Raising Awareness About Geoheritage at Risk in Portugal: the GeoXplora as a Case Study

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Abstract
This work reports an innovative event developed at the University of Coimbra (Portugal) and organized by undergraduate students of geology during the academic year 2020/2021 regarding geological heritage at risk outcropping in the Lusitanian Basin. Inspired by the current situation of vulnerability of two well-known geosites classified as Natural Monuments (Carenque and Cabo Mondego), the GeoXplora initiative targeted the general public, decision-makers and politicians. It aimed at stimulating curiosity and interest about geoconservation, raising awareness about the need to protect the physical integrity of both geosites and requiring the implementation of appropriate valuing and monitoring actions as provided by the Portuguese legislation. Based on a webinar format, the event was free of charge and took an entire day (April, 16th, 2021). It included four thematic sessions led by 21 experts from different sectors of the society. The social impact of this initiative was analyzed through data collected from two applications: Meta Business Suite© of the Facebook event page, and a survey included in the event registration form using the Google Forms©. Results show that more than 10,000 participants affiliated to different organizations attended the initiative, numbers that would hardly have been achieved with a traditional face-to-face seminar. They accessed from several countries around the world, with significant participation of people from the Community of Portuguese-Speaking Countries. The results relate to a study case, but the event design and implementation may be useful for inspiring other students, teachers and communities to develop similar interventions aiming at raising awareness about the role of geosciences in promoting sustainable development, and taking the 2030 Agenda goals into account.

Keywords Geoconservation · Geoheritage at risk · Students’ engagement · 2030 Agenda

Introduction
There is a wide consensus on the role that geoscientists can play in promoting sustainable use and management of the Earth’s non-renewable abiotic resources, namely through geoconservation (Stewart 2016; Avelar et al. 2018; Castro et al. 2021). Geoheritage and geotourism are among the issues where the geology community can contribute to achieve the Sustainable Development Goals or SDGs (UNESCO 2015; Rosado-González et al. 2020; Frey 2021; UNDP 2022). But this requires changes in education at all levels and a range of skills beyond competence in technical geoscience, namely in the training and professional development given to young geologists (Stewart 2016; Gill 2016, 2017).

Geoconservation refers to the conservation of geosites and/or materials as basic units of the geological heritage through the implementation of specific inventory, evaluation, conservation, valuation and monitoring procedures (Henriques et al. 2011). All steps are relevant to accomplish
geoconservation aims. The valuing and monitoring of geological heritage play a decisive role in the conservation of geosites previously subject to inventory and evaluation actions. Disregarding valuing and monitoring actions puts geoheritage at risk, even if they are protected by legal instruments (Lima et al. 2017).

The Lusitanian Basin (West Iberia) provides a significant stratigraphic record ranging from upper Triassic till upper Cretaceous and includes worldwide known Jurassic geosites with global relevance (Henriques 2004). One of the most important is the Cabo Mondego outcrop, where the Bajocian GSSP and the Bathonian ASSP have been defined (Pavia and Enay 1997; Fernández-López et al. 2009; Figs. 1 and 2). This important reference section is included in the inventory of the Portuguese geological heritage within the framework ‘Jurassic record in the Lusitanian Basin’ (Brilha et al. 2005). It was classified as Natural Monument in 2007 and integrated since then into the Portuguese Network of Protected Areas (Rocha et al. 2014; ICNF 2022a). The Mesozoic units of the Lusitanian Basin also provide exceptionally well-preserved body fossils and ichnites of dinosaurs, all included within the framework ‘Dinosaurs of western

![Location map of the Cabo Mondego Natural Monument and the Pego Longo-Carenque Natural Monument](image)
Iberia’ (Brilha et al. 2005). The Pego Longo-Carenque geo-
site (middle Cenomanian), located near Lisbon, displays a
127-m-long trackway of sub-circular footprints represent-
ing the youngest and largest Cretaceous dinosaur trackway
known in Europe (Santos et al. 1992). It is classified as Natu-
ral Monument since 1997, after a long media and political
battle that prevented its destruction due to the construction
of a motorway (Galopim de Carvalho 1994; Sá and Silva
2019; ICNF 2022b; Figs. 1 and 3).

