NEGOTIATING CLIMATE CHANGE IN CRISIS

EDITED BY STEFFEN BÖHM
AND SIAN SULLIVAN

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8. The Atmospheric Carbon Commons in Transition

Bruce Lankford

Originally conceived to discuss water in irrigation systems, this chapter adapts the concept of 'paracommons' to CO_2 governance. The paracommons is 'a commons of material salvages', occurring within the context of multiple pathways for resources salvaged from wastage/waste and via reduced consumption. The carbon/atmospheric commons can be framed in three consecutive stages, with implications for how carbon dioxide is conceived, counted and managed to achieve reductions in global emissions and levels: a 'sink-type atmospheric commons' occurring prior to the 1980/90s, a 'husbandry-type carbon commons' lasting from the 1980/90s to the 2030s, and an emergency 'carbon paracommons' post-2030s. The first stage sees the atmosphere treated as a dump or sink for carbon dioxide (CO_2) 'waste' resulting in rising CO_2 levels. The second stage sees climate change mitigation (e.g. carbon sequestration in forests) as Ostromian-commons husbandry that attempts to reduce CO_2 emission rates but continues to result in levels remaining above 400 ppm. In the third stage, the paracommons treats CO_2 and its 'salvaging' as a matter of urgency leading to permanent sequestration, non-use and transformation.

A 'Commons' Framing of Atmospheric Carbon Dioxide

This article frames carbon in the Earth's atmosphere as three sequential stages of commons,[1] as illustrated in Figure 4: a sink-type commons

1 An area or collection of resources for use by individuals and groups often held 'in common' but subject to varying pressures and ownership modalities.

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for carbon dioxide[2] waste;[3] a 'husbandry-type' Ostromian commons for governing CO_2 emissions; and a 'paracommons' where salvaged CO_2 products (such as liquid or frozen carbon dioxide) are created, permanently sequestered and un-used. The first stage, where wastes of combusting fossil fuel were dumped with little regard for their impact on climate change, occurred prior to the 1990s (but has continued), causing increases in atmospheric CO_2 levels. The second stage, running from the 1990s to the near future (2030), sees increasing management or 'husbandry' of terrestrial and atmospheric carbon and carbon emissions. It is suggested that the third stage will consolidate over the next twenty to thirty years as a scarcity or emergency-driven 'paracommons' concerned with controlling the means, amounts, pathways, and ownership of CO_2 'salvages' in order to drive down atmospheric levels. These commons are described in more detail below.

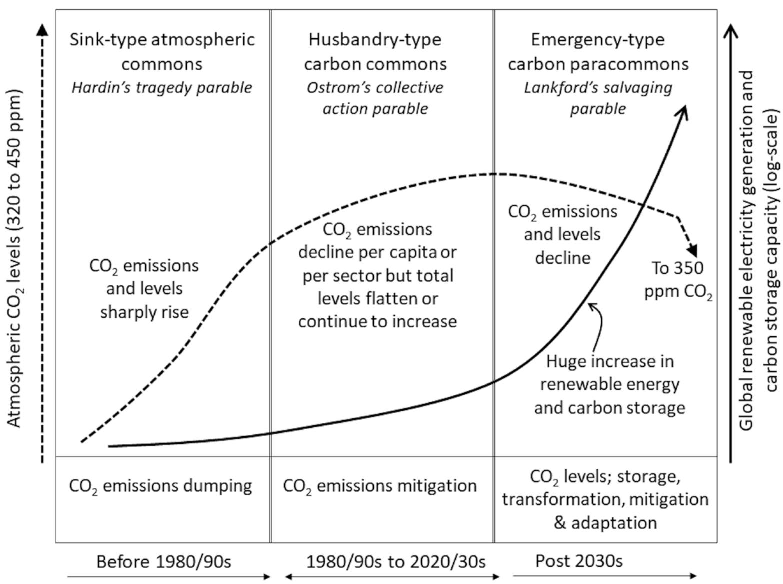

Fig. 4. Three frames and stages of the global atmospheric/carbon commons. Image by chapter author.

