European Geosciences Union

GIFT – Geosciences Information For Teachers

GIFT 2026

NATURAL HAZARDS, HUMAN IMPACT AND EARTH'S RESOURCES: SHAPING LIFE AND EARTH

Vienna, Austria, 3-6 May 2026

Dear Teachers,

Welcome to the 2026 GIFT workshop!

Our 24th GIFT workshop sees us back in Austria's capital to learn more about how geological processes have shaped our lives and that of our planet, Earth. In this workshop we examine Natural Hazards looking back at the past and thinking also about their impact on the future of our planet when balanced against our need/desire to exploit Earth's resources. Across 2.5 days we will look closely at five Natural Hazards: volcanoes, earthquakes, tsunami, climate and forest fires, and we will think also about our exploitation of Earth's natural resources. We hope you are excited to hear insights from the scientific community that will enhance your subject knowledge and spark questions and ideas. Do remember the most powerful way to show your appreciation for our speakers and workshop providers is by asking your questions.

For only the second time, our GIFT workshop will be introduced at a Union Symposium (US), which we hope will see many interested scientists in attendance alongside you, our valued geoscience educators. US are inter-disciplinary sessions designed to foster dialogue on major challenges facing the scientific community, and this edition will explore three key aspects of Earth's processes - volcanism, earthquakes, and energy issues - from the perspectives of three world-renowned experts. **Giorgia Stasi**, from the Geological Survey of Belgium and President of the Energy, Resources and Environment (ERE) Division of the EGU, will address the challenges surrounding humanity's energy needs and the potential issues these may cause.

Paolo Papale, volcanologist at the Istituto Nazionale di Geofisica e Vulcanologia (INGV, Italy), will present the most recent developments in volcanic activity in Europe, focusing on Campi Flegrei and Mount Etna. **Jean-Philippe Avouac**, California Institute of Technology (USA), will discuss the latest major earthquakes and examine whether predicting the time and location of these events is possible. Their insights will help us better understand how scientific research and technological innovation can shed light on the planet's complexity and guide us in coexisting with it.

Our final speaker of the opening morning, **Frederique Leclerc**, will reflect on a famous tsunami from 1956 and see if knowledge from the past can help us predict the future (a recurring theme this year). His talk will be the last scientific presentation of the day. But following a tradition in the GIFT workshops, our programme will include a number of practical hands-on activities and sharing of online tools and resources. So valued by teachers, this year we have increased their number. Sessions on Natural Hazards in the Classroom will be ably demonstrated by members of the Education and Outreach Committees and our team of Geoscience Education Field Officers (GEFO).

The European Space Agency have long supported the GIFT programme, and we are delighted that **Francesco Sarti** will kick-off Day 2's programme talking about how data gathered from ESA satellites orbiting the Earth can help in monitoring and predicting Natural Hazard events. **Sonia Seneviratne** will then explore the various climate hazards that impact our life and planet.

After joining the all-important Group Photo (usually at the front of the Austria Center Vienna), we return for some more workshops. And it's 2026, so we must talk about Artificial Intelligence (AI), proudly not used for this resume but increasingly a part of our everyday**. Bruce Malamud** will lead us through a workshop looking at Hazard Prediction using AI. In a parallel session, led by **Olga Villagrasa Flores**, we will build and trial an analog tool for use in the classroom: the Earthquake Shadow Meter.

Don't go too far away over lunch time, we are hoping scientists interested in the Teacher-Scientist pairing scheme (a collaboration with the Outreach Committee) will join us for a brief bit of geoscience speed-dating: your chance to make a connection or two to help bring science alive in your classroom.

After lunch, Tuesday continues with a trip to the Forest. Not literally, in fact virtually - in the hands **of Margarita Arianoutsou** who will present online about the increasingly alarming issue of Forest Fires

across the Mediterranean, which seem to appear more frequently in our news broadcasts every year. It is then time to head offshore and down to the seabed - a rich source of minerals located in difficult to access locations which raises concerns about their extraction methods and associated pollution hazards. **Peter Bernhardt** and **Steven Macko** will tell us more.

A popular feature of every GIFT workshop in the last 15 years is our poster session. We conclude Tuesday with presentations of posters by those of you who have offered to share *Projects on Natural Hazards, Human Impact and Earth's Resources at School.* This poster session is a great networking and sharing opportunity, and it's likely we will be joined by a number of scientists, participating at the General Assembly, who have an interest or experiences they wish to share. This is your chance to build collaborations with teaching colleagues around Europe, "steal" an idea or two or even strike up a collaboration with an EGU scientist.

Our final day kicks off with more thoughts about where and how do we get hold of 'critical' raw materials. How are we defining critical, and does their use and extraction have to be so widespread and destructive. **Holly Stein** will look at how their extraction processes are shaping our Earth. And as we start to think more about what life and Earth may look like in the future, GeoStorage is the topic that **Niklas Heinemann** will address in her presentation thinking about energy transition as we move away from fossil fuels. Our final presentation takes that discussion further, as we look at the geological consequences of a move to renewable energies around the world led by **Siddharth Joshi**. The GIFT workshop will close with a demonstration of various classroom exercises using the ESA School Atlas, led by three renowned ESA scientists: **Francesco Sarti**, **Connor Rhys Heeney** and **Clara Cruz Niggebrugge**.

As every year, and **prior to the workshop**, GIFT participants are most welcome to a guided tour of the Vienna Museum of Natural History on Sunday afternoon. Entry to the museum will require your Conference Badge. We welcome those present at 15:00. There will be short guided tour, followed by time to explore the museum at your pace. At 17:00 we will gather back in the foyer for a unique behind the scenes experience led by **Mathias Harzhauser**, **Oleg Mandic** and **Anna Weinmann**.

And at the end of GIFT 2026, do not forget to fill out the evaluation form. The success and direction of future workshops also depend on you and your valued feedback, and we do listen and try to improve GIFT year-on-year.

Acknowledgements

The GIFT-2026 workshop has been organised by the EGU Education Committee.

The European Geosciences Union (EGU) has supported the major hare of the expenses, but the workshop has also benefited from the help of

naturhistorisches museum wien

westermann

We would also like to thank all the speakers who have contributed to this educational workshop and their institutions.

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Programme

EUROPEAN GEOSCIENCES UNION

GENERAL ASSEMBLY

Geosciences Information for Teachers Workshop (GIFT) 2026

3-6 May 2026

'NATURAL HAZARDS, HUMAN IMPACT

AND EARTH'S RESOURCES: SHAPING LIFE AND EARTH'

Sunday, 3 May 2026

15:00-18:00 **GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA**

(optional) *WELCOME TO THE TEACHERS AND ATTENDEES OF GIFT*

Mathias Harzhauser, Oleg Mandic and Anna Weinmann

(Natural History Museum Vienna, Austria)

18:30-20:00 **ICE BREAKER PARTY AT AUSTRIA CENTER VIENNA (ACV)**

(optional) EGU General Assembly, Bruno-Kreisky Platz

Monday, 4 May 2026

8:30-8:45 **OPENING GIFT 2026**

EGU and the Education Committee welcome GIFT participants
Peter van der Beek (President of EGU)
Stavros Stathopoulos (Chair of the Education Committee, EC)

TB1: Chairs > **Stavros Stathopoulos and Francesca Funiciello**

8:45-9:15 **BALANCING RAW MATERIALS NEEDS AND PERSPECTIVES**
Giorgia Stasi (Geological Survey of Belgium, Institute of Natural Sciences, Brussels, Belgium)

9:15-9:45 **THE HIGH RISK CAMPI FLEGREI CALDERA IN SOUTHERN ITALY: RECENT EVOLUTIONS, CURRENT STATUS, AND POSSIBLE DEVELOPMENTS**
Paolo Papale (Istituto Nazionale Di Geofisica e Vulcanologia, Pisa, Italy)

9:45-10:15 **ADVANCES IN EARTHQUAKE FORECASTING**
Jean-Philippe Avouac (California Institute of Technology, U.S.A.)

10:15-10:45 **AM COFFEE BREAK**

TB2: Chairs >	**Jean-Luc Berenguer and Florence Bigot-Cormier**
10:45-11:00	**WELCOME** Stavros Stathopoulos
11:00-11:45	**THE INITIATIVES OF THE EGU EDUCATION AND OUTREACH COMMITTEES** Stavros Stathopoulos, Gina P. Correia, Solmaz Mohadjer, Laura Säilä, Nuno Pimentel
11:45-12:20	**FINDING THE SOURCES OF HISTORICAL TSUNAMIS TO BETTER ASSESS THE HAZARD: THE EXAMPLE OF THE 1956 AMORGOS TSUNAMI (CYCLADES, GREECE)** Frédérique Leclerc (University Côte d'Azur, Nice, France)
12:20-12:30	**INSTRUCTIONS FOR THE POSTER SESSION & THE HANDS-ON SESSIONS**
12:30-14:00	**LUNCH BREAK**
TB3: Chairs >	**Teresita Gravina and Friedrich Barnikel** **HANDS-ON ACTIVITIES (WS 1 and WS 2)** (2 groups alternating)
14:00-15:45	**WS 1: EXPLORING SITE EFFECTS DURING AN EARTHQUAKE – A HANDS-ON ACTIVITY** Jean-Luc Berenguer and Florence Bigot-Cormier (University Côte d'Azur, Nice, France)
14:00-15:45	**WS 2: TIPS FOR TEACHING ABOUT NATURAL HAZARDS: HANDS-ON ACTIVITIES ON FLOODS AND VOLCANOES** Anett Kádar[1], Giulia Realdon[1] & Gina P. Correia[2] ([1]EGU Geoscience Education Field Officer, GEFO; [2]EGU Education Committee)
15:45-16:15	**COFFEE BREAK**
TB4: Chairs >	**Gina Pereira Correia and Hélder Pereira** **HANDS-ON ACTIVITIES (WS 3 and WS 4)** (2 groups alternating)
16:15-18:00	**WS3: NATURAL HAZARDS DEMONSTRATIONS AND HANDS-ON ACTIVITIES FOR TEACHING (PART 1)** Solmaz Mohadjer (EGU Outreach Committee)
16:15-18:00	**WS4: NATURAL HAZARDS DEMONSTRATIONS AND HANDS-ON ACTIVITIES FOR TEACHING (PART 2)** Bruce D. Malamud (EGU Education Committee)
18:00-19:00	**NETWORKING**

Tuesday, 5 May 2026

TB1: Chairs > **Francesca Cifelli and Ulrike Kastrup**

08:30-09:15 **EXAMPLES OF EARTH OBSERVATION APPLICATIONS TO NATURAL HAZARDS**
Francesco Sarti (European Space Agency, Rome, Italy)

09:15-10:00 **THE CLIMATE CRISIS, CLIMATE EXTREMES AND SOCIETY: WHERE ARE WE HEADING?**
Sonia Seneviratne (ETH Zurich, Switzerland)

10:00-10:15 **GROUP PHOTO IN FRONT OF ACV**

10:15-10:45 **AM COFFEE BREAK**

TB2: Chairs > **Konstantinos Kourtidis and María Eugenia Dies Álvarez**

10:45-12:30 **HANDS-ON ACTIVITIES (WS 5 and WS 6)**

(2 groups alternating)

WS 5: ARTIFICIAL INTELLIGENCE, HAZARDS, RISK AND RESILIENCE: IDEAS AND ACTIVITIES FOR THE SECONDARY SCHOOL CLASSROOM
Bruce D. Malamud (Institute of Hazard, Risk and Resilience, Durham University, UK)

WS 6: THE EARTHQUAKE SHADOW METER: AN ANALOG TOOL FOR VISUALIZING AND CALCULATING SEISMIC SHADOW ZONES IN THE CLASSROOM
Olga Villagrasa Flores (IES El Portillo, Zaragoza, Spain)

12:30-14:00 **LUNCH BREAK (AND T-S PAIRING SCHEME)**

TB3: Chairs > **Stavros Stathopoulos and Stephen Macko**

14:00-14:50 **ON FOREST FIRES**
Margarita Arianoutsou (National and Kapodistrian University of Athens, Greece)
Lecture by ZOOM

14:50-15:45 **RESOURCES AND POLLUTION IN SEABED MINING**
Peter Bernhardt (rtd) and Stephen Macko (The University of Virginia, USA)

15:45-16:15 **COFFEE BREAK**

TB4: Chairs > **Annegret Schwarz and Stephen Macko**

16:15-18:00 **POSTER SESSION**
PROJECTS ON NATURAL HAZARDS, HUMAN IMPACT AND EARTH'S RESOURCES AT SCHOOL

18:00-19:00 **NETWORKING EVENT IN THE POSTER HALL**

Wednesday, 6 MAY 2026

TB1: Chairs > **Stavros Stathopoulos and Friedrich Barnikel**

08:30-09:15 **THE ORES WE MINE - WHAT IS A CRITICAL RESOURCE AND HOW AND WHEN DO WE FIND THEM**

Holly Stein ((Innosphere Ventures, Fort Collins, Colorado, USA)

09:15-10:00 **GEOSTORAGE: HOW EARTH'S GEOLOGY ENABLES THE ENERGY TRANSITION**
Niklas Heinemann (University of Barcelona, Spain)

10:00-10:45 **AM COFFEE BREAK**

TB2: Chairs > **Jean-Luc Berenguer and Francesca Funiciello**

10:45-11:30 **POWERING THE FUTURE: A GEOSCIENCE PERSPECTIVE ON RENEWABLE ENERGY**
Siddharth Joshi (International Institute for Applied Systems Analysis, Laxenburg, Austria)

11:30- 12:30 **EXAMPLES OF CLASSROOM EXERCISES USING THE ESA SCHOOL ATLAS**
(2 groups alternating)
Francesco Sarti, Connor Rhys Heeney and Clara Cruz Niggebrugge (European Space Agency)

12:30-12:45 **GENERAL SESSION AND CONCLUDING REMARKS & GOOD BYE!**

12:45-14:00 **LUNCH**

GOOD BYE!

GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA

Mathias Harzhauser, Oleg Mandic and Anna Weinmann

Natural History Museum Vienna

Mathias Harzhauser, on the right, Head of the Geological-Paleontological Department at the NHMW, and Professor at the University Graz (Austria) earned his degrees from the University of Vienna and has been employed by the NHM after his Master's thesis. He is interested in integrated stratigraphy and paleogeography of the Neogene Paratethys Sea and is a specialist for fossil gastropods. He is a corresponding member of the Austrian Academy of Sciences and is engaged in the popularization of science.

Oleg Mandic, on the left, is researcher and curator in the Geological-Paleontological Department at the NHMW and teaches at the University of Vienna (Austria). He is an expert for Eurasian Oligocene and Miocene stratigraphy and paleobiogeography and is a specialist for fossil bivalves. Oleg Mandic has worked at the NHMW since 2008 and is responsible for the collection of regional Tertiary geology.

Anna Weinmann is a micropaleontologist and earned her degree at the University of Bonn in Germany. She started her employment at the NHMW in 2020 and is the curator of the microfossil collection in the Geological-Paleontological Department. She specializes in fossil and recent foraminifera (single-celled organisms) including their biogeography and (paleo-)ecology at the NHMW since 2008 and is responsible for the collection of regional Tertiary geology.

GIORGIA STASI

Geologist

Geological Survey of Belgium (OD Earth & Life, Institute of Natural Sciences)

Brussels, Belgium

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EDUCATION

Current	PhD student in Applied Geophysics Doctoral School in Engineering, Sciences and Technology, University of Liège and Geological Survey of Belgium, Belgium
2016	MSc in Geology and Engineering Geology, University of Padova, Italy
2013	BSc in Geology, University of Padova,

CAREER

2018-present	Geologist Geological Survey of Belgium –Institute of Natural Sciences, Brussels, Belgium
2018	Project Assistant European Federation of Geologists, Brussels, Belgium
2017-2018	Junior Geologist Geological Survey of Belgium –Institute of Natural Sciences, Brussels, Belgium

RESEARCH INTERESTS

Giorgia's research focuses on understanding how mineral deposits form and how we can detect them using geochemical and geophysical methods. Currently she is working on the development of geophysical sensors for deep mining and robotic autonomous exploration. She studies critical raw materials by combining fieldwork, laboratory analysis, and technology development. She is also interested in planetary science, applying similar exploration tools to study the geology of other planets and moons, and science communication.

