



European Geosciences Union
GIFT – Geosciences Information For Teachers



GIFT 2023

*THE KEY ROLE OF GEOSCIENCES FOR THE GLOBAL
CHALLENGE OF SUSTAINABLE DEVELOPMENT:
THE AGENDA 2030*

Vienna, Austria, 24-26 April 2023

Dear teachers,

Welcome to the 2023 GIFT workshop!

This year, which marks the 20th anniversary of the GIFT workshop series, the general theme is “The key role of geosciences for the challenge of sustainable development: the Agenda 2030”.

Agenda 2030 is a series of resolutions, adopted by the members of the United Nations (ONU), that defines 17 goals to be achieved by 2030 to ensure the sustainable development of our planet. Achieving these goals by 2030 requires efforts from many communities working on a blended combination of research, innovation, capacity building and knowledge transfer.

In this frame, as GIFT 2023 will highlight, geosciences play a crucial role in reaching many of these goals by observing, understanding, managing and protecting the Earth. This knowledge has to be shared with other communities, translated into tools allowing for sustainable development and transferred to the broadest range of stakeholders (i.e., academia, industry, government and civil society) to reach the crucial challenge for society’s future: to save our planet.

GIFT 2023 will start with a presentation providing a panorama of Agenda 2030 and its goals, especially the ones linked to education and geosciences. After presenting in detail, climate change (Goal 13 of the Agenda), Education (Goal 4) and Gender Equality (Goal 5) will then be discussed, mainly focusing on the role teachers can play in reaching the Agenda 2030 goals, on the impact that gender equality may have on geosciences and vice-versa how geosciences may improve/maintain gender equality.

A look at the sea will be given, “taking” you on an oceanographic cruise in the Arctic Ocean focused on extreme environments that could increase our ability to understand the present and predict the future.

Thanks to hands-on sessions, you will discover how foraminifera can provide clues to investigate past climates and how 'data mining' freezes info on the interrelated dynamics of meteorological, hydrological and geological phenomena which are potentially responsible for floods and natural disasters.

The second GIFT 2023 day will start with the role of energy in sustainable development (Goal 7) and the predictability of heatwaves, one of the most dangerous natural hazards worldwide (Goal 13), before being inspired by both the Education Committee and the Science on Stage activities which excite students about STEM and promote scientific skills.

The second hands-on session will show how the digital maps of the Diercke International Atlas can develop Sustainable Development Goals awareness in the classroom. Then our EGU Field Officers will present practical activities on earthquakes, volcanoes, landslides and other surface phenomena, just before the poster session contributed by all of you, teachers, on the theme of the Agenda 2030.

On Wednesday morning, a talk on rivers full of life (Goal 6) and the presentation of the major challenges for ensuring sustainable use of freshwater (Goal 6) will precede the final talks on volcanic and earthquake hazards (Goal 15) and the presentation of the EPOS geoscience open data platform.

During these two and half days of GIFT 2023, you will discover how geosciences can serve mankind, helping to reach the Agenda 2030 goals, a message to firmly bring into your classes and amplify worldwide.

And at the end of the GIFT 2023 session, do not forget to fill out the evaluation form. The success of future workshops also depends on you.

Ready to start?

The Education Committee of EGU

Acknowledgements

The GIFT-2023 workshop has been organised by the EGU Education Committee. EGU has supported the major share of the expenses, but the workshop has also benefited from the help of:

westermann
Immer auf den Punkt



The
Geological
Society

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

EGU Education Committee

Jean-Luc Berenguer (Chair)

GEOAZUR
University Côte d'Azur
06560 Valbonne, France
berenguer@unice.fr

Friedrich Barnikel

Fachkoordinator für Geographie
Landeshauptstadt München,
Germany
friedrich.barnikel@awg.musin.de

Francesca Cifelli

Dipartimento di Scienze
Università degli Studi Roma TRE
Largo San Leonardo Murialdo 1
00146 Roma, Italy
francesca.cifelli@uniroma3.it

Gina Pereira Correia

CITEUC- University of Coimbra's Earth
and Space Research Centre
Coimbra, Portugal
gina_maria@sapo.pt

Francesca Funiciello (Deputy Chair)

Dipartimento di Scienze
Università degli Studi Roma TRE
Largo San Leonardo Murialdo 1
00146 Roma, Italy
francesca.funiciello@uniroma3.it

Teresita Gravina

Guglielmo Marconi University
Via Plinio, 44 , 00193 Roma
teresitagravina@gmail.com

Konstantinos Kourtidis

Department of Environmental Engineering
Democritus University of Thrace
12 Vas. Sofias str., 67132 Xanthi, Greece
kourtidi@env.duth.gr

Carlo Laj

École Normale Supérieure, PSL Res. Univ.
Département de Géosciences
75231 Paris Cedex 5, France
carlo.laj@ens.fr

Stephen A. Macko

Department of Environmental Sciences
University of Virginia
Charlottesville, VA 22903, USA
sam8f@virginia.edu

Giuliana Panieri

Centre of Excellence for Arctic Gas hydrate,
Environment and climate
Arctic University of Norway
giuliana.panieri@uit.no

Hélder Pereira

Escola Secundária de Loulé
Avenida Laginha Serafim
8100-740 Loulé, Portugal
hpereira@es-loule.edu.pt

Anna Anglisano Roca

Department of Geology
Autonomous University of Barcelona
anna.ar.93@gmail.com

Phil Smith (Secretary)

Teacher Scientist Network (TSN)
John Innes Centre
Colney Lane
Norwich, NR4 7UH Great Britain
phil.smith@nbi.ac.uk

Annegret Schwarz

Oberstudiendirektorin a.D.
Mainz, Germany
annegret.m.schwarz@gmail.com

Stavros Stathopoulos

Department of Environmental Engineering,
Democritus University of Thrace,
Xanthi, Greece
sstathop@env.duth.gr

EGU Education Committee



Jean Luc Berenguer



Anna Anglisano Roca



Annegret Schwarz



Carlo Laj



Francesca Cifelli



Francesca Funiello



Friedrich Barnikel



Gina Pereira Correia



Giuliana Panieri



Hélder Pereira



Konstantinos Kourtidis



Phil Smith



Stavros Stathopoulos



Stephen Macko



Teresita Gravina

Programme

EUROPEAN GEOSCIENCES UNION – GENERAL ASSEMBLY

Geosciences Information for Teachers Workshop (GIFT) 2023

24-26 April 2023

‘THE KEY ROLE OF GEOSCIENCES FOR THE GLOBAL CHALLENGE OF SUSTAINABLE DEVELOPMENT: THE AGENDA 2030’

→ THE PROGRAMME SCHEDULE USES CENTRAL EUROPEAN SUMMERTIME (CEST) ←

Sunday, 23 April 2023

16:00-18:00 **GUIDED TOUR OF THE NATURAL HISTORY MUSEUM VIENNA**
(optional) Mathias Harzhauser and Oleg Mandic
Natural History Museum Vienna, Austria

18:30-20:00 Ice breaker party at Austria Center Vienna
(optional)

Monday, 24 April 2023

Chairperson: Jean-Luc Berenguer

8:30-8:45 **WELCOME**
Helen Graves (EGU President)
Jean Luc Berenguer (Chair of the EC)

8:45-9:30 **INTRODUCTION ON THE AGENDA 2030**
Jonghwi Park (UNU-IAS)

9:30-10:15 **THE OCEAN AND ITS ECOSYSTEMS, CLIMATE CHANGE AND THE SUSTAINABLE DEVELOPMENT GOALS**
Laurent Bopp (Ecole Normale Supérieure)

10:15-10:45: COFFEE BREAK

10:45-11:30 **EQUITABLE EDUCATION FOR ALL: TEACHERS AS LEADERS OF CHANGE**
Clara Vasconcelos (University of Porto)

11:30-12:15 **GENDER EQUALITY IN GEOSCIENCES**
Lena Abrahamsson (Luleå University of Technology)

12:15-12:20 **AGENDA2030@SCHOOL: THE LICEO SPALLANZANI EXAMPLE**
Luigi De Filippis (Spallanzani Scientific High-School)

12:20-12:30 **THE CIRCULAR CITY CHALLENGE PROJECT**
Antonija Bogadi (SYNYO GmbH)

12:30-14:00: LUNCH

Chairperson: Phil Smith

- 14:00-14:10 **INSTRUCTIONS FOR THE POSTER SESSION EOS 5.2 (AGENDA 2030 AT SCHOOL)**
Annegret Schwarz and Stephen Macko (EGU EC)
- 14:10-17:30 **HANDS-ON ACTIVITIES (3 groups alternating)**
1. EVALUATING PAST CLIMATES THROUGH ANALYSIS OF MARINE MICROFOSSILS AND THEIR ISOTOPE COMPOSITIONS
Stephen Macko (EGU EC)
2. A VIRTUAL REALITY EXPEDITION ON BOARD: THE RESEARCH VESSEL KRONPRINS HAAKON
Giuliana Panieri (The Arctic University of Norway)
3. SOME EXAMPLES TO ADDRESS GEOSCIENCES STUDIES AT SCHOOL WITH ONLINE DATA
Jean Luc Berenguer (Université Côte d Azur)

17:30: TOUR OF THE EGU EXHIBITION

Tuesday, 25 April 2023

Chairperson: Kostas Kourtidis

- 8:30-9:15 **THE ROLE OF ENERGY IN SUSTAINABLE DEVELOPMENT**
Jarmo Kikstra (Imperial College London)
- 9:15-10:00 **THE PREDICTABILITY OF EUROPEAN HEAT WAVES**
Andreas Fink (Karlsruhe Institute of Technology)
- 10:00-10:15 **AN EXPEDITION IN THE ARCTIC OCEAN TO PROMOTE THE SUSTAINABLE DEVELOPMENT GOALS**
Giuliana Panieri (The Arctic University of Norway)

10:15-10:45: COFFEE BREAK (AND GIFT 2023 GROUP PICTURE!)

- 10:45-11:00 **HOW TO INTEGRATE THE SDGS IN STEM LESSONS – NEW TEACHING MATERIAL WITH HANDS-ON EXAMPLES**
Daniela Neumann (Science on Stage Deutschland)
- 11:00-12:30 **HANDS-ON ACTIVITIES (2 groups alternating) -first part-**
1. PRESENTATION AND PRACTICAL EXERCISE: 'HOW TO USE DIGITAL MAPS OF THE DIERCKE INTERNATIONAL ATLAS TO DEVELOP SDG AWARENESS IN THE CLASSROOM'
Björn Richter (Westermann Textbook Publishers)
2. GEOSCIENCE PRACTICAL ACTIVITIES ON NATURAL HAZARDS IN A RAPIDLY CHANGING WORLD
EGU Field Officers Team

12:30-14:00: LUNCH

- 14:00-15:30 **HANDS-ON ACTIVITIES (2 groups alternating) -second part-**
1. PRESENTATION AND PRACTICAL EXERCISE: 'HOW TO USE DIGITAL MAPS OF THE DIERCKE INTERNATIONAL ATLAS TO DEVELOP SDG AWARENESS IN THE CLASSROOM'
Björn Richter (Westermann Textbook Publishers)
2. GEOSCIENCE PRACTICAL ACTIVITIES ON NATURAL HAZARDS IN A RAPIDLY CHANGING WORLD
EGU Field Officers Team

Chairpersons: Stephen Macko and Annegret Schwarz

- 15:45-18:00 **EOS 5.2 – POSTER SESSION (AGENDA 2030 AT SCHOOL)**
(with coffee break)

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

Wednesday, 26 April 2023

Chairpersons: Francesca Cifelli & Francesca Funicello

- 8:30-9:15 **THE RIVER BASIN AS A LIVING ORGANISM**
Hubert H.G. Savenije (Delft University of Technology)
- 9:15-10:00 **THE MAJOR CHALLENGES FOR ENSURING A SUSTAINABLE USE OF FRESHWATER UNDER CHANGE**
Alberto Montanari (Università di Bologna)
- 10:00-10:15 **PRESENTATION OF THE ACTIVITIES BY THE EGU EDUCATION COMMITTEE**
- 10:15-10:45: COFFEE BREAK and GIFT POSTER CERTIFICATES DISTRIBUTION**
- 10:45-11:30 **CHALLENGES AND PERSPECTIVES FOR THE SCIENCE OF VOLCANOES IN THE CURRENT DECADE**
Paolo Papale (Istituto Nazionale di Geofisica e Vulcanologia)
- 11:30-12:15 **EARTHQUAKE HAZARD AND SOCIETAL RISK**
Domenico Giardini (ETH Zürich)
- 12:15-12:45 **EPOS: A NOVEL GEOSCIENCE OPEN DATA PLATFORM FOR A BETTER UNDERSTANDING OF PLANET EARTH**
Daniele Bairo, Rosanna Paciello, Carmela Freda (EPOS team)
- 12:45- 13:00 **GENERAL SESSION AND CONCLUDING REMARKS**

GOOD BYE

Guided Tour of the Natural History Museum Vienna

Mathias Harzhauser and Oleg Mandic, Natural History Museum Vienna



Standing on each side of the bronze elephant (an artwork of the Viennese artist Gottfried Kumpf) in front of the entrance, our two hosts for the visit to the Natural History Museum Vienna (NHMW):

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.

GIFT ORAL SESSIONS



JONGHWI PARK

UNU-IAS
5-53-70 Jingumae,
Shibuya-ku, Tokyo 150-8925
Japan
jonghwi.park@unu.edu

Dr. Jonghwi Park is the Head of Innovation and Education at the United Nations University Institute for Advanced Study of Sustainability (UNU-IAS).

She promotes the innovative and inclusive use of technology to provide inclusive lifelong learning opportunities to engage everyone in sustainable development. Her team serves as secretariats for two renowned networks on ESD, namely, Regional Centres for Expertise on ESD (RCEs) and Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.NET). Prior to joining the UNU, Dr. Park was a team leader of ICT in Education at UNESCO Asia Pacific Regional Bureau for Education and UNESCO Institute for Lifelong Learning in 2011-2020. She holds MA on Educational Technology from Hanyang University and PhD in Learning Sciences from McGill University.

EDUCATION AT THE CENTRE OF 17 SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Jonghwi Park

United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS)

This talk provides an overview of the 17 Sustainable Development Goals (SDGs) which were agreed and launched in 2015 and emphasizes the important roles of education and teachers in achieving the 17 SDGs by 2030. The 17 SDGs are a much extended commitment, resulted from intensive and collective reflection by international communities on the achievements and failures in the Millennium Development Goals (MDGs) era (2000-2015). Compared to the 8 goals in the MDG era, the 17 SDGs show a greater level of challenges that the world faces, including climate change, demographic shifts, biodiversity loss, food insecurity, degraded natural resources, frequent endemics, to name a few. In this world of complex problems, learners are required to prepare for the future that no one is certain about. The role of education in this regard is more critical than ever to put the humanity and human resources at the centre of sustainable development. Therefore, this talk will introduce urgent issues that the world is facing and concrete cases that education sectors have play a vital role in tackling the issues with innovative pedagogies, such as community-based education for sustainable development, digital citizenship education, problem-based learning, and multidisciplinary problem solving.



LAURENT BOPP

CNRS Senior Scientist

Director of the Geoscience Department

Ecole normale supérieure, Paris

Laurent.bopp@ens.fr

EDUCATION

After his secondary studies in Strasbourg, he attended the École Normale Supérieure in Paris. He obtained his PhD in 1998 at the University of Paris 6 and his “habilitation” in 2011.

CAREER

2012 - present: Directeur de Recherche CNRS

2003-2012: Chargé de Recherche CNRS

2002-2003: Post-Doctoral au LSCE

2000-2001: Scientific Researcher at MPI Biogeochemie, Jena

RESEARCH INTERESTS

Laurent Bopp is a specialist of the ocean carbon cycle and climate modelling. He has made major contributions in the analyses of feedbacks between the carbon cycle and climate changes and on ocean acidification. His research interests cover a large range of spatial (from open to coastal ocean) and temporal (from the past to future climate) scales. He has also investigated the impacts of climate change on marine ecosystems and fisheries.

PUBLICATIONS AND SERVICES

Laurent Bopp is author or co-author of more than 170 scientific publications in international journals and has participated to the writing to the chapter “Carbon cycle and other biogeochemical components” of the IPCC 5th report, and the chapter “Ocean and Coastal Ecosystems and their services” in the recent IPCC 6th report.

He is also author of several large public books including «Les poissons vont-ils mourir de faim (et nous avec)?» (Paris, le Pommier, 2010) “Fishes will die of hunger (and we also)” and «Les dessous de l’océan» (Paris, le Pommier, 2012) (“The bottoms of the Ocean”).