2 With limited space only carbon dioxide (CO_2) amongst greenhouse gases is discussed.

3 CO_2 is a gas wasted during fossil fuel conversion that is difficult to capture and recycle (usually termed a wastage), but can be captured with technological innovation.

The Atmospheric Commons: A Sink-Type Commons

The term 'atmospheric commons' observes carbon dioxide as a wastage/waste dumped into the atmosphere:

> One may argue that the atmosphere can also be regarded as a commons, exploited by all yet owned by none. Most significantly the atmosphere has been abused as a 'common sink'. Until relatively recently it provided a completely free waste disposal system for a whole range of anthropogenic pollutants. It also constitutes the ultimate 'public good', that is to say if resources are expended on improving air quality, it is impossible to exclude people from enjoying the benefits (Vogler 2001: 2427).

The word 'sink' has been used by others to cast the atmosphere as a commons (Edenhofer et al. 2012) consistent with Vogler's "exploitation by all" and also invoking Hardin's controversial Tragedy of the Commons hypothesis (Hardin 1968). As Brown et al. (2019: 61) argue, however, "this pervasive framing of climate change as a commons tragedy limits how we confront the climate challenge".

The Carbon Commons: A Husbandry-Type Commons

Brown et al. (2019) thus critique this sink-type view of the commons by reminding us of Ostrom's 'parable' of collective action regarding resources held in common and their management (Ostrom 1990) and joint governance (Schrijver 2016). Observing three characteristics, this 'carbon commons' invokes an Ostromian 'husbandry' of carbon and CO_2 emissions and levels, including: 1) recognition of the limited atmospheric headroom for further increases in CO_2 because of its causal contribution to climate change; 2) implementation of CO_2 mitigation tools to reduce carbon dioxide emissions (e.g. by carbon offsetting and raising fossil fuel efficiency), and; 3) questions of distribution regarding who is using and has used the carbon commons the most by emitting the most atmospheric carbon (Meyerson 1998; Pierrehumbert 2012).

Given accelerated climate change, however, the concern here is that 'business-as-usual' husbandry of the carbon commons is increasingly insufficient. Current governance will be ineffective, or not effective enough, in bringing down CO_2 levels within a rapid time-frame. Although carbon emissions will flatten out under present approaches to mitigation (Lovell et al. 2009), this 'emissions-focused' husbandry will not deliver stringent decreases in CO_2 concentration levels to less than 350 ppm, as required in order to avert climate volatility (cf. Rockstrom et al. 2009). Extending Brown et al.'s (2019) critique of a 'Tragedy of the Commons' framing of the 'sink' of atmospheric carbon, then, we should consider how a husbandry-type Ostromian commons also limits how we conceive of and confront escalating climate change (Rabinowitz 2010).

A Carbon Paracommons: An Emergency-Driven Resource-Salvaging Commons

This is where an adaptation of the 'paracommons' concept comes in. Drawing from analyses of efficiency gains and their variable uptake in irrigation systems (Lankford 2013, 2018), the term 'paracommons' describes a commons of 'conserved' or 'salvaged' resources arising from efficiency gains and managed non-consumption of natural resources. The Greek prefix 'para', meaning 'alongside', is used to signal that the commons here is of salvaged wastages that emerge from, and sit alongside, the primary commons resource under consideration (i.e. water in irrigation systems and atmospheric carbon in fossil-fuel-dependent industrial production).

Inspiration for the paracommons idea came from identifying why and how water resources believed to be 'lost' in inefficient irrigation systems became the focus of competition if these 'losses' could be 'salvaged'. Conceptually, four parties may compete for these salvages: a 'proprietor' making the efficiency gain (usually the irrigators managing an irrigation system); their 'immediate neighbour' (communities often placed near the periphery of the irrigation system gaining from or losing water 'losses' emanating from the irrigation system); 'society' more broadly; and 'nature', when water is freed up to benefit environmental processes beyond the irrigation system.

