

## Introduction: geoethics goes beyond the geoscience profession

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**Abstract:** This is the second volume focused on geoethics published as a Special Publication of the Geological Society of London, a significant step forward in which authors address the maturation of geoethics, a maturity that has strengthened its theoretical foundations in recent years and increased the insight of its reflections. The field of geoethics is now ready to be introduced outside the geoscience community as a logical platform for global ethics that addresses anthropogenic changes. What is clear is that geoethics has a distinction in the geoscientific community for discussing the ethical, social and cultural implications of geoscience knowledge, research, practice and education, as well as communication. This provides a common ground for integrating ideas, experiences and proposals on how geosciences can provide additional services to society, in order to improve the way humans interact responsibly with the Earth system. This book provides new messages to geoscientists, social scientists, intellectuals, law- and decision-makers, and laypeople. Motivations and actions for facing global anthropogenic changes and their intense impacts on the planet need to be governed by an ethical framework capable of merging a solid conceptual structure with pragmatic approaches based on geoscientific knowledge. This philosophy defines geoethics.

Since its foundation, the International Association for Promoting Geoethics (IAPG; <https://www.geoethics.org>, accessed 21 July 2020) has included in its strategy the publication of papers and books, subject to a rigorous peer-review process, through which to share advances in geoethical studies and applications of geoethical thinking in geoscientific practices, including case-studies. Those publications were intended to introduce reflections on the intersection between geosciences and humanities, social sciences and economics within the framework of scientific debate in geosciences. After all, geosciences comprise a set of disciplines that impact not only other scientific fields, but also philosophical, sociological and economic studies. This interdisciplinary nature triggered reflections by scientists and intellectuals from different cultural and academic backgrounds. The multidisciplinary and transdisciplinary discussions around geoethics are still at an early stage. However, growing forays by scholars from outside the geoscience community into publications on geoethics provides an encouraging sign of integration of cultural experiences and

interdisciplinary cross-pollination. The ultimate aim of this cooperation is to increase intra- and interdisciplinary awareness of the cultural value of geoscientific knowledge. Geosciences is not just a body of technical–scientific knowledge. The methods and intellectual content of geoscience are a way of approaching reality, of perceiving natural reality and the certainty of non-human nature with human realities, and of getting feedback in a continuous process of building humans’ intellectual structures. Geosciences are a cultural bridge between science, society and nature.

Note that the current development of geoethical thinking, as illustrated in Bohle (2019), derives from the definition of geoethics, which has been expanded and enriched in Di Capua and Peppoloni (2019): ‘(geoethics) 1) Consists of research and reflection on the values which underpin appropriate behaviours and practices, wherever human activities interact with the Earth system .... 2) Deals with the ethical, social and cultural implications of geoscience knowledge, research, practice, education and communication, and with the social role and

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responsibility of geoscientists in conducting their activities .... 3) Encourages geoscientists and wider society to become fully aware of the humankind's role as an active geological force on the planet and the ethical responsibility that this implies.'

The volume published in 2012 (Peppoloni and Di Capua 2012) provided insights with the final goal 'to recover the true meaning of being geoscientists and to highlight the active roles we can have in promoting new cultural values in modern society, on which to build a more conscious relationship between man and Nature'. This was the first volume in an international scientific journal dedicated to issues of geoethics and geological culture, in which the editors underlined 'the need for rediscovery of the cultural values of geology as a science that can contribute to the construction of ... social knowledge, and the need to be aware that geoethics cannot exist without a real awareness among geoscientists of the cultural value of the Earth sciences'. Papers collected in that issue offer reflections across themes, including 'philosophy of science, sociology, information and education about natural phenomena in both developing and developed countries, scientific communication and the relationships between science, media and policy makers, environmental sustainability and geodiversity, recovery of historical memory as a factor to prevent disasters, and the contribution of geological culture to the strengthening of the link between the identity of populations and their territories'. That special issue triggered numerous national and international initiatives and a collection of subsequent publications that show a clear outline in the progression of the development of geoethical thinking.

### Expanding and exploring geoethics

Following the geoethics session organized in 2013 at the European Geosciences Union General Assembly in Vienna (<https://meetingorganizer.copernicus.org/EGU2013/session/11853>, accessed 21 July 2020), the first book on geoethics, entitled *Geoethics: Ethical Challenges and Case Studies in Earth Sciences*, was released in November 2014, but dated 2015 (Wyss and Peppoloni 2015). Whereas some elements for the development of geoethics were suggested in the special volume of *Annals of Geophysics*, cited previously, the book by Wyss and Peppoloni is the first attempt to tackle deeper discourse on geoscientific topics from a more prominent ethical and social perspective. In Peppoloni and Di Capua (2015a) the initial formulation of the current and consolidated definition of geoethics (Di Capua and Peppoloni 2019) and a progressive widening of the theoretical aspects of what will become the current geoethical thinking

(Peppoloni *et al.* 2019) were provided. Wyss and Peppoloni highlighted that the chapters of their book were 'written by a global group of contributors with backgrounds ranging from philosopher to geopractitioner, providing a balance of voices. Includes case studies, showing where experts have gone wrong and where key organizations have ignored facts, wanting assessments favorable to their agendas. Provides a much-needed basis for discussion to guide scientists to consider their responsibilities and to improve communication with the public'. This means two significant things: authors with philosophical backgrounds were interacting with geoscientists by providing reflections on the meaning of geosciences and their ethical implications. For their part, geoscientists were making efforts to observe and reflect on their professional experiences by asking themselves 'where experts have not served the public, what more could have been done to reach and serve the public and the ethical issues surrounding the Earth Sciences, from a global perspective'.

