# SCIENTIFIC INTEGRITY and ETHICS in the GEOSCIENCES

Linda C. Gundersen
*Editor*

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# SCIENTIFIC INTEGRITY AND ETHICS IN THE GEOSCIENCES

**Edited by**
**Linda C. Gundersen**

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# PREFACE

Welcome to scientific integrity and ethics in the Anthropocene! We are now a densely populated and globally connected species, impacting every aspect of life on Earth, continually generating new technology, new substances, new data, and new challenges. We change the course of large river systems; destroy, replant, and harvest millions of acres of vegetation; modify the chemistry of water and soil on planetary scales; and move millions of tons of earth materials. From climate change to pandemics, from food and energy security to natural catastrophes, we are faced with high-stake dilemmas demanding solutions. Science and technology will need to help mitigate and solve these problems, especially the geosciences. However, without more careful attention to scientific integrity and ethics, we are headed into a dangerous future. Scientific integrity protects and upholds the framework of science itself, which is currently suffering under a barrage of research misconduct issues from data falsification and fabrication to systemic harassment and discrimination that is disrupting science and marginalizing women and minority students and scientists. Science skeptics have become even more outspoken, and some of that skepticism is being woven into public policy. Scientific misconduct fuels this skepticism and jeopardizes the trust the public has in the scientific enterprise.

Integrity and trust are the foundations of science. This is, in fact, the only way that science actually works. Every scientist trusts that the knowledge and data they use from other scientists is the truth and was produced honestly, objectively, and with integrity. Society is dependent on science and generally believes what scientists communicate and the way science is incorporated into their lives. Without trust and integrity, the system breaks down, and as a result advancement in science is hindered, time and research funds are wasted, society may be harmed and lose confidence in scientific institutions, there may be significant financial impacts to individuals and corporations, and funding for new science may diminish. There is a great deal at stake when a scientist chooses to forgo integrity. Science drives a significant portion of the wealth, health, safety, and well-being of our world, and here in the twenty-first century, science is also in the midst of significant change. The world is increasingly complex, making our integrity and ethical challenges more complex. The conduct of science is transitioning from individual-based, single-discipline research to large teams with multidisciplinary approaches. Scientific education, funding, and hiring are more

competitive. The scientific community is connected and global with different cultural attitudes toward the scientific process and integrity. Data and communication are instantaneous, and technology and data accessibility are advancing at an unprecedented pace, well ahead of policy, standards, and our ability to adapt to them.

Generally, scientific or research integrity codes focus on the individual behavior of the scientist, standards of professional behavior and knowledge, and integrity in the scientific process and publications; they may contain guidance on ethical treatment of humans, animals, and the environment when conducting science. Some codes also include rules on bias, conflict of interest, privacy, confidentiality, and issues of quality that may affect the integrity of the data and interpretation. Ethics underpins scientific integrity but also needs to be a foundation for our decisions regarding how we undertake science and the application of the scientific advancements we make. Ethics in science includes our broader responsibilities to society, moral decisions on the subject and use of science, and our behavior and interactions with both the scientific community and the public. The development of professional or applied ethical codes is well established in the medical, biological, and engineering fields and more recently in the environmental, geographic, and geoscience fields. Geoethics is one such emerging field that has garnered significant attention in the last few years through the focused efforts of several organizations and scientists. Chief among them is the International Association for Promoting Geoethics, which recently released the Cape Town Statement on Geoethics, the first international set of applied ethical principles for the geosciences (http://www.geoethics.org/ctsg). Additionally, the past 10 years have seen the emergence of new global and national scientific integrity codes, the emergence of new applied ethics codes and ideas, and the growing awareness of unacceptable behaviors in the research and educational environment. This volume presents an overview of the current thinking on scientific integrity and ethics from academic, professional, and governmental perspectives, with particular attention to the geosciences. Much of this book is also applicable to all the sciences, addressing common issues such as publishing, data stewardship, and the need for scientific integrity and ethics education for students and early career scientists.

