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# The planetary commons: A new paradigm for safeguarding Earth-regulating systems in the Anthropocene

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**The Anthropocene signifies the start of a no-analogue trajectory of the Earth system that is fundamentally different from the Holocene. This new trajectory is characterized by rising risks of triggering irreversible and unmanageable shifts in Earth system functioning. We urgently need a new global approach to safeguard critical Earth system regulating functions more effectively and comprehensively. The global commons framework is the closest example of an existing approach with the aim of governing biophysical systems on Earth upon which the world collectively depends. Derived during stable Holocene conditions, the global commons framework must now evolve in the light of new Anthropocene dynamics. This requires a fundamental shift from a focus only on governing shared resources beyond national jurisdiction, to one that secures critical functions of the Earth system irrespective of national boundaries. We propose a new framework—the planetary commons—which differs from the global commons framework by including not only globally shared geographic regions but also critical biophysical systems that regulate the resilience and state, and therefore livability, on Earth. The new planetary commons should articulate and create comprehensive stewardship obligations through Earth system governance aimed at restoring and strengthening planetary resilience and justice.**

Anthropocene | Earth system governance | global commons | international law | planetary boundaries

As we progress deeper into the Anthropocene with ever-expanding human pressures on the Earth system, there are increasing calls for a paradigm shift in our understanding of and approach to governing planetary risks and social transitions to a sustainable future (1). In this article, we argue that recognizing the critical biophysical systems that regulate the Earth system as "planetary commons" is an essential part of such a shift. It is now well established that human actions have pushed the Earth outside of the window of favorable environmental conditions experienced during the Holocene and that humanity has the capability of changing the functioning and trajectory of the Earth system (2–6). Several studies highlight the serious challenges posed to global governance to protect the functions of Earth's biophysical systems in ways that ensure planetary resilience and justice for present and future generations (7–12). If essential systems and processes are perturbed beyond critical thresholds, they can undergo irreversible state shifts with potentially dire consequences for life on Earth (13).

To maximize the probability for life to flourish, it is necessary to secure the core functions of the Earth system that regulate planetary resilience. This task falls under the remit of global law and governance (14, 15). In this constellation, one prominent approach is the global commons, with their distinctive status in international relations, law, and diplomacy (16). Four global commons have been variously identified using different legal terms (e.g., common heritage and common concern): the high seas and deep seabed, outer space, Antarctica, and (to a less clear extent) the atmosphere (e.g., ref. 17). These areas are shared by all states and lie outside of jurisdictional boundaries and thus sovereign entitlements, and all states and people have collective vested interests that they be protected and governed effectively for the collective good (18).

The global commons remain the closest example of global governance where multiple states have agreed to govern some, but not all, large elements of the Earth system, namely parts of the geosphere (deep seabed), hydrosphere (high

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seas), cryosphere (Antarctica), and the atmosphere (the climate system), while largely omitting the biosphere, and including outer space beyond the Earth system (19–22). Despite their potential to be governed as collective elements of the Earth system, there are several concerns related to the continued usefulness of the global commons as they are defined and governed today. The core of the problem is that the global commons, like international law more generally, have been negotiated by states within the context of the Holocene epoch, mainly to regulate resource access and use, geopolitical interests, and environmental protection under assumptions of a continuously stable Earth system, abundant resources to sustain life indefinitely, and predictable and relatively minor environmental disruptions to which humans can easily adapt through incremental governance interventions (23, 24). Given this conceptualization, the political and legal construct of global commons is unable to recognize and address governance challenges of an interlinked, continuously changing, and disrupted Earth system (25, 26).

Earth system science now shows that there are biophysical limits to what existing organized human political, economic, and other social systems can appropriate from the planet (7, 27, 28). Exceeding these limits will impact life-support systems, and the entire planet may irreversibly drift away from stable conditions. These long-term risks are preceded by immediate risks, where human pressures and interconnectedness between Earth's biophysical systems lead to rapid impacts globally, for example, accelerated ice-melt or a sudden pulse of carbon from forest fires in one location on the planet impact livelihoods across the world. This has major social–ecological and justice implications for present and future human and nonhuman generations (29, 30). Interlinked planetary boundaries are being transgressed (7, 27), tipping elements show signs of destabilization (6, 13), and the resilience of Earth's biophysical systems is being negatively impacted (31). Many of the systems critical to sustain life and the habitability of Earth lie outside of, or only partly within, the formal classification of the global commons. Examples are critical biomes such as boreal permafrost, tropical rainforests, coral reefs, and wetlands. Protecting their integrity is in the common interest of humanity, but the global commons framework has not been able to offer a comprehensive solution to safeguard these systems in ways that fully account for Anthropocene dynamics and interlinked Earth system characteristics.