The classification of a Natural Monument in Portugal
aims to protect natural values, namely notable occurrences
of the geological heritage, regarding the integrity of its
characteristics and in the immediately surrounding areas,
as well as the adoption of measures compatible with the
objectives of its classification (ICNF 2022c). However, both
Cabo Mondego and Carenque geosites have never been sub-
ject to any valuing and monitoring actions. This important
geoheritage is currently at risk, despite being included
within the National Network of Protected Areas. And this
was the motto that inspired a group of graduation students
of geology to put into practice an unprecedented initiative
with the goal of increasing public and political awareness
of the vast (but often under-used) potential of Earth Sci-
ences for society during the academic year 2020/2021: the
GeoXplora project.

The GeoXplora project was developed in the frame of
the ‘Académica Start UC—Network of Ambassadors for
Entrepreneurship’, a pilot project to raise awareness, train
and forming students at the University of Coimbra regarding
innovation and entrepreneurship (ASUC 2022a). This work
describes in detail the scientific, social and political dimen-
sions of the first event underlying the project focused on
geoconservation issues and its social impact among different
communities. In this sense, it configures a qualitative case
study of descriptive nature aiming at evaluating a specific
phenomenon within their contexts (Baxter and Jack 2008;
Rashid et al. 2019).

### The GeoXplora Project

The Académica Start UC Network of Ambassadors for
Entrepreneurship is a project launched by the University of
Coimbra and the Coimbra’s Students Association in 2016
to raise and educate students about innovation and entre-
preneurship, especially through the promotion of local
events (ASUC 2022b). It is in this context that an initiative
came up involving students with the purpose of developing
an annual event that promotes exposure and application of
goosciences in improving the quality of life and safeguarding
of the planet: the GeoXplora project.

A working group made of five undergraduate geology
students from the Coimbra (4) and Porto (1) universities
was thus created in order to formalize the project within the ‘Académica Start UC’ program, led by the first author of this work (the ASUC ambassador) and represented by an original logo (Fig. 4). The team acted as a nuclear structure to engage representatives of several private and public I & D organizations related to the geological heritage and geoconservation in Portugal in the implementation of the first GeoXplora event. Focusing on the existence of internationally relevant geoheritage at risk in Portugal, the event sought to continue major achievements in the implementation of the International Year of Planet Earth in Portugal (during 2007–2009) and to meet goals and targets of the 2030 Agenda (Henriques et al. 2010; UN 2022).

Conception and Planning of the Event

The GeoXplora event regarding geoheritage at risk in Portugal was held during the academic year 2020/2021, on April 16th, 2021. It was based on a webinar format, free of charge, and it took a whole day. It was composed by four thematic sessions conducted by 21 experts from different sectors of the society. Portuguese was the official language of the initiative, therefore enlarging its impact to other communities of Portuguese-speaking countries and contributing to reduce imbalances in Earth Sciences between the North and the South (Henriques et al. 2013).

But its design started long before that, about 6 months earlier, by submitting the local event proposal to the ‘Académica Start UC—Network of Ambassadors for Entrepreneurship’, made up of ambassadors who coordinated projects in the previous academic year and who then act as mentors in the following year (Fig. 5). Mentors assess the relevance of the entrepreneurship proposal, and if accepted, the proposer becomes an ASUC ambassador. Then, the new ambassador presents his/her proposal in detail to all mentors (the Idea Pitch phase), and one of these mentors assumes project supervision responsibilities. The ASUC ambassador takes charge of the implementation of a policy of proximity to their peers, raising awareness, recruiting them and promoting the local event (ASUC 2022b).

Implementation and Outputs of the Event

The implementation of the GeoXplora event started in March, 2021, when the GeoXplora team was created. The working group was made of five undergraduate geology students (two females, three males), and it was led by the first author of this work (a 23-year-old female student). The current glaring underrepresentation of women in Earth Sciences...
The event registration was limited to 250 participants, and registration used Google Forms®, which included the request of information to participants regarding affiliation and session preferences. Participants’ affiliation shows that most of them are primary and secondary school teachers, which reinforces the aforementioned interpretation of the main age range of participants (Fig. 12). This is followed by the group of participants affiliated to the University of Coimbra, which is justified by the expected interest of the community where the majority of team members belong. Regarding preferences, there were no significant differences in the choice of participants when they made their registration, which seems to indicate that the structure of the program was balanced and attractive. However, according to data from Meta Business Suite® related to the event performance, the morning sessions had a higher audience than the afternoon sessions (Fig. 13).

