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Safe, just and sufficient space

The planetary boundary for human water use in a more-than-human world

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Abstract

This paper explores the planetary boundary framework (PB-F) from a biocentric perspective. With a focus on the planetary boundary for freshwater, we show that a biocentric perspective implies a shift from a safe space for humanity to an environmental ceiling that also respects the water needs of other living beings. A safe, just and sufficient space respects the water needs of humans as moral agents, but replaces the idea of a maximum appropriation of freshwater by humans with a search for just and sufficient freshwater use. Highlighting the importance of the precautionary principle for PB-F, the chapter shows the ethical aspect of the planetary boundary frameworks, its relation to worldviews, and contributes to a critical, realist use in a pluralist world.

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1. Introduction

The global sustainability debate has been inspired by the iconic image of the *blue* planet as an entity with finite environmental limits. Most recently, these limits have been acknowledged via the discussion of planetary boundaries, which considers nine critical Earth system processes – all strongly influenced by human activities – in a single conceptual framework (Rockström et al. 2009, Steffen et al. 2015). One of these planetary boundaries is concerned with an upper global limit to human freshwater consumption (Gerten et al. 2013). This boundary implies scientific-ethical challenges worthy of serious and sustained attention, and as such will be elaborated on in this paper.

According to the general idea animating the concept of planetary boundaries (PB), human societies as we know them have developed within the conditions of the Holocene over roughly the last 11,000 years. With industrialization, human activities have come to affect the functioning of the Earth system to such an extent that its capacity to persist in a Holocene-like state is threatened (Steffen et al. 2015). As a result, there is the risk that human societies will exit the "safe operating space" delineated by the nine boundaries (Rockström et al. 2009). This risk diagnosis is worked out with planetary boundaries for: biosphere integrity (consisting of functional diversity and genetic diversity), climate change, introduction of novel entities, stratospheric ozone depletion, atmospheric aerosol loading, ocean acidification, biogeochemical flows (consisting of phosphorus, nitrogen), freshwater use, and land-system change (Steffen et al. 2015). Following the precautionary principle, the planetary boundaries are not specified as thresholds or tipping points, but rather are located upstream of such possible thresholds or gradual aggregate impacts (i.e. in a safe distance, at the lower tail of a scientific uncertainty zone). This is to account for uncertainty in the precise position of critical developments and to provide society with an early warning sign (Steffen et al. 2015). The planetary boundary for human freshwater use (PB-W), which we focus on here, is defined as the maximum tolerable amount of total global freshwater consumption by humans for irrigation, livestock raising, domestic purposes, manufacturing and cooling of thermal power plants. The term 'freshwater consumption' here refers to the fraction of the abstracted freshwater volume that evapotranspires during use and is no longer available in liquid form to other human or non-human water users; notably water quality is not considered. PB-W is "the maximum amount of freshwater that can be appropriated by humans, beyond which there is a high probability of (possibly abrupt) water-induced changes with large detrimental impacts on human societies" (Gerten et

al. 2013, 551). Human freshwater use does not have a singular threshold at the global or continental scales, but aggregate effects of excessive local freshwater use would imperil the Earth system.

What type of threats does excessive human freshwater use pose to the functioning of the Earth system? To begin with, freshwater biota (including riparian vegetation) as well as coastal biota suffer from alterations of ecologically relevant streamflow regimes. Alterations include decreases of mean annual streamflow, changes in the seasonality, decreases (in case of water abstractions) or increases of low flows and decreases of flooding (Döll et al. 2009). On more than one sixth of the global land surface (excluding Greenland and Antarctica), human water use has decreased mean annual streamflow by more than 10% as compared to the situation without human water use (Döll et al. 2009). These streamflow alterations have contributed to the observed strong population decline of freshwater species (MEA 2005, Döll et al. 2009). While knowledge about quantitative relations between streamflow alterations and changes of freshwater ecosystems is very poor, there is broad scientific agreement that even small alterations can change the complex ecosystems (Richter et al. 2006, Poff and Zimmermann 2010). Streamflow alterations lead to changes in the sediment transport and may cause salinization and inland movement of saltwater in delta areas. Excessive water use upstream may lead to a lack of water or even the drying out of downstream river stretches, thereby endangering crop and livestock production. In the case of groundwater depletion, with steadily falling groundwater tables, water supply for irrigated crop production or other human uses may become unavailable. Groundwater depletion contributes to rising sea levels, with an estimated 0.3 mm/yr during 2000–2009 (Döll et al. 2014). In addition, irrigation causes changes of spatial patterns and seasonal timing of atmospheric moisture flows.

The main driver of these threats is irrigated agriculture, which accounts for roughly 70% of the global rate of water abstraction, followed by industry (20%) and municipal water use (10%) for drinking water, hygiene etc. (FAO 2004). With a high amount of evapotranspiration, irrigation accounts for almost 90% of global water consumption. Water consumption in irrigated agriculture amounts to an estimated 1100 km^3/yr, while water consumption in the other water use sectors is estimated to be 300 km^3/yr (Döll et al. 2014). In addition, more than 200 km^3/year of evaporation loss is due to man-made reservoirs (Shiklomanov & Rodda 2003), such that global human water consumption now amounts to ~1600 km^3/year. The currently proposed PB-W is 4000 km^3/year (Steffen et al. 2015; Gerten et al. 2015). Therefore, the PB-W seems to suggest that we are currently well below the planetary boundary and therefore in the "safe space". What is the implication of such a finding for environmental philosophy? And what are the ethical presuppositions for arriving at this boundary estimate?

