



OGS

National Institute
of Oceanography
and Applied
Geophysics

Strategic Vision

2023–2032



Strategic Vision 2023–2032

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Abstract

This document outlines the OGS **vision** for the coming decade (2023-2032) in scientific research, technological innovation, capacity development, public engagement, staff management and work environment.

OGS contributes to build resilient and sustainable communities and ecosystems in a changing planet, through scientific knowledge and technological innovation. This long-term **vision** is realised through the **overall mission** of understanding Earth and Ocean processes and predicting their changes by collecting, analysing, modelling and interpreting oceanographic, geophysical and seismological data, sharing independent and impartial knowledge and improving community awareness. The fundamental **values** that shape the vision and actions of OGS are excellence, openness, people, inclusion and impact.

At international level, the OGS **scientific position** focuses on the grand societal challenges defined by major international policies, such as the United Nations 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction 2015-2030 and the United Nations Decade of Ocean Science for Sustainable Development 2021-2030, which also impact on the priorities of the New Urban Agenda and the Paris Climate Agreement.

OGS identifies the following long-term **research and innovation missions** for the coming decade:

- **Understanding Seas and Ocean** to promote sustainability and ecosystem health;
- **Understanding Earth Processes** to drive sustainable development;
- **Understanding Disaster Risk** to build prepared and resilient communities;
- **Exploring Polar Areas** to understand the Planet and its changes;
- **Fostering Open Science** to widen the user community of scientific data.

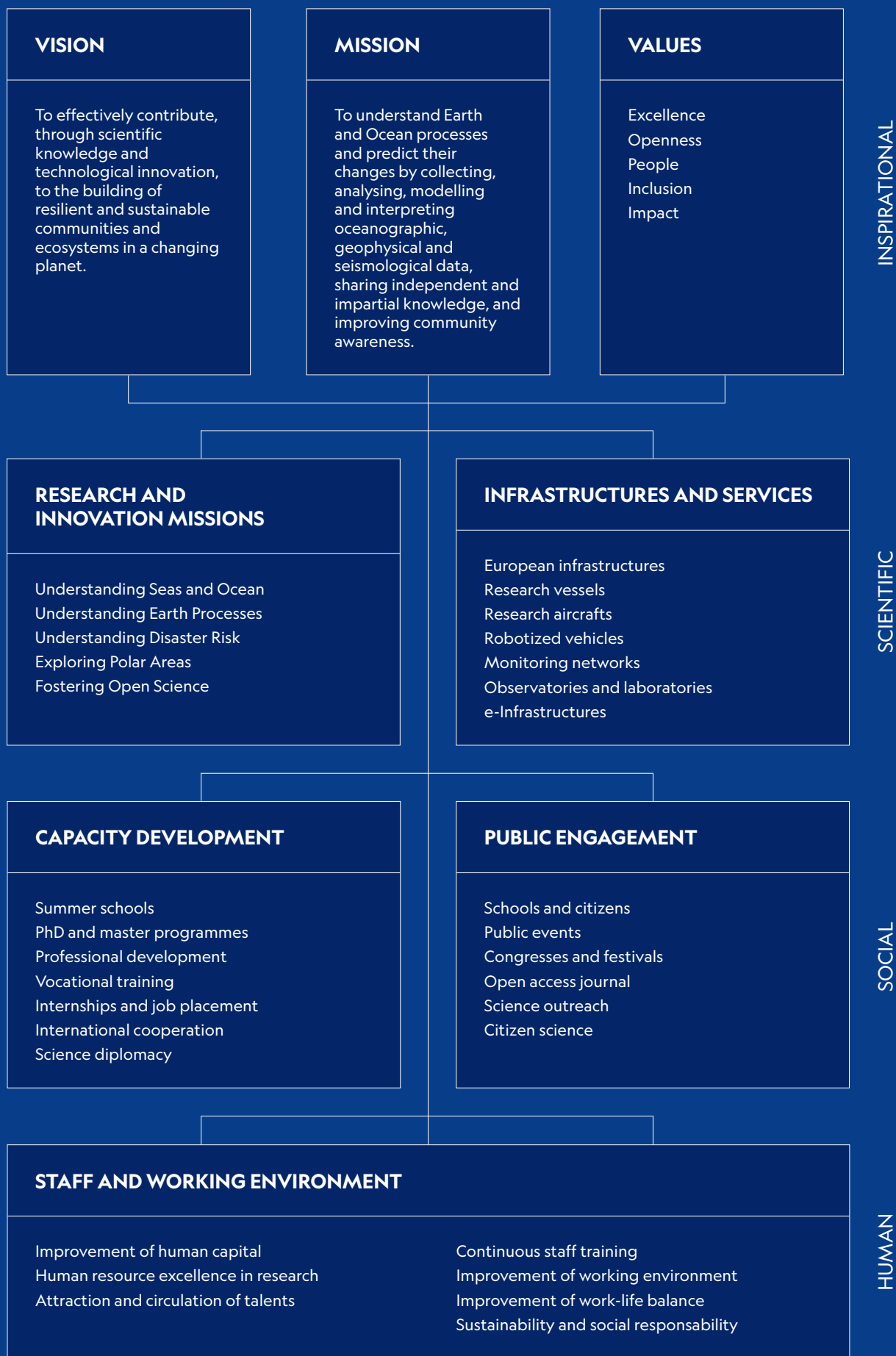
OGS will significantly expand its capabilities in the design, development, management and maintenance of **research infrastructures** such as observatories, monitoring systems, communication networks, open data infrastructures, high-performance computing, calibration centres, scientific data sets and sample collections. These form the basis for all research and innovation activities of OGS.

Capacity development and knowledge transfer are an important part of the future development of OGS. These include summer schools and other higher education initiatives, doctoral and master programmes in collaboration with universities, professional development and vocational training, internships and job placement, strategic partnerships and international relations.

In terms of **public engagement** and scientific outreach, OGS intends to continue and enhance the active involvement of schools and citizens, participation in public events, organisation of scientific conferences and festivals, and publication of its own open access scientific journal, the Bulletin of Geophysics and Oceanography.

Strategies to improve **staff and working environment** include the full implementation of the European policies for researchers, attraction and circulation of talents (including early-stage researchers), continuous staff training, full transparency and enhanced internal communication, improvement of the working environment and work-life balance, and paying special attention to sustainability and social responsibility objectives, including energy efficiency and full waste recycling.

OGS Strategic Vision at a glance



1.

Foreword

The **National Institute of Oceanography and Applied Geophysics - OGS** is an Italian public research institution operating in the field of Earth and Ocean Sciences at international level. Its activity is focused on **research and innovation** in the following areas:

- Oceanography (physical, chemical, biological and geological);
- Geophysics (applied and exploration);
- Seismology and engineering seismology.

The research competencies of OGS encompass **Earth and Ocean Sciences** to advance basic scientific knowledge, generate technological innovation and provide new solutions to environmental, economic and social challenges.

The rapid economic and societal changes of the past decades have presented us with **major global challenges** related to climate change, environmental degradation, pollution, depletion of natural resources, increase in natural hazards and shortages of food, water and energy.