PUBLICATIONS AND SERVICES

- EGU ERE Division President (2025-2027), ERE Deputy President (2024-2025), ERE ECS representative (2022-2024)
- AGU Voices for Science – Policy fellow (2023-2024)
- Deputy member for the Geological Survey of Belgium at the Mineral Resources Expert Group of EuroGeoSurveys in 2019-2021; 2025-2026, and the Geophysics Expert Group (GpEG) in 2025-2026
- Publications: https://orcid.org/0000-0002-9559-3114

BALANCING RAW MATERIALS NEEDS AND PERSPECTIVES

Giorgia Stasi

Geological Survey of Belgium, Institute of Natural Sciences

As the world moves toward cleaner and more efficient sources of energy, we face a growing challenge: many of the technologies needed for this transition depend on specific raw materials that are becoming scarcer and more critical. Solar panels, wind turbines, electric cars, and large-scale batteries all require metals such as lithium, cobalt, nickel, and rare Earth elements.

Understanding where these resources come from, how they are mined, their societal impact, and what alternatives or recycling options exist is crucial for building a resilient and responsible energy future. Developing a clearer picture of the geology behind these materials and the geological landscape we live in, will help guide future decisions about how we source, use, and manage the minerals that support modern energy technologies.

PAOLO PAPALE
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Google Scholar page:
https://scholar.google.com/citations?user=m8erPlUAAAAJ&hl=it

EDUCATION

Geological Sciences, University of Pisa, 1990 with Full Honours

CAREER AND SERVICES

2021-	Chair of the Class of Exact Sciences, Academia Europaea
2017-2021	Chair of the Earth and Cosmic Sciences Section, Academia Europaea
2016	Chair of the INGV Centre for Volcanic Hazards
2013-1016	Director of the INGV Division on Volcanoes
2007-2011	President of the GMPV Division, EGU – European Geophysical Union
2006-2012	Chair of the INGV Unit on "Physical Mathematical Modelling and Numerical Simulations"
2005-2010	Chair of the National Program in Volcanic Hazards of the Italian Civil Protection
1999-2003	Researcher in Volcano Physics, ING/INGV
1996-1999	Researcher in Volcanology, CNR/GNV
1990-1996	Contract Researcher, CNR/GNV

RESEARCH INTERESTS

Paolo Papale employs the methods of physics and mathematics, together with parallel computing and numerical simulations, to construct models of volcano dynamics and volcanic hazards. He also employs statistics and probabilities to explore large scale volcano behaviours and to analyse global and local hazards. He has directed for many years the Italian national programm in volcanic hazards, and has been the first director of the INGV Division on Volcanoes. He co-founded the series of workshops on Volcano Observatory Best Practices which gather volcano observatory representatives from all over the world providing an international venue for observatory scientists from developed and developing countries. He conceived and coordinated two large European Networks for the formation and growth of the new generation of volcano scientists, and coordinated or had responsibility roles in many other national and European projects. He is co-founder of the international initiative KMT – Krafla Magma Testbed which aims at the creation of a large infrastructure in Iceland representing the world's first magma observatory, for advancing science as well as for experimenting the production of energy directly from magma.

PUBLICATIONS

97 journal articles, about 10 articles in books, ~7000 citations, H-index 43.
Stanford's top 2% researchers list, https://topresearcherslist.com/.
"100,000 most impacting scientists of the world", Ioannidis et al. (2019 and subsequent updates till the current one): https://doi.org/10.1371/journal.pbio.3000384

AWARDS AND HONORS

IUGG Fellow (Honorary Member) from 2023, Member of the Academia Europaea from 2011 (from 2021 member of the Board of Trustees and Honorary Vice-President), National Delegate in the EPOS-ERIC General Assembly from 2023, Member of the EGU Council 2007-2011, Founding Member of Geo.8 (European Alliance for the Geosciences) 2012-2024, member or Chair of various Medals and Awards Committees, several Invited Lectures at organizations, institutes, conferences and meetings throughout Europe and abroad.

THE HIGH RISK CAMPI FLEGREI CALDERA IN SOUTHERN ITALY: RECENT EVOLUTIONS, CURRENT STATUS, AND POSSIBLE DEVELOPMENTS

Paolo Papale

Istituto Nazionale Di Geofisica e Vulcanologia, Pisa

The Campi Flegrei caldera is located on the western border of the city of Naples, whose metropolitan area hosts about 3 million people and large infrastructures including one major Mediterranean passenger and commercial harbor. The caldera is in an unrest state since the fifties of last century, with peaks in ground motion in the seventies and eighties, and escalation during the last 20 years.

Here I review the unrest dynamics and focus on the last period and current situation, comparing with observations and records from other calderas in the world. The extreme risks from Campi Flegrei are discussed in light of the uncertain developments inherently characterizing complex system dynamics, requiring statistics and probabilities in order to support rational decision making by civil authorities.

JEAN-PHILIPPE AVOUAC

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EDUCATION

1987 Ingénieur, Ecole Polytechnique, France

1991 PhD, Institut de Physique du Globe de Paris, France

CAREER

2018-pres.: Director, center for Geomechanics and the Mitigation of Geohazards,

20015-pres.: Professor of Mechanical and Civil Engineering, California Institute of Technology

2014-2015: Professor of Earth Sciences, University of Cambridge, UK.

2004-2014: Director of the Tectonics Observatory, California Institute of Technology

2003-pres.: Professor of Geology, California Institute of Technology

1992-2002: Département Analyse et Surveillance de l'Environnement, Commissariat à l'Energie Atomique, France

RESEARCH INTERESTS

Jean-Philippe Avouac uses geological, seismological, geodetic and remote sensing observations to develop dynamic models of crustal deformation, landscape evolution and earthquakes. He has worked extensively on crustal deformation and earthquakes related to the India-Asia collision and has studied most large earthquakes over the last 30 years. His recent activities have focused on the effect of subsurface fluid injection and extraction, for geothermal energy production or CO2 storage, on crustal deformation and seismicity.

PUBLICATIONS AND SERVICES

Jean-Philippe Avouac has published more than 270 articles in international peer-reviewed journals (Google scholar profile, Scopus Profile) and holds 4 patents in image processing.

Editor of *Earth and Planetary Sciences Letter*s since 2018

Elected to the Board of Faculty, Caltech (2024-present);
President of the Tectonophysics section, American Geophysical Union (2021-2022)

AWARDS AND HONORS

Elected to the U.S. National Academy of Sciences (2025); Gaspard Monge invited professor, Ecole Polytechnique, Palaiseau, France (2019); Wolfson Merit Award of the Royal Society, UK (2014); Elected Fellow of the American Geophysical Union (2014); Alexander von Humboldt Foundation, Senior Scientist Award (2010); Birch Lecture, American Geophysical Union (2007); E. A. Flinn Award of the International Lithosphere Program (1993).

ADVANCES IN EARTHQUAKE FORECASTING

Jean-Philippe Avouac

California Institute of Technology

The presentation will review earthquake phenomenology and recent advances in the development of dynamic models. I'll describe the insight gained from studying large natural earthquakes and earthquakes induced by human activities.

Abundant and well documented examples of earthquakes induced by extracting or injecting fluids from the subsurface have indeed provided an opportunity to understand better earthquake physics and test earthquake forecasting models. As a result, spatial and temporal variations of the seismicity rate due to such operations can be predicted well provided that a good monitoring system has been deployed.

This physics-based modelling framework can be used for time-dependent probabilistic forecasting of earthquakes. In practice, it can be used to mitigate the risk of induced seismicity during the design and operation of CO2 storage sites or of geothermal power plants. Predicting precisely the time, magnitude and location of future large natural or induced earthquakes is still out of reach.

FRÉDÉRIQUE LECLERC

Associate Professor
University Côte d'Azur (Nice, France)
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EDUCATION

Frédérique Leclerc holds a PhD in Earth Sciences from the *Institut de Physique du Globe de Paris* (2014). Her doctoral research focused on the active deformation of the Caribbean plate and its relationship with the Lesser Antilles subduction zone. She used marine geophysical data to study the morphology of the seafloor, identify active faults, and describe submarine reef platforms affected by tectonic processes.

CAREER

After her PhD, Frédérique Leclerc worked at the Earth Observatory of Singapore (Nanyang Technological University) for two years, where she carried our research projects along the Sumatra subduction zone and forearc, focusing on the identification and quantification of tectonic deformation at different time scales. In particular, she worked on the tectonic structure of the accretionary prism in the epicentral area of the Mentawai 2010 tsunami-earthquake in order to better understand the properties of the triggered tsunami. Since 2016, she is an Associate Professor in Earth Sciences at Université Côte d'Azur where she joined and developed several projects focusing on active submarine faults. She is developing teaching activities in Virtual Reality environments with the goal to give access to submarine outcrops, and develop knowledge and skills in marine geosciences and natural hazards.

RESEARCH INTERESTS

Frédérique Leclerc studies submarine active faults that can generate earthquakes and trigger tsunamis in order to better understand seismic and tsunami hazards. In 2013, she joined one of the first oceanographic cruises to have mapped and quantified with submarines the deformation of the seafloor generated by a recent tsunamigenic earthquake, giving valuable insights into the tsunami genesis. The capacity offered by such new tools (submarines), which allow imaging the seafloor with unprecedent resolution, allowed her to develop several projects aiming at finding the sources of historical and pre-historical tsunamigenic earthquakes, and constraining their frequency. She is presently coordinating the AMORGOS project that aims at finding on the seafloor the traces of one of the largest earthquakes to have occurred in the Mediterranean Sea in the past two centuries, in order to better understand its tsunami.

PUBLICATIONS AND SERVICES (selected)

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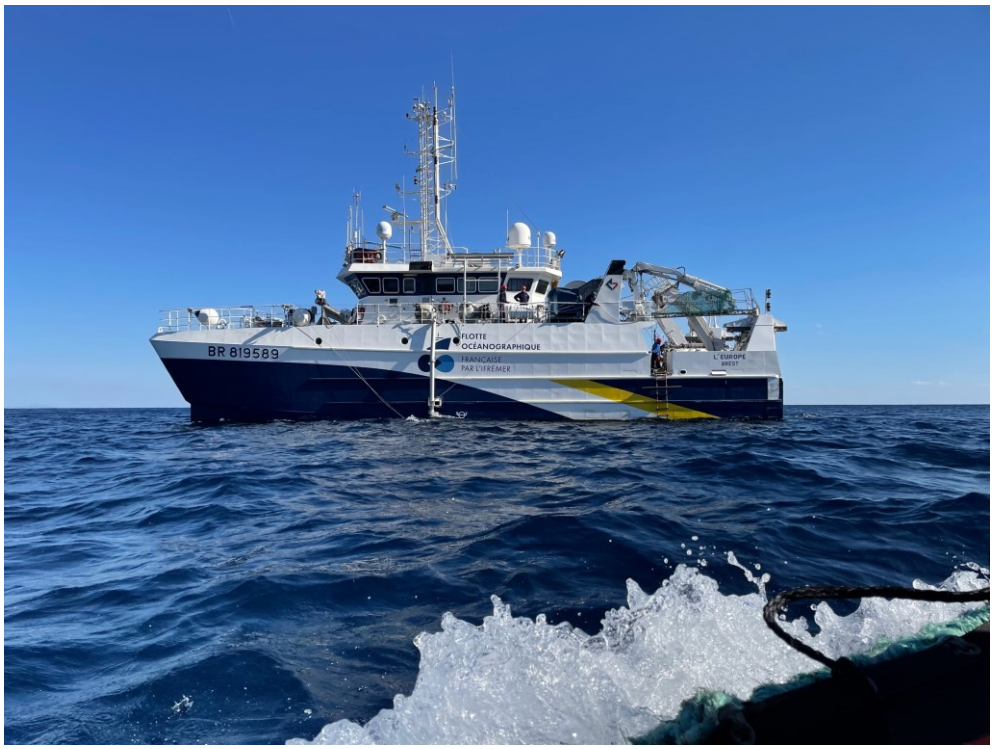
- Hughes, A., Escartín, J., Billant, J., Leclerc, F., Andreani, M., Olive, J.A., Arnaubec, A., Dano, A., Delorme, A., Deplus, C. and Feuillet, N., (2023). Seafloor earthquake ruptures and mass wasting from the 2004 Mw 6.3 Les Saintes submarine earthquake. *Communications Earth & Environment*, *4*(1), p.270.
- Hananto N., Leclerc F., Li L., Etchebes M., Carton H., Tapponnier P., Qin Y., Avianto P., Singh S.C., Wei S. (2020). Tsunami earthquakes: vertical pop-up expulsion at the forefront of subduction megathrust. *Earth and Planetaru Science Letters* volume 538, Article number: 116197
- Leclerc F. & Feuillet N., (2019), Quaternary coral reef complexes as powerful markers of long-term subsidence related to deep processes at subduction zones: Insights from Les Saintes (Guadeloupe, French West Indies), Geosphere, vol. 15. https://doi.org/10.1130/GES02069.1

FINDING THE SOURCES OF HISTORICAL TSUNAMIS TO BETTER ASSESS THE HAZARD: THE EXAMPLE OF THE 1956 AMORGOS TSUNAMI (CYCLADES, GREECE)

Frédérique Leclerc, Sylvain Palagonia, Nathalie Feuillet, Paraskevi Nomikou, Danai Lampridou, Paul Barrière, Alexandre Dano, Eduardo Ochoa, Nuno Gracias, Javier Escarti

University Côte d'Azur, Nice

Assessing tsunami hazards along coastlines implies knowing the sources of potential tsunami. But today, several historical large tsunamis are orphans, their sources unknown or debated. The recent development of submarines allows to explore the seafloor at an unprecedented resolution, opening the door to seafloor exploration with a new goal: identifying the traces earthquakes can imprint on the submarine landscape. How long can such traces last is an open question and is probably site-dependent, but the pilot survey carried out along an active fault in the Caribbean showed that they can last for more than ten years, and therefore that they may preserve for more. On July 9th, 1956, a Mw ~7.5 earthquake occurred between Santorini and Amorgos islands (Greece) and triggered one of the largest tsunamis in modern time. Two shepherds reported for instance that the waves reached a height of 20-30 m along the southern cliff of Amorgos Island, while along Astypalaea Island, tsunami deposits of the 1956 event have been found at an altitude of 10 m. Despite the importance of this event, its source is debated, preventing a proper hazard assessment in the Cycladic archipelago. I will present the result of oceanographic cruises carried out in the epicentral area in 2022-2023 and 2025 that allowed providing new constrains on the tsunami sources, based on geological submarine observations, in order to shed light on this event and on its source.



Research Vessel Europe offshore Amorgos Island during the AMORGOS-22 cruise. ©F. Leclerc

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CAREER

- Executive board, supervision students, teaching, committee memberships:
- EGU (European Geoscience Union) Committee of Education Chair (since 2022)
- IESO (Geoscience Olympiads) 2017 FRANCE - Organization Committee President (2017)
- EduMed Observatory project leader - University Côte d'Azur (since 2017)
- InSight Education project (NASA-CNES-IPGP) leader in France (since 2014)
- French educational seismological network leader (2006-2017)
- Biology and Geoscience Teacher in Valbonne International Highschool, France until 2019

More information about me:
https://geoazur.oca.eu/fr/jean-luc-berenguer

MOST RELEVANT PUBLICATIONS

Berenguer, J-L., Hands-on Booklet, SISMO Collector, DDTM 06, 2020.

