Supporting Information for
Planetary Commons for the Anthropocene

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Glossary of Key Terms

**Abrupt change** (based on ref. 1): A change in a system that is substantially faster than the typical rate of the changes in the system’s history and/or the typical rate of change in external forcing of the system. See also *Abrupt climate change* and *Tipping point.*

**Abrupt climate change** (based on ref. 1): A large-scale abrupt change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades and causes substantial impacts on human and/or natural systems. See also *Tipping point.*

**Anthropocene** (based on ref. 1): The proposed new geological epoch resulting from significant human-driven changes to the structure and functioning of the *Earth system*, including the climate system. Originally suggested in the Earth system science community in 2000, the proposed new epoch is undergoing a formalization process within the geological community based on the stratigraphic evidence that human activities have changed the Earth system to the extent of forming geological deposits with a signature that is distinct from those of the *Holocene*, and which will remain in the geological record. Both the stratigraphic and Earth system approaches to defining the Anthropocene consider the mid-20th century to be the most appropriate starting date, although others have been proposed and continue to be discussed. The Anthropocene concept has already been informally adopted by diverse disciplines and public discourse to denote the influence of humans on the Earth system.

**Climate feedback** (based on ref. 1): An interaction in which a perturbation in one climate quantity causes a change in a second, and the change in the second quantity ultimately leads to an additional change in the first. Negative feedback is one in which the initial perturbation is weakened by the changes it causes; positive feedback is one in which the initial perturbation is enhanced.

**Earth’s biophysical systems**: The Earth’s large biological, chemical, and physical systems or sub-systems, from critical biomes (like boreal and tropical forests) to ice sheets, and oceanic and atmospheric circulation systems.

**Earth system** (based on ref. 3): A single, self-regulating system comprised of interacting physical, chemical, biological and human components.

**Earth system governance** (based on ref. 4): A new paradigm in sustainability science that integrates insights from *Earth system* science with analytical, normative and transformative research on governance, institutions, and politics. Earth system governance is defined as the sum of the formal and informal rule systems and actor-networks at all levels of human society that are set up to influence the co-evolution of socio-ecological systems at planetary scale in a way that secures sustainable development – that is, a development that meets the needs of present generations without compromising the ability of future generations to meet their own needs.

**Earth system resilience** (based on refs. 5, 6): The capacity of the biogeophysical Earth system to absorb anthropogenic stressors, such that the system persists in, or recovers to, a *Holocene*-like interglacial regime, encompassing the essential regulating structures and functions that are the foundation for a habitable planet and sustainability. See also *Habitability/livability of the Earth.*

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* The process is led by the Anthropocene Working Group of the International Commission on Stratigraphy (2).
**Functions of the Earth’s biophysical systems**: Processes that enable the habitability/livability of the Earth. Some examples include carbon sequestration via ocean carbon pump (combination of physical, chemical and biological drawdown of carbon from the atmosphere), distribution of heat between low and high latitudes via ocean circulation, reflection of incoming solar radiation, regulation of sea levels by ice-sheets and glaciers, moisture recycling by forests, and absorption of ultraviolet radiation by stratospheric ozone.

**Global commons**: Large areas lying outside of national jurisdictions that have been recognized by states and that are regulated under international law. Understood broadly, these encompass the high seas and deep seabed, outer space, Antarctica, and the atmosphere (including the climate system).

**Habitability/livability of the Earth**: The ability of the Earth system to sustain life in general in its Holocene-like abundance, diversity and ecological integrity, and to support the entire human population in the current and projected size indefinitely, while also enabling achievement/maintenance of a decent living standard for all.

**Holocene** (based on ref. 1): The current interglacial geological epoch, spanning the interval from 11,700 years ago to the present day. The early part of the Holocene is marked by the late stages of deglaciation of Pleistocene (Ice Age) land ice, sea level rise, and the occurrence of warm phases that affected different regions at different times, often referred to as the ‘Holocene Thermal Maximum’. In addition, the epoch includes the post-glacial interval, which began approximately 7,000 years ago when the fundamental features of the modern climate system were essentially in place, as the influence of remnant Pleistocene ice sheets waned.

**Irreversibility** (based on ref. 1): A perturbed state of a dynamical system (including the Earth system and the climate system) is defined as irreversible on a given time scale if the recovery from this state due to natural processes takes substantially longer than the time scale of interest.

**Nested governance** (based on ref. 7, p. 560): A nested governance system is one that distributes decision-making among a wide range of institutions, where key governance functions are organized into multiple, reinforcing layers of governance, and where governance units operate under an overarching set of broadly agreed principles.

**Planetary boundaries** (based on refs. 8, 9): Values of nine dimensions of Earth system change, indicating the level of human-driven planetary change in respective nine key biophysical processes (namely, biosphere integrity change, climate change, stratospheric ozone depletion, ocean acidification, interference with biogeochemical cycles of nitrogen and phosphorus, land-system change, freshwater use, atmospheric aerosol loading, and introduction of novel entities) that should not be transgressed if we are to avoid unacceptable global environmental change, related to the risks humanity faces in the transition of the planet from the Holocene to the Anthropocene.