The first section of the book features new codes and reports that are having a strong influence on the landscape of scientific integrity. Chapter 1, on the Singapore and Montreal Statements, discusses the first international research integrity codes, created by the historical World Research Integrity Conferences, that speak beyond traditional fabrication, falsification, and plagiarism and include strong statements on professional behavior, collaboration, and values. Chapter 2 provides insight into the new National Academy of Science report on research integrity that breaks new ground, defining six core values that shape the norms of research, and goes beyond traditional research misconduct by

examining detrimental research practices. Chapter 3 provides in detail the Department of Interior Scientific Integrity and Ethics Policy that set the standard for new policies in federal science agencies in the wake of the landmark Memorandum on Scientific Integrity from President Obama in March of 2009.

The second section of the book examines the latest codes of conduct from several major geoscience professional societies and the challenges they face in the current science environment in supporting research integrity and ethical values. Chapter 4 presents the new American Geosciences Institute Guidelines for Ethical and Professional conduct that has been adopted by most American geoscience societies. Chapter 5 presents a discussion by the American Geophysical Union's past president on the society's recent scientific integrity and ethics policy, the challenges faced implementing it, outreach efforts, and the latest update that encompasses discrimination, harassment, and bullying. Chapters 6 and 7 provide current and historical perspectives from geoscience industry groups, including the National Association of State Boards of Geology, the American Association of Petroleum Geologists, and the Society of Economic Geologists, with a particular emphasis on the ethical issues most valued by professional geologists and the importance of enforceable codes.

The third section of the book addresses two very critical subjects in science: publications and data stewardship. Chapter 8 discusses the past and present ethical issues in science publication, the industry-wide challenge to scientific journals related to reproducibility, and the new movement in publication to ensure reliability and provide the data that underpin published science. Chapter 9 walks the reader through the scientific process within the framework of the research data lifecycle, providing checklists of practical ethical questions for every step of the lifecycle that students and faculty can use to ensure the ethics and integrity of their science.

The fourth section of the book introduces the concept of value and ethics in conducting science and the emerging field of geoethics. Geoscientists have traditionally stayed out of policy and secondary applications of their work. Increasingly geoscientists are asked to estimate risks, map areas of vulnerability, and think about the impact of their work on the health, benefit, and welfare of society. Chapter 10 discusses the role of ethical values in scientific integrity using the example of climate change, and Chapter 11 provides an extensive overview of the new field of geoethics.

The last section provides resources for educators on best practices for teaching scientific integrity, ethics, and geoethics. Chapter 12 provides strong support for an experiential approach to teaching integrity and ethics. Chapter 13 presents important understanding and best practices for teaching geoethics within the geoscience curriculum. Chapter 14 is an impassioned appeal on the importance of science ethics education for undergraduates that includes practical examples for implementation.

The book closes with two appendices providing teaching and reference resources for classroom practice and further research and understanding. It is hoped that students, faculty, and professionals in sciences and ethics will be able to use this book to learn, share, and dialogue about scientific integrity and ethics in this changing world and incorporate those lessons into their professional work and teaching.

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# Section I: Examples of Recently Developed International and National Codes and Policies

# 1. THE ORIGIN, OBJECTIVES, AND EVOLUTION OF THE WORLD CONFERENCES ON RESEARCH INTEGRITY

**Nicholas H. Steneck[1], Tony Mayer[2], Melissa S. Anderson[3], and Sabine Kleinert[4]**

## Abstract

The World Conferences on Research Integrity (WCRI) have grown over the past decade from a proposal to convene a joint U.S.–European conference on research integrity into a global effort to foster integrity in research through research, discussion, the harmonization of policies, and joint action. Over the course of the first four WCRIs, held in Lisbon, Portugal, in 2007; Singapore in 2010; Montreal, Canada, in 2013; and Rio de Janeiro, Brazil, in 2015, participation has grown from 275 participants from 47 countries in 2007 to 474 participants from 48 countries in 2015. The WCRIs have produced two global statements on research integrity: the Singapore Statement in 2010 and the Montreal Statement in 2013. In addition, three sets of proceedings and numerous papers and working reports archived on the WCRI website (www.researchintegrity.org) are available. The WCRI effort celebrated its tenth anniversary at the Fifth WCRI in Amsterdam, May 28–31, 2017. A total of 836 participants from 52 countries attended.