These global problems affect both terrestrial and marine environments and require a holistic and interdisciplinary approach based on the **full integration of Earth and Ocean Sciences**. OGS is well positioned to tackle such interdisciplinary research, as it has the required expertise in different scientific disciplines to address complex scientific problems and challenging technical issues.

Research activities focus on **key topical issues** such as the environment, its response to global change and other anthropogenic stressors, biodiversity and ecosystem functioning, geohazards and associated risks, sustainable and safe use of natural resources, green energy transition and geological storage of anthropogenic CO₂ and hydrogen.

This document outlines the OGS **vision** to address these global challenges over the next decade (2023-2032) through a variety of actions, including high-quality scientific research, technological development, continuous innovation, capacity development and public engagement.

The general strategic lines draw on the **Italian National Research Programme (PNR)** and **Horizon Europe** 2021-2027, as well as other key national and international policies.

OGS recognises that an effective sustainable development can only result from in-depth **knowledge of our planet** and its geological and ecological processes, and will contribute to filling the significant gaps in scientific knowledge in these areas, for the benefit of the society and the environment.

The OGS development strategy for the coming decade focuses on **understanding phenomena**, both in terms of scientific research and technological development, as well as capacity building and public engagement. If a sustainability or resilience policy is to be built upon natural and anthropogenic phenomena, then they must be understood in all their complexity by proactively seeking the synergistic contribution of science, industry, policy makers and citizens.

The continuous improvement in the **quality of scientific research**, with a clear move towards open science practices, remains a key priority of OGS for the next decade.

A crucial step forward will look towards **expanding interdisciplinarity**, to achieve in-depth integration of research on Earth and Ocean processes, which transcends conventional disciplinary boundaries. For this reason, OGS intends to strengthen its unique scientific approach, based on the close integration of Oceanography and Geophysics.

2.

Vision, mission and values

The overarching **vision** of OGS is to effectively contribute, through scientific knowledge and technological innovation, to the building of resilient and sustainable communities and ecosystems in a changing planet.

This long-term vision is achieved through the **overall mission**, which consists in understanding Earth and Ocean processes and predicting their changes by collecting, analysing, modelling and interpreting oceanographic, geophysical and seismological data, sharing information and knowledge and improving community awareness.

The fundamental **values** that shape the OGS vision and actions are listed below:

Excellence is the guiding principle in scientific research, technological development, management and organisation. OGS is firmly committed to pursuing excellence by continuously improving the quality of its research products, and the capabilities and efficiency of its infrastructures and services, including management and administration. These different aspects are interlinked, as progress in one promotes improvement in the others, in an open and circular process of quality enhancement.

Openness refers to the concepts of open innovation, open science and open to the world, as advocated by the European Commission. OGS acknowledges the paradigm of open science as a key principle for data and knowledge dissemination and citizen engagement, and as a necessary condition for supporting sustainability policies through shared and transparent scientific knowledge. The international dimension will be based on three main pillars: international cooperation, science diplomacy and networking.

People are at the centre of the OGS development strategies. People include researchers, technicians, administrative and support staff, research fellows, associates and trainees. OGS aims to offer them a stimulating, open and international working environment that is also attractive to highly skilled talents from around the world. OGS promotes the skills development and employees welfare while supporting their mobility. In addition, OGS ensures an open, transparent and merit-based policy for the recruitment and career advancement of its staff.

Inclusion means a commitment to embrace all people regardless of ethnicity, gender, religion, disability, medical or other needs, to provide them with equal access and opportunities, and to prevent discrimination and intolerance based on judgement, prejudice, racism and stereotypes. Effective inclusion is based on contexts that are sensitive to diversity and within which social action ensures that everyone has equal dignity, rights and representation, taking full account of individual orientations, abilities and attitudes.

Impact is increasingly important for the activities of research institutions. It encompasses cultural, social and economic impact, including scientific outreach and citizen engagement in science. The research and innovation missions that OGS proposes for the next decade are based on this principle. In addition, OGS is constantly focused on the impact of its activities on international policies regarding environmental sustainability and disaster risk reduction.

3.

Earth and Ocean sciences



Earth and Ocean Sciences are driving the fourth industrial revolution and are providing the basis for policies on **sustainable development and resilience** of communities and ecosystems.

Knowledge on the solid Earth and Ocean, including their internal structure and processes, provides invaluable information on the availability of natural resources (including energy, water, raw materials and renewable resources), interactions with human activities, Earth system functioning, natural hazards and associated risks, and on responses to global environmental change (including climate change and pollution).

Despite their fundamental importance, both the solid Earth and the Ocean are still largely unexplored and the processes controlling them are still only partially understood.

The coming decade is expected to see a significant surge in the development of Earth and Ocean Sciences due to the ongoing ecological and digital transformations.

The ecological transformation aims to achieve the sustainability goals defined by the United Nations and the objectives of the European Green Deal in the field of energy conversion and storage, waste management, pollution and environmental protection, with the ambitious goal of a carbon-neutral Europe by 2050.

This transformation must be accompanied by a solid and reliable scientific understanding of all the processes that regulate the complexity of the Earth system, including the lithosphere, hydrosphere, atmosphere, cryosphere, biosphere, anthroposphere and all their natural cycles (e.g. carbon and water cycles).

Recent geopolitical and climatic crises have dramatically brought the issue of strategic geo-resources and their fair and sustainable use to the attention of the general public. Therefore these problems require an increasingly in-depth knowledge of the availability of such resources and of the interactions between natural processes and human actions. Unlimited economic growth, through increased resource consumption, is not only impossible but dangerous for human society. A new economy could focus more on environmental health research needed to manage the risks of climate change.

The digital transformation is leading to a dramatic increase in connectivity and interaction between people and objects, with an unprecedented development in sensor technology, robots, satellites, telecommunications, data production and storage, processing capabilities based on artificial intelligence and big data technologies. New opportunities will be available to the scientific community with huge amounts of data and observations, feeding digital twins to support increasingly realistic predictions and more effective decisions.

Therefore, it is clear that the future Earth and Ocean Sciences will require tighter integration among remote sensing, in situ observations, real time data transmission, rapid processing by machine learning technologies driven by high performance computing, reliable predictive modelling and dissemination of validated scientific information presented in a plain language which is readily understandable by stakeholders and policy makers.

This transformation should be supported by the scientific community through the provision of reliable and high quality data on the state of the Earth, multidisciplinary observing systems, sound data management, advanced data modelling and digital twins in line with international standards and protocols.

4.

National and international position



OGS is the Italian National Institute of Oceanography and Applied Geophysics operating, both legally and financially, under the auspices of the Ministry of University and Research (MUR).

As part of a **national network** of research institutes supervised by the MUR, OGS maintains close scientific relationships with the National Research Council (CNR), the National Institute of Geophysics and Volcanology (INGV), the Stazione Zoologica Anton Dohrn (SZN), the National Institute for Nuclear Physics (INFN), the National Institute for Astrophysics (INAF), the AREA Science Park and the National Institute for Metrological Research (INRIM). Close links are also established with national research institutes supervised by other ministries - such as the Institute for Environmental Protection and Research (ISPRA) and the National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA) - and with universities and research institutes worldwide.