Berenguer, J.-L., Balestra, J., Jouffray, F., Mourau, F., Courboulex, F., and Virieux, J.: 25 years of seismology at school in France, Geosci. Commun. Discuss., https://doi.org/10.5194/gc-2020-32, in review, 2020

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Berenguer J-L., F. Bigot-Cormier, G. Coupechoux, F. Boutaud (2020) Juega con Namazu en el mundo de las Ciencias de la Tierra / Playing with Namazu in geosciences topic (2020) Enseñanza de las Ciencias de la Tierra, 2020 (28.1) – p.99-106

Bigot-Cormier F., **Berenguer J.-L.**, How Students Can Experience Science and become Researchers: Tracking MERMAID Floats in the Oceans, Seis. Res. Letters., 88, 10.1785/0220160121 , 2017

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Berenguer J.-L., Virieux J., How to teach natural hazards in school: Raising awareness on earthquake hazard, Office for Official Publications of the European Communities, 2008

FLORENCE BIGOT-CORMIER

Associate professor at University Côte d'Azur, Nice, France

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EDUCATION

Florence Bigot-Cormier holds a PhD in Earth Sciences from Université Côte d'Azur (2002). Her doctoral research focused on the uplift of the Argentera crystalline massif (France–Italy) and its relationship with Pliocene deformation of the Ligurian margin, combining thermochronology, geomorphology, and marine seismic analysis. She completed her doctoral work at the Géoazur laboratory (CNRS), where she specialized in quantitative approaches to landscape evolution and tectonic processes.

CAREER

Florence Bigot-Cormier is an Associate Professor in Earth Sciences at Université Côte d'Azur, affiliated with the Géoazur CNRS laboratory. Her career combines academic research, higher education teaching, and international pedagogical leadership. She has held research and teaching positions in France and abroad, including a research appointment at the University of Washington (Seattle, USA) and long-term international academic detachments in Shanghai and Dubai. Alongside her university role, she has developed innovative science education programs, coordinated international training initiatives, and contributed to science outreach and teacher development.

RESEARCH INTERESTS

Florence Bigot-Cormier studies Earth surface processes and landscape evolution, focusing on the interactions between tectonics, weathering, erosion, and hydrological systems. Her work relies on geochronological methods, including *in situ* cosmogenic nuclides (^{10}Be) and thermochronology, to constrain surface dynamics over Quaternary to Cenozoic timescales. Her current research investigates the role of tropical lateritic weathering profiles in aquifer recharge and vulnerability, integrating geomorphological, geophysical, and hydrogeological data. Through interdisciplinary projects in Central Africa, she aims to link long-term landscape evolution with groundwater functioning to support sustainable water management in the context of climate variability.

PUBLICATIONS AND SERVICES (selected)

Florence Bigot-Cormier's publications cover both Earth science research and science education. Her scientific work focuses on tectonics, landscape evolution, thermochronology, and active surface processes, while her education-oriented publications develop innovative ways to connect real research datasets with classroom learning. She is actively involved in academic service through participation in scientific and educational committees, international collaborations, graduate supervision, and outreach initiatives that strengthen links between geoscience research, teaching, and societal applications.

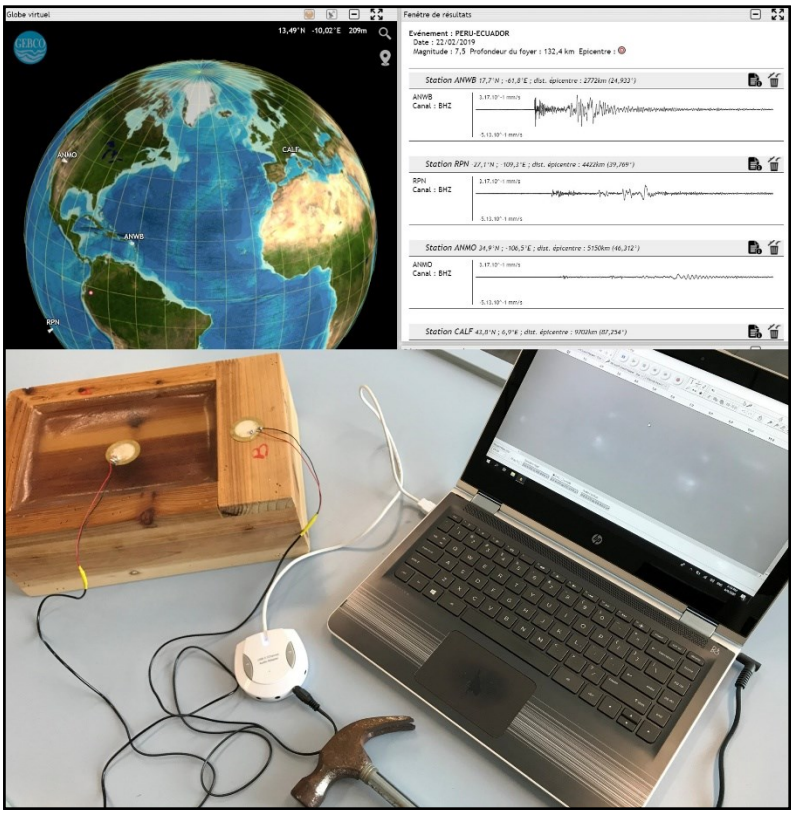
EXPLORING SITE EFFECTS DURING AN EARTHQUAKE

A HANDS-ON ACTIVITY

Jean-Luc Berenguer & Florence Bigot-Cormier

Geoazur Laboratory, University Côte d'Azur

Site effects refer to the local amplification or attenuation of seismic waves caused by variations in near-surface geological materials. Soft sediments, fractured rocks, or rigid bedrock can modify the amplitude and frequency of seismic shaking, sometimes increasing damage independently of the earthquake's magnitude or distance. Our educational activity will explore this phenomenon through a combination of digital and hands-on approaches. Participants will first analyze real earthquake data using Tectoglob3D to visualize seismic wave propagation, calculate wave velocities, estimate distances between stations and the earthquake source, and compare signal amplitudes to reveal how lithology influences ground motion. This digital investigation will then be extended through an analogue activity designed to model site effects physically, allowing participants to actively test and discuss how local geological conditions shape seismic response. Together, these complementary approaches aim to deepen conceptual understanding while providing transferable classroom strategies to engage students with real geophysical data.



Proposed classroom activities:
from numerical analysis to analogue modelling of site effects

ANETT KÁDÁR
EGU Geoscience Education Field Officer for Hungary
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Anett Kádár, PhD, is a secondary school teacher qualified in Geography and American Studies, with teaching experience in both primary and secondary education. She currently works as a university lecturer and education researcher at the University of Szeged. She is the head of the MTA–SZTE Research Group on Geography Teaching and Learning and, since 2024, has been the EGU Geoscience Education Field Officer for Hungary.

GIULIA REALDON
EGU Geoscience Education Field Officer for Italy
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Giulia Realdon, BSc in Biology, MSc in Science Communication, PhD in Earth Sciences Education, has been teaching Natural Sciences in high school. After retiring, she is working in education research within the University of Camerino, with EMSEA – European Marine Science Educators Association and EvoKE (on public understanding of evolution), in non-formal science education and teacher training. Since 2019 Giulia has been the EGU Geoscience Education Field Officer for Italy.

GINA P. CORREIA
Member of the EGU Education Committee
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Gina P. Correia, is a Eurogeologist and holds a PhD in Geology. She has over twenty-five years' experience as a secondary school Biology and Geology teacher. She has also taught in initial teacher education on Master's programmes in Biology and Geology and delivered continuing professional development courses for teachers. She is a member of the Earth Dynamics research group at the Centre for Earth and Space Research (CITEUC), University of Coimbra. Since 2023, she has been the Coordinator of the Education Working Group of the Portuguese Association of Geologists (APG) and a member of the Education Expert Panel of the European Federation of Geologists. She has been a member of the Education Committee of the European Geosciences Union (EGU) since 2022 and currently serves as its Deputy Chair. She is also the Director of the Teachers' Continuing Professional Development Centre at the APG. From 2019 to 2024, she served as the EGU Geoscience Education Field Officer for Portugal.

TIPS FOR TEACHING ABOUT NATURAL HAZARDS:

HANDS-ON ACTIVITIES ON FLOODS AND VOLCANOES

Anett Kádár[1], Giulia Realdon[1] and Gina P. Correia[2]

[1]EGU Geoscience Education Field Officer (GEFO)
[2]EGU Education Committee

Natural disasters have accompanied human history since its earliest days and continue to affect regions and populations around the world, causing between thousands and hundreds of thousands of deaths and enormous material damage every year, with a devastating impact on economies, especially those of the less developed countries. Among the most serious natural disasters, droughts, storms, floods, tsunamis and landslides have had a greater impact on humanity than other serious natural disasters such as earthquakes and volcanic eruptions. In the 21st century, however, advances in communication technologies and early warning have helped to reduce the number of victims: geoscience education and local community awareness initiatives can make a major contribution to promoting awareness and prevention and thus saving lives.

In this workshop, we offer hands-on educational activities focused on two categories of natural hazards: floods, and volcanic eruptions (Figure 1).

Flood will be introduced through a thought experiment, by using images of floods to raise questions and reflect on flood consequences in order to promote awareness and risk reduction.

Two practical activities will follow. The first focuses on soil erosion, by comparing two soil models - one covered with vegetation and the other bare – when exposed to rainfall, with the opportunity to see the different effects of runoff and, consequently, the different risks of mudslides (Figure 2). The second is based on the use of an online simulation that allows the testing of different types of soil and land cover with different amounts of precipitation and runoff.

Figure 1: Flood in a Czech town
Jenik, GNU Free Documentation license

Figure 2: Soil erosion model
BP photo, Earthlearningidea

The following activities will introduce the topic of volcanic eruption through a simplified simulation of the method used to measure the bulging of a volcano as a sign of an impending eruption. Two other activities will address the relationship between magma viscosity and the violence of an eruption by blowing bubbles in liquids of different viscosities (Figure 3) and measuring the speed of different “lava” models running down a slope (Figure 4).

Figure 3: bubbles and viscosity
Chris King, Earthlearningidea

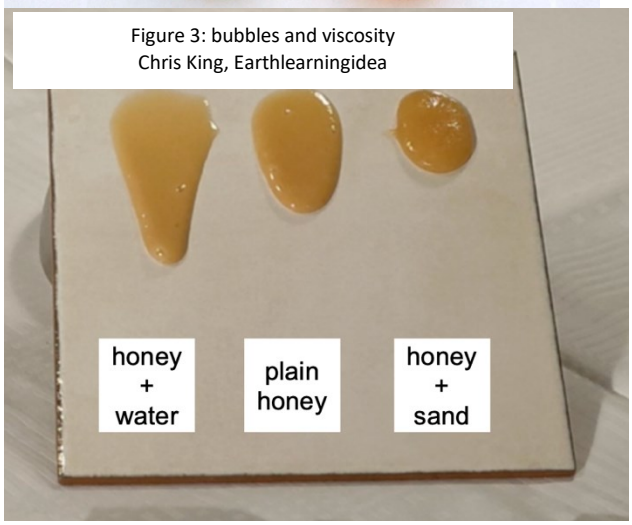

Figure 4: lava viscosity models
Giulia Realdon

The presented activities, and many others, are freely accessible on the Earthlearningidea website (https://www.earthlearningidea.com/), an open-access repository of practical teaching activities (more than 450!) addressing nearly all the geoscience topics present in school curricula.

Anett and Giulia are two of the EGU Geoscience Education Field Officers (GEFO), a team of geoscience teachers and researchers who provide professional development to schoolteachers with geoscience elements in their teaching curricula through interactive hands-on workshops. The team is supported by the European Geosciences Union Education Committee and is active in several countries around Europe. You can find more on the EGU GEFO programme here: https://www.egu.eu/education/.

SOLMAZ MOHADJER

Geoscience Lecturer

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EDUCATION

- Ph.D. in Geosciences (Geohazards), University of Tübingen, Germany, Dec 2019
- M.Sc. in Geosciences (Geodesy/Geohazard Education), University of Montana, USA
- B.Sc. in Geological Sciences, University of Washington, USA, Jun 2004

CAREER

- Academic Associate, Transdisciplinary Course Program, University of Tübingen, Germany, since July 2023
- Scientific Coordinator, Max Planck Institute for Intelligent Systems, Germany, (2022-2023)
- Assistant Professor, Earth & Environmental Sciences, University of Central Asia, Tajikistan (2020-2022)
- Postdoctoral Associate, Geosciences, University of Tübingen, Germany, (2017 – 2020)
- Ph.D. Researcher, Geosciences, University of Tübingen, Germany, (2013 – 2016)
- Natural Hazard Risk Model Consultant, Focus Humanitarian Assistance, Kabul, Afghanistan, (2012/2013)
- Natural Hazard Scientist, Aga Khan Development Network, Dushanbe, Tajikistan, (2012)
- Program Director, Teachers Without Borders, Seattle, WA, U.S.A, (2009 – 2011)

RESEARCH INTERESTS

- Natural hazards quantification, disaster risk reduction
- Geoscience communication, education, and science-policy
- Scientific uncertainty research and communication
- Service-Learning and civic engagement
- Techniques used: remote sensing, geodesy, cosmogenic nuclides, fieldwork, database programming & design

SERVICES (selected)

- Associate Editor, Natural Hazards and Earth System Sciences (open access), since Oct 2023
- Executive Editor, Geoscience Communication (open access), since Jun 2022
- Chair, European Geosciences Union (EGU) Outreach Committee, since Apr 2024

PUBLICATIONS (selected)

- Gani et al., The shadowlands of (geo)science communication in academia – definitions, problems, and possible solutions, 2024, https://doi.org/10.5194/gc-7-251-2024
- Hall et al., Diversifying the geosciences in higher education: a manifesto for change, 2022, https://doi.org/10.5194/gc-5-275-2022
- Mohadjer et al., Using paired teaching for earthquake education in schools, 2021, https://doi.org/10.5194/gc-4-281-2021.

NATURAL HAZARDS DEMONSTRATIONS

AND HANDS-ON ACTIVITIES FOR TEACHING (part 1)

Solmaz Mohadjer

EGU Outreach Committee Chair

This workshop introduces a mechanical model of a fault system (an earthquake machine) that educators can use to teach concepts related to earthquakes and faults including elastic rebound and stick-slip fault behavior. Educators can use this simple model to explore causes of earthquakes, earthquake occurrence in time, earthquake size (magnitude), earthquake prediction and earthquake models and hypotheses as well as the role models play in scientific inquiry. The model can also be used to collect empirical data about the behavior of earthquakes.

In this workshop, educators will have an opportunity to construct the model, play with it, and think about the different components of the model, what they represent, and model limitations. In addition, educators will learn how to collect data using the model to discuss questions related to earthquake size, frequency, impact and prediction.

Operating the model (earthquake machine) in a classroom

BRUCE D. MALAMUD
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Institute of Hazard, Risk and Resilience (IHRR)
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Google Scholar: https://tinyurl.com/BruceMalamudGoogleScholar

EDUCATION

6/1991–8/1997 Cornell University, Ithaca, New York, USA, Dept. of Geological Sciences (Ph.D. Geologic Sciences, 1/1998).

1/1984–5/1986 Reed College, Portland, Oregon, USA (B.A. Physics, 5/1986).

CAREER

3/2023–present Director and Wilson Chair of Hazard & Risk. Institute of Hazard, Risk and Resilience (IHRR), Durham University.

9/2000–2/2023 Professor of Natural & Environmental Hazards (2013–22023), Reader, Senior Lecturer, Lecturer (2000–2013). Dept of Geography, King's College London, UK.

7/1986–10/1988 USA Peace Corps Secondary School Physics/Chemistry Teacher. Lycée Diffa, Niger, W. Africa.