AWARDS AND HONORS

2011: Médaille de la Société d’Océanographie de France

2019: Prix des Sciences de la Mer-IFREMER

Member of Academia Europae

THE OCEAN AND ITS ECOSYSTEMS, CLIMATE CHANGE AND THE SUSTAINABLE DEVELOPMENT GOALS

Laurent Bopp

Ecole Normale Supérieure

Covering two-thirds of the planet, the ocean modulates the global climate system by regulating the cycles of heat, water and many elements, including carbon. The ocean supports vast ecosystems, harbours a high level of biodiversity and also provides food, minerals and energy for people.

In this lecture, I will make use of the recent IPCC reports to show the links between anthropogenic climate change, impacts on the ocean and its ecosystems, and threats on the ecosystem services the ocean delivers to our societies. I will also discuss some of the solutions offered by the ocean to better mitigate and adapt to climate change. The links between the ocean sustainable development goal (Life below Water SGD14) and the other SDGs will also be discussed.

In the context of anthropogenic climate change, the ocean plays a central role. It absorbs much of the additional heat in the climate system due to increasing greenhouse gas concentrations. It also absorbs a substantial fraction of our anthropogenic carbon emissions, and is therefore a key carbon sink. As a result, and by absorbing heat and carbon, the ocean slows the rates at which CO₂ is increasing in the atmosphere and the atmosphere is warming. It is a valuable ally in our fight against climate change.

On the other hand, this absorption of heat and carbon has consequences for the functioning of the ocean and its physical and chemical properties. The ocean warms, sea ice cover decreases and ocean circulation changes. The absorption of carbon, which leads to an increase in the concentration of carbonic acid in seawater, is responsible for ocean acidification. Finally, the increase in water temperature and ocean stratification, also linked to climate change, leads to a widespread decrease in oxygen concentrations in the ocean, called ocean deoxygenation.

All of these changes are exposing ocean ecosystems to changes not seen in thousands of years. Impacts on marine life are already detectable, with changes in the timing of seasonal activities and in the distribution and abundance of marine organisms, from plankton to large mammals. Shifts in the geographic range of marine species generally follow the rate and direction of global warming.

Surface warming since the 1950s has moved marine taxa and communities towards the poles in both hemisphere at an average rate of 60 km per decade.

Ocean conditions are expected to continue to move away from pre-industrial conditions, with the magnitude of warming, acidification, deoxygenation and other climate impacts depending on the emissions scenario. These changes could lead to a decrease in the biomass of marine organisms, linked to ocean stratification and lower nutrient concentrations at the ocean surface. The responses to climate change are very likely to be amplified in marine food webs over large areas of the ocean. The projected decreases in global phytoplankton biomass translate into larger decreases in fish biomass up to -15% for the high-emissions scenarios at the end of the 21st century. The future impacts of these changes will be amplified by the increased frequency and intensity of extreme events such as marine heat waves. Some particular ecosystems, such as coral reefs, kelp forests and seagrass beds, are particularly at risk from these events.

All these impacts will alter the ecosystem services provided by marine systems and are expected to have an impact on human communities. Although humans are already adapting to climate-induced changes in marine systems, further adaptation efforts are needed. In high-emission scenarios, adaptation options, such as hard infrastructure for coastal protection, assisted migration or evolution of marine organisms, human migration and resettlement, are uncertain and require transformational changes in governance. In low-emission scenarios however, more feasible, effective and low-risk nature-based adaptation options are available (e.g. ecosystem restoration and protection, early warning systems for extreme events). These ocean adaptation options, especially those involving nature-based solutions, also support other UN SDGs and as such, have positive synergies between adaptation options for life below water (SDG14), climate action (SDG13) and the social, economic and governance SDGs.



CLARA VASCONCELOS

Associated Professor (Habilitation in Science Education)

Faculty of Sciences of University of Porto

csvascon@fc.up.pt

ORCID: 0000-0002-4524-9788

[Ciência ID: 3313-76C3-8F08](#)

EDUCATION

2011 Ability in Science Education - Universidade of Minho

2008 Pos.Doc in Science Teaching Methodologies – University of Minho

2001 PhD in Education, University of Minho

1991 Graduation in Geology – educational branch - Universidade of Porto

CAREER

2020-Current Associated Professor with Habilitation in Porto University

2001-2019 Assistant Professor with Habilitation in Porto University

1999-2001- Assistant Professor in Porto University

RESEARCH INTERESTS

Geoscience Education, Sustainability Development, Teachers Training, Educational Research Methodologies.

PUBLICATIONS AND SERVICES

ORCID: 0000-0002-4524-9788

[Ciência ID: 3313-76C3-8F08](#)

AWARDS AND HONORS

ORCID: 0000-0002-4524-9788

[Ciência ID: 3313-76C3-8F08](#)

EQUITABLE EDUCATION FOR ALL: TEACHERS AS LEADERS OF CHANGE

Clara Vasconcelos

University of Porto, Portugal

Teachers are recognised as educators, but their role as leaders of change is underestimated. As they teach a class with a large audience, they are also communicators with competencies to engage students in developing competencies. The XXI century competencies intend to allow students to be better prepared to keep up with the lightning pace of modern markets and to master the preparation for their success in a rapidly changing world. In many documents from different countries, we read about diverse competencies to be developed. All these competencies are essential and are directed to prepare students for a digital society. They can be summarised in 12 relevant ones taught across disciplines: critical thinking, problem-solving, creativity, collaboration, communication, digital literacy, flexibility, leadership, entrepreneurship, civic literacy, and global awareness. Those desired outcomes of Education can only be achieved with proficient teaching and skilled students. Once developed, the students can become leaders of change, but this requires teachers that are also engaged in this process.

By using different approaches, teaching methodologies, and educational resources and believing that the rising generation will be the leaders of tomorrow, teachers can have an expert role as leaders of change. Today's youth care about environmental issues and are the first to act for humanity's well-being. They are interested in the Global Goals adopted by the United Nations in 2015 to protect the planet and develop a social and economic balance, peace, and prosperity, as they are the core of everything we do as a human society we have to ensure that all of them receive an Equal Education.

As addressed by Objective 4 (fig.1) of the United Nations by 2030, we need to:

- **“substantially increase the supply of qualified teachers**, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing states” (target 4. C)
- **“ensure that all learners acquire the knowledge and skills needed to promote sustainable development**, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and culture's contribution to sustainable development” (target 4.7).



Fig. 1 - Objective 4 of the United Nations Agenda for SD- Quality of Education. Leave no child behind.

How can teachers be leaders of change? How can students be the future generation of leaders of change? How can Geoscience Education contribute to this accomplishment?

The presentation will focus on the answers to these questions by presenting examples of geoscience experiences to promote equitable education for all and reinforce the role of teachers as leaders of change.



LENA ABRAHAMSSON

Human Work Science

Luleå University of Technology, Sweden

E-mail: lena.abrahamsson@ltu.se

Web page: <http://www.ltu.se/staff/l/leab>

EDUCATION

- Professor in Human Work Science, LTU, 2006-05-19.
- Associate professor [docent] in Human Work Sciences, LTU, 2003-03-21.
- PhD in Human Work Sciences [teknologie doktor i arbetsvetenskap], LTU, 2000-02-25.
- MSc in Industrial Work Environment Engineering [civilingenjör industriell arbetsmiljö], LTU, 1990-03-15.

CAREER

- Professor and head of subject [professor och ämnesföreträdare] in Human Work Science [Arbetsvetenskap], LTU, since 2016 (*current position*).
- Vice Scientific Leader [biträdande vetenskaplig ledare] (~20% of working time) for the strategic future area "Creaternity", LTU, since 2022 (*current assignment*).
- Dean [dekan] and vice dean [prodekan] for the faculty of Science and Technology at LTU (~60% of working time), 2016–2021.
- Professor and head of subject in Gender & Technology [Genus & teknik] at LTU, 2013–2016.
- Professor in human work science at Industrial Production Environment [Industriell produktionsmiljö], LTU, 2006–2013.
- Senior lecturer and assistant lecturer [lektor och forskarassistent] in industrial production environment, Human Work Sciences, LTU, 2000–2006.
- Visiting Research Fellow (post-doc) at Centre for Change Management, Department of Management, University of Wollongong, NSW, Australia, Aug-Dec 2001.
- PhD-student [doktorand] in industrial work environment, Human Work Sciences, LTU, 1995–2000.
- Engineering consultant at Ifa Production Development AB, 1990–1995.

RESEARCH INTERESTS

A selection of ongoing research projects:

- Innovation critical metals and mineral flows system demonstrator. 2022–2023. Vinnova.
- Roadmap for attractive, inclusive, and safe mine work. 2022–2025. Vinnova.
- Green work in a green mine – the green industrial transformation's effect on work, technology, and organisation. 2022–2025. LTU.
- EquaStream, gender equality in academia. 2022–2023. SI.
- Work organization, work environment and health & safety – research summary and analysis. 2022. Mynak.
- Gender, work, and technology in male-dominated organisations. Conclusions from the mining industry. 2020–2022. Forte.
- Mining communities – learnings and networking. 2021–2022. Vinnova.

AWARDS AND HONORS

External academic assignments (a selection):

- Member of the Swedish Agency for Work Environment Expertise's quality council [**Mynaks** kvalitetsråd], 2022–2025 (*current*).
- Member of the board for Blekinge Institute of Technology, 2018–(*current*).
- External reviewer of Malmö University's Gender Studies Collegium, 2021.
- Member of the reviewer committee of Linné University's system for quality assurance of research, 2019–2020, Swedish Higher Education Authority [UKÄ].
- Chair for the reviewer committee for the supervision and examination of Chalmers University of Technology's system for quality assurance in higher education and research, 2019–2020 and 2022, Swedish Higher Education Authority [UKÄ].
- Vice chair of the board of FORTE [Forskningsrådet för välfärd, hälsa och arbetsliv] 2016–2018, member of the board, 2013–2018.
- Member of the Swedish Work Environment Authority's advisory council [Arbetsmiljöverkets insynsråd], 2010–2019.
- Member of AFAs review committee for *occupational health and safety*, 2015–2018.

GENDER EQUALITY IN GEOSCIENCES

Lena Abrahamsson

Luleå University of Technology, Sweden

Lena Abrahamsson, professor in Human Work Science at Luleå University of Technology, will give a presentation on gender equality in geoscience – why and how? The talk will be based on her experiences from many years of research on gender equality in industry, mainly within mining industry, and especially the project ENGIE, Encouraging Girls to Study Geosciences and Engineering (see description below).

Some of the questions that will be addressed are: How is gender inequality created and recreated in workplaces and professions? How does gender inequality affect women and men? How does it affect organisations? Why do the industries and companies work with gender equality interventions? Why do we need more gender equality and gender mixing? How can male-dominated organisations and companies improve gender equality? What resistance does gender equality interventions meet? Ways forward to the sustainable and gender equal workplaces of the future?

“ENGIE – Encouraging Girls to Study Geosciences and Engineering” is an EIT Raw Materials funded project aiming to raise the interest of girls aged 13-18 for studying geosciences and related engineering disciplines. The final objective of the project is to achieve gender equality in the future of geo-sciences as well as understanding the reasons for the gender imbalance and early female disinterest in geo-sciences and creating best practices for the future.

ENGIE is implemented by the cooperation of 25 institutions. The partnership involves 3 universities (University of Miskolc, Luleå University of Technology and University of Zagreb), 2 research centres (Italian National Research Council and La Palma Research Centre) and a European-level professional geoscience organisation (European Federation of Geologists). 19 national member associations of EFG also take part in the project implementation as Linked Third Parties. By their contribution, the project activities are extended to 21 European countries.



Photo 1: Field trip in Portugal.



Photo 2: Girls take soil samples in the Netherlands.



LUIGI DE FILIPPIS

Geologist, PhD

Teacher of Science

Polo Liceale Statale "Lazzaro Spallanzani", Tivoli (Rome)

Head of the Laboratory of Earth Sciences "Renato Funicello"

luigidefilippis1@gmail.com

<https://www.spallanzanitivoli.edu.it/pagine/progetto-curvatura-geologico-ambientale>

EDUCATION

2012 PhD in Geology, Roma Tre University, Rome

2003 MSc in G.I.S. and Remote Sensing, Roma Tre University, Rome

1996 Professional habilitation in Geology

1995 MSc in Geology, Sapienza University, Rome

CAREER

2018-today: Coordinator of the Progetto Curvatura Geologico-Ambientale and of the Lectiones Magistrales Renato Funicello at Polo Liceale Statale "Lazzaro Spallanzani", Tivoli (Rome)

2000-today: Teacher of Science at Italian secondary schools

1996-2015: As professional geologist: numerous work experiences with emphasis on geologic hazard assessment, engineering geology, hydrogeology, structural geology, applied geophysics, natural resources, G.I.S. and remote sensing technologies in the use of geologic information in support of policy decisions

1999-2012: Teaching in several academic courses (geology, engineering geology, hydrogeology, geomorphology, G.I.S.) at Roma Tre University.

2010: Visiting Research Scientist at Stony Brook University and at Brookhaven National Laboratory (NY, USA).

RESEARCH INTERESTS

I'm a structural geologist mainly working on (a) neotectonics, (b) geofluids - fault interaction and (c) non-marine carbonates with special emphasis in Quaternary travertines and their relationship with tectonics and climate. I worked in Italy, Turkey and North America.

Since 2011 I teach science at Polo Liceale Statale "Lazzaro Spallanzani" (Tivoli, Italy) where I created a geologically-environmentally focused high school course, with the partnership of Roma Tre University, INGV and EGU.

PUBLICATIONS AND SERVICES

20 articles in journals with peer review, 620 citations

2 chapters in 2 books

+10 communications and posters in international and national meetings

+30 articles in outreach journals, 1 interview in Italian radio, several lectures in universities and municipality-association meetings

https://www.researchgate.net/profile/Luigi_De_Filippis

<https://scholar.google.it/citations?user=dJ91HZ4AAAAJ&hl=it>

<https://www.youtube.com/c/LuigiDeFilippis29121969>

AGENDA2030@SCHOOL: THE LICEO SPALLANZANI EXAMPLE

Luigi De Filippis

Spallanzani High-School (Tivoli, Rome, Italy)

"We've arranged a society based on science and technology, in which nobody understands anything about science technology. And this combustible mixture of ignorance and power, sooner or later, is going to blow up in our faces. Who is running the science and technology in a democracy if the people don't know anything about it?" (Carl Sagan)

How much do we know about the planet in which we live? Certainly much but not enough to face the challenges of the future. Above all, how widespread is basic science among people who are not directly involved in scientific issues? These are questions that scientists and teachers should ask themselves on a daily basis, a duty to the new generations.

As the scientific community moves forward with new discoveries there is a not inconsiderable part of society (including the mass media), which has not only lagged behind but is lagging dramatically behind in basic scientific knowledge. Even social media, and in particular their "bad" use, have a great responsibility in this regard.

Human activities have altered the planet's biogeochemical cycles and shaped the environment to the point that scientists have long wondered if we have entered a new geological era. According to the scientific community, these changes are so radical as to justify the hypothesis that today we are living in a new geological era, the **Anthropocene** (or human era). All human activities are the main drivers of environmental change.

The delicate balances of our society, already threatened by natural physical phenomena (earthquakes, volcanoes and floods) and the effects of climate change have recently been put to the test by Covid-19 and science has tried to give, once again, answers and solutions, as it has done for centuries, that is since Galileo Galilei with the *experimental method* laid the foundations of modern scientific research. Now that we are about to return to the Moon with the aim of "launching ourselves" even on Mars, Carl Sagan's phrase is more relevant than ever. Are there any useful tools to improve our "anthropogenic" society? The **Agenda 2030**, with its 17 ambitious and wonderful objectives, is one of them. One of the messages that springs from the foundations of the Agenda is: *sustainable development must guarantee the fairness and well-being of future generations*.

At Liceo Spallanzani (recently recognized by the Ministry of Education as 'Green School'), in addition to the initiatives related to Civic Education, we deepen every day some themes purely of geosciences present in the Agenda, such as climate changes, energy, water life, pure water, terrestrial life and natural risks, involving students, through projects, lectures, hands-on activities, field work and other educational initiatives, in this difficult but exciting mission. But we also realize that we are an anomaly in the Italian school landscape.

The teaching of Earth Sciences in Italian high schools, in fact, although widely provided for by current legislation, is not so obvious, indeed, it is often forgotten or relegated to very few topics that are generally treated badly and quickly, with the majority of science teachers graduated in biology. My brief contribution tries to stimulate a reflection on the situation of the teaching of Geosciences in schools.

Let me introduce the school where I have been teaching geosciences since 2011. More than 1400 students from the Aniene River Valley daily attend the Lazzaro Spallanzani Scientific High School (in Italian language: Liceo Scientifico) in Tivoli (Rome), that belongs to the eastern region of Rome's metropolitan area. About 120 teachers teach various disciplines at our school, and we have six different laboratories: Earth Science, Chemistry, Biology, Physics (with a planetarium), Informatics and Foreign Languages.