### Discussion

The conservation of the geological heritage through legal instruments represents a nuclear dimension in geoconservation, but it may be useless if valuing and monitoring procedures are not implemented later (Henriques et al. 2011). In addition to specific physical actions on the ground, community involvement and awareness are key aspects to achieve such goal, but this requires efficient communication between geoscientists and all the partners operating in a given territory like politicians, scientists, educators, businesses managers, media heads and leaders of non-governmental organizations (Tavares et al. 2015; Stewart 2016; Stewart and Gill 2017).

Unlike bottom-up strategies underlying the UNESCO Global Geoparks (Henriques and Brilha 2017), Natural Monuments and analogous legal instruments of geoconservation are top-down initiatives resulting from political decisions arising from government decisions taken outside the interests of the community. The need for subsequent valuing and monitoring actions is quite often neglected. The lack of community interest in preserving their geoheritage can lead, at the limit, to the emergence of conflicts. In any case, this puts the geoheritage at degradation risk.

Raising awareness about geoheritage at risk is, therefore, a permanent requirement in any territory displaying geoheritage, regardless of its protection status. Local communities play a major role as monitoring agents, but they must be collectively engaged with the problem, which demands constructing knowledge and developing skills that would enable them to address geoconservation issues responsibly. As pointed out by Yürür et al. (2019), when the geological heritage is in danger, working continuously for the awareness of the geological heritage by
implementing activities in social media and education in school is the best way to prevent its degradation, especially in situations where there is no need of quick intervention.

Formal education can contribute to promote significant and relevant learning on geoconservation over the 12 years of Compulsory Education (pupils between 12 and 15 years),

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Fig. 6 The program of the GeoXplora event held on April, 16th, 2021 at the University of Coimbra (Portugal)
especially if they involve outdoor activities, despite the recognized range of difficulties for its implementation (Henriques et al. 2012, 2022; Berrocal-Casero et al. 2018). But new educational methodologies and strategies are required in order to stimulate a more informed citizenship capable of mobilizing intellectual resources to the promotion of geoconservation as a path to achieve sustainability (Vasconcelos 2012). They should not go away with the completion of compulsory education and should be extended to all levels of education, including university, namely by building experience approaches that bridge academic knowledge and individual perceptions (Carbone et al. 2012).

Universities, the stage for the training of future leaders is particularly qualified to welcome innovative solutions of fostering appropriate behaviors and practices wherever human activities interact with the Earth system (Matteucci et al. 2014). Although some geologists may think that their jobs demand scientific and technological knowledge and skills, geoscientists’ professional duties transcend those requirements, as ethics is additionally a crucial dimension of their professional responsibility (Martinez-Frias et al. 2011; Stewart and Gill 2017). And as pointed out by Stewart and Gill (op. cit.), the principles and practices of ‘sustainability’ got to be explicitly integrated into geoscience education at all levels, training and continued professional development. Students must be taught to work with other scientists, business people and politicians, and to develop stronger academic engagement with local environmental issues in order to conceive, plan and implement viable solutions to current environmental challenges (Stewart 2016).

The GeoXplora event of the University of Coimbra proved to be an original initiative with strong social impact, despite the limitations resulting from the Covid-19 pandemic, which excluded face-to-face gatherings (Kelman 2021). However, the online format allowed the organization of a low-cost event with more than 10,000
**Fig. 9** Facebook page audience regarding users’ age and gender

**Fig. 10** Facebook page audience regarding users’ top towns/cities

**Fig. 11** Facebook page audience regarding users’ countries
participants from different countries and without any carbon footprint as a result of air travels (Martini et al. 2022). These numbers would hardly have been achieved with a traditional face-to-face seminar. Moreover, it enabled the participation free of charge of people from the Community of Portuguese-Speaking Countries, who otherwise might not be able to participate. In that regard, the event contributed to strengthening the scientific bilateral and multilateral cooperation related to geoconservation among the member-states by mobilizing the communication facilities that a common language may provide (Henriques et al. 2013).

