

AGEO: Advanced Citizens' Observatory for Atlantic Geohazard Risk Management

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Abstract. AGEO (Atlantic Geohazard Risk Management) platform has been employed from several pilots in Europe within the INTERREG AGEO project as Citizens' Observatory on geohazards. The aim was to demonstrate how citizens' involvement in geohazard risks prevention can strengthen regional and national risk management systems. Parallel with this activity AGEO fosters an efficient uptake of Copernicus data, products, and services on regional level. A combination of these two actions can result the improved geohazard risk prevention and resilience to natural disasters in the Atlantic region. National and regional authorities are directly involved in the project and have been in charge for the project outputs' development with the help of solution providers and facilitators. Public stakeholders (civil society and individuals) have been directly engaged with locally and on a regional, interregional, and national level. The requirements of all stakeholders have been considered in a combined effort to address the individual needs of each group to the satisfaction of everyone. Within this paper we aim to describe the AGEO platform for earth science application, with participatory sensing capability to facilitate the capture of citizen observations through the provision of an online catalogue of citizen science resources (best practice, software tools, datasets, usability trials, citizen engagement studies).

Keywords: Citizens' observatory · Geohazard Risk Management · Decision Support platform and mobile applications

1 Introduction

1.1 AGEO INTERREG

AGEO project is part of the INTERREG Atlantic Area Priority on "Strengthening the territory's resilience to risks of natural, climate and human origin, with the objective to strength risk management systems" [1]. AGEO has launched several Citizens' Observatory (CO) pilots on geohazards according to regional priorities [2]. The aim was to engage with local communities to actively participate in risk preparedness and monitoring and incorporate local capacities into risk management systems. Experiences gained

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during the implementation of the CO pilots have been used to formulate recommendations for the creation of future observatories in response to the widest range of hazards (both natural and human-induced) in the Atlantic region. Specific objectives within the project include the following actions:

– Create a cooperation and resource platform on Atlantic geohazards risk assessment, preparedness, mitigation, and prevention.
– Deliver concrete case studies to confirm the capacities of Citizens' Observatories in improving risk management systems.
– Encourage the regional-level uptake and use of products and services provided by European spatial data infrastructures (i.e., Copernicus [3]).

AGEO demonstrates a new form of engagement between civil society and local authorities for geohazards-related local capacity building and encourage the local use of innovative Earth Observation (EO) products and services [4] provided by European data infrastructures, in particular Copernicus. AGEO helps to empower citizens to initiate change by actively participating in geohazard risk preparedness actions. This will result in more informed decision making and new forms of social mobilization, facilitated by new ways of communicating and assessing information on natural hazards. COs are playing an increasingly important role in addressing social-technological challenges, primarily by allowing citizens and policymakers access to new forms of data-driven assessment of the problems at hand. The resulting effects on equal opportunities are numerous, covering security, demographics, socioeconomics, and sustainable development including the following:

- Enabling all actors of society to participate in making their community safer and stronger, including otherwise disadvantaged groups, senior citizens, or people with disabilities.
- Providing equal access to complementary training and experience related to natural hazards, data processing, use of mobile technologies.
- Creating more local support for bottom-up initiatives and entrepreneurship that could create new employment directly or indirectly related to AGEO objectives (for example environmental monitoring startups, drone-tech companies, other citizens' science initiatives).
- Create temporary occupational tasks for people on unemployment benefit, keeping them active and valuable contributors of their local community.
- Orient young people towards taking up scientific and engineering careers related to geosciences, information technologies, telecommunications.
- The AGEO CO pilots enable data-driven engagement on geohazards, creating the basis for more targeted future interventions and enhanced collaboration between the public and the authorities. This will not only contribute to the creation of more secure and inclusive local communities but will also support the creation of new jobs and economic development opportunities for groups facing employment and/or integration problems.