The reflection by geoscientists on these issues is certainly not new, especially for those who are used to applying geosciences in the defence against natural hazards or in the mining sector. In fact, geoscience–society interactions are evident in those two fields of geoscience applications. Most likely some may have thought that there were no 'geoethical' reflections in the decades before the word 'geoethics' was used for defining theoretical foundations of responsible behaviour towards the Earth system and the complex of reflections on ethical, social and cultural implications of geosciences (Peppoloni and Di Capua 2015b; Bobrowsky *et al.* 2018). In addition, as Peppoloni and Di Capua (2020) point out, the reflections by Zen (1993) and Moores (1997) also continue to be a point of reference for the geoscientific community, a strong reminder to reflect carefully on the ethical meaning of geoscience profession and on benefits that geosciences can bring to society. The book by Wyss and Peppoloni (2015) remains a pillar in the development of geoethics, for the richness of its contents concerning philosophical reflections, ethics of practice, anthropogenic and natural hazards, utilization of resources and low-income and Indigenous communities, as related to the geoscience community. From a careful reading, we confirm that geoethical reflection has the potential to venture beyond the field of professional ethics and intradisciplinary analyses. The philosophical contents of the book and the experiences discussed, assessed in the light of the impacts of professional choices on society, formally started in 2014 as part of geoethical reflections (Bohle 2019).

In 2014, a session on geoethics organized at the XII Congress for the 50th anniversary of the International Association for Engineering Geology and

the Environment (<http://iagpgeoethics.blogspot.com/2014/08/the-iaeg-session-on-geoethics-at-iaeg.html>, accessed 21 July 2020) provided the starting point for a new book that aimed to connect the geoethical thinking to another interesting field in geoscience application: engineering geology (Lollino *et al.* 2014). As indicated in Art. 2 of the Association's Statutes (1992; <https://www.iaeg.info/wp-content/uploads/2018/12/iaeg-statutes.pdf>, accessed 21 July 2020) 'engineering geology is the science devoted to the investigation, study and solution of the engineering and environmental problems which may arise as the result of the interaction between geology and the works and activities of man as well as to the prediction and of the development of measures for prevention or remediation of geological hazards'. Engineering geology is one of the geoscience fields in which human interaction with Earth system forms and processes is most evident, leading to a set of direct and collateral professional, ethical and social problems related to the construction of large infrastructures, defences against hazards and studies on environmental impacts by human activities. The book by Lollino *et al.* (2014) has a specific section dedicated to 'Geoethics and Natural Hazards' in which the authors focus on geoscience communication, geo-education and the science-policy-practice interface, in some cases inspired by the L'Aquila Earthquake case after the  $M_w$  6.3 earthquake in 2009 in central Italy that claimed 300 victims. Six scientists were initially convicted for negligence in the seismic risk assessment. After two further levels of judgement, in November 2015 those scientists were acquitted, but the discussion about stakeholder relationships and the responsibilities of scientists-decision makers-media-population has been permanently influenced and shaped by that case and inevitably has led geoscientists to confront the ethical dimension of their profession and their obligations towards society (Cocco *et al.* 2015; Geller 2015; Mucciarelli 2015). The L'Aquila earthquake case cast a light on the role and responsibilities of the geoscience community to manage knowledge for public use, to communicate that knowledge to authorities who are in charge of safeguarding citizens' safety, to disseminate information through the media to others in order to increase risk perception and act preventively in risk mitigation.

These are the contents of the first book on geoethics published in 2015 by the Geological Society of London (GSL; Peppoloni and Di Capua 2015b). The cover of the book (Fig. 1) contains an emblematic image of the fragility of the human condition on a dangerous planet, when people do not adopt adequate risk mitigation policies that are scientifically based and widely shared by communities.

Since the L'Aquila event, it has become increasingly clear that there must be a growing

awareness of professional responsibilities by geoscientists at the heart of geoethics. However, without further discussion of professional obligations and the social role that geoscientists play, geoethics would have remained as a beautiful but soulless idea. After 5 years of work in which geoethics had significantly progressed qualitatively (in its contents) and quantitatively (in the number of events and publications), it was necessary to consolidate its starting point for a new leap forward. The 2018 volume (Gundersen 2018) was a result of this necessity.

The aim of the 2018 volume was to re-analyse and deepen the meaning of doing geoscience with rigour and integrity. The thesis of this book was: 'Science is built on trust. The assumption is that scientists will conduct their work with integrity, honesty, and a strict adherence to scientific protocols. Written by geoscientists for geoscientists, *Scientific Integrity and Ethics in the Geosciences* acquaints readers with the fundamental principles of scientific ethics ... It is also useful for geoscientists working in industry, government, and policymaking'. The book contains chapters on codes of ethics and conduct, research/scientific integrity and the role of geoscience professional societies in assuring scientific integrity and ethics.