The planetary boundary proposal invites a reconsideration of Paul Taylor's argument, made in his seminal contribution to environmental philosophy (Taylor 1986). Arguments in environmental philosophy rely on the interrelation of fact and evaluation. On the one hand, we draw on what we know about the world – the knowledge made

available by hydrology, ecology, evolutionary theory, etc. – while on the other hand, we draw on our ethical principles and intuitions. A philosophical worldview[1] is the result of an attempt to bring together the descriptive and the evaluative in a way that is comprehensive and complete, systematic and coherent (Taylor 1986, 158f). Such a worldview informs and supports our attitude of living with others, and by implication the search for principles and standards that practically express the worldview (Taylor 1986, 41ff). Exploration of the planetary boundary framework should make the evaluative aspect explicit and explore its implications for operationalization and ultimately for water governance.

At first glance, the concern with a "safe operating space" for humanity seems to express an anthropocentric perspective.[2] This chapter argues otherwise and proposes that the planetary boundaries framework can show respect for a more-than-human world. It explores this claim via a discussion of PB-W and biocentrism, a worldview that recognizes the intrinsic value of all living beings. Our discussion focuses on an ideal-theory exploration: What does a global perspective on freshwater use look like if humanity were to take a biocentric perspective? As we will see, this question is a demanding one, pushing the boundaries of a chapter. The conclusion provides some suggestions for further development in the non-ideal world.

For our exploration, we first note that the planetary boundaries framework includes ethics. The central place of the precautionary principle in the framework focuses the quantitative analysis of water use on unacceptable moral harm (section 2). But what is unacceptable moral harm? And whose harm is to be considered? The focus on a collectively safe operating space requires a qualification: not only safe for the whole humanity – according to an anthropocentric reading, the biocentric community according to the reading explored here – but also for the individuals that the whole consists of. This introduces distributive justice and the idea of a safe *and just* operating space (section 3); "wellbeing depends on keeping total resource use below critical natural thresholds, but it equally depends upon every person having a claim on the resource they need to lead a life of dignity and opportunity" (Raworth 2013, 30). Evidently, con-

1 So the focus here is on the conceptual question. In addition, and in many ways complementary, worldviews can be empirically studied. For example, Hedlund-de Witt distinguishes four worldviews in Western culture, based on empirical research (Hedlund-de Witt 2014, 8313ff): traditional, modern, post-modern and integrative. We return to this link between environmental philosophy and worldviews in the conclusion.

2 Historically, this evaluative distinction rests on a number of further ideas. Anthropocentrism in the Western tradition pulls from Christian cosmology, which puts human beings at the top of the natural entities in the "Great Chain of Being", from a dualism of mind and nature (with humans attributed a non-material soul) and related to a further dualism of the mechanical material world subject to laws of nature versus an independent world of the mind. According to a widely and controversially discussed thesis in environmental philosophy, it is the combination of this world view with technical invention and the geographic specifics of Western Europe that enabled the "ecological crisis" (White 1977) – to which the planetary boundary framework seeks to respond at the global level.

sidering the "social foundation" (Raworth 2013) is very important to explore the link between the framework and global water governance discussions such as the human right to water and the water-related Sustainable Development Goals.[3] In a further step, section 4 critically revisits this social foundation and its relation to planetary boundaries. While broadly speaking the biocentric approach supports the call for a justice foundation of the framework, it challenges the idea that beyond a justice threshold of freshwater for humans and their needs, there is an additional empty "just and safe space". This space is already used by non-human biota. We highlight this additional consideration with the qualifier just, safe and *sufficient* space as it introduces a further challenge of *sufficient* human water use that is largely absent from the anthropocentric discussion of the framework. It highlights an alternative use of the PB-Framework with arguably radical consequences for production and consumption. We discuss biocentric priority rules for thinking about water use conflicts once this more-than-human space is taken into account. Thus, this exploration of the freshwater boundary shows a biocentric way of developing the framework. Its focus on sufficiency contributes to a reflexive use of the planetary boundaries concept and of global water ethics.

2. Safe operating space, the precautionary principle and environmental philosophy

A central bridge linking empirical boundary specification and ethical questions in the planetary boundaries framework is the precautionary principle. "The PB [planetary boundaries] framework is based on critical processes that regulate ES [Earth system] functioning. By combining improved scientific understanding of ES functioning with the precautionary principle, the PB framework identifies levels of anthropogenic perturbations below which the risk of destabilization of the ES is likely to remain low – a 'safe operating space' for global societal development" (Steffen et al 2015, 736).[4]

The precautionary principle is a key normative principle in global environmental politics, as testified by article three of the United Nations Framework Convention on Climate.[5] A general definition of the principle is offered by UNESCO COMEST: when

3 SDG 6 seeks to ensure availability and sustainable management of water and sanitation *for all* (http://www.unwater.org/sdgs/en/. Last accessed, 18.12.2015)

4 Steffen et al. further specify the precautionary principle: "human societies would be unwise to drive the Earth system substantially away from a Holocene-like condition. A continuing trajectory away from the Holocene could lead, with an uncomfortably high probability, to a very different state of the Earth system, one that is likely to be much less *hospitable* to the development of human societies" (Steffen et al. 2015, 737f, italics added). No further explicit definition of the principle can be found in Steffen et al., nor in Rockström et al. 2009.

5 According to Article 3 of the United Nations Framework Convention on Climate Change: "the Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such

human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm (UNESCO COMEST 2005). The definition clarifies central aspects of the precautionary principle: (a) morally unacceptable harm,[6] (b) accompanying scientific research[7] and (c) a call to action.[8] None of these are simple challenges for such a global issue!

Notably, climate ethics provides a lively debate around the question of limits and boundaries in relation to morally unacceptable harm, with contributions from the social sciences (for example Stern's green new deal proposal, Stern 2010, 44) as well as from political philosophy (Gardiner et al. 2010). According to a human rights perspective, *morally unacceptable harm* refers to human rights violations caused by or plausibly attributed to climate change. The human rights perspective articulates a threshold that no one should fall under. For example, the human rights to water specifies a minimum of safe, affordable and acceptable water for drinking and hygiene that every human being is entitled to qua human being (independent of specific contracts etc.). Entitlements generate a universal obligation to protect and respect this basic minimum standard (Caney 2010, 165).[9] In addition, the moral threshold enjoys lexical priority. "Human rights generally take priority over moral values such as increasing efficiency or promoting happiness" (Caney 2010, 165).