The scientific position of OGS in the next decade is aligned with the intervention areas of the 2021-2027 **National Research Programme** (PNR), focusing on natural systems safety, climate change mitigation and adaptation, sustainable management of marine ecosystems, high-performance computing and big data.

In the next few years, the national scientific position of OGS will be strengthened by the extraordinary resources secured from the **National Recovery and Resilience Plan** (PNRR), which will enable unprecedented investments in research and technological development, as well as the strengthening and networking of research facilities and infrastructures.

The OGS **headquarters** are in Trieste, with branch offices in Udine, Venice and Milazzo/Panarea. Over the next decade, OGS aims to broaden its national position by increasing the number of **offices** and **joint laboratories** with universities and other public and private organisations throughout Italy, such as Genova and Livorno.

Exploration of the Ocean and the Earth necessarily transcends national boundaries. For this reason, OGS will continue and expand its strong **international focus** and maintain close relationships with research institutes and universities around the world. Due to the geopolitical position of OGS, priority relationships are established and will be maintained in the Mediterranean, Balkan, Central European and Polar regions.

The OGS global positioning is also favoured by the presence of prestigious **international institutes in the city of Trieste**, among which the Abdus Salam International Centre for Theoretical Physics (ICTP), the International School of Advanced Studies (SISSA), the World Academy of Sciences (TWAS) and the International Centre for Genetic Engineering and Biotechnology (ICGEB), with which OGS maintains strong scientific relations.

Over the next decade, the scientific position of OGS will increasingly focus on the grand societal challenges defined by **major international policies**, such as the United Nations 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction 2015-2030 and the United Nations Decade of Ocean Science for Sustainable Development 2021-2030, which also impact on the priorities of the New Urban Agenda and the Paris Climate Agreement.

This position is also closely related to the strategic priorities of the **European Green Deal** aiming to make Europe climate neutral in 2050 and of **Horizon Europe** for a smarter, more sustainable and inclusive growth, particularly in the areas of climate, energy, sustainable blue economy, risk management, high-performance computing and big data.

5.

Research and innovation missions

The sectors in which OGS occupies a recognised **position of national and international leadership** are the following:

- Ocean observation, modelling and prediction;
- Geophysical exploration with multi-parametric techniques;
- Underground fluids storage characterisation and environmental impact;
- Multi-hazard and rapid risk assessment;
- Exploration of polar margins and ice sheets;
- Distribution of open data from observation and monitoring networks;
- Management of research vessels and large infrastructures.

Given these areas of excellence, the OGS development strategy for the new decade will strongly focus on the **grand societal challenges**, which will involve all staff in cross-cutting tasks with relevant socio-economic and cultural impact.

Against this backdrop, OGS commits to a mission-oriented scientific action plan with the following five long-term **research and innovation missions**:

- **Understanding Seas and Ocean** to promote sustainability and ecosystem health;
- **Understanding Earth Processes** to drive sustainable development;
- **Understanding Disaster Risk** to build prepared and resilient communities;
- **Exploring Polar Areas** to understand the Planet and its changes;
- **Fostering Open Science** to widen the user community of scientific data.

These missions are characterised by clear objectives, ambitious but realistic research priorities, cross-disciplinary, cross-sectoral and cross-cutting activities, strong integration and use of research infrastructures, broad relevance, scientific and social impact.

All of these include the digital representation of natural processes and environments, the quantification of the interaction with anthropogenic processes and the impact estimation using long-term observations and numerical modelling, thanks to the **close integration of oceanographic, geophysical and seismological approaches**.



01 Understanding Seas and Ocean

The Ocean is an essential component of the Earth ecosystem. It provides food, energy, climate regulation, abiotic and biotic resources, communication routes, job opportunities, leisure activities and cultural stimuli. Protecting the Ocean and marine life is one of the United Nations Sustainable Development Goals (SDG 14), and is also a prerequisite for achieving other SDGs.

In recent years the Ocean has been increasingly threatened by significant pressures from human actions and the rapid development of economic activities. The impact of such pressures results in warming, acidification, de-oxygenation, pollution, habitat degradation, stocks

depletion, and much more. All impacts cumulate and determine the loss of marine life and biodiversity.

Efforts to better understand, protect, manage and use marine resources, in a sustainable and fair manner, cannot be postponed. This challenge is even more urgent in coastal areas and marginal seas, which are vulnerable systems threatened by the cumulative impact of many co-occurring stressors. The Mediterranean Sea in particular is a scientific priority, due to its ecological, political, economic and social importance.

OGS contributes to international studies with sectoral and multidisciplinary expertise as well as infrastructural capabilities that span the full spectrum of marine processes. More specifically, OGS contributes to data collection, knowledge creation, technological transfer, monitoring and understanding of marine ecosystems, planning the use of maritime space and ensuring effective and sustainable management of activities at sea.

Over the next few years, OGS aims to consolidate and develop its capacity to observe, understand and quantitatively assess **ecosystem functioning and biodiversity**, with particular focus on their response to cumulative anthropogenic stressors. This objective requires the consolidation of specific disciplinary competencies related to physical oceanography, marine biogeochemistry, ecology, physical chemistry, environmental economics, systems theory and others, but most importantly the integration of these disciplinary approaches into a common, systemic, and possibly quantitative framework. Molecular biology and genetic approaches will be expanded to better assess and understand the dynamics of marine ecosystems. Experimental and modelling activities will engage in topics related to marine biodiversity and ecosystem functioning, on the relationships between gene-trait-function-services, and on the resilience of marine ecosystems.

The capabilities for **observation and prediction** will be strengthened, by consolidating the focus on the Mediterranean and the Polar areas, and by paying particular attention to coastal zones and the ecological dimension. The OGS observational facilities - such as its fleet of robotic instruments, the ARGO network, the long-term marine observatories, the coastal radars and the open data distribution infrastructures - will be expanded and further integrated into international networks. OGS will also pursue the development of digital twins of ocean and coastal waters for the dual purpose of improving real-time monitoring and providing predictive capabilities for decision support systems. It is, therefore, crucial to consolidate OGS expertise in areas such as data management, artificial intelligence, marine robotics, and high-performance computing, by also capitalising on the HPC infrastructure. At the same time, it will be important to further expand the role of OGS in the Copernicus Marine Environment Monitoring Service.

OGS contributes to research on the impacts of **climate change and ocean acidification** by developing numerical models capable of describing the potential impacts of climate on marine ecosystems, as well as their interactions with other stressors such as nutrient enrichment, habitat modifications, fishing and pollution. Future activities will expand the scope of climate-related research by pursuing the development of fully integrated Earth system models to analyse the importance of the Ocean to climate and life on Earth, thus including the development of a regional Earth system approach. The OGS research facilities in the Aeolian archipelago (ECCSEL *NatLab* Italy) will be significantly strengthened with new state-of-the-art equipment to study the impacts of natural CO₂ emissions on marine and coastal ecosystems, and to consolidate the OGS leadership in assessing the impacts of CO₂

leakage from geological storage systems.