National and regional authorities are directly involved in the project and have been in charge for the development of the main project outputs with the help of solution providers and facilitators (members of the AGEO INTERREG Consortium [1]). The requirements

of all stakeholders have been considered in a combined effort to address the individual needs of each group for the outputs designed and delivered to meet stakeholder needs. During the final months of the project stakeholder satisfaction has been assessed as a part of the evaluation of the pilots. This helped to anticipate future stakeholder needs of follow-up projects and replication of results.

1.2 AGEO INTERREG Platform

AGEO platform [5] can be used from citizens, to report, monitor, review and examine their observations. The main purpose behind AGEO Citizens' Observatory Platform's goals is to bring citizens and authorities together and enable communication and interaction between each other. The AGEO Platform allows authorities to manage citizens' observations by enabling the platform managers to direct citizens' observations to the correct facilities and take timely action.

AGEO CO Platform's development involved studying in detail any bottlenecks and risks to a more meaningful engagement with society via COs. Concrete cases, success stories, and existing initiatives have been discussed, analysed, and mapped, including cooperation and national projects with telecommunication companies and civil society initiatives. Information has been collected via surveys and concrete actions, recommendations, and a roadmap of exploitation either for the AGEO platform or the AGEO mobile applications [6, 7] were also developed. Several critical issues were addressed carefully in the software development and the resulting platform ensures data masking by adopting anonymization or pseudonymization in line with GDPR requirements. It also delivers a viewing metaphor that adopts a map-based interface using Google Maps as the vehicle which enables data to be viewed collectively. Provision for multimedia data collection is offered and this is stored in a cloud-based service. However, the software includes a rudimentary data quality filter that thwarts poor quality, incomplete or malicious/rogue data polluting the integrity of the data corpus.

2 Advanced Citizens' Observatory for Atlantic Geohazard Risk Management

AGEO platform is simple and easy to use with participatory sensing capability to facilitate the capture of citizen observations through the provision of an online catalogue of citizen science resources (best practice, software tools, datasets, usability trials, citizen engagement studies). A map-based interface [5] for social engagement through which citizens can observe the collective citizen observed geohazard data. An online catalogue of citizen science resources (best practice, software tools, datasets, usability trials, citizen engagement studies) collects relevant resources to stimulate the effective use of Citizens' Observatories for geohazards monitoring under operational conditions as integral part of regional/national risk management systems. Within this project Copernicus data (available products, services, uptake efficiency, recent use-cases) in the participating Atlantic regions have been reviewed and AGEO promotes the development of sustainable supply chains for new, geohazards-EO products and services with demonstrated value/importance for the stakeholders and communities in the Atlantic region. As

a result, there is increased engagement with citizens in the validation and improvements of EO products, processes/services via new generation mobile applications, encouraging them to actively participate in geohazards monitoring in their communities. Studies were carried out on a national/regional level within each five countries mobilizing national and regional clusters and stakeholders. The software tools developed [6–8], prioritize ease of use, and immediate accessibility for the citizen. The software ensures data masking adopting anonymization or pseudonymization in line with GDPR requirements. It delivers a viewing metaphor that adopts a map-based interface using open street maps as the vehicle which will enable data to be viewed collectively. Provision for multi-media data collection is offered through a cloud-based service. The software includes a rudimentary data quality filter that thwarts poor quality, incomplete or malicious/rogue data polluting the integrity of the data corpus. Concrete cases, success stories, existing initiatives have been mapped, including cooperation and national projects with telecommunication companies and civil society initiatives.

2.1 Functionality of Citizens' AGEO Observatory

AGEO observatory includes two distinct basic web interfaces, one as a search/data extraction tool and map based (Fig. 1). Additional major elements, such as a sophisticated map-based interface that uses Google Maps API and a managerial dashboard that allows viewing, forwarding, responding to, and extracting data from geohazard occurrences, have been created. A sophisticated implementation of RESTful API is in place, which can accept requests regarding events based on date and type and returning the results in JSON format is also necessary. The platform includes a dashboard with user login, sign in and the search/download tool, an advanced map-based interface implementation, an advanced RESTful API implementation, database updates/conversion, some graphic design, integration, and navigation work. AGEO Citizen Observatory Web Platform can be used to report various events (Wildfire, Tsunami, Earthquake, Rockfall, Sinkhole, Eruption, Landslide, River Flooding, Marine Flooding, Coastal Erosion, Building Settlement). The development of the observatory is available for inclusion of further events to cover any other geohazard the society finds suitable for inclusion.

