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Ethical Requirements for Applied Earth System Science and Engineering

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Anthropogenic global change challenges societal development and nature conservation [1, 2, 3]. The Earth science and engineering disciplines are therefore increasingly called upon to inform and help to guide societies towards better social and environmental outcomes based on their scientific understanding and technological know-how. While these disciplines have existing ethical frameworks relating to scientific methods and technological applications, their frameworks for the social or political consequences of their work, including their world views and codes of ethics are less developed even though these are becoming increasingly important as human activities increasingly shape environments, habitats and societal opportunities for future development. Strengthening the ethical framework that is in support of professionals working in geoscience, applied earth system science and environmental engineering could address these challenges.

Tackling anthropogenic global change involves scientific, technical, economic and other social concerns that require professional handling of ethical issues, which go well beyond the integrity of research or 'sound' engineering works. Societal concerns are especially value-laden, e.g. the cost of appropriation of resources, side-effects and risks of unexpected collateral damages. Engineering professionals and chartered geoscience professionals mostly do have ethical frameworks for such issues. Such frameworks are less familiar with scientists in earth system science. Nevertheless, these frameworks are needed because of the complexity of handling anthropogenic global change, be it only because of the number of different scientists involved. Many geoscientists or earth system scientists seem not to be well equipped to handle these kinds of issues even though challenging social questions are increasingly relevant, including how to engineer human-geosphere intersections [4], how to apply earth system sciences at regional scales, and how human support systems can be made more productive at lower environmental costs. For such applications, a well-developed framework of professional ethics could be an essential means to deal with the intersection of geoscience and human action, and to help guide behaviours and practices where human activities intersect with geosphere processes.

Some professions in geoscience, applied earth system science and environmental engineering are regulated to maintain the quality of their work, the integrity of the respective professional, and the trust of stakeholders. In less applied professions, these frameworks of regulations, codes and established practices are less elaborated. In turn, the role of training in research integrity gets more important [5]. To strengthen the ethical framework for applied earth system science an "Oath for earth scientists" [1] or a "The Geoscientist's promise" [6, 7] has been proposed. Such an 'ethical requirement' offers a general framework for professional ethics including its particular constraints, such as limited understanding of human-geosphere processes and of cultural biases in their valuation. Most importantly, the ethical requirements of an oath or promise could offer an additional level of scientific cultural standards and openness above existing professional codes relating to research integrity and public regulations and professional charters that refer to engineering works.

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