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## 1.1. Introduction

In an ideal world, integrity should be a regular element of all aspects of research. In practice, it is too often a topic that gets attention when there is a crisis and then is put on the shelf until the next crisis arises. Thus, over the 40 or so years that research integrity has been a topic of public discussion, universities, professional societies, and governments have responded to crises, issued reports, and then, too often, moved on to other issues, hoping that no further crises would arise.

The World Conferences on Research Integrity have evolved into an ongoing forum for the study and discussion of ways to promote responsible behavior in research. This was not, however, the goal of the initial and somewhat audaciously titled "World Conference on Research Integrity" held in Portugal in 2007. The aim of the initial conference was more modest.

The World Conferences began as an experimental extension of the U.S. Office of Research Integrity's (ORI) conference program to Europe. In 2000, ORI's authority was "changed to focus more on preventing misconduct and promoting research integrity through expanded education programs" [*Federal Register*, 2000]. Under its new authority, ORI initiated programs aimed at improving researcher training and engaging researchers and professional organizations in the discussion of integrity in research. The conference program (small grants to organizations and institutions to organize conferences) was part of this effort. In 2006, a consultant working at ORI, Nicholas Steneck, University of Michigan, was heading to Europe for an academic meeting and suggested that he explore the possibility of holding a Europe–United States conference to discuss research integrity issues of common interest. The ORI Director, Chris Pascal, and the Director of the Division of Education and Integrity, Larry Rhoades, agreed to provide $25,000 for this effort, with the understanding that a European partner be found to match ORI funding.

In 2006, a number of European countries and groups of European researchers were engaged in efforts to develop misconduct policies and otherwise promote integrity in research. However, most did not have enough funding to support a collaborative U.S.–European conference. In a series of meetings, World Conference initiator Steneck was assured of European interest in promoting integrity but received no commitment of support until one final meeting in Strasbourg with European Science Foundation (ESF) Chief Executive, Bertil Andersson.

While some countries had responded to research misconduct incidents at the national level, ESF was the first European organization to formally engage the topic of research integrity in its 2000 Science Policy Briefing, *Good Scientific Practice in Research and Scholarship* [*ESF*, 2000]. Andersson was deeply committed to taking an active role in promoting integrity in research and quickly agreed to match ORI's funding. More importantly, he also agreed to take the lead in

seeking additional support in Europe, starting with the European Commission, and appointed an ESF consultant, Tony Mayer, to co-organize and co-chair the proposed joint U.S.–European conference on research integrity. From this agreement on, Co-Chairs Steneck and Mayer assumed major responsibility for securing funding and organizing the first World Conference on Research Integrity.

## 1.2. The First World Conference on Research Integrity

With strong encouragement from Andersson and colleagues consulted during the early planning process, Co-Chairs Steneck and Mayer broadened the U.S.–European plan to an International Conference for Fostering Responsible Research, justifying the effort in their unpublished planning report to the ESF and ORI as follows:

> Research, which prides itself on its internal self-governance and its integrity, is now faced with a number of well publicized cases of misconduct, fraud and questionable research practices. The research community worldwide has to face this challenge in order to retain public confidence and establish clear best practice frameworks at an international level.

However, planning also included the need to address "questionable research methods and environments in which such methods are tolerated." With these broad objectives in mind, the overall purpose of the first World Conference was

> … to assemble an international group of researchers, research administrators from funding agencies and similar bodies, research organizations performing research, universities and policy makers for the purpose of discussing and making recommendations on ways to 1) improve, 2) harmonize, 3) publicize, and 4) make operationally effective international policies for the responsible conduct of research.