In the 2018 volume, there are multiple approaches to geoethics. First, there is an attempt to historically locate the origin of geoethical thinking, in relation to the growing anthropogenic impacts on the planet, and insights into its reference values and its topics of interest are provided (Bobrowsky *et al.* 2018; Mogk *et al.* 2018). Then, Bobrowsky *et al.* (2018) try to grasp the sense of being geoscientists and how professional obligations are addressed by some scientific organizations. For example, they consider the meaning of service to society, and the contribution of geosciences to transdisciplinary debates on some global issues from the point of view of geoethical thinking, such as climate change, georisks, natural resources, engineering geology, geoscience communication, geo-education, the protection of geoh heritage and geodiversity, sustainability and resilience. In the 2018 book, there is also speculation about the future of geoethics, identifying the following issues:

- How do we teach geoethics (Mogk *et al.* 2018)?
- How do we get scholars with different technical, scientific and cultural backgrounds to collaborate on multiple-disciplinary and multiknowledge approaches (Bobrowsky *et al.* 2018)?
- How can we reinforce the linkage between geodiversity and cultural diversity (Bobrowsky *et al.* 2018)?
- What is the role of cultural lobbying within the geoscience community to increase the importance



Fig. 1. Cover of the first book on geoethics published by Geological Society, London (Peppoloni and Di Capua 2015b).

and dissemination of geoscience knowledge into society starting with the sharing of scopes and initiatives (Bobrowsky *et al.* 2018)?

In spite of the publication of the 2018 book, the multipurpose character of geoethics integrating intra- and extra-professional ethics is only slightly evident, and not clearly obvious. This book remains the main reference of geoethics in its initial connotation of professional ethics, albeit with some important projections towards society.

Subsequently, a new *Annals of Geophysics* special issue (Peppoloni *et al.* 2017) proposed that geoethics starts its next stage of deepening the relationship between geosciences and society, with an ever clearer intrinsic awareness reflected by its title: *Geoethics at the Heart of all Geoscience* (this 'motto' was proposed by Nic Bilham during his speech entitled 'Geology for Society – engaging geoscientists, policy-makers and the public in meeting our future resource needs sustainably' at the 35th International Geological Congress (IGC) in Cape Town, South Africa). The special issue, full of ideas and analyses on a wide range of geoethical topics, is the result of the great success of the six sessions on geoethics and a panel organized by the IAPG at the 35th IGC in 2016 (<https://www.geoethics.org/35th-igc>, accessed 21 July 2020). Many works presented at the IGC flowed into this volume along with other reflections and insights coming from the session on geoethics at the European Geosciences Union General Assembly 2017 (<https://meetingorganizer.copernicus.org/EGU2017/session/23692>, accessed 21 July 2020). The special issue highlights a growing mix of reflections between geoscientists, philosophers and sociologists on topics of interest for geoethics, enriching the reference literature with theoretical analyses, case studies, complaints of fraud and operational proposals. The Cape Town Statement on Geoethics, the reference document for putting the IAPG vision on geoethics into action, which contains the Geoethical Promise (Matteucci *et al.* 2014), now translated into 35 languages (Peppoloni 2018) and supported by numerous geoscience organizations (<https://www.geoethics.org/ctsg>, accessed 21 July 2020), was published in this *Annals of Geophysics* special issue in the paper by Di Capua *et al.* (2017).

A book edited by Bohle (2019) is the most recent step of this brief excursus. It has become increasingly evident that geoethics needs to more aggressively reach out to other disciplinary sectors external to geosciences in order to provide and receive ideas. Yet how can stable bridges be created with other knowledge, or other cultural experiences? This important book 'explores the potential of geoethics, as designed within the operational criteria of addressing the deeds and values of the human

agent as part of the Earth system' (Bohle 2019). The cultural transition is clear; the authors now speak of human agents, not simply geoscientists as actors. Geoethics now applies to a dimension of human experience that is no longer just the realm of professional geoscientists. Geoethics reflects an ethics of human responsibility to assure a sustainable development of society. In this perspective, Bohle and his co-authors wonders: 'i) What should be considered 'geoethics' in an operational sense? ii) What is peripheral to it? iii) Is there a case therefore to establish a denomination, such as geo-humanities or geosophy, to capture a broader scope of thinking about geoscience and its interactions with society and the natural world, for the benefit of the geoscientists and others?'. In the initial two chapters of Bohle (2019), the current development of geoethical thinking is presented; in the subsequent chapters, authors explore 'the societal intersections of geosciences in the planetary "human niche"', whereas in the concluding chapter they discuss 'the challenges facing the emerging field of geoethics and how it may evolve in the future'. This book is a great step ahead through which authors show that the maturity of geoethics has strengthened theoretical foundations and become more profound in its reflections. The road to new horizons is now open.