In the Anthropocene, the Earth system is rapidly being stripped of its resilience, and critical planetary functions need to be secured through collective, more effective governance in ways that enable social–ecological resilience while reducing injustices (32–34). As the first step in conceptualizing a new approach to safeguard Earth's critical biophysical systems, we identify and define a new category of "planetary commons" for the Anthropocene. The planetary commons include, but significantly expand on, the current global commons by embracing all critical biophysical Earth-regulating systems and their functions, irrespective of where they are located, because they are essential to sustain all life across the planet, including the stability of our societies.

Governance of the planetary commons must draw on, but also expand and improve, existing global governance regimes to ensure more effective governance for planetary resilience and a just and livable planet. Drawing on the legacy of Elinor Ostrom's foundational research, which validated the need for and effectiveness of polycentric approaches to commons governance (e.g., ref. 35, p. 528, ref. 36, p. 1910), we propose that a nested Earth system governance approach be followed, which will entail the creation of additional governance arrangements for those planetary commons that are not yet adequately governed. A challenge for such regimes is to duly adapt and adjust notions of state sovereignty and self-determination, and to define obligations and reciprocal support and compensation schemes to ensure protection of the Earth system, while including comprehensive stewardship obligations and mandates aimed at protecting Earth-regulating systems in a just and inclusive way.

We arrive at our conclusion that a planetary commons framework is required for humanity to navigate the Anthropocene by first summarizing the evidence of risks of Earth system disruption, loss of Earth resilience and tipping cascades, and associated patterns of increasingly acute planetary injustice resulting from these disruptions. We then assess whether the current approach to global commons is still fit for purpose. Motivated by the limitations and deficiencies of the conventional global commons approach, we propose the planetary commons as an innovative path to safeguard planetary resilience and justice that must be achieved through stewardship obligations. While we do not attempt to offer a detailed description of a new global governance system that is perfectly aligned with the planetary commons framework, we make a first attempt to raise considerations, challenges, and features that need to be considered in the development of such a framework. We fully acknowledge the sheer complexity and magnitude of the endeavor implied in our proposed governance framework. Designing and implementing realistic, comprehensive, and well-functioning governance innovations in practice will require mobilization of efforts at an unprecedented scale, including future research. We suggest that the Anthropocene demands nothing less.

## 1. The State of the Earth System in the Anthropocene

The Earth system is a complex, self-regulating system, characterized by multiple interactions and feedbacks among large biophysical systems that interplay with life on Earth and determine the resilience of the entire system. The Anthropocene signifies the start of a no-analogue state of the Earth system that is fundamentally different from the Holocene (37). At its core is the exponential rise in human pressures on the planet, ranging from global warming to biodiversity loss, which have reached a level where signs of exceeding the coping capacity of ecologically adaptive biophysical systems and processes that regulate the state of the planet are now evident (38, 39). The decline of planetary resilience is revealed by planetary boundaries science (7, 28, 40). For life as we know it to continue, it is vital to keep the Earth system within, or at least close to, Holocene-like conditions for all systems and processes that regulate the functioning of the Earth system (28, 41). Humanity is rapidly exiting this safe operating space, as six of nine planetary boundaries are now assessed as crossed, including those for climate change, biosphere integrity, land use, interference with biogeochemical cycles of nitrogen and phosphorus, as well as novel entities and freshwater change (7, 28, 42, 43).

Earth's biophysical systems, ranging from critical biomes (e.g., tropical forests) to ice sheets, and oceanic and atmospheric circulation systems are particularly at risk. Many of these systems show evidence of having multiple stable states, separated by tipping points with feedback dynamics and interactions (within and between systems) that determine what state they reside in ref. 44. The planetary subsystems that can potentially exhibit tipping behavior and that play a key role in controlling the state of the Earth system have been defined as tipping elements (45). Various candidate tipping elements have been proposed, and studies have found substantial evidence for the existence of about 15 climate tipping elements (6, 45, 46). Rising climate forcing and degradation of the biosphere has led to a rapidly rising risk of pushing tipping elements across their tipping points (45, 47), with several climate tipping elements showing signs of instability (13). A recent assessment estimates that several feedback shifts could be triggered, causing tipping points to be crossed already at, or close to, 1.5 °C of global mean surface temperature (GMST) rise, i.e., even if global warming is limited to the level aimed at by the Paris Climate Agreement, while several other tipping points would likely be crossed at a 2 to 3 °C warming level (6; see also Fig. 1).