Our school was founded in 1962, and for the first 40 years our school had science teachers with a degree in biology and natural sciences, a situation that created a learning environment based entirely on biology. Since the 1990s, however, things have changed, and nowadays four of our nine science teachers are geologists with robust experience as freelance workers and as university researchers. I joined this team for the 2011-2012 school year after receiving my PhD in Geology at Roma Tre University.

Since then, I have been working to strengthen the teaching of geosciences with my colleagues Felice De Angelis and Tomaso Favale (now retired) who had already done much to improve the Earth Sciences department, including the seismic station that they planned and built in 2010 (<https://lnx.spallanzanitivoli.edu.it/stazionesismica/>).

The three of us have alternatively taken part in the 2006, 2007, 2008, 2010, 2012 EGU-GIFT editions. Another badge of honor is surely our Earth Sciences laboratory with the associated geology museum dedicated to Professor Renato Funicello (<https://www.facebook.com/geologicaliceospallanzani/>), a dynamic place for sharing knowledge, learning, and performing scientific experiments that are very useful for our young people to build a global awareness as inhabitants of the Earth. Every year we organize the *Lectiones Magistrales Renato Funicello* (LMRF), a series of lectures much appreciated not only by our students but also by the whole city. Every year LMRF give teachers from other institutions a chance for cultural growth and professional development.

The scientific, educational and informative value of the LMRF has meanwhile been recognized by the European Geosciences Union (EGU) which has decided to sponsor the opening conference the 2019-2020 school year. That edition of the LMRF was opened by Prof. Cristina Persano, professor and researcher at the University of Glasgow. The numerous speakers over the years have told us about the latest achievements on the knowledge of the Earth and the Universe, also through the reconstruction of its past, present and future scenarios. Starting from the Big Bang, through a journey of billions of years, our students were introduced to the most important topics and questions (which are also theirs) that concern our wonderful discipline and those close to it (chemistry, physics, planetary science, biology, etc.): How did the Universe begin? And the Solar System? How was life born and how did it evolve? How and when did plate tectonics begin? How do mountains start and die? How and why does the Earth's climate change? What are the major repercussions of the global warming on life? What is the role of Homo Sapiens in all this?

After several participations in international projects and courses on geology, geodynamics, educational seismology (not least at the Corinth Rift Laboratory School in Greece in 2022) and, most of all, the general lack of understanding of scientific culture and technology in modern society I decided to devote all my efforts as a teacher-geologist to create a field of study that attracted even more my students for their cultural growth helping them to become aware and responsible citizens.

So, in 2018, I decided to start working with the principal of my school, Dr. Lucia Cagiola, to develop a Geologically and Environmentally Focused Science High School, an idea that had already emerged in several meetings and discussions with Professors Francesca Funicello and Francesca Cifelli from Roma Tre University.

With a curriculum focused on geological and environmental subjects, we wish to become the lead school in the country for this ambitious project, with an important scientific support from the Science Department at Roma Tre University.

The students following this curriculum are in a third-year class belonging to the Applied Sciences High School. They follow a dual training system (learning and working) called "Dynamic Mediterranean" ("Mediterraneo Dinamico") that I have developed for the last four years with Dr. Tullio Ricci, researcher at INGV (National Institute of Geophysics and Volcanology). At the end of the school year the students attend a school camp (before the Covid-19 pandemic we were at the Elba Island and Aeolian Isle of Stromboli).

In the past years I have been working on a project for the eTwinning platform with my colleague Fotis Danaskos (Chalandri Gymnasium, Athens), whom I met at the CRL School 2018 in Nafpaktos. The name of the project was "Italia-Hellas, una faccia una razza. Same geology, same geohazards!". As a result of this collaboration we have twinned our schools and in May 2022 Mr. Danaskos with some colleagues and students came to Italy with an Erasmus+.

We truly believe that the example of our geology-focused course of studies in partnership with EGU, Roma Tre University and INGV may represent an important contribution to relaunch the teaching of Earth Sciences in the Italian and European school systems.

We believe that the new generations that we educate will raise awareness among the whole population about the geological risks and on the correct political choices to put into practice in order to protect the environment and life on Earth in general.



ANTONIJA BOGADI

Ph.D., Resilient urban and regional development

SYNYO GmbH, Vienna, Austria

antonija.bogadi@synyo.com

<https://www.antoniabogadi.com/>

- Social-ecological resilience scholar and advocate with 15 years of experience in creating forward-thinking research methods, strategies, plans, and educational materials for fair and greener cities and regions
- Instrumental in connecting insights from transdisciplinary resilience research with the decision-making support for policymakers, industry, and NGOs, related to Nature-based Solutions, Citizen Participation, Climate Adaptation, Governance, and Knowledge Management
- A sincere and self-motivated problem-solver dedicated to bridging the needs and expertise of involved actors toward implementing actionable solutions, thereby earning the trust, respect, and motivation of peers and stakeholders.

EDUCATION

- Doctor in Urban and Regional Studies-Technical University Vienna, Austria 2015 - 2020
- MSc. BSc. Architecture and Urban Planning, Zagreb University

WORK EXPERIENCE

- Green Projects for Europe Research and Development Department Head, SYNYO GmbH, Vienna, Austria | 2021 – present.
- Urban resilience researcher and university lecturer, Institute for Urban and Regional Research and Planning, Technical University Vienna, Austria | 2015 – 2021.
- Sustainable urban development researcher and senior lecturer, Faculty of Civil Engineering, UNIN University, Croatia | 2011 – 2015.
- NGO Executive, DAV - Association of Development Planners Croatia | 2013 – 2016.
- Architect and Urban Planner, Architecture and urban planning studio Brakus | 2008 – 2010.

THE CIRCULAR CITY CHALLENGE PROJECT

Antonija Bogadi

SYNYO Gmbh, Vienna, Austria

Research on education for sustainable development has shown that teaching sustainability and circularity is a challenge. It requires changing current disciplinary and subject-focused teaching towards systems thinking to understand the “bigger picture” of drivers, barriers, and solutions in societal, economic, and environmental aspects.

The Circular City Challenge project (<https://project.circularcitychallenge.eu/>) will set up a pan-European competition for students aged 16-18. The competition will be launched in April 2023. Through the competition, the consortium will collect submissions providing creative and novel ideas for circular city approaches. The challenge invites young people to submit their ideas for a sustainable future in their own environment while at the same time educating them on the topic of sustainable development. This approach will have a threefold effect: (i) the project will improve education for sustainable development through understanding the value of a competition-based approach, (ii) the project will support students to develop their ideas with local stakeholders while taking into account global complexity and relationships of resource use, and (iii) through fresh ideas and approaches, cities and industry may improve their resource use and waste management strategies for the common good.



STEPHEN MACKO

Professor

Department of Environmental Sciences

University of Virginia, Charlottesville, VA USA

sam8f@virginia.edu

434-924-6849

<https://evsc.as.virginia.edu/people/profile/sam8f>

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 foraminifera 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.

EVALUATING PAST CLIMATES THROUGH ANALYSIS OF MARINE MICROFOSSILS AND THEIR ISOTOPE COMPOSITIONS

Stephen Macko
EGU Education Committee

Fundamental to the evaluation of past climatological history of the Earth is the acquisition of a record of that history that is comprehensive, sensitive to the small scale perturbations and remaining accurate. Few records exist for such a powerful tool that can be invoked and which encompasses a global scale. Marine sediments are in fact one of the most complete records of the history of the Earth. Information can be gleaned from marine sediments on changes in oceanic climate, productivity and circulation through evaluation of the nearly continuous record obtained from cores of the muds from the bottom of the ocean. Marine sediments preserve a variety of chemical signals and microfossils, which are an archive of past oceanic environments. The assemblage of fossil floral and faunal remains, together with their chemical and stable isotope compositions have successfully been utilized to obtain a comprehensive history of the Earth and its Oceans (A “history book of the Earth”) . Multinational, international drilling programs and coring operations of the last and current century, including the DSDP, ODP and IODP have been a foundation for establishing a library for these “history books of the Earth”. dedicated to the inventory of sediments and microfossils for all oceans. With the initiation of various national and international drilling programs sediment cores have been systematically recovered from all ocean basins and since then have shaped our knowledge of the oceans and the Earth’s climate history. An appreciation for perhaps the key organism in this research and the focus in this hands-on activity of this GIFT are foraminifera (commonly called “forams”). Foraminifera skeletons accumulate on the seafloor and their calcium carbonate remains are buried in the sediments. Micropaleontologists carefully isolate the tests (Figure 1) from the cores that can be more than a hundred meters long. Forams are single-celled planktonic organisms (Figure 2) that can live in the photic zone (the upper part of the water column which permits photosynthesis) of the marine environment and float (planktonic foraminifera) or they can live on the bottom on the seafloor (benthic foraminifera). The tests are commonly calcium carbonate (CaCO_3) and can have many shapes ranging from spherical to conical to spiral, growing continuously with new chambers as the organism grows. The deeper the core goes, the sediments will be older and consequently it will be possible to read further into the past climate. The samples taken from the core are washed, dried before analysis and identified microscopically.

Living foraminifera are sensitive to in the water column changes (Figure 3) and are excellent indicators for the climatic history of the Earth. The formation of the tests is affected by the state of marine environment, and therefore can provide information on past temperature, salinity, pH and CO_2 of the water. Different species of planktonic foraminifera are adapted for living under different climatic conditions and can be grouped into assemblages that define the polar, temperate, and tropical regions. Sea-surface temperature appears to be one of the most important factors controlling assemblage composition. It becomes clear that knowing the species present in the sediments, it is possible to have an insight on the climatic conditions present in that area in the past. For instance, the morphology can reflect water temperatures: smaller shells are often associated with colder conditions and coiling direction can be associated with temperature changes. The oldest layers are on the bottom of the core, and the layers are progressively younger going upward. Once the forams are separated from the sediment layers in the core, they can be analyzed for their relative proportions of left and right coiling tests. The higher the percentage of right-coiling tests, the warmer the ocean temperature at the time that sediment layer was deposited. Lower in the

core is older sediment; higher in the core means younger or more recent sediment. If the forams have a lower percent right coil (more left coil), then this means a colder Ocean water temperature.

One of the most important applications of forams is that by the measurements of the oxygen isotopes on their shells (using a mass spectrometer) it is possible to understand in a relatively precise way the temperatures the animal lived at. The oxygen isotope ratio ($\delta^{18}\text{O}$) of test calcite is frequently used to reconstruct aspects of their environment. The $\delta^{18}\text{O}$ of the calcite depends mainly on the isotope composition of the water it is precipitated from, the temperature of calcification, and somewhat the carbonate ion concentration. Foraminifera and other organisms can potentially preserve their original isotope composition for many millions of years, although some depositional processes can alter the values. Work on oxygen isotope content of foraminifera has been important in the discovery of the theory of the ice ages and continues to be widely used in the study of modern climate change. Compilations of deep sea foraminifera oxygen isotopes have revealed the long history of global climate change over the past 100 million years (Figure 4). Planktonic foraminifera oxygen isotopes are used to investigate the history of past sea surface temperatures, revealing the extent of past 'greenhouse' warming and global sea surface temperatures. Used in combination, Foraminifera species, morphology and isotope composition increases the power of this incredibly important tool for "reading the history book of the Earth" (Figure 5).

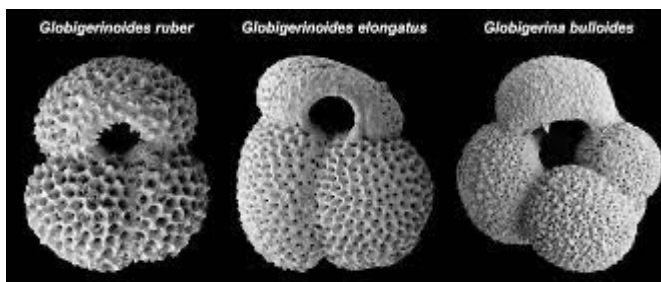


Figure 1. Specimens (tests) of recovered foraminifera from a sedimentary core

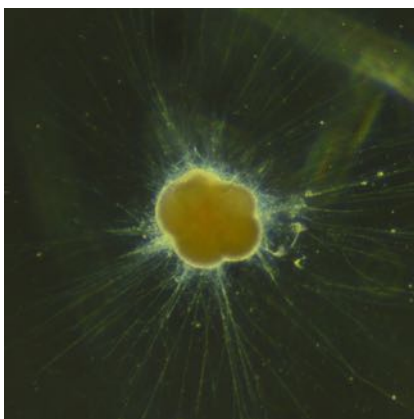


Fig 2. Living foraminifera

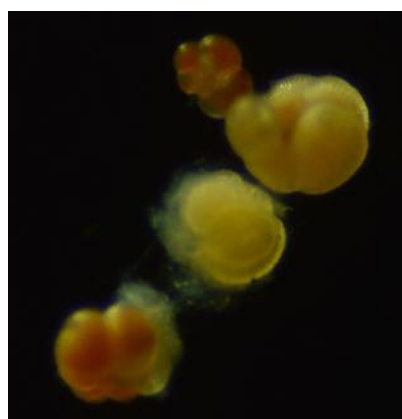


Fig. 3. Warmer water live foraminifera *O. universa*

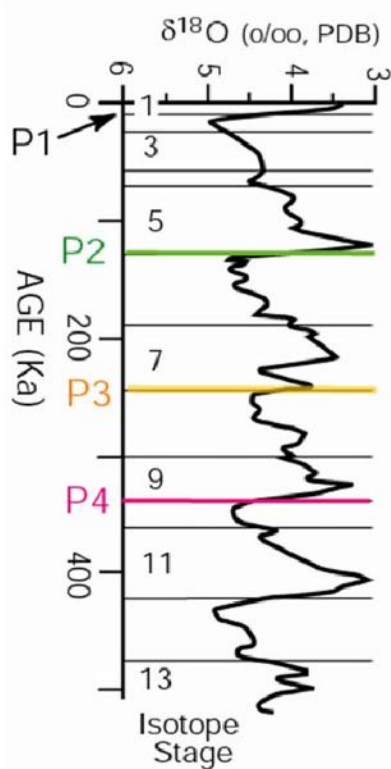


Fig. 4. Commonly seen downcore variations in foraminiferal $\delta^{18}\text{O}$ isotope signals with depth. Numbers indicate isotope stage. e.g. 1 is current interglacial.

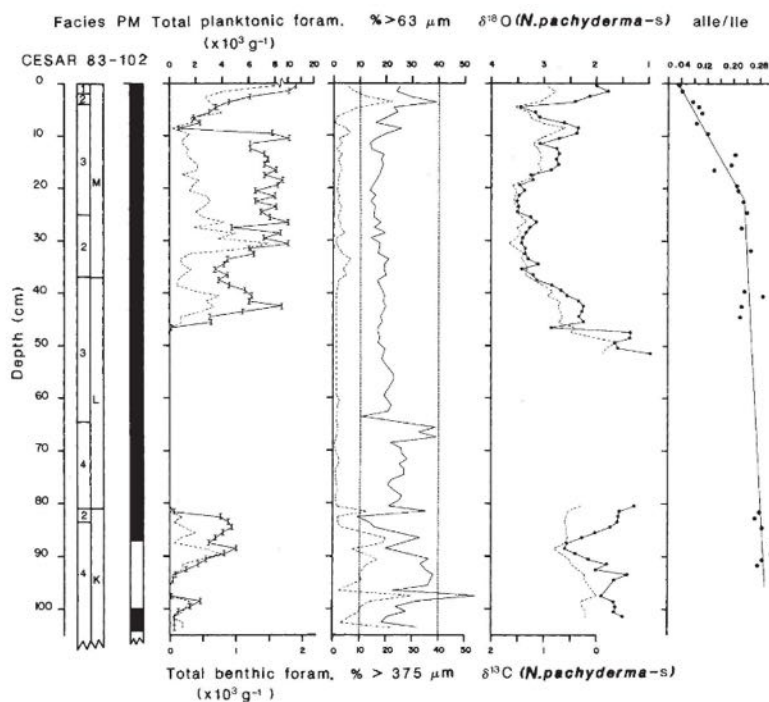


Fig. 5. Arctic Ocean sedimentation rates using foraminifera (Macko and Aksu, 1986)



GIULIANA PANIERI

Professor

UiT – The Arctic University of Norway

Department of Geosciences

giuliana.panieri@uit.no

EDUCATION

2020	Oxford Executive Leadership Programme, Saïd Business School, University of Oxford (UK)
2001-2003	Research Post-Doctorate in Micropaleontology, University of Bologna (IT)
2001	PhD in Paleontology, University of Modena and Reggio-Emilia (IT)
1996	BSc in Geology, University of Bologna (IT)

CAREER

2019-now	Professor in Geology, UiT (NO)
2019-2022	General Secretary (elect) of European Geosciences Union, EGU
2016-2020	President (elect), Division on Biogeosciences (BG) of European Geosciences Union, EGU
2016-now	Adjunct Scientist at WHOI, Woods Hole Oceanographic Institution, Woods Hole, MA (USA)
2013-2019	Associate Professor in Environment and Climate, UiT (NO)
2010-2013	Research fellow, Institute of Marine Sciences - National Research Council ISMAR CNR (IT)
2001-2010	Associate researcher at Institute of Marine Sciences - National Research Council I SMAR CNR and Department of Earth Science, University of Bologna (IT)
2001 -05 -10	Independent consultant in micropaleontology (Offshore Denmark, N Apennines, W Africa)

RESEARCH INTERESTS

Mainly interested in using micropaleontology and geochemistry to study marine extreme environments (cold seeps, gas hydrate and hydrothermal vents) and for paleoenvironmental reconstructions. She seeks to answer questions regarding the timing, periodicity, and intensity of methane emissions with the final goal of assessing their evolution through time and understanding possible connections to climate change.