At roughly the same time that planning for the first WCRI began, two members of the Organization of Economic Cooperation and Development (OECD), Canada and Japan, proposed the development of a Working Group on research integrity, with the goal of producing recommendations for action by all OECD members [*OECD*, 2007]. Steneck and Mayer soon established a collaborative working relationship with this effort and also began working with the International Council of Science (ICSU), which was also interested in increasing attention to integrity by the global scientific community [*ICSU*, 2002]. And most importantly, through the efforts of Andersson and Mayer, the European Commission agreed to provide major support for the first WCRI and to encourage Portugal to host the Conference during its upcoming presidency of the European Union. Through these and other related developments, what became the founding WCRI was set for September 2007 in Lisbon, Portugal, at and with further support of the Gulbenkian Foundation headquarters.

Opening talks by the Portuguese Minister of Science, the late Jose-Mariano Gago, the European Commissioner of Research Janez Potocnik, and others, challenged participants to engage the issues through discussion and further

action. As summarized in the final report [*Mayer and Steneck*, 2007], over the 2.5 days of meetings, the 275 participants from 47 countries participated in "a series of plenary sessions, three working groups, formal opening and closing sessions, and other events designed to promote discussion and begin a global exchange about ways to foster responsible research practices." More information on the first WCRI will be available on the World Conference for Research Integrity Foundation website: researchintegrity.org.

## 1.3. The Second World Conference on Research Integrity

One of the outcomes of the first WCRI was support for convening a second global conference, with some preference for a country in the rapidly expanding Asian research world. Given that by the time of the first WCRI, both Andersson (as Provost) and Mayer had moved to the Nanyang Technological University (NTU) in Singapore, Singapore quickly became the logical site for the Second WCRI. The NTU is one of the two highly ranked, research intensive universities in the city state, the other being the National University of Singapore (NUS).

Working within the Singaporean system, Andersson and Mayer were able to mobilize substantial funding for the Second WCRI through the two major universities (NTU and NUS), the Singapore Management University (SMU), and the Agency for Science, Technology and Research (A*STAR). All four institutions had high international research profiles and recognized the importance of carrying out research to the highest standards of integrity. In addition to these organizations, the Ministry of Education provided significant extra funding. The organizers also had the financial support of a number of other organizations, including the Committee on Publication Ethics (COPE), which has supported every WCRI held to date. The level of funding achieved enabled not only the support for the conference program but also provided the wherewithal for Co-Chairs Steneck and Mayer to offer modest travel grants to participants from disadvantaged countries. This was an important development in the transformation of research integrity into a global issue.

The Second WCRI was a truly global event with more than 340 participants from 51 countries attending. Building on the results of the first WCRI, the Second WCRI focused on national and international structures for promoting integrity and responding to misconduct, global codes of conduct and best practices for research, common curricula for training students and researchers in best practices, and uniform best practices for editors and publishers [*Mayer and Steneck*, 2012].

During planning for the Second WCRI, Steneck proposed developing some lasting legacy from the conference, such as a global code of conduct for research. With Planning Committee support, Steneck, Mayer, and Melissa Anderson, University of Minnesota, took the lead in drafting the *Singapore Statement on Research Integrity* (Box 1.1). A draft *Singapore Statement* was sent to all

## Box 1.1 The Singapore Statement on Research Integrity.

**Preamble.** The value and benefits of research are vitally dependent on the integrity of research. While there can be and are national and disciplinary differences in the way research is organized and conducted, there are also principles and professional responsibilities that are fundamental to the integrity of research wherever it is undertaken.