Users can view all the event reported plotted on a map view. Users can pan and zoom through the map for looking at different events. The map will be anchored around Europe by default. If the user allows location access, the map will get anchored to the user's location. Each event is represented by a separate pin. Multiple pins are clustered together and the total number of clustered pins (Fig. 2).

The Web platform allows admin and managers to download the event data in different format (JSON format supports complete event data dumping; Excel and CSV format allows only structured data download and custom event questionnaire answers are not included). The users can view all the event reported in a tabular view and sort data on various fields with search and selection functionality (Fig. 3).

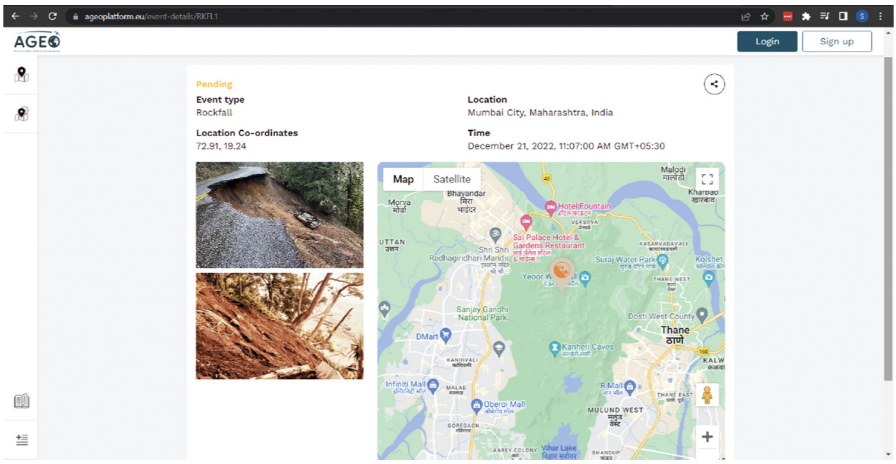

Fig. 1. Event review at the AGEO web platform: Pending Rockfall event

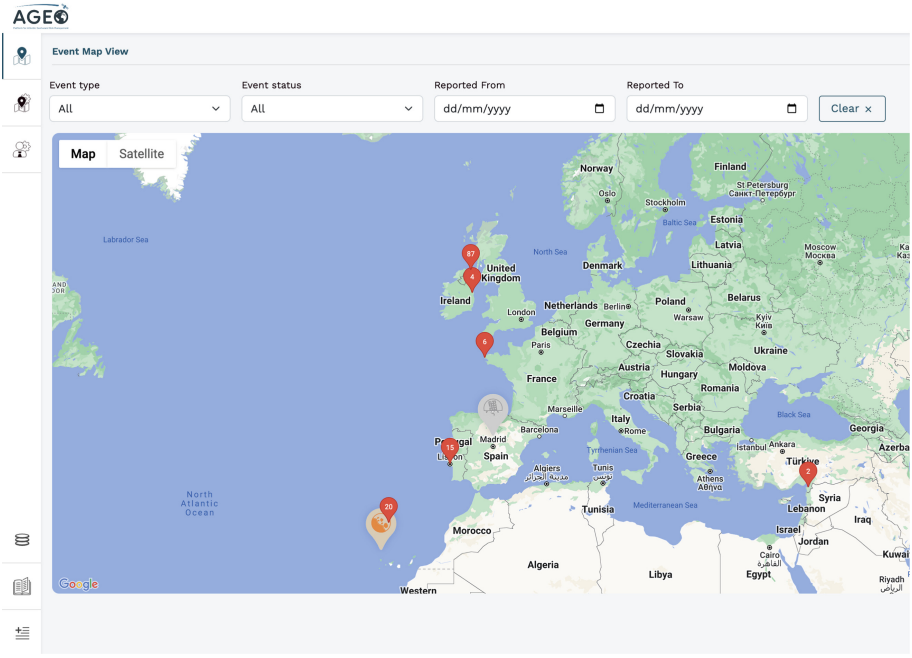

Fig. 2. Event pinned at the AGEO web platform map.

