Geoscience provides a needed holistic context for Earth System Governance

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Summary

2024 became both a reflective juncture in the UN's multilateral efforts to transform the world and a major step in the pure-to-applied transformation of geoscience. The latter surrounds the new concept of the Anthropocene, shorthand for humanity's disruptions of natural events and processes starting about 12,000 years ago that developed the Earth during its 4.6 billion-year-long history. Attracting wide scholarly interest and the attention of the public-at-large worried about adverse impacts of human activities on climates, environments and all other life, the Anthropocene positions geoscience to make a pivotal contribution to Earth Governance efforts.

Pulse of the Planet

Traditionally, the scientific study of the Earth relied on an encompassing conclusion by 'the father of geology', James Hutton (1726-1797), that its evolution shows "no vestige of a beginning, no prospect of an end"[1]. Generations of geologists were trained on this premise that the natural world is in a steady state, that the ways the planet changes now are how the planet has always changed and will always change.

In the late 20th century, new realizations about the pulse of the planet emerged across the scientific community. *Planet under Stress*, a multidisciplinary assessment by the Royal Society of Canada, recognized that "the human being is an animal that has moved out of ecological balance with its environment"[2]. Call-to-action contributions included: "The task of the future is to build understanding among and between citizens and scientists so that both become citizen scientists, potentially able to solve our problems together"[3].

There was also a breakthrough at NASA[4] tied to the US National Research Council's increasingly popular concept of Earth System Science: "Whereas in the past, each part of the Earth was studied separately, it is now appropriate and necessary to consider the whole Earth as a system that is composed of elements of diverse kinds in many ways, resulting in a spectrum of cycles with many different scales… and that a major challenge is to use this understanding to maintain an environment in which the biosphere and humankind will continue to flourish"[5].

Then a decade ago, the Rockefeller Foundation—Lancet Commission on Planetary Health warned: "By unsustainably exploiting nature's resources, human civilization has flourished but now risks substantial health effects from the degradation of

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[1] James Hutton, 2010. Theory of the Earth, 1788. Classic Books International.
[2] Constance Mungall and Digby McLaren, 1990. Planet under Stress: The Challenge of Global Change. Royal Society of Canada.
[3] Ursula Franklin, 1990. Reflections on science and the citizen, In Mungall and McLaren. ibid.
[4] NASA, 1986. Earth System Science: an overview. NASA.
[5] Gerard Middleton, 2005. Historical origins of Earth System Science. Geological Association of Canada.

nature's life support systems in the future"[6]. In another sweeping caution, the Director of the Max Planck Institute for the History of Science concluded: "We can no longer categorically segregate culture from nature but must face the fact that these spheres are inescapably mingled"[7].

Anthropocene

Meaning the human age, this increasingly familiar term was introduced in 2000 by Nobel laureate Paul Crutzen. He later anticipated that "the Anthropocene develops into a metaphor about the relationship between nature and humankind"[8]. Between 2009-2019 when the pure-to-applied transformation of geoscience was well underway, the Anthropocene Working Group of the International Commission on Stratigraphy, a body of the International Union of Geological Sciences with more than one million members, would have ideally framed a purpose mindful of humanity's intensifying disruptions throughout the Earth System. Last March, it was worldwide news that the Commission and Union had rejected the Group's narrow proposal that the Anthropocene be an epoch starting in the mid-20th century with atomic bomb tests in the atmosphere.

Instead, helpfully, an Anthropocene Event approach encompasses all disruptions of the Earth System by *Homo sapiens* — us, the one remaining human species — since the melting of ice-sheets over much of Eurasia and the Americas during the Ice Age that began 2.6 million years ago and ended with what geologists refer to as the Pleistocene Epoch[9].

In 2016 a political economist declared: "The Anthropocene is a key theme in contemporary speculations about the meaning of the present and the possibilities for the future... How the Anthropocene is interpreted, and who gets to invoke which framing of the new human age... matters greatly for both the planet and for particular parts of humanity"[10].