**Principles**

***Honesty*** in all aspects of research
***Accountability*** in the conduct of research
***Professional courtesy and fairness*** in working with others
***Good stewardship*** of research on behalf of others

**Responsibilities**

1. ***Integrity:*** Researchers should take responsibility for the trustworthiness of their research.
2. ***Adherence to Regulations:*** Researchers should be aware of and adhere to regulations and policies related to research.
3. ***Research Methods:*** Researchers should employ appropriate research methods, base conclusions on critical analysis of the evidence, and report findings and interpretations fully and objectively.
4. ***Research Records:*** Researchers should keep clear, accurate records of all research in ways that will allow verification and replication of their work by others.
5. ***Research Findings:*** Researchers should share data and findings openly and promptly, as soon as they have had an opportunity to establish priority and ownership claims.
6. ***Authorship:*** Researchers should take responsibility for their contributions to all publications, funding applications, reports, and other representations of their research. Lists of authors should include all those and only those who meet applicable authorship criteria.
7. ***Publication Acknowledgement:*** Researchers should acknowledge in publications the names and roles of those who made significant contributions to the research but do not meet authorship criteria, including writers, funders, sponsors, and others.
8. ***Peer Review:*** Researchers should provide fair, prompt, and rigorous evaluations and respect confidentiality when reviewing others' work.

9. ***Conflict of Interest:*** Researchers should disclose financial and other conflicts of interest that could compromise the trustworthiness of their work in research proposals, publications, and public communications as well as in all review activities.
10. ***Public Communication:*** Researchers should limit professional comments to their recognized expertise when engaged in public discussions about the application and importance of research findings and clearly distinguish professional comments from opinions based on personal views.
11. ***Reporting Irresponsible Research Practices:*** Researchers should report to the appropriate authorities any suspected research misconduct, including fabrication, falsification, or plagiarism, and other irresponsible research practices that undermine the trustworthiness of research, such as carelessness, improperly listing authors, failing to report conflicting data, or the use of misleading analytical methods.
12. ***Responding to Irresponsible Research Practices:*** Research institutions, as well as journals, professional organizations and agencies that have commitments to research, should have procedures for responding to allegations of misconduct and other irresponsible research practices and for protecting those who report such behavior in good faith. When misconduct or other irresponsible research practice is confirmed, appropriate actions should be taken promptly, including correcting the research record.
13. ***Research Environments:*** Research institutions should create and sustain environments that encourage integrity through education, clear policies, and reasonable standards for advancement, while fostering work environments that support research integrity.
14. ***Societal Considerations:*** Researchers and research institutions should recognize that they have an ethical obligation to weigh societal benefits against risks inherent in their work.

participants prior to the conference and became an underlying theme for much of the discussion during the meeting. This effort paralleled the ESF/All European Academies (ALLEA) initiative to develop a *European Code of Conduct on Research Integrity* [*ESF/ALLEA*, 2011]. At the closing session, participants acting as individuals rather than as institutional representatives discussed the few areas where there were differences of opinion about coverage and/or wording. Finding proper wording for Responsibility 14, Social Considerations, took the most time. At the end of the session, those present broadly endorsed the code, pending a few minor revisions. These revisions were made after the Second WCRI

and sent to all participants for comments and approval. The final 4 principles and 14 responsibilities set out in the *Singapore Statement* were then posted on the Web and have since been translated into 27 languages [*Singapore Statement*, 2010].

The Second WCRI achieved its objective to consolidate the work of the first WCRI and set the pattern for an ongoing series of World Conferences on Research Integrity. Having held meetings in Europe and Asia, consideration was given to other major regions. Steneck and Mayer also wanted to bring in new leadership and turned to Melissa Anderson to take on organizing and chairing responsibilities. She quickly brought in Sabine Kleinert, from *The Lancet*, to continue the practice of having conference co-organizers and co-chairs. Exchanges between the new conference Co-Chairs and the Conference Services Office of the National Research Council Canada confirmed a mutual interest in siting the conference in Montréal, Canada, in May 2013 and established a financial mechanism for support through the council's practice of funding conferences on a reimbursement basis.