In adapting the paracommons concept to global carbon management, the following eight features can be identified:

Scarcity and emergency. The irrigation paracommons sees that 'salvages of irrigation losses' become valuable when water scarcity boosts competition for 'losses freed up' through efficiency gains. In a post-2030 climate future, however, circumstances for carbon management will presumably be different, although analogous in certain respects. Atmospheric CO_2 will not become valuable or sought after under demand-driven conditions of scarcity, but by viewing climate change as an "emergency" (Gills and Morgan 2020), and as a form of scarcity (Asayama et al. 2019), three features will reshape how we view CO_2 'salvage' from the atmosphere. First, a regulated scarcity of CO_2 headroom emission possibilities will mean that CO_2 levels can no longer grow. Second, greater financial and societal values afforded to CO_2 salvages permanently removed from the atmosphere will potentially create much greater interest in taking such salvage action. Connected to this valorisation, broad spectrum ownership of effective carbon salvaging technologies at all levels of society will give an appearance of competition for salvaging CO_2 amongst many players, sitting within a broader cooperative endeavour.

Salvage. A definition for 'salvage' as a verb is to retrieve, utilise or preserve something from potential loss, with 'salvage' as a noun being short-hand here for any means by which CO_2 within, or destined for, the atmosphere is removed from, or stopped from passing to, the atmosphere, thus signalling the production of negative emissions. Examples of CO_2 salvage include its transformation and sequestration into organic liquids and solids (e.g. trees and algae-based fuels), or into liquid or frozen and stored CO_2, or fossil and man-made organic solids and liquids whose oxidation or burning is avoided or minimised (on the complexities posed by such 'salvage' technologies, also see Dyke et al. this volume).

Transience and impermanence. In complex systems represented by water and carbon, the amounts, boundaries and pathways of the resources and their salvaging are leaky and transient (Murray et al. 2007). This means that without strict controls, most husbandry attempts to sequester carbon dioxide into, for example, soil organic matter or trees, are impermanent beyond a time scale of twenty to fifty years. A related problem is the difficulty of accurately accounting for carbon in ways that value and record permanent sequestration (Gifford 2020), as also signalled in the chapters in this volume by Bigger et al. and Hannis.

Consumption rebound. An effect of transience and leakiness is that unused or temporarily salvaged products in one part of the economy may be prone to a consumption rebound elsewhere. This is akin to the Jevons paradox (Stoknes and Rockström 2018; Ruzzenenti et al. 2019), arising, for example, when an increase in vehicle fuel efficiency is undermined by increases in the number of vehicles in use.

Exteriorising and making visible the wastes. In the paracommons, potential wastes/wastages need to be made visible and exteriorised (Lankford 2018), meaning their presence needs to be seen as an integral part of the unused and untransformed resource. Progress in the public understanding of climate change, for example, means that many people now see that oil and coal reserves are not only fuels for energy but also constitute the future atmospheric loading of CO_2 'wastes'. The CO_2 in the fossil fuel has been made visible, and society's changing relationship with the properties of fossil fuels has become a discussion about what becomes exteriorised as they are used, and with what socio-environmental effects.

Exteriorising (*making visible*) *the salvage.* The second 'making visible' that exists in the CO_2 paracommons involves the transformation of wastes/wastages into salvage. In irrigation the waste that previously is 'lost' water becomes a gain, because through efficiency innovations losses are recovered or water withdrawals (and their internal losses) are foregone, making more water available for reuse and repurposing (Lankford 2018). With carbon dioxide, various visible salvages exist: CO_2 is permanently evacuated in the form of timber or frozen CO_2; CO_2 is not produced because fossil fuel extraction and burning is foregone; or CO_2 is turned into carbon-salvaged fuels (more or less emission-neutral) that replace fossil fuels (generating additional CO_2 emissions).