Although elements have different GMST threshold levels, there is increasing evidence of links between tipping elements, which can cause cascade or domino effects (48), also between low temperature tipping elements and higher temperature elements. An example of such a cascade is the Greenland Ice Sheet melting that will lead to a large flux of freshwater into the North Atlantic, reducing the density of surface seawater and thus weakening its deep convection (or sinking). This can slow down the Atlantic Meridional Overturning Circulation, in turn leading to heat accumulation in the Southern Ocean and accelerated melting of the West Antarctic Ice Sheet. This could cause a shift of the Intertropical Convergence Zone, possibly affecting weather patterns in the Amazon rainforest region (13, 49, 50). The tipping cascades could accelerate short-term Earth system impacts such as fires, droughts, and floods and undermine planetary resilience in the long term (6, 48, 49).

Crossing the tipping points will not only have environmental implications as their structure and functioning change (e.g., from stable to erratic regional rainfall) but is also likely to disrupt socio-economic and political systems that have developed with and are reliant on the stability of the Holocene (23). For instance, around 400 million people would directly suffer from a demise of tropical corals (51), and at 3 °C of global warming, over three billion people would be living in regions with health-threatening levels of heat (52). The same is true for the planetary boundaries, which, despite critique (reviewed in ref. 53), are considered precautionary "scientific assessments about what is safe, dangerous and unacceptable" (54, p. 83). Transgressing boundaries and undermining the functioning of biophysical systems already have severe multispecies justice implications for present and future


**Fig. 1.** A map of climate tipping elements, i.e., Earth system subdomains that determine the state of the climate system and are susceptible to dramatic change if global warming crosses threshold values corresponding to their tipping points. The ranges of global warming values where a tipping point is found for a specific tipping element are presented in colors (yellow for <2 °C, orange for 2 to 4 °C, and dark red for ≥4 °C). The map is derived from Armstrong McKay et al. (6) and printed with permission from the American Association for the Advancement of Science. See *SI Appendix, Glossary* for key definitions.

generations, and this is set to intensify as we move deeper into the Anthropocene (55).

The continuous erosion of Earth system resilience suggests that we urgently need a more comprehensive and effective approach to govern all critical Earth-regulating components, subsystems, and their functions to stay as close as possible, or within, Holocene-like conditions. The global commons are the closest example of an approach that is focused on safeguarding some collectively shared systems on Earth. In the following section, we critically reflect on the continued suitability of the global commons framework in the light of the Anthropocene.

## 2. Revisiting the Global Commons

The idea of the commons (or commoning) responds to the concern that people who rationally pursue their self-interest are more likely not to work in favor of the common good if they believe that there are no, or little, restraints imposed on the exploitation and use of shared resources (56–61). To avoid a situation where the commons are depleted at the cost of its users and the resource itself, "collective action is needed to maintain the commons and the interest of the group that relies on it" (62, p. 27). This, in turn, has led to designing systems of innovative collaborative governance at local scales and calls for those at larger scales (59, 61, 63).

At the global level, commons have been defined as large areas on Earth that lie beyond the national jurisdictions of states where no sovereign rights vest and that are shared by all states. These global commons have usually been considered either res nullius (owned by no one) or res communes (owned by everyone), or their status has been ambiguous or disputed (64). They are large areas from which all states and people benefit and in which they accordingly all have interests, although they are too extensive, important, and complex for any one state to govern on its own (65). Their uniqueness lies therein that they are "domains that have an inherent value for humankind and the planet, and therefore have assumed a non-national status in international relations" (16, p. 423).

There is no overarching global commons governance regime; each of the four global commons (the high seas and deep seabed, the atmosphere, outer space, and Antarctica) is treated differently and governed by individual treaties, with Antarctica presenting the most coherent, and the high seas and deep seabed the most complex regime (*SI Appendix*, Table S1). These regimes have some generic characteristics that are shared to a greater or lesser extent and that are beneficial for governing shared areas. For example, sovereignty should be restricted, and global commons cannot be appropriated by anyone; all states should be involved as stakeholders in their governance and must share equitably in benefits; they must be used for peaceful purposes; and states have a shared and differentiated responsibility to protect the commons for their collective good (66). The governance regimes aim to foster collaboration, constrain behavior, promote compliance and honoring of obligations, and increase reputational costs for norm-breaking behavior (15). To a more limited extent, they also offer mechanisms whereby states are forced to relinquish some of their sovereign claims and accept external costs associated with resource use, degradation, and depletion (67, 68).