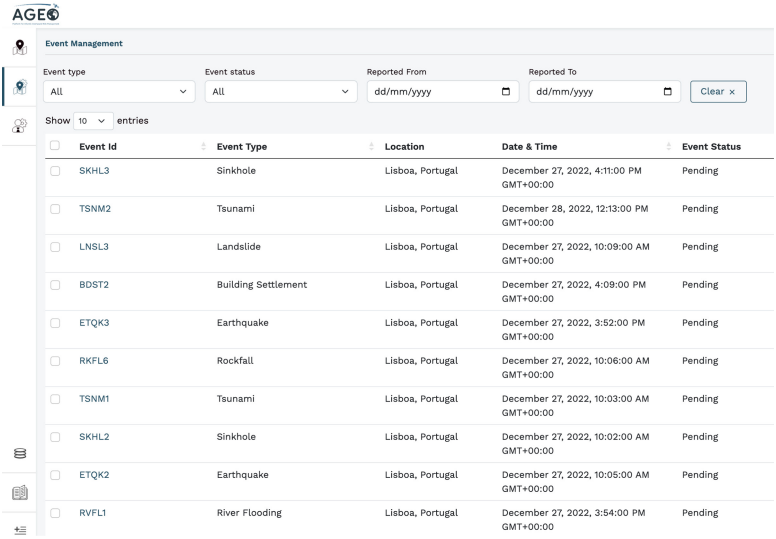

Fig. 3. Example of event data - AGEO pilot in Lisbon (Portugal).

Educational content (Fig. 4) is also available through the AGEO Citizen Observatory with a detailed help guide for the user to prepare and steps to follow in case of an event. The educational content also gives further details about the event. The AGEO platform also supports the plugin facility of local data stations (Fig. 5). All content and information to login an event and view live logs of data can be accessible through the mobile application (Fig. 6).



Fig. 4. AGEO Platform Educational Content



Fig. 5. Example of Madeira based data station within AGEO web platform.

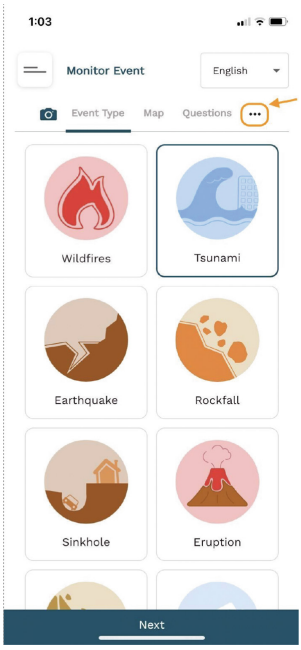

Fig. 6. AGEO mobile application platform.

2.2 Provision of Satellite-Derived Multi-temporal Interferometry of Synthetic Aperture Radar (InSAR) Data for the AGEO Citizen Observatory Pilots

Copernicus products and services are expected to be a key component of many future COs on geohazards [9]. Within AGEO project, the review of the use of Copernicus

data (available products, services, uptake efficiency, recent use-cases) in the participating Atlantic regions has taken place at the first phase of the project. This has resulted the provision of satellite-derived multi-temporal Interferometry of Synthetic Aperture Radar (InSAR) data for the AGEO Citizen Observatory Pilots (Fig. 7) to enhance the region's stakeholders' (including SMEs) potential to take advantage of present and future market opportunities offered by Copernicus. This task also created the groundwork for increased engagement with citizens in the validation and improvements of EO products, processes/services via new generation mobile applications, encouraging them to actively participate in geohazards monitoring in their communities. Studies were carried out on a national/regional level within each five countries involved in AGEO mobilizing national and regional clusters and stakeholders.