A distributive and destination puzzle. Being concerned with controlling CO_2 salvages in a notoriously leaky environment where many possible carbon pathways, distributions and destinations exist, a paracommons framing asks 'who gets the final salvage'. As introduced above, this question identifies four parties acting as destinations for the salvages. Determining these CO_2 pathways and destinations is about bearing down on leakage and the rebound effect in order to ensure salvages permanently end up where they need to be so as to prevent further emissions. As an illustrative example, in the 'husbandry-commons' (as per the description above) vehicle, fuel efficiency results in reduced emissions per driver-kilometre in the short term, but may lead to an uptick in fuel consumption elsewhere either with the same driver (the 'proprietor') or their partner (the 'immediate neighbour') making more journeys, or with more people driving overall ('society'), because it has become more efficient and less costly to do so. Here, then, the salvage (fuel not burnt) passes to the proprietor, their immediate neighbour, or to society, but is not passed to, or withheld permanently, 'in nature'. This example can be extrapolated analogously to the sorts of thorny discussions regarding whether or not voluntary carbon trading in actuality supports effective CO_2 'salvage', or if it instead mostly passes the emitted CO_2 elsewhere (as also highlighted in Hannis's chapter, this volume).

What or who is nature here? The paracommons concept proposes schematically that 'nature' is one of four parties that may benefit from conserved resource salvages, either by recovering the salvages to 'the environment' or by not consuming resources in the first place. In the case of irrigated river basins, irrigation 'wastes' recovered to nature should see ecological/environmental water flows restored. In a CO_2 paracommons, nature is defined schematically as a benefitting party when levels of CO_2 in the atmosphere are decisively reduced. Nature in this simplified CO_2 budget is thus not forest, biochar or organic sediment, if these carbon stores are set to re-release their CO_2 back into the atmosphere within twenty-five to thirty years, such that the trajectory of carbon dioxide levels will remain upwards, undulating or flat (Figure 4). In these urgent terms, mechanisms for permanently sequestering CO_2, such as, for example, in warehouses containing frozen CO_2, would proffer a clearer salvage pathway 'to nature'. That said, such 'fixes' pose their own CO_2 and other complexities, since to industrially process and store CO_2 in ways that do not increase CO_2 levels requires a considerable growth in renewable energy (these concerns are also highlighted in the chapters by Dyke et al., Bigger et al., and Dunlap in this volume). However, in this unreserved 'crisis' definition of 'nature' in a CO_2 paracommons is complicated by the many overlapping 'ecosystem services' also harmed or benefited by a shifting carbon cycle (O'Connor 2008).

Illustrating the Three Commons for Carbon/CO_2 Management

These three types of commons can be illustrated by imagining an industrial mining company that owns one gigatonne of carbon dioxide in coal reserves. In the sink-type commons, the coal is entirely burnt within ten years, dumping waste CO_2 into the Earth's atmosphere.

In the husbandry-type commons, attempts to reduce the company's emissions of CO_2 are made. The gigatonne of coal CO_2 is emitted over a longer twenty-year period because the company reduces annual combustion responding to pricing charges for emissions. Lower emission rates are also offset with a programme of afforestation leading to a forest with a lifespan of thirty years. But after thirty years practically all of the coal's CO_2 ends up in the atmosphere.

A paracommons view of the husbandry-type commons asks where CO_2 'salvaged wastes' (including coal not burnt) end up during attempts to manage, offset or be more efficient with this coal and its yet-to-be-released CO_2. The paracommons argues that four parties compete over the salvaged gain but 'predicts' that with the leakiness of the husbandry-type commons none of these options is easy to trace or constitutes the 'salvage' needed to meet the 350ppm target.

For example: the industrial company (the proprietor) may sell or burn any non-consumed coal after the period under focus; an immediate neighbour (e.g. a community connected to land afforested through offsetting mechanisms) may use the forest resulting in this carbon released back into the atmosphere; 'society' may use fossil carbon from other sources, thereby failing to make the necessary reductions in net consumption; and unused coal retained in the ground may produce 'atmosphere-nature' gains from non-released CO_2. The paracommons model envisages that gains are most likely to pass to the proprietor, its immediate neighbour, and society. Without strong social, political and economic regulation, a permanent salvage is least likely to protect, pass to, or be retained within 'nature'. Unsurprisingly, then, these observations suggest that a nature-safeguarding paracommons needs to be actively designed and regulated so as to genuinely lower atmospheric CO_2 levels.