Ecological and sociological reflections ensued. 2017: "… the Anthropocene has spilled out of its natural sciences origins to become a cultural zeitgeist… about how to understand and respond to human domination of the Earth"[11]. 2019: "Nature and humanity are now locked in lopsided coevolution—that is, nature would persist in the absence of humanity, but humanity cannot exist without nature… the fusion of science and humanism can address contemporary challenges"[12]. 2022: "the wide cultural currency of the term Anthropocene offers a rich opportunity to engage a global audience with issues that are relevant to us all"[13].

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[6] The Rockefeller Foundation—Lancet Commission on Planetary Health, 2015. Safeguarding human health in the Anthropocene epoch. The Lancet.

[7] Jürgen Renn, 2020. The Evolution of Knowledge: Rethinking Science for the Anthropocene. Princeton University Press.

[8] Christian Schwägerl, 2013. https://www.environmentandsociety.org/exhibitions/welcome-anthropocene/huge-variety-possibilities-interview-nobel-laureate-paul-crutzen

[9] Emlyn Koster, Philip Gibbard and Mark Maslin, 2024. The Anthropocene Event as a cultural zeitgeist in the Earth-Human Ecosystem. Journal of Geoethics and Social Geosciences.

[10] Simon Dalby, 2016. Framing the Anthropocene: the good, the bad and the ugly. The Anthropocene Review.

[11] Yadvinder Mahli, 2017. The concept of the Anthropocene. Annual Review of Environment and Resources.

[12] Stephen Jackson, 2019, Humboldt for the Anthropocene. Science.

[13] Nicole Boivin, Todd Braje and Torben Rick, 2024. New opportunities emerge as the Anthropocene epoch vote falls short. Nature Ecology & Evolution.

By 2020, in addition to growing outbreaks of violence, the pandemic-struck world was anxious about anthropogenic warming of climates, melting of glaciers and ice-sheets, rising of oceans, and atrophying of ecosystems. As a more meaningful scientific and societal term than the Earth System, the Earth-Human Ecosystem in an Anthropocene context conveys the planet's reality of competing unnatural and natural forces with a needed ecological mindset. Not only are the Earth's enveloping shells of air, water, ice, land and life, both human and non-human, interconnected, they form an unbreakable continuum. This fact underscores why climate change should be neither described nor interpreted in isolation from other Earth-encircling dynamics.

Unlocking the Future

In 2023 a UN special report *Toward a Rescue plan for People and Planet* declared: "It's time to sound the alarm. At the mid-way point on our way to 2030, the *Sustainable Development Goals (SDGs)* are in deep trouble… the potential for science, technology and innovation to be applied to the SDGs is vastly untapped and institutional". Looking back, "That our fractured and ultimately short-sighted approach to growth has given rise to the [Anthropocene] should be enough to give us pause and force a reflection not just of the scale of what we have done but more so of what we need to do now"[14].

The subtitle of *Timefulness* about why awareness of the Earth's temporal rhythms is critical to our planetary survival was 'How thinking like a geologist can help save the world'[15]. Geoscience is indeed the profession that develops and monitors evidence about the once pristine Earth. It was the Future Earth organization that synthesized the Earth System's 12 accelerating trends as well as the world's 12 accelerating socio-economic trends, both since 1750[16].

Icon for the 2014-2016 'Welcome to the Anthropocene: The Earth in our Hands' exhibition at the Deutsches Museum, a joint undertaking with the Rachel Carson Center for Environment and Society. Courtesy of Helmuth Trischler, Head of Research at the Museum.