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measures." The UNFCC refers to a principle adopted by the 1992 Rio Summit on Environment and Development: "in order to protect the environment, a precautionary approach should be widely applied, meaning that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Rio Declaration on Environment and Development 1992).

6 Of course, the principle could also be defined more generally with a view to harm as such, but this opens the principle to the objection of an irrational and extreme risk aversion. See also Gardiner 2011, who restricts the principle to "unacceptable outcomes" drawing on John Rawls' theory of justice. UNESCO COMEST (2005) refers to "harm to humans or the environment that is threatening to human life or health, or serious and effectively irreversible, or inequitable to present or future generations, or imposed without adequate consideration of the human rights of those affected".

7 According to UNESCO COMEST (2005), "the judgment of plausibility should be grounded in scientific analysis. Analysis should be ongoing so that chosen actions are subject to review. Uncertainty may apply to, but need not be limited to, causality or the bounds of the possible harm."

8 UNESCO COMEST (2005) specifies actions as "interventions that are undertaken before harm occurs that seek to avoid or diminish the harm. Actions should be chosen that are proportional to the seriousness of the potential harm, with consideration of their positive and negative consequences, and with an assessment of the moral implications of both action and inaction. The choice of action should be the result of a participatory process."

9 The threshold specification is also important for reasons of intergenerational justice. The focus with a view to future generations cannot be harm to specific, future individuals (non-identity problem). Rather, the notion of harm is set with a view to general conditions that we expect would harm future generations.

The human rights perspective suggests thinking about unacceptable harm in terms of a moral threshold, and we follow this idea here. But while the human rights approach helpfully clarifies various aspects of a moral threshold, it is only concerned with harms to humans. Yet, in environmental philosophy, an open question is whose harm is to be considered? Harm only to human beings, or also harm to sentient beings (sentientism), or harm to all living beings (biocentrism), or damage (in a wide sense) to all entities (holism)?[10] The concept of dignity, which at least in the Western tradition plays an organizing role for the justification of human rights, can also be explored for sentient beings and living beings. In fact, the Swiss constitution recognizes the dignity of creatures (*Würde der Kreatur*), and explicitly includes in this animals, plants and other organisms. In a well-known justification of human rights, rights are understood as instruments to protect and promote central capabilities for leading a life in dignity (Nussbaum 2006). 'Dignity' here serves as an organizing term for various goods ("doings" and "beings") that are claimed to be of constitutive importance for leading a dignified life. For moral agents, those capable of deliberation and choice, the freedom aspect is important; treating them as ends requires a recognition of their capacity to choose ends for themselves. Yet already within the species of humans, there are moral patients (synonym: moral subjects), i.e. human beings (e.g. young children) who are not capable of deliberating and choosing but who still have a dignity and various goods that moral agents recognize. This observation suggests an extension of the moral community (Nussbaum 2006). The first ethical question at this point is: can we speak of "good for *x*" where this good does not depend on the interest of a third party (instrumental value)? "Perhaps the most ethically significant fact about moral subjects is that it is always possible for a moral agent to take a moral subject's standpoint and make judgments from its standpoint about how it ought to be treated. The standard implicit in such judgments is the furtherance or preservation of well-being of the subject, not of the one who does the judging" (Taylor 1986, 17). By contrast, if we cannot take the standpoint of the respective being, the discussion of "good for *x*" necessarily depends on an external standard we impose, and thus becomes an instrumental use. According to the biocentric position, moral subjects "include all living organisms … inanimate objects (stones, grains of sands, puddles of water, snow, fire, ice, air) are not themselves moral subjects" (Taylor 1986, 18).[11]

If the scope of having a good of one's own includes all living organisms, does this also mean that we have to respect them as ends in themselves on an equal level with us? Are human beings not superior? At this step, Taylor proposes a worldview argument. Taking into account an evolutionary and ecological perspective, we can observe the joint, evolutionary membership of the human species in the Earth's community of life,

10 For a detailed discussion of this classificatory scheme see Gorke (2010).

11 While the extension of the moral community for sentient beings is a relatively well-known topic due to the animal rights movement, the same cannot be said about our relation to plants. For a pioneering study see Kallhoff (2001).

an interdependent community that consists of diverse members each with a good of their own (Taylor 1986, Chapter 3). From this outlook, the idea of human superiority can be understood in a historical perspective, i.e. as a result of earlier ontology that posits human beings on top of the chain of living beings ("scale naturae" in Greek philosophy and influential strands of early Western Christianity, White 1967) or that posits a mechanical world of *res extensa* and an independent world of *res cogitans* (Cartesianism). However, in Taylor's worldview argument, these earlier worldviews are no longer consistent with what we know about the world. The idea of human superiority cannot be simply posited; rather, the new default position is equal moral consideration of all beings that have a good of their own (even if these goods are (partly) species-specific, and thus also the respective notion of dignity and what it means to harm the respective being, Nussbaum 2006). To be sure, this biocentric argument is more complex than the brief sketch that we can offer here. It is also controversial (Nolt 2014, 169ff). But a controversial status is a general feature of basic positions in environmental ethics. More important for our purposes, biocentrism offers one possible and coherent outlook for thinking about planetary boundaries in contrast to a purely anthropocentric reading.

In conclusion, a closer look at the precautionary principle leads to an ethical question in terms of environmental ethics: the question of moral inclusion, i.e. who should be considered morally? This consideration pushes in the direction of further reflection for a transparent and reflexive discussion of the planetary boundaries framework.[12] In contrast to the conventional anthropocentric reading, we explore the framework from a biocentric perspective in section 4 below. But first we need to attend to a further qualification.