Innovative and well-intended as they are, the global commons have limitations. Among other issues, and with exceptions, the principal motivation behind global commons regimes is not so much focused on promoting sustainability as on facilitating equitable use (67, 68). Even in the case of Antarctica and outer space, where the preservationist ethos is strongest, rules against utilization are to a significant extent intended to maintain the geopolitical balance. Most global commons regimes have also been designed on the back of interstate processes that promote states' political interests, and not because of evolving scientific criteria that would support the declaration of new commons or improved governance (17). This is problematic because a principal concern regarding global commons is not only to control risks of depletion by certain groups at the expense of other people but also the risk for all future people around the world when the commons lose their capacity to regulate the livability of the Earth system. Relatedly, not all global commons sufficiently address multiple global inter- and intragenerational injustices among and between species that arise from the dominance of the global North and increasingly restricted access and scarcity for the global South (69, 70).

The global commons also do not provide a workable solution for areas of common concern that lie within state borders (71). Earth system components that contribute vital ecological functions for the benefit of everyone do not respect national borders; they ultimately affect everyone and the entire Earth system itself. The Amazon rainforest, which is also classified as a global tipping element (6), is one example, where deforestation and ecological degradation contribute to global risks associated with the release of carbon from forest dieback and loss of $CO_2$ uptake capacity, biodiversity loss, changes in critical freshwater flows, and pathogen spillovers from wildlife to humans (72–74). At the same time, unsustainably high greenhouse gas emissions in wealthier countries and their growing demand for natural resources generate excessive external pressures on the Amazon and other ecologically fragile regions. This, in turn, reduces the space for developing countries to flourish while threatening the stability of the Earth system. The global commons framework does not address this challenge and dismisses the nature, size, and ecological boundaries of biophysical systems that interact within and across Earth's life support systems, which overlap spatially and have diverse characteristics (1, 75–77). It is furthermore focused on specific areas, but not on governing Earth system functions that characterize each of the commons (20–22, 78). As a legal and political concept, the global commons, in terms of scale and how this maps onto jurisdictions "do not align [...] with the often unclear boundaries and complex interactions, loops and interdependences of social-ecological systems, and [...] this mismatch affects the resilience of these systems" (32, p. 266).

While they might have guided sovereign states in the past on what to do about large areas lying outside of their jurisdictions, the way global commons have been constructed and are currently understood are inadequate for tackling Earth system oriented challenges in the Anthropocene. In the next section, we propose the planetary commons as an alternative to the global commons approach. In contrast to the global commons, the planetary commons recognize the complexities and interdependencies inherent in the Earth system and acknowledge the potential of an all-encompassing commons approach that extends its focus beyond facilitating equal access to resources, to one that is focused on safeguarding critical Earth system regulating functions.

## 3. Planetary Commons for the Anthropocene

The foregoing discussion suggests that the global commons have been conceptualized, and their governance regimes have evolved, at a time when human experience and knowledge were informed by presumptions of Earth system stability that has been subject, at most, to incremental, linear changes in Earth system functions. There has been little consideration of risks of transgressing carrying capacities, triggering irreversible nonlinear changes, or to safeguarding biophysical planetary functions that are crucial to sustain favorable conditions for humanity (23, 24). In this context, "institutional success came most straightforwardly in the form of rules or informal arrangements to control access, rather than in adaptation to ecological dynamism of the sort that could be expected were stable Holocene conditions to change" (23, p. 938).

The evidence of rapidly rising planetary risks that we explored earlier supports our call for a new paradigm that foregrounds planetary stewardship and secures critical planetary life-support systems in a safe and just way. The global commons could play a significant role in such a paradigm shift, but only if they transition from their current conceptualization to match the new reality of the Anthropocene. Any new conception of the global commons must therefore be informed by Anthropocene dynamics and include, as its core rationale, the need to safeguard and steward critical Earth system functions that regulate the stability of the planet and that sustains its resilience, avoid breaching planetary boundaries causing tipping point risks, and work toward ensuring a just and inclusive world for everyone, now and in the future.

We propose giving this Anthropocene-aligned definition of global commons a new, more expansive term, i.e., the planetary commons. The planetary commons (Fig. 2) are defined by the functions they provide to Earth system stability and resilience and include all critical Earth-regulating biophysical systems and their functions, irrespective of where they are located, because they are essential to sustain all life across the planet.

Critical elements of the planetary commons concern all major Earth system spheres (e.g., atmosphere, oceans, land, and cryosphere) with which the biosphere (humans included) interact (Fig. 2). They also cover all large subsystems that determine the overall structure, functioning, and stability of the Earth system and that provide the vital conditions in which just livelihoods for present and future humans and nonhumans are possible. These are made up of tipping elements, which form a subset of the planetary commons (see *SI Appendix*, Table S1 which presents tipping element functions and governance responsibilities/instruments, anthropogenic drivers of change, and temporal and spatial scales). The planetary commons further extend beyond the tipping elements to encompass those Earth subsystems that are not likely to undergo tipping dynamics but that are still at risk of significant degradation and on aggregate continue to provide vital services, support life, and planetary resilience. Examples are the Congo and Southeast Asian rainforests, temperate forests, wetlands, and coastal blue carbon ecosystems, even though these might not have documented evidence of nonlinear change behavior (Fig. 2).