Designing an Effective Paracommons to Serve 'Nature'?

How, then, might we treat the Earth's atmosphere as a purposively governed paracommons wherein future carbon/CO_2 salvages assuredly protect nature? The points below sketch some principles in moving forward, demonstrating the very real challenges faced in creating meaningful societal structures that combine both CO_2 and decarbonisation:

- Recognising the leakiness and impermanence of the carbon cycle, the paracommons emphasises carbon dioxide *levels* over emissions. A vision for averting dangerous climate change is that salvaged CO_2 must be permanently locked away, as defined by a lowering of CO_2 concentration below 350 ppm within a defined time period (e.g. one hundred years).
- The carbon paracommons asks for a switch to an economy and society that highly values salvaged carbon dioxide products, thus calling for a substantial enablement, reward and valorisation (Luque and Clark 2013) of CO_2 salvage. At the same time, however, such valorisation needs to be considered against the sorts of financialising dynamics, complexities and inequities considered in the chapters by Bracking and Kaplan and Levy, this volume.
- Carbon storage could be enabled by volume-dense cold-storage carbon warehousing, created and managed by a mix of public and private entities and companies. Carbon storage is a provocative 'techno-fix', but consider the following figures. Trees and tree-planting to lock up CO_2 work well in the right conditions: they have a low unit price, are scalable, can be planted by many actors, and of course already exist. But they are slow growing, relatively impermanent, and not 'CO_2 dense enough' to constitute carbon salvage at the rates needed. This is of course not to argue 'against trees', but to draw a storage comparison with large-scale warehousing of CO_2. Assuming an effective annual tree-based CO_2 sequester of 30 t/ha/year

(from absorption per tree of 20 kg/year and a tree density of 1500/hectare), a target of CO_2 removal at 2.2 ppm/year (17.2 Gt/yr) would require 5,727,333 sq km.[4] (In other words, an area three-quarters the size of Australia would effectively need to be afforested, kept forested on a rolling basis, plus the timber products would need to be locked away after trees had been harvested). The same hundred-year total of 1718,2 Gt of CO_2 in warehousing at 60% effective storage would require a total of 2864 cubic kilometres of volume or a warehouse footprint of 28,637 km^2 to be built (in one-hundred-metre-high buildings at an approximate density of 1 tonne CO_2 to 1 cubic metre CO_2) which is 0.376% of the size of Australia.[5] Put another way, CO_2 warehousing outclasses trees on an area basis by 200 to one. The permanence of warehousing of CO_2 would, however, need to be powered by a considerable increase of renewable energy generation with its own associated environmental impacts.[6]

- Household storage of permanently evacuated carbon could become a normalised everyday activity, with the storing of several tonnes of liquid or frozen carbon dioxide on a private property (and provision of energy to do so) becoming a rational response to the urgent need for carbon salvage.
- As already noted, carbon salvage would require an immense expansion of renewable energy to power carbon transformation, and direct air capture and carbon storage. There is a serious paradox here in that energy, and the cost of energy, cannot be the limiting factor in creating a carbon-salvaging paracommons. This paradox,

4 Drawing on Smith et al. (2006). Furthermore, the figure of 2.2 ppm/year for a span of 100 years is set as an example of a rate that would both counter on-going emissions plus bring net reductions in atmospheric CO_2 levels to 350 ppm within 100 years. This is equivalent to a target sequestration of 1718.2 Gt over 100 years.

5 A volume of 2864 cubic kilometres in 100 years is equivalent to building approximately 2600 Tesla Nevada gigafactories each year at 60% effective storage.