### Geoethics: status and future perspectives through the lens of this new GSL book

This book, *Geoethics: Status and Future Perspectives*, further develops the historical path outlined in sections 1 and 2. The chapters that comprise this book are articulated within this ideal reference framework, without forgetting the original core from which geoethics developed. Chapters cover several geoethical issues: theoretical aspects, science ethics, professionalism in geoscience, the role of a code of ethics/conduct, responsible management of georesources and its sociological aspects, water ethics, ethical implications in climate change matters, the geoscience–politics interface, international geoscience cooperation, ethics in georisk management and communication, geoscience communication, (geo)ethics in forensic geology, and space ethics. As evident in the book title, some traditional and crucial issues of geoethics such as professionalism and working climate issues are examined in the light of increased geoethical sensitivity. However, in addition, issues that mostly affect the geosciences and society interface are also addressed, with new perspectives, such as responsible management of natural resources, climate change, international cooperation in geosciences and communication. The book ends with a reflection that scans beyond the Earth's horizon, thinking of a humanity as



projected towards space. The book aims to suggest new topics for reflection and offers new concrete proposals to contribute to the cultural change of societies necessary to advance humanity towards a condition of increased justice, equity, inclusiveness and respect.

In chapter 1, **Peppoloni and Di Capua (2020)** provide an overview of current geoethical thinking and analyse the hot topics of geoengineering and deep sea/ocean mining from the perspective of geoethics. It is necessary to deepen the geoethical reflection on these topics in the near future, within both the scientific community and public opinion, by assessing more carefully their ecological impacts (from a technical and scientific point of view) and ethical and social implications (from a more philosophical point of view). The decisions that must be taken regarding the practice of geoengineering and deep sea/ocean mining must be supported by more robust scientific knowledge, by environmentally friendly designed methods and techniques, and by ethical frameworks capable of an acceptable alignment of values crossing economic, environmental and social interests. This chapter ends with an ambitious proposal: ‘a chart for a responsible course of human development, articulated in nine principles and actions, is proposed to trace a path for the future development of geoethics as a global ethics for society’.

The contribution by **Bohle (2020)** in chapter 2 discusses sense-making mechanisms within the ‘human niche’. That notion summarizes metaphorically what scientific notions describe as complex-adaptive social–ecological systems. Sense-making mechanisms are intrinsic parts of the human niche. As geoethics is designed to shape human sense-making, it offers cultural references, regarding analytical and affective sense-making. Therefore, geoethics may help human agents (individual, collective, and institutional) to handle ‘the complex-adaptive features ... of the human niche, such as anthropogenic pressure or participatory governance’.

The first two chapters focus on the more philosophical aspects of geoethical reflection, although oriented to provide concrete proposals to face global anthropogenic challenges, whereas some chapters that follow deal with issues related to geoscience professionalism, diversity in geosciences to achieve equitable, inclusive and safe professional practices, and the introduction of teaching geoethics in a geoscientist’s curricula. These chapters show a range of analysis and proposals, highlighting that the professional ethics dimension remains an essential aspect of geoethics.

In this regard, **Keane and Asher (2020)** in chapter 3 report that, in the US, ‘Though the need of ethical conduct by geoscientists has always existed, the uneven professional licensing and

standards for geoscientists as well as high profile misconduct by geoscientists is driving employer demand for geoethical competency’. Since ‘degree programs are poorly equipped to teach geoethics beyond academic honesty and research integrity’, they propose as a ‘means to address the deficiency’ a ‘proactive engagement by the community and students in co-curricular activities to address specific needs’ by using online on-demand professional development courses, despite problems that remain especially in ‘acceptance by faculty and employers in the geosciences’. After all, as **Cronin (2020)** affirms in chapter 4: ‘Many university geoscience departments have not incorporated considerations of ethics or geoethics into their routine operations, strategies for student development, curriculum, or research efforts. Starting to emphasize ethics within a departmental community takes an ongoing commitment’. The thesis by Cronin is that ethics and geoethics ‘should be the common thread that binds a university geoscience department together’ and his chapter can be considered a call for action, providing (geo)ethical frameworks and ‘structural steps to facilitate geoethical learning and practice’.

The paper in chapter 5 by **David Mogk (2020)** explores the concept of diversity in the geoscience profession, defining it through a very rich, in-depth, and articulated perspective that fits into the international discourse following many protests. The thesis by Mogk is that ‘the diverse ways of exploring the Earth system, and the complexity of the grand challenges facing humanity living on Earth, require contributions of experience, skills, knowledge, and motivations from diverse populations ... All people should have access and opportunity to pursue careers in the geosciences. Geoscientists have a responsibility to create work spaces that are welcoming, inclusive, safe and supportive’. In a certain sense, natural diversity can be understood only if human beings are able to create a world in which human diversity is respected and appreciated. The geoscience community has to start to change from within, and it is time to act now.

Regarding professional conduct, in chapter 6 **Bonham and Waldie (2020)** wonder ‘What ethical behaviour, exactly, should be desired of geoscientists? How is that desired ethical behaviour best instilled? And finally, and most importantly, is ethical behaviour enforced when geoscientists conduct themselves unethically?’ Three important questions which authors answer by looking ‘at how expectations concerning ethical behaviour (often referred to as “professional conduct”) in geoscience are typically established, articulated, and instilled’ through codes of ethics/conduct and exploring ‘the important role of enforcement in ethics compliance, including differences in enforcement approaches and actions’, because in their thesis, ethics enforcement

across all of geoscience is a transcending topic, not concerned with certification and licensing only. This chapter is a deep analysis of professional ethics in geoscience that will surely have an impact and will find much space for discussion within international professional communities.