The GeoXplora design involved different sectors of the society with intervention/responsibility in the geoconservation of the Portuguese geological heritage. In this way, the public image was disseminated that geological heritage issues are inherent to sustainable development, as a concept based on the positive articulation between economic development, social development and environmental protection, and not related only to mere environmental awareness or as actions related to pro-environmental issues (Vasconcelos et al. 2016).

The event attracted a significant number of basic and secondary school teachers, who are willing to find credible information regarding geoconservation to design educational interventions involving fieldwork using geosites, and thus succeed to meet curricular issues and the abilities that students must develop in each school year according to the Essential Learning Program (ME-DGE 2018; Henrique et al. 2022).

The GeoXplora event features a low-cost and effective bottom-up solution to face a global problem that complements existing top-down measures, and in this sense it represents a successful path to global sustainability (Werlen et al. 2016). It assisted the dialog between different social actors around a societal problem which demands knowledge provided by geoscientists (Mulder et al. 2006), and provided the opportunity to expose students to new ideas, research skills, and career paths (Stewart and Gill 2017). Moreover, it also created the opportunity for students to experience a new scenario, distinct from their daily routine, which enhances their critical thinking and enables the construction of an active citizenship (Henriques et al. 2012; Carvalho et al. 2020). They also had the opportunity to enlarge their perception regarding the relevance of collaborative work and the role of communication and diplomatic skills in the co-production of innovative solutions in the design of capacity strengthening projects (Gill 2017).

The GeoXplora project addresses issues pertaining to the ways we live in an increasingly globalized world and endeavors to view the transformation of nature from a global sustainability perspective (Werlen et al. 2016). It represents an example of extracurricular activity aiming at supporting the need of embedding sustainability thinking into undergraduate geoscience curricula (Stewart and Gill 2017) and a culturally differentiated model of core everyday (best) practices towards global sustainability (Werlen et al. 2016).
researchers or readers will recognize their utility (Baxter and Jack 2008; Cohen et al. 2010; Starman 2013). But, despite of its local character, the event design and implementation may inspire other geology students and other universities to generate similar initiatives carried out by students, and consequently assuming their collective responsibilities in implementing the 2030 Agenda goals and targets.

Conclusions and Implications

The ‘Académica Start UC—Network of Ambassadors for Entrepreneurship’ is a project created in 2016 by the University of Coimbra and Coimbra’s Students Association aiming to train students for innovation and entrepreneurship, therefore contributing to accomplish several targets within the 2030 Agenda goals.

The GeoXplora project was conceived, planned and implemented at the University of Coimbra (Portugal) during the 2020–2021 academic year. Portuguese was the language used in this first event underlying the project which it was focused on geoconservation, a particularly relevant issue regarding the protection and safeguard of the world’s cultural and natural heritage (SDG 11). But this requires that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature, and this was the focus of one of the event’s sessions (SDG 12).

The initiative was held in the frame of the Covid-19 pandemic restrictions. But such limitations became an opportunity to extend the event’s participation worldwide with a webinar format, which was attended by more than 10,000 people. In this sense, the event became an inclusive and equitable tool to promote quality education and lifelong learning opportunities for all the participants (SDG 4). The remote attendance to the event turns possible doing more and better with less regarding consumption and production of water, food and energy (i.e. the core of SDG 12), as well as greenhouse gas emissions (SDG 13).

The GeoXplora design can be used as a model for encouraging innovation, particularly pertinent and suitable for developing countries (SDG 9), therefore contributing to reduce inequality within and among countries (SDG 10). Its implementation succeeded to engage public, public–private and civil society partnerships around the problem of geoheritage at risk in Portugal, emphasizing the value of networking between different stakeholders as a path to achieve global sustainability (SDG 17). The team composition behind the event included two female and three male geology students and was driven by a female student who was the Académica Start UC Ambassador for the 2020–2021 academic year. Such composition meets the need to promote gender equality and empower all women and girls at all levels of decision-making, as highlighted in SDG 5, an essential requirement to promote peaceful and inclusive societies for sustainable development (SDG 16).

The first GeoXplora event has undoubtedly achieved its main goal: raising awareness about the role of geosciences in promoting sustainable development and taking the 2030 Agenda goals into account. The experience was so gratifying for the team that the second edition is already underway.

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Declarations

Conflict of Interest The authors declare no competing interests.

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