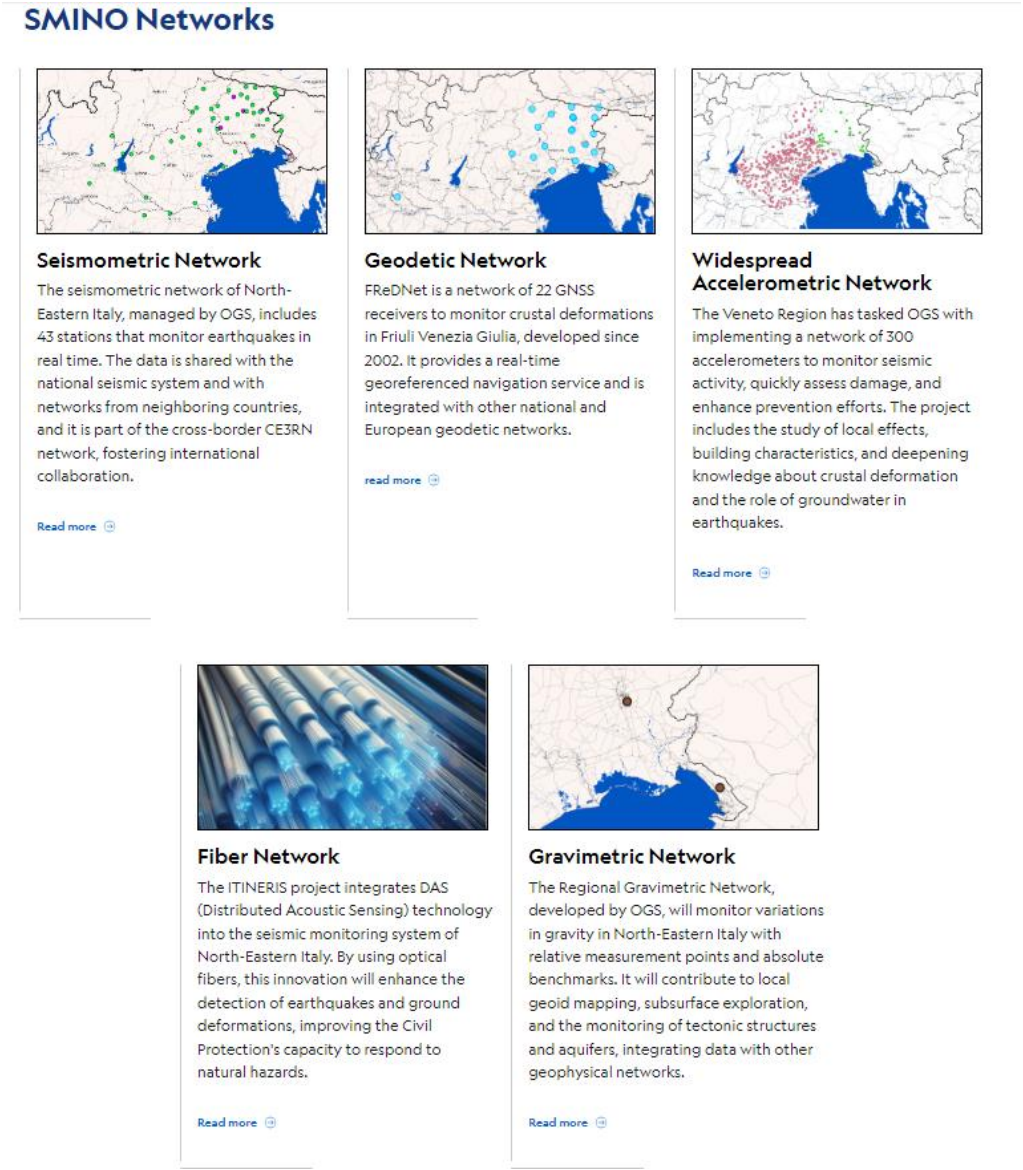

Figure 6 - SMINO's home page: the quick overview of the various networks.