RESEARCH INTERESTS

- Range of natural hazards (landslides, fire, floods, earthquakes, tornadoes), hazard interrelationships, anthropogenic processes.
- Main Methodologies/Approaches of my research/outreach in natural hazards and risk:
- Statistics, Time Series and Spatial Analysis Applied to Single and Compound Hazards (e.g., time series models, clustering of values in time, spatio-temporal clustering)
- Focus on Urban Risk in Context of Multi-Hazards (dynamic hazard, vulnerability, exposure)
- Interactions of Physical & Social Dynamics
- Systematic (Critical) Mapping of Blended Sources of Evidence
- Data Quality & Data Flow in the Context of DRR
- Education & Communications for Natural Hazards and Risk (e.g., workshops for secondary school teachers, virtual reality, serious games)

PUBLICATIONS AND SERVICES (selected)

- I was President for four years (2007−11) of the Natural Hazards Division of the European Geosciences Union (EGU), Programme Committee Chair for the EGU General Assembly 2010 & 2011 and Programme Co-Chair of the AOGS–EGU Conference Series on New Dimensions for Natural Hazards in Asia (2018−2022).
- In the last eight years, I have been Project Lead/Co-Lead on 15 research grants, with research focused in India, Philippines, UK, Kenya, Turkey, and Japan. Grants have varied from early-warning landslides (in India) to multi-hazard interrelationships (in multiple countries), and the impact of hazards of physical-human systems (energy, health, water).
- I am currently executive editor of Natural Hazards & Earth System Sciences and have authorship on 82 peer-review publications with >14,200 citations (Google Scholar) to my publications.
  If interested in my background leading to becoming interested in natural hazards, including time as high-school teacher, see my BBC Radio 4 *The Life Scientific* interview at bbc.co.uk/programmes/m001mlkz.

NATURAL HAZARD DEMONSTRATIONS AND HANDS-ON ACTIVITIES FOR TEACHING (part 2)

Bruce Malamud

Durham University

This workshop introduces a range of short demonstrations and hands-on activities that can be used to teach concepts related to natural hazards (e.g. landslides, earthquakes, volcanoes, wildfires, tsunamis, mass movements, and asteroid impacts). In many classroom settings, teaching relies heavily on lectures or presentations using slides, whiteboards, or digital projectors. While these approaches can be effective, they often place students in a largely passive role. Short demonstrations and hands-on activities can help create a more interactive learning environment, encouraging curiosity, discussion, and critical thinking.

Workshop participants will be exposed to several demonstrations that typically take 5–10 minutes and use simple, inexpensive materials. Examples illustrate physical processes associated with hazards such as slope failure, wave propagation, and energy release. Even when only peripherally related to the topic being discussed, demonstrations often capture students' attention and stimulate questions and discussion.

Experience shows that students frequently remember these demonstrations long after the class itself. The workshop will highlight several examples, discuss practical considerations for classroom use, and provide references and links to additional resources from government agencies, educational organisations, and books describing similar activities.

FRANCESCO SARTI
Scientific Coordinator of the Education and Training Activities
Directorate of Earth Observation Programmes
ESA/ESRIN (Frascati, Italy)

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EDUCATION

After his Master Degree in Electrical Engineering (University "La Sapienza" of Rome, Italy), he completed a PhD on "Optical-radar remote sensing for the monitoring of surface deformation and change with applications to natural risk management" (University "Paul Sabatier" of Toulouse, France).

CAREER

After working as a spacecraft control systems engineer at ESA/ESTEC for 5 years, he moved to France to pursue his PhD and was hired in CNES (French Space Agency) as a SAR specialist and Earth Observation Applications expert. He was the first Project Manager of the International Charter on Space and Major Disasters.

Since 25 years he is back in ESA (ESRIN) where he is currently appointed as ESA Scientific Coordinator of the Education and Training Activities in Earth Observation. He is also in charge of the ESA cooperation in Earth Observation Capacity Building with NASA, UNOOSA, CEOS, CONAE and ISRO.

Other responsibilities include the technical management of scientific projects on Remote Sensing applications to Solid Earth (Tectonics and Volcanology), the scientific coordination and preparation of ESA workshops about SAR Polarimetry and the development of scientific and educational toolboxes for SAR Polarimetry.

RESEARCH INTERESTS

Although no longer active in research, his scientific interests are mainly in the developments of SAR Interferometry and Polarimetry, with applications to Tectonics, Volcanology and Land Cover.

PUBLICATIONS

The majority of his publications cover the application of radar and optical Remote Sensing to damage mapping, tectonics, disaster management, as well as Remote Sensing Education/Training/Capacity Building.

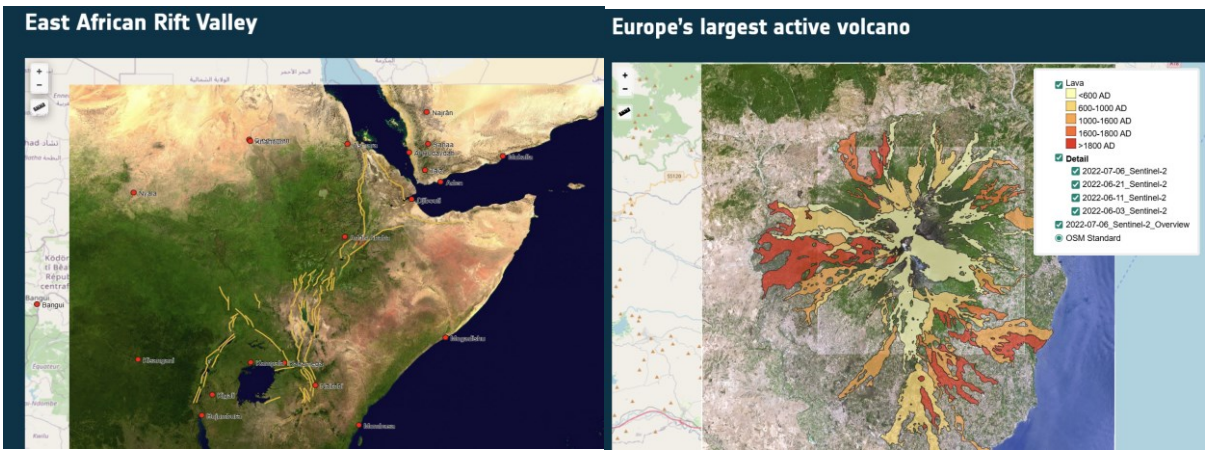
EXAMPLES OF EARTH OBSERVATION APPLICATIONS TO NATURAL HAZARDS

Francesco Sarti

European Space Agency

Through its Earth Observation (EO) Programme, ESA undertakes a large variety of projects and scientific activities related to the application of EO for the monitoring, understanding and improved modelling of natural hazards. These include contribution to operational services for rapid mapping and post disaster relief, as well as research and demonstration projects on the use of EO techniques for natural hazard analysis and modelling.

Examples of catastrophic events, mapped and analysed using satellite data, have been used by ESA in order to create computer exercises for secondary schools, such as those included in the *new ESA School Atlas*, a recent free online tool available for secondary school teachers (https://esa-schoolatlas.eu/esa-schoolatlas/) e.g. : Mount Etna (Europe's largest active volcano), Kilimanjaro, La Palma eruption, Tracy Arm Fjord landslide, The East African Rift Valley and many other similar examples



Among operational applications of EO to Disasters, the *International Charter "Space and Major Disasters"* created in 1999 (https://disasterscharter.org/) provide a unified system of space data acquisition and delivery to those affected by natural or man-made disasters worldwide, coordinating many different space agencies and organisations putting at the disposal of the Charter their satellite resources and their processing resources, in order to provide timely products to the Civil Protections needing this type of information for their rescue operations. The Charter benefits from an ever-growing number of satellites that increase the revisit frequency and the choice of sensor for spectral and spatial resolution. Data from these sensors are processed, merged and interpreted in a variety of ways to extract the best possible information on the effects of a given disaster. One of the advantages of using Earth Observation satellites for disaster mapping is that ground-based information in the region affected is often difficult to generate otherwise because the infrastructure on ground, needed to generate the information might be destroyed or damaged by the disaster. Furthermore, satellites are the most effective means for synoptic viewing for disaster response on an emergency and priority basis. The Charter products are delivered to users on the ground with fast turnaround and at no cost for the beneficiaries.

Value-adding and extraction of information from satellite data is generously sponsored by the individual Charter members. However, the Charter covers only the response phase of a disaster, on a best effort basis, whereas the later recovery and rehabilitation efforts are excluded by this mechanism. This is, however, covered by Copernicus Emergency service (also addressed in this talk).

Disasters covered by the Charter include earthquakes, volcanoes, floods, landslides (and many others).

Floods have been the most commonly covered disaster, representing roughly 50% of the Charter requests received. Typically, the main feature of the products is based on deriving flooded surfaces, either from the nature of the spectral response of these surfaces, and/or by comparison with the reference imagery predating the disaster. The flood vectors are usually presented as final products in GIS layers. With the advent of high-resolution SARs (metric resolution), products showing changing water depths of inundated areas have been created.

In the case of volcanic eruptions, volcanic plumes and ash clouds can easily be detected using optical sensors from space. However, the volcanic cloud often hampers observation of the crater and the surface topography during the eruption. Therefore radar backscattering properties of the ground features can be exploited to delineate the different types of volcanic deposits.

For fires, thermal and optical sensors from space constitute the core Charter capability for monitoring this disaster type, such as burnt area mapping products.

Similar (and complementary) to the Charter is *the Emergency Management Service*, one of the services of Copernicus (https://emergency.copernicus.eu/) provided by the Commission. It includes 3 different components: Early warning and monitoring, On-demand mapping, Exposure mapping.

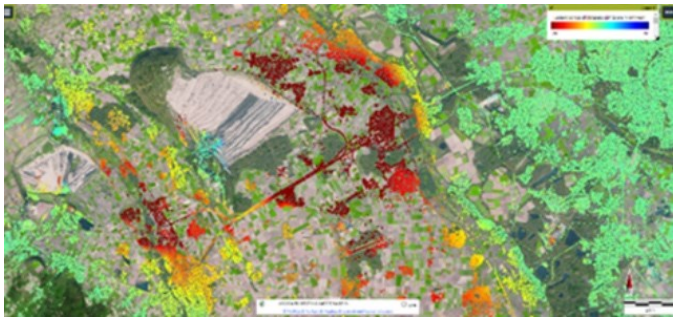
Copernicus develops services dedicated to a systematic monitoring and forecasting of the state of the Earth's subsystems. It collects data from multiple sources (earth observation satellites and in situ sensors such as ground stations, airborne and sea-borne sensors), processes these data and provides users (mainly policymakers and public authorities) with reliable and up-to-date information through services. Different thematic areas are developed: marine, land, atmosphere, emergency, security and climate change.

Another activity in the application of EO for natural hazards is the development of a service for landslide monitoring. Ground Instabilities are among the most widespread geological hazards on Earth. Thousands of deaths and injuries, and enormous economic loss are regrettable evidence of worldwide slope instabilities. The necessity to identify and monitor slope movement is of paramount importance to reduce the socio-economic toll that every year is paid in developing as well as in developed countries. Several projects funded by ESA have investigated the feasibility

and the operational applicability of spaceborne imagery to respond to the needs of governmental institutions that have a mandate in landslide prevention.

The European Ground Motion Service https://land.copernicus.eu/en/products/european-ground-motion-service (as part of Copernicus) uses Synthetic Aperture Radar Interferometry (InSAR) data

derived from Sentinel-1 to detect and measure ground movements across Europe with millimetre precision.



These products are updated annually and can be used for a variety of applications; city, regional, or state authorities can use it to monitor the structural integrities of dams, bridges, railways, and buildings. They allow urban planners to make data-driven decisions about where to build new infrastructure by assessing the likelihood of natural hazards such as landslides or subsidence.

In conclusion, Earth Observation contributes to the monitoring of a wide range of disasters worldwide at all phases of the event cycle, including risk analysis and forecasting, immediate disaster mapping (in the case of the International Charter and Copernicus Emergency Management Service), and post disaster recovery, rehabilitation and reconstruction. Continued availability of Earth Observation data is a prerequisite for the continuity of crisis mapping and disaster mitigation services in the long term. The availability of the Sentinel missions (with rapid multisensor coverage over potential disaster-stricken areas) provides continuous and reliable resources necessary for operational services related to Disasters and Natural Hazards.

While most research has focused so far on single hazards as standalone event or short-term impact following major earthquakes or floods, scientists seek to fill a critical gap by investigating the long-term assessment of hazards and their interaction in space and time. Presently, research studies are being carried out to revolutionize multi-hazard assessment by developing AI-driven models to better understand long-term hazards scenarios associated to landslides, floods and earthquakes. In the case of the ESA/BGS project AMHEI on Multi-hazards (https://eo4society.esa.int/projects/amhei/) the initial focus was on the analysis of the effects of earthquakes, using the February 2023 Turkey-Syria earthquake as a case study. Building on this, the approach was extended to address the multi-hazard dynamics associated with storm events, selecting the May 2023 floods in Emilia Romagna as a representative example. By integrating satellite-derived data on key environmental and climate variables with advanced machine learning techniques, scientists aim at the generation of novel multi-hazard maps and guidelines that may provide actionable insights for civil protection agencies, urban planners, and policymakers, contributing to disaster risk reduction and sustainable development.

ARTIFICIAL INTELLIGENCE, HAZARDS, RISK AND RESILIENCE: IDEAS AND ACTIVITIES FOR THE SECONDARY SCHOOL CLASSROOM

Bruce Malamud

EGU Education Committee, Institute of Hazard, Risk and Resilience (IHRR), Durham University

Artificial intelligence (AI) is increasingly influencing how information about hazards, risk, and resilience is analysed, interpreted, and communicated. This workshop introduces secondary school teachers to practical ways AI tools can be used to explore these topics in the classroom.

Participants will be exposed to a series of classroom-ready examples using AI tools. These include prompting AI to explain hazard processes (such as earthquakes, floods, or landslides) at different levels of complexity; transforming short technical descriptions into different communication formats (e.g. a news article, classroom explanation, or public safety message); and examining how risk messages change when written for different audiences such as scientists, policymakers, or the general public.

The workshop will also illustrate how AI can support simple classroom “experiments” related to hazards and risk. Examples include testing how small changes in prompts alter explanations and risk messages, using simple probability scenarios to explore how hazard likelihood accumulates over time, and examining how hazard, exposure, and vulnerability combine to influence risk. Additional examples will demonstrate how AI can assist with tasks such as organising information in tables or spreadsheets and exploring simple simulations, while avoiding complex coding.

The session also emphasises the ethical and responsible use of AI, encouraging critical engagement with outputs, awareness of bias and uncertainty, and discussion of when AI should—and should not—be used. Participants will leave with adaptable ideas that can support teaching about hazards, risk, resilience, and AI literacy in the secondary school classroom.

OLGA VILLAGRASA FLORES
IES El Portillo (Zaragoza, Spain)
Head of Studies | Biology and Geology Professor

PROFESSIONAL PROFILE

Senior Biology and Geology teacher with 35 years of experience in Secondary and High School education. Specialist in developing manipulative didactic resources and gamification strategies to simplify complex geodynamic concepts. Extensive experience in mentoring future teachers and training scientific researchers, combined with institutional leadership in professional biological associations.

INSTITUTIONAL ROLES & REPRESENTATION

- **President of the Education Commission:** Professional College of Biologists of Aragon.
- **Aragon Delegate:** Spanish Biology Olympiad (OEB).
- **Head of Studies:** IES El Portillo (Zaragoza, Spain).

TEACHING EXPERIENCE & TEACHER TRAINING

- **Classroom Teaching (35 years):** Specialist in 10th to 12th-grade Science curriculum.
- **Mentorship & Practicum (8 years):** Tutor for students in the Master's Degree in Secondary Education Teacher Training.
- **CSIC Trainer:** Program "Didactic Tools to bring science into the classroom," aimed at researchers from the Spanish National Research Council (CSIC).
- **ICT Specialist:** Trainer in Information and Communication Technologies for educational environments.
- **Speaker at "Del Aula al Máster":** Four-year collaboration in the initial training of future secondary teachers.