Research on **pollutants and plastics**, including emerging contaminants of various types and underwater noise, will continue with a focus on environmental threats, ecosystem restoration and recovery, including the improvement of risk assessment models. In the coming years these activities will focus on the quantitative aspects related to contaminant bioaccumulation and biomagnification along the food chain, and on the integration of the results into transport models and under alternative climate scenarios.

Experimental and modelling activities related to **sustainable ecosystems and blue economy** will be extended, to include analyses of socio-ecological systems, human dynamics and sustainability science, in order to put the principles of sustainable development and blue prosperity into practice. In particular, the development of knowledge and tools supporting the implementation of ecosystem approaches to fisheries and aquaculture remains one of OGS priorities.



02 Understanding Earth Processes

The exploitation of the Earth, both in marine and terrestrial environments, is constantly growing not only for mining activities, but also for the storage of energy, water, gas and hazardous waste (including radioactive waste), the development of urban and industrial areas, the construction of large infrastructures and the groundwater supply. Therefore, better knowledge of geological and geophysical processes is a major challenge for the development of a sustainable, safe and informed society.

Recent crises in the availability of basic natural resources - such as water, energy and raw materials - have demonstrated to society and policymakers how important the knowledge of Earth processes is for a more sustainable and safer use of the natural resources and for environmental protection. In particular, ongoing conflicts and related energy security issues, as well as the growing awareness of the environmental impacts of the current oil and gas based economy, are accelerating research into greener energy sources and are paving the way towards the longer-term implementation of alternative solutions, including a new hydrogen-based economy.

OGS represents one of the largest internationally recognised centres with both theoretical and operational expertise in the field of geophysics and intends to further develop its capacity to understand Earth processes and study the Earth subsurface, by promoting greater integration of geophysical and geological research.

A fundamental approach will be numerical and analogue modelling, to simulate processes and predict the response to anthropogenic pressures, including climate change. Geophysical modelling capabilities will be greatly enhanced in the coming years through the systematic use of high-performance computing and advanced big data analysis techniques that are well-suited to pressing environmental and green energy applications.

The strengths of OGS in this area are its subsurface exploration capa-

bilities in terrestrial, marine and transitional environments, including polar and high alpine areas. These capabilities rely on several cutting-edge research facilities for airborne, ground-based and marine geophysics.

Over the next decade, OGS aims to further expand its geophysical research infrastructures for data acquisition, increase the integration of in situ data with remote sensing data from space, and acquire next generation air- land- and ship-based sensors that will transform its ability to image and model the sub-surface for both environmental and basic scientific research and also services.

New synergies will be established with universities, research institutes, leading industries and corporate partnerships, in a close association with regional, national and European policy makers and funders.

Basic research on **Earth dynamics and basin evolution** remains a pillar in our future science vision and strategy, and includes large-scale geodynamic evolution, palaeoclimatology, high-resolution sequence stratigraphy and basin modelling. Key advancements will be achieved by developing 3D and 4D (i.e. time lapsed) combined geophysical methods, including seismic, multibeam swath bathymetry, electrical resistivity, magnetic, gravity and radar methods, supported by enhanced geophysical data acquisition, processing and interpretation facilities. The OGS capabilities will be enhanced by strengthening its facilities for geophysical exploration and borehole geophysics, as well as its specialised sediment and rock core laboratories and those for the processing and analysis of geophysical data.

The development of acquisition, processing, analysis and integrated geophysical modelling capabilities remains critical for **mapping, modelling and monitoring processes**, particularly in the Mediterranean and Polar regions. There is untapped potential for developing closer links between satellite-based Earth Observation (EO) and geophysical imaging over the next decade. This will enable next generation 4D mapping, modelling and monitoring, through the use of airborne geophysics, including innovative unmanned aerial vehicles for calibration, validation and augmentation of EO data. In the coming years, mapping, modelling and monitoring will increasingly rely on the digital representation of subsurface structure and geological processes, from shallow to deep levels, to create digital twins based on geophysical dataset integration, monitoring networks and satellite observations.

Research activity on **sustainable geo-resources** is being expanded and increasingly focused on renewable energies and raw materials. The extensive experience of studies on natural gas, gas hydrates and geothermal resources will be further developed, in terms of geophysical prospecting and to define storage and protection strategies, with particular attention to sustainability and environmental impacts. Extensive technical and scientific experience in seismic and electromagnetic monitoring of underground gas storage facilities will be further developed to better identify the criteria for distinguishing between natural and induced seismicity and deformation.

We plan to enhance **integrated water systems** research over the next decade, in consideration of the vital role of water resources and hydrogeology in modern society. The geological and geophysical expertise of OGS is being rapidly adapted to the study of water systems and, in particular, groundwater and reservoirs, both for the assessment of water resources and for the protection of water quality and reserves.

The next decade will also see an increasing need for research into **net zero carbon solutions**, including green energy sources (e.g. geothermal, solar and wind energy) and carbon capture, utilisation and storage (CCUS), coupled with hydrogen underground storage. OGS plans to contribute by helping to develop a wider understanding of potential underground energy storage sites and developing enhanced monitoring strategies. This is crucial in mitigating potential environmental impacts and safety issues associated with energy storage, and is also necessary to increase public acceptance of these ever-evolving approaches.



03 Understanding Disaster Risk

The prevention and reduction of human, environmental, economic and material losses from natural hazards is of fundamental and urgent importance worldwide and is in line with the UN disaster risk reduction policy (Sendai Framework 2015-2030).

Effective risk reduction measures require a better understanding of natural processes and an improved estimation of the expected consequences on the human and natural environment. This can be achieved by strengthening technological infrastructures for the identification and monitoring of natural phenomena, both *in situ* and remotely (e.g. from space).

Thanks to a close cooperation with national and regional civil protections, OGS has gained extensive experience over the years and has established a state-of-the-art multi-parametric ground motion observational network in north-eastern Italy.

This infrastructure will be significantly improved with the deployment of new seismological sensors, through the integration of satellite Earth observation facilities, GNSS data for near-real time monitoring of surface deformation at a regional scale, and with the use of cutting-edge and innovative technologies, such as the distributed acoustic sensing (DAS) over the existing regional fibre-optic communication infrastructure, to detect both long-term (e.g. ground subsidence) and short-term (ground shaking due to seismic events) deformation.

Fundamental research to understand **hazard processes and mechanisms** will focus on seismotectonic studies, physics of earthquake sources, wave propagation in heterogeneous media, characterisation of active or potentially seismogenic faults, ground motion forecasting, site response analysis, and monitoring of seismicity possibly induced and/or triggered by human activities. To support these activities, OGS will also rely on the improvement of its existing observation infrastructure. The seismicity of north-eastern Italy provides an ideal environment for the development and testing of algorithms for the detection of microseismicity including machine learning approaches, or for the statistical analysis of space-time variations, both in background seismicity and during seismic sequences.