PUBLICATIONS AND SERVICES

Giuliana Panieri is the author and co-author of 60 scientific publications in international journals and books and more than 300 presentations at international scientific conferences. She has been involved in EGU since 2016 as President of Biogeosciences Division, member of the Outreach Committee, member of the executive as General Secretary and since 2022 she is a member of the Education Committee.

A VIRTUAL REALITY EXPEDITION ON BOARD: THE RESEARCH VESSEL KRONPRINS HAAKON

Giuliana Panieri

The Arctic University of Norway

Have you ever dreamt of sailing into the Arctic and participating in a research expedition? Have you ever wondered how scientists live and work when out at sea? If so, then look no further and check out the new virtual research expedition developed aboard of the Norwegian Research Vessel Kronprins Haakon (Fig. 1). The virtual reality expedition was filmed with a 360-degree camera, allowing the participant to move around the ship at will. Plus (+) icons indicate an information bubble about the equipment, types of analyses and general day-to-day life aboard the vessel. Interviews with crew and scientists are also available. This education tool is reusable - for teachers, students and anyone who wants to know what it is like to be a scientist on an Arctic research expedition. The virtual cruise (DOI [10.18710/PO8PD1](https://doi.org/10.18710/PO8PD1)) was developed in the framework of the AKMA project (project number 287869).



Fig. 1. The Research Vessel Kronprins Haakon



BERENGUER JEAN-LUC

Science Teacher – EGU Education team member
GEOAZUR Laboratory (University Côte d’Azur), France
berenguer@unice.fr

EDUCATION

Science Teacher (Biology and Geosciences) in France.
Agrégation ‘Biology-Geology’ (University Aix Marseille)

CAREER

since 2022 EGU Committee of Education Chair
since 2017 EduMed Observatory project leader - University Côte d’Azur
2017 IESO 2017 FRANCE - Organization Committee President
2014 - 2022 InSight Education project leader in France
2006 - 2017 French educational seismological network leader
since 1996 Education & Outreach team – UMR Geoazur, University Côte d’Azur
1994 - 2019 Science teacher – International High School Valbonne, France

RESEARCH INTERESTS

As a science teacher, I am interested in the link between science and society, and in the importance of disseminating scientific culture to the general public and more particularly to school children. I had, since 25 years, the opportunity to set up various educational projects whose objectives were to bring together the world of Research and Education around the geosciences.

PUBLICATIONS AND SERVICES

Berenguer, J-L., Book, SISMO Collector, DDTM 06, 2020
Berenguer, J-L., Balestra, J., Jouffray, F., Mourau, F., Courboux, F., and Virieux, J.: 25 years of seismology at school in France, Geosci. Commun. Discuss., <https://doi.org/10.5194/gc-2020-32>, 2020.
Balestra J., Berenguer J-L., F. Bigot-Cormier, F. Courboux, L. Rolland, D. Ambrois, M. Van Driel, and P. Lognonné (2020) The InSight Blind Test: An Opportunity to Bring a Research Dataset into Teaching Programs, SRL - doi: [10.1785/0220190137](https://doi.org/10.1785/0220190137). Volume 91, Number 2A, March 2020
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](https://doi.org/10.1785/0220160121) , 2017
Berenguer J-L. et al., Tuned into the Earth from the school EduSismo: French educational seismological network, Bull. Soc. Géol. de France, 184, 183, [10.2113/gssgfbull.184.1-2.183](https://doi.org/10.2113/gssgfbull.184.1-2.183), 2013.

Awards and honors



French ‘Palmes Académiques’ Officer (2018)

SOME EXAMPLES TO ADDRESS GEOSCIENCES STUDIES AT SCHOOL WITH ONLINE DATA

Jean-Luc Berenguer

GEOAZUR Education & Outreach – University Côte d’Azur

Whether from the atmosphere or from the dynamics of the earth's crust, populations are exposed and vulnerable to brutal and violent episodes and events.

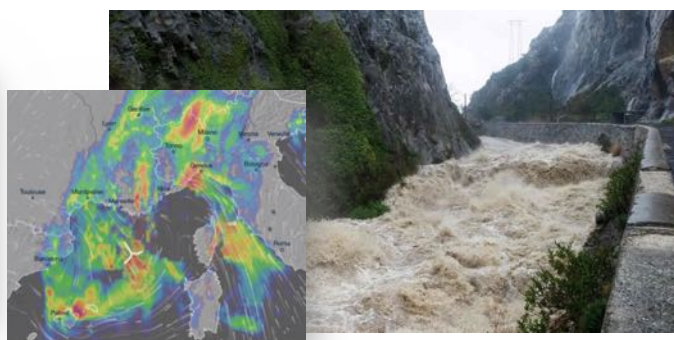
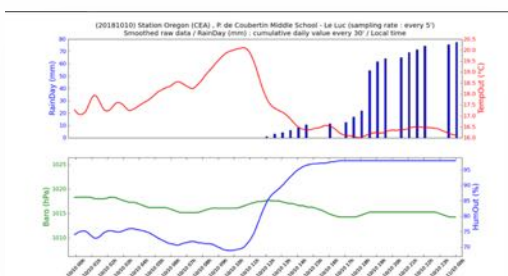
This is the case of Mediterranean climatic episodes.

Mediterranean episodes are violent thunderstorms caused by upwelling of warm and humid air from the Mediterranean, which meets cold air masses from the northwest. Usually, these Mediterranean episodes occur in September-October, when the sea is warmest, which favours strong evaporation.

This meeting of hot air masses with cold air masses is blocked on the main massifs (Alpine foothills) which form a basin effect.

There, violent storms are triggered. The thunderstorms that arise from this confrontation are often stationary, blocked by these massifs. It is then a series of thunderstorms that follow one another over a given area for 12 to 36 hours with very high rainfall totals. They pour 150 to 300 millimetres of water in a few hours, whereas a thunderstorm causes about 50 millimetres of water. Such a large amount of water in such a short period of time has important hydrological consequences with floods, accentuated by the fact that the arid soils are unable to absorb these quantities of water.

Most of these Mediterranean lows on record have formed in the area bounded to the west by the coasts of Spain, to the north by the coast of France, to the east by the island of Corsica and to the south by the shores of Algeria. The most intense of these are called ‘Medicanes’.

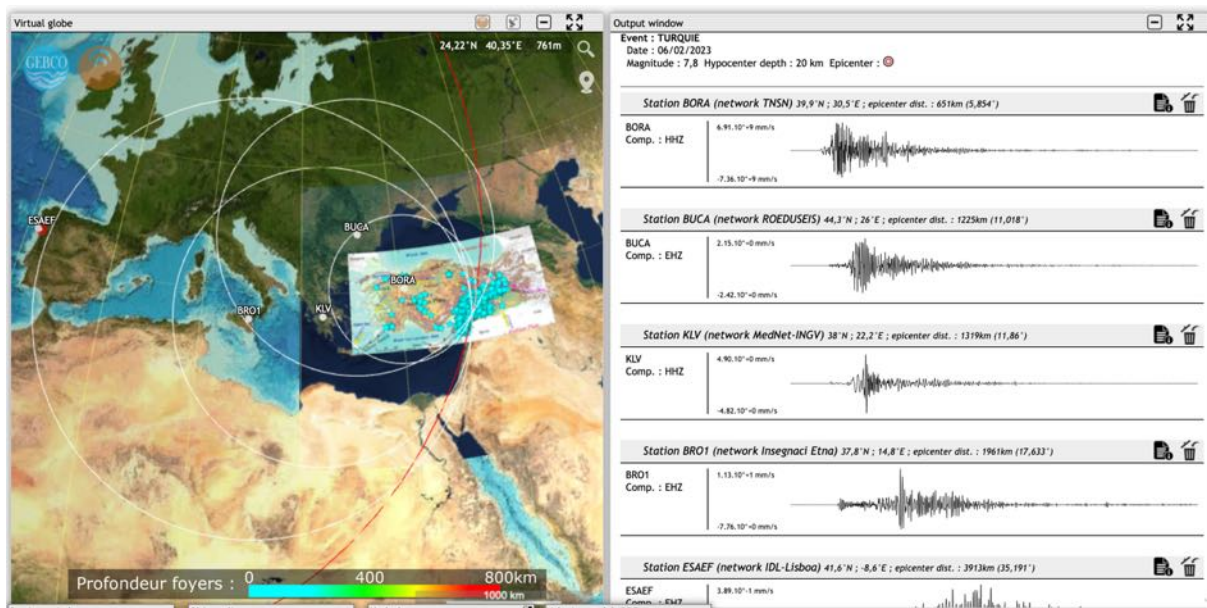


Mediterranean weather episode

This is also the case for earthquakes whose magnitude and location constitute a real risk because of the populations exposed to this hazard.

On 6 February, two earthquakes along the Anatolian Fault shook the populations of southern Turkey and Syria. In this densely populated region, which is also criss-crossed by numerous faults, the seismic risk is very high. The damage is even greater when the event occurs at night or affects buildings that are not very resistant to vibrations.

These two seismic events have been widely recorded in Europe. The data available online can be used to build knowledges to understand earthquakes with students.



Seismic event – 2023 February 6th – Magnitude 7.8

This hands-on workshop presents examples of a case study that can be conducted in the classroom with students, using online data.

This 'data mining' exercise allows students to combine meteorological (rain!), hydrological (rivers!) and geological (the undergroundwater system!) data to understand the dynamics of these phenomena that are potentially responsible for floods and disasters... phenomena that are becoming more frequent and intense with the warming of the Mediterranean.

It will also be an opportunity to look back at another natural hazard with the case of the very recent 6 February earthquake in Turkey/Syria.



JARMO SYBREN KIKSTRA

Institute for Applied Systems Analysis (IIASA)
Laxenburg, Austria
kikstra@iiasa.ac.at

Jarmo Kikstra is a researcher in the IIASA Energy, Climate, and Environment Program (ECE), and a PhD candidate at the Grantham Institute and the Centre for Environmental Policy of Imperial College London. His main scientific research interest is in how to simultaneously model future achievement of climate mitigation and the eradication of poverty in all its forms, with a focus on minimum energy requirements. He was awarded an MSc degree (2019) in Climate Change from University College London, UK, and holds a BSc degree (2018) in Technology, Liberal Arts, and Sciences from the University of Twente, The Netherlands. In 2022, he received the Award for Early Career Researcher from the Integrated Assessment Modelling Consortium.

His research is interdisciplinary, with a main scientific interest in the integrated assessment of scenarios of climate change and the linkages to a broader suite of sustainable development and human wellbeing objectives. In his research he brings together human well-being and climate change through energy. This work is a continuation of the Decent Living Energy project, which aims to gain insight into the present state of multidimensional poverty from a basic needs perspective, its relation to energy requirements, and the implications for climate mitigation pathways.

In addition to the above, Jarmo has contributed to several international reports. As a contributing author to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, Jarmo coordinated the climate runs for the mitigation scenarios for Working Group III, and did similar work for the 2022 UNEP Emissions Gap Report.

THE ROLE OF ENERGY IN SUSTAINABLE DEVELOPMENT

Jarmo Kikstra

Imperial College London

Eradicating poverty and avoiding ecological breakdown are both linked to energy use. The energy sector is the largest contributor to global CO₂ emissions, and thus energy is currently tightly linked to climate change. The crucial role for development has also been recognized in the Sustainable Development Agenda, which features a separate goal for clean and affordable energy.

In this lecture, we will take a holistic look at energy, by looking both at how it is produced, but also what it is currently used for.

On the production side, we will look into the potential for reducing greenhouse gas emissions on the way towards net-zero. There are multiple different options for the energy transition, each with their own characteristics such as costs, energy production potential, and side-effects potentially benefiting or limiting other sustainable development goals (including land-use and water issues).

On the side of the user, we will look into the minimum energy requirements for supporting basic needs and eradicating poverty. The good news from recent research is that essential energy needs to meet everyone's basic needs, framed as "decent living standards", are multiple times lower than the current total energy used globally. For many poor countries, however, growth remains inevitable and urgent – leading to a discussion on what future pathways are compatible with both stimulating global development and halting climate change.



FINK, ANDREAS H.

Professor of Meteorology

Institute of Meteorology and Climate Research,
Karlsruhe Institute of Technology, Karlsruhe, Germany

andreas.fink@kit.edu

https://www.imk-tro.kit.edu/14_5585.php

EDUCATION

1991 Diploma in Meteorology, University of Cologne, Germany
1995 PhD in Meteorology, University of Cologne, Germany
2004 Habilitation in Meteorology, University of Cologne, Germany

CAREER

since 10/2013	Professor, KIT, Karlsruhe, Germany
10/2011- 09/2013	Professor, Univ. of Cologne, Germany
09/2004-09/2011	Associate Professor, Univ. of Cologne, Germany
11/1995-08/2004	Postdoc at Univ. of Cologne, Germany

RESEARCH INTERESTS

- Mid-latitude weather and climate dynamics
- Weather predictability and climate projection of extreme events (Heat Waves, Floods, Storms)
- Monsoons, tropical waves and cyclones, tropical waves
- Weather and climate of Africa

PUBLICATIONS AND SERVICES

ca. 130 peer-reviewed journal publications (>3500 citations, h-index 36 (Web Science))

- [01] Lemburg, A and A. H. Fink, 2022: Identifying causes of short-range forecast errors in maximum temperature during recent Central European heatwaves using the ECMWF-IFS ensemble. *Wea. Forecast.*, doi: 10.1175/WAF-D-22-0033.1.
- [02] Becker, F. N., A. H. Fink, J. G. Pinto, and P. Bissolli, 2022: Towards a more comprehensive assessment of the intensity of European heat waves (1979-2019). *Atmos. Sci. Lett.*, e1120, doi: 10.1002/asl.1120.
- [03] Fink, A. H., T. Brücher, A. Krüger, G. C. Leckebusch, J. G. Pinto, and U. Ulbrich, 2004: The 2003 European summer heat waves and drought – synoptic diagnosis and impacts. *Weather*; 59 (8), 209-216, doi: 10.1256/wea.73.04.

AWARDS AND HONORS

Jan. 2022	Fellow of the American Meteorological Society
May 2015	Vaisala Award for Observing & Instrumentation, Royal Met. Soc., U.K.
June 2008	Gordon Manley Weather Prize, Royal Met. Soc., U.K.

THE PREDICTABILITY OF EUROPEAN HEAT WAVES

Andreas H. Fink

Karlsruhe Institute of Technology, Karlsruhe, Germany

Heatwaves are one of the most dangerous natural hazards worldwide and can lead to tens of thousands of premature human deaths, as for instance in central Europe in 2003 and western Russia in 2010. They are often preceded and accompanied by drought conditions, leading to a compound extreme event with far-reaching aggregated impacts ranging from drought-inflicted forest mortality and reduction in agricultural yields to increased wildfires. In Germany, the summer of 2018 was such a compound heat and drought event, potentially only rivalled out by the recent hot and dry summer 2022. The last IPCC 6th Assessment Report concluded that it is virtually certain that heat waves have become more frequent and more intense since the 1950s and that every additional 0.5°C of global warming leads to discernible increases in the intensity of heat waves. So, this hazard is expected to become worse in the future.

In order to take anticipatory action, reliable early warnings of heat waves are necessary at time scales of more than 3 days up to a few weeks. However, in general the uncertainty in the weather forecast inevitably increases with forecast lead time. To assess this uncertainty in a given forecast situation, meteorologists calculate, for example, the spread, i.e. the difference of the forecasted maximum temperature, among the different ensemble members of a forecast; the latter are, for example 50 15-day long weather forecasts of the same model, but with different initial conditions and perturbed physics. The growth in uncertainty in this ensemble with forecast time is dependent on the meteorological flow situation not only over Europe, but also far away over the North Atlantic and North America in the days leading to the extreme heat over Europe.

With our research we aim at improving the understanding of the chain of meteorological processes that lead to extreme heat waves over Europe, how they are represented in models used in weather forecast and how the predictability evolves with lead time in these models. We particularly aim at understanding the predictability of heat waves from a few days to 2-3 weeks in general, but also under which weather constellation the predictability is anomalously high or low. One overall goal is thus to improve early warnings and early action for European heat waves in the summers to come. In addition, the process understanding of present-day heat waves also helps in better projecting heat waves in the next decades which will by far supersede the amplitude of recent European heat waves.

