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Challenges in sustainable resource management

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To live sustainably according to Life–Environment principles is the grand challenge of our time. This includes learning to respect life, diversity, and inclusion among all species and at all scales. It further includes the promotion of wellbeing, development, and the progression of human endeavor. Considering humanity is currently in a period of overshoot in terms of our presence on the planet compared with its ecological capacity to provide resources sustainably, a transition to a new relationship between ourselves and nature is needed (Meadows et al., 2004). How we use and manage resources is a key part of this challenge. This is not an isolated effort as a recent search on Google Scholar finds almost 1,000 articles published already in 2022 with the precise phrase “sustainable resource management” (e.g., Bal and Brookes, 2022; Potočnik, 2022; Scuderi et al., 2022), and over 35,000 articles without the quotation marks. While thousands of researchers are engaged in this challenge, much more work is needed and there is still space to make meaningful contributions. The journal aims to welcome, promote, and disseminate scholarship, ideas, experiences, and cases that cover this topic. Specifically, *Frontiers in Sustainable Resource Management* is the needed application of sustainability principles to how humans obtain, use, and return the resources for our cultural flourishing. By necessity and purpose, it is interdisciplinary (Bolger, 2021; Locatelli et al., 2021).

The term sustainability conjures to mind nature and the vast species biodiversity of living organisms. However, it is useful to remember that individual organisms have finite life spans as part of a life–death cycle, without which evolution is not possible. Sustained life occurs not at the individual level, but at the system level, such as an ecological community interacting with its environment—an ecosystem. Therefore, Fiscus and Fath (2019) promoted a unified Life–Environment concept that makes the fragmentation between life and the environment difficult, if not impossible. The fundamentals of sustainability must consider this integration and interdependence. Although our knowledge of ecosystem science has increased greatly in the past decades, the challenge for humans to implement this understanding into building sustainable communities and a sustainable society remains a challenge.

A sustainable system must first be able to create order from disorder (negentropy) and then maintain its order from disorder (e.g., using code script such as DNA). It does this by using the flow of renewable inputs to self-organize and regenerate structural couplings that continue the functioning processes. As Schrödinger (1944) remarked in his classic book, *What is Life*, the order and organization within a complex (living) system emerge and are maintained by “sucking orderliness from its environment.” This creates order from disorder.

Within the confines of its systems boundary, the rate of internal entropy generation is minimized. In ecology, the sharpness of the system boundary diminishes as one goes along the hierarchy, from the cell → organism → population → community → ecosystem → biome, and only regains clarity at the planetary scale. There is no denying the unitary nature of all life upon the planet—in the words of Lynn Margulis, a “Symbiotic Earth.” In particular, it is in this thin Life–Environment layer, the critical zone, that harbors the interacting spheres (atmosphere, biosphere, hydrosphere, and lithosphere all actively impacted by the anthroposphere), where humans must come to terms with and implement ideas of sustainability. Eventually, we may carry these challenges beyond the confines of planet Earth, but for now, it is urgent enough to start at home.

In applying sustainability to socio-economic-ecological systems, we are concerned with multiple dimensions and interactions. Sustainable resource harvesting is possible with an intimate knowledge of the cycles of the natural world and the rates of replenishment, whether it is forests, fish, soils, or sunlight. Understanding the concept of carrying capacity is critical as a measure of the impact (historically measured in terms of the number of grazing animals that can be supported) that can be absorbed by the specific location under the presence of its occupants according to sustainable land use. Carrying capacity is dynamic as it can be constrained or expanded by the occupants themselves co-constructing the interactive Life network. This also implies that carrying capacity is a geographical and place-based consideration. Ultimately, sustainability comes down to living and thriving within the limits and opportunities of place, protecting, renewing, and enhancing the very ground, literally and figuratively. The soil beneath our feet is motivation to “Think globally, Act locally”. This is one reason the indicator, ecological footprint, has resonated so well and become so popular. As a measure of the area of land (in hectares), one uses to support oneself, it directly connects each of us to the place our resources originate and the place they return to. More research is needed to deepen our understanding of direct and indirect connections that make up our footprints and also how to tease out the tension between producer and consumer responsibility.