Activities on **forecasting and risk scenarios** will be based on a multidisciplinary approach, combining seismological, geophysical and engineering skills to improve hazard assessment models, micro-

zonation techniques, exposure datasets, vulnerability functions and quantitative risk assessment methods. The collected knowledge can be leveraged into novel seismic, landslide (on and off-shore) hazard and risk assessment methods which can be tested in well-characterised areas to demonstrate their application at broader-scale. This includes rapid scenario analyses that can be used for disaster management. New approaches will be developed to assess multiscale environmental degradation. In particular they will be based on new technologies, protocols, modelling frameworks for the quantitative assessment, simulation, and management of cumulative multiscale hazards related to multiple sources of impact on terrestrial, coastal and marine environments, including pollution and environmental threats, while also considering climate change.

It is now clear that scientific research must shift its focus from hazard to risk in order to achieve the goals of sustainability and societal adaptation to natural hazards. This approach overcomes the traditional separation between different types of geohazards and creates a vision of **integrated multi-risk** research. Risk management aims at societal changes and solutions that necessarily require a holistic understanding of the different types of hazards and their impacts. OGS will accelerate the ongoing transition from the classical hazard-centric approach to a new multi-risk approach including landslides, sinkholes, glacier instabilities, volcanic processes, river and coastal floods, tsunamis and their impact on urban settlements, environment and fragile ecosystems. This approach will also quantify the effects of cascading impacts and will benefit from a combination of process based numerical simulations and advanced statistical approaches, to quantify the different hazards and their possible interactions. Understanding the exposure to multiple hazards and developing ad hoc taxonomic classifications is paramount in developing reliable risk estimates accounting for both direct impacts and cascading effects.

The continuous development of the OGS strong motion network satisfies the needs of civil protection authorities and now provides leading-edge services, including rapid **impact assessment and risk mitigation**. The high data quality and reliability of the OGS facilities enables the development, testing and application of innovative methods for seismic early warning and real-time assessment of impact scenarios, also using expert crowdsourced information. These objectives require the improvement of hazard assessment methods that can effectively integrate local effects on ground motion and develop a better understanding of ground-structure interaction. In this context, the development of cost-effective technologies to monitor earthquakes and landslides and measure acceleration in representative buildings is a key priority for the coming years.

OGS manages large infrastructures, laboratories and instrument pools useful for **rapid emergency response**. These infrastructures will continue to grow in the coming years, providing more and more high-quality data needed for multidisciplinary research on risk prevention and disaster relief. This will strengthen the institutional role of OGS as the competence centre of the National Civil Protection Service for the assessment of multi-risk scenarios in the land, marine and coastal areas, in order to provide useful information and data for emergency management.



04 Exploring Polar Areas

Polar research is receiving increasing attention worldwide due to its importance in assessing the detrimental effects of climate change on accelerated global sea level rise, the changes of ocean currents due to ice melting, the growing human presence in the polar regions and the need to preserve and protect the polar environment.

The unprecedented rapid changes in polar ice sheets and in ocean temperatures, as well as in the reduction of sea ice, have major impacts on global climate. Therefore, studies on the processes involved are of utmost importance for a robust assessment of sea level rise and its impact on the world coastal population and near-shore infrastructures.

Research in the polar regions is a priority for Italy as it is a member of the Antarctic Treaty and an observer in the Arctic Council. Understanding the mechanisms that regulate the global environment is the ultimate goal of the Ocean and Cryosphere in a Changing Climate programme and the Horizon Europe programme.

Polar research is a pillar of the OGS activities, with funding from the National Antarctic Research Programme (PNRA) and from the more recent Arctic Research Programme (PRA). OGS contributes to polar exploration in an interdisciplinary manner, linking oceanography, biology, geology, geophysics and seismology, both in terms of scientific expertise and infrastructures, with the fundamental support of its ice-breaker vessel, *Laura Bassi*.

OGS has developed a wide portfolio of scientific and logistic capabilities during 16 scientific campaigns in Antarctica and 4 in the Arctic region, and will build upon this in the next decade, using both the R/V *Laura Bassi* and vessels of other countries through international collaborations.

OGS plays a leading role within major national and international research projects in polar areas, and in the management of research infrastructures such as the Antarctic Seismograph Network (ASAIN), the Antarctic Seismic Data Library System (SLDS) and the deep-ocean observing systems in the Arctic that will help underpin future research. An important focus will be on numerical modelling of ocean circulation, polar ice sheets and the coupled response of the lithosphere-cryosphere system.

In the next decade OGS aims to play a leading role in launching new ambitious international efforts in both Antarctica and the Arctic that straddle the traditional boundaries between oceanography, geology, geophysics, glaciology and biology to link ice sheet and environmental responses to climate change, in particular by better connecting the past, present and future.

Studies on **solid Earth and cryosphere** interactions will define the subglacial bedrock geology and the deeper lithosphere hidden beneath polar ice sheets and outlet glaciers through higher resolution geophysical investigation. OGS will contribute to future international efforts to map the geology and define the subglacial bed on which glaciers flow, by focusing on linking geothermal heat flux and subglacial hydrology that influence both ice sheet dynamics and basal ice deformation. Seafloor and sub-sea floor mapping and sampling will unveil past subglacial conditions and ice sheet responses. This is key to help predict future trends especially in marine-based ice sheet regions

where the bedrock lies below sea level and dips inland. These regions are presently experiencing rapid ice sheet retreat and instability or did so in the past when the climate was as warm as predicted over the course of the 21st century and beyond.

Monitoring of the polar ocean will focus on the interactions between ocean circulation and marine sediment transport in relation to the extent of sea and continental ice. These studies will be extended by analysing the water column to determine the processes of ice melt-water and dense water formation in relation to sea ice formation and climatic conditions. The circulation in the deep sea will be monitored to investigate the interaction of deep water with the seafloor, which is related to the erosion or deposition of sedimentary bodies (sediment drifts) that also contain key paleoceanographic and palaeoclimatic information.

Geophysical data (radar, gravity, magnetic, electromagnetic, seismic and seismological), collected by ships, airborne platforms and satellites in collaboration with international partners, will be used for **mapping the subglacial lithosphere**. This will help unveil the topography, geology and architecture of the crust and lithosphere hidden beneath polar ice sheets and along the continental margins of Antarctica and Greenland. The results will underpin next generation basic research into the role of Antarctica and Greenland in the supercontinental cycle and into present and past Solid Earth-cryosphere interactions.

Research on past ice sheet behaviour will contribute to international **palaeoclimate and climate change** studies. Marine sediment sampling coupled with seafloor bathymetry and seismic data will help develop new simulations and models of past ice sheet extent. Determining key thresholds of change will contribute to the assessment of global sea level rise of the Intergovernmental Panel on Climate Change (IPCC). These efforts will also contribute to long-term international efforts such as the Arctic and Southern Ocean bathymetric mapping (IBCAO and IBCSO) and the International Ocean Discovery Program (IODP).

The **protection of polar ecosystems** requires a clear understanding of the interactions between marine ecosystems and the presence of sea ice. These will be further studied by analysing the carbon cycle and plankton biodiversity in the deep sea and polynya areas, in parallel with the study of the processes involved in the fixation and production of CO₂ in the deep sea.



