Introduction

The natural environment constitutes a complex and dynamic global ecosystem that provides essential resources for societal well-being and survival. However, the environment is also subject to unprecedented threats from human activities, such as climate change, pollution, habitat loss, biodiversity decline, and the overexploitation of scarce natural resources including rare-Earth metals that are vital to driving the transition to cleaner technologies but also risk further habitat destruction. To address these challenges, there is an imperative need for coordinated polycentric action by multiple stakeholders at various governance scales, including governments, civil society, the private sector, academia, self-organized communities, and individuals. Such interventions require not only scientific knowledge and data about the state and functioning of the environment, but also social and institutional knowledge and data about the values, preferences, norms, and behaviors of the actors involved in environmental governance and management to build trust, and ultimately community.

Yet environmental knowledge and data are often dispersed, heterogeneous, incomplete, inaccessible, or contested, making it difficult to share, integrate, and apply these data for the common good. Moreover, environmental knowledge and data are not static or neutral, but rather are often dynamic and value-laden, reflecting the interests, perspectives, and power relations of different knowledge producers and users. Therefore, finding ways to govern shared environmental knowledge commons that can serve the needs and goals of diverse and sometimes conflicting stakeholders is a formidable challenge that requires careful design and governance.

There are numerous examples underscoring the stakes of information sharing in the environmental context. Consider the global processes undergirding the Intergovernmental Panel on Climate Change, which involves more than 750 scientists from around the world exploring the physical science of climate change as well as studies involving adaptation and mitigation (IPCC n.d.). Similar issues are playing out in near-Earth orbital space with growing constellations of satellites competing for scarce slots while avoiding crashing into each other, or the

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estimated 34,000 other objects that clutter the cosmos (Bongers and Torres 2024; Pultarova 2024). Absent concerted, multistakeholder information sharing, cascading accidents, translation errors, and associated governance gaps can worsen global collective action challenges.

In this book, *The Environmental Knowledge Commons: Cases and Lessons for Knowledge Sharing*, we examine this challenge through the lens of the environmental knowledge commons itself, which is a concept that draws on the literature on knowledge commons and the literature associated with the Ostrom Workshop including the commons itself (Agrawal et al. 2023, which defines "commons" as "resources used or governed by groups of heterogeneous users through agreed-upon institutional arrangements"), polycentricity, the Institutional Analysis and Development (IAD) framework, and the Governing Knowledge Commons (GKC) framework. The first efforts to extend the IAD framework to knowledge sharing occurred in 2006 with Elinor Ostrom and Charlotte Hess (Hess and Ostrom 2007), which laid the groundwork for later efforts to create the GKC framework, which "is an institutional approach to governing the management or production of knowledge commons" (Ostrom Workshop n.d.). "Knowledge commons" in this context refers to "information, science, knowledge, data and other types of intellectual and cultural resources" (Ostrom Workshop n.d.). The GKC, then, is a framework to study the institutionalized community governance of the sharing and, in some cases, creation, integration, and preservation of information, science, knowledge, data, and other types of intellectual and cultural resources (Frischmann et al. 2014). "Environmental commons" are systems that allow communities of users to devise and enforce rules on how to sustainably manage and use biophysical resources that are essential for their livelihoods and well-being (Poteete et al. 2010).

We contend that the environmental knowledge commons can be seen as a special type of knowledge commons that focuses on the collection, management, and sharing of knowledge and data related to the natural environment and its governance. We further assert that the environmental knowledge commons can benefit from applying the GKC framework, which enables us to identify and analyze the key components and variables that shape the performance and outcomes of the environmental knowledge commons, such as the characteristics of the knowledge resources, the actors and their interactions, the rules and norms that govern the commons, the external factors that influence the commons, and the evaluation criteria that measure the success of the commons. The GKC framework also allows us to compare different cases of environmental knowledge commons across various domains, contexts, and scales, and to derive generalizable insights and lessons for knowledge sharing and governance.

The network of universities, organizations, governments, scientists, and private citizens working to address environmental challenges is decentralized and polycentric in nature. Given the recognition of the natural environment as a system of interconnected ecosystems and socioecological contexts, there is a growing demand

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for understanding about the best ways to collect, manage, and share environmental data. The framework of GKC provides a useful starting point to address this demand and answer the following question: *What makes a successful environmental knowledge commons?* Building on an emerging field of knowledge commons study in which a growing knowledge commons community has worked to enhance the GKC framework, this edited volume addresses challenges particular to managing a successful environmental knowledge commons.[1] The GKC approach capitalizes upon the parallels between the institutional analysis initially developed by Ostrom and continued through the GKC framework and the contextual integrity framework, allowing new questions, surrounding data and information, to be included in diverse analyses, such as questions about legitimacy, power imbalances, regime effectiveness, and equity.