In 2015, the first exhibition on the Anthropocene was at the Deutsches Museum in collaboration with the Rachel Carson Center for Environment and Society: with a promotional logo conveying humanity's pervasive influence on the planet, its subtitle was *The Earth in Our Hands*[17]. Following the UN's 2015-2030 plan with its siloed approach of 17 SDGs, imagine a science-infused *Transforming Our World 2.0* plan embracing an Earth-Human Ecosystem framework in which the atmosphere, hydrosphere, cryosphere, non-human biosphere and surface lithosphere sub-systems are the seamless

[14] Paula Caballero and Patti Londōno, 2022. Redefining Development: The Extraordinary Genesis of the Sustainable Development Goals. Lynne Rienner Publishers.
[15] Marcia Bjornerud, 2018. Timefulness: How Thinking like a Geologist can help Save the World, Princeton University Press.
[16] Future Earth, 2015. https://futureearth.org/2015/01/16/the-great-acceleration/.
[17] Nina Möllers, Christian Schwägerl and Helmuth Trischler, 2015. Welcome to the Anthropocene: The Earth in Our Hands. Deutches Museum and Rachel Carson Center.

baseline for stewardship of the ethnosphere, defined by a leading anthropologist as the embodiment of human ingenuity[18].

Communicating the relevance of geoscience to global exigencies relies on individual and team efforts publishing in progressive journals and proactive in multidisciplinary networks. Johan Rockström, Founder of the Stockholm Resilience Centre and Director of the Potsdam Institute for Climate Impact Research in Germany, was among *TIME* magazine's 100 most influential people in 2023[19]. Since 2009, he has pioneered and communicated the concept of planetary boundaries as environmental guidelines that people need to operate within in order to keep humanity safe.

Metaphor for the influence that today's Anthropocene-mindful geoscience profession should be in Earth Governance efforts. Courtesy of VistaCreate.

TIME urged that "new business models for shaping the path forward, guiding leaders on how to turn complex science into clear, quantifiable actions" are needed. Generative breakthroughs for governing our Planetary Emergency hinge on holistic principles with SMART goals, defined as specific, measurable, assignable, realistic, and time-related[20], each with an influential champion. Looking back, the UN's 1986 Montreal Protocol to phase out harmful ozone-depleting gases ranks as an exemplar. Signed in 1987, UNEP projects that the ozone layer will return to its 1980 composition by 2066. The above-noted Nobel laureate Paul Crutzen (1933-2021) was the principal researcher and ambassador.

Ideally, decisions about the future embody Aristotle's philosophy that leadership should strive for the harmonious pursuit of positive consequences in the world. Today we also need to recognize that the sustaining seven generation and good ancestor traditions of Indigenous peoples are inspirational fuel[21]. As UNEP cautioned: "If science has taught us anything, it is that the environment can pull the rug from the economy and society at any time"[22]. Above all, global governance must be equally attentive to environmental and societal challenges and opportunities[23].

Born in the Suez Canal Zone and with UK, Canadian and US citizenships, Emlyn was the 50th anniversary board president of the Geological Association of Canada, worked in three UNESCO World Heritage Sites, and was at the helm of four major nature and science museums in North America. Presenting and publishing on the relevance of the Anthropocene concept since 2011, he is an Earth-Human Ecosystem synthesist. Current appointments include Honorary Professor in the Evolutionary Studies Institute at the University of the Witwatersrand in South Africa.

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[18] Wade Davis, 2009. The Wayfinders: How Ancient Wisdom matters in the Modern World. Anansi.

[19] https://time.com/collection/100-most-influential-people-2023/6269887/johan-rockstrom/

[20] https://en.wikipedia.org/wiki/SMART_criteria

[21] Emlyn Koster, Philip Gibbard, Matthew Edgeworth and Richard Josey, 2022. Time is pressing: can we be good ancestors? https://www.mos.org/blog/the-earth-around-us/good-ancestors

[22] UNEP, 2020. The triple planetary crisis: forging a new relationship between people and the Earth, Statement prepared for delivery to the Sub-Committee, Committee of Permanent Representatives.

[23] Augusto Lopez-Claros, Arthur Dahl and Maya Groff, 2020. Global Governance and the Emergence of Global Institutions in the 21st Century. Cambridge University Press.