EDUCATIONAL INNOVATION & PUBLICATIONS

- **Article/Project:** Dies Álvares, M.E.; Gorriz Ibáñez, E. and Villagrasa Flores, O. 2024. Una herramienta para calcular las zonas de sombra de las ondas sísmicas en el aula de secundaria. *In: "XXII Simposio sobre la enseñanza de la Geología " Montañas do Courel 2024- 8 al 13 de julio Libro de Actas.* 67-69. ISSN: 2385-34833.
https://www.aepect.org/documentos/ACTAS_SIMPOSIO-AEPECT_QUIROGA_2024.pdf

- **Article/Project:** Villagrasa Flores, O. 2020. *¡Cuando el juego de rol se vuelve realidad!* *In:* Salavera Bordás, C. E. and Usán Supervía, P. (eds.) *Gamificación educativa.* 251-258. ISBN: 978-84-17532-51-2

THE EARTHQUAKE SHADOW METER: AN ANALOG TOOL FOR VISUALIZING AND CALCULATING SEISMIC SHADOW ZONES IN THE CLASSROOM

Olga Villagrasa Flores, Estefania Górriz Ibáñez & Dies Alvarez

IES El Portillo, Zaragoza

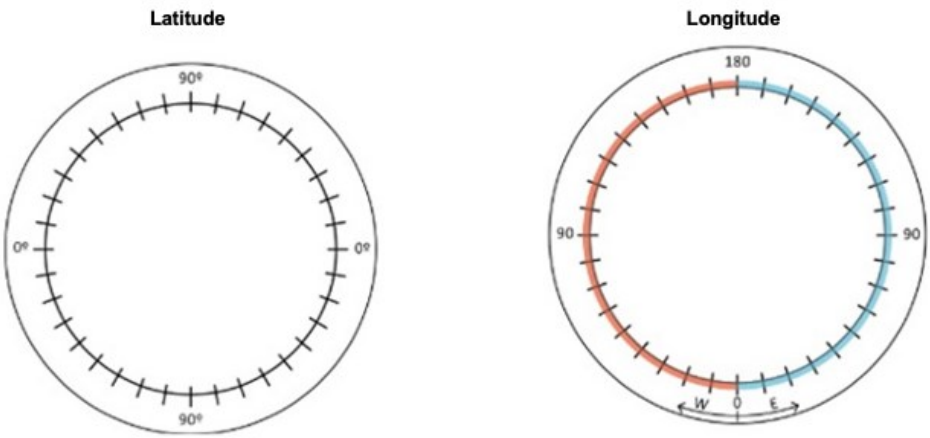
In Secondary and Higher education, studying Earth's internal geodynamics and seismic wave propagation presents significant conceptual challenges. Specifically, determining and understanding P and S wave **shadow zones** is often abstract and prone to geometric calculation errors for students.

This presentation introduces the **"Earthquake-shadow-meter"**, a low-cost, easy-to-build didactic resource designed to improve spatial visualization and minimize mistakes in solving seismic problems. The classroom methodology integrates a construction phase followed by a practical comparison: solving exercises using traditional calculation methods versus using the "earthquake-shadow-meter" on specific mapping.

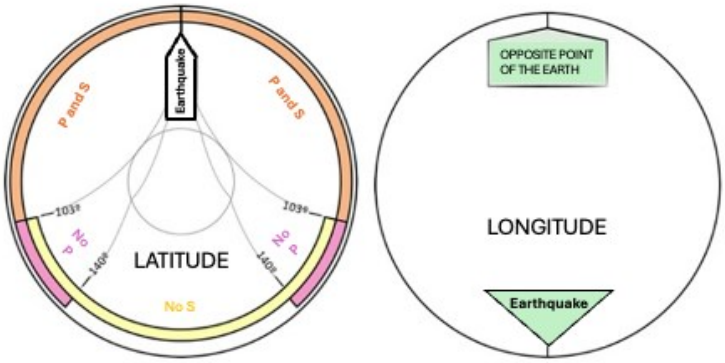
Results indicate that using this tool not only improves accuracy in locating shadow zones but also reinforces the understanding of Earth's layered interior model. We conclude that the "earthquake-shadow-meter" is an effective resource for transforming a complex theoretical concept into a hands-on and visual learning experience, meeting geoscience curricular goals in an innovative way.

Keywords: Seismic shadow zones, Geoscience education, educational innovation, Secondary education, Sismosombrímetro, Earthquake.

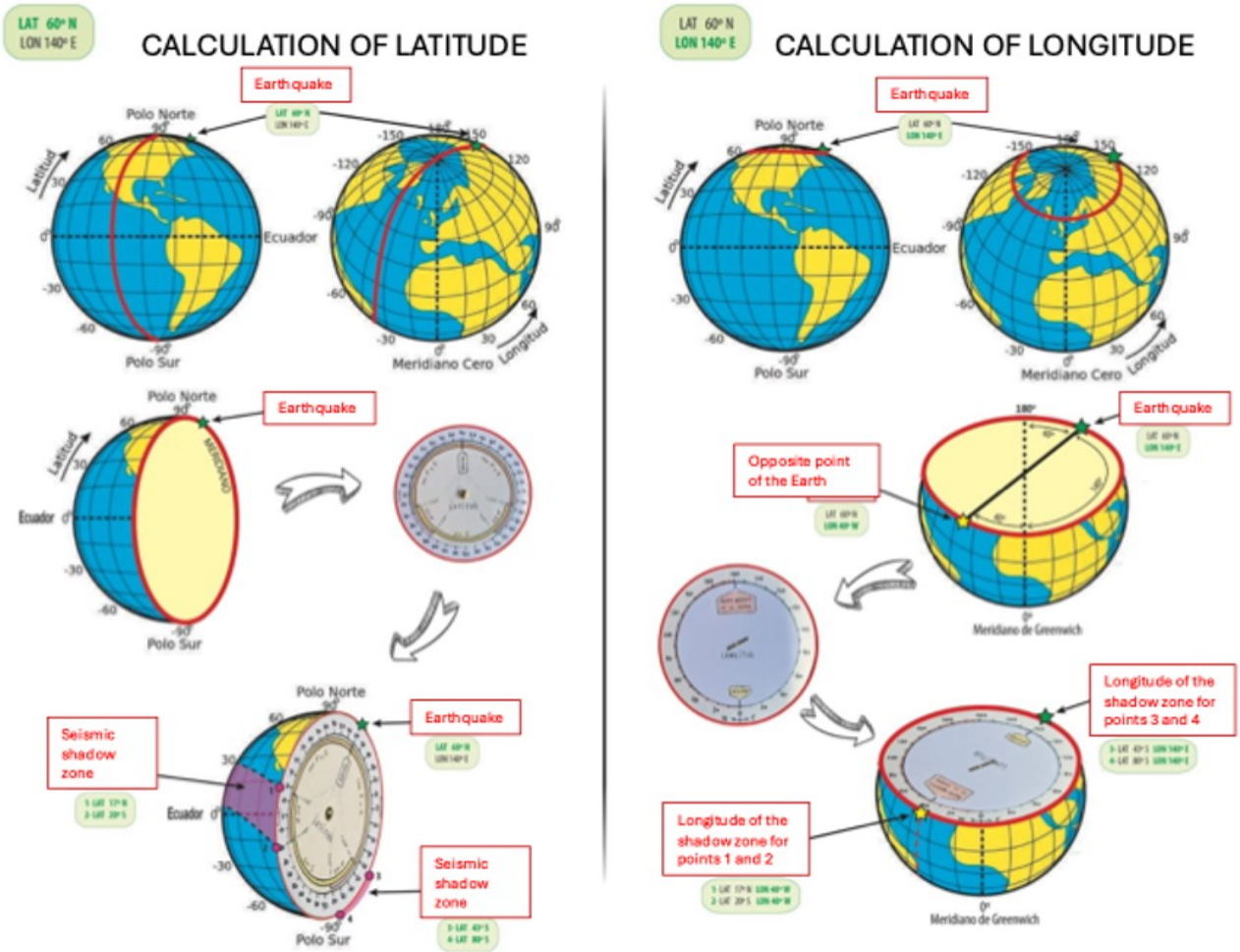
Instructions: (Dies Álvares, M.E.; Gorriz Ibáñez, E. and Villagrasa Flores, O., 2024)



Step 1. Marks to be drawn on each side of the circle with a diameter of 14 cm circle. They will be used to measure latitude (left image) and longitude (right image).



Step 2. Marks to be drawn on each circle with a diameter of 10.8 cm.



Step 3. Example of tool usage for an earthquake with an epicenter at latitude 60º and longitude 40º.

References

Dies Álvares, M.E.; Gorriz Ibáñez, E. and Villagrasa Flores, O. (2024). Una herramienta para calcular las zonas de sombra de las ondas sísmicas en el aula de secundaria. *In: "XXII Simposio sobre la enseñanza de la Geología " Montañas do Courel 2024- 8 al 13 de julio Libro de Actas.* 67-69. ISSN: 2385-34833. https://www.aepect.org/documentos/ACTAS_SIMPOSIO-AEPECT_QUIROGA_2024.pdf

MARGARITA ARIANOUTSOU

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Faculty of Biology
School of Sciences
National and Kapodistrian University of Athens (NKUA)
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IN SHORT

Margarita Arianoutsou has served as full Professor of Ecology in the Faculty of Biology. Since September 2021 she is an Emeritus Professor at the same Faculty. She has a considerable experience in the study of ecology and management of Mediterranean ecosystems. She has acted twice as Secretary of the International Society of the Mediterranean Ecologists (ISOMED). She has been a member of the National Committee for combating desertification (Implementation of UN Convention to Combat Desertification).

She is a member of the scientific committee for climate change of the Hellenic Ministry of Environment and Energy and member of the scientific committee of the Academy of Athens for studying the effects of climate change upon the forest ecosystems of Greece. She is also a member of the Scientific Committee of the Bank of Greece for the study of climate change (EMEKA). She has acted as secretary of the Management Body of Mt Parnitha National Park. She is Associate Editor of the scientific journals Bio-Invasions Records, and Forests. She has participated in more than 70 international conferences. She has published more than 120 scientific articles and 5 scientific books. She established and coordinated the post-graduate Master's program on Ecology and Management of Biodiversity at the NKUA. She has supervised 10 PhD Theses, >15 Master's Theses and over 50 Diploma Theses.

RESEARCH INTERESTS

Structure and function of mediterranean ecosystems/Fire Ecology/Biological Invasions/Conservation Biology/Climate change/Environmental Education and Citizen Science

PUBLICATIONS (selected)

1. Paula S., Arianoutsou M., et al. 2009. Fire-related traits for plant species of the Mediterranean Basin. Ecology, 90, (5), 1420-1420.
2. Arianoutsou M., et al. 2014. Comparative patterns of plant invasions in the Mediterranean Biome. PLOSone, 8(11): 1-13.
3. Christopoulou A., Mallinis G., Vassilakis E., Farangitakis G.P., Fyllas N.M., Kokkoris G.D., and Arianoutsou M. 2019. Assessing the impact of different landscape features on post-fire forest recovery with multitemporal remote sensing data: the case of Mount Taygetos (southern Greece). International Journal of Wildland Fire 28, 521–532.
4. Karasmanaki E., Mallinis G., Mitsopoulos I., Karteris A., Chrysafis I., Bakaloudis D., Kokkoris I.P., Maris F., Arianoutsou M., Goldammer J.G., Rego F., Vallejo R. and Tsantopoulos G. 2023. Proposing a Governance Model for Environmental Crises. Land, 12, 597. https://doi.org/10.3390/land12030597
5. Arianoutsou, M., Athanasakis, G., Kazanis, D., Christopoulou, A. 2024. Attica: A Hot Spot for Forest Fires in Greece. Fire, 7, 467. https://doi.org/10.3390/fire7120467
6. Elmqvist, T., Valkó, O., Stoof, C., Akala, T., Arianoutsou, M., Arsava, K., Ascoli, D., et al. EASAC (2025). Changing Wildfires: Policy Options for a Fire-literate and Fire-adapted Europe. (Journal Article) In: EASAC policy report 48, no. 48, 2025

ON FOREST FIRES

Margarita Arianoutsou

National and Kapodistrian University of Athens (NKUA)

Key words: Mediterranean climate, plant adaptations, fire regime, climate change

Forest fires constitute a frequent phenomenon occurring in the Euro-Mediterranean region and in the other regions of the world having mediterranean climate. It is scientifically accepted that fire has been an inherent component of the Mediterranean climate ecosystems, under certain conditions, having defined their structure, their function and evolution, since the establishment of this type of climate on earth. In the current lecture we present several cases of time and space related deviations from the normal fire periodicity derived from mediterranean climate regions, Greece included. We try to stress on ecological issues related to biodiversity conservation as well as to ecosystems' management. Finally, we attempt to identify possible causes of such deviations in the conditions induced by global change.

PETER BERNHARDT, JD

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School of Law
University of Virginia
Charlottesville, Virginia 22903, USA

oldcarnut33@gmail.com

CAREER

John Peter Ashley Bernhardt graduated from Dartmouth College (summa cum laude) and was a recipient of the Reynolds Fellowship to Trinity Hall Cambridge.
He went to the London School of Economics and received a JD from the University of Virginia School of Law.
He served as a Lieutenant in the U.S. Navy Reserve and later held legal positions in the Office of General Counsel at the U.S. Department of Commerce, the Solicitor's Office at the U.S. Department of the Interior, and the U.S. Department of State's Office of the Law of the Sea and Bureau of Oceans, Environmental, and Scientific Affairs.
From 1973 to 1982, Mr. Bernhardt served as a U.S. delegate to the United Nations Third Conference on the Law of the Sea.
He later headed the U.S. delegation to France in1984, during which he negotiated a bilateral agreement concerning the remains of the C.S.S. Alabama, and received a Superior Honor Award from the Department of State for his work.

Mr. Bernhardt was a Lecturer at the University of Virginia School of Law and the Deputy Director of the Center for Oceans Law and Policy.

PUBLICATIONS

Over the years, he authored numerous law review articles on the Law of the Sea, mostly appearing in the *Virginia Journal of International Law*.

His career reflects more than three decades devoted to ocean governance, maritime law, and international negotiations.

STEPHEN MACKO

Professor

Department of Environmental Sciences

The University of Virginia, Charlottesville, VA, USA

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EDUCATION

B.S Chemistry, Carnegie Mellon University

M.S. Oceanography, University of Maine

Ph.D. Chemistry, University of Texas

CAREER

Assistant to Associate Professor Earth Sciences, Memorial Univ. St. John's, NF Canada
Associate to Professor, Environmental Sciences, Univ. Virginia, Charlottesville, VA, USA

RESEARCH INTERESTS

Origin and history of organic matter in ocean sediments and petroleum
Origins and evolution of Life on the prebiotic Earth
Evaluating impacts of ocean acidification
Identifying sources and fates of ocean pollution

PUBLICATIONS AND SERVICES

Engel, M.H. and S.A. Macko, eds. (1993). Organic Geochemistry, Principles and Applications. Plenum Publ., New York, NY, 861p.
Engel, M.H. and S.A. Macko (1997) Isotopic evidence for extraterrestrial nonracemic amino acids in the Murchison meteorite. Nature 389:265-268.
Engel, M.H., S.A. Macko and J.A. Silfer (1990). Carbon isotope composition of individual amino acids in the Murchison meteorite. Nature 348:47-49.
Engel, M.H. and S.A. Macko (1986). Application of stable isotopes for evaluating the origins of amino acids in fossils. Nature 323:531-533.
Macko, S.A. and A.E. Aksu (1986). Amino acid epimerization in planktonic for aminifera suggests slow sedimentation rates for Alpha Ridge, Arctic Ocean. Nature 322:730-732.

Committee on Education (and Human Resources) EGU and AGU for over 25 years

AWARDS AND HONORS

Fellow, Geochemical Society
Fellow, European Association of Geochemistry
Outstanding Teaching Award, University of Virginia
State of Virginia SCHEV, Teacher of the Year
President's Award for Outstanding Research, Memorial University
Program Director, Geobiology, US National Science Foundation
Visiting Scholar, Smithsonian Institution, Washington D.C.