AN EXPEDITION IN THE ARCTIC OCEAN TO PROMOTE THE SUSTAINABLE DEVELOPMENT GOALS

Giuliana Panieri

The Arctic University of Norway

AKMA-OceanSenses Research Expedition (11-23 May 2022) aboard the research vessel Kronprins Hakon to the Barents Sea and the Arctic Ocean focused on science and education. The scientific topic of the expedition focused on extreme environments such as natural methane seep sites - where environmental stressors affect biological communities and produce peculiar seafloor features. Combining newly acquired data with the already available data would increase our ability to understand the present and predict the future.

The participants on board included scientists, artists, social scientists, musicians, lawyers, members connected to the Indigenous community, university students and school teachers. Most of the participants had never done anything like this before. Schools and scientists from Norway, Italy, France, Iran, Portugal, Brazil, Tanzania and Botswana could join the expeditions via video call, moving towards decolonising science and making discovery accessible to all.

During the expedition, the participants on board have developed prototypes that will be used to teach different aspects related to “oceans”. The ocean is something distant and abstract for most of us. Through this project, we want to foster ocean literacy promoting the achievement of the Sustainable Development Goals (SDGs) and the implementation of 2030 Agenda developed by the United Nations and adopted by most countries in the world. This expedition received endorsement from the UN Ocean Decade.

(Giuliana Panieri CV is at page 33)



Daniela Neumann
Project manager
Science on Stage Germany
www.science-on-stage.de
d.neumann@science-on-stage.de

INTERESTS

Digital and coding education
Data literacy in STEM education
Education for Sustainable Development

PUBLICATIONS AND SERVICES

Co-Editor of teaching material
Football in Science Teaching (<https://www.science-on-stage.eu/football-in-science-teaching>)
Coding in STEM Education (<https://www.science-on-stage.eu/material/coding-in-stem-education>)
Act Now for the UN Sustainable Development Goals – SDGs in STEM Education
(<https://www.science-on-stage.eu/act-now-sdg>)

HOW TO INTEGRATE THE SDGS IN STEM LESSONS NEW TEACHING MATERIAL WITH HANDS-ON EXAMPLES

Daniela Neumann

Science on Stage Deutschland

Sustainability and environmental protection topics are important for students throughout Europe. How we deal with these issues will shape our future. Motivated and skilled teachers are key to enabling students to meet the challenges of tomorrow.

In the Science on Stage project “Act Now for the UN Sustainable Development Goals”, 20 teachers from 12 countries have worked for over two years and developed concrete hands-on examples with practical instructions on how to integrate the 17 SDGs into STEM lessons, covering various topics such as smart cities, responsible production and consumption, and climate change. The free online material includes many different elements, such as videos, code tutorials, and interactive worksheets.

Science on Stage is the European network of and for science teachers. From more than 30 countries we bring together STEM teachers with outstanding teaching ideas and offer them the opportunity to learn from each other through training courses, the development of teaching materials and competitions. More information at www.science-on-stage.eu.



BJÖRN RICHTER

Editor of Cartography
Westermann Textbook Publishers
Georg-Westermann-Allee 66
38104 Braunschweig / Germany
bjoern.richter@westermanngruppe.de
www.diercke.de
www.diercke.com
www.westermanngruppe.de

EDUCATION

1972-1985: Primary and secondary education, 1985 Abitur at Idar-Oberstein Gymnasium
1987-1995: Tertiary education at Bonn University, 1995 Diploma degree in Geography (major),
Political Science and International Law (minors)
1989/90: Exchange student at University of Tennessee, Knoxville/USA, Fulbright scholar
1991/92: Erasmus student at University College London

CAREER

1985-1987: Civil service at a social organization for elderly and people with special needs
Summer 1990: Internship at the United Nations, New York
1995-1997: Project manager at the Cologne Chamber of Industry and Commerce for the compilation
and production of an Atlas on commercial/industrial development sites in the Rhineland region
Since 1997: Editor of cartography with Westermann textbook publishers
2001: Summer teacher for GIS at the Instituto Tecnológico y de Estudios Superiores de Monterrey
(ITESM) in Mexico City

PROFESSIONAL INTERESTS

Geographic information systems in education, population geography/demography, statistical maps,
English and Spanish speaking countries in general

HOW TO USE DIGITAL MAPS OF THE DIERCKE INTERNATIONAL ATLAS TO DEVELOP SDG AWARENESS IN THE CLASSROOM

Björn Richter

Westermann Textbook Publishers

The maps included in the print version of the Diercke International Atlas (see www.diercke.com) can also be displayed and edited in a digital format as part of the Diercke Atlas app. The app separates different layers of a map, similar to a geographic information system, and makes it easier for students to focus on specific topics of the many thematical layers which are usually merged in the printed map. In this context map names and texts can be switched off in order to create completely or partially silent maps. Also, the app allows to put two maps from different atlas pages on the screen, to adjust both scale and map window separately or in synchronicity and thus to focus on and to compare regions and topics in a way the printed atlas version cannot make possible.

In all, the workshop intends to present the main features and functions of the Diercke Atlas app as well as the map content under specific consideration of SDG awareness in the classroom. Also, participants will have the opportunity to perform some individual steps in the app and find their way around under the guidance of small tasks and assignments, related to one or two specific SDGs embedded in a not fully developed but touched on teaching unit.

EGU Field Officers Team



Gina P. Correia

EGU Geoscience
Education Field Officer
for Portugal

gina_maria@sapo.pt
<https://orcid.org/0000-0002-0269-7564>

Gina P. Correia, MSc in Environmental Education and PhD in Geology, has been a Biology and Geology teacher at lower and upper secondary school for over two decades.

She is also a teacher trainer, integrates the research group 'Earth Dynamics' of the Earth and Space Research Centre, University of Coimbra (CITEUC), and is a EGU Education Committee member.

Since 2019, she is EGU Geoscience Education Field Officer for Portugal.



Xavier Juan

EGU Geoscience Education
Field Officer for Spain

xjuan03@gmail.com

Xavier Juan has been a secondary teacher for 37 years. He is a Mentor of the Spanish Olympic Team in the IESO and member of the International Group of the UK ASE (Association for Science Education).

He is also involved in the training of science teachers, especially through the Teachers' College of Catalonia.

Since 2019 he is EGU Geoscience Education Field Officer for Spain.



Giulia Realdon

EGU Geoscience
Education Field Officer
for Italy

giulia.realdon@unica-m.it

Giulia Realdon, BSc in Biology, MSc in Science Communication, PhD in Earth Sciences Education, has been teaching Natural Sciences in high school for many years.

After retiring, she is working in education research within the University of Camerino, EMSEA – European Marine Science Educators Association and EuroScitizen COST Action, in non-formal science education and in teacher training.

Since 2019 Giulia is EGU Geoscience Education Field Officer for Italy.



Guillaume Coupechoux

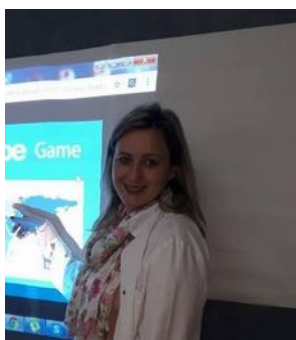
EGU Geoscience Education
Field Officer for France

gcoupechoux21@gmail.com

Guillaume Coupechoux, MSc in Biology and Geology has been teaching these subjects in French schools abroad and now he is *Inspecteur Education Nationale - Circonscription de Gex*. He is also working at the organization of sciences events and is involved in the training of primary teachers.

Since 2019, Guillaume is EGU Geoscience Education Field Officer for France.

EGU Field Officers Team



Almida Cercizaj

EGU Geoscience
Education Field
Officer for Albania
cerciziida@yahoo.it

Almida Cercizaj, MSc in teaching and learning, has been teaching in primary school and now is principal of her school. Scientix and eTwinning Ambassador for Albania, teacher trainer, MIE for Microsoft, Teach Pitch Instructor, NSC for Science on Stage.

Lately she is graduated as School Evaluator. Since 2022 Almida is EGU Geoscience Education Field Officer for Albania.



Pete Loader

EGU Geoscience
Education Field Officer
for the UK
peteloader@yahoo.co.uk

Pete Loader, FGS, BSc in Geology, is a retired secondary school geology teacher. He is the chair of A-Level geology examiners in the UK and a member of the Earthlearningidea team. He is geoscience teacher trainer for the Earth Science Teachers' Association and the Geological Society of London. Since 2022 Pete is EGU Geoscience Education Field Officer for the UK.



Candan Kafalı

EGU Geoscience
Education Field
Officer for Türkiye

candan26.ck@gmail.com

Candan Kafalı has been a secondary school science teacher for 14 years. She is a member of the Geoscience Education Working Group (YEÇG) and organizes scientific events and projects in Çanakkale, Türkiye. She is also Scientix Ambassadors to European Schoolnet Academy since 2020.

Since 2022 she is EGU Geoscience Education Field Officer for Türkiye.



Dragos Tataru

EGU Geoscience
Education Field Officer
for Romania
dragos@infop.ro

Dragos Tataru, Dr. Eng., is a researcher at the National Institute for Earth Physics (NIEP) in Romania, also engaged in outreach and training. With a Geophysics degree, he has worked in seismology research and has led national educational projects and international education programmes. Experienced in disseminating research, he also organizes workshops for children, teachers, and high school students. Since 2022 he is EGU Geoscience Officer for Romania.



Fotios Danaskos

EGU Geoscience
Education Field
Officer for Greece
fdanas@yahoo.gr

Fotios Danaskos, BSc in Geology, MSc in Education and Human Rights - Special Education, has been teaching Geology, Biology and Sciences in Junior High School for many years. He is responsible for Geoscience, Environmental and eTwinning Projects for his school and has developed several school projects at European and National level. Since 2022 Fotios is EGU Geoscience Education Field Officer for Greece.



Sylke Hlawatsch

EGU Geoscience
Education Field Officer
for Germany
kontakt@sylke-hlawatsch.de

Sylke Hlawatsch, degree and PhD in geology, state examination in teaching (physics, geography), has been teaching geosciences, sciences, physics, social sciences and geography in secondary school since 2011. She is a mentor of the German team for the International Earth Science Olympiad (IESO) and speaker of the *Fachsektion Geodidaktik und Öffentlichkeitsarbeit der GeoUnion/AWS* (DGGV/HGD). Since 2022, Sylke is EGU Geoscience Education Field Officer for Germany.



Inga Zaitseva-Pärnaste

EGU Geoscience
Education Field
Officer for Estonia

inga.zaitseva@gmail.com

Inga Zaitseva-Pärnaste, professional diploma in Hydrography, MSc in Earth Sciences (Oceanography), Ph.D. in Civil and Environmental Engineering, has been teaching Hydrography, Cartography, and related courses for undergraduate and graduate students. She is the director of the Waterways Safety Management study programme at Tallinn University of Technology and is qualified as International Engineering Educator ING-PAED IGIP of the International Society for Engineering Education IGIP. Since 2022 Inga is EGU Geoscience Education Field Officer for Estonia.

GEOSCIENCE PRACTICAL ACTIVITIES ON NATURAL HAZARDS IN A RAPIDLY CHANGING WORLD

EGU Field Officers Team

One of the main objectives of the Education Committee (EC) of the European Geosciences Union (EGU) is to increase the public understanding of the processes that take place on our planet. Only with this knowledge is it possible to make the public aware of the natural or induced risks that these processes generate.

In order to meet this objective, the Education Committee have designed a strategy based mainly on the training of primary and secondary school teachers. As many of these teachers do not have a geological background, some do not feel confident when they have to teach geological topics. This is especially true when facing practical activities designed to help students to understand the links between the different spheres of our planet (lithosphere, biosphere, hydrosphere, and atmosphere).

The Field Officers' (FO) Programme was launched in 2019 with the training of four EGU European members (France, Italy, Portugal, and Spain) and two non-European officers (India, and Morocco). Recently (2022) 13 more FOs were appointed in Europe (Albania, Estonia, Germany, Greece, Romania, Türkiye and United Kingdom) and in non-European countries (Burkina Faso, Chile, Colombia, India, Malaysia, and Togo) (Fig. 1). Since May 2019 each FO has been able to offer free workshops for teachers within their own country (Fig. 2).



Fig. 1. Map distribution of the Field Officers



Fig. 2. Workshop performed by the Field Officer from Spain

The methodology used in these workshops is the CASE approach (Cognitive Acceleration through Science Education). CASE is based on a constructivist-metacognitive approach and is aimed, not just at science teaching, but also at the improvement of cognitive skills through all teaching.

CASE is developed through five “pillars”:

- Concrete preparation: teachers prepare the ground, ensuring students’ familiarity with the apparatus, the terminology and the problem being addressed,
- Construction: students have the opportunity to collect data and detect a pattern in the data,
- Cognitive Conflict: the activities provide new data which often do not fit the expected pattern, challenging students’ previous knowledge,
- Metacognition: throughout the activity students are invited to reflect on their own thinking, verbally or on paper,
- Bridging: students are requested to apply the new understanding to new contexts and to the real world of the modelled phenomena.

Within EGU GIFT 2023, and related to its main topic, “The key role of geosciences for the global challenge of sustainable development: the Agenda 2030”, we are presenting a number of practical activities addressing natural hazards.

This proposal is motivated by the need to educate students to face the challenges of a rapidly changing world, where anthropogenic pressures and growing population make environmental issues increasingly urgent, requiring new skills for adaptation and resilience.

Natural hazards can be due to geological causes (earthquakes, volcanoes etc.) or to exogenous factors (global warming and climate change): both threaten human life, infrastructures, the economy, and our society of 8 billion people living in rapidly expanding big cities, in vulnerable areas near plate boundaries, on the coast and along the main rivers.

In this scenario, strong geoscience education is needed. This workshop, together with many others run by EGU Education Field Officers in their respective countries and with the wealth of teaching resources provided by the Earthlearningidea (ELI) repository (<https://www.earthlearningidea.com/index.html>) and IGEO textbooks (<http://www.igeoscienced.org/teaching-resources/geoscience-text-books/>), can contribute to strengthen teachers’ skills and motivation.

We will be sharing a number of activities as a taste of those that are available from the previously mentioned sources. In particular, we are presenting some practical’s on earthquakes, volcanoes, landslides and other surface phenomena. As with all EGU workshop activities, these are interactive, hands-on and simple, requiring a maximum of one hour teaching time. The materials used are inexpensive, easy to obtain and build and readily available in normal school classrooms and science laboratories.

We are running this workshop in the memory and honour of Professor Chris King who died recently. He was a guide and an inspiration not only for us but for many generations of Geoscience teachers across the world.



HUBERT H.G. SAVENIJE

Professor
Delft University of Technology
The Netherlands

Email: h.h.g.savenije@tudelft.nl
Telephone: +31 15 2781433

Prof. Savenije studied at the Delft University of Technology, in the Netherlands, where he obtained his MSc in 1977 in Hydrology. As a young graduate hydrologist he worked for six years in Mozambique where he developed a theory on salt intrusion in estuaries and studied the hydrology of international rivers.

From 1985-1990 he worked as an international consultant mostly in Asia and Africa. He joined academia in 1990 to complete his PhD in 1992. In 1994 he was appointed Professor of Water Resources Management at the IHE (now UNESCO-IHE, Institute for Water Education) in Delft, the Netherlands. Since 1999, he is Professor of Hydrology at the Delft University of Technology, from which he retired as Emeritus Professor in 2018.

In 2008 he received the Henry Darcy Medal of the *European Geosciences Union* for outstanding contributions to Hydrology and Water Resources Management. In 2010 he received the 'Leermeesterprijs' (Master Award) of the TU Delft, which is an annual award for the most distinguished teacher. In 2015 he was awarded the Alexander von Humboldt medal of the *European Geosciences Union* for providing superb graduate training opportunities in developing regions. He is Fellow of the *American Geophysical Union* and received the International Award of the AGU in 2017.

Prof. Savenije has published widely in the fields of hydrology, estuary hydraulics and water resource management. In 2005 he published a book on "[Salinity and Tides in Alluvial Estuaries](#)". He was chief executive editor of Hydrology and Earth System Sciences (HESS) and editor in chief of Physics and Chemistry of the Earth. He was President of IAHS (the International Association for Hydrological Sciences) and President of Hydrological Sciences of the European Geosciences Union (EGU). He has organised several regional and international water conferences, and has wide-ranging experience in Africa, Asia and South America.

He (co-)authored more than 300 scientific articles in international journals and has graduated more than 150 MSc students and 38 PhD students in the fields of hydrology and water resources management.