3. Just operating space

If we care about unacceptable damage to the Earth system that renders it less hospitable for the development of human societies, we also ought to care about the individual members of these societies, if they are unacceptably damaged as individuals, as groups etc. Thus the concern with a safe operating space implies a concern with justice, including the distributive consequences of industrialization in the Holocene. It is unsurprising then that the discussion of the planetary boundaries framework quickly yields the proposal of a safe *and* just space (Raworth 2013).

In the eco-space literature, of which the planetary boundaries framework is a more recent development at the global level, this point has been recognized in terms of securing a social minimum (Spangenberg 2003, 28). Likewise, it has been pointed out in the planetary boundaries discussion that in addition to an environmental ceiling (syn-

12 This push is typical for environmental ethics, which is not only driven in the direction of application of frameworks to specific problems, but also in the direction of further reflection on how to think about specific principles etc. (Ott 2008).

onymous here with planetary boundary), we also need to discuss the social foundation in terms of the resources needed for leading a life in dignity (Raworth 2013; with respect to the Sustainable Development Goals discussion see Griggs et al. 2014). The importance of this point is hard to overestimate: the warning of a possible exit from a hospitable space remains strangely biased if it does not take into account that the conditions in this space are already not hospitable for billions of people lacking adequate access to drinking water and sanitation, food or energy.

With respect to our focus on freshwater, this calls for a specification of unacceptable harm occurring if basic human needs for freshwater[13] are not met so as to arrive at estimates of the social foundation. Here we can only sketch what such an estimate might look like. A fully worked out specification is far beyond the possibilities of a chapter; moreover, a social process is required to determine the needs in each specific context[14].

For drinking water and domestic use, Chenoweth 2008 (quoted in Feitelson 2012) notes two approaches:

- Investigate the freshwater requirements for basic domestic functions (drinking, sanitation, washing, cooking). Gleick (1996) argues that 50 liters per capita per day, equaling 18.25 m^3 per capita per year, are needed for this.
- Investigate the amount of water abstractions by prudent societies that enjoy a high level of technological development. For this, Falkenmark (1986) specifies 274 liters per capita per day, about 100 m^3 per capita per year, as the required amount.

Norman Feitelson (2012), combining both approaches, arrives at an estimate of 60 m^3 per capita per year. This value is approximately equal to the per capita abstractions for public water supply in Germany (Statistisches Bundesamt 2013). With a global population of currently 7.3 billion people, this amounts to a freshwater requirement of roughly 440 km^3/yr, and of 134 km^3/yr according to the more modest proposal by Gleick (1996). Global freshwater abstractions for household use were estimated at 350 km^3/yr during the period 2003-2009, of which 60 km^3/yr was water consumption (Döll et al. 2014). Thus, considering both the water needs and water abstractions of households in comparison to the PB-W value of 4000 km^3/yr as specified in Steffen et al. (2015), there is no global freshwater problem as far as the physical availability for meeting this need is concerned. PB-W would not be transgressed if the basic human water needs of domestic water use were met for all human beings.

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13 There is an extended debate in ethics about basic needs, needs and wants, central capabilities and capabilities, basic interests etc. (O'Neill 2012). For the sake of not further complicating an already complex discussion, we bracket these distinctions here and only assume that such a threshold distinction is possible and plausible (even if there are different ways of drawing the distinction).

14 With a view to climate change, see Caney (2010) for one idea of how such a process might look.

However, there are many places around the globe where this need is not met. The adjusted (just and safe) planetary boundary framework highlights that the challenge with meeting this need is not due physical freshwater limitation globally. In this sense it opens space for further discussions and practical possibilities: As freshwater is not equally distributed worldwide, do water-rich societies have a responsibility to help water-poor societies meet their needs? Do they only have this responsibility when their way of living negatively affects, or puts pressure on meeting, water-needs in water-poor societies? And linked to this last question: what about the responsibility of each society to develop ways of meeting the need adapted to their geographical-cultural context and within the possibilities of their watershed? The adjusted planetary boundary framework does not provide "the answer" to these questions, but it helps to put them in a global context and thus to move beyond the frequently very place-based discussions in water ethics and water governance.

What about water for food production under irrigation, by far the largest water use at the global level? According to FAO estimates, about 3000 kcal per person per year need to be produced (e.g. consisting of 80% vegetal and 20% animal-based products) for healthy nutrition (see Mauser 2007, Gerten et al. 2011).[15] At current levels of productivity, this requires on average 1075 m^3 per person per year of green water (precipitation evapotranspired in both rainfed and irrigated agriculture) and blue water (irrigation water evapotranspired in irrigated agriculture) (Gerten et al. 2011).[16] With a population of 7.3 billion people, this amounts to roughly 8000 km^3 of green and blue water per year. This estimate consists of the green and blue water consumption on both cropland (including crops grown for feeding livestock) and grazing land (from which only 30% of evapotranspiration is assumed to contribute to food production). In the year 2000 about 13% of total water consumption of cropland and grazing land was from irrigation water (estimate derived by combining data of Siebert and Döll 2010 and Gerten et al. 2011). Thus, at current crop productivity levels, roughly 1000 km^3/yr of consumptive blue water use (which is what PB-W refers to) is required to allow healthy nutrition for 7.3 billion people. Note that from a biocentric perspective this is a conservative over-estimate of human freshwater needs as the FAO estimate includes 20% animal-based products. The actual green and blue water use for crop production and grazing is estimated to be rather similar to the estimated required value of 1075 m^3 per person per year (given the large uncertainties), with on average 1400 m^3 per person per year (estimate derived by combining data of Siebert and Döll 2010 and Gerten et al. 2011). Assuming, however, a fraction of only 10% instead of 20% animal-based food, the food-related basic water need would drop to only 768 m^3 per person per year.

15 This kcal estimate includes assumptions about current food waste and loss, while actually consumed kcal levels are lower (around 2200–2300 km^3/yr).