Not allowing the foregoing biophysical systems to drift away from Holocene conditions will enhance the likelihood

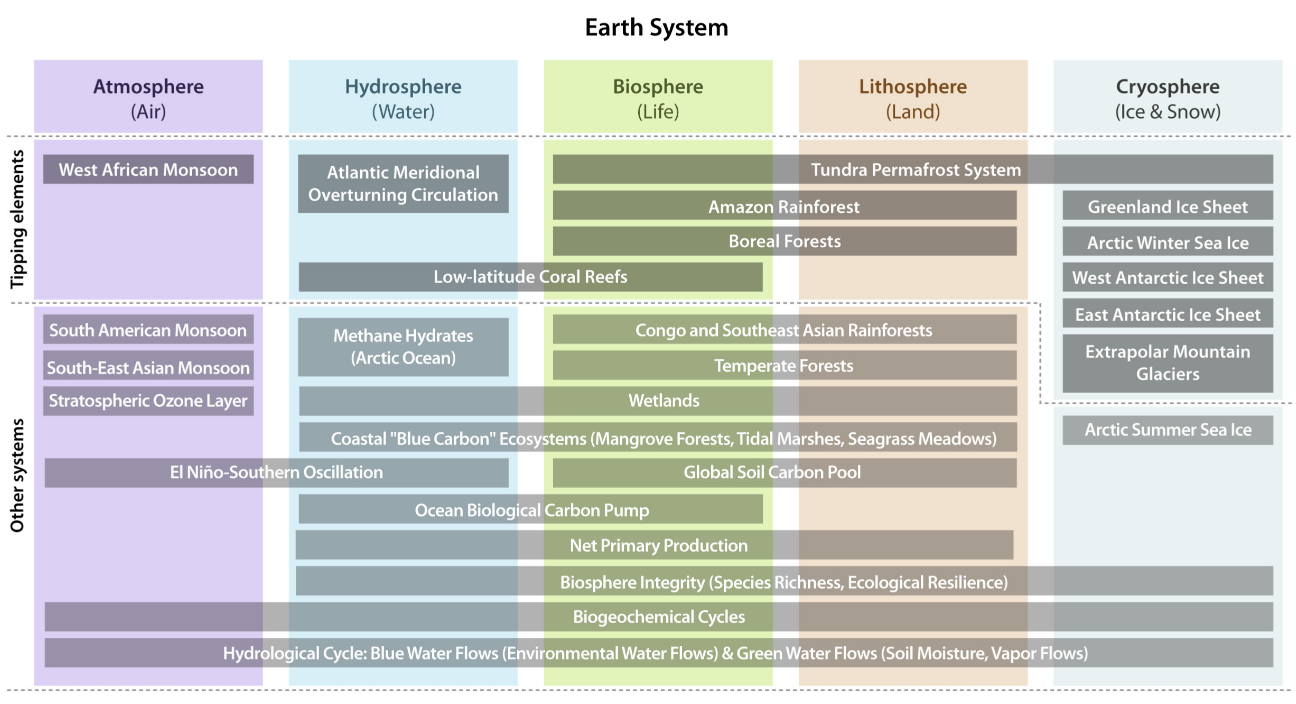


**Fig. 2.** Proposed categories of planetary commons. The Earth system, represented by the outer gray frame, constitutes the ultimate overarching planetary common, given its interconnected self-regulating characteristics. The Earth system is configured by planetary commons "spheres" (atmo-, hydro-, bio-, litho-, and cryosphere) and other subsystems within and across these spheres, namely the tipping elements (in bold font) and other biophysical systems that may not exhibit tipping behavior but play a vital role in regulating the livability on Earth. Image credit: Reprinted with permission from ref. 6.

that the Earth system will continue to support societies and all life on Earth. The consequences of such a "planetary shift" in global commons governance are potentially profound. Safeguarding these critical Earth system regulatory functions is a unique planetary scale challenge characterized by the need for collective global scale solutions that transcend national boundaries (79). The planetary commons framework provides the foundation to tackle this planetary challenge by requiring us to become active stewards of our own life-support system and by imposing planetary stewardship obligations on states and civil society to collectively safeguard Earth system regulatory functions.