RESOURCES AND POLLUTION IN SEABED MINING

Peter Bernhardt & Stephen Macko

The University of Virginia

This presentation discusses the old and modern antecedents - Mare Clausum and Mare Liberum - from the 1945 Truman Proclamation to the 2025 Trump Executive Order. We present the five applicable sources of international law and the five major interpretative principles of treaty law, explain their nature as primus inter pares, and identify the challenges they pose. We analyze the geographic limits of the Area, its juridical form - from res nullius to res communis omnium - and the definition of the continental shelf under the United Nations Convention on the Law of the Sea (UNCLOS) Article 76, as well as the definition of islands under UNCLOS Article 124.

We further examine the machinery of the UNCLOS, particularly Part XI and Annex VI, and evaluate the powers and functions of the International Seabed Authority (ISA), including those of its Council, Assembly, and Seabed Disputes Chamber. We also highlight the critical dispute-settlement mechanisms available to States Parties, including conciliation, mediation, arbitration, special arbitration, and the Seabed Disputes Chamber.

First, we examine in detail instances where both State Parties and non-State Parties have issued their own exploration and exploitation licenses, with the United States serving as the primary example. Next, we assess how the ISA can impair, jeopardize, and even preclude the mining activities of non-State Parties. Now that the ISA has promulgated rules and regulations for seabed mining, State practice has, for the moment, diminished in prominence. However, this shift is only temporary. If the ISA does not effectively enforce binding measures and merely remains at the level of issuing regulations, then State practice may once again become the dominant norm. This potential reversal could undermine the integrity of the treaty-based governance framework and challenge the collective model of international law. Therefore, sustained adherence to the ISA's regulations is essential to preserve the treaty's authority and ensure sustainable resource management.

HOLLY STEIN
Professor (emerita) and
Senior Research Scientist
Founding Director, AIRIE (Applied Isotope Research for Industry and the Environment), Innosphere Ventures, Fort Collins, Colorado, USA
and
NHM (Natural History Museum), University of Oslo, Norway
holly@airieprogram.org

EDUCATION

B.S. Western Illinois University
M.S. and Ph.D. University of North Carolina at Chapel Hill
Post-Doctoral, US Geological Survey, Denver

CAREER

Early career in mineral industry, 15 years at US Geological Survey, development of Re-Os technology for ore geology and mineral exploration, 11 years with Geological Survey of Norway in Trondheim, ore geologist turned petroleum geologist, invited to join PGP (Physics of Geological Processes Centre of Excellence) in 2012 at University of Oslo, invited to join CEED (Earth Evolution and Dynamics, Centre of Excellence) at University of Oslo in 2013, joined Department of Geosciences, University of Oslo in 2019, invited to join faculty and students at the Natural History Museum, University of Oslo in 2025, where she is dating pyritized ichthyosaur ribs and vertebrae from Svalbard with a PhD student.
Twelve research grants U.S. National Science Foundation (lead PI on 8, second PI on 4), Scientific Leader for Norwegian Research Council Petromaks grant "Re-Os Isotopic Tracing of Hydrocarbon Systems in Arctic Regions" (2007-2011), Project Manager and Lead Principal Investigator (Judith Hannah, co-PI) for CHRONOS (2012-2017), supported by the Norwegian petroleum industry.

Founded the globally renowned and award-winning AIRIE Program at Colorado State University (CSU) which pioneered Re-Os dating in Earth's continental crust (1996-2022) – with all AIRIE salaries and laboratory operations supported by external soft-money (no university financial support). 25 years of AIRIE success and innovation landed Holly the University-wide Scholarship Impact Award from the CSU Vice President of Research. Three months later an unpopular geosciences department head made a solo decision to terminate the AIRIE research team, throwing the door wide open for AIRIE to form a start-up company. A supportive CSU higher administration gave AIRIE their full laboratory and equipment, all purchased on external grant funds obtained by Dr. Stein and her AIRIE colleagues. Since September 2022, AIRIE has been thriving as an independent small business which Dr. Stein describes as an academic-industry hybrid operation, and perhaps a bellwether of what future education programs may look like. Their new facility has no shortage of students and other visitors, and Holly remains a sought-after mentor by students and early career scientists.

RESEARCH INTERESTS

- Re-Os isotope geochemistry – shales and hydrocarbons, sulfides and ore deposits.
- Source rocks, release and migration of metals and hydrocarbons – crust and mantle influence, fluid and volatile migration.
- Global metallogeny and ore geology – deep and shallow processes for metal enrichment pinned in time, beyond the traditional ore deposit model for exploration.
- Metals and their role in mass extinctions.
- EDI (Equality-Diversity-Inclusivity) – taking an active role in calling it out.

PUBLICATIONS

For a full list of AIRIE's diverse publications, please visit:
https://www.airieprogram.org/assets/files/AIRIEPublications.pdf

THE ORES WE MINE
WHAT IS A CRITICAL RESOURCE AND HOW AND WHERE DO WE FIND THEM?

Holly Stein

AIRIE, Fort Collins, CO, USA and NHM, University of Oslo

The news regarding evaluation of Earth's critical resources and their finite availability at times approaches doomsday. But how finite is finite? In part, that is limited by present technology for their extraction. The definition of "critical" fluctuates with our expectations for lifestyle, balancing social-economic disparities, as well as political upheavals leading to excessive use or limited exploration (e.g., in times of war). Thus, a critical resource can only be defined in the moment. Among the most sensitive elements to world events that sow doubt and instability are gold, platinum, silver, and palladium. Stewardship is essential to managing our resources responsibly. In turn, that requires some appreciation for how ore deposits form and their rarity in nature. An uneducated public may see resources as sitting there for the taking. But there is significant investment involved plus a smart strategy to make discoveries that are economic, which means minerals can be extracted from the earth for financial profit.

In this talk, I will discuss several different types of metal deposits, what conditions make the metals concentrate in economic quantities, how and where we find profitable ore deposits, and our responsibility in using resources wisely.

NIKLAS HEINEMANN

Beatriz Galindo Distinguished Professor
University of Barcelona, Spain

n.heinemann@ub.edu

EDUCATION

Niklas Heinemann (NH) studied geology at the Universities of Bonn and Freiburg (Germany) and spent a term in Tromsø (Norway) as an Erasmus student. After obtaining his German Diploma, he moved to Scotland to begin his research career with a PhD at the University of Edinburgh, where he investigated the permanent storage of CO_2 in North Sea rock formations using reservoir simulation and geochemical approaches. Since completing his PhD in 2012, NH continued his work on the subsurface, both as an industry consultant and in academia. He is a Fellow of the Higher Education Academy and has taught courses on the versatile use of the subsurface in the UK, China, and Spain.

CAREER

NH began his professional career as a subsurface pore pressure specialist at Ikon Science. From 2015 onwards, he continued his research on the sustainable use of the subsurface at the University of Edinburgh, first as a Postdoctoral Researcher and later as a Research Fellow. He has taught courses in the classroom, in computer labs, and in the field on subjects such as geoenergy, hydrogeology, and computer modelling. In 2025, he was awarded a Beatriz Galindo Senior Fellowship. He currently works at the Faculty of Earth Sciences at the University of Barcelona (Spain).

RESEARCH INTERESTS

Heinemann's primary focus has been to improve the understanding of subsurface processes relevant to the energy transition and energy security. His work follows a two-stage approach: first, investigating subsurface processes, and second, applying this understanding through computer simulation tools for environmental benefit. His research has particularly focused on the versatile use of the subsurface, including hydrogen storage and CO_2 storage, for climate change mitigation and increased energy security.

PUBLICATIONS AND SERVICES (selected)

NH has published over 40 peer-reviewed articles with colleagues from countries such as Spain, UK, Netherlands, Germany, US and China.

- **Heinemann, N**., Alcalde, J., Miocic, J., et al., 2021. Enabling large-scale hydrogen storage in porous media – the scientific challenges. Energy & Environmental Science. DOI: 10.1039/D0EE03536J
- Schultz, R., **Heinemann, N.**, et al., 2023. An overview of underground energy-related product storage and sequestration. Geological Society, Special Publications (528). DOI: 10.1144/SP528-2022-160
- **Heinemann, N.**, Scafidi, J., Pickup, et al., 2021. Hydrogen Storage in Saline Aquifers: The Role of Cushion Gas for Injection and Production. International Journal of Hydrogen Energy. DOI: 10.1016/j.ijhydene.2018.09.149

GEOSTORAGE: HOW EARTH'S GEOLOGY ENABLES THE ENERGY TRANSITION

Niklas Heinemann

University of Barcelona

Burning fossil fuels for energy is responsible for over 75% of global greenhouse gas emissions. Achieving a low-carbon energy system requires not only renewable energy generation, but also the ability to **store energy and materials safely and reliably over time**. Subsurface *geostorage* plays a critical role in this challenge, using the Earth's natural geological formations to store substances such as **carbon dioxide, hydrogen, compressed air, heat, and natural gas**, helping to balance energy supply and demand and reduce greenhouse gas emissions.

This talk introduces *geostorage* from a **big-picture perspective**, explaining *why* storage is needed in modern low-carbon energy systems and *what* can be stored underground. It will explore the main *geostorage* technologies currently in use or under development—including **carbon capture and storage (CCS), underground hydrogen storage, geothermal energy, compressed air energy storage, and radioactive waste disposal**—highlighting their benefits, limitations, and societal relevance.

The talk will then focus on how geology enables *geostorage*. Using accessible examples, diagrams, and real-world case studies, it will show how rock type, porosity and permeability, depth, pressure and temperature, fluids, and geological structures such as reservoirs, seals, and faults determine whether a geological formation can safely store energy or materials. Teachers will gain clear explanations of these key geological features, how they are assessed, and why different storage technologies require different geological settings.

Geostorage provides a compelling way to show students how fundamental geological processes underpin real-world solutions to global energy and climate challenges.

SIDDHARTH JOSHI
Research Scholar
International Institute for Applied Systems Analysis,
Laxenburg, Austria
joshis@iiasa.ac.at

EDUCATION

2022	Ph.D. in Energy Engineering, University College Cork, Ireland *Thesis Title: Applications of big data and machine learning in global energy system modelling.*
2018	M.Eng.Sc. in Sustainable Energy, University College Cork, Ireland *Thesis Title: Opportunity identification of new energy market strategies for Ireland*
2010	B.E. in Electronics, Instrumentation and Control, Thapar University, India

CAREER

Jan'23- Present	Research Scholar, Lead for Modelling for National Transformations Theme International Institute for Applied Systems Analysis, Laxenburg, Austria
Apr'22- Dec'22	Research Assistant MaREI, the SFI Research Centre for Energy, Climate and Marine, Ireland
Jun'20- Dec'22	Energy Consultant Xavier Dubuisson Sustainable energy consulting Ltd, Ireland
Jan'18- Dec'18	Climate Ambassador An Taisce and Department of the Environment, Climate and Communications, Ireland
Dec'14- Sep'17	Head - Research and Development TeleICU Services Pvt. Ltd., India
Aug'10- Dec'10	Graduate Engineer Trainee GS Engineering and Construction, India and South Korea

RESEARCH INTERESTS

Low carbon global energy system transition using hydrogen, carbon capture and storage, and renewable generation technologies. Application of big data and machine meaning for global energy systems. Application of Geographic Information Systems (GIS) and remote sensing in renewable energy technology potentials and deployment. Decision making under uncertainty using multi criteria assessment.

PUBLICATIONS (selected)

- Sept'25 Gidden, M.J., Joshi, S., Armitage, J.J. et al. A prudent planetary limit for geologic carbon storage. Nature 645, 124–132 (2025). https://doi.org/10.1038/s41586-025-09423-y
- Jan'25 Mori, S., Joshi, S. et al. Energy system transformations for the phase-out of fossil fuels towards 1.5°C future. (Preprint) https://doi.org/10.21203/rs.3.rs-5698098/v1, In review Nature Portfolio
- May'24 Joshi, S., Zakeri, B., Mittal, S. et al. Global high-resolution growth projections dataset for rooftop area consistent with the shared socioeconomic pathways, 2020–2050. Sci Data 11, 563 (2024). https://doi.org/10.1038/s41597-024-03378-x
- Feb'23 Joshi, S., Ó Gallachóir, B. & Glynn, J. A deep learning architecture for energy service demand estimation in transport sector for Shared Socioeconomic Pathways. Sci Rep 13, 3522 (2023). https://doi.org/10.1038/s41598-023-30555-6
- Oct'21 Joshi, S., Mittal, S., Holloway, P. et al. High resolution global spatiotemporal assessment of rooftop solar photovoltaics potential for renewable electricity generation. Nat Commun 12, 5738 (2021). https://doi.org/10.1038/s41467-021-25720-2.

POWERING THE FUTURE:

A GEOSCIENCE PERSPECTIVE ON RENEWABLE ENERGY

Siddharth Joshi

International Institute for Applied Systems Analysis

Transitioning to a sustainable future requires a deep understanding of Earth's renewable resources. This session provides a clear, accessible overview of key technologies, including solar, wind, geothermal, and hydropower. We will evaluate the specific advantages and challenges of each, focusing on their practical role in mitigating human impact on the planet.

Designed specifically for educators, this lecture avoids complex jargon, offering up-to-date insights and real-world context to help you confidently guide students through the complexities of the global energy transition.

CONNOR RHYS HEENEY
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EDUCATION

University of Edinburgh, September 2023 – August 2025
MSc Earth Observation and Geoinformation Management, Edinburgh, Scotland

Dissertation: Assessing the Impact of Tectonic Activity on River Displacement in the Tibetan Plateau by Using High-Resolution DEMs and InSAR-Derived Vertical Velocity

University of Exeter, September 2019 – August 2022: BSc Geography, Falmouth, Cornwall

Dissertation: GIS-Based Assessment of Ash Dieback (Hymenoscyphus fraxineus) Severity in Ash Trees (Fraxinus excelsior): Proximity and Tree Age Analysis in Cornwall

CAREER

Remote Sensing Specialist, RSAC Ltd c/o European Space Agency (ESA), May 2024 – Present, Frascati, Italy

- Led EO capacity-building programs for 2,000+ global stakeholders across 25 countries, developing standardised curricula and MOOC infrastructure aligned with Sentinel data and SDG applications, enhancing multinational access to space capabilities.
- Produced science communication materials (policy briefs, infographics, explainer videos, interactive visualisations) translating complex space science and EO data for non-expert audiences including teachers, policymakers, and development practitioners.
- Coordinated curriculum development across inter-agency partnerships with NASA, ISRO, UNOOSA, and CONAE, translating technical training requirements into pedagogically sound learning frameworks and identifying gaps in existing educational resources.

Permanent Delegate to the UN, DMUN Foundation October 2025 – Present, Geneva, Switzerland

- Represented DMUN at COP-6 UN Minamata Convention, engaging 128-country delegates on mercury policy, advocating EO integration into Effectiveness Evaluation Group—demonstrating output-focused multilateral advocacy.
- Built networks with international organizations and national agencies, promoting evidence-based space data for environmental governance.

Geospatial Analyst, EOLAS Insight Ltd April 2023– August 2023 Edinburgh, Scotland

- Designed and delivered bespoke GIS training programme for 30 urban planners, developing clear, step-by-step instructional materials for watershed restoration workflows and achieving 70% post-training tool adoption.
- Communicated practical applications of commercial EO data (Pleiades Neo) to conservation professionals and policymakers, demonstrating how satellite imagery supports real-world environmental decision-making.