The main sections of the website are:

- SMINO in a nutshell: a rapid overview of SMINO's origine and tasks;
- SMINO networks (Figure 6): The reader is led to know the various networks composing SMINO through a simple short description, that can be deepened through the "read more" link. There, more detailed information is added, together with the link to the sites, where the data provided by the network are accessible. Figure 7 shows the

example of the geodetic network, whereas Figure 8 the page where its data and products are accessible (FAIR);

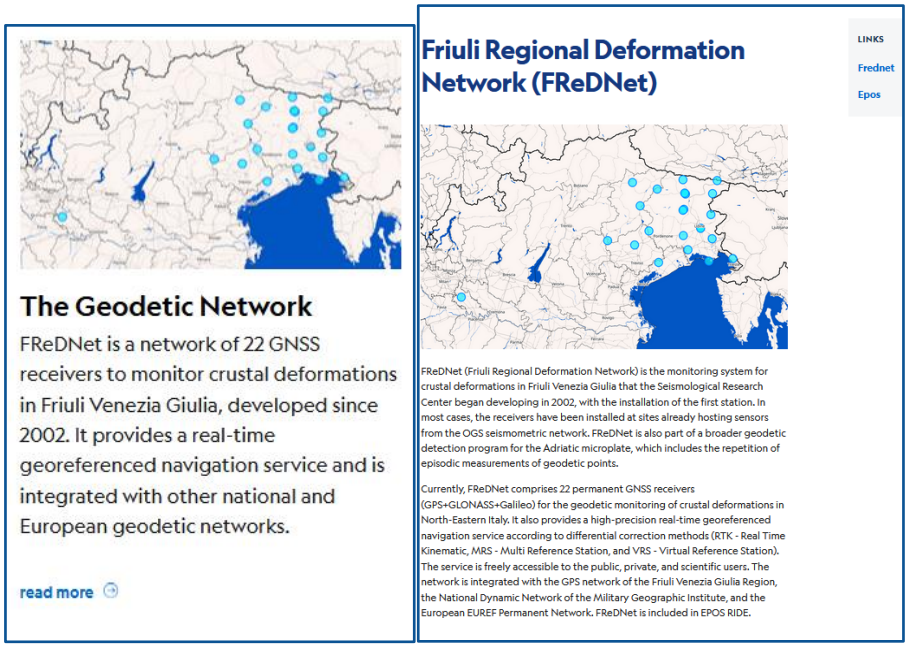

Figure 7 - The description of the FReDNet geodetic network on the home page (left) and the detailed description with the links to the data distribution (right).

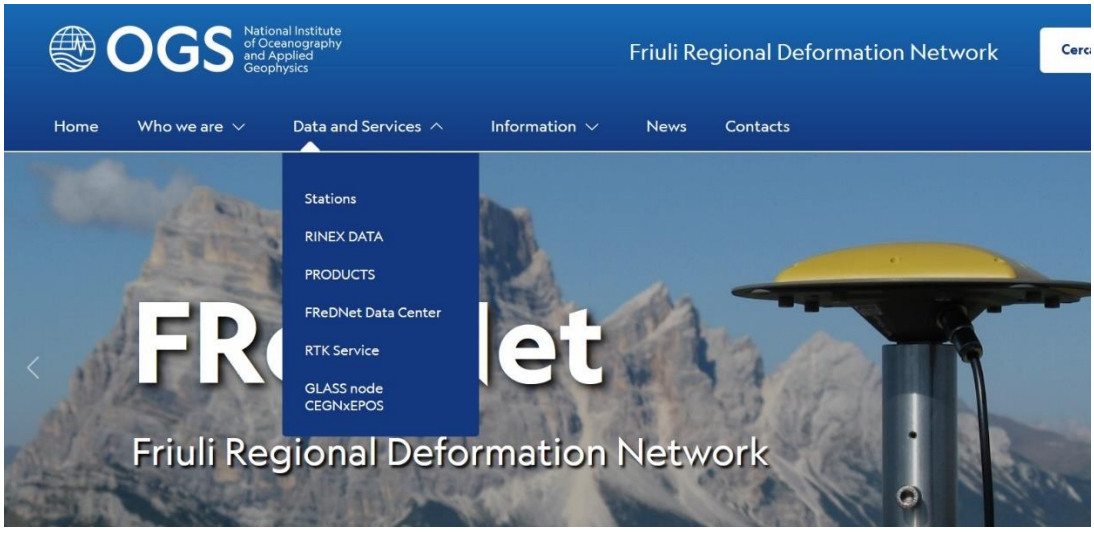

Figure 8 – Page of FReDNet portal with the menu for access to the data, raw and processed (https://frednet.crs.ogs.it/en/)

- Projects: The home page provides information on the main agreements/projects funding SMINO, with a short overview, and a more detailed description in the "read more" part. Figure 9 shows the example of the PNRR projects of which OGS is a co-proponent that are funding the development of SMINO;
- SMINO data: the links to the data portals for the various seismological and geodetic data provided by SMINO's networks;
- Contacts