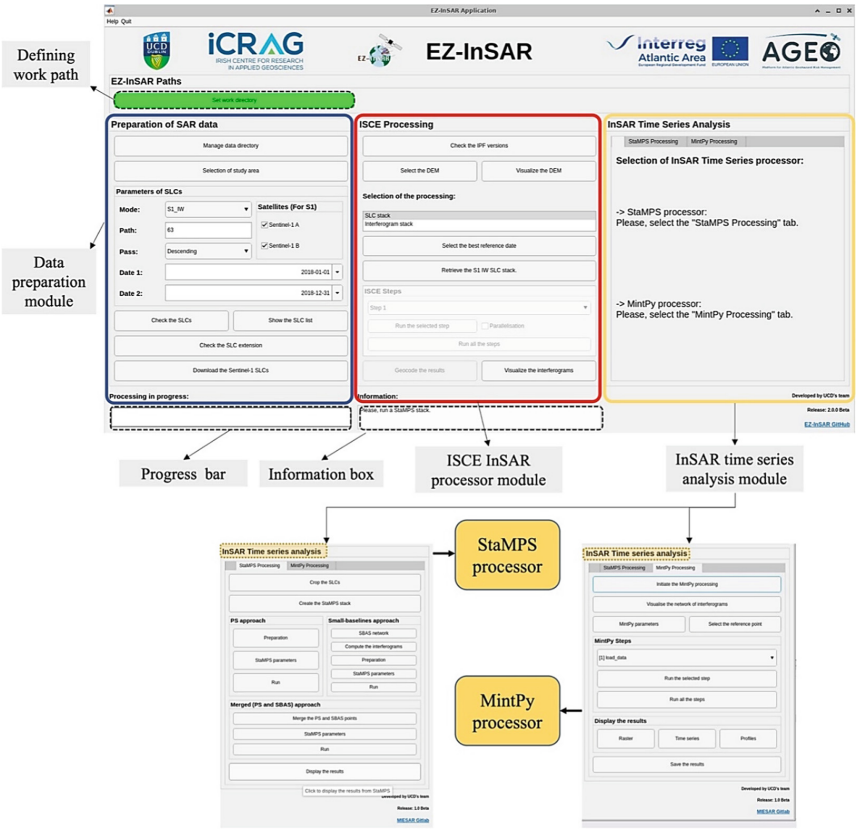

Fig. 7. Snapshot of AGEO EZ-InSAR toolbox GUI [10].

The level and efficiency of the use of Copernicus (including Copernicus EMS) in geohazards risk reduction in the participating Atlantic regions has been reviewed taking into account existing reviews [11–13] aiming to understand the level of user engagement and the scalability of Copernicus solutions on a regional scale for a range of geohazards: landslides, floods, tsunamis, earthquakes, volcanic activity, cascading events that may

include other types of natural hazards (such as forest fires) and human-induced geohazards (e.g. induced seismicity or surface subsidence). The activities included development and build up on the open access data policy of Copernicus and ensure that the evolution of services considered the specific needs of the Atlantic region with regards to evolving user needs and services; regional investments and priorities, and the identified challenges related to geohazard risks. Another aim is to further develop the geohazard dimension of Copernicus to enable its response to evolving user needs, from the Atlantic region. The results of these activities include:

- Provision of satellite-derived multi-temporal Interferometry of Synthetic Aperture Radar (InSAR) data for the AGEO Citizen Observatory Pilots (Fig. 8)
- Provision of an easy-use, open-source, multi-temporal InSAR processing tool for future (post-AGEO) geohazard monitoring [14].