## 1.4. The Third World Conference on Research Integrity

The Third WCRI continued the practice of previous conferences in engaging government officials, publishers, and leaders in policy and education, but it also intentionally recruited participants who were actively conducting research on or relating to the responsible conduct of research. A broad search through publications in the field yielded a list of hundreds of scholars who had recently published research on research integrity. To encourage their participation, Anderson and Kleinert issued a broad call for presentation proposals. The many presentation proposals received in response to this call led to the decision to expand the conference from 2.5 to 3 full days. Attendance at the Third WCRI grew to 366 participants from 44 countries.

Building on the success of the workshops that concluded the Second WCRI, the Third WCRI incorporated four tracks of focused discussions on the following topics: integrity in international research collaborations, cooperation between research institutions and journals in cases of suspected misconduct, education in the responsible conduct of research, and research integrity in relation to societal responsibility [*Steneck et al.*, 2015]. The track related to international research collaborations was devoted to discussion of a draft document that was eventually published as the *Montréal Statement on Research Integrity in Cross-Boundary Research Collaborations* [2013]. The *Montréal Statement* (Box 1.2) is intended to serve as a companion document to the *Singapore Statement*. The 20-point document focuses on aspects of research integrity that have particular relevance to collaborative research that crosses national, institutional, disciplinary, or sector boundaries (the last representing, for example, public-private or academy-business collaborations). It is now available in 14 different languages.

## Box 1.2 The Montreal Statement on Research Integrity in Cross-Boundary Research Collaborations.

**Preamble.** Research collaborations that cross national, institutional, disciplinary, and sector boundaries are important to the advancement of knowledge worldwide. Such collaborations present special challenges for the responsible conduct of research because they may involve substantial differences in regulatory and legal systems, organizational and funding structures, research cultures, and approaches to training. It is critically important, therefore, that researchers be aware of and able to address such differences, as well as issues related to integrity that might arise in cross-boundary research collaborations. Researchers should adhere to the professional responsibilities set forth in the *Singapore Statement on Research Integrity*. In addition, the following responsibilities are particularly relevant to collaborating partners at the individual and institutional levels and fundamental to the integrity of collaborative research. Fostering the integrity of collaborative research is the responsibility of all individual and institutional partners.

**Responsibilities of Individual and Institutional Partners in Cross-Boundary Research Collaborations**

**General Collaborative Responsibilities**

1. ***Integrity.*** Collaborating partners should take collective responsibility for the trustworthiness of the overall collaborative research and individual responsibility for the trustworthiness of their own contributions.
2. ***Trust.*** The behavior of each collaborating partner should be worthy of the trust of all other partners. Responsibility for establishing and maintaining this level of trust lies with all collaborating partners.
3. ***Purpose.*** Collaborative research should be initiated and conducted for purposes that advance knowledge to the benefit of humankind.
4. ***Goals.*** Collaborating partners should agree at the outset on the goals of the research. Changes in goals should be negotiated and agreed to by all partners.

**Responsibilities in Managing the Collaboration**

5. ***Communication.*** Collaborating partners should communicate with each other as frequently and openly as necessary to foster full, mutual understanding of the research.
6. ***Agreements.*** Agreements that govern collaborative research should be understood and ratified by all collaborating partners. Agreements that

unduly or unnecessarily restrict dissemination of data, findings, or other research products should be avoided.

7. ***Compliance with Laws, Policies, and Regulations.*** The collaboration as a whole should be in compliance with all laws, policies, and regulations to which it is subject. Collaborating partners should promptly determine how to address conflicting laws, policies, or regulations that apply to the research.
8. ***Costs and Rewards.*** The costs and rewards of collaborative research should be distributed fairly among collaborating partners.
9. ***Transparency.*** Collaborative research should be conducted and its results disseminated transparently and honestly, with as much openness as possible under existing agreements. Sources of funding should be fully and openly declared.
10. ***Resource Management.*** Collaborating partners should use human, animal, financial, and other resources responsibly.
11. ***Monitoring.*** Collaborating partners should monitor the progress of research projects to foster the integrity and the timely completion and dissemination of the work.