Professionalism is also a key aspect in forensic geology as underlined in chapter 7 by **Dawson *et al.* (2020)** that outlines examples of where this discipline delivers to science and society. It requires ‘the competence of the scientist ...; best practice guidelines; duties of the expert’, since it can directly affect the legal condition of people. There is the necessity of taking into account ‘ethical aspects in forensic geology activities and ethical aspects in communicating evidence’. In order to improve the awareness about (geo)ethical implications in forensic geology, the authors outline ‘a proposal on which to build a white paper on geoethics in forensic geoscience, focusing on forensic geology per se, although of relevance to the wider forensic geosciences’. This white paper would be the result of a joint IAPG and IUGS Initiative on Forensic Geology (IFG) activity. The aim of the white paper is to build an ethical framework capable to help fill the ethical gap in the profession, defining ethical values in the applications and a set of guidelines for ‘geoscientists to refer to, defend and be guided by’ and for practising forensic geology across the world.

This is in line with calls for different communities of geoscientists in various countries to provide technical and scientific solutions that follow the best international standards to tackle a wide range of global problems. Only skilled and experienced professional geoscientists can ensure competence, credibility and reliability to society. Therefore, **Fernández-Fuentes *et al.* (2020)** illustrate in chapter 8 how in this framework, ‘systems for professional regulation and certification of geoscientists facilitate mobility, interchanging of ideas and knowledge, best ethical practice and protection of the public and environment’: under this perspective, the professional recognition of the ‘EurGeol’ title by the European Federation of Geologists, through a standard mechanism of evaluation, aims at strengthening a professional’s responsibility towards clients, society, and the environment and aspires to become an international qualification, despite differences existing in the professional competence, regulation, organization, and application around the world.

In addition, ‘geosciences are fundamentally transnational activities’ as stated in chapter 9 by **Ovadia and O’Connor (2020)**. The authors deal with international cooperation in geosciences and its ethical issues, showing lights and shadows. In their conclusion, the authors put in evidence that ‘Often, when

the researcher is asked by his or her university, institution or company to catch a plane to a remote place in order to do some science or attend a meeting, the last thought is whether that work should, ethically, take place and, if so, how it should be conducted. Compared to our colleagues in medicine, for example, as geoscientists we are far less constrained by regulations and procedure in what we do and how we do it. This is a precious freedom that can be easily lost if we fail to act ethically in our international activities’. So, Ovadia and O’Connor propose to build a code of ethics, in order to guide individuals and organizations ‘to deal with the inevitable challenges’ of international cooperation.

One of the geoscience and economic fields in which application of ethical framework is essential to assure a more equitable, sustainable, and just world is mining. To this aim, in this book chapters 10–12 are focused on different issues related to responsible mining from different perspectives. In chapter 10, **Boon (2020)** deals with a ‘sociological approach that links mineral exploration company characteristics such as management style, culture, skill sets, resources and social responsibility strategy to the core concepts of sociological theory’ that he shows to be the way for ‘managing a mineral exploration project and its interaction with surrounding communities’. The thesis of Boon’s chapter is that geosciences should establish dialogue with other sciences because their applications invest in problems related to human communities and their dynamics, that are investigated by sciences other than geosciences. A statement from his conclusions underlines his thought, to be intended as a sort of invitation to shift geoscientists’ perspective to interact with local communities affected by mining projects: ‘Relationships are the motor that drives mineral exploration projects through well-understood sociological processes’.

The necessity to change current and obsolete paradigms in mining and to embrace holistic perspectives is also the thesis by **Bilham (2020)** in chapter 11. He deals with the responsible mining concept considering different value chain actors (from mining companies to manufacturers), and illustrates the scope and results of a 2018 workshop organized by the GSL. This event brought ‘together mineral value chain actors and researchers to discuss responsible mining, responsible sourcing and certification of minerals, and opportunities and barriers to implementing and better connecting value chain actors’ responses to these challenges’. In his conclusions, Bilham highlights the implications of workshop outputs for research and practice. Failure to address existing and potential global economic and social power imbalances in mining activities and value chains can lead to what Bilham calls ‘resource neo-colonialism’. Geoscientists must be ready for

these challenges and work for a better future: ‘professional and ethical codes of conduct have an essential part to play in assuring others of the credibility and responsibility of geoscientists, and building relationships of trust’.

In chapter 12, **Mudd (2020)** provides a detailed and concise synthesis on key trends in mining and their implications, and frameworks for ethical, responsible and/or sustainable mining. He combined many datasets and unique studies on global mining of numerous metals and minerals and reviews the main protocols, chosen for their breadth of coverage or importance in establishing the concepts of responsible, sustainable or ethical mining, that are related to conflict minerals, extractive industries transparency, carbon disclosure, artisanal mining, or responsible mining. The final message by Mudd seems positive and encouraging: ‘Despite the numerous complex challenges – especially the increasing environmental burden of modern mining – there remains great optimism that the trajectory forward is positive, more sustainable and absolutely geoethical’.