Despite ongoing concerns about the path-dependent course of action that mostly prioritizes short-term national security and interest over a commonly shared interest in long-term planetary resilience, there are also encouraging signs suggesting some progress toward safeguarding planetary commons. This suggests that designing a planetary commons governance framework over the long term, while challenging, is not unrealistic and such an effort can draw on existing initiatives. One example is the global governance regime of one of the nine planetary boundaries, namely halting the depletion of the stratospheric ozone layer, whereby states are successfully protecting the ozone layer by deliberate and far-reaching global cooperation (80). Another is the 2023 agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (81). Yet another example is the Sustainable Development Goals. Although they are nonbinding, and while some question their effectiveness (82), they do provide evidence of a global agreement among states on aspirational development targets, demanding that collective action must be taken by everyone for the greater good (83, 84).

While such initiatives hold some promise, much more will be required to establish and fulfill planetary stewardship obligations: "Without such stewardship, the Anthropocene threatens to become for humanity a one-way trip to an uncertain future in a new, but very different, state of the Earth System" (85, p. 757). Designing a governance system that can facilitate stewardship obligations around the planetary commons framework will be a complex endeavor, and it is not one we comprehensively explore here. While meaningful responses to these issues will have to be developed collectively over time, and more research is required to propose realistic solutions, we take a first step below to outline a nonexhaustive list of challenges, considerations, and suggestions guiding the future development of a planetary commons governance framework.

As a point of departure, what is clear is that implementing a governance system for the planetary commons will likely challenge barriers of state sovereignty and self-determination (86–88), vested corporate interests (89), global power inequalities (90), and demarcation complexities that differ from the existing global commons and state borders. Overcoming the path-dependent political course of action that prioritizes short-term national security and interest over a commonly shared interest in long-term planetary resilience is another major challenge. Moreover, parts of the planetary commons are often owned by communities within countries, and there will be myriad aspects around increasing stakeholder involvement and effective representation of marginalized interests in the designation and governance of the planetary commons (91). Another matter is how the planetary commons will effectively ensure global justice that advances a broader understanding of multispecies and inter- and intragenerational coexistence for living well (92, 93).

Considering these complexities and challenges, planetary commons governance could be based on a nested Earth system governance approach. Unlike traditional fragmented, state-driven environmental governance approaches, the idea of nested Earth system governance departs from the influential commons scholarship of Elinor Ostrom (35, 36). It offers a polycentric governance approach that connects scales and integrates sectors and jurisdictions, providing an innovative Earth system–focused framework for governing complex, interlinked, multiscalar governance challenges arising from a changing Earth system (10). Earth system governance is the sum of the formal and informal rule systems and actor–networks at all levels of society that are set up to influence the coevolution of social-ecological systems at the planetary scale in a way that secures sustainability and planetary resilience (88). It is "nested" to the extent that it refers to "inclusive systems which aid autonomous functioning of smaller, more exclusive units operating within broadly agreed principles [where] key governance functions [...] are organized into multiple, reinforcing, layers of governance" (94, p. 560). Nested governance figures prominently in commons scholarship and refers to shared governance approaches that combine formal and informal, higher- and lower-level, established and self-organized, but reasonably coordinated, governing entities (59, pp. 101–102, 94. p. 560). In governing smaller-scale commons, nested approaches are often more effective than command-and-control arrangements imposed by a central government authority without consultation of and cooperation with affected stakeholders (36). A local Earth system governance–based example are institutions responsible for fisheries and marine protected areas governance in countries such as Belize (95). The biodiversity governance regime, incomplete as it is and although it is faced by multiple challenges, is an example of a global regime (96, 97).

A nested Earth system governance approach is especially relevant when the scale on which social-legal-political systems operate do not fully correspond with the scale of the ecological issues or processes they seek to govern (98, 99). It is therefore particularly suited for larger, sometimes overlapping, areas situated across several jurisdictions characterized by multiple, varied social relations, institutional frameworks, and ecosystems (99, p. 58). Moreover, the complex teleconnections in the Earth system (100), where activities in one country or area affect planetary commons in other regions, require a new conceptualization and stronger architectures of effective Earth system governance (101). These architectures will utilize a wide variety of rules, principles, state and nonstate governance institutions and actors, decision-making procedures and mechanisms, and enforcement and compliance strategies (102, 103).