**Responsibilities in Collaborative Relationships**

12. ***Roles and Responsibilities.*** Collaborating partners should come to mutual understandings about their roles and responsibilities in the planning, conduct, and dissemination of research. Such understandings should be renegotiated when roles or responsibilities change.
13. ***Customary Practices and Assumptions.*** Collaborating partners should openly discuss their customary practices and assumptions related to the research. Diversity of perspectives, expertise, and methods, and differences in customary practices, standards, and assumptions that could compromise the integrity of the research should be addressed openly.
14. ***Conflict.*** Collaborating partners should seek prompt resolution of conflicts, disagreements, and misunderstandings at the individual or institutional level.
15. ***Authority of Representation.*** Collaborating partners should come to agreement on who has authority to speak on behalf of the collaboration.

**Responsibilities for Outcomes of Research**

16. ***Data, Intellectual Property, and Research Records.*** Collaborating partners should come to agreement, at the outset and later as needed, on the use, management, sharing, and ownership of data, intellectual property, and research records.

17. ***Publication.*** Collaborating partners should come to agreement, at the outset and later as needed, on how publication and other dissemination decisions will be made.
18. ***Authorship and Acknowledgement.*** Collaborating partners should come to agreement, at the outset and later as needed, on standards for authorship and acknowledgement of joint research products. The contributions of all partners, especially junior partners, should receive full and appropriate recognition. Publications and other products should state the contributions of all contributing parties.
19. ***Responding to Irresponsible Research Practices***. The collaboration as a whole should have procedures in place for responding to allegations of misconduct or other irresponsible research practice by any of its members. Collaborating partners should promptly take appropriate action when misconduct or other irresponsible research practice by any partner is suspected or confirmed.
20. ***Accountability.*** Collaborating partners should be accountable to each other, to funders, and to other stakeholders in the accomplishment of the research.

## 1.5. Recent and Future Conferences

During the Third WCRI, Steneck, Mayer, Anderson, and Kleinert agreed to work together as a steering committee to assure the continuity of the WCRI effort. Their first task was to review proposals from several countries that had responded to a call for bids to host the Fourth WCRI. Brazil was selected as the site for the next conference, under the local leadership of Sonia Vasconcelos, Edson Watanabe, and Martha Sorenson of the Federal University of Rio de Janeiro. The selection of Rio de Janeiro brought the World Conferences to South America, with the goal of encouraging participation from countries that had previously been underrepresented. Representatives from 48 countries participated, with total conference participation of 474.

The theme of the Fourth WCRI was "Research Rewards and Integrity: Improving Systems to Promote Responsible Research." It was expressed not only in the plenary sessions but also in focus tracks that addressed the relationships between research integrity and systems represented by funders, countries, and research institutions. The conference continued to attract decision makers, publishers, and researchers, in a somewhat greater spread in their experiential bases. Some countries had made considerable strides in policy development, oversight, and education in the responsible conduct of research. They brought to the Fourth WCRI relatively well-developed models of programs, documents, and instructional programs. Other countries represented at the Fourth WCRI were at earlier

stages in their efforts to foster research integrity. In some cases, delegates from these latter countries illustrated ways in which integrity initiatives were developing along lines that diverged somewhat from earlier models, showing how important local context is to policy, instruction, and oversight related to research integrity. Selected papers from the Conference were published as: *Proceedings of the 4th World Conference on Research Integrity* [2016].

Continuing the tradition of naming the next site at each meeting, the bid submitted by a team organized by Lex Bouter, Vrije Universiteit Amsterdam, was warmly accepted, with the Fifth WCRI held in late May 2017 in Amsterdam. Information on the Fifth WCRI can be found at http://www.wcri2017.org The Conference was co-chaired by Steneck, Mayer, and Bouter and mark the 10th anniversary of the WCRI effort and the founding conference in Europe. In Rio, the Steering Committee also added Susan Zimmerman, Secretariat on Responsible Conduct of Research, Canada, and Sonia Vasconcelos, to its membership as representatives of the countries hosting the Third WCRI and the Fourth WCRI, respectively.