05

Fostering Open Science

The paradigm of open science is recognised as a fundamental and indispensable principle for the advancement of knowledge and a necessary condition for sustainable management policies of natural resources based on shared and transparent scientific information.

Scientific communities, public institutions and industry need free, easy and fast access to certified data and information. The ‘decide, promulgate and defend’ strategy of policy makers is gradually being replaced by the ‘share, open, negotiate’ strategy based on citizen participation in data collection, education and scientific information.

In recent years, OGS has placed the principles of open science at the heart of all its actions by defining programmes to implement them for marine, geophysical, seismological and polar data. OGS has also contributed to the definition and systematic use of open data policies for data collection, supported by the possibility of assigning digital object identifiers (DOIs), to create and share open datasets and software repositories, disseminate and exchange scientific knowledge, for higher education and for citizen science initiatives.

These policies entail important social, economic and cultural implications for the scientific community, as well as for civil and business sectors. The massive sharing of data in all OGS fields is supported by the development of several data management systems and e-infrastructures that are currently used by the relevant scientific communities, industry, public and private organisations, and citizens.

The open science programme of OGS for the next decade is consistent with the principles of the UNESCO Recommendation on Open Science and Horizon Europe, as well as with the objectives of the National Plan for Open Science of the Ministry of University and Research. In this context, OGS has recently established an institutional repository for research products (ricerca.ogs.it) and defined its own open access policy.

In the coming years, OGS will continue to develop tools that will enable researchers to create **data** and products **findable, accessible, interoperable and reusable (FAIR)** with collaborative, transparent and reproducible procedures. This includes measures to increase staff awareness of open science and incentives to publish research products in institutional repositories following the paradigm of ‘as open as possible, as closed as necessary’.

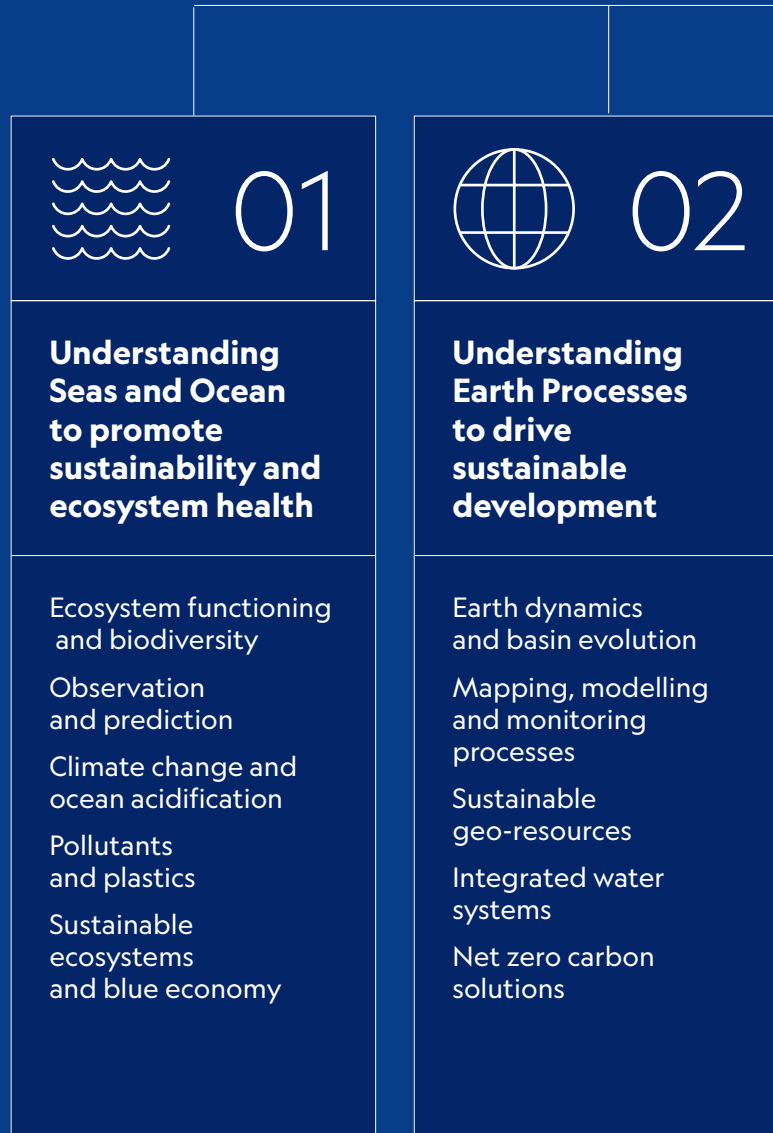
Through an extensive programme of science outreach and public engagement, in the years to come, OGS will increase its involvement in **risk education and ocean literacy** programmes promoted by the United Nations and the European Union, in line with the objectives of the Sendai Framework for Disaster Risk Reduction and the Decade of Ocean Science for Sustainable Development.

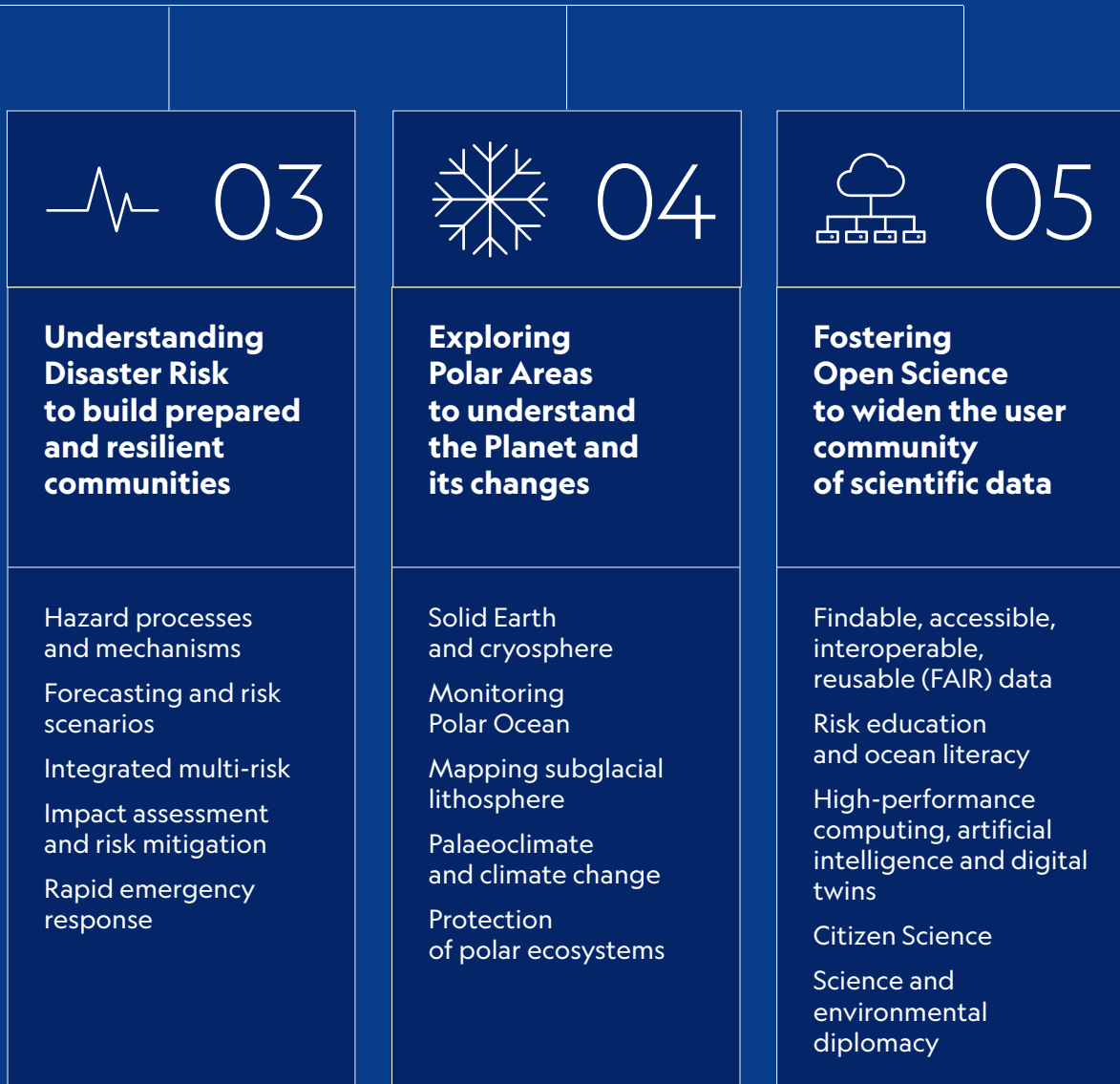
Following the roadmap for the European Open Science Cloud (EOSC), OGS contributes to the development of **high-performance computing, artificial intelligence and digital twins** through its research and innovation activities. These also include training programmes for HPC applications in the Earth Sciences aimed at young researchers.