An earth system governance approach will require an overarching global institution that is responsible for the entire Earth system, built around high-level principles and broad oversight and reporting provisions. This institution would serve as a universal point of aggregation for the governance of individual planetary commons, where oversight and monitoring of all commons come together, including annual reporting on the state of the planetary commons. At present, the United Nations General Assembly, or a more specialized body mandated by the Assembly, could be the starting point for such an overarching body, even though the General Assembly, with its state-based approach that grants equal voting rights to both large countries and micronations, represents outdated traditions of an old European political order. Novel arrangements, such as weighted voting or the addition of a United Nations Parliamentarian Assembly or a Global Deliberative Assembly might be needed to make governance at the planetary scale more representative, legitimate, just, effective, and reflective (104). This planetary scale arrangement will likely fulfill generic governance functions through orchestration (105) to ensure that the governance of distinct planetary commons is sufficiently aligned and integrated to avoid problem-shifting within and between Earth system spheres, tipping elements, and other biophysical systems (Fig. 2 and refs. 106 and 107).

More specific governance arrangements would then be needed for each of the central Earth system spheres, such as the atmosphere, the hydrosphere, the oceans, and the cryosphere. For some, such governance arrangements could be based on existing regimes (*SI Appendix*, Table S1), such as those established by the United Nations Framework Convention on Climate Change and its follow-up agreements; the Convention on Biological Diversity (CBD); the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses; or the Antarctic Treaty. For others such as land, new arrangements might be needed that rely on existing regimes under the Food and Agricultural Organization, the Convention to Combat Desertification, the CBD, and related agreements. Detailed governance arrangements would also be needed for each tipping element and biophysical subsystem that make up the planetary commons. For some of these, such as the stratospheric ozone layer, relatively effective planetary regimes exist, as we have shown above (108). For others, new regimes must be developed.

Designing planetary commons governance will be controversial and complex. For one, there is the sheer complexity of actors, governance levels, and norms that characterize any governance arrangement (109). New governance arrangements might also raise the specter of climate and environmental colonialism (110), which requires a transformative approach in international relations marked by planetary justice and fair global cooperation. Any new governance arrangement must avoid legacies and practices of (neo)colonialism and neoliberal exploitation often attached to development policies and resource governance (111, 112). Given that most people live in the Global South, governance of planetary commons situated in global South countries will need to build on the decisive agreement and leadership of these countries. This, in turn, must enable inclusive and representative governance that are attentive to the multiple patterns of planetary injustice (113). In the spirit of polycentrism outlined above, planetary commons governance must be structurally fair and agreeable to a range of different voices and worldviews (114), and be based on broad societal consultation and consent.

Fundamentally important is also the relationship between territorial custodians of a planetary commons and the broader spectrum of planetary beneficiaries, noting also the planetary scale of harm caused by local activities such as excessive greenhouse gas emissions. If a governance framework for, e.g., permafrost ecosystems and the Amazon rainforest were put in place, then the primary responsibility for coordinating these planetary commons would fall to a finite set of sovereign countries, Indigenous peoples, and communities. If excessive emissions and harmful activities in some countries affect planetary commons in other areas—for example, the melting of polar ice—strong political and legal restrictions for such localized activities would be needed. In addition, some form of legally binding and agreed compensation scheme for the host steward countries and those directly responsible for governing planetary commons would be required, with particular engagement of Indigenous peoples for their knowledges, practices, and contributions to ensure stable living conditions across the planet. Moreover, considering that any move to strengthen planetary commons governance would likely be voluntarily entered into, the burdens of conservation must be shared fairly (115). For instance, a more equal sharing of the burdens of climate stabilization would require significant multilateral financial and technology transfers in order not to harm the poorest globally (116). The extent of such transfers will need to be determined and shaped by the historical responsibilities for global environmental degradation. If the world community would define tipping elements as planetary commons, such as the remaining boreal and tropical rainforests, and legally protect them as such, this could enable setting up compensation schemes, allowing nations hosting planetary commons to be compensated for stewardship of these systems on behalf of all people over the world. This would align with the recent statement by Brazilian President Lula da Silva, who affirmed the Amazon rainforest as a collective responsibility which Brazil is committed to protect on behalf of all citizens around the world, and that deserves and justifies compensation from other nations (117). Moreover, the regional summit that he convened for Amazonian states in August 2023 to agree for the first time on a common policy to protect the Amazonian rainforest, although it failed to facilitate such an agreement for now, is a step in the right direction.