THE RIVER BASIN AS A LIVING ORGANISM

Hubert H.G. Savenije

Delft University of Technology, The Netherlands

Physical processes in the atmosphere, the hydrology, ecosystems, and geology are interconnected, influencing each other with numerous feedbacks at a wide range of temporal scales. This was realised as early as the 18th century by Alexander von Humboldt who did empirical research in many parts of the world and came to the conclusion that all these processes were connected. In present times, in the science of hydrology, specialisation and reductionism has forced us towards fragmentation and focus on laboratory processes instead of system-wide and interdisciplinary research. This has led to wide applicability of laboratory scale-based methods that have been erroneously upscaled to catchment level.

Wherever water moves through a medium, fractal-type patterns appear. These are omnipresent in nature: in the veins of leaves, in branches and root systems, in rills of overland flow, in alluvial fans, in seepage of water, in soil infiltration, in sub-surface drainage patterns, in the shape of river networks and in the veins of our own body. Although hard to observe, these drainage patterns are also present in the groundwater system, which is the cause of the mismatch between the travel times of dissolved substances and the water in predominant groundwater models.

These patterns are formed by different processes at different time scales. They evolve over time and are not static. The speed of pattern formation in geo-morphological processes depends on the erodibility and consistency of the medium through which the water flows and often has long time scales. Biological processes of pattern formation are much faster. But although these processes are dominant, main stream hydrological models don't take them into account. They are dead, while river basins are alive!

The ecosystem, as the most active agent in the natural system, manages the water. It does this for a simple evolutionary purpose: to optimise survival. If an ecosystem had not managed its water resources well, it would simply no longer be there. People, who also manage the water system, obey similar laws of survival, by trial and error. But in the head waters of a catchment, the ecosystem is dominant and has a high potential for adaptation under existing climatic, landscape and geological constraints. With the ecosystem as the active water manager, the hydrological system is alive and able to adjust to changing climatic or human-induced circumstances. But although the ecosystem-atmosphere-hydrology-geology interaction is very complex, to our surprise, hydrological laws that we observe in nature are often described by simple equations. How can this be explained?

The only physical law that has a unique direction in time is the second law of thermodynamics, which functions at all scales, and which states that entropy can only increase. The Earth is a “dissipative structure” that exchanges low entropy for high entropy. It does so at Maximum Power, close to the 'Carnot limit' of a dissipative engine. The ecosystem that has the potential to evolve, appears to operate close to the Carnot limit, the most efficient way in which free energy can be converted into work. It appears that maximizing the Power of a natural process often leads to surprisingly 'Simple Laws'.

Hydrology is the bloodstream of the ecosystem. There are several ways in which the ecosystem manipulates the hydrological system. Interception of rainfall by leaves channels water to dominant dripping points, directing the water to places where infiltration is facilitated and preventing surface runoff. Through preferential patterns this infiltration reaches the root zone and facilitates flow to the groundwater. If there is too much water in the soil, then it is evacuated through sub-surface drainage patterns that are formed under the root zone. In addition, the ecosystem creates sufficient storage in the root zone to overcome critical period of drought. Hence, the ecosystem stores and partitions the precipitation to its advantage and in doing so determines the parameter values of hydrological models.

The root zone storage capacity is a crucial parameter in all hydrological models, which is normally calibrated, but which can be predicted by a simple water balance method similar to the way in which engineers size a reservoir. Considering hydrological systems as a living, evolving ecosystem holds the key to independent determination of model parameters, such as the root zone storage capacity, but can potentially also be applied to interception, infiltration and drainage capacity.

A good illustration of how ecosystems adapt to climatic drivers and of transition points that occur when an ecosystem is no longer capable of meeting atmospheric conditions is provided by Singh et al. (2020). In a number of transects through Africa and South America they showed how ecosystems adapt their root zone storage capacity to the occurrence of drought and dry spells, indicating the point where evergreen rainforest gradually switches to less dense (often deciduous) forest, such as the African Miombo forest, until a maximum root zone storage is achieved, after which a transition occurs to savannah and dry land vegetation. These tipping points are crucial because they are often strengthened by positive feedbacks, such as in the transition of rainwater harvesting tiger bush to barren land.

Considering the hydrological system as a system that can adapt itself to changing climatic and human circumstances, while trying to optimise its conditions for survival, is a way to discover parameter values that agree with an unknown future. Instead of confronting a calibrated model, tuned to the past (i.e. a dead model), to changing atmospheric drivers, one should use a living and adaptable model that corresponds with these changing circumstances.

Dealing with a world that is continuously changing is the main challenge of the coming decades and the ecosystem-centred approach may be a promising way to address this challenge.



ALBERTO MONTANARI

Professor of Water Engineering and Hydrology

University of Bologna

alberto.montanari@unibo.it

<https://www.albertomontanari.it>

EDUCATION

- High School Diploma: High School Diploma in Environmental Survey and Civil Constructions obtained in 1985 in Reggio Emilia, with the maximum grade (60/60).
- Master Degree: Master Degree in Civil and Hydraulic engineering obtained at the University of Parma in 1992, maximum grade cum laude, by defending a master degree thesis entitled "A Water Quality Model of the Baganza River (in Italian)", whose supervisor was Renzo Rosso.
- Professional habilitation: professional habilitation in Engineering obtained in Parma in 1992.
- Ph.D.: Ph.D. in Hydraulic Engineering obtained in 1996 by defending a Ph.D. thesis entitled "Stochastic Modelling of Hydrological Variables Affected by Long Term Persistence" (in Italian).

CAREER

- Post-doctoral student at the University of Bologna from March 1997 to January 1998.
- Assistant Professor in Hydraulic Works and Hydrology at the Department DISTART of the University of Bologna from 1998 to 2001.
- Associate Professor at the Department DISTART (now Department DICAM) of the University of Bologna from 2001 to 2012.
- Professor at the Department DICAM) of the University of Bologna from 2012.

RESEARCH INTERESTS

Alberto Montanari focused his research activity on water resources management and flood risk mitigation, in the presence of environmental change and climate change. In particular, Alberto Montanari dedicated his attention to advanced methods for environmental management and engineering design in the presence of uncertainty, by bringing forward the idea that estimation of design variables in hydrology should always be associated to uncertainty assessment. To this end, Alberto Montanari proposed a blueprint for modelling uncertain hydrological systems, which is based on the concept of stochastic physically-based modelling that allow one to properly account for inherent uncertainty in hydrology. By following a coherent path for modelling hydrological change, Alberto Montanari initially focused on statistical method for real-time prediction of precipitation, simulation techniques for hydrological variables observed at fine time scale, statistical methods for real time updating of flood forecasting and spatially distributed rainfall-runoff models. Currently Alberto Montanari is concentrating on uncertainty assessment for hydrological models in the presence of hydrological change, identification of critical areas for flood risk, climate change impact assessment, flood frequency analysis, open science and data sharing.

PUBLICATIONS

Alberto Montanari authored 203 publications in international scientific journals (140 papers), conference proceedings or book chapters (55 contributions) and monographs (8 contributions).

SERVICES

- Head of the Department of Civil, Chemical, Environmental and Material Engineering at the University of Bologna (2015-2021).
- President of the European Geosciences Union (2019-2021).
- Editor in Chief of the scientific journal Water Resources Research, published by the American Geophysical Union (wrr.agu.org) from 2013 to 2017.
- President of the International Commission on Water Resources Systems of the International Association of Hydrological Sciences (IAHS) from 2013 to 2017.
- President of the Division on Hydrological Sciences of the European Geosciences Union (EGU) from 2007 to 2011.
- Chair of the Union Award Committee of EGU from 2009 to 2016

AWARDS AND HONORS

- Recipient of the [2019 Dooge medal](#) of the International Association of Hydrological Sciences
- Elected member of the Academia Europaea in 2019
- Recipient of the [2018 William Kaula Award](#) of the American Geophysical Union
- Recipient of the [2018 Henry Darcy medal](#) of the European Geosciences Union.

THE MAJOR CHALLENGES FOR ENSURING A SUSTAINABLE USE OF FRESHWATER UNDER CHANGE

Alberto Montanari

Department of Civil, Chemical, Environmental and Material Engineering, Alma Mater Studiorum
University of Bologna

The world is experiencing water problems, related to water shortage, pollution and security. Resolving the concerns related to global water resources management during the XXI century is one of the focus of Sustainable Development Goals 6, 11, 13 and 14. To get to target, we need to gain new knowledge on the dynamics of the water cycle. In fact, the truth is that humans still do not know what actually happens to a rain drop after it landed on the earth surface, during its travel over and below the Earth surface. We can see the final results of rainfall occurring, because we observe water in rivers, lakes, sea and finally homes (not everywhere). But how a drop actually reaches such water bodies and locations is still a mystery. This is one of the reasons why floods and droughts are difficult to predict and manage, and water resources management is still a challenge.

Hydrology is the science of the water cycle and hydrologists try to improve our knowledge of the travel of water through the earth system, for the sake of improving scientific understanding and supporting water resources engineering and water resources management.

The water cycle is a circular trip that can be started everywhere. Classical hydrology assumes that the trip begins from the clouds, after water has condensed to form a drop. Earth's gravity pulls the drop down to the surface, but once it starts falling there are many places for the drop to go, depending also on wind direction. The drop can land on a leaf in a tree, in which case it would either evaporate or subsequently fall on the ground under the tree. If it evaporates, it heads to the clouds again. If the drop falls on the ground it starts moving downstream by flowing either on the earth surface or underground. Actually, how rain separates between surface water and groundwater is not fully known. Human action is likely to modify the trip of the drop through, for instance, river diversion, river flow withdrawal or groundwater pumping. Most of the human-used water is sprayed on crops, from where it mainly evaporates, therefore originating the so-called "blue-to-green flow diversion". Only a small amount of water is utilized for civil uses, therefore ending up in house water taps and other civil destinations. From these places the drop is likely to reach a sewer system, then a water sanitation plant and finally a water body, from which it travels towards the ocean, to be ready to evaporate back in the sky.

The above described processes are partly random. In fact, the trip of the water drop in several instances develops by chance. The processes that bring the drop downstream are governed by physical laws, but these latter are however satisfied along several different pathways for the drop itself. Therefore, the trip direction is chosen randomly in many occurrences. It follows that inherent uncertainty affects hydrological processes, therefore limiting their predictability to varying extent. This is an important issue that must be considered when trying to understand and model hydrological processes.

To manage water resources, humans take water from appropriate sources. River water is more convenient for human exploitation than groundwater because it does not need pumping. However, often there is the problem that river water availability does not match the water demands, and therefore humans started to build dams to store water when not needed, to be used during water scarcity.



Water consumption for food production accounts for 70% of the total freshwater withdrawal. Picture by <http://www.usda.gov/oc/photo/>, Public domain, via Wikimedia Commons

Therefore, human activity induces river and groundwater depletion and is responsible for water degradation and pollution. There is a limit to the amount of water that can be used by humans without substantially compromising the quality of the environment. Estimation of such limit is needed if we want to make our societal development sustainable.

The above explanation clarifies the relevant role that humans may play in the water cycle. In fact, the study of the two-way interaction between humans and water is ranking high in today's research agenda of hydrologists and social scientists. Humans are not only water users; they are rather becoming a fundamental part and a driver of the water cycle in many regions of the world.

This talk will focus on the travel of a drop along the water cycle and will emphasize what we know, what we do not know and the role of causality. We will analyze the distribution of water in the earth and the most relevant challenges for water resources management. An overview will be presented of open research issues and modeling approaches in hydrology. Finally, a vision will be outlined for the future of hydrology and water, which is more and more requiring an interdisciplinary and coordinated research effort.

Information at:

<http://water.usgs.gov/>

<https://www.usgs.gov/special-topics/water-science-school/science/water-cycle>

<https://www.albertomontanari.it>



PAOLO PAPALE

Research Director

Istituto Nazionale di Geofisica e Vulcanologia, Pisa, Italy

Chair, Class of Exact Sciences, Academia Europaea

EDUCATION

Geological Sciences at the University of Pisa (1990), with full honours

CAREER

Head of the National Program in Volcanic Hazards, 2005-2010; Director of the INGV Volcanoes Division, 2013-2016; Coordination and other key roles in several European and national projects in volcanology and geophysics.

RESEARCH INTERESTS

Physics of magmas and volcanoes, thermo-fluid dynamics of magmatic and volcanic processes, analysis of global volcano databases, volcanic hazards, volcanic hazard forecasts.

PUBLICATIONS AND SERVICES

About 90 peer-reviewed papers, ~5500 Citations, H-index 39, i10-index 65 (Google Scholar). Listed among the “100,000 most impacting scientists of the world”:

<https://doi.org/10.1371/journal.pbio.3000384>; Co-founder of the EGU journal “Solid Earth”:

<https://www.solid-earth.net/> ; Co-founder of the workshop series “VOBP – Volcano Observatory Best Practices”.

AWARDS AND HONORS

President of the GMPV Division at EGU, 2007-2011 (Secretary of Volcanology since 2005); Bunsen Medal Award Committee, 2005-2011 (Chair since 2008); Holmes Medal Award Committee, 2010-2012; Member of the Academia Europaea from 2011, Chair of the Class of Exact Sciences from 2022; Erasmus Medal Award Committee, from 2019.

CHALLENGES AND PERSPECTIVES FOR THE SCIENCE OF VOLCANOES IN THE CURRENT DECADE

Paolo Papale

Istituto Nazionale di Geofisica e Vulcanologia

Volcanoes are well known for the severe risks they pose on the inhabited areas surrounding them. Several ancient and recent examples remind us about those risks: the eruption of Santorini volcano, in the XVII century B.C., is supposed to have initiated the decline of the Minoan civilization. The AD79 eruption of Vesuvius destroyed Pompeii and Herculaneum and provided us with a true and fair view of life at the times of the Roman Empire. The Tambora eruption in 1815 killed an estimated 1-2 hundred thousand people, and caused starvation and famine all over Europe resulting in uncounted additional casualties and heavy migrations. More recently, volcanoes have been re-discovered for their detrimental effects extending far beyond their surrounding areas. One relevant example is the 2010 eruption of Eyjafjallajökull, which caused the shutdown of air traffic operations over central and northern Europe for nearly two weeks and an estimated economic loss of 200 million dollars per day.

The above examples refer to historical records only. However, the lifetime of volcanoes extends far beyond our limited historical experience, which is short compared to the time intervals separating the largest eruptions on Earth. The largest known explosive eruption took place about 74,000 years ago from the Toba volcano in the Island of Sumatra, Indonesia. The amount of discharged material was as big as several tens Tambora eruptions altogether, giving origin to the debated theory of a “bottle-neck” in human evolution as a consequence of the eruption. Other volcanoes in the world produced such large scale, “VEI 8” super-eruptions: Yellowstone in Wyoming, US, La Garita in Colorado, US, Aso in Japan, Taupo in New Zealand, only to cite some of the most famous ones. The most recent one in this monster category is the about 26,000 years old Oruanui eruption from Taupo volcano, NZ.

The existence of patterns in the occurrence of volcanic eruptions on Earth has been hidden by the difficulties of analyzing sparse and uncertain data on the effective size and age of eruptions. Systematic research during last decades, and more recent organization into accessible databases, have opened the path to statistical analysis. That has revealed the features of the global time-size distribution of volcanic eruptions on Earth: on the global scale, volcanic eruptions emerge as independent events characterized by what is known as a Poissonian distribution, well characterized by an exponential distribution of the inter-event times. Not surprisingly, the same distribution also characterizes other sequences of independent events, either natural or man-made, such as the telephone calls arriving to a call center, the decay of radioactive particles, and many others. All of those phenomena share some peculiar properties, one of them being the so-called “memoryless” property. That property, typical of exponential distributions, implies that the time to the next event is totally independent from the time spent from the last event. The implication is that there is no “overdue” eruption: for volcanic eruptions, as well as for bingo draws, the time passed from a last event (e.g., from the last volcanic super-eruption) does not affect the probability of occurrence of the next such event. On that basis we have been able to determine the global probability of occurrence of volcanic eruptions of any size on Earth. By referring to the largest eruptions with global impacts, that provides a measure of the global volcanic hazard on Earth. That is of relevance, as volcanic super-eruptions represent the only natural events with terrestrial origin (letting apart much rarer flood basalt eruptions) having the potential to deeply impact the world at the global scale, to a level such that the same fabric of civilization could be severely undermined, and the clock of civilization brought backwards. We have assisted in these days (September 2022) to the first test ever, by the NASA, of hitting an asteroid with the objective of deviating its path. That is important, as a large asteroid may in the future be a concrete menace for us all. Still, the probability of an

asteroid with km-scale diameter to hit the Earth is at least ten times smaller than the probability of a volcanic super-eruption on Earth. While for the former we are spending, with reason, big money, there is nothing yet done for the latter. One of the reasons for that, probably lies in the fact that we cannot even imagine, by now, any viable way to impede, stop, or reduce a large volcanic eruption. However, acting on the source of the hazard is only part of the process of defending ourselves from the devastating consequences of a volcanic super-eruption. The other relevant part, is to develop a global resilience plan so that the catastrophic impacts of a volcanic super-eruption can be at least limited, and the global recovery can be guaranteed and accelerated.