Citizen Science activities will be further developed to include the participation of people in the collection of scientific data based on crowd-sourcing techniques, smart-apps, polls and statistical surveys, as well as volunteering. In selected projects, Virtual Research Environments (VRE) will be created to share data and available information across various disciplines, providing new services to address societal relevant issues.

A major programme of **Science and environmental diplomacy** is undertaken by OGS with the awareness that the open science paradigm can be fully achieved through an effective scientific collaboration between nations to address common problems and build international partnerships, with particular attention to the less developed and developing countries. OGS recognises that science helps to improve diplomatic relations between countries and that international diplomacy facilitates scientific progress through open borders, open science and open data. In all its activities, OGS promotes and supports international relations and science and environmental diplomacy on a global scale, with a particular focus on the Mediterranean and Balkan regions, Central Europe, the Black Sea, Latin America, Central Asia and the Polar regions.

Research and innovation missions at a glance





6.

Infrastructures and services



Research infrastructures, providing resources and services to communities to conduct research and foster innovation, are a key component of European policies.

OGS is significantly involved in the design, development, management and maintenance of research infrastructures, such as large-scale facilities, instrument pools, observatories, monitoring systems, communication networks, open data infrastructures, high-performance computing, calibration centres, scientific data sets and sample collections.

OGS has developed bespoke expertise to manage large and complex infrastructures within the European Strategy Forum on Research Infrastructures (ESFRI) and the National Research Infrastructure Plan (PNIR).

The icebreaker *R/V Laura Bassi*, owned and operated by OGS, will continue to be used for scientific activities and logistical support for Italian polar expeditions. The vessel is currently the only Italian polar ship and is part of the European EUROFLEETS network and the Arctic Research Icebreaker Consortium (ARICE).

In the coming years OGS intends to consolidate its activities as national coordinator of three European infrastructures present in the ESFRI roadmap, two of which established as European Research Infrastructure Consortia (ERIC):

Euro-Argo ERIC: the European component of the Argo worldwide system for in situ observation of ocean, polar and marginal seas based on a global float network reporting subsurface ocean properties to a wide range of users via satellite transmission links to data centres. The ERIC status allows active coordination and strengthening of the European contribution to the international Argo programme.

ECCSEL ERIC: the European infrastructure on the capture, utilisation and storage of carbon dioxide, which includes the special NatLab infrastructure in the Aeolian archipelago, built to allow access to a CO₂ venting area to be used as a natural laboratory for assessing the impact of CO₂ leakage on marine and coastal ecosystems, to test new instrumentation and monitoring methods and for research on CO₂ migration and environmental change.

PRACE: the European partnership for high-performance computing (HPC) for promoting access to world-class HPC and data management resources and services for multidisciplinary research. It is associated with the HPC Training and Research programme for Earth Sciences (HPC-TRES), also coordinated by OGS.

OGS will also continue, and possibly expand, its participation in other ERIC and ESFRI infrastructures coordinated by other public research organisations in the field of Earth and Ocean Sciences.

OGS will carry out the management of the **Terrestrial Monitoring System for Northeast Italy** (SMINO) composed of a seismological, strong motion and GNSS network, implemented for scientific and civil protection purposes. The strong motion network is under major development and it will be largely expanded in the coming years, becoming one of the densest regional networks in the world. The management of other relevant permanent seismic networks in Antarctica and on Mount Everest will be continued and renewed by OGS.

Several marine observatories are operated by OGS in the Adriatic Sea and will be further expanded, including the **North Adriatic Observing Platform**, equipped with a long-term ecological research network (LTER) station, which is also provider of operational marine

biochemistry services for the European Earth observation programme Copernicus.

OGS intends to continue its direct commitment to the management and development of its own research facilities, such as its **research aircraft** for remote sensing on land and at sea, the **test site for borehole geophysics**, specialised **laboratories** for the analyses of sediment and rock cores, and geophysical data processing, its cutting-edge **geophysical exploration infrastructure**, the fleets of aerial and underwater **robotized vehicles** (drones, drifters, gliders), and other high-end equipment.

OGS contributes to **scientific ocean drilling** programmes, such as the International Ocean Discovery Program (IODP), by hosting the Office of the Science Support and Advisory Committee (ESSAC) of the European Consortium for Ocean Research Drilling (ECORD).

Special attention will be given to **data management and distribution infrastructures** in seismology, geophysics and oceanography, based on the principles of FAIR (findability, accessibility, interoperability, and reusability) and including, among the others, the Italian National Oceanographic Data Centre (NODC).

Furthermore, OGS will continue to manage its **calibration and metrology centres** for oceanographic, geophysical and seismological instruments, and its **collection of marine microorganisms** making them available to the scientific community and industry.

This major set of research facilities will be strongly expanded and strengthened over the coming years thanks to the extraordinary funding from the **National Recovery and Resilience Plan** (PNRR) and the excellent success rate of OGS researchers in competitive projects.