16 For a similar result see Gleick (2000).

Assuming that a PB-W of 4000 km^3/yr is not an underestimation, there seems to be no global freshwater problem as far as physical availability for meeting this need is concerned. However, with further growth in world population as well as changes in de facto food consumption habits, crossing PB-W (*sensu* Gerten et al. 2013 who calculated variants of the boundary value with an average estimate of 2800 $km^3\ yr^{-1}$) is a possible scenario at current levels of technology and water consumption per food unit produced. As water use for food in the global North is much higher than in the global South (Mauser 2007, 180), the following questions arise again: Do water rich societies have a responsibility to help meet food-related water-needs of water-poor societies? Do they have this responsibility only when their food habits negatively affect the possibility of meeting the needs in other societies (for example large-scale land acquisition for food exports and water grabbing, virtual trade in water that does not enhance water efficiency but yields net exports of virtual water from water poor countries, Metha et al. 2012)? What is the responsibility of each society within its watersheds and physical water availability? Again, the adjusted PB-framework does not provide "the answer" to these questions, but it helps to put them in a global context, which these global dynamics of trade and political economy require.

4. Planetary boundaries and sufficiency – the biocentric addition

If all living beings are to be considered as users of water in their own right and not just because freshwater biodiversity is good for humans, then how are we to think of the safe space and the numerous moral conflicts between different water users? Taylor proposes four main biocentric rules for moral agents (Taylor 1986, 172–186):

1. Rule of non-maleficence: the duty not to harm any entity in the natural environment that has a good of its own.
2. Rule of non-interference: the duty to refrain from placing restrictions on the freedom of individual organisms, hands-off policy with regard to whole ecosystems and biotic communities, i.e. providing "safe space" for ecosystems due to minimal interference by humans.
3. Rule of fidelity: the duty not to deceive or mislead any animal capable of being deceived or misled, to uphold an animal's expectations, which it has formed on the basis of one's past actions with it, and to be true to one's intentions as made known to an animal when it has come to rely on one.
4. Rule of restitutive justice: the duty to restore the balance of justice between a moral agent and a moral subject when the subject has been wronged by the agent.

As it is difficult for humans *not* to violate these rules, Taylor also proposes priority rules so as to deal with conflicts between users. These contribute a genuine addition to

the discussion of distributive justice within a planetary boundaries framework. The priority rules can be stated as (Taylor 1986, 265ff):[17]

- a principle of self-preservation for meeting and securing one's basic interests,
- a principle of proportionality that gives priority to basic interests over non-basic interests in case of conflicts,
- a principle of minimum wrong for the pursuit of non-basic human interests as long as they concern culturally important human interests (Taylor 1985, 281) and as long as they are performed in a way that minimizes harm to non-humans – essentially this is the contested space where human water use can in principle exceed the sufficiency threshold,
- a principle of restitutive justice to make up for harm done under the prior principles – for example the preservation or restoration of rivers as a compensation for the modification of rivers elsewhere for meeting basic human interests (Taylor 1985, 305).

The principle of self-preservation has a special justification for humans as moral agents: meeting basic needs is a way to ensure that the conditions of moral agency are met, and thus of ensuring a precondition of the "respect for nature" demanded by environmental philosophy. If you starve or die from thirst, there is little space for moral action. As Taylor does not say much about the further moral and political implications of moral agency, it is noteworthy that his discussion of basic interests is conceptually very close to Nussbaum's discussion of central capabilities. This link suggests that for the political implications of moral agency, a biocentric approach to planetary boundaries could learn from and build on her work on justice (Nussbaum 2006).

In Taylor's view, interests are objects or events that serve or protect, to some degree or other, the good of a living thing (270f). For human beings, "basic interests are what rational and factually enlightened people would value as an essential part of their existence as persons. They are what people need if they are going to be able to pursue those goals and purposes that make life meaningful and worthwhile. Thus for human beings their basic interests are those interests, which when morally legitimate, they have a right to have fulfilled" (Taylor 1985, 272). Thus, basic interests refer very much to those interests that need to be secured with a view to the moral threshold discussed in the last section. With the biocentric view, not only humans have such interests but also other living beings, each in their species specific-way. The distinction between basic and non-basic interests is significant for humans due to the unlimited way of

17 This is a simplified presentation that merges Taylor's first and fourth priority rule. In his original discussion of the distributive justice principle, Taylor notes that "fair share" does not require sacrifices in terms of basic interests (Taylor 1986, 294–295). This suggests the simpler statement of the priority rules presented here: His original principle of self-defense can be expanded to a principle of self-preservation that entitles moral agents (just as moral patients) to meet and protect their basic interests.

shaping needs and wants via culture and in capitalism especially via markets. The significance of the distinction is much less clear for other living beings. We therefore here generically refer below to "water needs of living beings", keeping in mind that for human beings this refers to their basic needs.

In sum, there is a way of dealing with the interests of different water users.[18] This is no doubt demanding, but not logically incoherent or in principle impossible; and with it comes a fresh way for thinking about the planetary freshwater boundary. We turn to this now.

Human appropriation of freshwater revisited

At first sight, the biocentric perspective suggests to move from a social foundation (Figure 1A, modified from Raworth 2013) to a biocentric foundation that includes the freshwater needs of all living beings (Figure 1B).[19] A second possibility to harmonize the planetary boundaries framework with the biocentric perspective is to re-interpret the PB-W. In the anthropocentric specification (Figure 1A), all freshwater is a possible object of human appropriation, and PB-W is defined as the maximum amount of human water consumption that avoids detrimental impacts on human societies. In the biocentric specification, both human and non-human water users have the right to use water, and priority rules need to be applied to determine the environmental ceiling PB-W (Figure 1C). Note that the environmental ceiling in Figure 1C is lower than in Figure 1A, as under the biocentric worldview more water is allocated to non-human water users, who have to be equally considered.