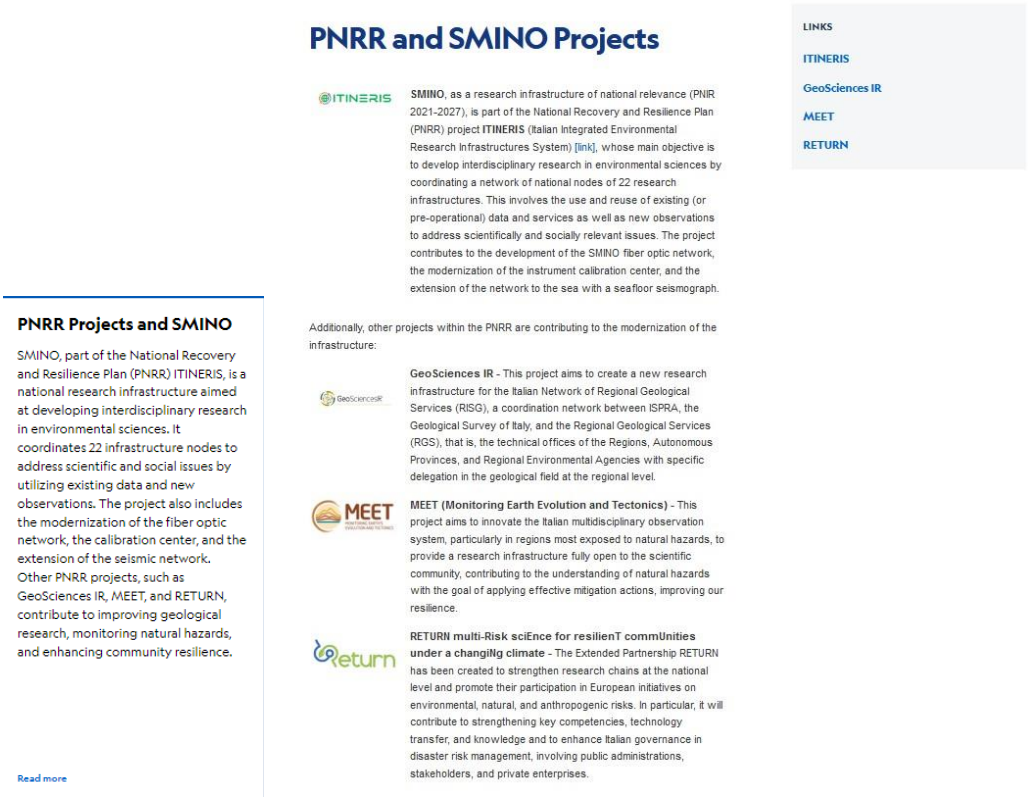

Figure 9 - The list of the PNRR projects in which OGS is a co-proponent and that are funding the development of SMINO (right), and a short description of their aims (right).

3.2 Future developments

A WordPress-based version of the site is under development with the following objectives:

1. Simplify page maintenance;
2. Allow non-technical users to manage content through a user-friendly interface;
3. Leverage the WordPress ecosystem of plugins and themes to extend the site's functionality;
4. Potentially improve SEO performance and content management.

The migration to WordPress will allow for more efficient site management in the long term, reducing dependence on specific technical skills for routine content updates.

Moreover, the site will be upgraded with links to the new portals under development and constantly updated with the latest projects and news.

4. REFERENCES

Bragato, P.L., Comelli, P., Saraò, A., Zuliani, D., Moratto, L., Poggi, V., Rossi, G., Scaini, C., Sugan, M., Barnaba, C., Bernardi, P., Bertoni, M., Bressan, G., Compagno, A., Del Negro, E., Di Bartolomeo, P., Fabris, P., Garbin, M., Grossi, M., Magrin, A., Magrin, E., Pesaresi, D., Petrovic, B., Plasencia Linares M.P., Romanelli, M., Snidarcig, A., Tunini, L., Urban, S., Venturini, E., Parolai, S., 2021. The OGS–Northeastern Italy Seismic and Deformation Network: Current Status and Outlook, Seismological Research Letters 92 (3): 1704–1716, https://doi.org/10.1785/0220200372.

Tunini L., Magrin A., Rossi G., Zuliani D. 2024. Global Navigation Satellite System (GNSS) time series and velocities about a slowly convergent margin processed on high-performance computing (HPC) clusters: products and robustness evaluation, Earth Syst. Sci. Data, 16, 1083–1106, https://doi.org/10.5194/essd-16-1083-2024.

Zuliani D., Fabris P., Rossi G., 2018. FReDNet: evolution of permanent GNSS receiver system, in "Lecture notes in Geoinformation and Cartography" Barbarella, M., Cefalo R., Zielinski J. (Eds), Springer, pp.123-137.