A special effort will be dedicated to **business creation** and to the development of **small and medium enterprises**, as part of special innovation projects co-funded by the private sector to bridge the gap between research and business. These new technological infrastructures will focus on life sciences, artificial intelligence and energy transition, through the creation of new high-tech laboratories capable of attracting start-ups and providing services to small and medium-sized enterprises.

Services to third parties are strategic activities for OGS, and are related to its nature as a public institution with a strong focus on applied research. These activities will take up a significant part of the Institute resources and will contribute in a decisive manner to the high reputation it has earned in both the public and private sectors at national and international level.



7.

Capacity development

Capacity development is one of the core activities of OGS and an important part of its overall strategic vision. The Institute integrates capacity development in its activities as a cross-cutting support to all scientific research programmes.

OGS, together with other partners from public and private sectors (universities, research institutions, governmental bodies and industries), is promoting a training path aimed at overcoming the existing **skill mismatch** between higher education and the labour market needs.

The **capacity development programmes** of OGS include summer schools and other higher education initiatives, PhD and master programmes in cooperation with national and international universities, professional development and vocational training, internships and job placements, strategic partnerships and international relations.

The OGS scientific reputation in capacity development is based on a consolidated network of national and international **relationships with academic and research institutions**, as well as relevant governmental and non-governmental organisations.

Capacity development is also a key component of the activities carried out by OGS in the field of **international cooperation and science diplomacy**, which includes mobility and exchange programmes as well as continuing education and professional qualification programmes.

The main capacity development programme of OGS in the coming years will be dedicated to the **Sustainable Blue Economy**, which points towards the enhancement of skills and promotion of opportunities for 'Blue careers' by developing competencies, leveraging innovation and sharing knowledge for a more sustainable development in the marine and maritime sectors. All Blue skills activities will be supported by the Western Mediterranean Geopolitical Forum for Research, Innovation and Higher Education - **Dialogue 5+5** - and will contribute to the development of scientific diplomacy among Mediterranean countries.

Another important capacity building programme will be dedicated to **high-performance computing (HPC)** for developing skills and providing advanced training for Earth system modelling (atmosphere, hydrosphere, lithosphere and biosphere) using numerical methods.

OGS recently joined the **Copernicus Academy** to bring its capacity development activities to the European network on Earth Observation and to provide the future generation of researchers, scientists and entrepreneurs with the skills necessary to exploit the full potential of Copernicus data and information services.

All the capacity development programmes will include awards, PhD scholarships, student grants and international mobility to encourage the participation of students and young researchers, also from less developed countries.

For the next decade, OGS intends to extend its capacity development programmes to **other areas**, such as disaster risk reduction, geophysical exploration, energy storage, carbon sequestration and sustainability.

In addition, OGS will continue its commitment to **attracting talent** and supporting **international mobility**, especially from less developed countries, through the consolidation of qualified relationships with the World Academy of Sciences (TWAS), foreign universities, research centres and other international organisations.

8.

Public engagement



Outreach and public engagement are priority activities for OGS to ensure a continuous dialogue with institutions and citizens and to consolidate its institutional identity and scientific competences in the service of society.

The scientific activities and research facilities of OGS will be used to stimulate public interest and promote social, economic and cultural development.

High-level technical support will be offered to national and international organisations working on sustainability policies, risk mitigation, open science and innovation. OGS researchers actively participate in key governmental and non-governmental technical committees in oceanography, geophysics, seismology and polar sciences.

OGS intends to continue and strengthen its participation in **public events**, such as science festivals, night of researchers, science weeks, science cafes, open days and other similar initiatives aimed at a broad audience.

Within the United Nations Decade of Ocean Science for Sustainable Development and in collaboration with WWF and other organisations, OGS has launched its own **Science Festival MareDireFare**, based on the combination of the languages of Art and Science for a better scientific outreach on marine topics. The festival, addressed to the public, will be organised each year with new partners and new formats.

OGS plans to continue and expand its **outreach activity for schools** of all levels - from young age to university students - with seminars, conferences, site visits to headquarters and facilities, field trips, internships, short-term stages and scientific games. Specific training programmes are devised for teachers and people from the private sector.

Institutional communication through the website and the main social channels has been strengthened in the last years and will be further developed with continuous inputs of new original contents, infographics and video productions.

The intense activity in the organisation of conferences and scientific events will be increased, in co-operation with scientific associations and other stakeholders.

OGS publishes its own international science journal, which has just been relaunched under the new name **Bulletin of Geophysics and Oceanography**, with the aim of increasing its international reach, attractiveness and high scientific quality, as well as consistently applying the principles of open access.

In the framework of its mission on open science, OGS promotes the active and direct **involvement of citizens in scientific activities**, through original apps, web forms, statistical surveys and other tools.

An innovative and multi-disciplinary **laboratory on quantitative sustainability** has been recently established with other research institutions in the region, to promote the use of quantitative approaches in the science of sustainability, analysis of sustainable development goals, and impact assessment of policies and technologies on economy and ecosystems.

9.

Staff and working environment



The promotion of human resources, their continuous training and well-being will remain fundamental priorities for OGS, in the awareness that building a better working environment will make it possible to effectively carry out research and innovation activities. Various measures will be implemented in the coming years to develop staff skills and promote growth, researcher mobility, equal opportunities and inclusion to create a vibrant, open and international working environment.

Strategies to improve human capital will include the full implementation of the European policies for researchers, the attraction and circulation of national and international talents, the continuous staff training, the enhancement of transparency and internal communication, and the improvement of both the work environment and the work-life balance.

Special attention will be paid to the confirmation of the **Human Resources Excellence in Research** certification, obtained for fully complying with the principles of the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers. OGS was the first Italian public research institution to receive such acknowledgment and intends to maintain it in the future.

Professional development through various pathways such as PhDs, research fellowships and international mobility will be an important component of the OGS strategy for the continuous training of present and future employees.

OGS strives to **develop the technical and scientific skills** of its staff and to improve its human resources for the benefit of society and individuals. The main challenge is to accelerate the improvement in performance, innovation and transparency and to face global competition with a strong team spirit and heightened sense of belonging to the institution.

In addition, OGS intends to improve the **soft skills** of all staff members, by providing training to develop specific and relational abilities, improving the working environment and the work-life balance, surging international attractiveness and continuing to innovate towards a results-oriented culture.

Human resource planning will aim at encouraging the entry of early career researchers with new ideas and skills, while balancing the demographic configuration of staff. Both recruitment and career advancement will be based on open, transparent and merit-based procedures.

The strategic areas and specific objectives of the **integrated plan of activities and organisation** for the coming years will include:

- Improve the scientific research quality;
- Strengthen the scientific impact on society;
- Reinforce the general and administrative organisation;
- Enhance and develop the staff;
- Commit to sustainability and environmental protection;
- Guarantee ethics and transparency;
- Boost the digital transformation.

Over the next ten years, OGS will pay special attention to **sustainability and social responsibility**, by contributing to carbon neutrality, energy efficiency of buildings, full waste recycling, zero plastic and paper consumption, and environmentally conscious behaviour. For this purpose a green branding programme will be introduced to underline the firm commitment to sustainability and social responsibility.



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