**Planetary commons**: The planetary commons include the main Earth-regulating components, subsystems and their functions, irrespective of where they are located, because they are essential to sustain all life across the planet. Key elements of the planetary commons include all major Earth system domains, such as the atmosphere, the oceans, land and the cryosphere, with which the biosphere, humans included, interact. They also include all large sub-systems of the Earth 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 non-humans are possible. These include the tipping elements, but also systems such as the Congo and Southeast Asian
rainforests, temperate forests, wetlands, and coastal blue carbon ecosystems, because they also contribute to regulate the state of the Earth system, even though they might not have documented evidence of non-linear and irreversible change behavior. Not allowing these biophysical systems to drift away from their Holocene conditions, or to drift away further, will ensure that the Earth system can continue to support life. See also *Earth system resilience* and *Habitability/livability of the Earth.*

**Tipping element** (based on refs. 1, 10): A large-scale component of the *Earth system* (of the order of at least ~1,000 km in length, i.e., ~1 million km²) that is susceptible to a *tipping point* with far-reaching potential impacts on human societies and the biophysical systems.

**Tipping point** (based on refs. 1, 10, 11): A point at which a small perturbation can qualitatively alter the state or development of a system, i.e., a critical forcing threshold beyond which a system reorganizes, often abruptly and/or irreversibly. This qualitative change may occur immediately after the cause, but in the context of the *Anthropocene* the tipping dynamics may also unfold over long timescales (centuries to millennia). This has implications for the governance time horizon, including time over which policies and political decisions can determine whether a tipping point is reached ("political time horizon", up to ~100 years) and additional time over which the subsequent qualitative changes in the *Earth’s biophysical systems* (e.g., disintegrating ice sheets) proceed to have ethically problematic consequences, such as adverse impacts on future generations ("ethical time horizon", approximated to ~1,000-10,000 years). In the Anthropocene context, the qualitative change in an *Earth system’s tipping element* relates to the severity and scale of impacts unleashed by transgressing the tipping point, such as a change in the overall mode of operation of the Earth system or significant and widespread harm to human welfare (e.g., as caused by rising sea levels, collapsing biomes or increasing frequency of extreme events due to shifting weather patterns). See also *Irreversibility* and *Abrupt change.*
<table>
<thead>
<tr>
<th>Tippping element</th>
<th>Service/function provided by the tipping element</th>
<th>Tipping to avoid tipping</th>
<th>Timescale of change</th>
<th>Current governance</th>
<th>Main anthropogenic drivers of change (e.g., carbon emissions, deforestation, aerosols)</th>
<th>Scale of influence on anthropogenic drivers of change (local/global)</th>
<th>Spatial scale at which impacts of anthropogenic change in the tipping element occur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenland Ice Sheet</td>
<td>Alleviates the cooling, avoiding catastrophic low-level rise</td>
<td>decades</td>
<td>centuries to millennia (likely with some major impacts occurring on the timescale of decades)</td>
<td>Greenland, local</td>
<td>northern hemispheric emissions / climate change</td>
<td>local</td>
<td>global</td>
</tr>
<tr>
<td>Arctic Winter Sea Ice</td>
<td>Regulation of regional and global climate</td>
<td>decades?</td>
<td>centuries to millennia (likely with some major impacts occurring on the timescale of decades)</td>
<td>northern; local</td>
<td>northern hemispheric emissions / climate change</td>
<td>local</td>
<td>global</td>
</tr>
<tr>
<td>Atlantic Multidecadal Overturning Circulation (AMOC)</td>
<td>Regulation of climate in Europe and globally, avoidance of substantial low-level rise along the East Coast of North America</td>
<td>decades?</td>
<td>centuries to millennia (likely with some major impacts occurring on the timescale of decades)</td>
<td>northern; local</td>
<td>northern hemispheric emissions / climate change</td>
<td>local</td>
<td>global</td>
</tr>
<tr>
<td>Salar de Uyuni (Salt Desert)</td>
<td>Saline lakes, biodiversity, nutrient recycling</td>
<td>decades</td>
<td>centuries to millennia (likely with some major impacts occurring on the timescale of decades)</td>
<td>northern; local</td>
<td>northern</td>
<td>local</td>
<td>global</td>
</tr>
<tr>
<td>West African Monsoon</td>
<td>Regulation of climate in the Sahel</td>
<td>decades?</td>
<td>centuries to millennia (likely with some major impacts occurring on the timescale of decades)</td>
<td>local</td>
<td>northern</td>
<td>local</td>
<td>global</td>
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</tbody>
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**Table S1.** Tipping elements as a subset of the planetary commons, with some key characteristics relevant for developing their governance, including functions by which they regulate habitability/ livability of the Earth, main anthropogenic pressures that put them at risk of tipping with associated spatial and temporal scales, and subnational, national, and international spheres that currently play, or could play, a role in governing these planetary commons.
SI References