6 Alternatives to warehousing include deep-sea storage (Hume 2018) and evacuation to space.

and its accompanying emissions-linked complexities, is scrutinised in Dunlap's chapter, this volume.

- Carbon dioxide transformation is also exemplified by all carbon fuels being sourced from man-made biological sources (powered by renewable energy).
- Highly accurate carbon accounting to track and trace the products, size, pathways and final destinations of salvaged CO_2 is required with tangible monitoring and targets vital to an exteriorised 'making visible' of salvaged/stored carbon 'gains' (Allen 2009). As Hannis, this volume, clarifies, however, it is fiendishly difficult to secure accounting practices that provide certainty in this regard.
- Onerous standards and specifications on paracommoners and new institutional rules to salvage carbon will be required (Bosselmann 2019), in a context where environmental 'red tape' is elsewhere being contested as a constraint to economic growth and post COVID-19 economic recovery.

Concluding Remarks

Governing the global atmosphere as a sink- or husbandry-type carbon commons brings attendant concerns over whether and how we will reduce carbon dioxide levels sufficiently and quickly enough. Clearly, we should see the permanent and rapid reduction of CO_2 levels in the atmosphere as a matter of urgency. In a paracommons framing, carbon dioxide, its conversion products, storage and non-generation are seen through the lens of emergency and scarcity that results in new economic, financial, legislative, technological and behavioural solutions to bring down its concentration in the atmosphere. By being aware of the different leaky/impermanent or permanent pathways that CO_2 takes, the paracommons then asks how we solve this leaky pathway uncertainty to ensure that we put carbon dioxide permanently away when attempts to salvage CO_2 are made.

The framing of an atmospheric, climate and carbon commons needs to be expanded, but also better defined (Schrijver 2016; Edenhofer et al. 2012). Debating this conceptual challenge will bring forward alternative framings fit for the next hundred years. New commons metaphors and parables, of which the paracommons is an example, should aim to stretch our conceptual space in which the target of <350 ppm CO_2 is to be achieved.

References

Allen, Myles, 'Planetary Boundaries: Tangible Targets Are Critical', *Nature Climate Change*, 1 (2009), 114–15, https://doi.org/10.1038/climate.2009.95.

Asayama, Shinichiro, Rob Bellamy, Oliver Geden, Warren Pearce, and Mike Hulme, 'Why Setting a Climate Deadline Is Dangerous', *Nature Climate Change*, 9 (2019), 570–72, https://doi.org/10.1038/s41558-019-0543-4.

Bosselmann, Klaus, 'The Atmosphere as a Global Commons', in *Research Handbook on Global Climate Constitutionalism*, ed. by Jordi Jaria-Manzano and Susana Borrás (Cheltenham: Edward Elgar Publishing, 2019), pp. 75–87, https://doi.org/10.4337/9781788115810.

Brown, Katrina, W. Neil Adger, and Joshua E. Cinner, 'Moving Climate Change Beyond the Tragedy of the Commons', *Global Environmental Change*, 54 (2019), 61–63, https://doi.org/10.1016/j.gloenvcha.2018.11.009.

Edenhofer, Ottmar, Christian Flachsland, and Bernhard Lorentz, 'The Atmosphere as a Global Commons', in *The Wealth of the Commons. A World Beyond Market & State*, ed. by David Bollier and Silke Helfrich (Amherst, MA: Levellers Press, 2012).

Gifford, Lauren, '"You Can't Value What You Can't Measure": A Critical Look at Forest Carbon Accounting', *Climatic Change*, 161 (2020), 291–306, https://doi.org/10.1007/s10584-020-02653-1.

Gills, Barry, and Jamie Morgan, 'Global Climate Emergency: After Cop24, Climate Science, Urgency, and the Threat to Humanity', *Globalizations*, 17 (2020), 885–902, https://doi.org/10.1080/14747731.2019.1669915.

Hardin, Garrett, 'The Tragedy of the Commons', *Science*, 162 (1968), 1243–48.