Several other general considerations will be key when designing planetary commons governance. One is the need to prioritize the coherence, coordination, and institutional interplay between, within, and across different governance arrangements at various global and local scales in ways that create collective planetary stewardship obligations (118). One practical way to achieve this could be through the formation of global clubs such as “climate clubs” (119). The club model of international governance recognizes that some international treaties tend not to produce their intended effects unless strong enforcement mechanisms are put in place (120); something that states are often reluctant to do. Under the club model, a more pragmatic approach that might have a realistic chance of success is based on the participation of a subset of nations with strong interests (or high ambition states) in tackling a global challenge such as climate change, wherein membership dues are lower than penalties for nonparticipants. In terms of this approach, environmental taxes can effectively be imposed on those who violate the planetary climate commons (121). Participants hence have a strong incentive to abide by the club agreement, while nonparticipants have an incentive to join, whereby free riding that has marred much of global environmental governance could be addressed. The funds collected in the process could, e.g., finance new technologies in low-income countries and support planetary commons preservation and restoration efforts, including containment of permafrost thaw (122). Similarly, civil society and private sector actors could form clubs of their own to advance planetary commons governance by leveraging their influence. An example is the Seafood Business for Ocean Stewardship initiative, which seeks to achieve a sustainable global seafood industry via a partnership between science and seafood companies. By controlling a large share of the global seafood market, and guided by scientific insights based on research on keystone species, these companies aim to exert more influence on the structure and functioning of the entire seafood system, including governance of the Earth's ocean systems, which they hope to steer toward sustainability (123).

Governments also need to agree on a shared and ambitious goal that planetary commons governance must strive toward, such as just planetary resilience. Working toward such a common goal and devising ways to keep everyone accountable to reach it, could optimize coherent institutional integration and counter unambitious governance path dependency (124, 125). An ambitious goal will also be a critical catalyst to create and implement planetary stewardship obligations (126) and strengthen state and nonstate rights and duties to safeguard planetary resilience. While often claimed to stifle the dynamics of societal innovations, institutionalizing such an ambitious goal could drive societal and technological innovation. Practically, this could be accomplished by repurposing the all-but-defunct United Nations Trusteeship Council that could exercise an overarching stewardship role for the planetary commons (127).

Earth system science will play a prominent role in all these foregoing efforts (128, 129), while eventual governance outcomes must be informed by societal values, different approaches to risk, and democratic and participatory decision-making. Effectively linking law, politics, governance, science, and other knowledge domains must lead to planetary commons governance that is undergirded by mutually supportive knowledge creation that is also reflective of the state of the planet, its living order, and models of coexistence, kinship, and pluriversal knowledges (130–132). The latter will require epistemological humility and the need to restrain active human interference in planetary systems, including hubristic and risky approaches such as solar geoengineering.

Planetary commons governance must also rely on a set of core principles, which would include existing principles of international environmental law (e.g., precautionary principle, no-harm principle, and the principle of common but differentiated responsibilities and respective capabilities (133)). These would need to be strengthened by new principles that align with novel Anthropocene dynamics and that could reverse the path-dependent course of current governance. These new principles are captured under a new legal paradigm designed for the Anthropocene called earth system law and include, among others, the principles of differentiated degrowth and sufficiency, the principle of interconnectivity, and a new planetary ethic (e.g., principle of ecological sustainability) (134).

Looking ahead, the transition to better govern Earth's critical biophysical systems, while evidently challenging, is both critically necessary and possible. Fortunately, we can draw inspiration from existing examples of stewardship involving diverse state and nonstate actors that we have alluded to above, as well as place-based research and transformational change, ocean stewardship via transnational corporations, or global adaptive governance of regional marine resources and ecosystems (135–137). There are also lessons to be learned from transitions research, clarifying how to shift into new pathways and trajectories of change and how to navigate them (138–140).

## 4. Conclusion

We are confronted by rapidly rising risks of triggering irreversible and increasingly unmanageable Earth system–wide impacts and persistent shifts in life support systems. This requires a new approach to safeguard Earth's critical biophysical systems that contribute to regulate planetary resilience and livability on Earth. This approach must be fully in sync with Anthropocene dynamics and the most recent scientific evidence of eroding planetary resilience. It must simultaneously recognize the integrated nature of the Earth system and the importance of its functions to sustain planetary resilience, while creating obligations for planetary stewardship and addressing injustices.

Planetary resilience is in the common interest of everyone, everywhere, and is central to sustaining the foundations of all life and ensuring justice. A global commons approach to govern collective nonexcludable resources in the best interest of the world community therefore remains valid but must be expanded to include critical Earth regulating systems in order to open up a more comprehensive and innovative path to safeguard planetary resilience and global justice. The planetary commons will require moving away from global commons as a means of governing resource use of natural resources beyond national borders, to universal rules of how to collectively secure critical biophysical Earth system functions that regulate livability on Earth for everyone, irrespective of where these functions are located. We believe that the planetary commons framework has the potential to initiate the long overdue paradigm shift that we urgently need to safeguard the Earth system as we move deeper into the Anthropocene.

**Data, Materials, and Software Availability.** All study data are included in the article and/or *SI Appendix*.

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