RESEARCH INTERESTS

- Earth Observation applications in environmental monitoring and disaster response
- Capacity building and training curriculum design for EO and geospatial technologies
- SAR polarimetry, InSAR, and high-resolution DEM analysis for geohazards

CLARA CRUZ NIGGEBRUGGE

STEM Education Officer

European Space Agency

clara.cruz.niggebrugge@esa.int

EDUCATION

Master International Communication Management
University of Applied Sciences the Hague, The Netherlands — 2011
Licenciatura (5-year integrated degree, pre-Bologna, master equivalent) Mathematics, specialization in Education
University of Lisbon, Portugal

CAREER

Clara Cruz Niggebrugge has been working at the European Space Agency (ESA) since 2013 within the Education Office, where she currently serves as STEM Learning Coordinator. In this capacity, she coordinates a network of national ESERO offices, working closely with ESA Member States and partners to strengthen the use of space as a context for education and to support teachers and students in STEM subjects.
Before joining the Education Office, Clara held several roles within ESA. She started as a National Trainee in Communication and Institutional Relations at ESA's ESRIN centre in Italy. She later moved to the Netherlands, where she joined the Strategic Planning and Outreach Office of the Human Spaceflight and Operations Directorate at ESTEC, where she was responsible for high-level communication activities and supported communication campaigns for ESA Earth Observation missions in coordination with ESA Member States.
Clara began her professional career as a Mathematics teacher in Lisbon, Portugal. Throughout her career, she has combined expertise in project management, institutional relations, communication, and science education. She is a strong advocate for harnessing the inspirational power of space to promote STEM learning and skills development, contributing to innovation, societal progress, and economic growth.

RESEARCH INTERESTS

Mathematics, Didactics, Education, Earth Observation, Exploration, Capacity Building, International Relations

CONFERENCE PAPERS AND PROCEEDINGS

- **Mission MINERVA: The ESA–ASI Education Activities to Tackle Educational Poverty in View of Developing the Future Space Workforce** Paper No. 78303, International Astronautical Federation (IAF) Paper information (78303) — IAF
- **Aeolus Satellite: A Breath of Fresh Air for Climate Change Education** EGU General Assembly 2023 DOI: 10.5194/egusphere-egu24-20057 10.5194/egusphere-egu24-20057

ARTICLES AND OUTREACH PUBLICATIONS

- **ESERO – Space Research in Classroom Instruction** Ars Electronica Blog, 2016ESERO – Space Research in Classroom Instruction – Ars Electronica Blog,
- **Interview: Clara Cruz Niggebrugge, Mathematician, ESA Education Department** Interviews in Portuguese - Clara Cruz Niggebrugge, Mathematician, Education department of ESA
- **Conference Sessions and Speaking Engagements**
- **ESA – Ecsite 2023** Session: "Space research: from the wonders of the universe to the challenges of humankind?" ESA - Ecsite 2023 – Session "Space research: from the wonders of the universe to the challenges of humankind?"
- **European Initiatives and Educational Campaigns**
- **EU Code Week** – Contributor and supporter of European digital education initiatives EU Code Week

EXAMPLES OF CLASSROOM EXERCISES USING THE ESA SCHOOL ATLAS

Francesco Sarti, Connor Rhys Heeney and and Clara Cruz Niggebrugge

European Space Agency

ESA has developed the ESA School Atlas, a free digital platform that is designed to bring satellite data and interactive maps into secondary school classrooms for the study of natural hazards and global environmental change. Building upon complementary work highlighting EO applications to natural hazards at operational and research scales, this session focuses on the pedagogical dimension: demonstrating how real satellite imagery from the Copernicus Sentinel-1 (radar) and Sentinel-2 (multispectral optical) missions can be transformed into engaging, inquiry-based classroom activities that develop students' observational skills, critical thinking, and awareness of natural processes shaping our planet. Through practical case studies and step-by-step classroom exercises, teachers can guide students from simple visual inspection of satellite images to advanced interpretation tasks that connect EO data to real-world disasters and environmental hazards affecting human communities.

Below is a list of possible case studies that can be showcased during the session:

Case Study 1: Volcanic Eruptions – La Palma 2021

The 2021 eruption of Cumbre Vieja volcano on La Palma (Canary Islands, Spain) provides an excellent and well-documented case study for monitoring volcanic processes using multispectral optical imagery. The eruption, which began on 19 September and continued until 13 December 2021, is the longest and most damaging recorded on La Palma. Lava with temperatures exceeding 1240°C destroyed over 1,300 homes and forced the evacuation of nearly 7,000 people, while hundreds of acres of agricultural land and banana plantations were buried beneath lava flows. The solidified lava eventually extended the island's coastline as molten rock entered the ocean.

The ESA School Atlas provides interactive map layers showing pre-eruption and post-eruption satellite imagery acquired by Copernicus Sentinel-2 (La Palma - ESA Schoolatlas), allowing participants to visualise the spatial extent and evolution of lava flows across the three-month eruption period. Sentinel-2 data have been processed using multiple spectral bands, including shortwave infrared channels, to highlight the thermal signature of active lava flows. The classroom exercise guides participants through a structured investigation:

1. Visual identification of hazard extent: Participants compare false-colour composites (including shortwave infrared composites) acquired before and after the eruption to identify areas of new lava coverage. The shortwave infrared bands enhance the contrast between fresh dark lava and surrounding vegetation and rock.

2. Spatial delineation: Using the Atlas's interactive map tools or paper-based grid overlays, students manually delineate lava flow boundaries by visual interpretation of image features – sharp edges, colour differences, and texture changes.

3. Quantitative assessment: Participants estimate the area affected by eruption using grid-based area calculation methods, developing skills in geometric approximation and measurement.

4. Socio-economic and environmental reasoning: By overlaying lava extent with settlement boundaries, transportation networks, and land-use classes, participants can discuss questions such as: *Which towns and infrastructure were most threatened? What types of land use were most affected? How might the eruption have impacted the local and regional economy?* This integration connects satellite data observation to human geography and disaster impact assessment.

Case Study 2: Hydrological Hazards – Derna, Libya 2023

The catastrophic flooding in Derna, Libya, in September 2023 (Derna - ESA Schoolatlas) offers a compelling and recent case study for change detection, flood extent mapping, and the analysis of water bodies in satellite imagery. From 16–18 September 2023, storm Daniel brought unprecedented precipitation, with rainfall surpassing 200 millimetres in just 48 hours, an extreme event linked to amplified weather patterns and climate variability. This exceptional rainfall caused the collapse of two upstream dams regulating water flow in the valley, unleashing catastrophic flooding that inundated more than 30% of the city and affected approximately 15 square kilometres of land. Thousands of casualties and extensive property damage resulted, with the disaster exacerbated by inadequate infrastructure and urban planning in the flood-prone region.

The ESA School Atlas incorporates satellite data spanning the flood event: pre-flood imagery acquired on 7 September 2023 and post-flood data from 12 September, obtained from both Sentinel-1 and Sentinel-2 sensors. These complementary datasets allow participants to execute a comprehensive flood analysis:

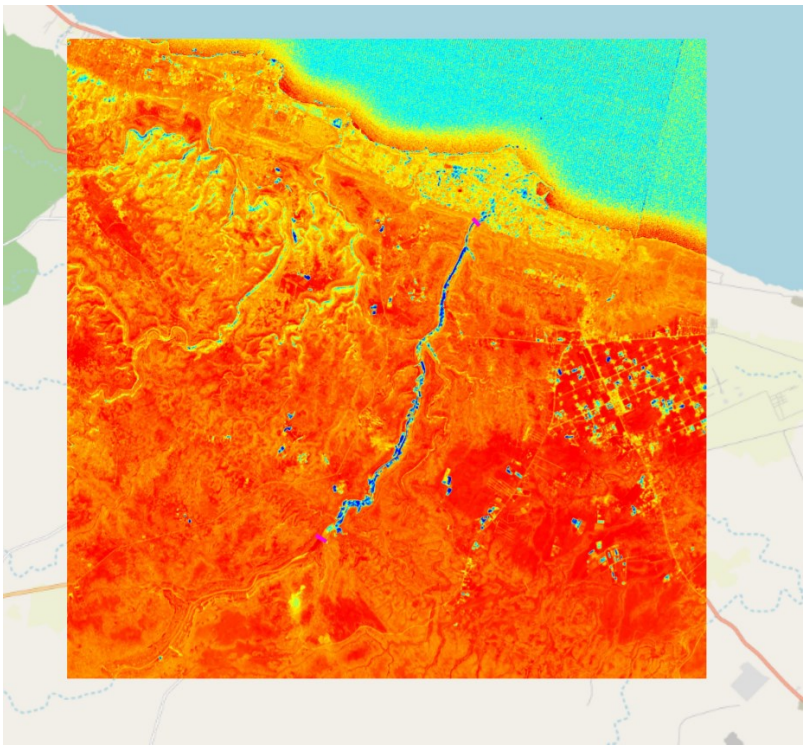
1. Pre- and post-event optical comparison: Participants examine side-by-side Sentinel-2 true-colour RGB composites to visually identify areas where standing water, sediment-laden runoff, and flood damage obscure vegetation and buildings. Flooded areas typically appear darker than pre-event conditions due to water absorption of visible light.

2. Multispectral flood mapping: Participants explore false-colour infrared (FIR) composites, in which healthy vegetation appears bright red. By comparing pre- and post-flood FIR images, students observe how vegetation is destroyed or submerged, appearing darker or absent in post-flood imagery. This layer teaches the principle of spectral signatures and the value of near-infrared data for vegetation monitoring.

3. Moisture Index analysis: Participants examine a normalised Moisture Index layer provided through the Atlas, wherein blue tones indicate wet areas and red tones indicate dry areas. Although the Moisture Index lacks absolute calibration, this semi-quantitative approach develops participants' understanding of spectral indices, a core EO concept used by operational flood-mapping services. Comparing pre- and post-event moisture indices reveals the spatial pattern of inundation and drainage.

4. SAR-based flood detection: Students are introduced to Sentinel-1 SAR backscatter data, which penetrate cloud cover and reveal water surfaces through their characteristically low radar return (dark signature). By comparing pre- and post-flood SAR images, participants identify inundated regions that may be obscured by clouds in optical data, a critical advantage in operational flood response.

5. Quantitative flood extent and impact discussion: Participants map flooded areas and estimate the percentage of the city and surrounding land submerged.



Case Study 3: Cascade Hazards – Tracy Arm Fjord Landslide

A critical addition to the ESA School Atlas is the Tracy Arm Fjord case study (Tracy Arm Fjord - ESA Schoolatlas) (added October 2025), which documents a major landslide on 10 August 2025 triggered by multi-decadal glacier retreat. Tracy Arm is a steep, glacier-carved fjord in southeast Alaska, stretching more than 45 kilometres inland and terminating at two major outlet glaciers: South Sawyer and North Sawyer. The fjord walls rise nearly vertically, creating dramatic topography. However, this landscape is far from static: climate warming has driven progressive retreat of outlet glaciers, removing the ice that historically buttressed steep rock walls. When a glacier ceases to support a slope, gravitational failure becomes inevitable.

The August 2025 landslide involved tens of millions of cubic metres of rock that detached from the fjord wall, generating a massive dust cloud and scattering debris into the water. The event created new

landscape features, exposed fresh pale rock contrasting with older weathered surfaces, and generated localised flooding and wave effects affecting the fjord environment and tourism operations.

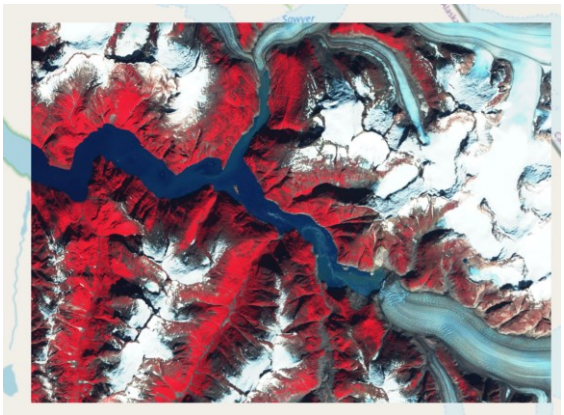
The classroom exercise progresses through several learning objectives:

1. Terrain analysis and glacier-slope coupling: Participants use Sentinel-2 optical imagery to observe the relationship between glacier extent, glacier surface characteristics (crevasses, meltwater lakes, dark debris-covered ice), and adjacent steep topography. Discussions address the mechanical role of glacier ice in slope stabilisation and the consequences of rapid glacier retreat for slope stability.

2. Multi-temporal change detection: Participants compare pre-landslide Sentinel-2 true-colour composites from July 2025 with post-event imagery from August 2025. The pre-event image shows intact fjord walls and active glacier terminus. The post-event image reveals the striking dark scar of the failed slope, the debris fan in the fjord basin, and changes to the glacier terminus position.

3. Hazard impact and cascade reasoning: Participants map the affected area and estimate the volume of mobilised material using simple geometric models. Classroom discussion emphasises that natural hazards rarely occur in isolation: climate change → glacier retreat → loss of slope buttressing → gravitational failure → flooding and debris flows. Participants reason about how EO enables monitoring of these linked processes.

4. Remote sensing advantages for hazardous terrain: Given Tracy Arm's remote location and difficult ground accessibility, participants recognise that satellite imagery is essential for hazard monitoring, providing synoptic views without the expense and danger of ground surveys in unstable terrain.



Case Study 4: Permafrost Thaw and Ground Subsidence – Batagaika Crater, Siberia

A recently added case study (March 2025) showcases the impacts of climate change on permafrost stability in Siberia's Batagaika Crater (Batagaika Crater - ESA Schoolatlas), colloquially known as the "Gateway to Hell." Located in northeastern Siberia, Batagaika is the world's largest retrogressive thaw megaslump, a thermokarst depression formed by ground subsidence as permafrost thaws. The crater spans approximately 1 kilometre in width and expands at an alarming rate of approximately 30 metres per year, removing the equivalent volume of an Olympic-sized swimming pool from its edifice daily.

The origins of Batagaika exemplify human-environmental interactions: logging of Siberian boreal forest in the 1950s-1960s removed root systems that had insulated the permafrost layer. This disturbance initiated a positive feedback loop: exposed ground absorbed more solar radiation, permafrost began to thaw, exposed ice-rich soil subsided, expanded thawed ground received more insolation, and thawing accelerated. The permafrost exposed within the crater contains Ice Age fossils and organic

material frozen for tens of thousands of years. As it thaws, methane and other greenhouse gases trapped in permafrost hydrates are released, potentially amplifying warming, a climate feedback mechanism of global significance.

The ESA School Atlas provides Sentinel-2 optical imagery of Batagaika spanning multiple years, enabling students to observe the crater's expansion through time. The classroom exercise unfolds as follows:

1. Terrain and process observation: Participants examine Sentinel-2 natural-colour and false-colour infrared images to identify the crater's boundaries, the unvegetated subsided floor (appearing brown or grey), surrounding tundra vegetation, and the escarpment where permafrost is actively thawing.

2. Multi-temporal change detection: Participants compare Sentinel-2 images from different years and estimate changes in crater width and area using simple measurement tools.

3. Permafrost and climate linkage: Discussion connects observed ground subsidence to underlying permafrost physics: ice-rich permafrost, thermal thaw, latent heat dynamics, and feedback loops. Participants reason about why permafrost thaw is accelerating with Arctic warming and discuss global implications of permafrost carbon release.

4. Cascading impacts: Participants discuss consequences of permafrost thaw: infrastructure damage, ecosystem disruption, and greenhouse gas release. This exercise illustrates how climate hazards cascade through natural and human systems.

Case Study 5: Ice Sheet Dynamics and Sea-Level Rise – Jakobshavn Isbrae, Greenland

The Jakobshavn Isbrae outlet glacier (also known as Sermeq Kujalleq), located on Greenland's west coast, exemplifies the complex dynamics of ice-sheet response to climate forcing. Historically the world's fastest outlet glacier, with ice velocities exceeding 40–50 metres per day, Jakobshavn is a critical contributor to global sea-level rise, making its monitoring essential for coastal communities worldwide.