Human societies are open systems that continually take from the environment and return our wastes to it. These wastes are reused and reincorporated into that same environment. It is easy to take this environmental context for granted because the medium is always around us, but just as a fish out of water or a bird out of the air, we too depend on our environment for every breath we take and every bite we eat. The scale of impact of humans has increased manifold since we emerged as a distinct hominid line circa 250,000 years ago, living off the land and real-time flows of energy and resources. Around 10,000 years ago, we harnessed more control of the solar energy flows by actively selecting, tending, and domesticating both edible crops

and edible and laboring animals. During most of this history, the human population was low compared with the available resource base. This is referred to as an “empty world” in terms of human presence relative to nature (Daly, 2015). A few centuries ago, ancient sunlight concentrated into dense energy fuels was tapped into becoming the main driver of expanding human civilization. This originated in the United Kingdom and the United States and spread to much of the rest of the world in earnest by the mid-20th century. Populations exploded, arable land under cultivation soared, cities and factories grew and spread, the mining of resources boomed, wastes accumulated, and the pace of life increased. In contrast to an earlier time, humans became a major presence compared to natural places. The consequences were not invisible as species diversity declined, forests fell, deserts grew, acid rain fell, fossil aquifers drained, and the climate changed. For example, currently, around 96% of all biomass of large terrestrial mammals is either humans or the livestock we grow for our use (Bar-On et al., 2017). This leaves little space or resources for the rest of the approximately 8 million species and clearly demonstrates our transition from the “empty world” to a “full world” in just a few hundred years. We now know that the pace and scale of the changes have altered the basic biogeochemical cycles that regulate and balance the Earth’s self-organizing and regenerative processes. If we are to continue benefitting from nature’s services, then we must deepen our understanding of natural systems and our utilization of them.

While much emphasis is on how we (humans) do things, and how to do those things more effectively and efficiently, ultimately sustainability will also include a discussion about the ends and not just the means. The “how” of the question must be in light of the “why.” As Salaten (2009) remarked in the movie *Food, Inc.*, “In cattle we have learned how to plant, fertilize and harvest corn using global positioning satellite technology, and nobody sits back and asks, ‘But should we be feeding cows corn?’” Cows have evolved as forage eating ruminants with digestive tracks suited to extract energy from cellulose and although they fatten quicker with high protein and high carb corn, the diet is unnatural and unhealthy to them. Again, rather than fixing this at the root cause, and returning to the synergistic, win-win grass-based diet, modern farming takes an approach of adding more resources and control loops such as antibiotics, feedlots, and other interventions. These require yet additional resources, generate additional waste, and create more control loops. I bring this tale here, into the preamble for a scientific journal, because sustainability science should address root problems and not just clean up apparent symptoms. One must put the milk jug right before cleaning up the spilled milk. To reiterate, science has a role in asking why certain actions are taken, not just how. In fact, science should lead by example and strive to conduct itself in a sustainable, renewable, and supportive fashion that respects the life it studies and the life with which it interacts.

There are many practical questions that need to be addressed surrounding sustainable resource management. Asking ourselves the basic questions, such as, “Where do things come from?” and “Where do things go?” can act as guideposts and involves knowledge of the following: material flow and life cycle analysis of the ecosystem services, extraction technologies, efficiency improvements, supply chains, households and communities as both producers and consumers; the leakage, spillage, and unintended consequences on biogeochemical cycles in land, oceans, and air; the renewability and recyclability of the materials and methods; and, finally, the policies and economics that guide and drive the decisions. Practically, to start, the journal welcomes papers in four specialty sections: Natural Resources, Sustainable Materials, Smart Technologies, and Sustainable Land Use. We are still recruiting a specialty chief editor in the section of Sustainable Resources and Policy and remain flexible to move into other areas of need and interest. The journal is broad in its scope but targeted in its desire: to publish high-quality research related to sustainability that helps understand and advance the transition to sustainable resource management.

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Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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