Hume, David, 'Ocean Storage of CO2' (Theliquidgrid.com, 2018), https://theliquidgrid.com/2018/07/22/ocean-storage-co2/.

Lankford, Bruce, 'The Liminal Paracommons of Future Natural Resource Efficiency Gains', in *Releasing the Commons. Rethinking the Futures of the Commons.*, ed. by Ash Amin and Philip Howell (London: Routledge, 2018), pp. 66–68.

Lankford, Bruce, *Resource Efficiency Complexity and the Commons: The Paracommons and Paradoxes of Natural Resource Losses, Wastes and Wastages* (Abingdon: Routledge, 2013).

Lovell, Heather, Harriet Bulkeley, and Diana Liverman, 'Carbon Offsetting: Sustaining Consumption?', *Environment and Planning A: Economy and Space,* 41 (2009), 2357–79, https://doi.org/10.1068/a40345.

Luque, Rafael, and James H. Clark, 'Valorisation of Food Residues: Waste to Wealth Using Green Chemical Technologies', *Sustainable Chemical Processes*, 1 (2013), 10, https://doi.org/10.1186/2043-7129-1-10.

Meyerson, Frederick A. B., 'Population, Development and Global Warming: Averting the Tragedy of the Climate Commons', *Population and Environment*, 19 (1998), 443–63, https://doi.org/10.1023/A:1024622220962.

Murray, Brian C., Brent Sohngen, and Martin T. Ross, 'Economic Consequences of Consideration of Permanence, Leakage and Additionality for Soil Carbon Sequestration Projects', *Climatic Change*, 80 (2007), 127–43, https://doi.org/10.1007/s10584-006-9169-4.

O'Connor, David, 'Governing the Global Commons: Linking Carbon Sequestration and Biodiversity Conservation in Tropical Forests', *Global Environmental Change*, 18 (2008), 368–74, https://doi.org/10.1016/j.gloenvcha.2008.07.012.

Ostrom, Elinor, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge: Cambridge University Press, 1990).

Pierrehumbert, Raymond T., 'Cumulative Carbon and Just Allocation of the Global Carbon Commons', *Chicago Journal of International Law*, 13 (2012), 527–48.

Rabinowitz, Dan, 'Ostrom, the Commons, and the Anthropology of "Earthlings" and Their Atmosphere', *Focaal*, 57 (2010), 104–08, https://doi.org/10.3167/fcl.2010.570108.

Rockström, Johan, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin, Eric Lambin, et al., 'Planetary Boundaries Exploring the Safe Operating Space for Humanity', *Ecology and Society*, 14(2) (2009), 32, http://www.ecologyandsociety.org/vol14/iss2/art32/.

Ruzzenenti, Franco, David Font Vivanco, Ray Galvin, Steve Sorrell, Aleksandra Wagner, and Hans Jakob Walnum, 'Editorial: The Rebound Effect and the Jevons' Paradox: Beyond the Conventional Wisdom', *Frontiers in Energy Research*, 10 (2019), https://doi.org/10.3389/fenrg.2019.00090.

Schrijver, Nico, 'Managing the Global Commons: Common Good or Common Sink?', *Third World Quarterly*, 37 (2016), 1252–67, https://doi.org/10.1080/01436597.2016.1154441.

Smith, James, Linda Heath, Kenneth Skog, and Richard Birdsey, 'Methods for Calculating Forest Ecosystem and Harvested Carbon with Standard Estimates for Forest Types of the United States', Gen. Tech. Rep. NE-343 (Newtown Square, PA: US Department of Agriculture, Forest Service, Northeastern Research Station, 2006).

Stoknes, Per Espen, and Johan Rockström, 'Redefining Green Growth within Planetary Boundaries', *Energy Research & Social Science*, 44 (2018), 41–49, https://doi.org/10.1016/j.erss.2018.04.030.

Vogler, John, 'Future Directions: The Atmosphere as a Global Commons', *Atmospheric Environment*, 35 (2001), 2427–28, https://doi.org/10.1016/S1352-2310(01)00127-3.