Jakobshavn's recent history illustrates non-linear climate responses: From the late 2000s until 2012–2013, the glacier accelerated dramatically, flowing faster and losing mass at record rates as warm ocean waters in Disko Bay entered the glacier fjord and melted ice at the terminus. However, since 2013, ocean temperatures have declined by more than 1°C, and the glacier has slowed, thickened at its terminus, and even begun to advance. Yet despite this recent slowdown, Jakobshavn's drainage basin continues to lose more ice than it gains through snowfall, contributing to rising sea levels at a measurable rate.

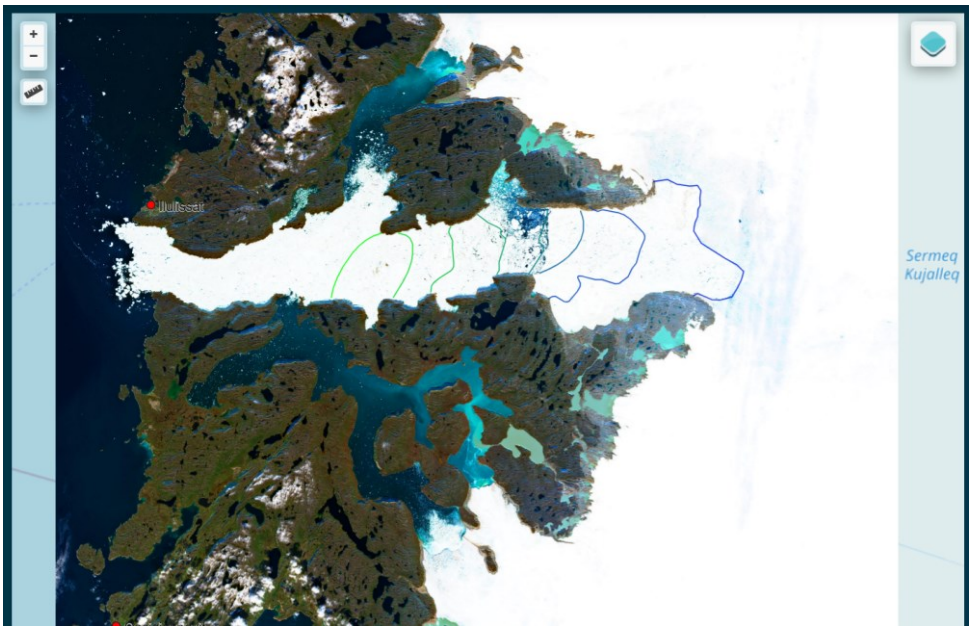
The ESA School Atlas provides Sentinel-1 radar and Sentinel-2 optical imagery of Jakobshavn spanning the period of most dramatic change (2013-present), supplemented by ice velocity maps derived from Sentinel-1 offset tracking (Jakobshavn Isbrae - ESA Schoolatlas). The classroom exercise progresses as follows:

1. Glacier feature recognition: Participants examine Sentinel-2 optical imagery to identify characteristic glacier features: the bright white accumulation zone, the heavily crevassed ablation zone, blue proglacial lakes, the glacier terminus, and the proglacial fjord. These features reveal the spatial pattern of glacier processes.

2. Ice velocity analysis: Participants interpret ice velocity maps derived from Sentinel-1, wherein colours represent ice speed. Students observe that the fastest flow occurs in the central trunk of the glacier and that velocities are highest near the terminus. Comparison of velocity maps from different years reveals how Jakobshavn has decelerated.

3. Temporal change detection: Participants compare multi-year Sentinel-2 optical imagery to track terminus position and meltwater lake evolution. Pre-2013 images show the glacier terminus far inland. Post-2013 images document terminus re-advance and reduced meltwater production.

4. Sea-level and climate connectivity: Discussion connects glacier dynamics to climate drivers (ocean and atmospheric forcing) and to global impacts. Participants reason about why this single glacier remains critical to monitor and why its long-term trend is a concern for global coastal communities.



Pedagogical Framework and Classroom Implementation

All case studies in the ESA School Atlas are designed to support inquiry-based and constructivist learning. For each case, the Atlas provides guiding questions that scaffold student observation and reasoning, interactive map layers allowing students to toggle between temporal snapshots and sensor types, downloadable materials in multiple languages, explicit curricular linkages to international science and geography standards, and extension activities connecting satellite observations to ground-based research and policy frameworks.

The interactive globe and map interface, optimised for classroom projectors and student tablets, makes the platform accessible to instructors with limited technical backgrounds.

Conclusion and Resources

All case studies and materials discussed are freely accessible through the ESA School Atlas website (https://esa-schoolatlas.eu). The platform provides interactive 3D globe and 2D map viewers optimised for classroom use, multilingual downloadable PDF guides with integrated exercises, high-resolution satellite imagery and vector GIS data, embedded links to complementary Copernicus services, and continuous updates with newly released case studies.

This contribution to the GIFT workshop will equip teachers with practical strategies for integrating satellite-based Earth observation into natural hazards and environmental change education. By working through the case studies presented: La Palma volcanic eruption, Derna flooding, Tracy Arm landslide, Batagaika permafrost thaw, and Jakobshavn glacier dynamics, educators can foster students' scientific literacy, environmental awareness, and appreciation for space-based technologies in monitoring planetary hazards.

POSTER SESSION
PROJECTS ON NATURAL HAZARDS, HUMAN IMPACT AND EARTH'S RESOURCES AT SCHOOL

Posters on site: Tue, 5 May, 16:15–18:00 | Hall X5, Display time: Tue, 5 May, 14:00–18:00

X5.248 EGU26-1952
Surduk Quarry - Analysis of anthropogenic pollution and degradation of areas
Marina Marjanovic

X5.249 EGU26-2003
Hands-on Renewable Energy for Earth System Learning
Ana Freire

X5.251 EGU26-2273
Enhancing Climate Change Literacy and Disaster Preparedness through Simulation-Based Learning: Lessons from the ECOSTAND Project
Mihaela Ionescu

X5.252 EGU26-2365
Climate Education through Physical Modeling in Non-Formal Science Education
Kateryna Terletska and Stanislav Dovgyi

X5.253 EGU26-2548
Ocean Literacy Beyond Knowledge: Investigating Emotional Connections to the Ocean Among Students and Adults
Giulia Realdon, Michelina Occhioni, Maria Teresa Gallo, and Eleonora Paris

X5.254 EGU26-2627 ECS
Observations of the Seismic Shadow Zone from the 29 July 2025 M 8.8 Kamchatka Earthquake.
Rosario Mario Raffaele, Dario Alberti, Matteo Marino, and Roberto Taranto

X5.255 EGU26-3000
EDUMED IBERATLAS, a new educational project
Patrick Strozza

X5.256 EGU26-3150
Learning about Natural Hazards through Local Risk Assessment: A Secondary School Experience
Esmeralda Pérez

X5.257 EGU26-3838
How does doing science foster self-esteem among students from socially disadvantaged backgrounds?
Eugénie Blaszczyk

X5.258 EGU26-4017
Learning from Our Local Ground: Investigating Soil Health in Tetovo Through Biology and Mathematics
Renata Mersini Zulfiu and Duygu Reçani

X5.259 EGU26-4183
School-Based Education on Natural Hazards, Human Impact and Earth's Resources
Daniela - Lorina Stegariu and Mihaela - Cecilia Chiriță

X5.260 EGU26-4280
From Educational Seismometers to Real Seismic Data – Practical Activities in High School Education
Cristina Iulia Anghel

X5.261 EGU26-4298
"What future for the Alentejo region (Portugal) in the context of climate change?"
Maria Anabela Palma

X5.262 EGU26-4392
Water and biodiversity: shaping life in the context of human impacts in the Bay of Pollença (Mallorca, Balearic Islands)
Maria Pons Suau and Jordi Borras Aguilar

X5.263 EGU26-4414
Coastal erosion risk and impacts on populations
Gaëlle Piriou

X5.264 EGU26-4489
Exploring Learning through Inquiry on the Topics of Water Scarcity, Groundwater Quality in Educational Settings, and the Effects of Flooding on Water Quality.
Purabi Majumdar, Sumita Dey, Tanusree Goswami, and Paramita Bhakta

X5.265 EGU26-4524
Teaching Natural Hazards and Human–Environment Interaction in Elementary Geography: Experiences from Skopje, North Macedonia
Aleksandar Gareski

X5.266 EGU26-4539 ECS
Adopt a tree
Mariela Ioana Micu

X5.267 EGU26-4598
Impact of the 1952 Tottori Fire on Tree Growth: Linking Local Environmental History and Natural Disasters through Tree-Ring Analysis
Shuji Nakamura

X5.268 EGU26-4718 ECS
Disaster Heroes: A Game-Based Approach to Teaching Natural Hazards and Risk Awareness at School
Semih Esendemir

X5.269 EGU26-5072
The Makiš Water Source – a Source of Drinking Water for Belgrade
Danka Jovanovic

X5.270 EGU26-5082
How does what we eat affect the environment?
Michele Cutini

X5.271 EGU26-5582
Our Sea Begins Here, in the Lis River Basin -Leiria, Portugal
Dina Francisco, Fatima Carvalho, Isabel Roldão, and Isabel Vieira

X5.272 EGU26-5806
Using analog models to teach flood-risk management and the nature of science.
Grégoire Pagnier

X5.273 EGU26-6913
Natural disasters, the role of schools in raising awareness of risk
Ana Sofia Costa

X5.274 EGU26-6925 ECS
Projects on Anthropogenic and Natural Hazards for Gifted Students: A Study From Istanbul to the Arctic
Seda Oskay Yirmibeşoğlu

X5.275 EGU26-7392 ECS
Collaborative multimodal learning as a tool for diversifying input options
Dóra Hegyesi

X5.276 EGU26-7913
Water Matters! Understanding Drought through Inquiry and Play in Kindergarten
Anna Thomadaki

X5.277 EGU26-7935
From Seafloor to Classroom: Exploring Submarine Volcanism and Hazards
Séverine Furst, María Blanch Jover, Megan Campbell, Fiene Stoepke, Anne Hennke, Joachim Dengg, Emma Hadré, Effrosyni Varotsou, Jens Karstens, Thies Bartels, Christian Timm, and Gareth Crutchley

X5.278 EGU26-8181
A combination of field trip, laboratory analyses, use of digital tools and literature review as a pedagogic strategy for student research projects
Sara Gloria Domínguez Oliver

X5.279 EGU26-8310
Mathematical Modeling of Floods: Natural Hazards and Human Impact
Ksenija Bojchevska

X5.280 EGU26-8323
Teaching Natural Hazards with Analogue Models and Classroom Experiments
Petra Veselá

X5.281 EGU26-8324
'DANA' 2024: Turning Extreme Floods into Learning Opportunities for ESO Students
Elisenda Costa, Trini Miota, Daniel Luna, Núria Castillo, Lara Morgado, Francisco Soriano, Joan Beltrán, Norman Yelamos, Norbert Pijoan, Laura Fusté, Alba Nievas, and Luis Fernández

X5.282 EGU26-8445 ECS
Comparative analysis of atmospheric parameters (temperature, humidity, and rainfall) using local and modern weather monitoring systems.
Wirnsungrin Timothy Ndzeyebi, Mani Miegue Estelle, Florence Bigot-Cormier, Fabrice Jouffray, Julien Balestra, Alessandra Robodetti, Marie Rose Koh Minfele, and Benoit Landry Messende Mba
X5.283 EGU26-10047

Harnessing Open Data in Classroom: Fostering Water Literacy
Chrysanthi Tziortzioti and Elias Dimitriou
X5.284 EGU26-10316
From flood experience to scientific understanding: engaging students with natural hazards through active learning
Alicia Cortinas Vicent, José Úbeda, Susana Hernández Sáez, and David Chiralt Garcia

X5.285 EGU26-11099
Bridging geoscience and education: inquiry-based learning at the Sitia Unesco Global Geopark
Eirini Dermitzaki, Ifigeneia Papamatthaiaki, and Panagiota Pierrou

X5.286 EGU26-11602
Which natural hazards could damage the area you live in?
Cristinel Scutaru

X5.287 EGU26-11911
Characteristics of Education for Disaster Prevention in Social Studies in Japan
Hiroaki Sakaue and Yoshimichi Yui

X5.288 EGU26-12068
An Integrated Educational Approach to Studying Wildfires as Natural Hazards and Their Impact on Ecosystems
Biljana Arsovska

X5.289 EGU26-12359
Ideas for teaching geological hazards in secondary education
James Hansen

X5.290 EGU26-12616
Building Resilience from the Ground Up: A Practical Framework for Hazard and Risk Education in Romania
Adriana Lichi

X5.291 EGU26-13199 ECS
Integrating Environmental Education in Greek Schools
Sofia Kalaroni

X5.292 EGU26-13296
Workshops by GEFO in FRANCE: « how to involve teachers in Geosciences »
Carole Larose

X5.293 EGU26-13764
Learning to manage volcanic risk: the educational value of reality-based and active teaching in Middle School
Luisa Stellato and Maria Giuseppa Dolce

X5.294 EGU26-13832
Seismic Risk and Education: Engaging students in understanding earthquakes and exposure.
Elisabetta Casatta, Carla Barnaba, Manuela Bittolo, Francesco Gobbo, Daniela Novel, Antonella Peresan, Matteo Sema, and Chiara Scaini

X5.295 EGU26-13944 ECS
Educating on Natural Hazards, Resource Preservation, and Human Impact on the Planet in an International Context
Inès Freyssinel

X5.296 EGU26-14264
Raising Seismic Risk Awareness through Geoscience Education in Primary School
Maria Sofia Bagiati

X5.297 EGU26-14312
Developing Map Literacy for Understanding Natural Hazards, Human Impact and Earth's Resources in Geography Education
Anett Dr. Kádár

X5.298 EGU26-14697 ECS
The Tisza Competition – A Regional Academic Contest Related to the Environmental Hazards of a Hungarian River
Ádám Tóth

X5.299 EGU26-14766 ECS
Inquiry-based science learning in primary school: Human and environmental impact of a potential natural disaster in an urban habitat
Eleni Moustroufa

X5.300 EGU26-15055
Teaching magmatic differentiation as a mechanism for the concentration of ore deposits – a visual approach
Steph OGrady

X5.301 EGU26-15069
Monte de Santa Luzia, in Viseu, Portugal, as a geological and educational resource
Ana Bernardes Pereira

X5.302 EGU26-16007
Teaching geosciences in the classroom using open data. A case study on the utilization of active fault database
Kyriakoula Makri and Athanassios Ganas

X5.303 EGU26-16540
From School Garden to Global Responsibility: Student-Led Projects on Human Impact and Earth's Resources
Katarzyna Kwiatek-Grabarska

X5.304 EGU26-17468 ECS
Anchored in Nature: Structural Stability through Nature-Inspired Design in Middle School Science
Merve Çoban

X5.305 EGU26-17663
EngageMINT: Transfer and communication of knowledge for environmentally aware young people to raise interest in STEM
Anne Wiesner, Jens Voigtländer, Mira Pöhlker, Ralf Käthner, Thomas Gabor, Katharina Düsing, Ute Harms, Louisa Weinhold, and Till Bruckermann

X5.306 EGU26-20718
QuakeQuest: Immersive and Hands-On Earthquake Education Bridging Research Infrastructure and the Classroom
Dragos Tataru, Eduard Nastase, Mihai Boni, and Alexandru Macovei

X5.307 EGU26-21464
Integrating Geosciences, Astronomy, and Art: An STS-Based Nature Education Model for Middle School Students
Selda Demircali and Semra Demircali

X5.308 EGU26-21701
Unveiling the Invisible: A Low-Cost Student Methodology for Microplastic Monitoring
Elisa Saraiva

X5.309 EGU26-22493
Projects on Natural Hazards, Human Impact and Earth's Resources at School
Fatbardha Sulaj

X5.310 EGU26-8327
Digital Herbarium
Bojana Mitriceski Andjelkovic, Sladjana Jovic, and Silvester Gereg