Figure A shows a safe and just space for human water use between the social foundation (basic human water needs) and the environmental ceiling (PB-W) from an anthropocentric perspective (modified from Raworth 2013). The social foundation space refers to needs in relation to consumptive water use (as estimated in section 3 in relation to domestic water needs and food). Figure B shows what happens if we extend the idea of the moral community: as all freshwater potentially useable by humans is used by some living being, the new biocentric foundation covers the entire space, and includes as a subpart the human social foundation (now with a wavy background to underline the community continuity). Strictly speaking, this is a partial representation of the biocentric foundation as there is freshwater use by living beings beyond the amount potentially useable by humans (for example river run-off in remote areas). An

18 This biocentric possibility might be too easily dismissed if priority rules are not fully discussed. For example, Düwell in his discussion of human dignity and future generations claims that biocentrism must assume that the lexical priority of human rights is overruled and by implication that there is no viable discussion that takes dignity seriously in a more-than-human world (compare Düwell 2014, 552).

19 In his discussion of a hierarchy of needs for water governance, Feitelson (2012) makes a similar suggestion when he clusters human basic freshwater needs and basic freshwater needs of ecosystems at the ethical bottom of his hierarchy before politics and markets.

illuminating tension results from the observation that the freshwater use of living beings is not necessarily consumptive. While water use of some plants causes evapotranspiration and it thus consumptive, the freshwater needs of fish refer to water as a habitat, with seasonally appropriate water availability and flow velocities and without barriers to migration. The total amount of potentially useable freshwater beyond the social foundation should therefore not be identified with water that is consumed by non-human living beings, but rather with water that is blocked due to a variety of non-consumptive water uses by non-human living beings. Figure 1C considers the human basic water needs (social foundation) vis à vis the water needs of other living beings in the outer wavy zone. From the biocentric perspective, excessive water consumption is still potentially dangerous for human beings, but in addition the water is intrinsically valuable for other species. We mark this shift in normative significance with a wavy red background to mark the blurring of "danger for human beings" with "water needs of other living beings". The wavy red area refers to a difficult-to-define "basic water need of non-human living beings". The new biocentric environmental ceiling is lower because it includes, further to anthropocentric risks, a respect for the water needs of other living beings (as a reference point, we keep the purely anthropocentric environmental ceiling as a dotted lined). The respect for water needs of others refers to the extended sense of water use: humans can respect the water needs of a migrating fish like the Huchen by not damming and abstracting water from the river. The sufficient space between the outer and the inner zone refers to the possibility of human water uses beyond basic needs that do not negatively interfere with the water needs of other living beings. In the limit, the boundary of the social foundation is a sufficiency ceiling; there is no consumptive human water use that does not negatively interfere with the water needs of other living beings, and the social foundation is equivalent with a just, safe and sufficient space for humans. If there are synergetic uses or use potentials, then there is a (potential) *safe, just and sufficient space* beyond the social foundation.

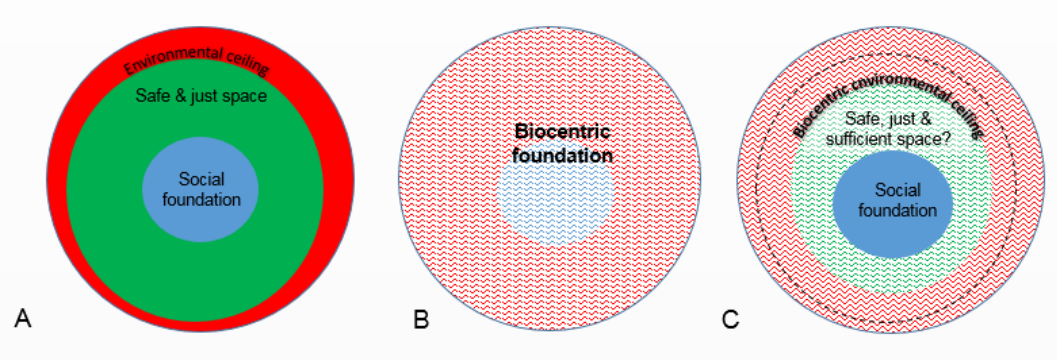

Figure 1. A represents an anthropocentric perspective, B and C a biocentric perspective. All figures: the outer line of the circle describes the total amount of freshwater potentially useable by humans (for an estimate see Gerten et al. 2013). The figures should not be read as representations of factual water use proportions; they seek to clarify the complex relation between a biocentric perspective and PB-W.

There is some evidence that biocentric aspects are present in the conceptual and operational development of the planetary boundary framework so far. "It has been recognized that terrestrial systems and aquatic ecosystems are legitimate water users for the sake of maintaining the ecosystems themselves *and* their contribution to services that support human well-being" (Gerten et al. 2013, 552, drawing from Rockström and Falkenmark 2004). In short, non-human water users are framed instrumentally (contributing services that support human well-being) and at least indirectly as potential ends in themselves ("for the sake of maintaining the ecosystem themselves"). In terms of operationalization, the maximum amount of freshwater is defined as accessible blue water, but 30% of accessible blue water is subtracted to avoid "water stress" (to ensure maintenance of moisture feedback, wetlands and estuaries, Gerten et al 2013, 554) and in addition environmental flow requirements are subtracted. Environmental flow requirements can be a way to recognize the water needs of other species in and around aquatic ecosystems. As Figure 1C illustrates, a biocentric application of environmental flow requirements implies a shift in the normative significance of the framework: water consumption beyond the environmental ceiling is not just a likely danger for humans, it also most likely curtails the water needs of other beings. We can thus think of environmental ceilings not only in terms of risks to human beings but also in terms of a respect for other beings.

