



Preface to the special issue of the Division Energy, Resources and the Environment at the EGU General Assembly 2023

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Received: 8 January 2024 – Published: 19 January 2024

Abstract. The European Geosciences Union (EGU) brings together geoscientists from all over Europe and the rest of the world, covering all disciplines of Earth, planetary and space sciences. The Division on Energy, Resources and the Environment (ERE), as part of the EGU, follows an interdisciplinary approach to serve society and provide solutions to challenges of our time and in the future. One task for humankind, for example, is to provide adequate and reliable supplies of affordable energy and other resources, obtained in environmentally sustainable ways, which will be essential for economic prosperity, environmental quality and political stability around the world. This volume of *Advances in Geosciences* spans the range of topics of the division and continues a series of ten ERE special issues over the course of the last ten years. We incorporate emerging topics into the division ERE along the line and we advocate that every idea and opportunity should be studied and tested.

Preface to the special issue 2023

The EGU brings together geoscientists from all over Europe and the rest of the world, covering all disciplines of the Earth, planetary and space sciences. This geoscientific interdisciplinarity is needed to tackle the challenges of the future. A major task for humankind is to provide adequate and reliable supplies of affordable energy and other resources. These should be obtained in environmentally sustainable ways, which is essential for economic prosperity, environmental quality and political stability around the world. One goal of the division Energy, Resources and the Environment

(ERE) is to be a leading discussion forum for these issues. The core of the division consists of experts in various fields that will help meet the mutually coupled challenges of energy, resources and the environment.

The scientific activities of the EGU are organised through the Divisions, encompassing all studies of the Earth, its environment, and the effects of anthropogenic activities. The major task is to provide a sub-programme for the General Assembly of the EGU. With that we want to bring together scientists and foster discussion between them. This year's conference was held from 23 to 28 April 2023 in Vienna. The Union is supposed to pursue scientific objectives exclusively. Through our Division, we promote cooperation and discussion among scientists concerned with studies about the resources of the Earth and how we can provide e.g. energy for humankind in a sustainable way.

The use of natural resources is always and unavoidable associated with environmental impacts. This was explicitly reflected in the program of ERE with the chapters “Landscape and Land Use” we had in the years 2013 (Kühn et al., 2013) and 2014 (Juhlin et al., 2014) or “Impact of energy and resource exploitation on the environment” through the years 2015 to 2018 (Kühn et al., 2015, 2016; Martens et al., 2017, 2018). Within 2023 sessions like “Towards a sustainable low-emissions future: the role of low-carbon energy sources and Land Use, Land-Use Change and Forestry” or “Control of Post-mining Issues – A Global Perspective” covered that under the chapter “Integrated Studies”. The latter has been an integral part of the division's multidisciplinary programme since 2015. We have to accept that resource utilisation has significant consequences.

Natural resources provide the material, energy and basis of our standard of living. In addition to abiotic and biotic raw materials, we use water, soil, air, land and other resources, such as wind, solar energy or tidal currents as a source of energy. Energy is one of the division's most important topics. In 2013 (Kühn et al., 2013) and 2014 (Juhlin et al., 2014) this was a chapter by itself and developed further in the years 2015 through to 2019 into the areas "Carbon based energy" and "Non-carbon based energy" (Kühn et al., 2015, 2016; Martens et al., 2017, 2018, 2019). In the years 2020 (Martens et al., 2020) and 2021 (Bruckman et al., 2021) the program was set up with "Renewable energy" and "Fossil energy" and most recently in 2022 (Bruckman et al., 2022) and 2023 it is reduced to "Renewable energy" considering the current developments around the globe.

Natural resources are required as well as a sink for emissions and to absorb our waste. A strong chapter in the years 2013 (Kühn et al., 2013) and 2014 (Juhlin et al., 2014) was "CCS – Carbon Capture and Storage" which developed from 2015 to 2019 into "Geo-storage for a sustainable future" (Kühn et al., 2015, 2016; Martens et al., 2017, 2018, 2019). In the last years this chapter has been labelled "Geo-storage" (Martens et al., 2020; Bruckman et al., 2021, 2022). Integral part in that are sessions like "Geological Repositories – Geosciences in the assessment of radionuclide migration and long-term evolution of the geosphere" since a couple of years.

Our use of resources changes our ecosystems, often permanently. The extraction and processing of non-renewable raw materials is often energy-intensive, involves considerable interference with the natural and water balance and leads to emissions of pollutants into water, soil and air. The production and extraction of renewable raw materials is also often associated with high energy, material and chemical inputs, is sometimes water-intensive and is accompanied by a wide range of pollutant emissions. In 2023 we ran the session "Challenges of circularity: Considering the energy and material demands/benefits of a circular economy across global supply chains" in that regard and in general covered the topic over the years 2015 to 2020 as chapter "Geo-materials and natural resources" (Kühn et al., 2015, 2016; Martens et al., 2017, 2018, 2019, 2020). Since then, this theme has been referred to as "Raw materials" (Bruckman et al., 2021, 2022). In principle, every extraction and processing of a raw material has an impact on the environment.

What makes things even worse, the utilisation of natural resources already significantly exceeds the earth's ability to regenerate. This is because natural resources are only available in limited quantities and often not in high quality. The program of the division ERE dealt with those issues in 2023 in sessions like "Sustainable solutions for proactive mine and quarry waste management and raw material supply valorization", "Powering low carbon transition within planetary boundaries" or "Solutions for sustainable agri-food systems under climate change and globalisation". Global population

growth and the associated increasing pressure on natural resources is constantly rising and can increasingly lead to competition for utilisation.

In addition to the consequences for the environment, the use of natural resources also has a wide range of social impacts. This is because it is linked to issues such as the distribution of raw materials, secure access to fresh water and food security for people around the world. This is why the division introduced the session "The water, energy, food, ecosystem nexus: complex dynamics, uncertainties and implications" into the program 2023.

In order to reduce the negative consequences of resource consumption to an ecologically and socially acceptable level, strategies are needed for the careful and more efficient use of resources in production and consumption. Waste management and the legal regulations on product responsibility also make an important contribution. From this perspective, the division Energy, Resources and the Environment (ERE) is endeavouring to make a significant contribution here, for example with the sessions like "Cultural heritage and the environment: interaction, vulnerability, past and future changes". The cultural heritage of mankind and its sustainable development has been a key component of the programme for many years now.

The programme during the General Assembly of the EGU in 2023 from ERE covered the chapters integrated studies, renewable energy, geo-storage, raw materials and process coupling and monitoring related to geo-energy applications. The contributions came from 1881 members of a total of 19 886 of the EGU with 59 % male and 38 % female and overall 77 % early career scientists (ECS). The division ran 23 sessions and co-organised another 16 and received 585 respectively 988 abstracts. This volume of *Advances in Geosciences* spans the range of topics of the division and continues a series of ten ERE special issues over the course of the last ten years (Bruckman et al., 2021, 2022; Kühn et al., 2013, 2015, 2016; Juhlin et al., 2014; Martens et al., 2017, 2018, 2019, 2020). We incorporate emerging topics into the division ERE along the line and we advocate that every idea and opportunity should be studied and tested.

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Acknowledgements. We would like to thank all participants for their contributions to EGU2023. Our special thanks go to the conveners, who made the program of the ERE division possible. We would also like to thank all reviewers for their effort and time put into the evaluations of the contributions within this special issue.

Financial support. The article processing charges for this open-access publication were covered by the Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences.

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