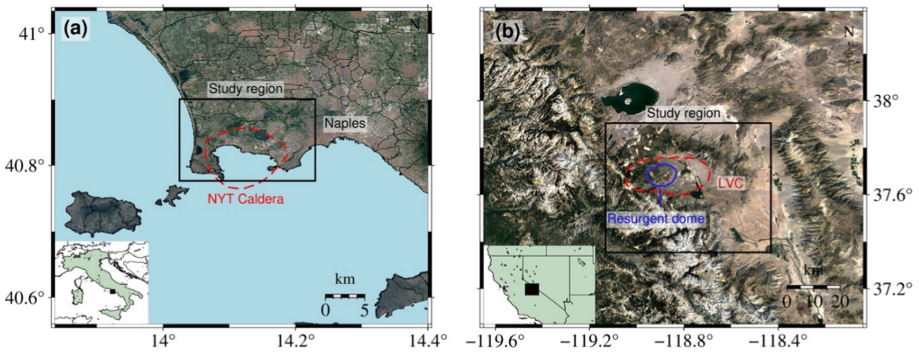

Fig. 8. Sample of Satellite maps, provided by Google Earth, of the test site Campi Flegrei volcano (a) and Long Valley caldera (b). The rectangles are the coverage of the Regions of Interest. The red dashed lines are the NYT caldera boundary in (a) and LVC boundary in (b). The solid blue line within LVC outlines the Resurgent Dome.

3 AGEO Pilot (Northern Ireland)

The Northern Ireland CO located on the Causeway Coast, County Antrim (Fig. 9), consists of two individual sites: Giants Causeway and Carrick-a-rede. The Giants Causeway is a designated UNESCO World Heritage Site (WHS) with Carrick-a-rede located 14km east. Both sites hold significant geological, cultural, and commercial status. The objectives of the pilot were to

1. Carry out routine monitoring of the sites.
2. Engage local communities and stakeholders to provide them with education awareness of geohazards.
3. Encourage their active participation in hazard monitoring through a mobile application developed by the AGEO project.

4. Evaluate satellite data from the Copernicus programme as a geohazard monitoring tool and
5. Promote better understanding of geohazard risk to stakeholders to enhance risk management at the sites using evidence-based information.

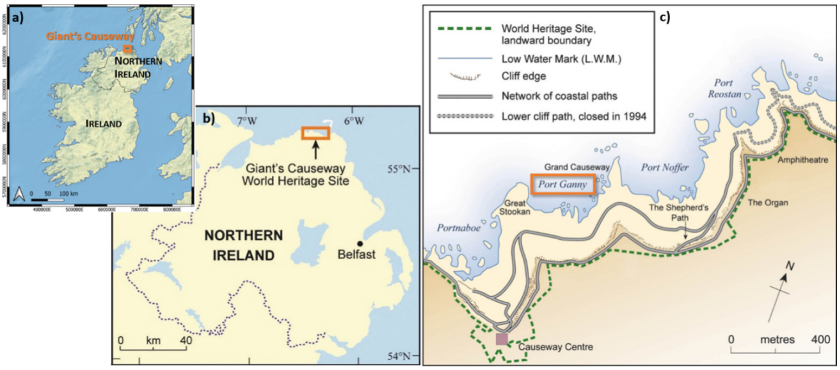

Fig. 9. Northern Ireland AGEO Pilot: a) Location of the Causeway Coast and Giant's Causeway in Northern Ireland. b) Map of the Causeway Coast. c) Outline map of the network of publiuc access routes at Giants Caiseway (source, www.qub.ac.uk/geomaterials).

To meet these objectives, research was initiated to better understand and characterize the risk through carrying out geological site survey; geotechnical monitoring took place and assessed satellite derived data and incorporation of citizen monitoring data were collected through the AGEO platform. The pilot also initiated a series of outreach events within the local communities to raise awareness of geohazard and the participatory role citizens could take in monitoring their landscape using the AGEO platform. The work carried out resulted in the recording of numerous landslide events including images of each event leading to an increased understanding of the areas and exposure of risk across the sites. Citizen involvement was achieved through local engagement and collection and evaluation of citizen data as a means of geohazard monitoring to enhance risk management of the sites. The use of the AGEO platform was the first of its type in Northern Ireland to utilize such a public application to assist in geohazard monitoring. National Trust staff, who manage both sites, were provided with training on its use and a series of public workshops was delivered to promote citizen involvement through using the application. Between September 2022 and January 2023, a total of ninety-three (93) citizen monitoring images, identifying recent slope failures, were uploaded to the AGEO platform (Fig. 10).