In chapter 13, the message by **Groenfeldt (2020)** on water ethics is positive: ‘The widespread acceptance of agroecology as an alternative to monocrop industrial farming, and corporate support for water stewardship initiatives, illustrate a societal turn towards valuing a broader range of spiritual, environmental, and social benefits of water. We are undergoing a transformation in how we perceive the water around us. The need for clarifying the ethical foundations of water management decisions has never been greater’. Groenfeldt states that ‘A water ethics framework helps to integrate diverse and sometimes conflicting values’. A framework having among its pillars values recognized by geoethics as absolutely necessary in modern times, such as integrity, justice, and solidarity, owing to their powerful effect to create a ‘space for dialogue and mediation’ between sometimes conflicting perspectives.

It is well known that water management, and in particular groundwater, is a major challenge in natural resources governance due to the uncertainty of the nature of the resource in reserve estimation, the complexity of groundwater dynamics and evolution as well as the irreversibility of its use, when affected by overexploitation, including possible contamination: this is the focus of chapter 14 by **Bellaubi and Arasa (2020)** that deals with a case study in Spain. The authors present a geoethical dilemma in groundwater management. They propose ‘a method to explore the underlying conflicting values that may explain current management practices and a way forward to reverse current trends’ based on possible scenarios, that include technical, societal, decision-making and cultural considerations arising when taking into account different stakeholders. Like **Bilham (2020)**, they recall the necessity

for a more holistic approach in problem-solving or in taking decisions when dilemmas are present.

Although there are geological differences between managing groundwater and landslide risks, the need to have a more holistic approach is also the focus of the contribution by **Oboni and Oboni (2020)** in chapter 15, related to landslide risk management. These authors are convinced that deploying a holistic geoethical slopes’ portfolio risk mitigation brings numerous benefits: ‘confidence, clear decision-making and powerful leadership; clarity and transparency from streamlined risk assessment; optimum allocation of resources and effort, focusing detailed analyses where necessary; ease of internal and external communication thanks to the use of a clear glossary and definitions based on solid science; rational and unbiased inclusion of lessons learned; enhancement of disclosure transparency, negotiating angles and increase of competitive edge’. These approaches would permit one to face difficult public issues related to landslide risk mitigation programs in a more transparent and all stakeholder inclusive way.

It is clear that inclusivity in risk management needs an effective strategy for risk communication and that is the focus of chapter 16 by **Cerese (2020)**, analysed through the lens of ethics. The author affirms that ‘The growth and the consolidation of risk communications as an independent, cross-cutting discipline appear to be strictly connected to the growing concern for both public’s and individual recipients’ needs and rights. ... The shift from a source-centred approach toward negotiated and participatory approach to risk communication can be first explained as a by-product of social conflicts arisen in the risk arena’. The evolution of risk communication following numerous studies in social science and humanities has led to changes in its theoretical and operational paradigms, introducing ‘principled practices and well-established principles, arising from testing, evaluation and robust research evidence’, and has also suggested ‘a number of epistemological, methodological and ethical questions to be carefully evaluated’. This chapter provides ‘an analytical account of such a perspective change’, giving indications on future development in risk communication.

In chapter 17, **Stewart and Hurth (2020)** argue that rethinking of science communication and its wider implementation is fundamental to tackle long-term geo-environmental concerns of society. Their proposal may appear a provocation: geoscientists need to learn from ‘dominant paradigms that shape business marketing’ to improve effectiveness of science communication, since they ‘have a critical role to play in communicating to the public and policy makers what we know about present and future geo-environmental threats and challenges, such as



climate change, extreme natural events, resource conflicts and the energy transition'. Stewart and Hurth argue that 'scientists are the interface between the research organizations that produce knowledge and the wider public who could use that knowledge, and, in that regard, are akin to marketers in the business world'. Finally, Stewart and Hurth identify in newly emergent guide-and-co-create mode a promising communication key.

New communication modes are more than necessary as climate change issues demonstrate. In chapter 18, **Wuebbles (2020)** affirms that, although 'Science shows that human influence has been the dominant cause of observed warming and other major changes in the Earth's climate since at least the mid-20th century', 'that doesn't keep misinformation and overstatement of remaining uncertainties from appearing in the news, social media or in various blogs'. This means that 'distortions and misrepresentations of the science, or refutation of the underlying premises for basic physics' is a clear ethical issue, going beyond scientific skepticism and ignorance. Wuebbles outlines a reasoning on climate change ethics putting on the table some fundamental ethical dilemmas 'How do we balance the rights and responsibilities of the developed and developing nations of our planet? How do we sort out the possible use of geoengineering approaches that are being proposed to reduce or reverse climate change and/or its adverse societal impacts? How do we assess our responsibility to future generations for the actions we take today and the resulting changes in climate they must live with?'