There are at least two ways in which a biocentric conception of the planetary boundaries framework for freshwater can be considered: the needs of moral agents in relation to the needs of other living beings (Figure 1C); the shared needs of living beings in the bounded "operating space" of a full planet (Figure 1B). They are not exclusive but rather highlight different aspects of what such a conception has to focus on. To be sure, this only accounts for one aspect of these needs (i.e. in relation to consumptive water use), but this is a limitation of the planetary framework in general that is not specific to the anthropocentric-biocentric discussion. The social foundation, which Figure 1C highlights, comprises the water needs of human beings, and thus of the moral agents in the Earth system.[20] It provides a very relevant focus from a biocentric perspective: the specification of basic needs (not wants) of moral agents in relation to freshwater. This way of exploring the planetary boundary framework from a biocentric perspective has the pragmatic advantage of fitting with the general planetary boundaries framework in a straightforward way.

Sufficient space – a biocentric addition to the debate

From the biocentric perspective, the basic interests and by implication the basic freshwater needs of all living beings deserve the respect of moral agents. For moral agents, the distinction of basic and non-basic interests and subsequent water needs is especial-

20 We bracket here the philosophical discussion whether there are also non-human moral agents. This move seems justified as humans are the central agent forcing the putative exit from the Holocene conditions.

ly important. Moral agents, based on cultural and individual preferences as well as their knowledge (technological know-how, etc.) are capable of consuming considerably more freshwater than would be required for meeting their basic needs. It is an open eudemonistic question whether consuming more than basic needs is enjoyable or really a nuisance (Paech 2012). Independently of this question, the biocentric perspective suggests a moral distinction:

- Claiming and meeting basic water needs is legitimate (principle of self-preservation), but requires estimates of freshwater needs for drinking, food etc., i.e. of the water-related social foundation of moral agents, and to this end ultimately a social process to determine this foundation.
- Human water use beyond this basic level is subject to the principle of proportionality, which prioritizes the basic interests of plants and animals over non-basic interests of humans.[21]

Thus, with the biocentric perspective the way of thinking about the safe operating space changes. Rather than focusing on the possible human freshwater appropriation that does not lead to negative impacts for human (the purely anthropocentric case), the focus is on the *sufficient human use* that leaves a maximum of water to non-human water users. Here there is an overlap with the discussion of the social foundation in the prior section – with the difference that beyond the social foundation there is no "empty" space for humans to use, but freshwater that is used by other species. Thus, the operating space for human water use needs to not only be safe and just, but safe, just and sufficient (Figure 1). To be sure, human appropriation does not necessarily mean that water has to be maximally used in this space, even on the anthropocentric reading – but with the powerful narrative of "growth within limits" (Crépin & Folke 2014, 58), this maximization reading is certainly there. The biocentric reading provides *an* alternative reading.

Environmental flow requirements reconsidered

PB-W is computed by subtracting environmental flow requirements, i.e. the water needs of non-human water users, from total renewable water resources, both in an anthropocentric and in a biocentric perspective. In an anthropocentric perspective, humans need to leave some water for freshwater ecosystems as otherwise they would degrade, which would have some negative impacts on humans. But as (1) knowledge on sufficient water for ecosystems to avoid negative impacts for humans is to a large degree lacking and (2) more water for ecosystems restricts human water use and thus

21 So as not to increase complexity even further, we bracket here legitimate non-basic interests, which in Taylor's theory require an account of culturally important water uses, as well as the further challenges of compensation and reparation in accordance with the principle of restitutive justice where needs have been violated. Feitelson (2012, 56) discusses spiritual needs of humans in relation to water as basic needs.

well-being, environmental flow calculations are highly value-laden. The PB-W value of 4000 km^3/yr was derived by assuming that a "fair-to-good" status of the freshwater ecosystem (Steffen et al. 2015, Pastor et al. 2014).[22] Following a biocentric perspective, a "good-to-very good" status appears to be more appropriate. This would lower PB-W and require human water use to become more sufficient.

5. Conclusion

The precautionary principle provided an entry for our discussion of the planetary boundary framework and environmental philosophy. The principle calls for a clarification of morally unacceptable harm. So what harm does this refer to? And whose harm is to be considered?

With a view to moral agents, we first turned to a threshold notion of moral harm, the concept of dignity and of human rights as a political framework to further specify the idea of morally unacceptable harm. The first lesson of this discussion was that the planetary boundary framework, with its focus on "a *safe operating space* for humanity," needs to be extended to also consider the members of which this whole consist. It is at this level that harm occurs and where many people are already harmed. Morally unacceptable harm occurs not only if the PB-W (or environmental ceiling) is exceeded but also if basic human water needs are not fulfilled (if the social foundation is absent). Such a *safe and just space* (Raworth 2013) in turn provides a conceptual link to other planetary boundaries where similar questions emerge (see for example Caney 2010 on harm in relation to dangerous climate change).

In a second step, we explored a biocentric perspective that considered all living beings, and not just humans, as subjects of potentially unacceptable harm. We concluded that the planetary boundary framework is not necessarily anthropocentric. According to a biocentric conception of the framework, we could move from a social foundation to a biocentric foundation to highlight the full scope of the moral community. Alternatively, we can redefine the planetary boundary such that the water needs of non-human living beings are considered, not only with the aim to avoid harm to humans by degradation of the freshwater ecosystems but also taking into account the water needs of non-human living beings as intrinsically valuable beings. This shift from an anthropocentric to a biocentric interpretation of the PB-W could be achieved by aiming for a better ecological status of the freshwater ecosystem of the PB-W. For this, it is im-

22 From a biocentric perspective, holistic methods that combine hydrological, hydraulic, habitat simulation methods and expert knowledge for an in-depth understanding of aquatic ecosystems are clearly the preferred approach (Pastor et al. 2014 et al, 5044). The current obstacle with respect to this goal is mostly pragmatic, i.e. a lack of global eco-hydrological data (Richter et al. 2006, Poff and Zimmermann 2010). In the absence of such data, hydrological estimates are the "second best" (for an overview of methods, see Pastor et al. 2014) as a rough indicator for the global level to be complemented as much as possible with more fine-grained accounts on the regional level (see also Dearing et al. 2014).