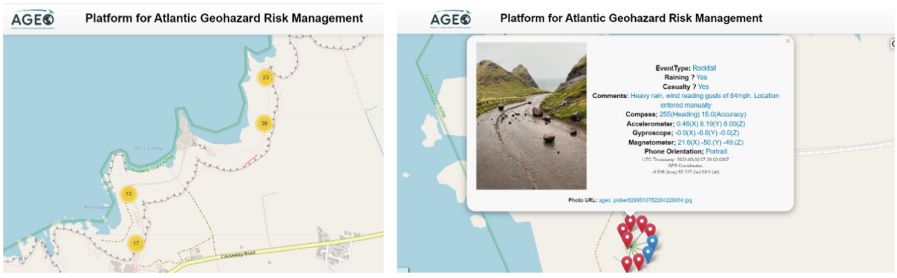

Fig. 10. AGEO online platform applied for Northern Ireland pilot

4 Conclusions

The Citizens' Observatories that have been delivered are the immediate outputs of the project, also constituting the basis of a long-term result i.e., direct involvement of citizens in natural hazards monitoring and risk preparedness along the Atlantic region. AGEO, apart from the web platform of the citizens' observatory, has delivered:

- Five (5) Citizens' Observatories covering geohazards of regional importance: landslides, rockfalls, floods, seismic risks. A comprehensive toolbox that facilitates the deployment of the Citizens' Observatories to be also used in follow-up projects.
- Information leaflets and dissemination materials.
- A project website and social media channels for direct engagement with citizens and the professional community.
- Several high-impact conferences and workshops organized on a national and international level with the aim of stakeholder engagement and the mobilization of external expertise.
- A Platform dedicated to long-term cooperation and information sharing on geohazards.
- An evaluation of the AGEO Citizens' Observatories and recommendations for the future regional use of Copernicus products and recommendations for the future.
- Overarching recommendations for the development of new policies and measures in view of improving the resilience of land and maritime areas to climate and nature changes.

All these results will help regional authorities and stakeholders be better prepared to facing potential risks occurring in the Atlantic territory of natural or anthropogenic origin. AGEO platform has tangible contribution towards increased resilience of society against natural hazards with better capacity in disaster risk reduction based on the principle of public engagement. The project is designed with the objective to create permanent links amongst partners using a cooperation platform supported by an easy to maintain social media presence. Within the next decade the following are anticipated:

- Citizens' Observatories will become a regular component of risk management systems at local, regional, and national levels.
- Stronger public awareness for the importance of geohazard risk prevention and a strong social license for the implementation of new measures.

- More efficient uptake of Copernicus data on a regional level and a new range of innovative Earth Observation services and products seamlessly integrated with Citizens Observatories.
- New methodologies and technologies (for example new Apps) developed for risk reduction raising young people's interest for the topic.
- Increased public confidence in the regional authorities' abilities to manage natural hazards because of increased transparency.
- Community leaders will be empowered to take up active roles in risk prevention, and recovery and regeneration actions.

AGEO has contributed to the development of a proactive and socially licensed risk management approach that takes into consideration vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. The platform and the mobile apps can be utilized for disaster risk governance especially for the north-east Atlantic area at the transnational, regional and local levels, which is very important for prevention, mitigation, preparedness, response, recovery, and rehabilitation. Investment in disaster risk prevention and reduction through structural and non-structural measures are important for the economic, social, health and cultural resilience of persons, communities, countries and their assets. The project has strengthened disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels through proper policy making based on the stakeholders' requirements and transnational and regional interrelations. AGEO acts as a catalyst among the so far limited regional policy initiatives and cooperation.

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