The main objective of this book is to showcase the application and usefulness of the GKC framework for the study of the environmental knowledge commons, by presenting a diverse and rich set of case studies that illustrate the challenges and opportunities of creating and governing environmental knowledge and data for the common good. The case studies cover various topics, such as climate change, forestry management, space, and green tech that span different geographical regions, levels of analysis, and types of actors and institutions. The case studies are based on original empirical research conducted by the contributors, who come from different disciplinary backgrounds and perspectives. The case studies also demonstrate the policy relevance and implications of the environmental knowledge commons, by showing how they can inform and support decision-making and action for environmental sustainability and justice. For instance, some of the case studies extend the scope of the environmental knowledge commons to the space domain, by examining how knowledge and data about the Earth's orbit and the outer space can be shared and governed for the benefit of humanity and the environment.

The book is structured in four parts, focusing on environmental knowledge commons. Part I is composed of Chapters 1–3. Chapter 1, "The Value of Having Values: Artifacts of Normative Knowledge as Instruments of Collective Self-Governance for Data Flows," by Greg Bloom, focuses on boundaries around data resources

[1] See Brett M. Frischmann, Michael J. Madison, and Katherine J. Strandburg (eds.), *Governing Knowledge Commons* (New York: Oxford University Press, 2014); Katherine J. Strandburg, Brett M. Frischmann, and Michael J. Madison (eds.), *Governing Medical Knowledge Commons* (Cambridge: Cambridge University Press, 2017); Erwin Dekker and Pavel Kuchař (eds.), *Governing Markets as Knowledge Commons* (Cambridge: Cambridge University Press, 2021); Madelyn Rose Sanfilippo, Brett M. Frischmann, and Katherine J. Strandburg (eds.), *Governing Privacy in Knowledge Commons* (Cambridge: Cambridge University Press, 2021); Brett M. Frischmann, Michael J. Madison, and Madelyn Rose Sanfilippo (eds.), *Governing Smart Cities as Knowledge Commons* (Cambridge: Cambridge University Press, 2023); Madelyn Rose Sanfilippo and Melissa G. Ocepek (eds.), *Governing Misinformation in Everyday Knowledge Commons* (Cambridge: Cambridge University Press, 2025).

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that can be drawn through the intentional development and application of values statements. Chapter 2, "Inexorably Entangled Environmental and Knowledge Commons," by Todd Aagaard and Brett M. Fischmann, analyzes the interrelationship between environmental and knowledge commons that weave together different strands of commons research and practice. Chapter 3, "RACs: Truth as a Shared Resource within the ESG Knowledge Commons," by Chris Draper and Simon Sun, examines the role of Human Impact Units and Regenerative Authentication Credits (RACs) in transforming Environmental, Social, and Governance (ESG) governance into a more transparent and equitable knowledge commons.

Part II comprises Chapters 4 and 5. Chapter 4, "Linking Physical and Knowledge Commons in a Green Stormwater Infrastructure Program," by Erik Nordman, Patrick J. Doran, Christian Glupker, Sam Haapaniemi, Elaine Isely, Paul Isely, Valerie Strassberg, and Shanyn Viars, investigates the ecological paradigm in stormwater management that mimics natural hydrology by diverting stormwater into well-designed green stormwater infrastructure practices. Chapter 5, "Co-Curating Institutional Data on Climate Change-Induced Loss and Damage via Expert Panels: Implications for the Environmental Knowledge Commons," by Mathew Kurian, Yu Kojima, Wa'ed Alshoubaki, Sekela Twisa, and V. Ratna Reddy, focuses on analysis of five cases of common pool resources management combined with an expert panel review of climate loss and damage in Jordan to examine their implications for the knowledge commons framework.

Part III focuses on environmental knowledge commons in the space context. Specifically, Chapter 6, "Building A Sustainable Space Knowledge Commons," by Laetitia Cesari and Simon Sun, examines the extent to which the Space Data Association has become an effective stop valve for gaps in prevailing multilateral space governance instruments. Chapter 7, "Terrestrial Environmental Data Obtained from Space," by Andrea J. Harrington, examines the institutional barriers surrounding the sharing of environmental data from Earth-orbiting satellites and associated infrastructure with stakeholders around the world.

Finally, Part IV, comprising Chapters 8 and 9, begins with Jorge L. Contreras' chapter, "The Prospects for Green Patent Commons," which considers whether, and under what conditions, private firms can productively combine existing patent assets to support the dissemination and use of green technology. Chapter 9, "The IPCC as Expert Knowledge Commons," by Michael J. Madison, uses the IPCC's governance of that shared knowledge to motivate and illustrate a model of expert knowledge commons. At the end, we provide a brief summary and couch these findings within the growing literature on GKC, along with providing a research agenda to help highlight unanswered questions on the road ahead.

In this effort, we are building on previous successes and applying the framework to systematically study scientific data issues within knowledge commons, including the ways that sharing, cooperation, hubs, and trusts aid or act as governance and how questions of collaboration and cooperation are raised relative to governance

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when examining data sharing, specifically in scientific communities. As we have recognized from the beginning, the GKC framework requires an iterative case study process, to both improve the framework and support identification of patterns across studies. To do so effectively, we continue to try to attract other scholars to this collaborative research project. We will continue to solicit interdisciplinary contributions to develop a rich set of case studies. We are also now able to draw on both the network we have developed in studying knowledge commons and the interdisciplinary environmental studies, with which we work. Our hope is for this book to be among the first, but certainly not the last, to tackle the thorny topics associated with governing the environmental knowledge commons.

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