portant to distinguish the water needs of moral agents (i.e. humans) from their water wants. According to the biocentric priority principles of self-preservation and proportionality, basic interests should be taken into account when thinking about water use conflicts. In the biocentric perspective human appropriation of freshwater beyond basic needs is in principle subject to scrutiny: does it conflict with the basic interests of other members of the moral community? A sufficient human water use is asked for, and from a biocentric perspective the operating space for moral agents should be *safe, just and sufficient.*

Inversely, the biocentric perspective (as well as water ethics) can benefit from an adjusted planetary boundaries framework. A central contribution is no doubt the effort to move beyond the (important but not exhaustive) local or regional level to also consider global dynamics. Economic globalization, population growth and climate change imply that water use cannot be considered as a merely regional, catchment-based question. The freshwater boundary provides one way to identify threats to the global community of living beings, which in turn can be linked back to local issues and responsibilities.

This paper has delineated the conceptual space for a biocentric conception of planetary boundaries. Operationalizing such a conception with a view to a biocentric freshwater ceiling as well as estimating further freshwater basic needs are logical next steps. In addition, the link between the conception and water governance needs to be considered[23]. A further conceptual question is to move from the exploration of the ideal environmental ethics perspective as explored here (if humankind, especially its water managers, acted as if everyone took a biocentric perspective) to the non-ideal world where this is not the case.[24] We conclude with some considerations of why these steps should be taken and how they are likely to enrich the discussion of planetary boundaries, global water ethics, and ultimately the actions that the precautionary principle requires (see footnote 5).

Sufficiency and development

There is a tendency to interpret the planetary boundaries framework as "'growth within limits' especially in relation to the biophysical expansion of the human dimension", whereas others call for a more substantial shift to a focus on qualitative development in terms of wellbeing and fair distribution (Crépin and Folke 2014, 58). The biocentric perspective supports this second reading, and helps to identify priority areas. Current water use in agriculture together with an expected growth in population

23 For an interesting suggestion, see Feitelson's discussion of a hierarchy of needs in relation to ethical, political and economic governance mechanisms in this book.

24 An important question resulting from this concerns aggregation rules and judgments about sufficient space in the real world: if in some river basins "good to very good" river status is not achieved, are we still in a sufficient space in the world as a whole? If yes, what are permissible reasons?

suggests as key priorities of biocentric politics and economics of planetary boundaries: a search for improved water productivity (including a discussion of improved spatial distribution) as well as on the demand side a reconsideration of water-intensive 'lifestyle choices', in particular diets that include a large amount of animal products. In the field of energy production, it suggests a need to reconsider hydropower not just as a potential renewable energy source for climate protection but also as a technology that strongly interferes with aquatic ecosystems (and in the case of large dams, also human settlement and cultural heritage). Accordingly, energy sufficiency as well as restitutive justice – e.g. where dams are built or have been built – become important topics.

Realism

While growth within limits is no doubt one current worldview, it is by no means the only one. The biocentric worldview is a philosophical articulation of what has been identified as an integrative worldview (in contrast to traditional, modern, and post-modern worldviews, see Hedlund-de Witt 2014). It is not traditional as science plays a central role; it is not modern as science as such it not identified with progress; it is also not post-modern as the aspiration is ultimately global and affirmative of an ideal of universal values. It is held by members of Western societies but also resonates with views elsewhere. A prominent example is the new Mother Earth movement that reflects Latin American indigenous perspectives on the human-environmental system and recognizes intrinsic rights of nature[25]. The rights of nature have already been included in the constitution of some Latin American countries, also affecting water governance (compare the water use specifications in the constitution of Ecuador).[26]

The recognition of values and worldview differences is a first step toward a realist use of the framework: there are different value perspectives that should not simply be ignored in democratic practice. In addition, it has been argued that making values explicit is a "low-threshold entry" to debates, and thus may improve the possibility to include citizens and other stakeholders in discussion (Meisch 2014, 433). The recognition of different worldviews also encourages self-reflexivity (Hedlund-de Witt 2014, 8322ff): if we come to understand how our way of thinking and acting is embedded in a worldview, we can also better appreciate other worldviews and even learn from them, the overlaps between these as well as the areas where discussion is called for.

25 See http://therightsofnature.org/universal-declaration/, last accessed 31.1.2016.

26 Article 318 of the new 2008 constitution of Ecuador includes this priority list (within a constitution that recognizes rights of nature): "The State, through the sole authority for water, shall be directly responsible for planning and managing water resources for human consumption, irrigation to guarantee food sovereignty, ecological wealth and productive activities, in this order of priority" (Source http://pdba.georgetown.edu/Constitutions/Ecuador/englisho8.html, last accessed 17.12.2015).

Pluralism and overlaps

However, there is no need to focus on difference exclusively. Recalling environmental flow requirements, it is evident that there are biocentric and anthropocentric reasons for considerations of a planetary boundary for human freshwater use[27]. This is of practical importance for the application of PB-W in water governance in a world with different worldviews and should not be overlooked due to a misconceived understanding of various centrism (i.e. as if there is no place for a social foundation in a biocentric approach, and no role for freshwater beyond economic exploitation in an anthropocentric approach). Crossing planetary boundaries means detrimental impacts on the Earth system and its human and non-human living beings.

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27 Likewise, the conceptual framework for the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) that has been developed over the last five years suggests that anthropocentric and biocentric/holistic perspectives can and need complement each other in global sustainability efforts. Driven by actors favoring the Mother Earth perspective led by the delegates from Bolivia, the final framework version includes alternative anthropocentric (e.g. "ecosystem goods and services") and physiocentric (e.g. "nature's gifts") terms (Borie and Hulme 2015).

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