We are asked to think about possible answers and, if we will not be able to find them, probably we should look toward the stars, so that in chapter 19, **McLean (2020)** proposes 'the development of a set of reasoning tools in the form of principles and virtue to guide scientists, the public, and policy makers in creating an ethical framework to steer and constrain our reaching out from Earth' 'allowing for prudent space exploration'. Yet we do not need to prepare solid rocket boosters to escape from Earth to Mars or other planets. McLean states that 'If we blast-off for Mars without having reassessed our relationship with the Earth system – both biological and geological – then we will have shirked our responsibility to "contribute to the conservation of the geosphere and its habitability for future generations" (Peppoloni and Di Capua 2015a, p. 8)'. So, if space ethics is an important emerging field for scientists, philosophers, and general thinkers, we should take care to develop and promote geoethics by favouring cultural, scientific, social, economic, technical and ethical paradigm shifts capable of routing humanity on more safe, just, inclusive and sustainable ways to live on our planetary home.

## Conclusions

Two years have passed since the idea of publishing this book was launched. Since then, many major events on a planetary scale have occurred, including the SARS-CoV-2 pandemic and increasing scales of social unrest around the planet. Research in the field of geoethics has progressed considerably, broadening the involvement of not only geoscience practitioners but also scholars outside the geoscience community. The geoethics community has also increased its involvement with communities outside of geosciences, with the aim of projecting geoscientists into the twenty-first century with a more mature and collaborative interaction with other cultural dimensions.

This volume provides a timely record of the rapidly evolving field of study surrounding geoethics at this stage of its evolution – as practitioners embrace new links, obligations and trends in earth sciences that are somehow influenced by the solidifying paradigms of geoethical study and practice. Other relevant topics are equally strongly related to the field of geoethics and are not specifically addressed herein but warrant additional detailed discussion. For instance, the role of geoscientists as expert witnesses covers a wide range of issues, potential conflicts, and limitations – all with serious societal impacts. For instance, how is it possible that two strongly opposing positions in a court of law can each rely on the expertise of a professional geoscientist to make their case? If both testifying geoscientists are competent and believe they are providing truthful facts and opinions, then how is it possible that they do not share the same interpretation and opinion? The dilemma is clear – is one of the experts uninformed, not telling the truth or incompetent, or are both professionals correct? Expert witness testimony by geologists dates back to the previous century and touches all aspects of study including health and safety issues, water and mineral resources, hazards and risk, to list a few.

Above all, the goal of geoethics activities is to enhance the profound sense of doing geoscience with increasing conviction and accuracy, because the past practices of geosciences and related disciplines have contributed in some ways to bringing the world towards a condition of ecological unsustainability of human society. In contrast, an antidote for humans and their survival is that the geosciences can give back to humans that sense of wonder at the knowledge of nature and its beauty.

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## References

- Bellaubi, F. and Arasa, A. 2020. Geoethics in groundwater management: the geoethical dilemma in La Galera Aquifer. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-125>
- Bilham, N. 2020. Responsible mining and responsible sourcing of minerals: opportunities and challenges for cooperation across value chains. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-130>
- Bobrowsky, P., Cronin, V.S., Di Capua, G., Kieffer, S.W., and Peppoloni, S. 2018. The emerging field of geoethics. In: Gundersen, L.C. (ed.) *Scientific Integrity and Ethics: With Applications to the Geosciences*. American Geophysical Union, Washington, DC/John Wiley and Sons, Hoboken, NJ, Special Publications, **73**.
- Bohle, M. (ed.). 2019. *Exploring Geoethics: Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences*. Palgrave Pivot, Cham.
- Bohle, M. 2020. Geo-societal sense-making. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-213>
- Bonham, O. and Waldie, A. 2020. Geoscience, ethics and enforcement. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-245>
- Boon, J. 2020. Sociology for mineral exploration. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-230>
- Cerese, A. 2020. From 'good' intuitions to principled practices and beyond: ethical issues in risk communication. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-104>
- Cocco, M., Cultrera, G. *et al.* 2015. The L'Aquila trial. *Geological Society, London, Special Publications*, **419**, 43–55, <https://doi.org/10.1144/SP419.13>
- Cronin, V.S. 2020. Geoethics as a common thread that can bind a geoscience department together. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-256>
- Dawson, L.A., Di Maggio, R.M., McKinley, J., Di Capua, G., Peppoloni, S., Pringle, J. 2020. A proposal for a White Paper on geoethics in forensic geology. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-80>
- Di Capua, G. and Peppoloni, S. 2019. Defining geoethics. Website of the IAPG – International Association for Promoting Geoethics, <http://www.geoethics.org/definition>
- Di Capua, G., Peppoloni, S. and Bobrowsky, P.T. 2017. The Cape Town Statement on Geoethics. In: Peppoloni, S., Di Capua, G., Bobrowsky, P.T. and Cronin, V.S. (eds) *Geoethics at the Heart of all Geoscience*. Annals of Geophysics, **60**, Fast Track 7, <https://doi.org/10.4401/ag-7553>
- Fernández-Fuentes, I., Correia, V. and Neumann, M. 2020. The importance of professional regulation of geoscientists and their role in a fast-changing world. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-26>
- Geller, R.J. 2015. Geoethics, risk-communication, and scientific issues in earthquake science. In: Wyss, M. and Peppoloni, S. (eds) *Geoethics: Ethical Challenges and Case Studies in Earth Sciences*. Elsevier, Amsterdam, 263–272, <https://doi.org/10.1016/B978-0-12-799935-7.00022-8>
- Groenfeldt, D. 2020. Ethical considerations in managing the hydrosphere: an overview of water ethics. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-99>
- Gundersen, L.C. (ed.). 2018. *Scientific Integrity and Ethics: With Applications to the Geosciences*. American Geophysical Union, Washington, DC/John Wiley and Sons, Hoboken, NJ, Special Publications, **73**.
- Keane, C.M. and Asher, P. 2020. Addressing the geoethics skills gap through co-curricular approaches. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-251>
- Lollino, G., Arattano, M., Giardino, M., Oliveira, R. and Peppoloni, S. (eds). 2014. *Engineering Geology for Society and Territory – Volume 7: Education, Professional Ethics and Public Recognition of Engineering Geology, Set: Engineering Geology for Society and Territory*. Springer, **XVII**.
- Matteucci, R., Gosso, G., Peppoloni, S., Piacente, S. and Wasowski, J. 2014. The 'Geoethical promise': a proposal. *Episodes*, **37**, 190–191, <https://doi.org/10.18814/epiiugs/2014/v37i3/004>
- McLean, M.R. 2020. Reaching out from Earth to the stars. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-16>