In 2020 I was invited to provide my perspective, in a dedicated session at the American Geophysical Union fall meeting, on what the big changes characterizing volcano science would be in the decade 2020-2030. That followed other two such assessments, made at the same meeting in the years 2010 and 2000, each referred to the decade forward. Clearly, the first point in my talk was to compare my forecasts made ten years before, with the actual evolutions in the past decade. In 2010 I anticipated the outburst of statistics and probabilities in volcanology, but I should say that was an easy exercise; and together with that, the evolution towards a global approach based on sharing resources, such as data, infrastructures, protocols and best practices for volcano surveillance, and similar. In 2020 my forecast has been that of a further evolution driven by increasing levels of cooperation and sharing as well as by technological improvements, towards what we generally call "Big Science". Big Science is generally characterized by big budgets, big staff, big machines, big laboratories. Examples from other disciplines clarify that concept better. Particle physicists developed large particle accelerators, such as the Large Hadron Collider in Geneva, an underground tunnel 27 km-long, with a circular shape, instrumented with the most advanced technology and where particles are accelerated at velocities close to that of light, and crushed one against the other. The budget of the LHC is of order 10 billion euros. The astrophysics can count on the James Webb Space Telescope, launched in 2021 and which is providing the most astonishing infrared images of the deep Universe. The budget is around 10 billion dollars.

In my talk at AGU I discussed whether the volcano community needs a similar Big Science approach. In fact, I am a fan of the nerd scientist who can change everything from his office room with just a pen and a few copybooks, and I am convinced such geni will continue to surprise the world. At the same time, there are accomplishments that are simply impossible, without a Big Science approach. That was certainly the same observation that drove the physicists towards the construction of the most expensive scientific infrastructures ever. In the case of volcanoes, the simple observation is that besides the deep purely scientific interest represented by understanding the functioning of our planet Earth, we deal with some of the most risky, potentially most destructive processes occurring on Earth; and at the same time, we miss a fundamental part of it. First of all, we miss any direct observation inside and beneath an active volcano, where magma transfer occurs leading to an eruption. The volcanic processes are extremely complex, at least as complex as the atmospheric processes which are classically described as the prototype of the complexity: we all know the so-called "butterfly effect", illustrative of the non-linear physics of complex systems: a butterfly flaps its wings in the Amazon forest, and a tornado is generated on Japan. That complexity is at the basis of the limitations in weather forecasts, the accuracy of which rapidly decays with increasing time window. With the volcanic processes the situation is entirely similar, with the difference that we do not directly observe the system the evolution of which we wish to predict. We can only rely on indirect information coming from geophysical and geochemical signals recorded from the surface (or remotely, from satellites), which adds substantial uncertainty. It is as if the atmospheric scientists had to make their forecasts without looking at (that is, directly probing) the atmosphere, even more, without having ever seen it. The KMT project (www.kmt.is) aims at reaching a magmatic body below a volcano and building the first direct magma observatory in the world, in the form of a well open to the magma body and accessible for instrumentation and real-scale experiments. The estimated budget is 100 million dollars, 100 times less than the large infrastructures seen above,

and less than one third of the costs by the NASA to deviate an asteroid in September 2022. The benefits expected from a similar infrastructure largely compensate for the costs: we would see, for the first time, the processes that the volcano scientists hypothesize and model, and as it always happens when direct observations step in, that would likely mark a big change in our understandings. We would be able to continuously measure those processes, e.g., recognizing deep magma convection, arrivals of deep magma batches, magma degassing and crystallization, evolutions in the magma-rock interface, etc., all of which form a basis for our forecasting models, and that we have never tested through direct observations. We could slightly change the local conditions in magma, measure the changes recorded at the surface, and develop the next gen models of magmatic unrest by double-controlling the source and the surface, leading to an advanced capability to understand the signals at active volcanoes and anticipate the occurrence of dangerous events. And we could experiment in the field of unconventional geothermal energy, learning how to extract energy directly from a buried magma body, with an estimated 100x increase in the energy productivity of a single geothermal well and the potential to impact the energy transition policies in terms of clean, renewable, stable, efficient energy production systems.

In this abstract I have focused more on KMT, but my AGU talk (and a paper in Bulletin of Volcanology, written together with Deepak Garg and which followed from the AGU meeting) also considered two other aspects of Big Science that I expect they will make the scene in the coming years. These are the development of big volcano databases, and the development of the fundamental components of what will be a Global Volcano Model - or, with a language that is more preferably being used in this time, a “Digital Twin” of a volcano. That is a digital replica of a system – in this case, of a volcanic system – which allows scientists and stakeholders to make scenarios, such as forecasts and “what if” scenarios, by simply accessing a user-friendly interface which activates a series of operations – a “workflow” – whereby data are accessed somewhere in the form of static data or real-time data streaming into the system; computations are activated at supercomputers or through cloud systems such as EOSC, the European Open Science Cloud, and others in the world; huge sequences of numerical results are processed; and the output are presented as graphics, images, videos, etc. In a Digital Twin of a volcano, the computations involve highly sophisticated, deterministic codes solving the fundamental fluid-dynamic, thermodynamic, visco-elasto-dynamic etc. equations describing the space-time evolution of complex systems; probabilistic models bringing in the uncertainties of the system, both the intrinsic or “aleatoric” uncertainties and those related to our limited knowledge, called “epistemic” uncertainties; and computations based on artificial intelligence approaches. The European Union is launching the “Destination Earth” programme (<https://digital-strategy.ec.europa.eu/en/policies/destination-earth>), that will shape much of the research and activities in the construction of digital twins of the Earth system. The DT-GEO project (<https://dtgeo.eu>) under the Horizon Europe framework programme by the EU includes among its aims that of building the first components of a digital twin for volcanoes.



DOMENICO GIARDINI

Department of Earth Sciences
ETH Zurich
Energy Science Center (ESC)
NO H 69.1
Sonneggstrasse 5
8092 Zürich
Switzerland

Domenico Giardini is Chair of Seismology and Geodynamics in the Dept of Earth Sciences at ETH Zurich.

He was President of the National Institute of Geophysics and Volcanology, Chairman of the Department of Earth Sciences, ETH Zürich, Director of the Swiss Seismological Service, Head of the Swiss Competence Center on Energy Research - Supply of Electricity (SCCER-SoE), Chair of the Seismic Risk Section of the Major Risks Commission, Italy, President of the European Seismological Commission (ESC), President of the International Association of Seismology & Physics of the Earth Interior (IASPEI).

He published over 400 papers, on deep earthquakes, Earth free oscillations, mantle and core structure, waveform modelling in complex media, seismic hazard and risk, planetary seismology, induced seismicity, geo-energy, earthquake physics, detection of gravitational waves.

He coordinated EU projects in the fields of seismic risk (SHARE, STRESS) and research infrastructures for seismology and earthquake engineering (SERA, NERA, NERIES), leading to the establishment of the European Plate Observing System (EPOS).

He is a co-PI of the ESA LISA mission for the detection of gravitational waves and PI of the SEIS electronics and head of the MarsQuakeService for the NASA InSight mission to Mars.

He founded the Bedretto deep underground laboratory, to host experiments on earthquake physics and geoenergy, and is the PI of the ERC SYG FEAR: Fault Activation and Earthquake Rupture.

EARTHQUAKE HAZARD AND SOCIETAL RISK

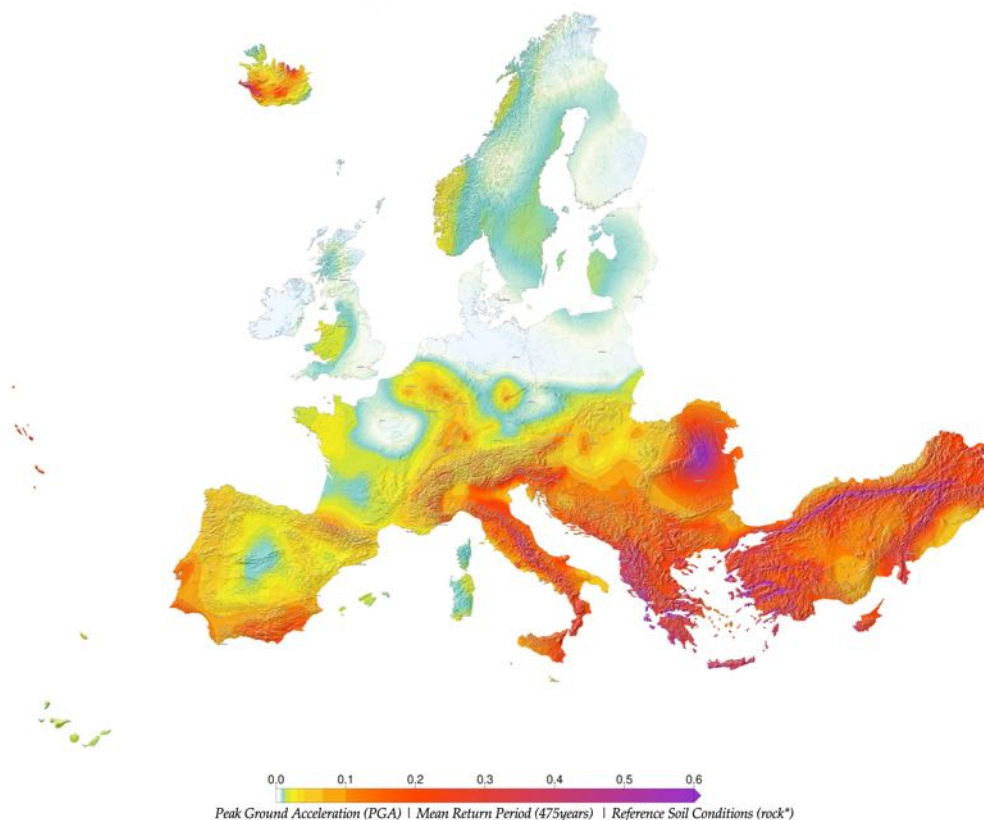
Domenico Giardini

ETH Zürich

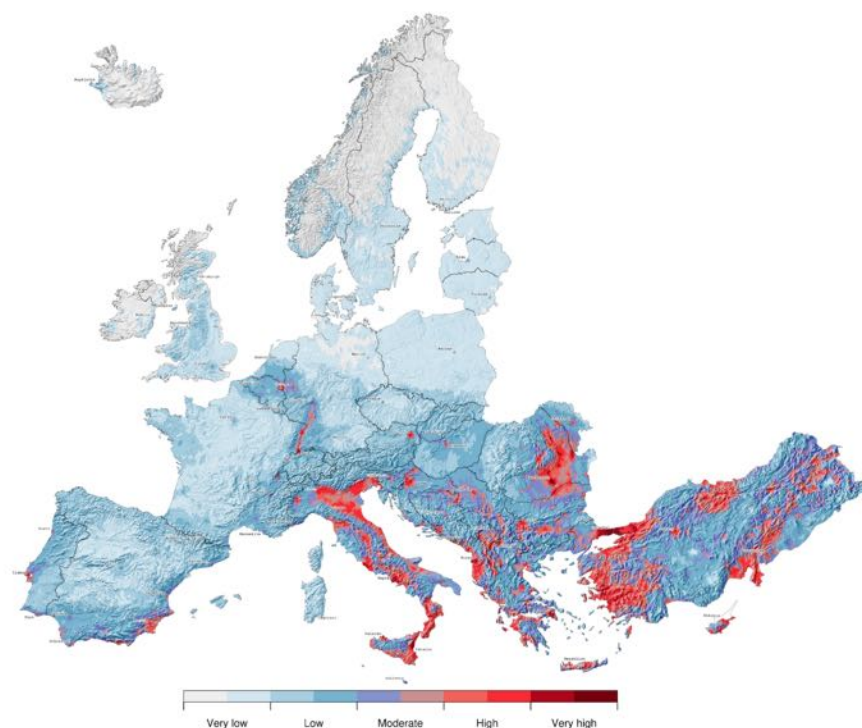
Europe and the Mediterranean region have a long history of catastrophic earthquakes, which have changed the history of cities and entire regions. During the twentieth century alone, earthquakes accounted for more than 200,000 deaths and more than 250 billion Euros of direct losses in Europe.

The first step of any lasting mitigation strategy is good construction practice supported by modern and strictly observed seismic norms. These in turn are based on estimates of the location, frequency and magnitude of future earthquake shaking. Seismic hazard defines the likelihood of ground shaking associated with the occurrence of future earthquakes, and is the first step to evaluate seismic risk – the likelihood of damage and loss – obtained by combining earthquake hazards and vulnerability factors (e.g., the type, age and value of buildings and infrastructures, population density and land use). High hazard does not necessarily imply high risk: frequent large earthquakes result in high hazard but pose limited risk if they occur in remote areas, while even moderate earthquakes may expose densely populated areas to high seismic risk.

The assessment of seismic hazard is done at European-Mediterranean scale by combining the historical and recent instrumental catalogues of earthquakes covering over 2000 years of seismic history, and a detailed mapping of over 80,000 km of active faults, to obtain a model of the occurrence, frequency and magnitude of future expected seismic activity, which is then transformed in the shaking expected over a typical lifetime of buildings.



The map shows the latest model of seismic hazard in the EuroMed region, and displays the horizontal acceleration expected to be exceeded with a probability of 10% in the next 50 years. These values serve as reference for the European building code EC8, which in turn serves as reference for the national building codes. The map shows in red colors the areas with the highest expected shaking. Turkey, Greece, Albania, Italy, and Romania are the regions with the highest seismic hazard, followed by Iceland, Bulgaria, Croatia and Bosnia-Herzegovina. Regions of relatively moderate ground shaking hazard include Rhine Graben in Germany, France, Switzerland and Belgium, the Valleys and Alpine front in Switzerland, Pyrenees Mountains in France and Spain, Southern Spain, Lisbon area, Azores Islands, and Southern Portugal.



Hazard is the first step to map risk. The European seismic risk map illustrates the relative distribution of losses across Europe, combining expectations of average annual economic loss and of average annual loss of life, normalized by the GDP in each nation. It contains about 143 Million buildings, which contain an average of 460 Million occupants and a total replacement cost (structural, non-structural and contents) of 50 Trillion Euros, of which 66% is from the residential building stock.

The highest seismic risk is expected in urban areas that are located in regions with a comparably high level of seismic hazard, and soft soil conditions. Cities like Istanbul and Izmir in Turkey, Catania and Naples in Italy, Bucharest in Romania, and Athens in Greece are all prone to high seismic risk. But also cities like Zagreb (Croatia), Tirana (Albania), Sofia (Bulgaria), Lisbon (Portugal), Brussels (Belgium) or Basel (Switzerland) have an above-average level of seismic risk compared to less exposed cities, such as Berlin (Germany), London (UK) or Paris (France).

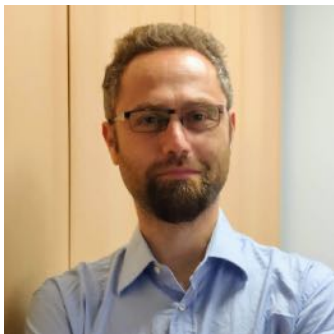
Older mid-rise reinforced concrete buildings constructed before the 1980's and low-rise unreinforced masonry houses subjected to high seismic hazard levels are the main drivers of seismic risk in Europe. If these building classes in the residential building stock were brought to the level of seismic design required by the latest European standards (Eurocode 8) in just Turkey and Italy alone, the average annual number of fatalities in Europe could be reduced by over 50% and the average annual economic losses by at least 30%.

The recent earthquake in Turkey-Syria was one of the most catastrophic in our history and illustrates all the difficulties we face in protecting society against earthquakes. The event happened on the well-known Eastern Anatolian fault, where the Arabian and Anatolian plates move past each other. This is one of the major faults known, starting from the Red Sea on a N-S direction and traversing Israel (where it is called Dead Sea Fault), Lebanon, western Syria and then turning to the North East where the last quake occurred, and continuing to the junction with the North Anatolian fault and the Caucasus. The fault moves at 2-3 cm per year on average, or 2-3m per century, compatible with the average slip of 6m observed in this event of magnitude 7.8, and a return time of about 2-3 centuries.

The large magnitude measures the large size of the waves, but it also indicates the vast area hit by the strong seismic shaking, with the fault rupture extending over 200-300km. After such a large event, all the surrounding faults are also likely to move, and a M7.5 was recorded a day later on a lateral fault. Site effects are also very dangerous, as buildings constructed on soft sediments will experience a larger shaking. Finally, the rupture was very shallow, implying severe ground deformation and collapse in sedimentary areas, as well as concentrated strong shaking close to the fault, which unfortunately was cutting across dense urban areas.

Aftershocks of large dimensions are expected for weeks and months after a large magnitude event, and here the crucial question is to understand if this event has increased the probability that the neighboring segments of the fault, to the South and to the North-East, will also move with large earthquakes. These plate-boundary faults move with cycles which can last a few decades, and then remain quiet for longer times until the next quake is ready. Careful monitoring will be required to capture signals which may indicate that these faults are approaching rupture.