During the Fifth WCRI, the Steering Committee met and made the decision to establish the World Conferences on Research Integrity Foundation to coordinate future planning. The new Foundation is led by Board Chair Lex Bouter. The Steering Committee also accepted a bid for the 6th World Conference in 2019 to be hosted by Hong Kong and organised jointly by WCRIF, Hong Kong and Australia. Further information on these and other efforts will be available on the Foundation website, researchintegrity.org.

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# 2. FOSTERING INTEGRITY IN RESEARCH: OVERVIEW OF THE NATIONAL ACADEMIES OF SCIENCES, ENGINEERING, AND MEDICINE REPORT

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## Abstract

Research integrity is essential to the health of the research enterprise, providing the foundation for good science. The past decade has seen a steady flow of high-profile cases of data fabrication from around the world, a sharp increase in retractions of scientific articles, and an increase in the number of research misconduct allegations investigated by U.S. research institutions. Research misconduct and detrimental research practices can damage science and its reputation. Much still needs to be learned about why researchers engage in these behaviors. Future studies should focus not only on individual behavior but also on practices, incentives, and institutional environments. Mitigating hypercompetitive research environments, setting expectations of integrity and excellence at the highest levels of institutions and professional societies, and creating common standards for authorship, data and model accessibility, and reporting will greatly improve the current situation. Providing tools to institutions to aid in addressing responsible conduct of research education and for handling misconduct is strongly recommended, including establishing an independent Research Integrity Advisory Board to bring neutrality and focus to understanding and responding to research misconduct across all disciplines. This chapter summarizes the key themes, findings, and recommendations of the report *Fostering*


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*Integrity in Research*, released by the National Academies of Sciences, Engineering, and Medicine in 2017. The report contains broad guidance and specific recommendations for fostering integrity and addressing breaches in integrity directed to all participants in the research enterprise: researchers, research institutions, research sponsors, societies, and science, engineering, technology, and medical publishers.

## 2.1. Introduction

The National Academies of Sciences, Engineering, and Medicine (NASEM) released the report *Fostering Integrity in Research* in 2017 [*NASEM*, 2017]. The 13-member authoring committee included representation from a range of research disciplines and various career stages as well as experience in administrative and educational roles related to research integrity. The study was sponsored by several U.S. federal agencies, the National Academies, and other organizations. This article summarizes the report's key themes, findings, and recommendations. The full text of the findings and recommendations is provided at the end of the chapter.

In framing its treatment of research integrity, the committee draws on past National Academies' work. The 1992 report *Responsible Science: Ensuring the Integrity of the Research Process* was issued in the midst of major shifts in approaches to research misconduct and research integrity on the part of the U.S. government and research institutions in the wake of several highly publicized investigations of research misconduct allegations [*NAS-NAE-IOM*, 1992]. The 2002 report *Integrity in Scientific Research: Creating an Environment that Promotes Responsible Conduct* described what was known about how research environments may support (or not support) research integrity, and it outlined an approach to assessing research environments [*IOM-NRC*, 2002). In 2009, the National Academies released the third edition of the popular educational guide *On Being a Scientist: A Guide to Responsible Research Conduct* [*NAS-NAE-IOM*, 2009a]. Also in 2009, *Ensuring the Integrity, Accessibility and Stewardship of Research Data* was released [*NAS-NAE-IOM*, 2009b]. This report described the growing challenges and opportunities facing the research enterprise in the area of digital data and recommended principles for addressing those challenges.

The committee benefited from the presentations of numerous experts from academia, industry, and government using a wide range of sources from around the world. These include surveys aimed at shedding light on the incidence and causes of research misconduct and detrimental research practices, policy reports framing national approaches to addressing misconduct, explorations of research values and research best practices, responsible conduct of research educational materials, and institutional and media reports on notable cases.