- Mogk, D.W. 2020. The intersection of geoethics and diversity in the geosciences. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-66>
- Mogk, D.W., Geissman, J.W. and Bruckner, M.Z. 2018. Teaching geoethics across the geoscience curriculum: why, when, what, how, and where? In: Gundersen, L.C. (ed.) *Scientific Integrity and Ethics: With Applications to the Geosciences*. American Geophysical Union, Washington, DC/John Wiley and Sons, Hoboken, NJ, Special Publications, **73**.
- Moores, E.M. 1997. Geology and culture: a call for action. *GSA Today*, **7**, 7–11.
- Mucciarelli, M. 2015. Some comments on the first degree sentence of the 'L' Aquila trial'. In: Wyss, M. and Peppoloni, S. (eds) *Geoethics: Ethical Challenges and Case Studies in Earth Sciences*. Elsevier, Waltham, MA, 205–210, <https://doi.org/10.1016/B978-0-12-799935-7.00017-4>
- Mudd, G.M. 2020. Sustainable/responsible mining and ethical issues related to the Sustainable Development Goals (SDGs). *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-113>
- Oboni, F. and Oboni, C.H. 2020. Holistic geoethical slopes' portfolio risk assessment. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-157>
- Ovadia, D.C. and O'Connor, E.A. 2020. International geoscience cooperation – fair and equitable? *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2019-254>
- Peppoloni, S. (ed.). 2018. *Spreading Geoethics Through the Languages of the World. Translations of the Cape Town Statement on Geoethics*. International Association for Promoting Geoethics, <http://www.geoethics.org/ctsg>
- Peppoloni, S. and Di Capua, G. (eds). 2012. Geoethics and geological culture. *Reflections from the Geoitalia Conference 2011*. *Annals of Geophysics*, **55**, 163.
- Peppoloni, S. and Di Capua, G. 2015a. The Meaning of Geoethics. In: Wyss, M. and Peppoloni, S. (eds) *Geoethics: Ethical Challenges and Case Studies in Earth Science*. Elsevier, Waltham, MA, 413, 3–15, <https://doi.org/10.1016/B978-0-12-799935-7.00001-0>
- Peppoloni, S. and Di Capua, G. (eds). 2015b. *Geoethics: the Role and Responsibility of Geoscientists*. *Geological Society, London, Special Publications*, **419**, <https://doi.org/10.1144/SP419.0>
- Peppoloni, S. and Di Capua, G. 2020. Geoethics as global ethics to face grand challenges for humanity. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-146>
- Peppoloni, S., Di Capua, G., Bobrowsky, P.T. and Cronin, V.S. (eds). 2017. *Geoethics at the Heart of all Geoscience*. *Annals of Geophysics*, **60**, Fast Track 7. <https://www.annalsofgeophysics.eu/index.php/annals/issue/view/537>
- Peppoloni, S., Billham, N. and Di Capua, G. 2019. Contemporary geoethics within the geosciences. In: Bohle, M. (ed.) *Exploring Geoethics: Ethical Implications, Societal Contexts, and Professional Obligations of the Geosciences*. Palgrave Pivot, Cham, [https://doi.org/10.1007/978-3-030-12010-8\\_2](https://doi.org/10.1007/978-3-030-12010-8_2)
- Stewart, I.S. and Hurth, V. 2020. Selling Planet Earth: re-purposing geoscience communications. *Geological Society, London, Special Publications*, **508**.
- Wuebbles, D.J. 2020. Ethics in climate change: a climate scientist's perspective. *Geological Society, London, Special Publications*, **508**, <https://doi.org/10.1144/SP508-2020-17>
- Wyss, M. and Peppoloni, S. (eds). 2015. *Geoethics, Ethical Challenges and Case Studies in Earth Sciences*. Elsevier, Waltham, MA.
- Zen, E.-A. 1993. The citizen geologist. *GSA Today*, **3**, 2–3.