The area hit by the recent earthquake is densely inhabited, with cities of over 2 million inhabitants, like Gaziantep and Adana. The building code of Turkey is considered one of the best in the world, and was able to contain the catastrophic losses to about 0.5% of the population hit, whereas large historical events in the area would cause losses exceeding 10%. This is a good step in the right direction, but we are still far from an acceptable level of the protection of our society.



DANIELE BAILO

EPOS IT Officer

daniele.bailo@ingv.it

www.epos-eric.eu

www.danielebailo.it/job

EDUCATION

2008 – 2011 UNIVERSITÀ DEGLI STUDI "LA SAPIENZA" DI ROMA, DOCTOR OF PHILOSOPHY (PHD) IN MATERIAL SCIENCE

2007 – 2008 UNIVERSITÀ DEGLI STUDI DI ROMA TRE

SSIS - SCUOLA SUPERIORE PER L'INSEGNAMENTO SECONDARIO

MASTER FOR ELECTRONICS AND INFORMATICS TEACHING IN HIGH SCHOOLS

2005 UNIVERSITÀ DEGLI STUDI DI ROMA TRE QUALIFICATION FOR THE PROFESSION OF ENGINEER

1996 – 2003 UNIVERSITÀ DEGLI STUDI DI ROMA TRE, DEGREE IN COMPUTER SCIENCE AND ENGINEERING

RESEARCH INTERESTS

e-infrastructure design; systems interoperability; metadata standards for interoperability; Virtual Research Environments; FAIR data system.

PUBLICATIONS AND SERVICES

Last five recent publications:

- 2022 Bailo D, Jeffery KG, Atakan K, Trani L, Paciello R, Vinciarelli V, Michalek J, Spinuso A. Data integration and FAIR data management in Solid Earth Science. Ann. Geophys. [Internet]. 2022Apr.29 [cited 2022May3];65(2):DM210.
- 2022 Saleh Contell K, Karlzén K, Cocco M, Pedersen HA, Atakan K, Bailo D, Lange O, Mercurio D, Maracchia G, Piras D, Sangianantoni A, Fredella M, Freda C., Long-term sustainability of a distributed RI: the EPOS case . Ann. Geophys. [Internet]. 2022Apr.29 [cited 2022May3];65(2):DM209.
- 2022 Cocco M, Freda C, Atakan K, Bailo D, Saleh-Contell K, Lange O, Michalek J. The EPOS Research Infrastructure: a federated approach to integrate solid Earth science data and services. . Ann. Geophys. [Internet]. 2022Apr.29 [cited 2022May3];65(2):DM208.
- 2022 Alessandro Spinuso, Mats Veldhuizen, Daniele Bailo, Valerio Vinciarelli, Tor Langeland; SWIRRL. Managing Provenance-aware and Reproducible Workspaces . Data Intelligence 2022; doi: https://doi.org/10.1162/dint_a_00129
- 2020 Romain David, Laurence Mabile, Alison Specht, Sarah Stryeck, Mogens Thomsen, Mohamed Yahia, Clement Jonquet, Laurent Dollé, Daniel Jacob, Daniele Bailo, Elena Bravo, Sophie Gachet, Hannah Gunderman, Jean-Eudes Hollebecq, Vassilios Ioannidis, Yvan Le Bras, Emilie Lerigoleur, Anne Cambon-Thomsen, The Research Data Alliance – SHaring Reward and Credit (SHARC) Interest Group, FAIRness Literacy: The Achilles' Heel of Applying FAIR Principles . Data Science Journal, 19(1), 32. DOI: <http://doi.org/10.5334/dsj-2020-032>

**EPOS: A NOVEL GEOSCIENCE OPEN DATA PLATFORM
FOR A BETTER UNDERSTANDING OF PLANET EARTH
Daniele Bailo, Rossana Paciello, Carmela Freda
EPOS team**

Understanding how the Earth works as an interconnected system of physical and chemical processes that control earthquakes, tsunamis, volcanic eruptions, as well as all processes driving tectonics and Earth surface dynamics, is crucial for modern society. Presently, European countries own and operate a mosaic of hundreds of distributed, but separated, research infrastructures that include observing networks, observatories, temporary deployments of instrumentation, laboratories and modelling facilities for solid Earth scientific research. Therefore, scientific investigations into these processes tremendously benefit from seamless, trans-national integration of geographically distributed measurements through observing, experimental, and modelling systems.

EPOS, the European Plate Observing System, harmonizes and integrates multidisciplinary solid Earth data acquired through diverse scientific systems and optimizes their open access by interacting and cooperating with e-science experts. By improving and facilitating the access, use, and re-use of solid Earth science data, data products, services and facilities, EPOS contributes to maintain and extend the leading role of Europe in solid Earth science research. EPOS, being the sole research infrastructure representing solid Earth science in Europe, is in the special position of potentially interacting in synergy with other initiatives both in Europe and worldwide not only in the solid Earth domain, but also in the atmospheric, marine and biodiversity, and e-science domains.

The session will present the achievements of the EPOS community with a focus on the EPOS Data Portal which provides access to data and data products from ten different geoscientific areas: Seismology, Near Fault Observatories, GNSS Data and Products, Volcano Observations, Satellite Data, Geomagnetic Observations, Anthropogenic Hazards, Geological Information and Modelling, Multi-scale Laboratories and Tsunami Research.

Through a short demo we will present how the integrated use of multidisciplinary solid Earth science data enable innovative research for a better understanding of the Earth's physical and chemical processes that control earthquakes, volcanic eruptions, ground instability, tsunami as well as the processes driving tectonics and Earth's surface dynamics. Indeed, the use of integrated data will allow the Earth Science community to make a step change in developing new concepts and tools for key answers to scientific and socio-economic questions concerning geo-hazards and geo-resources as well as Earth sciences applications to the environment and to human welfare, thus contributing to the UN Agenda 2030 for Sustainable Development and related goals.

GIFT POSTER SESSION

	<p align="center">GIFT POSTER SESSION EOS 5.2 “AGENDA 2030 at School”</p> <p>Convener: Stephen MackoCo-convener: Annegret Schwarz</p>
1	<p>X2.11 EGU23-115 <u>Building International Capacity In Earth Sciences Education Through GIFT Workshops</u> Jean Luc Berenguer and the EGU Committee on Education</p>
2	<p>X2.12 EGU23-116 <u>Over 20 Years of Geoscience Information for Teachers (GIFT) Workshops at the European Geoscience Union General Assembly</u> Jean Luc Berenguer and the EGU Committee on Education</p>
3	<p>X2.13 EGU23-1716 <u>What future awaits us if we do not take action against climate change? CHANGE TO ANOTHER PLANET</u> Carme Hernandez</p>
4	<p>X2.14 EGU23-1740 <u>The fate of erosion products</u> Nicolas Fayemendy</p>
5	<p>X2.15 EGU23-1760 <u>Stone Dolls</u> Pane Perunovski</p>
6	<p>X2.16 EGU23-1784 <u>Carbon of Our Planet</u> Sladjana Jovic and Bojana Mitriceski Andjelkovic</p>
7	<p>X2.17 EGU23-1811 <u>Learning Situation through commentary activities of the Canarian and African natural coasts.</u> PhD. Antonio Delgado García</p>
8	<p>X2.18 EGU23-1842 <u>Beauty of Science</u> Mukta Kulkarni</p>
9	<p>X2.19 EGU23-1913 <u>U-DATinos: An automated IoT device for monitoring water quality in lakes and rivers</u> Chrysanthi Tziortzioti, Panagiotis Verras, and Irene Mavrommati</p>
10	<p>X2.20 EGU23-1925 <u>Earthlearningidea: 15 years on and still going strong!</u> Pete Loader, Chris King, Elizabeth Devon, and Peter Kennett</p>
11	<p>X2.21 EGU23-1930 <u>Linguistically Science (Using EGU Planet Press to promote Science in a native language)</u> Michael Anthony Pope</p>
12	<p>X2.22 EGU23-2010 <u>Astronerds saving the world</u> Panagiota Alexandra Fratti</p>

13	X2.23 EGU23-2077 <u>Arduino coding in the classroom</u> Veronique Bouquelle
14	X2.24 EGU23-2194 <u>Learning the Concept of Sustainability: Interdisciplinary Activities @Primary Education</u> Daniela Damian
15	X2.25 EGU23-2208 <u>The Energy Dilemma. Let's debate!</u> Annalaura Achenza
16	X2.26 EGU23-2344 <u>Steam Hub Project - Seismo Lab Activity</u> Baltag Andreea Marcela
17	X2.27 EGU23-2348 <u>The Interdisciplinary Approach of Physics and Its Role in Environmental Protection</u> Gabriela Tudor
18	X2.28 EGU23-2369 <u>Educational trails of the Carpathian Schools</u> Fenesan Mirela Dana
19	X2.29 EGU23-2412 <u>Improving STEM Education Across European Schools</u> Nadia Grozavescu
20	X2.30 EGU23-2873 <u>How to reduce and manage the end-of-life of plastics and find an alternative to plastics?</u> Raffaella Fatica
21	X2.31 EGU23-3030 <u>Developing and assessing systems thinking competencies in geography education: through rubric-based feedback</u> Keishin Shuto
22	X2.32 EGU23-3522 <u>Understanding the role of coal in CO2 geological sequestration</u> José Vieira da Silva, Cristina Rodrigues, Celeste Pimenta, and Manuel J. Lemos de Sousa
23	X2.33 EGU23-3583 <u>"C4TS IN SPACE" project – Carrying Four Tiny Sensors with a high-altitude balloon at the upper limit of the atmosphere</u> Diana Cristina Bejan
24	X2.34 EGU23-3586 <u>Interdisciplinarity through extra-curricular projects</u> Alina Stefania Lazar
25	X2.35 EGU23-3636 <u>EGU (European Geosciences Union) Field Officer Programme In Türkiye</u> Candan Kafalı

26	X2.36 EGU23-3694 <u>A key for education towards the Agenda 2030 Goals: the integration among geosciences, biology and chemistry.</u> Ilaria Furfori
27	X2.37 EGU23-3862 <u>IRiS: a professional telescope at the service of students</u> Emmanuelle Jammart, Stéphane Basa, Bertille Mille, Lisa Lemee, Lou-Eva Marchand, Clément Marciaux, Emily Chiev, and Mazir Houari
28	X2.38 EGU23-3873 <u>Walking around the geopark of Cabo de Gata-Níjar- Spain</u> José Miguel Cantos
29	X2.39 EGU23-3945 <u>Transferring The Space Mining Legacy – Teaching The Next Generation About the Contemporary Space Mining Concepts</u> Raymond Kudzawu-D’Pherdd, Hassan Al Hassan, and Ekow Bartels
30	X2.40 EGU23-3979 <u>SUSTAINABILITY HUB: a virtual world island to teach Agenda 2030 and Sustainability</u> Michelina Occhioni, Alessandra Beccaceci, and Eleonora Paris
31	X2.41 EGU23-4109 <u>Minerals in your daily life: a game for science education</u> Isabel Teixeira and Dulce Lima
32	X2.42 EGU23-4156 <u>Promoting Geosciences Education for Sustainability by educational project</u> ines freyssinel
33	X2.43 EGU23-4287 <u>Geography in Ukraine, at school, in the heart</u> Valentina Kitchenko
34	X2.44 EGU23-4424 <u>The CRL School in the European Education community and the modern classroom</u> Fotios Danaskos, Kyriaki Makri, George Kaviris, and Panagiotis Elias
35	X2.45 EGU23-4480 <u>Is it a science fiction movie or reality of the future?</u> Ayca Akin
36	X2.46 EGU23-4498 <u>Taking care of our planet: measuring and managing the environmental impact</u> Caterina Stornelli
37	X2.47 EGU23-4519 <u>Green Energy Saves the Earth</u> Mutlu Cansu Kaya
38	X2.48 EGU23-4986 <u>Accurate information is power</u> Ruzhica Jagurinoska

39	X2.49 EGU23-5110 <u>Analysis of water purity and its influence on ecosystems</u> Maghiar Ramona
40	X2.50 EGU23-5484 <u>Earth science teaching in Italy and Sustainable Development Goals (SDGs), how is it going?</u> Teresita Gravina and Alessandro Iannace
41	X2.51 EGU23-7232 <u>The Role of Teachers' Competencies in Education of Sustainable Development</u> Natalija Aceska
42	X2.52 EGU23-7242 <u>We invent pictograms</u> Beba Ugrenović and Biljana Kovačić
43	X2.53 EGU23-7278 <u>Course of human geography with climate change point of view</u> Laura Hallanoro
44	X2.54 EGU23-7397 <u>Teaching science, sustainability and technology through gamification: The approach of escape rooms.</u> Angeliki Alexandropoulou and Athina –Spyridoula Tsezou
45	X2.55 EGU23-8290 <u>Data Mining at school with InSight space mission</u> Jean Luc Berenguer, Dragos Tartaru, Julien Balestra, and Christelle Saliby
46	X2.56 EGU23-8727 <u>Geoscience Today And Tomorrow In The Ukrainian Physical And Mathematical Lyceum Of Taras Shevchenko National University Of Kyiv</u> Armine Melnyk-Mirzoian
47	X2.57 EGU23-9044 <u>The history of Geosciences, as teaching scenario</u> Kyriaki Makri and Fotios Danaskos
48	X2.58 EGU23-9099 <u>Ecogaming for circular economy</u> Crina Elefteriu
49	X2.59 EGU23-9230 <u>Teaching Sustainable Development through indoor and outdoor activities</u> Anca Chitu
50	X2.60 EGU23-9606 <u>Ancient science laboratorial instruments from Latino Coelho High school, Lamego, Portugal</u> Andreia Liliana Santos Borges
51	X2.61 EGU23-9730 <u>Geosciences and alternative teaching practices in a French primary school.</u> David Grandclément

52	X2.62 EGU23-9754 <u>The EGU Geoscience Education Field Officer Programme is growing!</u> Gina P. Correia , Giulia Realdon, Helder Pereira, Anna Anglisano Roca, Guillaume Coupechoux, and Xavier Juan
53	X2.63 EGU23-10028 <u>Monitoring and protecting a river ecosystem near the school: a path to sustainability through field trips</u> Tânia Pinto and Clara Vasconcelos
54	X2.64 EGU23-10276 <u>Middle Jurassic at Praia da Mareta, Algarve</u> Maria Assunção
55	X2.65 EGU23-10298 <u>Hydroponics in the Urban Classroom: Learning geoscience in the classroom while addressing issues on food justice.</u> Carolina Castro-Skehan
56	X2.66 EGU23-10793 <u>Using Ancient Greek Myths to teach Geology in High School</u> Natassa Detsika
57	X2.67 EGU23-11223 <u>Using Sustainable Storylines to Support Next Generation Science Standards at the Middle School Level – Natural Hazards and Tsunamis</u> Tricia Kearns
58	X2.68 EGU23-12286 <u>Teachers training on climate change</u> Athina Ginoudi
59	X2.69 EGU23-12868 <u>Creating School Seismology Labs For the Development of Students'</u> Cristina Simionescu , Dragos Tataru, Eduard Nastase, Eduard Necula, Adina Vanciu Rau, and Bogdan Zaharia
60	X2.70 EGU23-14701 <u>2019-2022 - EGU Geoscience Education Field Officer Programme across the COVID-19 pandemic</u> Giulia Realdon , Xavier Juan, Guillaume Coupechoux, and Gina Correia
61	X2.71 EGU23-14868 <u>Collaborative Implementation of the Polar Star Project Toolkits, using science to inspire students' interest in how the world works</u> Svetla Mavrodieva
62	X2.72 EGU23-16206 <u>The development of the teacher's professionalism: a Gowin's V as an inquiry-based resource</u> Dulce Lima , Nir Orion, and Clara Vasconcelos
63	X2.73 EGU23-16525 <u>Agenda 2023 at school: making chemistry curriculum more sustainable</u> Rosana Marques

64	X2.74 EGU23-16980 <u>ROLL IN STONES How to get students excited about studying rocks</u> Marta Azevedo and José Fradique
65	X2.75 EGU23-17130 <u>Learning Geo-Edu-Ethics at Junior High School</u> Gloria Gordini and Elena Astore
66	X2.76 EGU23-2119 <u>NAOseuM - NAO a bridge between past and future-Challenges in STEAM Education</u> Costantina Cossu and Simonetta Falchi
67	X2.77 EGU23-4380 <u>Bringing AMS and NOAA Oceanic water testing field experience in a chemistry class</u> Bhavna Rawal and Nundini Rawal
68	X2.78 EGU23-6281 <u>From Class to Universe</u> Ayşe Fizan Sasa , Dilek Özgül, Onur Kırık, Seher Gül, Kadir Yetiş, Umut Guzel, Fatma Sevgi Aydın Altınışik, Aylin Açıkgöz, Cihannur Kırık, and Hisamiddin Dinç

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